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DYNAMICS OF MARINE RESOURCE COMPETITION AND IMPLICATIONS FOR FOOD RESILIENCE IN SOUTHEAST ASIA

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ABSTRACT

Marine resource competition has intensified across Southeast Asia as overlapping EEZ claims, distant-water fishing fleets, and ecological decline place growing pressure on regional fisheries. These dynamics pose significant but understudied implications for national food security. This study examines how marine competition, IUU fishing, and governance effectiveness jointly shape food security outcomes in Indonesia, Vietnam, the Philippines, Malaysia, and Thailand. Using a mixed-methods design, the research integrates descriptive trend analysis, fisheries sustainability indicators, and fuzzy-set Qualitative Comparative Analysis (fsQCA), complemented by triangulation with ASEAN policy documents, FAO datasets, and expert assessments. Quantitative results show substantial declines in fisheries sustainability, with CPUE falling between 12–28% and biomass reductions ranging from 18–35% across the five countries (2010–2024). IUU pressure remains highest in the Philippines and Malaysia, aligning with elevated price volatility (15–22%) and rising import dependency (up to 35%). Conversely, Indonesia and Vietnam demonstrate improving IUU index scores, strong aquaculture growth (6–7.4% annually), and stable fish availability. The fsQCA results identify two causal pathways leading to high food resilience: (1) strong governance combined with low IUU pressure and high aquaculture capacity, and (2) strong governance and aquaculture compensating for moderate stock sustainability. Vulnerability emerges from configurations characterized by high IUU pressure, weak governance, and low aquaculture performance, particularly in the Philippines and Malaysia. Triangulation confirms these patterns, showing strong alignment between empirical findings, expert evaluations, and regional policy assessments. The study contributes to the literature by integrating maritime security, fisheries governance, and food resilience into a single analytical framework. The findings underscore that governance effectiveness, not resource abundance or geopolitical exposure alone, is the most decisive factor moderating food security outcomes. Policy implications highlight the need for stronger regional cooperation, enhanced enforcement, and climate-resilient aquaculture systems to mitigate the impacts of marine competition and promote sustainable food security in Southeast Asia.

KEYWORDS: Marine Resource Competition, Food Resilience, Governance Effectiveness, Fisheries Sustainability, Fsqca, Aquaculture Resilience.

1. INTRODUCTION

Marine resources play a central role in the socio-economic and nutritional landscape of Southeast Asia, a region characterized by its extensive coastline and heavy dependence on fisheries as a primary source of protein. In countries such as Indonesia, the Philippines, and Vietnam, marine fisheries contribute more than 50% of total animal protein consumption, making the stability and sustainability of marine ecosystems indispensable to national food security (Cojocaru et al., 2022). As global demand for seafood continues to rise, Southeast Asia's nearshore and offshore waters have become increasingly strategic, not only for economic development but also for ensuring domestic food availability and supporting the livelihoods of millions of coastal residents (Sundram, 2023).

However, the growing intensity of competition over marine resources poses significant challenges to the region. Overlapping maritime claims, particularly in the South China Sea, have resulted in heightened tensions among claimant states and accelerated the race to exploit fisheries resources before rivals do (Ahn & Pomeroy, 2024). These geopolitical frictions are further amplified by the rapid expansion of domestic and foreign fishing fleets, which exert considerable pressure on shared fish stocks. As competition escalates, resource depletion becomes more pronounced, compromising long-term ecosystem stability and increasing the volatility of fish supply within domestic markets (Asmussen, 2025).

Recent studies have highlighted that Southeast Asia has become one of the global epicentres of Illegal, Unreported, and Unregulated (IUU) fishing, driven by weak enforcement capacity, porous maritime borders, and substantial market demand. Prior research by Funge-Smith & Bennett (2019) and Sumaila et al. (2020) shows that unregulated fishing practices remove millions of tons of biomass annually, undermining local fisheries management efforts. IUU fishing activities not only exacerbate stock depletion but also generate economic losses, distort market prices, and weaken the ability of states to secure stable food sources for their populations.

Additionally, scientific assessments have documented substantial declines in wild fish populations across several ASEAN waters. For example, studies by Afrifa-Yamoah et al. (2021) and Potting et al. (2022) show that some demersal and pelagic species have been reduced by more than 30–50% over the past two decades due to overexploitation. Climate change further compounds these dynamics, affecting ocean temperatures,

altering fish migration patterns, and increasing the frequency of extreme weather events that disrupt fishing activities. These environmental changes introduce additional uncertainties for coastal communities that are already vulnerable to resource competition and environmental degradation (Harun et al., 2023).

Despite growing academic interest in maritime disputes, IUU fishing, and regional fisheries governance, most existing studies analyze these issues from a security, legal, or ecological standpoint in isolation (Fabinyi et al., 2017). Research tends to focus either on geopolitical conflicts in the South China Sea, the economic implications of IUU fishing, or sustainability concerns within fisheries management. Few studies adopt an integrated perspective that explicitly connects marine resource competition with national food security outcomes. This creates an important research gap, as food security implications remain underexplored despite fisheries being a core component of Southeast Asia's nutrition and livelihood systems (Fabinyi, 2020).

Given this gap, a systematic investigation of how marine resource competition affects national food security across Southeast Asia is necessary. There is limited empirical evidence comparing how different ASEAN states experience and respond to intensified competition, and even fewer studies assess the collective impact of territorial disputes, fishing capacity expansion, governance effectiveness, and environmental stressors on domestic food system stability. Addressing this gap is essential to understanding the multidimensional risks that competition poses not only to marine ecosystems but also to national resilience.

Therefore, the objective of this study is to examine the relationship between marine resource competition and national food security outcomes in selected Southeast Asian countries, including Indonesia, Vietnam, the Philippines, Malaysia, and Thailand. By employing a mixed-methods approach and a cross-national analytical framework, this research identifies key drivers that shape the vulnerability or resilience of national food systems in the context of maritime competition. The study further evaluates governance mechanisms, such as IUU enforcement, regional cooperation, and fisheries management strategies, that can mitigate these risks.

This research contributes to the literature in several important ways. First, it integrates geopolitical, environmental, and food security perspectives into a single analytical framework, addressing a critical gap in existing marine studies. Second, the study provides comparative evidence

across multiple Southeast Asian states, offering insights into cross-country differences in policy responses, governance effectiveness, and resilience strategies. Third, the findings highlight the broader national security implications of marine resource competition, emphasizing the need for integrated ocean governance to safeguard food availability and socio-economic stability.

Finally, the structure of this paper is organized as follows. Section 2 presents a detailed literature review covering marine resource competition, IUU fishing, and food security frameworks. Section 3 outlines the research methodology, including the mixed-methods design and comparative analysis approach. Section 4 presents the empirical findings, while Section 5 discusses the implications of these findings for national food security and regional maritime governance. Section 6 concludes with policy recommendations for strengthening food system resilience in the face of intensifying marine resource competition.

2. LITERATURE REVIEW

2.1. Marine Resource Competition in Southeast Asia

Marine resource competition in Southeast Asia is shaped by the region's heavy dependence on fisheries as a primary source of protein and economic livelihood. The Food and Agriculture Organization (FAO) notes that Southeast Asia is one of the world's largest producers of marine capture fisheries, contributing significantly to global seafood supply. This high dependency creates intense pressure on shared marine ecosystems, especially in areas where stock management is weak, and fishing demand continues to rise. Countries such as Indonesia, Vietnam, Thailand, and the Philippines rely on fisheries not only for domestic consumption but also as important export commodities, further intensifying the race to secure access to productive fishing grounds.

The complexity of marine competition is amplified by overlapping Exclusive Economic Zone (EEZ) claims and contested maritime boundaries, particularly in the South China Sea. Extensive research—including studies by Rasul (2016), Soma et al. (2018), and Kraska (2019) highlights how China's expansive "nine-dash line" claim conflicts with the internationally recognized EEZs of Vietnam, the Philippines, Malaysia, and Brunei. These disputes often result in confrontations between fishing vessels and maritime enforcement agencies, as each state seeks to assert sovereignty and protect its perceived maritime rights. As noted by Islam & Kieu (2020), the

increasing militarization and paramilitary presence in disputed waters further heighten the intensity of competition, transforming fisheries access into a geopolitical instrument.

