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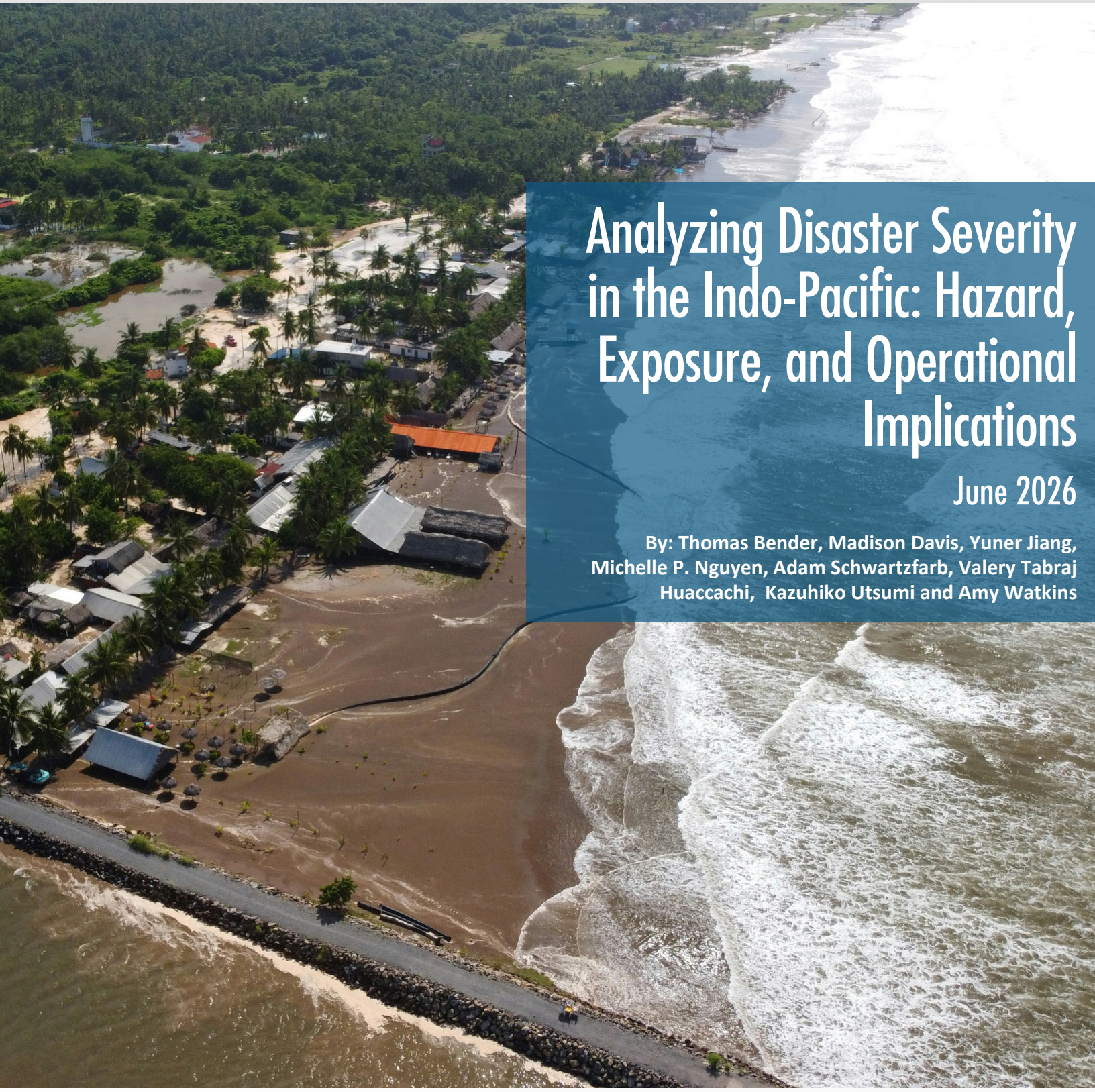

Analyzing Disaster Severity in the Indo-Pacific: Hazard, Exposure, and Operational Implications

June 2026

By: Thomas Bender, Madison Davis, Yuner Jiang, Michelle P. Nguyen, Adam Schwartzfarb, Valery Tabraj Huaccachi, Kazuhiko Utsumi and Amy Watkins

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Table of Contents

Acknowledgements ..... **iii**
Executive Summary **1**
Introduction **3**
Methodology and Framework **4**
Quantitative Approach 4
Qualitative Approach 5
Limitations 6
Analytical Tiers 6
Research Hypotheses 7
Risk Assessment Analysis 8
Regional and Cluster Analysis **13**
Mainland and Coastal Asia 14
Maritime Southeast Asia 15
Small Pacific Island States 16
Western Pacific Region 17
Disaster Trends **19**
Disaster Occurrence and Trends in Socioeconomic Factors 19
Disaster Impact Trends 22
Country-Specific Differences and Future Research Challenges 25
Recommendations **27**
Further Research **29**
Conclusion **32**
Appendix I: Acronyms and Initialism **33**
Appendix II: Background Data **34**
Appendix III: Disaster Trend Analysis **37**
References **39**

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Analyzing Disaster Severity in the Indo-Pacific: Hazard, Exposure, and Operational Implications

June 2026

Executive Summary

Over the past 25 years, disasters in the Indo-Pacific region have become more visible, costly, and operationally complex. However, existing analytical frameworks used to inform humanitarian assistance and disaster response (HA/DR) planning often do not fully capture how disaster risk is generated in practice, namely in the interaction between hazards, exposure, vulnerability, and coping capacity. As a result, planners risk misidentifying the drivers of operational demand. This report addresses that gap by examining whether rising disaster impacts are driven by changes in hazard frequency and severity or by underlying socioeconomic dynamics that expand exposure and vulnerability.

This report finds that while hazard occurrence varies by type and location, increasing disaster impacts are best explained by the interaction of hazard type, expanding exposure, structural vulnerability, and uneven coping capacity across the region. The growth of exposed populations and infrastructure emerge as the most consistently observed contributing factor.

By applying a multidimensional risk framework and cluster-based analysis, this study reframes disaster risk as a function of interacting systems rather than isolated events, with cascading hazard effects further amplifying impacts. These findings carry direct implications for U.S. Indo-Pacific Command (USINDOPACOM) HA/DR planning. They suggest a need to shift away from reactive, event-based responses and toward more anticipatory, risk-informed approaches that account for exposure, vulnerability, and operational context.

Key Finding 1: Disaster impacts are driven more by exposure than hazard frequency. Increases in economic losses, displacement, and operational demand are more closely associated with population growth, urbanization, and asset concentration in hazard-prone areas than with consistent increases in hazard occurrence. As exposure expands, more people and higher-value assets are placed in harm's way; therefore, the scale of damage, the number of affected populations, and the resources required for response all increase. As a result, even relatively stable hazard patterns can produce greater impacts due to the concentration of exposure.

Key Finding 2: Risk varies significantly across clusters, with vulnerability and coping capacity driving divergent outcomes. Grouping countries by shared hazard profiles and structural characteristics reveals distinct risk profiles across clusters of countries: some experience frequent but manageable events, while others face infrequent but high-impact disasters due to structural fragility and limited response capacity.

The study groups countries into four broad categories based on shared hazard profiles and operational characteristics.

- The Mainland and Coastal Asia cluster consists largely of monsoon-affected states with high flood exposure and uneven resilience.
- The Maritime Southeast Asia cluster includes coastal and archipelagic states with exposure to rapid-onset hazards alongside logistics-intensive response needs.
- The Small Pacific Island States cluster includes Pacific islands and strategic territories with high exposure, remoteness, and narrow economic bases.
- The Western Pacific Region cluster includes higher-capacity allies and partners with stronger institutions and greater capacity to generate surge support, including rapid mobilization of personnel, logistics, and humanitarian assistance during large-scale disaster responses.

Key Finding 3: Small Pacific Island States face the highest relative vulnerability despite lower aggregate disaster counts. Geographic remoteness, limited infrastructure, and constrained local response capacity pose outsized operational challenges for HA/DR planning, as they require longer supply lines, greater logistical coordination, and more external support per event. In these contexts, a single severe event can impose outsized damage relative to Gross Domestic Product (GDP) and generate disproportionate humanitarian need.

Recommendations

To address the evolving drivers of disaster risk and their implications for HA/DR operations, this report advances the following recommendations:

- **Prioritize HA/DR planning around exposure, vulnerability, and coping capacity rather than disaster counts alone.** Planning efforts should focus on identifying where concentrated exposure, weak coping capacity, and hazard-specific vulnerability are most likely to generate severe operational burdens. The findings indicate that disaster impacts across the region are increasingly shaped by these underlying risk conditions rather than by hazard frequency alone.
- **Pre-position supplies and strengthen logistics in the most vulnerable islands and remote environments.** Given the disproportionate vulnerability of Small Pacific Island States, planners should prioritize strategic pre-positioning to reduce response lag and improve operational reach during high-impact disaster events. These environments combine lower aggregate disaster frequency with high variability in impacts, a combination that makes timely access to resources critical.
- **Strengthen capacity-building efforts to address prolonged and multi-phase disaster impacts.** While this study focuses on the primary drivers of disaster risk, disasters can generate downstream effects (e.g., infrastructure disruption, displacement, and public health strain) that extend response timelines and complicate transitions to recovery. Expanding training, coordination mechanisms, and investments in health, sanitation, transport, and local response systems will improve preparedness for these extended operational demands.

Research Design

This study was conducted for the Center for Excellence in Disaster Management and Humanitarian Assistance as part of a Columbia SIPA capstone project. It employs a mixed-methods design combining quantitative and qualitative analysis to assess whether rising disaster impacts in the Indo-Pacific are being driven by changes in hazard occurrence or by shifts in exposure and vulnerability. The quantitative component applies a country-year panel built from disaster occurrence and impact data alongside socioeconomic indicators such as GDP, population, and urbanization to evaluate patterns across the region. The qualitative component then establishes the analytical framework through literature review and institutional assessment, and it informs the development of a four-cluster structure used to assess patterns in exposure, vulnerability, and operational implications.

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Introduction

The Indo-Pacific is one of the most disaster-exposed regions in the world. Tropical cyclones, flooding, earthquakes, drought, volcanic activity, and extreme heat regularly affect large parts of the region. At the same time, rapid population growth, urban expansion, and the concentration of infrastructure and economic activity in hazard-prone areas have increased the scale of potential loss. The region's disaster burden is therefore shaped not only by physical hazards but also by the social and economic systems in which hazard events occur.

This report examines the relative contributions of hazard patterns and changes in exposure, vulnerability, and coping capacity to rising disaster impacts in the Indo-Pacific. While hazards remain the trigger for disaster events, this study assesses whether changes in exposure and vulnerability may better explain the observed increase in disaster impacts. That distinction matters because it affects how planners define risk. A hazard-centered approach emphasizes event forecasting, while a multidimensional approach emphasizes where people, assets, and critical systems are located, how vulnerable they are, and whether local institutions can respond effectively.

The answer will carry direct implications for United States government agencies' roles in HA/DR. USINDOPACOM's area of responsibility (AOR) spans 38 countries, about 52% of the earth's surface, and over 50% of the global population.[1] It encompasses a wide range of risk environments and response conditions. With over 375,000 military and civilian personnel and a number of longstanding regional partnerships, USINDOPACOM, as the largest of the U.S. armed forces' geographic combatant commands, plays a central role in supporting large-scale disaster response operations and promoting the development of coping capacity across the region.[2]

Existing risk assessments often emphasize hazard occurrence or aggregate risk scores without fully capturing the underlying drivers that determine disaster impacts and demand for response operations. This absence creates a gap between how disaster risk is measured and how HA/DR operations are planned. To address this gap, this report will apply a cluster-based analytical approach and multidimensional risk framework to assess disaster trends across the Indo-Pacific. By examining the interactions among hazards, exposure, vulnerability, and coping capacity, the analysis seeks to distinguish between changes in hazard patterns and changes in underlying risk conditions.

Ultimately, the goal of this report is to translate findings into actionable insights for USINDOPACOM planners by clarifying what is driving disaster impacts in the region and what those drivers might imply for the scale, frequency, and nature of future HA/DR operations.

1 U.S. Indo-Pacific Command, "About USINDOPACOM," accessed 11 April 2026, https://www.pacom.mil/about-usindopacom/.

2 Ibid.

Methodology and Framework

This study employs a mixed-methods approach that integrates two complementary strands of analysis. The first is a quantitative analysis of structured disaster event data to identify trends in hazard frequency, reported mortality, economic loss, and urbanization. The second is a qualitative analysis that draws on regional expertise and country-level HA/DR capacity assessments to contextualize those statistical findings.

Quantitative Approach

The quantitative analysis informs the identification of priority hazard types and their association with higher-risk geographic clusters.

The primary quantitative dataset is drawn from EM-DAT, the international disaster database, maintained by the Centre for Research on the Epidemiology of Disasters (CRED).[3] The disaster counts, hazard types, and impact measures presented in the graphs and tables are based on EM-DAT records, which include only events that meet specific impact thresholds (e.g., deaths, affected population, or emergency declarations).[4] As a result, the dataset does not capture all hazard event occurrences. These data were then aggregated by cluster. To reduce volatility in annual observations, each indicator is generally visualized using a three-year moving average.

The analysis covers the period 2000-2025. Disaster events were filtered according to EM-DAT disaster types and subtypes, including but not limited to tropical cyclones (including typhoons and severe tropical storms), riverine and flash floods, earthquakes, volcanic eruptions, landslides, droughts, and storm surges.[5]

To prevent distortions in the analysis results, three events that affected four countries and, therefore, account for four records in EM-DAT, were treated as outliers and excluded: the 2004 Indian Ocean tsunami, which affected Indonesia and Sri Lanka; Cyclone Nargis, which struck Myanmar in 2008; and the 2011 Great East Japan "Tōhoku" Earthquake. These disasters were the only events among the 2,378 recorded natural hazard incidents during the study period to result in more than 10,000 fatalities each; collectively, they account for approximately 75% of all fatalities and 30% of total economic damage, and their inclusion would therefore exert undue influence on the interpretation of long-term trends.[6]

To support the exposure and vulnerability analysis, additional sources supplement the EM-DAT data. World Bank World Development Indicators (WDI) provided information related to GDP per capita, urban population share, and coastal population density, all of which were used as proxies for socioeconomic exposure. As 2025 GDP and population figures were unavailable for all countries and multi-year GDP data were incomplete for some island states, missing values were systematically imputed. GDP estimates were generated using the average annual growth rate from the most recent available years, while population and urban population figures were imputed by carrying forward the latest available values. This approach was adopted to preserve consistency and reproducibility in the dataset.[7]

The analysis also incorporates the INFORM Risk Index to strengthen country-level comparisons of hazard and exposure, vulnerability, and coping capacity. In addition, USINDOPACOM historical HA/DR operation records and after-action reports were used to assess past operational demands and response footprints.[8] Where multiple sources were available for the same variable, priority was given to the source with the longest consistent time series and the broadest country coverage.

3 Ibid.

4 Ibid; World Bank, World Bank Open Data, https://data.worldbank.org.

5 Note that population data is available through 2024 only; population figures for 2025 are not included in this analysis.

6 Appendix III: Disaster Trend Analysis.

7 Appendix III: Disaster Trend Analysis.

8 In instances where data from multiple sources related to the same variable were available, the source with the longest consistent time series and broadest country coverage was prioritized. Discrepancies between sources were flagged and, where material, documented in the relevant appendix tables.

Qualitative Approach

The qualitative analysis helps explain variations that aggregate data alone cannot capture; these variations include the role of governance quality, pre-positioned assets, and bilateral defense relationships in mediating disaster outcomes.

Understanding disaster risk in the Indo-Pacific requires moving beyond a narrow focus on disaster occurrences. While the number of reported disaster events has increased over time, this metric alone does not sufficiently capture the evolving nature of risk. Rather, disaster outcomes are shaped by the interaction of hazards, exposure, vulnerability, and coping capacity, which together determine the scale and severity of impacts and how response efforts are carried out. This analytical framework thereby adopts a multidimensional risk lens, recognizing that increases in disaster impacts may be driven as much by socioeconomic changes as by changes in hazard frequency or intensity.

To ensure analytical consistency, this study uses standardized terminology aligned with the Sendai Framework for Disaster Risk Reduction.[9] At its core, disaster risk is conceptualized in contemporary literature as the interactions among four primary components:

- **Hazard**: A process, phenomenon, or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption, or environmental degradation.
- **Exposure**: The situation of people, infrastructure, housing, production capacities, and other tangible human assets located in hazard-prone areas.
- **Vulnerability**: The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards.
- **Coping Capacity**: The ability of people, organizations, and systems, using available skills and resources, to manage adverse conditions, risk, or disasters. The capacity to cope requires continuing awareness, resources, and good management both in normal times and during disasters or adverse conditions.

Thus, a **disaster** occurs when these elements intersect in a way that overwhelms local response capacity and results in human, economic, and environmental losses. This distinction is important because hazards and disasters are not interchangeable. Hazards are the physical phenomena, whereas disasters are the social and operational consequences that occur when those phenomena intersect with the populations and systems that are insufficiently protected or insufficiently able to respond. This framing is especially relevant in the Indo-Pacific, where exposure is high yet impacts vary significantly across countries due to differences in governance, infrastructure, and socioeconomic conditions.

Accordingly, this report treats disasters not as isolated natural events but as the outcome of a broader risk system. This system includes the physical characteristics of hazards, the distribution of exposed populations and assets, the structural vulnerabilities that magnify damage, and the coping capacities that determine whether countries can absorb shocks without requiring large-scale external assistance. This framing also aligns with the Indo-Pacific region's contemporary disaster risk practice, which increasingly emphasizes impact-based forecasting and risk assessment models that focus not simply on "what the weather will be" but on "what the weather will do."[10]

9 United Nations Office for Disaster Risk Reduction, "Disaster Risk Reduction Terminology," accessed 11 April 2026, https://www.undrr.org/drr-glossary/terminology.

10 United Nations Economic and Social Commission for Asia and the Pacific, Seizing the Moment: Targeting Transformative Disaster Risk Resilience (Bangkok: ESCAP, 2023).

Limitations

Several data and methodological limitations should be noted. They include reporting heterogeneity, the challenge of coding compound and cascading events, the subjectivity inherent in qualitative assessments, and the influence of high-magnitude outliers.

Reporting Heterogeneity

As EM-DAT relies on data reported by national governments, international organizations, and the media, reporting quality and thresholds vary significantly across countries and over time. These variations can lead to instances where apparent trends in disaster frequency may partly reflect improvements in observation and reporting capacity rather than genuine changes in event occurrence. This study mitigates this limitation by focusing primarily on impact metrics (deaths, affected persons, economic losses) rather than raw event counts, and by using decade-level rather than annual comparisons where feasible.

Compound and Cascading Events

Disasters are recorded as discrete events in the EM-DAT database; however, many significant Indo-Pacific disasters involve compounding hazards – e.g., an earthquake triggering a tsunami and landslides. Attribution of impacts to individual hazard types in such cases introduces uncertainty. Where compound events are identified, they are flagged and, where possible, disaggregated in the analysis.

Exclusion of High-Magnitude Outliers in Data Visualization

Certain catastrophic events generate impact figures so extreme that their inclusion in time-series charts obscures underlying patterns of recurrent, lower-magnitude disaster activity. Notable examples include the 2011 Great East Japan "Tōhoku" Earthquake and the 2004 Indian Ocean tsunami, which was centered off Sumatra but impacted multiple countries. In selected visualizations, these outlier events are excluded to allow seasonal fluctuations and long-term trends in more frequent hazards to remain legible. Where exclusions are applied, they are noted in the relevant figure caption, and the full data inclusive of outlier events are presented in the accompanying appendix tables.

Qualitative Assessment Subjectivity

Country-level HA/DR capacity assessments are based on publicly available government documents, multilateral reporting, and analyst judgment. These assessments reflect conditions at the time of data collection and may not capture recent organizational or capability changes. Where uncertainty remains significant, findings are presented as preliminary assessments requiring further validation rather than as definitive conclusions.

Analytical Tiers

To operationalize the report's multidimensional risk framework across a large and highly diverse region, this report uses a layered analytical structure composed of regional, cluster, and country-level analysis. The study was deliberately designed to avoid relying solely on individual country case studies, which would have made broad comparison difficult. Instead, the cluster approach allows the team to compare countries that share hazard exposure profiles and similar geographic, economic, infrastructural, or demographic characteristics while still preserving enough variation for a more tailored interpretation.

At the regional level, the analysis examines broad disaster trends and occurrences across the Indo-Pacific and situates them within the region's strategic significance. This contextualization matters because the Indo-Pacific is not only highly disaster-prone but is also central to U.S. alliance structures, trade routes, basing access, and broader resilience planning.

At the cluster level, the study groups countries into four broad categories based on shared hazard profiles and operational characteristics. The **Mainland and Coastal Asia** cluster consists largely of monsoon-affected states with high flood exposure and uneven resilience. The **Maritime Southeast Asia** cluster includes coastal and archipelagic states with exposure to rapid-onset hazards alongside logistics-intensive response needs. The **Small Pacific Island States** cluster includes Pacific islands and strategic territories with high exposure, remoteness, and narrow economic bases. Lastly, the **Western Pacific Region** cluster includes higher-capacity allies and partners with stronger institutions and greater capacity to generate surge support, including rapid mobilization of personnel, logistics, and humanitarian assistance during large-scale disaster responses. This framework is not intended to minimize differences that exist at the country level; rather, the intention is to provide a manageable and strategically legible structure for identifying patterns in disaster exposure, vulnerability, and response needs across an AOR of over 30 countries and territories. Figure 1 displays a map of the four clusters used in this analysis.

At the country level, the study considers how specific national conditions shape outcomes within each cluster. Here, the analysis incorporates differences in population growth, urbanization, GDP, infrastructure, and prior dependence on external assistance amongst all the clusters. There is a need to understand and analyze not just hazard and exposure variables, but also vulnerability, coping capacity, and external influences such as governance stability and openness to outside support. Importantly, coping capacity is being disaggregated from external influences in the context of this report as coping capacity relates to the theoretical ability of a country to manage a disaster with its own resources. This dimension stands in contrast to external influences, which are meant to better account for the greater context of an issue within the geopolitical environment. In this way, external influences account for context and coping capacity accounts more for theoretical ability and preexisting infrastructure.

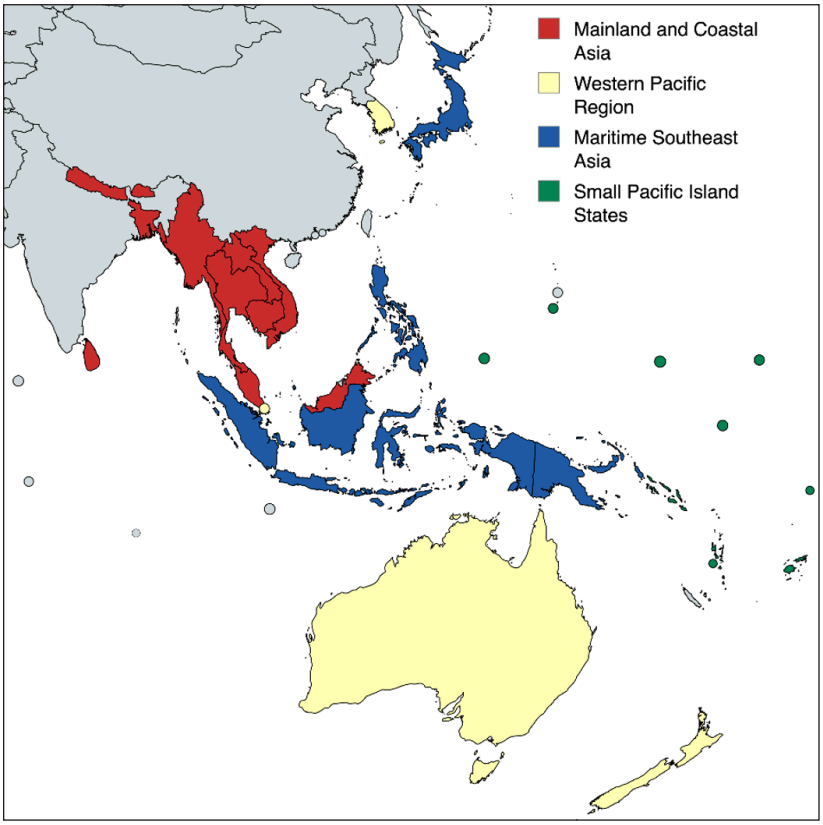


Figure 1: Indo-Pacific Clusters

Overall, this three-tiered approach ensures that country-level specifications are preserved within broader regional and cluster patterns, enabling more precise and context-sensitive HA/DR planning and response.

Research Hypotheses

This analytical framework is guided by related hypotheses. **First, the report hypothesizes that rising disaster losses in the Indo-Pacific are not explained by hazard occurrence alone.** Instead, reported increases in damage and disruption are expected to reflect a combination of hazard exposure, expanding populations, and uneven national coping capacity. Heightened risk results from a combination of disaster trends and socioeconomic and capacity-related factors rather than from solely an increase in disaster numbers.

Second, the report hypothesizes that disaster impacts vary substantially across clusters, as hazards interact with distinct patterns of geography, settlement, infrastructure, and institutional readiness. For example, a flood in a densely populated delta, a typhoon in an island archipelago, and an earthquake in a high-capacity advanced economy may all be severe, but they do not generate the same downstream logistical and operational burdens.