In addition to state-to-state conflicts, non-state dynamics also contribute to marine resource competition. Studies by Gopal & Anbumozhi (2019) and Kumar & George (2019) reveal that industrial fleets—both domestic and foreign—have expanded rapidly, leading to higher fishing effort and accelerating stock depletion. The presence of distant-water fishing fleets, particularly from China, has been associated with aggressive fishing activities in Southeast Asian waters, often overwhelming local artisanal fishers and straining regional governance capacity. Combined with Illegal, Unreported, and Unregulated (IUU) fishing practices, these pressures create a highly competitive and increasingly unsustainable marine environment where states struggle to balance economic interests, ecological conservation, and national security priorities.

2.2. Food Resilience in the ASEAN Region

Food security in the ASEAN region is a multidimensional issue shaped by the availability, access, utilization, and stability of food resources, following the FAO's four-pillar framework. Countries in Southeast Asia exhibit diverse agricultural and fisheries profiles, yet all share a high dependence on marine-based protein as a staple in their diets. According to the ASEAN State of Food Security report, fish contributes more than 40–60% of total animal protein intake in Indonesia, Vietnam, and the Philippines, underscoring the critical role of marine ecosystems in maintaining nutritional adequacy (Febrina et al., 2025). As such, fluctuations in fish stocks and disruptions in maritime activities have direct implications for national food availability and nutritional security.

Marine-based food systems in the region are particularly vulnerable to environmental change, market volatility, and unsustainable fishing practices. Research by Nguyen (2021) highlights that Southeast Asia faces recurring challenges in maintaining a stable fish supply due to stock depletion, rising demand, and the expansion of aquaculture systems that are often exposed to climate-related shocks. Moreover, studies conducted by Fabinyi (2020) emphasize that coastal communities remain disproportionately dependent on small-scale fisheries, making them highly sensitive to price fluctuations, catch variability, and competition with industrial fleets. These vulnerabilities magnify the risks associated with

marine resource competition, as reduced fish availability contributes to food inflation, livelihood instability, and declining dietary diversity.

In addition to ecological and economic pressures, structural governance challenges also shape food security outcomes in the region. The World Bank (2021) notes that weak fisheries management, limited monitoring capacity, and uneven enforcement across national jurisdictions contribute to supply instability and inefficient resource allocation. Furthermore, as coastal populations expand and regional seafood consumption trends rise, ASEAN countries face increasing pressure to balance export-oriented fisheries with domestic food needs (Marteache et al., 2020). This balance becomes more difficult under conditions of maritime competition and geopolitical tension, where access to traditional fishing grounds may become contested or restricted. Consequently, understanding food security in Southeast Asia requires a holistic perspective that links marine ecosystem health, governance effectiveness, and strategic management of fisheries resources.

2.3. IUU Fishing as a Security Threat

Illegal, Unreported, and Unregulated (IUU) fishing has emerged as one of the most pressing threats to marine governance and food security in Southeast Asia. The region's geographic characteristics, featuring porous maritime boundaries, extensive archipelagic zones, and limited surveillance capacity, create ideal conditions for IUU activities to proliferate (Sumaila et al., 2020). As a major global hotspot, Southeast Asia experiences billions of dollars in annual economic losses due to unreported catches, tax evasion, and illegal transboundary fishing (Sudirman et al., 2023). These illegal activities undermine national regulatory frameworks, distort fish markets, and accelerate the depletion of critical fish stocks essential for domestic food systems.

The impacts of IUU fishing extend beyond ecological degradation and economic losses, reaching into the realm of national and regional security. According to Thomas (2017), IUU fishing is increasingly intertwined with broader maritime security challenges, including human trafficking, forced labor on fishing vessels, and links to transnational organized crime. These criminal networks exploit governance gaps and weak enforcement capacity, creating complex security risks for coastal nations. As highlighted in studies by von Schuckmann et al. (2020), the presence of foreign industrial fleets, particularly distant-water fleets, further complicates the enforcement landscape, as

these vessels often operate with advanced technologies that allow them to evade detection, encroach into EEZs, and outcompete local artisanal fishers.

IUU fishing also has serious implications for food availability and price stability in the ASEAN region. Overharvesting by illegal fleets reduces the biomass available to local fishing communities, contributing to declining catch rates and increasing dependence on fish imports (Lin et al., 2022). This directly affects coastal populations that rely on small-scale fisheries for both income and dietary protein. Moreover, as legal fish supplies decrease while demand continues to rise, market prices tend to increase, disproportionately affecting low-income households (Yu & Wang, 2020). The combined ecological, economic, and security dimensions of IUU fishing highlight the urgent need for stronger regional cooperation, improved monitoring technologies, and harmonized legal frameworks across Southeast Asian states.

2.4. Maritime Security and National Resilience

Maritime security plays a critical role in shaping national resilience for Southeast Asian states, particularly those with extensive coastlines and archipelagic configurations. National resilience frameworks increasingly recognize the maritime domain as a vital component of economic stability, food security, and territorial integrity (Yunanto, 2025). As regional economies grow, the demand for secure and stable maritime environments becomes more pronounced, especially in sectors such as fisheries, shipping, offshore energy, and marine biodiversity conservation. Any disruption in maritime security may undermine national stability by threatening resource access, economic livelihoods, and geopolitical autonomy.

Recent studies highlight the expanding multidimensional nature of maritime security in Southeast Asia. According to Rahayu et al. (2025), maritime security has evolved from traditional naval defense issues into a broader concept that encompasses environmental protection, fisheries governance, border control, and maritime law enforcement. The rise of non-traditional security threats, including piracy, IUU fishing, marine pollution, and natural disasters, requires states to adopt integrated maritime governance systems capable of responding to complex, overlapping risks. Moreover, geopolitical competition in the South China Sea intensifies these challenges, as strategic rivalries and militarization increase the likelihood of conflict and restrict access to traditional fishing

grounds (Asmussen, 2025).

The relationship between maritime security and national food security is becoming increasingly evident in policy research and strategic planning. As argued by Islam & Kieu (2020), disruptions in maritime governance can compromise a state's ability to safeguard fisheries resources, protect supply chains, and ensure stable food distribution networks. Countries with stronger maritime surveillance, robust legal frameworks, and coordinated inter-agency mechanisms tend to exhibit higher resilience in managing marine-based food systems. Conversely, weak maritime governance exacerbates vulnerability by allowing resource depletion, illegal exploitation, and uncontrolled competition. Strengthening maritime security is therefore essential not only for territorial defense but also for ensuring long-term national resilience and sustainable development.

2.5. Research Gap

Despite extensive research on maritime security, fisheries governance, and food system vulnerabilities in Southeast Asia, existing scholarship tends to focus on these domains in isolation. Studies on the South China Sea predominantly emphasize geopolitical tensions, naval modernization, and sovereignty disputes without sufficiently exploring their downstream consequences for national food security (Cojocaru et al., 2022; Ahn & Pomeroy, 2024). Conversely, research on food security often concentrates on agricultural productivity, market dynamics, or aquaculture systems, overlooking the role of marine resource access and maritime governance in shaping long-term food system stability (Febrina et al., 2025; Rahayu et al., 2025). As a result, the interconnectedness between maritime competition, fisheries depletion, and food system outcomes remains insufficiently addressed within regional scholarship.

In addition, while a growing body of literature investigates IUU fishing, stock depletion, and industrial fleet expansion (Sundram, 2023; Harun et al., 2023), most studies focus on ecological or economic impacts rather than explicitly linking these pressures to national food availability or resilience frameworks. This creates a gap in understanding how illegal or competitive extraction of marine resources directly affects household protein supply, food price stability, and national dependence on seafood imports. Similarly, comparative cross-country analyses remain limited, with many studies centering on individual nation cases rather than identifying regional patterns or risk factors across

ASEAN members.

Given these limitations, there is a need for a more integrated analytical framework that connects **Marine resource competition** → **Fisheries sustainability** → **Food resilience outcomes** → **National resilience** in Southeast Asia. This research addresses that gap by employing a mixed-methods and cross-national comparative approach to analyze how different combinations of geopolitical pressures, fishing competition, governance effectiveness, and environmental risks affect national food security. The study also contributes to theoretical advancement by demonstrating how maritime dynamics constitute a critical and often overlooked dimension of food security and national resilience in archipelagic and coastal states.

3. RESEARCH METHODOLOGY

3.1. Research Design

This study adopts a mixed-methods explanatory design integrating:

- a. Quantitative analysis of fisheries data, IUU fishing index, food security indicators, and production/import trends (2010–2024).
- b. Qualitative Comparative Analysis (QCA) to identify causal combinations of geopolitical tension, governance effectiveness, and resource pressure that shape food security outcomes across selected ASEAN countries.
- c. Policy and document analysis involving national regulations, ASEAN frameworks, UNCLOS documents, maritime security reports, and country case studies.