Risk Assessment Analysis

To evaluate these hypotheses, this report adopts a mixed-methods risk assessment framework structured around four dimensions: hazard and exposure, vulnerability, coping capacity, and external influences. It draws on existing assessments from international and institutional sources and leverages current risk indicator data to support a coherent and methodologically sound analysis.[11]

Quantitative Components

- Disaster frequency and type (EM-DAT)
- Economic loss metrics (% GDP, per capita)
- Mortality rates (per 100,000)
- Exposure indicators (population, urbanization)

Qualitative Components

- Literature review of regional risk assessments
- Institutional and governance analysis
- Conversations with subject matter experts

Through an initial cross-analysis of existing assessments, a consistent pattern emerges across risk classifications when viewed through the combined lenses of hazard and exposure, vulnerability, and coping capacity. Drawing on the INFORM Risk Profile and aggregating its component risk scores according to this report's clustering framework, the analysis finds that areas categorized as lower risk under INFORM generally align with the clustering framework laid out by the team, while higher-risk areas correspond with clusters characterized by greater structural vulnerability and weaker coping capacity.[12] This alignment lends added support to the team's clustering approach by demonstrating that the groupings developed for this study are not only analytically useful, but also broadly consistent with established risk assessment frameworks.

Figure 2 illustrates the INFORM Risk Index classifications of regional countries. According to INFORM, which uses a monotone scale, countries categorized with the highest risk are identified by a dark red color and countries at very low risk are indicated by a pink color.

Figure 3 takes the INFORM scoring system and plots hazard and exposure, vulnerability, and coping capacity sub-scores to visualize the general risk of each cluster. INFORM gives each country a risk score of 1-10 (1 being the lowest risk and 10 the highest) for each of the dimensions, categories, and components of risk. Larger triangular representations illustrate greater risk, based on the three components assessed, whereas smaller triangular representations indicate less risk. This visualization illustrates alignment between INFORM and the clustering system used by the team in this study. An example of how to read the visualization is that Western Pacific Region cluster countries have lower risk scores across all three variables, whereas Maritime Southeast Asia countries bear greater risk due to the hazards and exposure component with a risk score of 6/10.

11 Information was sourced from the European Commission's INFORM Risk Profile, Germanwatch Climate Risk Index, and the National Center for Disaster Preparedness' Climate Finance Vulnerability Index

12 European Commission, "INFORM Risk," Disaster Risk Management Knowledge Centre, accessed 16 April 2026, https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk.

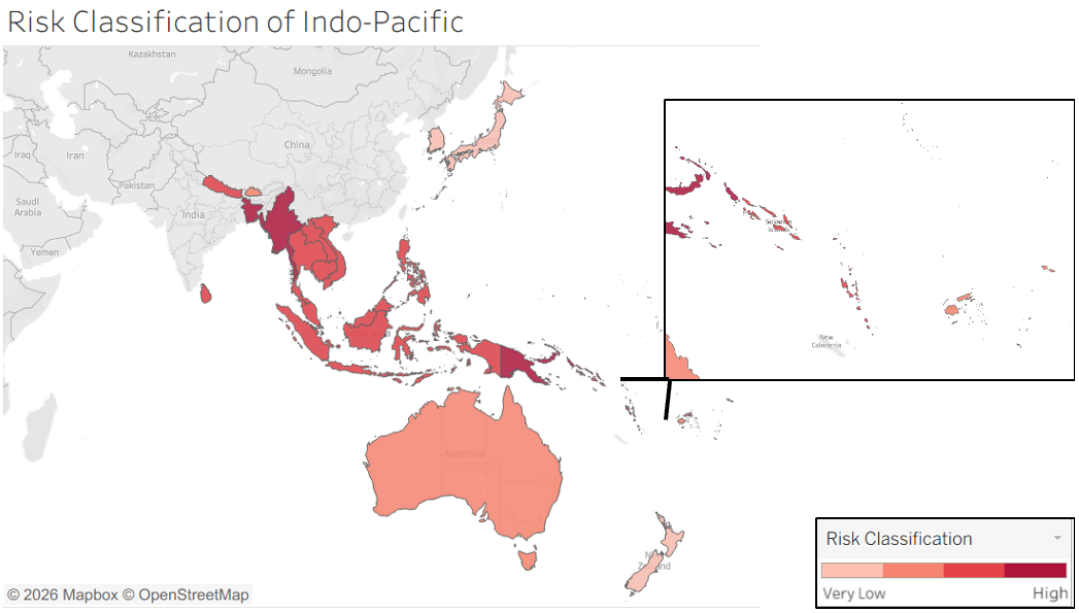


Figure 2: Indo-Pacific Risk Classifications from INFORM Risk Profile Scoring

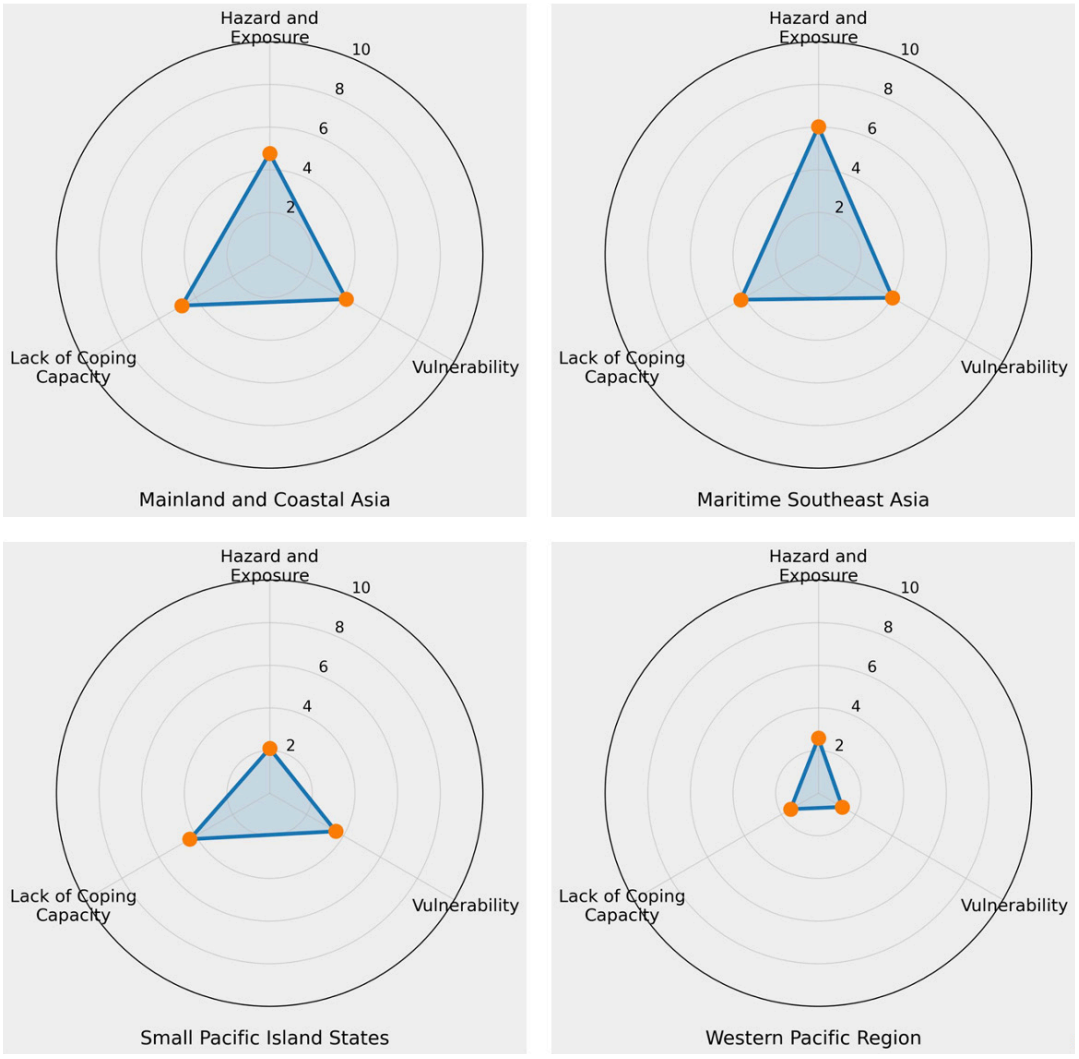


Figure 3: Cluster-Based Risk Classifications from INFORM Risk Profile Scoring (1-10: 1 being lowest and 10 highest risk)

This expanded risk assessment framework builds on existing literature while incorporating this study's cluster-based approach and expanding the traditional dimensions of hazard and exposure, vulnerability, and coping capacity to include a fourth dimension – external influences. This addition integrates established risk assessment methodologies with a distinct operational lens by explicitly accounting for HA/DR response dynamics and implications. In doing so, the framework extends beyond conventional industry risk assessments by linking underlying risk conditions to the practical realities of disaster response and strategic planning. Figure 4 illustrates this framework through its inclusion of dimensions, categories, sub-categories, components, and sub-components.

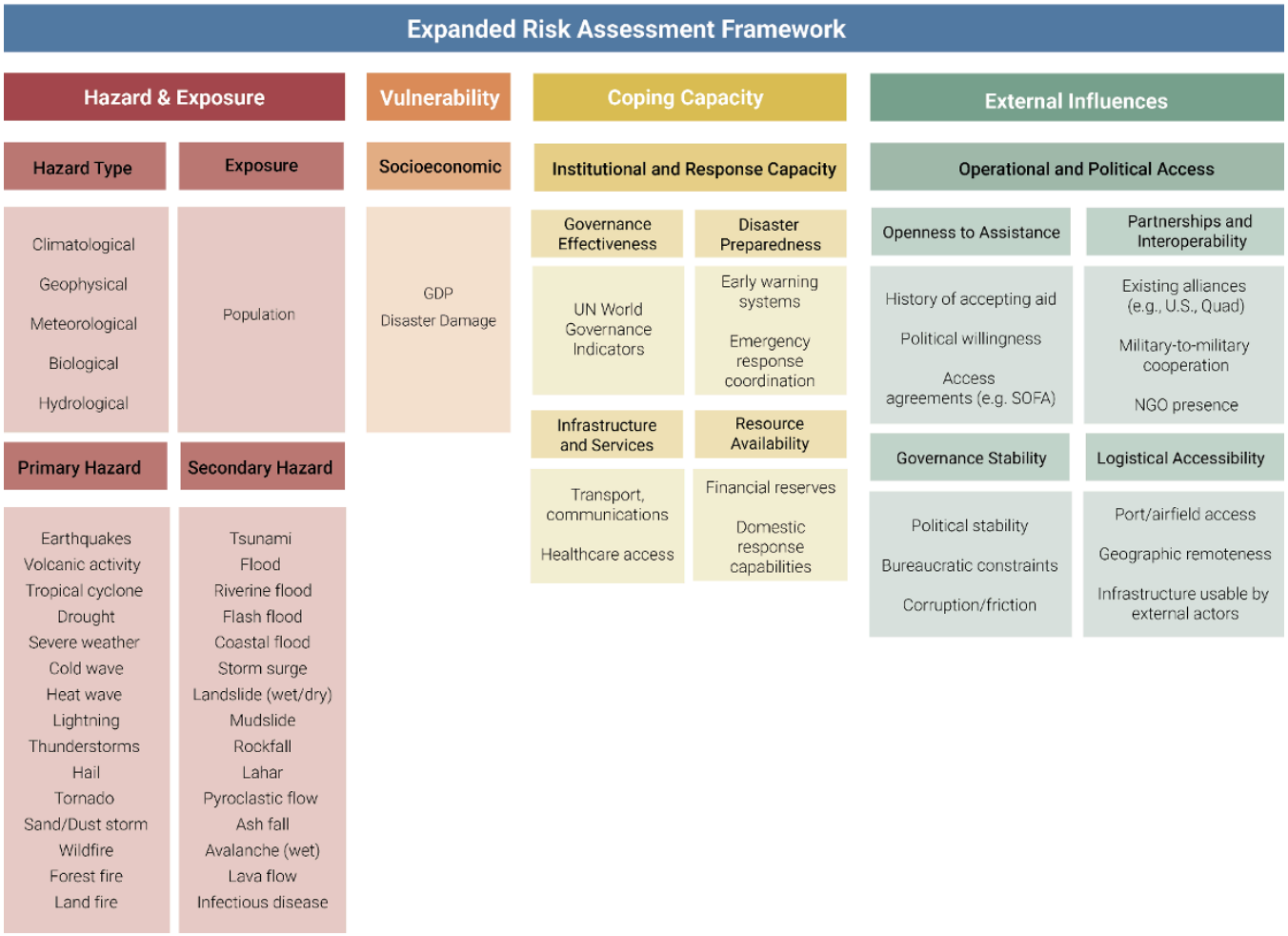


Figure 4: Expanded Risk Assessment Visual Mapping

Hazard and Exposure

This dimension captures the physical foundations of disaster risk by focusing on both the types of hazards affecting the Indo-Pacific and the populations and assets exposed to them. While hazard frequency is often used as a primary indicator, this study finds that hazard occurrence alone does not fully explain disaster impact. Instead, risk is driven by the interaction between hazard characteristics and patterns of exposure.