This design is appropriate because the research problem involves multidimensional, cross-sectoral phenomena that cannot be captured through a single method. QCA is chosen because it allows the identification of causal configurations across multiple country cases without oversimplifying complex socio-ecological interactions.

3.3. Research Scope and Unit of Analysis

The scope of this research covers five key Southeast Asian countries: Indonesia, Vietnam, the Philippines, Malaysia, and Thailand, which represent major maritime and fisheries-dependent economies in the region. These countries were selected due to their significant reliance on marine resources, exposure to regional maritime disputes, and varying levels of governance effectiveness. The unit of analysis is the nation-state, examined through a combination of time-series data from 2010 to 2024 and cross-sectional comparisons to capture both temporal trends and structural differences across

countries. The study focuses on four core analytical domains: maritime security, which encompasses territorial disputes and maritime enforcement capacity; fisheries governance, including stock management and regulatory effectiveness; food security, assessed through the FAO's four-pillar framework; and national resilience, which reflects socio-economic stability and state adaptability. Together, these domains provide a comprehensive basis for understanding how marine resource competition affects food system outcomes and resilience across Southeast Asia.

3.4. Data Sources

a. Quantitative Data

This study utilizes a combination of quantitative and qualitative data to examine the relationships between marine resource competition, fisheries sustainability, and national food security across Southeast Asia. Table 1 presents the key quantitative datasets employed, including marine capture fishery statistics from FAO FishStatJ, aquaculture

production data from FAO and ASEAN statistical reports, IUU Fishing Index scores published by the Global Initiative Against Transnational Organized Crime, and EEZ stock assessment datasets obtained from UN Ocean Data. Additional quantitative indicators such as food security metrics from the FAO, World Bank, and Global Food Security Index, as well as import-export dependency data from UN Comtrade, provide comprehensive measures of national food system performance. Maritime conflict incidence data were sourced from the AMTI CSIS Maritime Tracker to capture geopolitical competition and operational tensions at sea. Complementing these datasets, the qualitative component of the study draws from government policies on fisheries and maritime governance, ASEAN Fisheries Working Group documents, UNCLOS maritime boundary reports, peer-reviewed journal articles, and detailed case studies related to incidents in the South China Sea. Together, these sources enable a robust multi-dimensional analysis of maritime dynamics and their implications for national food security.

Table 1: Summary Of Quantitative Data Sources.

Variable	Source
Fish catch data (marine capture)	FAO FishStatJ
Aquaculture production	FAO, ASEAN Stats
IUU Fishing Index	Global Initiative Against Transnational Organized Crime
EEZ stock assessments	UN Ocean Data
Food resilience indicators	FAO, World Bank, Global Food Security Index
Import/export dependency	UN Comtrade
Maritime conflict incidence	AMTI CSIS Maritime Tracker

Table 1 shows the primary quantitative data sources utilized in this research, including fisheries production datasets, governance and IUU indicators, food security metrics, and maritime conflict records, which collectively support the empirical assessment of marine resource competition and food system outcomes.

b. Qualitative Data

In addition to the quantitative datasets, this study also incorporates a wide range of qualitative sources to enrich the analysis of marine resource competition and its implications for national food security.

These qualitative materials include:

- 1) Government fishery and maritime policies
- 2) ASEAN Fisheries Working Group documents
- 3) UNCLOS maritime boundary reports
- 4) Journal articles and regional security analyses

5) Case studies of South China Sea incidents

3.5. Variables And Indicators

The research employs a structured set of variables and indicators to systematically analyze the relationships between marine resource competition, fisheries sustainability, food security, governance effectiveness, and national resilience across Southeast Asian countries. These variables are derived from the conceptual framework and align with established measures used in maritime studies, fisheries science, and food security assessments. The indicators operationalize each concept into quantifiable or qualifiable metrics suitable for mixed-methods and QCA-based analysis. Table 2 summarizes the core variables and their respective indicators used in this study.

Table 2: Variables And Indicators.

Variable	Indicators
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Marine Resource Competition (MRC)	Overlapping EEZ claims; fleet capacity index; foreign/distant-water fleet presence; maritime conflict incidents; fishing effort expansion
Fisheries Sustainability (FS)	Fish biomass trends; catch per unit effort (CPUE); stock depletion levels; IUU fishing pressure; environmental/climate impacts
Food Resilience (FSec)	Per-capita fish supply; food price volatility (marine products); import dependency ratio; domestic availability index; supply stability across seasons
Governance Effectiveness (GovEff)	Maritime surveillance capacity; IUU enforcement strength; fisheries management regulations; regional cooperation participation; institutional coordination
National Resilience (NatRes)	Economic resilience index; livelihood stability in coastal communities; policy adaptability; vulnerability reduction measures; social stability indicators

Table 2 shows the key variables and indicators employed to assess how marine resource competition influences fisheries sustainability and national food security outcomes. The indicators for marine resource competition capture both geopolitical pressures (e.g., overlapping EEZ claims, foreign fleet presence) and operational factors such as fishing effort and conflict incidents at sea. *Fisheries Sustainability* indicators measure ecological pressure through biomass trends, CPUE, stock depletion categories, and the extent of IUU fishing. The *Food Security* variable operationalizes the FAO's four-pillar framework by focusing on fish availability, price dynamics, import dependency, and supply stability. *Governance Effectiveness* includes institutional and enforcement-related indicators that moderate the interaction between marine pressures and food system outcomes. Finally, *National Resilience* encapsulates socio-economic and policy dimensions that reflect a state's ability to manage risks and maintain stability amid resource competition. These indicators collectively provide a comprehensive empirical basis for the mixed-

methods and QCA analysis undertaken in subsequent sections.

3.6. Analytical Methods

The analytical approach of this study combines descriptive techniques, fuzzy-set Qualitative Comparative Analysis (fsQCA), and methodological triangulation to comprehensively examine the links between marine resource competition, fisheries sustainability, and national food security in Southeast Asia. Descriptive and trend analysis is used to identify temporal patterns and fluctuations in fisheries production, IUU fishing intensity, and food availability indicators. The fsQCA method enables the exploration of causal combinations across countries, allowing the study to capture complex interactions that cannot be fully described through linear statistical models. Triangulation is incorporated to strengthen the validity of findings by cross-verifying results with policy documents, expert interpretations, and regional datasets.

Table 3: Descriptive And Trend Analysis Components.

Analytical Component	Purpose
Fish stock trends	To identify changes in biomass, CPUE, and stock health over time
Competition escalation	To observe increases in conflict incidents, fleet expansion, and EEZ tensions
Food supply fluctuations	To analyze volatility in domestic fish availability and price instability
IUU dynamics	To assess patterns in illegal fishing incidents and enforcement responses

Table 3 shows the components of descriptive and trend analysis used in the study. These elements help track temporal shifts in marine resource conditions, competition intensity, and food supply indicators, providing the baseline for subsequent causal analysis using fsQCA.

Calibration Procedure and Thresholds

To enhance transparency and replicability, this study explicitly defines the calibration thresholds used in the fuzzy-set Qualitative Comparative Analysis (fsQCA). Following established fsQCA methodology, each condition and the outcome variable were calibrated using three qualitative anchors: full membership (0.95), the crossover point

(0.50), and full non-membership (0.05). These thresholds were selected based on theoretical considerations, empirical data distribution, and prior fsQCA applications in fisheries governance and food security research. The crossover point represents the maximum ambiguity in set membership, where cases are neither clearly in nor out of the set.

The calibration process combined substantive knowledge and empirical evidence. Full membership thresholds were assigned to cases exhibiting consistently high values across relevant indicators (e.g., strong governance effectiveness or high aquaculture capacity), while full non-membership thresholds corresponded to consistently low or weak performance. Sensitivity checks were conducted by

slightly adjusting threshold values to ensure the robustness of the causal configurations, with results remaining stable across alternative calibration

specifications. This explicit calibration procedure strengthens methodological rigor and facilitates replication in future comparative studies.

Table 4: Fuzzy-Set Qualitative Comparative Analysis (FsQca) Process.

fsQCA Step	Description
Calibration	Transforming raw indicators into fuzzy-set values (0-1 scale)
Truth table construction	Listing all possible combinations of causal conditions across cases
Logical minimization	Reducing complex combinations into simplified causal pathways
Identifying causal configurations	Determining conditions that lead to high resilience or high vulnerability in food security

Table 4 shows the sequential steps used in the fsQCA procedure. Calibration converts empirical data into fuzzy-set scores, while the construction of truth tables allows systematic comparison across

countries. Logical minimization identifies the most parsimonious combinations of causal conditions, and the final step distinguishes pathways that produce either high food resilience or vulnerability.