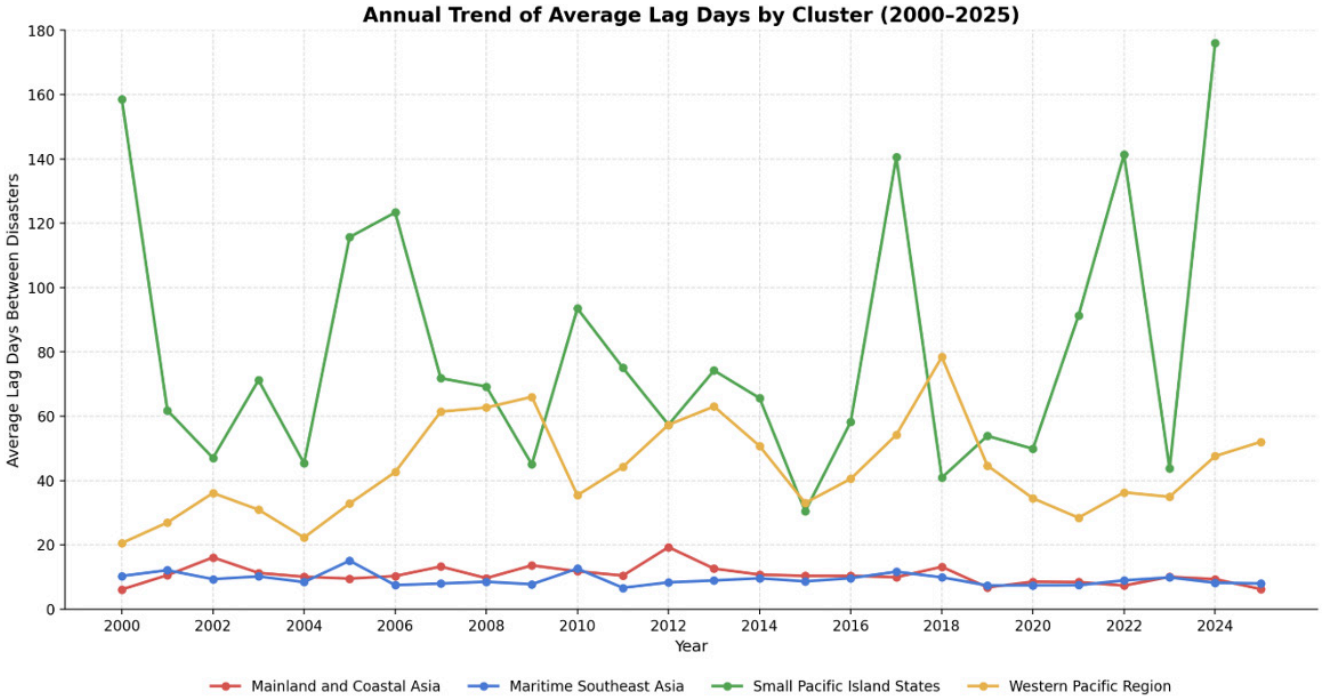
Hazards in the Indo-Pacific include a wide range of meteorological, hydrological, and geophysical phenomena, such as tropical cyclones, flooding, earthquakes, and drought. These hazards are unevenly distributed across the region in a reflection of geographic and climatic variation. Exposure is shaped by population density, urbanization patterns, and the concentration of infrastructure and economic activity in hazard-prone areas. Together, hazard characteristics and exposure conditions establish the baseline context in which disasters occur.

To operationalize this dimension, the analysis incorporates both events-based indicators (e.g., disaster frequency, type, and severity) and structural indicators (e.g., population distribution and development patterns).

This approach allows for a more comprehensive assessment of risk by accounting for both the occurrence of hazards and the scale of what is potentially affected.

In addition to spatial patterns, the framework also considers the temporal dynamics of hazard occurrence. Primary and secondary hazards are examined through a tiered approach that accounts for potential sequencing and interaction between events. **Lag times**, seen in the context of lag days between disasters, are used as an analytical tool to explore how closely spaced events may influence overall risk conditions, especially in contexts where recovery processes overlap.

In the initial analysis of the EM-DAT dataset, a pattern emerges in which the Mainland and Coastal Asia and Maritime Southeast Asia clusters experience consistently shorter intervals between disaster events. With an average of approximately 7–15 days, this lag pattern points to limited recovery space between disasters. Meanwhile, the Small Pacific Island States cluster exhibits much longer and more volatile intervals. This differentiation can suggest a different but still operationally significant form of temporal risk. Graph 1 illustrates the year-on-year change in average lag days, by cluster.



Graph 1: Annual Trend of Average Lag Days by Cluster

Vulnerability

The vulnerability dimension captures the socioeconomic and structural conditions that influence the degree to which exposed populations and systems are susceptible to harm. While hazards and exposure establish where risk exists, vulnerability determines the extent to which those risks translate into adverse outcomes. In other words, vulnerability is not inherent to hazards themselves but is instead shaped by underlying social, economic, and environmental factors.

In the Indo-Pacific, vulnerability varies significantly across countries and subregions. It reflects differences in development, governance, infrastructure, and access to resources. Factors such as income levels, economic dependence, infrastructure quality, and social inequality all influence the ability of communities to withstand and absorb shocks. Populations that possess limited access to resilient infrastructure, health care, and financial resources are more likely than populations with greater access to experience disproportionate impacts, even when exposed to similar hazard conditions.

To operationalize vulnerability within this study, the analysis considers indicators that reflect both economic sensitivity and structural fragility. These include measures such as economic losses relative to GDP; dependence on agriculture, heavy industry, and imported energy; and broader development constraints. By incorporating these elements, the framework captures how systemic conditions shape the severity of disaster impacts beyond the initial hazard event.

Coping Capacity

Coping capacity reflects the ability of countries, institutions, and communities to prepare for, respond to, and recover from disaster events. While vulnerability captures susceptibility to harm, coping capacity captures the mechanisms available to manage and mitigate that harm once a hazard event occurs. Together, these dimensions determine whether exposed systems absorb shocks independently or require external assistance. Countries with stronger institutional capacity and more robust infrastructure are generally better positioned to respond rapidly and limit cascading impacts.

Within this study, coping capacity is assessed through indicators that reflect both preparedness and response capabilities. These indicators include governance effectiveness and variables related to reliance on foreign aid contributions.

By incorporating coping capacity as a distinct analytical dimension, the framework emphasizes that disaster outcomes are not solely determined by exposure or vulnerability but also by the ability of systems to manage disruption in real time or during recovery phases.

External Influences

Given this study's focus on HA/DR operational implications, this section considers how external factors shape the environments in which disaster response occurs. While hazard, exposure, vulnerability, and coping capacity provide the primary foundation for assessing disaster risk, they do not fully capture the operational conditions that influence how response efforts are carried out.

External influences encompass governance structures, political stability, and the degree of openness to international assistance from the perspective of U.S. and partner engagement. These factors shape not only how disasters are managed domestically but also whether and how external actors, including the U.S. and regional partners, can support response efforts. Variations in governance effectiveness, coordination mechanisms, and regulatory environments can affect the speed, scale, and accessibility of HA/DR operations.

This distinction is important in relation to coping capacity. In this report, coping capacity refers to a country's internal disaster management systems and infrastructure, while external influences refer to the broader operating environment in which those systems function. In other words, coping capacity reflects what a country can do, whereas external influences shape how external support can be delivered and integrated.

In the Indo-Pacific, factors of external influence are especially salient, as countries differ widely in their willingness and capacity to receive external assistance and in their relationships with international partners. While not a primary analytical variable in this study, these conditions shape how disaster risk translates into operational demand and response feasibility across different contexts. As such, they provide important context for interpreting how underlying risk conditions may influence HA/DR planning and engagement.

Regional and Cluster Analysis

As this project seeks to identify and analyze broader trends across the Indo-Pacific, a selection of 32 countries and territories from the USINDOPACOM AOR was chosen to represent some of the region's most disaster-affected environments.[13]

These countries and territories were further categorized into four clusters to support both current and future analysis. These clusters were developed through a mixed analytical approach rather than through a purely quantitative clustering model. Countries were grouped based on a synthesis of hazard exposure patterns, socioeconomic structure, and qualitative expert judgment. The clusters reflect not only the types of hazards states most frequently face but also the conditions that shape disaster response outcomes. Expert judgment was used to refine these groupings where shared strategic and operational features made the clusters more analytically useful. The resulting framework is therefore intended to capture and understand disaster risk and response dynamics across the Indo-Pacific.

This clustering system is intended to help clarify recommendations, visualize broader regional trends, and support both briefing needs and wider strategic analysis. It also creates a structure that can be expanded in future iterations, as country-by-country raw metrics and analysis provide the foundation for all qualitative cluster measures used in this report. At the same time, this approach has limitations. As it prioritizes broad trend analysis, it may be less useful for individual countries seeking highly tailored guidance for improving national disaster management systems.

To support the analysis and build a more contextual understanding of the USINDOPACOM AOR, this report assesses disaster vulnerability and resilience across four distinct clusters.

"Mainland and Coastal Asia" comprises monsoon-dependent countries with high flooding risk and varying disaster preparedness levels. It includes key economies. This cluster shares land borders with China and Russia and has access to both the South China Sea and Bay of Bengal, a geographic position that demonstrates its strategic significance to USINDOPACOM.

"Maritime Southeast Asia" consists of coastal and island nations in the First Island Chain. They have high exposure to extreme weather events and variable economic resilience, and they include critical U.S. allies, some of which host U.S. military bases. The political institutions and sophistication of infrastructure of countries in this cluster vary significantly.

"Small Pacific Island States" encompass small island developing economies with limited infrastructure, high disaster exposure (particularly tropical storms and droughts), and strategic value as military waypoints. This combination makes these islands vulnerable to both primary disasters and secondary effects like disease outbreaks and food insecurity. These countries' weaker economies and lack of strong enforcement mechanisms heighten the risk that extreme disasters pose.

Lastly, the "**Western Pacific Region"** represents the region's wealthiest and most institutionally resilient states, with sophisticated urban infrastructure, strong disaster preparedness, and the highest levels of economic resilience. These countries will serve as a model for disaster preparedness in the Indo-Pacific. Countries in this cluster, such as Australia and South Korea, are key military allies to both the United States and the West as a whole.

Across all clusters, tropical storms and flooding emerge as the predominant hazards. Secondary risks vary significantly based on infrastructure quality and economic stability. In particular, secondary risks such as disease outbreaks and food insecurity disproportionately threaten lower-income clusters with weaker infrastructure and more limited state capacity. The structured analysis highlights stark disparities in disaster preparedness across the region. While Western Pacific Region countries such as South Korea have implemented advanced "smart city" systems indicative of their comparatively rich resources and the Small Pacific Island States have invested

13 China, India, and Mongolia were left out of this analysis at the request of CFE-DM.

in weather-resilient infrastructure with international support, the Mainland and Coastal Asia, Maritime Southeast Asia, and Small Pacific Island States clusters generally require substantially more aid to prevent cascading impacts after disaster events.[14]

The geographic diversity of the Indo-Pacific region, ranging from landlocked areas to archipelagos to dense coastal urban zones, further compounds disaster management challenges. The analysis emphasizes that these countries' strategic importance to the U.S. Department of Defense (DoD) extends beyond hosting forward-deployed forces and critical sea lanes. It also includes their importance to humanitarian assistance, disaster response, and regional stability, with infrastructure resilience in the Western Pacific Region being particularly crucial for maintaining broader Indo-Pacific stability. Improving infrastructure resilience and HA/DR capabilities across all clusters is essential not only for humanitarian response but also for sustaining broader Indo-Pacific stability.

While not within the specific scope of this report, it is crucial to mention that many of the countries in the INDOPACOM AOR actively receive and have benefited from post-disaster aid from international organizations – e.g., United Nations entities, the International Red Cross and Red Crescent Movement, Oxfam, and Save the Children – as well as bilateral support from countries like Australia, which has taken measures to grant aid to many of the small island nations mentioned in this report.



Mainland and Coastal Asia

Bangladesh, Bhutan, Cambodia, Lao PDR, Malaysia, Myanmar, Nepal, Sri Lanka, Thailand, Vietnam

The Mainland and Coastal Asia cluster is unified by shared dependence on monsoon systems and high exposure to severe flooding. It includes economically significant countries with diverse development profiles, political systems, and risk factors. These countries are strategically significant to DoD, as some of them share land borders with China and Russia and many have sea access to the South China Sea and Bay of Bengal. While the countries in this cluster share broad exposure to natural hazards, they vary considerably in disaster preparedness, emergency management infrastructure, access to resources during crises, and economic resilience to absorb disaster-related shocks.

This cluster represents a wide spectrum of disaster vulnerability and response capacity across South and Southeast Asia. Geography exposes its component countries to a range of natural hazards, including cyclones, floods, landslides, earthquakes, and drought, all driven by monsoonal climates, major river basin systems, and proximity to tectonic faults. Bangladesh, Myanmar, Nepal, and Vietnam are among the most exposed countries; they face recurring severe flooding, typhoons, and seismic events. Meanwhile, Cambodia and Lao PDR face recurring flood and drought risks associated with the Mekong River system.[15] By contrast, Malaysia and Thailand represent the cluster's more developed members, with established early warning systems, trained national rescue teams, and formal legislative frameworks for disaster risk management.[16] Bhutan, Cambodia, Lao PDR, and Myanmar have more limited institutional infrastructure and smaller economies, characteristics that constrain their capacity to respond effectively to major disaster events.

14 Jaekyoung Kim, Jung-Min Lee, and Junsuk Kang, "Smart Cities and Disaster Risk Reduction in South Korea by 2022: The Case of Daegu," *Heliyon* 9, no. 8 (August 2023): e18794, https://doi.org/10.1016/j.heliyon.2023.e18794.

15 Mekong River Commission (MRC), "Flood and Drought," accessed 16 April 2026, https://www.mrcmekong.org/flood-and-drought.

16 Center for Excellence in Disaster Management & Humanitarian Assistance, *Thailand Disaster Management Reference Handbook*, May 2025, https://www.cfe-dmha.org/LinkClick.aspx?fileticket=Lzww4BKKIlk%3d&portalid=0; Asian Disaster Reduction Center, "Malaysia Country Report FY2024," 2024, https://www.adrc.asia/countryreport/MYS/2024/Malaysia_CountryReport_FY2024.pdf.

Preexisting Disaster Infrastructure and DoD Involvement

DoD maintains an active HA/DR footprint across this cluster through recurring exercises, bilateral training programs, and regional disaster response initiatives. In Bangladesh and Nepal, U.S. Army Pacific regularly conducts the Pacific Resilience Disaster Response Exercise and Exchange, bringing together disaster response professionals from across the Indo-Pacific for combined tabletop and field training.[17] The U.S. also co-hosts the long-running Cobra Gold exercise with Thailand; this exercise has included large-scale HA/DR components involving Thai, Malaysian, and other regional partners for decades.[18] In Malaysia, DoD has built a sustained partnership through the National Guard's State Partnership Program, which has facilitated civilian and military disaster response coordination.[19]

In Sri Lanka, cooperation has included humanitarian and civil-military engagement activities such as Pacific Angel, which focuses on disaster preparedness, medical support, and civil-military coordination.[20] U.S.-Vietnam HA/DR cooperation is more limited but has expanded in recent years through disaster preparedness training and broader defense engagement.[21] Cambodia represents a notable gap, as joint exercises under the Angkor Sentinel program were suspended in 2017 amid Cambodia's expanding military ties with China's People's Liberation Army.[22] However, it appears this gap may be closing, with plans to potentially restart the Angkor Sentinel program in late 2026.[23] Engagement with Lao PDR is limited in scope and occurs primarily through multilateral frameworks, such as the Lower Mekong Initiative Disaster Relief Exercise and Exchange, rather than dedicated bilateral exercises. Bhutan has no formal bilateral defense or diplomatic relationship with the United States.[24]

Altogether, these engagements reflect a broad but uneven U.S. HA/DR presence across the cluster. Continued work to expand and regularize that presence, particularly in countries where engagement is nascent or constrained, could help close gaps that might otherwise leave regional response capacity short in a major disaster event.



Maritime Southeast Asia

Indonesia, Japan, Papua New Guinea, Philippines, Timor-Leste

The Maritime Southeast Asia cluster consists of countries defined by coastal populations, mountainous terrain, and island chains.[25] Its members are highly susceptible to damage from extreme weather and geophysical events, but they display major variations in economic resilience, disaster management, and response infrastructure.[26] These countries are especially important for DoD, as they include critical regional allies and occupy key positions

17 Sgt. 1st Class Corey Ray, "US Army Pacific, Nepali Army Co-Hosts Disaster Response Exercise," The United States Army, 26 September 2018, https://www.army.mil/article/211615/us_army_pacific_nepali_army_co_hosts_disaster_response_exercise

18 Washington Military Administrator, "WA Guard, Thai Exchange Expands Disaster Response Topics," *Washington Military Department*, 20 February 2025, https://mil.wa.gov/news/wa-guard-thai-exchange-expands-disaster-response-topics.

19 Staff Sgt. Adeline Witherspoon, "Washington Guard Hosts Disaster Response Training with Malaysian Partners," *National Guard*, 14 November 2025, https://www.nationalguard.mil/News/Article-View/Article/4331715/washington-guard-hosts-disaster-response-training-with-malaysian-partners/.

20 U.S. Embassy Sri Lanka, "United States and Sri Lanka Launch Multilateral PACIFIC ANGEL (Pac Angel) 25 Exercise to Enhance Disaster Response," 8 September 2025, https://lk.usembassy.gov/united-states-and-sri-lanka-launch-multilateral-pacific-angel-pac-angel-25-exercise-to-enhance-disaster-response/.

21 Sgt. 1st Class Timothy Hughes, "Pacific Friendship 2025: U.S. Army Deploys to Vietnam for Humanitarian Engagement," *U.S. Embassy & Consulate in Vietnam*, 11 September 2025, https://vn.usembassy.gov/pacific-friendship-2025-u-s-army-deploys-to-vietnam-for-humanitarian-engagement/.

22 Heang Tong, "Angkor Sentinel Resurfaces as Cambodia Reasserts Strategic Equilibrium," *Cambodianess*, 24 February 2026, https://cambodianess.com/article/angkor-sentinel-resurfaces-as-cambodia-reasserts-strategic-equilibrium.

23 Ibid.

24 Mekong-U.S. Partnership, "Mekong-U.S. Partnership Plan of Action 2024–2026," August 2024, https://mekonguspartnership.org/wp-content/uploads/2024/08/MUSP-Plan-of-Action-2024-2026-1.pdf; U.S. Department of State, "U.S. Relations with Bhutan," last updated 2024, https://2021-2025.state.gov/u-s-relations-with-bhutan/.

25 World Meteorological Organization, *State of the Climate in Asia 2024* (Geneva: World Meteorological Organization, 2025), https://wmo.int/publication-series/state-of-climate-asia.

26 Ibid.

in the First Island Chain.[27] Strategic relevance of this cluster is heightened by the presence of U.S. bases that are vulnerable to impacts from hazard events. Overall, the cluster exhibits substantial variation in resilience and preparedness, with clear implications for long-term vulnerability.

Preexisting Disaster Infrastructure and DoD Involvement

The countries in this cluster are highly exposed, but they differ significantly in the infrastructure and institutional capacity available to respond.[28] Japan has one of the world's most sophisticated disaster response systems, and it shares characteristics with the Western Pacific Region. Indonesia, Papua New Guinea, the Philippines, and Timor-Leste have smaller economies and more limited state capacity and infrastructure, all elements that can constrain their ability to respond effectively to major disasters.[29] Historically, Japan relied extensively on U.S. assistance to rebuild its economy and support affected populations in the aftermath of World War II. Today, Indonesia, Papua New Guinea, Philippines, and Timor-Leste remain recipients of U.S. assistance.[30] These countries also often depend on the international community for humanitarian aid, technical support, and policy development to address the risks posed by their natural environments.[31]

Small Pacific Island States

American Samoa, Fiji, Guam, Kiribati, Marshall Islands, Micronesia, Nauru, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

The countries of this cluster also vary in the depth of their interaction with the U.S. military. Japan is the only state in this group that hosts permanent military bases, though all members maintain some level of military cooperation with the U.S.[32] Overall, the combination of military cooperation and dependence on external assistance suggests continued opportunities for long-term HA/DR coordination and partnership.

The Small Pacific Island States cluster is defined by small and developing economies with high exposure. These countries and territories also share important geographic similarities; they are islands of considerable strategic value for military operations, including as potential anchorage, landing, and refueling points for trans-Pacific travel.[33] Their disaster risk drivers include tropical storms and droughts.[34] Limited preexisting developed infrastructure across many of these islands, combined with dependence on subsistence agriculture, heightens susceptibility to secondary risks such as fires, waterborne disease outbreaks, malnutrition, and other public health crises.[35]

Due to the smaller size of these economies and their dependence on external actors, it is difficult to fully define the scope of their exposure to economic losses from natural disasters. However, these nations are all highly

27 U.S. Department of State, A Free and Open Indo-Pacific: Advancing a Shared Vision (Washington, DC: U.S. Department of State, 4 November 2019), https://www.state.gov/wp-content/uploads/2019/11/Free-and-Open-Indo-Pacific-4Nov2019.pdf.

28 ESCAP, *Asia-Pacific Disaster Report 2023*.

29 World Bank, "World Bank Tokyo Disaster Risk Management (DRM) Hub," accessed 16 April 2026, https://www.worldbank.org/en/programs/tokyo-drm-hub.

30 Congressional Research Service, *U.S. Foreign Aid to East and South Asia: Selected Recipients*, RL31362 (Washington, DC: Congressional Research Service, 15 June 2007), https://www.everycrsreport.com/reports/RL31362.html.

31 Global Facility for Disaster Reduction and Recovery (GFDRR), *Stories of Impact: Building Climate and Disaster Resilience in Timor-Leste* (Washington, DC: World Bank, 3 November 2016), https://www.gfdrr.org/sites/default/files/publication/GFDRR_Stories%20of%20Impact%20Timor-Leste%20ACP-EU_0.pdf.

32 George Riebling, "U.S. Military Bases in Japan: Strategic Roles & Locations," *MyBaseGuide*, 18 September 2025, https://mybaseguide.com/military-bases-in-japan.

33 Charles Edel, Kathryn Paik, and John Augé, "Shifting Tides: The National Security Implications of the United States' Pacific Drawdown," Center for Strategic and International Studies, 22 July 2025, https://www.csis.org/analysis/shifting-tides.

34 World Meteorological Organization, "Climate Change Transforms Pacific Islands," 27 August 2024, https://wmo.int/news/media-centre/climate-change-transforms-pacific-islands.

35 Yan Li, Hao Li, and Yi Jiang, "Analysis of the Burden and Trends of Communicable Diseases in Pacific Island Countries from 1990 to 2019," *BMC Public Health* 23, no. 1 (October 2023): Article 2064, https://doi.org/10.1186/s12889-023-16894-z.

susceptible to economic disruptions during disasters. Important factors shaping this vulnerability include reliance on remittances, dependence on subsistence agriculture, industrial fishing as a major source of income in some cases, and continued dependence on foreign aid.[36]

Preexisting Disaster Infrastructure and DoD Involvement

DoD maintains a significant presence across this cluster, with the deepest engagement in the Federated States of Micronesia, the Marshall Islands, and Palau, where Compacts of Free Association grant the U.S. full defense authority and responsibility. In the Marshall Islands, DoD operates the U.S. Army Garrison-Kwajalein Atoll and the Ronald Reagan Ballistic Missile Defense Test Site, which itself suffered severe flood damage in January 2024.[37] In Palau, DoD is constructing a radar facility and expanding the Peleliu airstrip and dock for both defense and HA/DR purposes.[38]

In 2024, DoD established Joint Task Force-Micronesia in Guam and announced over US$2 billion in infrastructure projects, including airfield and seaport modernization efforts.[39] Guam, with roughly 7,000 military personnel, is home to the largest DoD footprint in the Pacific Islands region. However, in 2023, Super Typhoon Mawar exposed severe vulnerabilities in both military and civilian infrastructure and led to requests for over US$1 billion for disaster recovery.[40] In American Samoa, in the wake of Tropical Cyclone Gita (2018), the U.S. Army Corps of Engineers developed a 50-year Post-Disaster Watershed Plan, supported by the Federal Emergency Management Agency (FEMA).[41]

Western Pacific Region

Australia, New Zealand, Singapore, South Korea

In the remaining Pacific Island states, DoD engagement is generally more indirect and occurs through the U.S. Defense Attaché Office and Office of Defense Cooperation, joint HA/DR exercises like Pacific Partnership, and shiprider agreements related to maritime law enforcement.

The Western Pacific Region is defined by sophisticated critical infrastructure concentrated in developed urban hubs, such as Sydney, Australia; and Seoul, South Korea.[42] These countries have some of the region's highest GDPs, which contribute to their economic resilience and overall preparedness for disasters. They are also among DoD's most important regional allies, particularly in terms of logistics, coordination, and surge support.[43] The

36 World Bank, *Macro Poverty Outlook: Central Pacific Islands* (Washington, DC: World Bank, April 2026), https://thedocs.worldbank.org/en/doc/c6aceb75bed03729ef4ff9404dd7f125-0500012021/related/mpo-cpi.pdf.