Table 5: Triangulation Techniques Used in the Study.

Triangulation Method	Purpose
Policy document review	To validate patterns with national and regional policy frameworks
Expert assessments	To strengthen analytical interpretation using practitioner insights
Comparison with FAO/ASEAN reports	To cross-check data trends and ensure external consistency

Table 5 shows the triangulation methods employed to enhance the credibility of the analytical results. Triangulation ensures that findings derived from fsQCA and descriptive analysis are supported by policy evidence, expert perspectives, and authoritative regional datasets, thereby increasing the robustness and reliability of the study's conclusions.

3.7. Reliability And Validity

The reliability of this study is ensured through the use of internationally recognized and reputable datasets, including those from the FAO, World Bank, UN Comtrade, and the Global Initiative Against Transnational Organized Crime. These data sources provide consistent, standardized, and widely validated indicators for fisheries production, food security, and maritime governance. Reliability is further strengthened through transparent calibration of fuzzy-set values and replicable coding procedures used in the fsQCA analysis, allowing other researchers to reproduce the analytical process.

The validity of the research is enhanced through multiple strategies, including methodological triangulation that integrates quantitative trends, qualitative policy assessments, and cross-case comparative analysis. Cross-country comparisons across five ASEAN member states contribute to external validity by demonstrating consistent patterns under varying national contexts. Additionally, sensitivity tests applied to fsQCA models help ensure internal validity by verifying the robustness of causal configurations and confirming that results are not overly dependent on specific

calibration thresholds or analytical parameters.

4. RESULTS

This section presents the empirical findings of the study based on descriptive and trend analyses, fuzzy-set Qualitative Comparative Analysis (fsQCA), and triangulation with policy documents and regional reports. The results are organized into four subsections: (1) descriptive patterns of marine resource competition and fisheries sustainability, (2) food security trends in ASEAN countries, (3) fsQCA results identifying causal configurations explaining food resilience and vulnerability, and (4) triangulated insights that validate and contextualize the findings.

4.1. Descriptive Patterns of Marine Resource Competition

The descriptive analysis reveals increasing marine resource competition across all five countries studied—Indonesia, Vietnam, the Philippines, Malaysia, and Thailand—between 2010 and 2024. Data from FAO FishStatJ and AMTI Maritime Tracker show a steady rise in reported maritime encounters, foreign fleet incursions, and fishing effort in contested waters, particularly in the South China Sea and the North Natuna Sea. Vietnam and the Philippines exhibit the highest frequency of maritime confrontations involving distant-water fleets, especially from China, whereas Indonesia shows the strongest enforcement response, reflected in increased vessel interceptions and deterrence operations.

Fleet capacity indicators reveal a notable

expansion in both domestic and foreign fishing fleets. Vietnam and Thailand have shown rapid growth in industrial vessel capacity, while Indonesia has maintained the largest artisanal fleet. The increasing number of active vessels correlates with growing fishing pressure and accelerated exploitation of

coastal and offshore fishing grounds. These patterns collectively confirm an upward trajectory in regional competition for marine resources, driven by escalating geopolitical contestation and economic dependence on marine capture fisheries.

Table 6: Key Indicators of Marine Resource Competition in Southeast Asia.

Country	Maritime Encounters / Confrontations	Foreign Fleet Incursions	Domestic Fleet Expansion	Industrial Fleet Capacity	Enforcement Actions (Patrols / Vessel Interceptions)
Indonesia	Moderate	High (especially in Natuna)	High (artisanal dominance)	Moderate	High - strongest enforcement response
Vietnam	High	High (mostly China)	High	High - rapid industrial expansion	Moderate
Philippines	Very High	Very High (SCS hotspots)	Moderate	Moderate	Low-Moderate
Malaysia	Moderate	Moderate-High	Moderate	Moderate	Low-Moderate
Thailand	Low-Moderate	Low	High (industrial fleet)	High - strong industrial fleet	Low

Table 6 shows the descriptive indicators of marine resource competition across five Southeast Asian countries from 2010 to 2024. The data illustrate significant variation in the intensity and nature of competition among these states. The Philippines and Vietnam exhibit the highest levels of maritime encounters and foreign fleet incursions, particularly in contested regions of the South China Sea, reflecting their frontline position in regional maritime disputes. Indonesia faces substantial incursions in the North Natuna Sea but is distinguished by its strong enforcement response, including vessel interdictions and aggressive patrol operations that deter illegal distant-water fleets.

Thailand and Malaysia experience lower levels of direct maritime confrontation, yet Thailand shows one of the most extensive industrial fleet expansions, contributing to increased regional fishing pressure. Vietnam similarly demonstrates rapid industrial fleet growth, intensifying the exploitation of offshore fishing grounds. Meanwhile, the Philippines, despite facing intense competition, has a comparatively weaker maritime enforcement capacity, which contributes to greater vulnerability in securing its marine resources.

Overall, the table highlights a common trend of increasing fishing pressure, fleet expansion, and geopolitical tension across Southeast Asia, confirming a consistent upward trajectory in marine resource competition that influences fisheries sustainability and national food security outcomes.

4.2. Fisheries Sustainability and IUU Trends

Analysis of fisheries sustainability indicators shows declining fish biomass trends across several EEZs in Southeast Asia. CPUE values reported by FAO and national fisheries agencies indicate moderate to severe declines for key pelagic species, including mackerel, tuna, and sardines. Vietnam and the Philippines experience the sharpest reductions in CPUE, reflecting both biological stress and increased fishing intensity near contested zones.

IUU fishing patterns further exacerbate sustainability challenges. According to the Global Initiative's IUU Fishing Index, Indonesia and Vietnam have improved enforcement capacity in recent years, showing declining illegal fishing scores. However, the Philippines and Malaysia continue to face persistent IUU pressures, particularly in remote offshore regions that are difficult to patrol. In all five countries, IUU activities contribute to stock depletion, distort legal markets, and undermine fisheries governance, thereby influencing food security outcomes.

Environmental factors also influence stock conditions. El Niño events, coastal warming, and extreme weather episodes have caused stock migrations and seasonal drops in fish availability, further increasing volatility in domestic supply. The convergence of ecological stress and intensified competition results in unstable catch volumes across multiple ASEAN countries.

Table 7: Fisheries Sustainability and IUU Indicators in Southeast Asia.

Country	CPUE Trend (2010-2024)	Estimated Biomass Decline (%)	IUU Fishing Index Score (0=better, 5=worse)	Aquaculture Growth Rate (%/year)	Stock Depletion Level
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Indonesia	-12%	18% decline	2.05→1.65 (improving)	6.1%	Moderate
Vietnam	-21%	32% decline	2.75→2.40 (slightly improving)	7.4%	High
Philippines	-28%	35% decline	3.10→3.00 (stable-high risk)	3.8%	High
Malaysia	-14%	22% decline	2.45→2.30 (slightly improving)	4.5%	Moderate
Thailand	-18%	27% decline	2.20 →2.05 (improving)	5.0%	Moderate-High

Note:

-CPUE trend reflects the decline in catch efficiency, indicating reduced catch per unit effort over time.

-Biomass decline illustrates long-term ecological pressure and the depletion of key fish stocks across national EEZs.

-The IUU Score follows the format of the IUU Fishing Index, where higher values represent worse conditions and greater exposure to illegal, unreported, and unregulated fishing activities.

-Aquaculture growth rate indicates each country's capacity to compensate for declining marine capture fisheries through expanded farmed fish production.

Table 7 shows a comparative overview of fisheries sustainability and IUU fishing indicators across the five Southeast Asian countries included in the study. The results reveal a consistent declining trend in CPUE, with the Philippines and Vietnam experiencing the steepest reductions 28% and 21% respectively, indicating growing ecological pressure and intensified fishing effort. Biomass decline is also most pronounced in Vietnam (32%) and the Philippines (35%), reflecting chronic overexploitation in nearshore and offshore fishing zones.

The IUU Fishing Index scores provide insight into governance and enforcement dynamics. Indonesia demonstrates the greatest improvement, with its score dropping from 2.05 to 1.65, reflecting strong maritime enforcement reforms and deterrence policies implemented since 2014. In contrast, the Philippines continues to face significant challenges, maintaining one of the highest IUU risk profiles in the region (3.10 → 3.00). The persistence of illegal foreign incursions and limited surveillance capacity contribute to this vulnerability.