37 U.S. Department of State, "U.S. Partnership with the Republic of the Marshall Islands," *Office of the Spokesperson*, 20 September 2025, https://www.state.gov/releases/office-of-the-spokesperson/2025/09/u-s-partnership-with-the-republic-of-the-marshall-islands/; United Nations Development Programme (UNDP), "Enhancing Disaster and Climate Resilience in the Republic of the Marshall Islands through Disaster Preparedness and Infrastructure," 24 February 2021, https://www.undp.org/pacific/publications/enhancing-disaster-and-climate-resilience-republic-marshall-islands-through-disaster-preparedness-and-infrastructure.

38 United Nations Development Programme (UNDP), "Palau Disaster Preparedness and Improved Infrastructure," accessed 16 April 2026, https://www.undp.org/pacific/projects/palau-disaster-preparedness-and-improved-infrastructure.

39 U.S. Department of Defense, "Joint Statement on the United States Department of Defense and Federated States of Micronesia Understanding on Shared Force Posture and Infrastructure Priorities," press release, 27 March 2025, https://www.war.gov/News/Releases/Release/Article/4136656/joint-statement-on-the-united-states-department-of-defense-and-federated-states/.

40 Society of American Military Engineers, "In Guam, Infrastructure Resilience, Integrated Response, and Collaboration," *The Military Engineer*, July–August 2025, https://www.same.org/tmearticle/in-guam-infrastructure-resilience-integrated-response-and-collaboration; Andrew Tilghman, *Disaster Recovery Funding for Military Facilities on Guam*, IN12434 (Washington, DC: Congressional Research Service, 1 October 2024), https://www.congress.gov/crs-product/IN12434.

41 U.S. Army Corps of Engineers, Honolulu District, "American Samoa Post-Disaster Watershed Plan," accessed 16 April 2026, https://www.poh.usace.army.mil/Missions/Civil-Works/Civil-Works-Projects/Post-Disaster-Watershed-Plan/.

42 Sinéad Barry et al., *Climate, Peace and Environmental Resilience in the Asia-Pacific Region* (Berlin: adelphi global gGmbH, June 2025), https://weatheringrisk.org/sites/default/files/document/%28Final%29%20Climate%20Peace%20and%20Environmental%20Resilience%20in%20Asia_Pacific_Report_0.pdf.

43 Michael Beckley, Nikolas K. Gvosdev, Connor Fiddler, Shannon Vaughn, Jaehan Park, and Takuya Matsuda, "Strengthening U.S. Alliances in the Indo-Pacific," *Foreign Policy Research Institute*, 26 March 2025, https://www.fpri.org/article/2025/03/strengthening-us-alliances-in-the-indo-pacific/.

Western Pacific Region demonstrates the highest resilience in the region; maintaining that resilience will be essential to broader Indo-Pacific stability.

Preexisting Disaster Infrastructure and DoD Involvement

The advanced disaster infrastructure found in these countries reinforces their resilience and helps reduce the impact of high-intensity disasters. One notable example is South Korea's "smart city" of Daegu, which uses centralized data collection, sharing, and propagation to reduce property damage and casualties associated with natural disasters.[44] Australia, New Zealand, and Singapore likewise have centralized government systems dedicated to disaster preparedness and resilience funding.[45]

Following the Korean War, South Korea relied heavily on U.S. assistance to rebuild and support recovery, whereas Australia, New Zealand, and Singapore have not traditionally been recipients of aid. Today, these countries serve as regional models of disaster preparedness and intergovernmental coordination at both the national and local levels. Given their sustained exposure to natural hazards, these countries have cultivated a "culture of cooperation" to best address the accelerating challenges they face.[46] As leaders in the technology sector, these countries also leverage advanced systems to strengthen disaster management and public safety capacity.[47]

These characteristics, coupled with strong military partnerships with the U.S., position Australia, New Zealand, Singapore, and South Korea as highly capable and reliable partners for USINDOPACOM. Their strong political institutions further reinforce their value as effective regional partners in HA/DR planning and operations.

44 Kim, Lee, and Kang, "Smart Cities and Disaster Risk Reduction in South Korea."

45 U.S. Government, "Data," *ForeignAssistance.gov*, accessed 16 April 2026, https://foreignassistance.gov/data.

46 Glenn Dolcemascolo, Yongkyun Kim, and Teh-Lan Linda Mu, "Reducing Disaster Risk in Cities — the Republic of Korea's Experience," *World Meteorological Organization*, 1 November 2011, https://wmo.int/media/magazine-article/reducing-disaster-risk-cities-republic-of-koreas-experience.

47 "Prevention-Centric Disaster and Safety Management Systems of the Republic of Korea," *PreventionWeb*, 19 May 2022, https://www.preventionweb.net/news/prevention-centric-disaster-and-safety-management-systems-republic-korea.

Disaster Trends

This section examines whether rising disaster risk in the Indo-Pacific is driven primarily by an increase in the frequency of disasters or instead by changes in socioeconomic factors, especially the growing concentration of populations and assets in hazard-prone areas. The analysis suggests that, overall, **no cluster shows a consistent upward trend in disaster frequency over time**. As a result, changes in disaster risk cannot be explained by frequency alone. Instead, expanding exposure increases the number of people affected, the value of assets at risk, and the scale of response required when hazard events occur. To fully understand changes in disaster risk, these socioeconomic factors must be considered.

The impacts of disasters are also not uniform. Economic damage tends to be intensified by meteorological disasters such as floods and typhoons, while human casualties are more often associated with less predictable events such as earthquakes and tsunamis. A comparison across clusters reveals distinct patterns. In the Mainland and Coastal Asia cluster, disaster impacts increase alongside expanding exposure. In the Maritime Southeast Asia cluster, impacts fluctuate cyclically because of the high frequency and diversity of disaster events. In the Small Pacific Island States cluster, structural dependence on specific hazard types means that extreme damage can occur even when disasters are relatively infrequent. By contrast, in the Western Pacific Region cluster, damage levels remain comparatively low and stable despite high levels of exposure.

Altogether, these findings suggest that disaster risk is shaped not only by how often disasters occur but also by a broader combination of factors – i.e., where populations and assets are concentrated, the types of hazards to which a region is exposed, and the capacity of states and communities to absorb and manage damage.

For reference, this section analyzes disaster trends over the period from 2000 to 2025; it uses EM-DAT disaster data and World Bank indicators for socioeconomic variables, aggregated at the cluster level. To smooth year-to-year volatility, all figures are presented using a three-year rolling average. As a result, the visualized time series begin in 2001 and end in 2024.

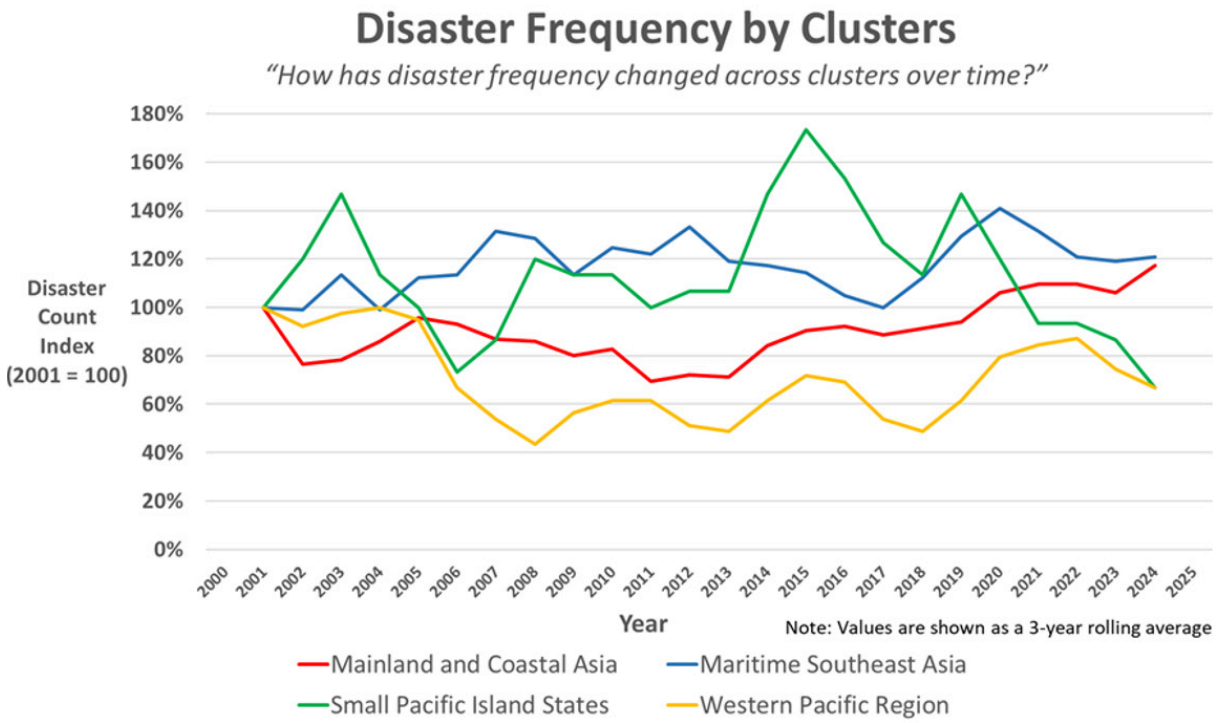
To prevent distortions in the analysis results, four event entries were treated as outliers and excluded: the 2004 Indian Ocean tsunami's effects on Indonesia and Sri Lanka; Cyclone Nargis in Myanmar (2008); and the 2011 Great East Japan "Tōhoku" Earthquake. These disasters were the only events among the 2,347 recorded incidents over the entire study period to result in more than 10,000 fatalities each; collectively, they account for approximately 75% of all fatalities and 30% of total economic damage, and their inclusion would therefore exert an undue influence on the interpretation of long-term trends.

Disaster Occurrence and Trends in Socioeconomic Factors

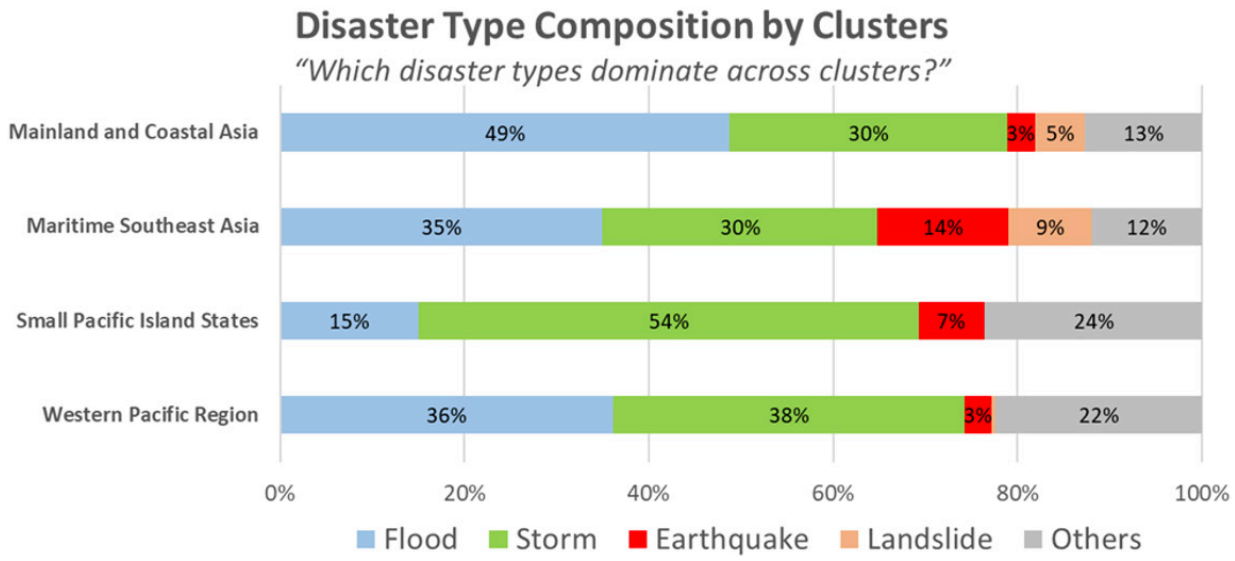
This section presents an indexed comparison of disaster occurrence by cluster (Graph 2) alongside the proportional composition of disaster types (Graph 3) based on EM-DAT data. Together, these visualizations allow the team to examine shifts in disaster frequency across the Indo-Pacific and identify the dominant hazard types within each cluster, an exercise that helps clarify long-term disaster patterns that underpin this research.

Based on Graphs 2 and 3, the Mainland and Coastal Asia cluster exhibits a gradual upward trend in disaster frequency, and it reaches 120% of baseline at the end of the period. In terms of composition, disasters in this cluster are dominated by floods and storms, with earthquakes and landslides accounting for smaller proportions.

The Maritime Southeast Asia cluster records a high level of disaster frequency relative to the other clusters and reached a level of 120% of baseline by the period's end. Floods and storms constitute the primary disaster types, followed closely by earthquakes, and these elements result in a structural pattern characterized by the overlapping occurrence of multiple disaster types.



Graph 2: Disaster Frequency by Clusters



Graph 3: Disaster Type Composition by Clusters

The Small Pacific Island States cluster is marked by considerable volatility in disaster frequency, which stands at around 70% of baseline at the end of the study period. Storms account for more than half of all disaster events in this cluster, while the occurrence of other disaster types is limited. Consequently, the frequency pattern is heavily shaped by the timing and magnitude of storms.

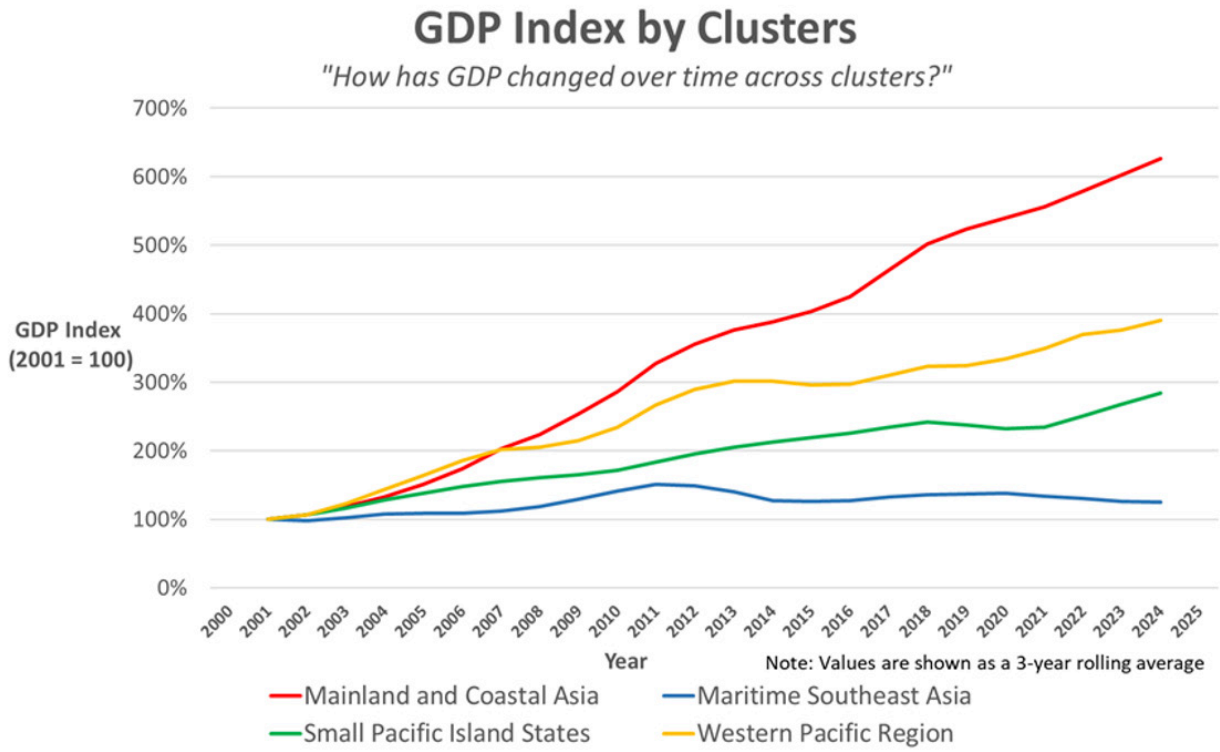
The Western Pacific Region cluster demonstrates an overall downward trend in disaster frequency, standing at around 70% of baseline at the period's end. Disasters in this cluster consist predominantly of floods and storms, while earthquakes exert only a limited influence on the overall hazard profile.

Although disaster frequency varies across all clusters, the data do not show a substantial long-term increase in frequency overall. Accordingly, the observed increase in disaster risk cannot be explained by event frequency

alone. While floods and storms account for the majority of recorded disasters, the broader hazard composition (including earthquakes and landslides) differs across clusters. These differences help explain the distinct ways in which disaster-related damage manifests in each region.

Building on the analysis of disaster patterns, the team next examined GDP and urbanization as socioeconomic factors that can influence the scale and character of disaster damage.

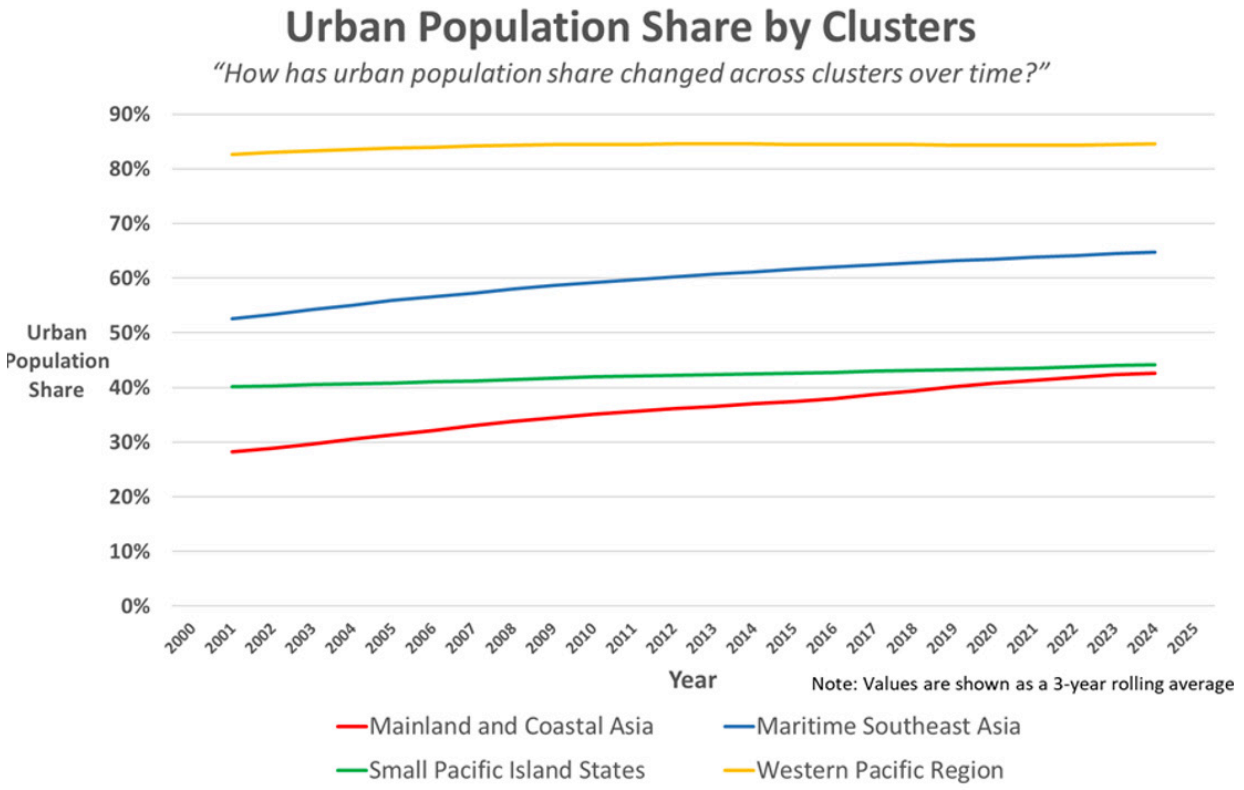
Graph 4, based on World Bank GDP data, illustrates changes in GDP indices across each cluster. As the graph demonstrates, GDP increases across all clusters; however, there are distinct differences in growth rates. In the Mainland and Coastal Asia cluster, rapid economic growth is observed. Conversely, in the Maritime Southeast Asia cluster, economic growth is sluggish. The Small Pacific Island States cluster exhibits gradual economic growth, and the Western Pacific Region cluster maintains stable economic growth.



Graph 4: GDP Index by Clusters

Graph 5, based on World Bank total population and urban population data, illustrates changes in urban population shares across each cluster. The graph illustrates increasing urban population ratios across all clusters; however, there are distinct differences in patterns. In the Mainland and Coastal Asia cluster, advancing urbanization is observed alongside swiftly rising GDP. Conversely, in the Maritime Southeast Asia cluster, urbanization continues to progress despite slower economic growth. The Small Pacific Island States cluster exhibits only gradual changes in urbanization, and the Western Pacific Region cluster maintains a high level of urbanization.

The expansion of GDP and the advancement of urbanization unfold in distinct ways across the clusters. These distinctions result in varying degrees of population and asset concentration. Thus, the manifestation of disaster damage also exhibits structural diversity across different regions and suggests that variation in exposure, driven by socioeconomic factors, plays a critical role in the accurate assessment of risk.



Graph 5: Urban Population Share by Clusters

Disaster Impact Trends

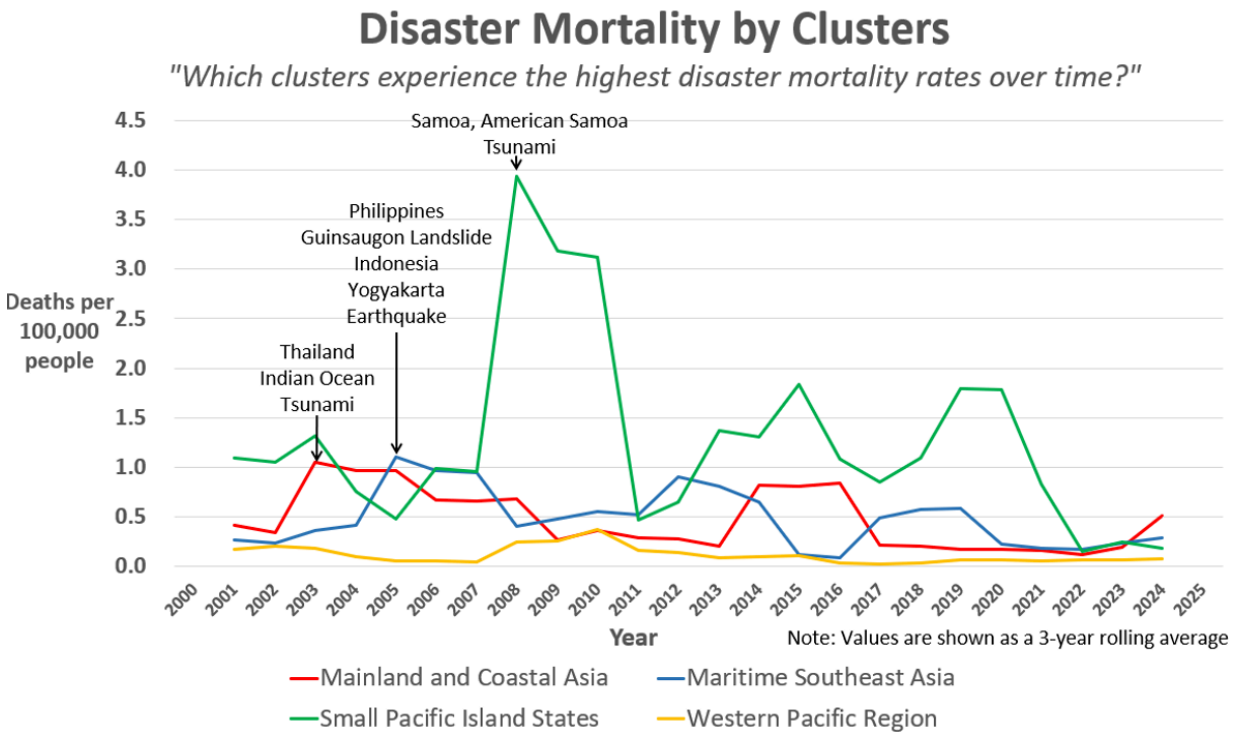
Having examined disaster frequency and the socioeconomic factors that shape exposure, the analysis next turns to trends in disaster impacts. Graphs 6 and 7, based on EM-DAT and World Bank data, present disaster-related fatalities per 100,000 population and economic losses as a percentage of GDP, both aggregated by cluster. The disaster names annotated within the graphs identify representative events that were the primary drivers of observed spikes. Comparing these indicators allows for an assessment of fluctuations in human and economic loss, differences in long-term patterns, and the relationship between major disaster events and the forms of damage they produce.

In the Mainland and Coastal Asia cluster, the mortality rate generally follows a downward trend and converges toward a relatively low level in recent years. At the same time, distinct spikes occur due to the impact of events such as massive tsunamis. While levels remain low during normal periods, this cluster is characterized by a structure in which human casualties surge significantly whenever large-scale disasters strike. Economic damage follows a similar pattern; it remains low in most years but increases noticeably during major flood events.