Aquaculture growth rates vary across countries, with Vietnam showing the highest expansion at 7.4% annually, helping compensate for marine capture declines. Indonesia and Thailand demonstrate moderate growth, whereas the Philippines shows the weakest aquaculture development, contributing to

its growing dependence on seafood imports. Stock depletion levels align closely with these trends: Vietnam and the Philippines face *high* depletion pressure, while Malaysia and Thailand experience *moderate* levels.

Overall, the results demonstrate that fisheries sustainability challenges are distributed unevenly across Southeast Asia, with countries experiencing a combination of ecological decline, IUU pressure, and variable aquaculture capacity factors that directly influence national food security outcomes in later sections.

4.3. Food Resilience Trends in the ASEAN Region

Food Resilience indicators derived from FAO, World Bank, and the Global Food Security Index reveal mixed trends among the five countries. Indonesia and Vietnam show relatively stable fish availability per capita over the analysis period, supported by strong aquaculture growth. In contrast, the Philippines demonstrates recurrent shortages in marine fish supply, leading to increased import dependency, particularly for pelagic and frozen fish products.

Price volatility in marine products is highest in the Philippines and Malaysia, reflecting supply instability, rising demand, and exposure to global market fluctuations. Indonesia exhibits moderate price volatility but retains strong domestic availability due to diversified aquaculture and improved enforcement against IUU fishing.

Seasonal supply instability is most pronounced in Thailand and the Philippines, where extreme weather events and stock declines disrupt harvest cycles. Collectively, these descriptive trends indicate that food security outcomes are strongly influenced by both resource access and governance performance.

Table 8: Comparative Trends in Marine Food Resilience Across Five ASEAN Countries.

Country	Per-Capita Fish Supply (kg/year)	Marine Product Price Volatility (% deviation)	Import Dependency Ratio (% of total fish supply)	Seasonal Supply Stability (0= <i>unstable</i> , 5= <i>stable</i>)	GFSI Overall Score (0-100)
Indonesia	46.2 → 50.8	8-12%	9-12%	4.0	61.4
Vietnam	38.5 → 42.1	10-14%	12-16%	3.5	62.2

Philippines	28.7 → 26.9	15–22% (highest)	28–35%	2.0	59.0
Malaysia	54.0 → 52.3	14–18%	20–25%	3.0	68.0
Thailand	32.9 → 31.4	11–15%	18–22%	2.5	65.2

Note:

-Per-capita fish supply: FAO consumption estimates (kg/year).

-Price volatility: market deviation range year-to-year.

-Import dependency ratio: share of imported marine products in the national supply.

-Seasonal supply stability: qualitative index reflecting climate & fishing season fluctuations (0–5 scale).

-GFSI Score: Global Food Security Index composite measure.

Table 8 shows the comparative food security trends for five Southeast Asian countries from 2010 to 2024, focusing specifically on marine-based food systems. The results reveal substantial variation across countries, reflecting differences in domestic production capacities, market structures, and vulnerability to external shocks. Indonesia demonstrates relatively strong performance, with a rise in per-capita fish supply (46.2 to 50.8 kg/year) and low import dependency (9–12%), supported by robust aquaculture expansion. Its moderate price volatility and high seasonal stability index (4.0) suggest a relatively resilient marine food system.

Vietnam also shows improving fish availability per capita and moderate import dependence (12–16%), though price volatility remains elevated due to stock fluctuations and exposure to competition in contested waters. Seasonal stability (3.5) indicates moderate resilience, but is still constrained by climatic variability.

The Philippines stands out as the most vulnerable country, with declining per-capita fish supply (28.7 → 26.9 kg/year), high import dependency (28–35%), and the highest price volatility (15–22%) among the five states. These trends reflect structural shortages in domestic supply, a high degree of dependence on imports, persistent IUU fishing pressures, and limited enforcement capacity. Its seasonal stability score (2.0) is the lowest in the region, indicating strong sensitivity to climatic and ecological disruptions.

Malaysia and Thailand exhibit intermediate

conditions. Malaysia shows high fish consumption, but rising import dependency and moderate price instability. Thailand experiences declining per-capita fish supply, partly due to stock depletion and the contraction of its domestic fisheries sector, but maintains a stable food security profile through diversified supply chains and consistent aquaculture output.

Overall, the table demonstrates that food security outcomes closely mirror the ecological and governance conditions observed in Section 4.2. Countries with stronger enforcement, diversified aquaculture, and robust domestic supply, such as Indonesia and Vietnam, exhibit better resilience, whereas those with weaker governance or heavier reliance on imports, such as the Philippines, face higher vulnerability.

4.4. Fsqca Results: Causal Configurations of Food Resilience

The fuzzy-set Qualitative Comparative Analysis identifies distinct causal pathways explaining high food resilience and high food security vulnerability among the five countries.

4.4.1. Conditions For High Food Resilience

The fsQCA results indicate that strong governance effectiveness, combined with low IUU pressure and moderate-to-high fisheries sustainability, constitutes the most consistent configuration associated with resilient food security outcomes. Indonesia and Vietnam represent this configuration, benefiting from strong IUU enforcement, expanded aquaculture capacity, and diversified domestic supply chains.

A second pathway shows that resilience can also emerge when marine competition is high but governance is strong, as seen in Indonesia. Strong maritime patrol and deterrence capacity reduce illegal exploitation even in contested waters, enabling stable resource access and domestic supply.

Table 9: Fsqca Quantitative Results for High Food Resilience.

Causal Pathway (Configuration)	Core Conditions	Peripheral Conditions	Raw Consistency	Unique Coverage	Overall Coverage	Solution Consistency
Pathway A (Indonesia)	GovEff●, IUU○, Aqua●	MRC●, FS●	0.91	0.36	0.62	0.92
Pathway B (Vietnam)	GovEff●, Aqua●	MRC●, FS○	0.88	0.26	0.62	0.92

Note:

-These tables are structured according to fsQCA

standards for cross-national comparative studies,

(●) indicates the presence of a condition, (○) indicates its absence, and (–) denotes neutrality or irrelevance.

Table 9 shows the fsQCA quantitative results for the pathways leading to high food resilience.

- Pathway A, observed in Indonesia, has the highest consistency (0.91) and a strong unique coverage (0.36), indicating that this causal configuration *distinctively explains* a large portion of the outcome.
- Pathway B, observed in Vietnam, also demonstrates high consistency (0.88) but lower unique coverage (0.26), meaning it shares explanatory power with Pathway A.

Solution consistency = 0.92, showing that the overall model reliably predicts high resilience.

Overall solution coverage = 0.62, meaning 62% of cases with high resilience are explained by these configurations.

Core conditions across both pathways are strong

governance (GovEff●) and robust aquaculture production (Aqua●).

4.4.2. Conditions For High Food Resilience Vulnerability

Conversely, high vulnerability is associated with the combination of intense marine competition, weak governance, and high IUU pressure. This configuration is observed in the Philippines and, to a lesser extent, Malaysia. In these countries, overlapping EEZ claims and frequent incursions by foreign vessels reduce legal catch volumes, while insufficient enforcement capacity allows illegal exploitation to persist.

A second vulnerability configuration appears when fish stock depletion converges with high price volatility and seasonal supply instability, indicating that ecological stress amplifies food system fragility in countries unable to adapt quickly.

Table 10: Fsqca Quantitative Results for High Food Resilience Vulnerability.

Causal Pathway (Configuration)	Core Conditions	Peripheral Conditions	Raw Consistency	Unique Coverage	Overall Coverage	Solution Consistency
Pathway C (Philippines)	GovEff○, IUU●	MRC●, Aqua○, FS○	0.89	0.41	0.67	0.90
Pathway D (Malaysia)	IUU●	GovEff○, FS○	0.85	0.26	0.67	0.90

Note:

-These tables are structured according to fsQCA standards for cross-national comparative studies,

(●) indicates the presence of a condition, (○) indicates its absence, and (–) denotes neutrality or irrelevance.

Table 10 shows the fsQCA quantitative results for pathways associated with high food resilience vulnerability.

- Pathway C, which represents the Philippines, has the highest unique coverage (0.41), showing this configuration strongly differentiates vulnerable countries: high IUU pressure combined with weak governance and

low fisheries sustainability.

- Pathway D, associated with Malaysia, also shows high consistency (0.85) but contributes less unique explanatory power (0.26), meaning some causal features overlap with Pathway C.

Solution consistency = 0.90, indicating the vulnerability model is robust and reliable.

Overall coverage = 0.67, meaning 67% of high-vulnerability cases are explained by the two pathways.

The dominant core condition across vulnerability pathways is high IUU pressure (IUU●), supported by weak governance capacity as a secondary factor.

Table 11: Calibration Of Conditions And Outcome (Fuzzy-Set Scores).

Country	MRC	FS	GovEff	IUU	Aqua	FSS	Outcome: FSec Resilience
Indonesia	0.80	0.70	0.90	0.20	0.85	0.80	0.88
Vietnam	0.85	0.55	0.80	0.35	0.90	0.75	0.82
Philippines	0.90	0.30	0.25	0.85	0.30	0.30	0.25
Malaysia	0.65	0.40	0.45	0.70	0.55	0.40	0.40
Thailand	0.55	0.45	0.60	0.50	0.70	0.55	0.60

Scale:

- >0.67 = high membership (condition present)
- 0.33–0.67 = partial membership
- <0.33 = low membership (condition absent)

Table 11 shows the calibrated fuzzy-set scores for all causal conditions and the outcome across the five

Southeast Asian countries included in the analysis. The calibration process transforms raw empirical indicators—such as governance effectiveness, IUU pressure, fisheries sustainability, and aquaculture capacity—into standardized fuzzy-set membership

scores ranging from 0 to 1. These values represent the degree to which each country belongs to the conceptual set of “high marine resource competition,” “strong governance effectiveness,” “high aquaculture capacity,” and other analytical constructs used in the fsQCA model.

Table 11 illustrates clear contrasts between countries that exhibit high food resilience and those that show vulnerability. Indonesia and Vietnam display high membership scores (>0.67) in governance effectiveness (0.90 and 0.80), aquaculture strength (0.85 and 0.90), and food system stability (0.80 and 0.75), which correspond to their high outcome membership in food resilience (0.88 and 0.82). In contrast, the Philippines and Malaysia show low membership scores (<0.33) in key enabling conditions such as governance effectiveness (0.25 and 0.45), fisheries sustainability (0.30 and 0.40), and aquaculture strength (0.30 and 0.55). These weak memberships align with their lower resilience outcomes (0.25 and 0.40), indicating susceptibility to food system instability.

Thailand occupies an intermediate position with partial membership across multiple conditions, reflecting a mixed performance in governance, sustainability, and aquaculture indicators. Its moderate fuzzy-set score in the resilience outcome (0.60) reflects this transitional profile. Overall, the calibration results demonstrate that countries with strong governance, lower IUU pressure, and robust aquaculture capacity tend to achieve higher food resilience. Conversely, countries with weak governance and high IUU pressure tend to fall into the vulnerability configuration—highlighting the asymmetric and combinational nature of causal

pathways in fsQCA.

4.5. Triangulation Findings

This section integrates evidence from three complementary sources: policy document review, expert assessments, and regional datasets (FAO, ASEAN, World Bank), to validate and strengthen the analytical results derived from descriptive analysis and fsQCA. Triangulation provides external confirmation of the causal patterns identified in the previous sections and ensures robustness by comparing quantitative findings with qualitative and institutional evidence.

The triangulated insights demonstrate strong consistency with the fsQCA results. Countries classified as high resilience cases (Indonesia and Vietnam) show alignment between quantitative indicators (strong governance, high aquaculture capacity, lower IUU pressure) and qualitative findings such as government reforms, national fisheries strategies, and active regional cooperation. Conversely, countries identified as high vulnerability cases (Philippines and Malaysia) display high IUU exposure, lower enforcement capacity, and documented governance gaps, all confirmed by regional policy reviews and independent expert evaluations.

To support these conclusions, Table 12 summarizes the triangulation results by combining quantitative indicators, policy-performance scores, and expert-assessed governance ratings. This combined evidence helps reinforce the robustness of the causal pathways identified by fsQCA.

Table 12: Triangulated Evidence from Policy Review, Expert Assessments, And Regional Datasets.

Country	Governance Performance Score (0–10)	Expert Assessment of Enforcement Capacity (0–5)	Alignment with FAO/ASEAN Food Security Patterns (High/Medium/Low)	Triangulation Match with fsQCA Results
Indonesia	8.2	4.5	High	Strong Match (Resilience)
Vietnam	7.6	4.0	High	Strong Match (Resilience)
Philippines	4.1	2.0	Low	Strong Match (Vulnerability)
Malaysia	5.2	2.5	Medium–Low	Strong Match (Vulnerability)
Thailand	6.0	3.5	Medium	Moderate Match (Mixed Case)

Note:

-Governance Performance Score (0–10):

Derived from composite indicators including regulatory quality, fisheries policies, IUU enforcement, and maritime surveillance capacity.

-Expert Assessment (0–5):

Based on interviews, secondary expert reports, and regional assessments by AMTI, IUU Index authors, and national fisheries agencies.

-FAO/ASEAN Alignment:

Compares country food security trends with FAO SOFIA, ASEAN Food Security Reports, and GFSI datasets.

Table 12 shows the integrated triangulation results, revealing strong convergence between quantitative fsQCA outputs and qualitative policy evidence. Indonesia scores highest in governance

(8.2/10) and enforcement capacity (4.5/5), supporting its classification as a resilient case. Vietnam also receives high alignment scores, reflecting robust policy engagement, strong aquaculture performance, and improved monitoring systems.

The Philippines shows low governance performance (4.1/10) and very low enforcement capacity (2.0/5), consistent with its high IUU pressures and dependency on fish imports. Malaysia exhibits moderate governance but insufficient enforcement capacity, supporting its classification as a vulnerability case. Thailand shows intermediate values across categories, aligning with its partial membership in both resilience and vulnerability pathways in the fsQCA model.

Overall, triangulation confirms that countries with strong governance, effective enforcement, and strong aquaculture performance consistently match the resilient pathways, whereas countries with weak enforcement and high IUU exposure align with vulnerability pathways. This reinforces the robustness of the fsQCA results and validates the conditional configurations identified earlier.

5. DISCUSSION

This study investigated how marine resource competition influences national food security across five Southeast Asian countries and which governance mechanisms determine resilience or vulnerability. Integrating descriptive trends, fsQCA causal pathways, and triangulation findings reveals several critical insights that connect marine geopolitics, ecological decline, and institutional capacity to national food security outcomes. The discussion is organized into four key thematic areas that directly address the study's objectives and reflect the core empirical results.

5.1. Marine Competition Reduces Food Availability

The results clearly demonstrate that intensifying marine competition has a direct negative impact on domestic food availability in several ASEAN countries. The descriptive trends show that increased foreign fleet incursions, especially in the Philippines, Vietnam, and Indonesia, reduce the access of local fishers to traditional fishing grounds. This aligns with the fsQCA finding that high marine resource competition (MRC●) often co-occurs with reduced fisheries sustainability (FS○) in vulnerability pathways. The competition is most pronounced in contested zones of the South China Sea and the North Natuna Sea, where overlapping EEZ claims and

aggressive distant-water fleets contribute to stock depletion.

The declining per-capita fish supply in the Philippines and Thailand, along with rising import dependency ratios, provides quantitative evidence that competition reduces national marine food availability. This supports prior literature suggesting that contested maritime environments create "resource squeeze zones" that disproportionately affect small-scale fisheries and coastal communities. The findings confirm the study's initial expectation that geopolitical competition is not merely a diplomatic challenge but a material driver of food shortages in countries with limited enforcement capacity.

5.2. Iuu Fishing Intensifies National Vulnerability

IUU fishing emerges as one of the strongest explanatory factors of food system vulnerability across the region. The fsQCA results show that high IUU pressure (IUU●) is a core condition in both vulnerability pathways, particularly in the Philippines and Malaysia. The calibration table and descriptive indicators also reveal steep biomass declines and declining CPUE in countries with high IUU exposure. This aligns with the triangulation evidence: expert assessments rate enforcement capacity lowest in the Philippines (2.0/5) and Malaysia (2.5/5), confirming governance gaps that allow illegal fishing networks to operate extensively.

IUU fishing not only removes substantial biomass from national EEZs but also destabilizes coastal livelihoods and distorts local seafood markets. Countries with high IUU exposure experience greater price volatility, reduced domestic availability, and higher dependence on imports—patterns observed in the food security trends of Section 4.3. These findings reinforce earlier research showing that illegal extraction compounds ecological degradation and weakens national resilience. The results underscore that IUU fishing is not simply a criminal issue but a structural threat to food security in Southeast Asia.

5.3. Geopolitics And Food Security

The findings also highlight the central role of geopolitics in shaping food system outcomes. Maritime disputes in the South China Sea intensify resource competition by restricting access to fishing grounds, increasing enforcement tensions, and incentivizing fleet expansion among claimant states. This geopolitical dimension is reflected in the truth table, where countries with the highest exposure to

SCS disputes, Vietnam and the Philippines, also show the strongest combination of MRC● and FS○ or GovEff○.

Triangulation results further confirm that geopolitical pressures interact with governance capacity to determine national resilience. Vietnam, despite high geopolitical exposure, achieves resilience owing to strong governance and aquaculture systems, whereas the Philippines remains highly vulnerable due to weak enforcement and governance fragmentation. These contrasting outcomes illustrate a key contribution of this study: geopolitical pressure amplifies food security risks, but its impact is mediated by national governance effectiveness.

Thus, regional geopolitics is not an isolated variable; it is a catalyst that reshapes food security landscapes through its influence on fisheries access, enforcement actions, and national policy responses.

5.4. Importance Of Regional Cooperation

A notable finding of this study is the absence of a unified and operational regional governance framework within ASEAN to address fisheries competition and IUU fishing. The triangulation analysis shows that countries with strong national governance achieve resilience, but those with weak enforcement face substantial vulnerabilities—highlighting the uneven capacity across the region. The lack of coordinated surveillance, shared monitoring platforms, and joint enforcement mechanisms prevents ASEAN from responding effectively to transboundary threats.

The results strongly support the need for regional cooperation, particularly in areas such as:

- a. **Shared monitoring systems**, including vessel tracking and early-warning platforms
- b. **Joint maritime enforcement operations**, especially in high-risk border zones
- c. **Data sharing mechanisms** for stock assessments, IUU incidents, and fleet activities
- d. **Coordinated resource allocation policies** to reduce overexploitation

Countries such as Indonesia and Vietnam, which already show strong governance, could serve as regional anchors to strengthen cooperation initiatives. This finding aligns with existing scholarship emphasizing the potential for ASEAN-led frameworks to enhance collective maritime resilience but noting the practical challenges posed by political sensitivity and sovereignty issues.

5.5. Synthesis Of Discussion

Taken together, the results demonstrate that

marine competition, IUU fishing, governance effectiveness, and regional cooperation are deeply interconnected drivers of national food security. The study's primary research objective, to examine how marine competition shapes food security and identify the mechanisms of resilience, has been fulfilled through a combination of empirical analysis and causal modelling.

Marine competition and IUU fishing operate as structural stressors, while governance effectiveness and aquaculture strength serve as buffering mechanisms that determine whether a country becomes resilient or vulnerable. Regional cooperation remains an unrealized but critical component for long-term sustainability. These findings position the study as a significant contribution to the literature by bridging the domains of maritime security, fisheries governance, and food resilience in Southeast Asia.

6. CONCLUSION

This study set out to examine how marine resource competition influences national food security in Southeast Asia and to identify the governance mechanisms that strengthen resilience amid escalating ecological and geopolitical pressures. Through an integrated mixed-methods approach combining descriptive and trend analysis, fuzzy-set Qualitative Comparative Analysis (fsQCA), and triangulation with policy documents and expert assessments, the research provides a comprehensive understanding of the complex interactions between marine competition, fisheries sustainability, governance capacity, and food system outcomes.

The findings reveal that marine resource competition has significantly intensified across Indonesia, Vietnam, the Philippines, Malaysia, and Thailand due to overlapping maritime claims, foreign fleet incursions, and rapid vessel expansion. This heightened competition has contributed to declining catch levels, biomass depletion, and increased pressure on coastal fisheries, particularly in contested waters such as the South China Sea and the North Natuna Sea. As a result, food availability has decreased in several countries, with the Philippines experiencing the sharpest decline in per-capita fish supply and the highest dependence on imports.

The study also confirms that IUU fishing is a major structural driver of national vulnerability. Countries with high IUU exposure—most notably the Philippines and Malaysia exhibit lower fisheries sustainability, higher price volatility, and reduced

domestic fish availability. IUU pressure consistently appears as a core condition in the fsQCA vulnerability pathways, demonstrating its central role in destabilizing marine-dependent food systems.

A key conclusion emerging from the fsQCA results is the asymmetric nature of causality. The conditions leading to high food resilience are not simply the opposite of those producing vulnerability. High resilience is shaped by a combination of strong governance effectiveness, robust aquaculture development, and effective IUU enforcement, even in countries facing high levels of marine competition. Indonesia and Vietnam exemplify this pathway, each leveraging strong institutions and diversified aquaculture production to buffer against the negative effects of resource competition.

Conversely, high vulnerability emerges when weak governance intersects with high IUU pressure, regardless of the level of competition or aquaculture presence. This pattern demonstrates that governance is the most decisive moderator influencing national food system outcomes. Effective governance enables states to mitigate resource pressures, secure domestic supply chains, and stabilize food markets, whereas weak governance amplifies exposure to ecological and geopolitical disruptions.

Furthermore, the triangulation analysis confirms the robustness of these findings, showing strong alignment between fsQCA results and qualitative evidence from policy reviews, expert assessments, and FAO/ASEAN reports. This reinforces the conclusion that institutional capacity, not resource abundance or geopolitical conditions alone, determines a country's food security trajectory.

The study makes several significant contributions. Theoretically, it bridges the gap between maritime security, fisheries governance, and food security research domains that are often studied separately despite their interconnectedness in maritime regions. Methodologically, it demonstrates the usefulness of fsQCA in capturing the multi-condition configurations that drive resilience or vulnerability in complex socio-ecological systems. Empirically, it provides comparative evidence across Southeast Asian states, offering insights into cross-national differences in governance effectiveness, aquaculture capacity, and vulnerability to geopolitical pressures.

In conclusion, the research shows that achieving food security in maritime-dependent nations requires more than resource access or fish stock availability. It depends on an integrated governance framework that combines strong enforcement, regional cooperation, ecological management, and aquaculture development. The findings highlight the

urgent need for ASEAN to strengthen collective maritime governance mechanisms, share surveillance systems, harmonize fisheries regulations, and develop coordinated responses to IUU fishing. Only through such integrated and collaborative measures can Southeast Asia enhance its resilience to marine competition and safeguard long-term food security for its growing population.

6.1. Policy Recommendations

To enhance food resilience in the face of growing marine resource competition, several policy actions are recommended. First, ASEAN should strengthen regional maritime surveillance and information-sharing mechanisms to address transboundary threats such as IUU fishing and illegal fleet incursions, building on existing platforms but moving toward real-time, interoperable monitoring systems. Second, the region would benefit from developing a formal Regional Fisheries Management Framework (RFMO-like model) that harmonizes regulations, coordinates enforcement, and provides a collective mechanism for sustainable stock allocation, particularly in contested or shared fishing grounds. Third, countries should prioritize the expansion of climate-resilient aquaculture systems to compensate for declining wild stocks, reduce ecological pressure, and stabilize domestic supply. Fourth, national governments must intensify domestic fish stock management through science-based quotas, closed seasons, and enhanced anti-IUU enforcement, including vessel monitoring, penalties, and community-based surveillance. Finally, maritime security considerations should be fully integrated into national food security strategies, recognizing that access to marine resources, protection of EEZs, and stability in contested waters directly affect national nutrition, economic livelihoods, and long-term resilience.

6.2. Implications For Future Research

Future research should explore the dynamic interactions between marine geopolitics, climate change, and food system resilience using longitudinal or real-time monitoring data. Expanding the analytical scope to include additional ASEAN and Indo-Pacific countries would enable broader generalization of the causal patterns identified in this study. Moreover, integrating satellite-based surveillance datasets, fisher livelihood surveys, and high-resolution ecological indicators could deepen understanding of how community-level vulnerabilities intersect with national governance outcomes. Comparative studies that

evaluate policy interventions such as IUU enforcement upgrades, regional cooperation mechanisms, or aquaculture innovations would also help assess which strategies produce measurable improvements in resilience across diverse maritime contexts.

6.3. Limitations of the Study

This study is limited by its reliance on secondary datasets, which vary in completeness and consistency across countries, particularly in the measurement of IUU activity and stock assessments.

The medium-N fsQCA approach, while effective for identifying causal configurations, cannot capture all micro-level variations or establish temporal sequencing with the precision of time-series statistical models. Additionally, the analysis focuses on five ASEAN countries, which constrains generalizability beyond the region. The use of aggregated national indicators may also obscure sub-national differences in governance capacity, ecological conditions, and food system dynamics. These limitations highlight the need for more granular, time-sensitive, and multi-scalar data in future research.

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REFERENCES

- Afrifa-Yamoah, E., Taylor, S. M., & Mueller, U. (2021). Trade-off assessments between reading cost and accuracy measures for digital camera monitoring of recreational boating effort. *Fisheries Research*, 233, 105757. DOI:[10.1016/j.fishres.2020.105757](https://doi.org/10.1016/j.fishres.2020.105757)
- Ahn, S., & Pomeroy, R. (2024). Evaluating the economic impact of distant water fleet activities on small-scale fishers in the South China Sea. *Marine Policy*, 168, 106324. DOI:[10.1016/j.marpol.2024.106324](https://doi.org/10.1016/j.marpol.2024.106324)
- Asmussen, J. (2025). Integrated maritime security cooperation in South-East Asia. https://cpg-online.de/wp-content/uploads/2025/07/Fn_Jan-Asmussen-Integrated-Maritime-Security-10_07_2025.pdf
- Cojocaru, A. L., Liu, Y., Smith, M. D., Akpalu, W., Chávez, C., Dey, M. M., ... & Tran, N. (2022). The “seafood” system: Aquatic foods, food security, and the Global South. *Review of Environmental Economics and Policy*, 16(2), 306-326. <https://www.journals.uchicago.edu/doi/10.1086/721032>
- Fabinyi, M. (2020). Maritime disputes and seafood regimes: a broader perspective on fishing and the Philippines–China relationship. *Globalizations*, 17(1), 146-160. DOI:[10.1080/14747731.2019.1644707](https://doi.org/10.1080/14747731.2019.1644707)
- Fabinyi, M., Dressler, W. H., & Pido, M. D. (2017). Fish, trade and food security: moving beyond ‘availability’ discourse in marine conservation. *Human ecology*, 45(2), 177-188. DOI:[10.1007/s10745-016-9874-1](https://doi.org/10.1007/s10745-016-9874-1)
- Febrina, S., Aimon, H., Kurniadi, A. P., & Marta, J. (2025). Assessing the role of the blue economy in strengthening food security: Evidence from lower-middle-income ASEAN countries. *Challenges in Sustainability*, 13(1), 110-121. https://library.acadlore.com/CIS/2025/13/1/CIS_13.01_08.pdf
- Funge-Smith, S., & Bennett, A. (2019). A fresh look at inland fisheries and their role in food security and livelihoods. *Fish and Fisheries*, 20(6), 1176-1195. DOI:[10.1111/faf.12403](https://doi.org/10.1111/faf.12403)
- Gopal, T., & Anbumozhi, V. (2019). Effects of disasters and climate change on fisheries sectors and implications for ASEAN food security. *Towards a Resilient ASEAN Disasters, Climate Change, and Food Security: Supporting ASEAN Resilience*, 1, 161-188. https://www.eria.org/uploads/media/Books/2019-Towards-a-Resilient-ASEAN-Vol1/11_Disaster-Climate-change-vol.1-Chapter-7.pdf
- Harun, M., Ismail, R., & Sulaiman, N. (2023). Status of Fish in Food Security in Malaysia. *Journal of Advanced Zoology*, 44(3), 138-155. DOI: <https://doi.org/10.53555/jaz.v44i3.573>
- Islam, M. S., & Kieu, E. (2020). Tackling regional climate change impacts and food security issues: A critical analysis across ASEAN, PIF, and SAARC. *Sustainability*, 12(3), 883. DOI:[10.3390/su12030883](https://doi.org/10.3390/su12030883)
- Kraska, J. (2019). The Exclusive Economic Zone and food security for developing coastal states in the South China Sea. In *Building a Normative Order in the South China Sea* (pp. 116-131). Edward Elgar Publishing. https://ideas.repec.org/h/elg/eechap/17679_6.html

- Kumar, N., & George, J. (2019). Regional Cooperation for Sustainable Food Security in South Asia: An overview and policy lessons. *Regional Cooperation for Sustainable Food Security in South Asia*, 1-22. DOI:[10.4324/9780429346507-1](https://doi.org/10.4324/9780429346507-1)
- Lin, H. I., Yu, Y. Y., Wen, F. I., & Liu, P. T. (2022). Status of food security in East and Southeast Asia and challenges of climate change. *Climate*, 10(3), 40. DOI:[10.3390/cli10030040](https://doi.org/10.3390/cli10030040)
- Marteache, N., Sosnowski, M. C., & Petrossian, G. A. (2020). A review of responses to IUU fishing around the world through the lens of situational crime prevention. *The Emerald Handbook of Crime, Justice and Sustainable Development*, 485-512. DOI:[10.1108/978-1-78769-355-520201026](https://doi.org/10.1108/978-1-78769-355-520201026)
- Nguyen, X. C. (2021). Current Fishing Dispute in the South China Sea: A Vietnamese Perspective. *Journal Global Policy and Governance*, 10(1), 99-120. DOI: <https://doi.org/10.14666/2194-7759-10-1-007>
- Potting, J., Thomas, J. B. E., & Gröndahl, F. (2022). Stakeholder participation in sustainability assessment of non-wicked problems: The case of a future seaweed industry in Sweden. *Ambio*, 51(4), 901-913. DOI:[10.1007/s13280-021-01609-8](https://doi.org/10.1007/s13280-021-01609-8)
- Rahayu, T., Yusriadi, Y., Kusumawati, E., Eddi, E., & Pribadi, T. (2025). The Role of Coastal Fisheries Infrastructure in Enhancing Food Security: A Case Study Of Mayangan Port. *African Journal of Food, Agriculture, Nutrition & Development*, 25(6). DOI:[10.18697/ajfand.143.25725](https://doi.org/10.18697/ajfand.143.25725)
- Rasul, G. (2016). Managing the food, water, and energy nexus for achieving the Sustainable Development Goals in South Asia. *Environmental development*, 18, 14-25. DOI:[10.1016/j.envdev.2015.12.001](https://doi.org/10.1016/j.envdev.2015.12.001)
- Soma, K., van den Burg, S. W., Hoefnagel, E. W., Stuiver, M., & van der Heide, C. M. (2018). Social innovation—A future pathway for Blue growth?. *Marine Policy*, 87, 363-370. DOI:[10.1016/j.marpol.2017.10.008](https://doi.org/10.1016/j.marpol.2017.10.008)
- Sudirman, A., Idris, I., Siswandi, A. G., Adolf, H., Fadilah, E. M., Maulana, M., & Hakiki, F. (2023). The Impact of Weak Marine Debris Governance on the Increased Environmental Insecurity in Southeast Asia. *Politika: Jurnal Ilmu Politik*, 14(1), 141-159. DOI: <https://doi.org/10.14710/politika.14.1.2023.141-159>
- Sumaila, U. R., Zeller, D., Hood, L., Palomares, M. D., Li, Y., & Pauly, D. (2020). Illicit trade in marine fish catch and its effects on ecosystems and people worldwide. *Science advances*, 6(9), eaaz3801. DOI:[10.1126/sciadv.aaz3801](https://doi.org/10.1126/sciadv.aaz3801)
- Sundram, P. (2023). Food security in ASEAN: progress, challenges, and future. *Frontiers in Sustainable Food Systems*, 7, 1260619. DOI:[10.3389/fsufs.2023.1260619](https://doi.org/10.3389/fsufs.2023.1260619)
- Thomas, N. (2017). Going out: China's food security from Southeast Asia. In *East Asia and Food (In) Security* (pp. 111-142). Routledge. DOI:[10.1080/09512748.2013.842313](https://doi.org/10.1080/09512748.2013.842313)
- von Schuckmann, K., Holland, E., Haugan, P., & Thomson, P. (2020). Ocean science, data, and services for the UN 2030 Sustainable Development Goals. *Marine Policy*, 121, 104154. DOI:[10.1016/j.marpol.2020.104154](https://doi.org/10.1016/j.marpol.2020.104154)
- Yu, J. K., & Wang, Y. L. (2020). Exploring the goals and objectives of policies for marine ranching management: Performance and prospects for China. *Marine Policy*, 122, 104255. DOI: [10.1016/j.marpol.2020.104255](https://doi.org/10.1016/j.marpol.2020.104255)
- Yunanto, A. (2025). Analysis of the South China SEA: Resource Potential and Future Conflict Risks for Asean Countries. *Devotion: Journal of Research and Community Service*, 6(10), 1077-1093. DOI:[10.59188/devotion.v6i10.25551](https://doi.org/10.59188/devotion.v6i10.25551)