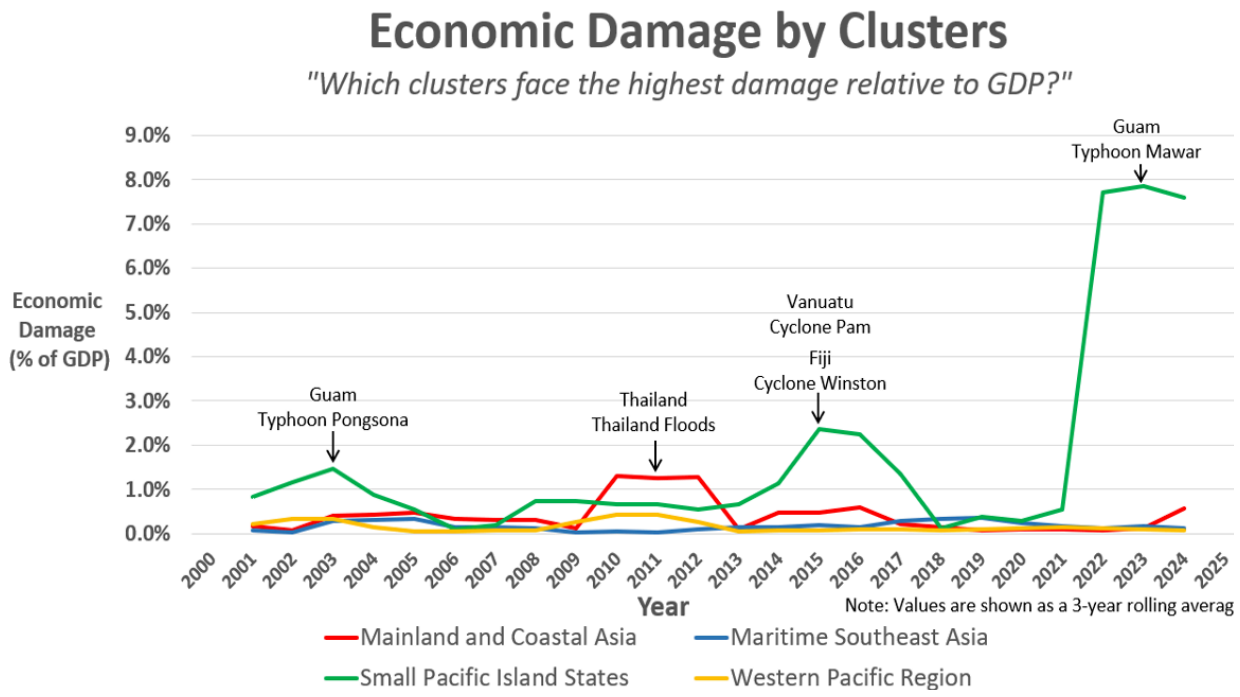
In the Maritime Southeast Asia cluster, mortality also remains generally low, though periodic spikes occur in connection with major earthquakes and landslides. Economic damage remains relatively stable at low levels overall, with no spikes comparable to those seen in other clusters. This trend suggests that disaster-related economic damage remains comparatively limited relative to the overall economic scale of the countries in this group.

In the Small Pacific Island States cluster, relative to the other clusters, mortality shows extremely high volatility, with particularly sharp spikes. Mortality from large-scale tsunamis is especially notable and stands out as the highest among all clusters. Economic damage is similarly volatile, with spikes consistently associated with storms. The data point to a structural pattern in which a single major disaster can determine the overall annual level of damage.

In the Western Pacific Region cluster, both mortality and economic damage remain comparatively low and



Graph 6: Disaster Mortality by Clusters



Graph 7: Economic Damage by Clusters

stable, with only limited fluctuations. Relative to the other clusters, this stability suggests a higher degree of resilience to disaster impacts.

Across the Indo-Pacific region, disaster-related mortality has generally declined over time. However, mortality still spikes sharply when earthquakes and tsunamis occur in combination, a sign that these sudden-onset hazards can inflict severe localized damage within a short timeframe. Economic damage, by contrast, tends to spike in connection with large-scale meteorological disasters (notably typhoons and floods), which affect wider geographic areas and disrupt economic activity more broadly. These patterns reveal that human and economic losses do not necessarily rise at the same time or in response to the same hazards.

This distinction is important. The full impact of disasters cannot be captured through a single metric. A meaningful assessment of disaster risk must account for multiple mechanisms, including disaster frequency, hazard type, and the different ways disasters affect human populations and economic systems.

Organization of Risk Structures by Cluster

Synthesizing the preceding findings, the report organizes the disaster risk structure of each cluster across six dimensions: hazard type, disaster frequency, exposure, vulnerability, human impact, and economic impact. As shown in Table 1, this comparison helps clarify the mechanisms through which disaster risk is formed in different parts of the Indo-Pacific.

Clusters	Hazard Type		Frequency		Exposure		Vulnerability		Human Impact		Economic Impact	
Mainland and Coastal Asia	Flood and Storm Dominant	Relatively Diversified	Moderate	↑	High Growth	↑	Moderate with Spikes	→	Low with Occasional Spikes	↓	Low with Occasional Spikes	→
Maritime Southeast Asia	Flood, Storm, and Earthquake Mixed	Multi-Hazard Structure	High	↑	Limited Growth and Stagnation	→	Moderate with Recurrent Spikes	→	Low with Recurrent Spikes	↓	Low and Stable	→
Small Pacific Island States	Storm Dominant	Single-Hazard Dependent	Low	↓	Moderate and Gradually Increasing	↑	Very High	↑	Highly Volatile	↑	Highly Volatile	↑
Western Pacific Region	Diversified	Highly Diversified	Low	↓	High and Stable	→	Low	→	Low and Stable	→	Low and Stable	→

Note: Risk levels are indicated as High, Moderate, or Low, while trends are represented by arrows (↑: Increasing; ↓: Decreasing; →: Stable)

Table 1: Risk Structure by Cluster

In the Mainland and Coastal Asia cluster, disaster frequency shows only a moderate increase, but exposure has expanded significantly due to growth in both GDP and urban populations. Human and economic damages remain relatively low during normal periods, and no clear long-term upward trend is observed, though severe events can still produce sharp spikes.

In the Maritime Southeast Asia cluster, disaster frequency is high, but GDP growth has been more limited, and this combination results in only a modest expansion of exposure. Human casualties generally remain low but rise periodically, and a cyclical pattern of impact is visible due to the overlap of multiple hazard types.

In the Small Pacific Island States cluster, disaster frequency is comparatively low, yet both human and economic losses fluctuate sharply. A single major storm can largely determine annual damage levels, and this influence reveals a highly vulnerable structure in which severe impacts can occur despite relatively infrequent events.

In the Western Pacific Region cluster, exposure is high, yet both human and economic losses remain low

and stable. Although hazard types are varied, overall impacts are generally contained; they demonstrate a stable structure in which damages remain limited despite substantial exposure.

Overall, these findings show that disaster risk in the Indo-Pacific is shaped not simply by frequency but by the interaction of hazard type, exposure, and vulnerability. The analysis therefore examines not only how hazards unfold across the region but also how those hazards intersect with concentrations of people and assets and with each country's ability to absorb and manage resulting damage.

Country-Specific Differences and Future Research Challenges

To extend the cluster-level findings, the analysis also examined country-specific variation within each cluster and identified the countries exerting the greatest influence on overall cluster trends. This exercise helps clarify where cluster-level patterns are being associated with national cases. The findings are summarized in Table 2 and detailed data are provided in Appendix II.

Clusters	Deaths per 100,000 people Rank			Economic Damage Rank (% of GDP)			
	Top1	Value	Value	Top1	Value	Top2	Value
Mainland and Coastal Asia	Nepal	2.11	High Growth	Nepal	1.00%	Myanmar	0.94%
Maritime Southeast Asia	Philippines	1.10	Limited Growth and Stagnation	Philippines	0.36%	Japan	0.17%
Small Pacific Island States	Samoa	4.93	American Samoa	Tonga	3.16%	Vanuatu	2.63%
Western Pacific Region	New Zealand	0.20	Australia	New Zealand	0.79%	Australia	0.19%

Table 2: Top Impact Countries by Cluster

When examined at the country level, the top-ranking countries vary depending on the specific indicator used. In some cases, such as the Western Pacific Region cluster, the same countries rank highly across both mortality and economic damage indicators. In the Mainland and Coastal Asia cluster, the Maritime Southeast Asia cluster, and the Small Pacific Island States cluster, however, this alignment is much less consistent. These differences are strongly shaped by hazard type. Sudden-onset disasters such as earthquakes and tsunamis tend to drive mortality upward because they produce severe casualties over a short period of time and in relatively concentrated areas. By contrast, meteorological disasters such as typhoons and floods tend to drive up economic damage as a share of GDP because they disrupt economic activity across much broader areas.

Differences in disaster response capacity and infrastructure resilience also matter. Neighboring countries affected by similar hazards can experience very different levels of damage depending on the strength of their institutions, infrastructure, and preparedness systems. As a result, the countries ranking highest in terms of mortality do not necessarily match those ranking highest in terms of economic loss, even within the same cluster.

In addition, the potential negative effects of disasters on economic growth should be considered. Particularly in lower income countries, human and economic losses caused by disasters may constrain growth and lead to reduced investment in infrastructure and disaster preparedness. This stagnation may, in turn, increase vulnerability and limit coping capacity and result in greater disaster impacts. These effects may further constrain economic growth through a reinforcing feedback loop.

This dynamic further reinforces the central argument of this analysis: vulnerability and coping capacity, rather than hazard frequency alone, are the primary drivers of disaster impact. Collecting more detailed economic and fiscal data, including post-disaster recovery expenditures, macroeconomic fluctuations, and changes in infrastructure and disaster preparedness budgets, would allow for a more precise examination of this relationship between disasters and economic stagnation.

At the same time, important data limitations must be acknowledged. In the EM-DAT dataset, economic damage figures are recorded for only 893 of the 2,347 disaster events analyzed; therefore, the monetary value of damage remains unspecified for a large share of cases. This gap can produce misleading comparisons. For instance, Bhutan appears in this study as a top-ranking country in terms of mortality rate while also ranking at the bottom in terms of economic damage.

Thus, while country-level analysis helps reveal variation and exceptions that cluster-level analysis cannot fully capture, it also underscores an important challenge for future research: the need to strengthen the underlying dataset, particularly with respect to economic damage. Meeting this challenge will require supplementing EM-DAT with national government statistics, disaster-specific reports, and other country-level sources. Future work could also improve precision by incorporating additional country-specific socioeconomic variables (e.g., infrastructure quality, institutional capacity, and disaster response capability) alongside aggregate measures such as GDP and population.

Recommendations

While the findings of this report indicate that aggregate disaster frequency has not increased dramatically, the intensity and complexity of major events present a growing operational challenge for USINDOPACOM. A small number of catastrophic seismic and meteorological events have accounted for a disproportionate share of total deaths and economic damage across the AOR. Therefore, the tail risk of singular high-impact events remains operationally decisive.

The findings of this report suggest that the most operationally significant disaster risks in the Indo-Pacific do not necessarily stem from the highest frequency events but from the interaction of hazard exposure, vulnerability, and limited coping capacity. This dynamic is especially evident in the Small Pacific Island States, where disaster events may occur less often in aggregate but can produce outsized human, economic, and logistical consequences when they do occur. As demand for HA/DR support across the USINDOPACOM AOR evolves, future planning should prioritize the locations and conditions most likely to generate severe operational burdens rather than relying on disaster counts alone.

To address the evolving drivers of disaster risk and their implications for HA/DR operations, this report advances three strategic recommendations.

- **USINDOPACOM should prioritize HA/DR planning around exposure, vulnerability, and coping capacity.** Planning should focus on a framework that captures where concentrated exposure, weak coping capacity, and hazard-specific vulnerability are most likely to produce severe operational burdens. The report's findings indicate that disaster impacts across the region are increasingly shaped by expanding exposure, rapid urbanization, and vulnerability rather than by a dramatic rise in disaster frequency. For example, our findings show that, in 2015, the Small Pacific Islands States had a spike in disaster events of around 170%; however, the mortality vulnerability was low. In comparison, one event in 2008, the American Samoa tsunami, had a greater mortality rate, an outcome that shows that coping capacity is essential when greater disaster events happen. A planning framework centered primarily on disaster event counts risks underestimating the burden posed by lower-frequency, high-impact disasters, particularly in areas with limited infrastructure and absorptive capacity.
- **The U.S. government, with advice from USINDOPACOM, should continue to pre-position and strengthen logistics capacity, especially supplies of fuel and power equipment, in the most vulnerable islands and remote environments, with particular attention to the Small Pacific Island States.** Given the disproportionate vulnerability of that cluster, pre-positioning logistic supplies in strategically located sites reduces response lag and improves operational reach during high-impact events. The Small Pacific Island States cluster combines lower aggregate disaster frequency with high volatility in both human and economic impacts, making it one of the clearest cases in which pre-positioned assets could yield disproportionate operational value. Guam is the most immediate candidate for fuel and power requirements because of its existing military infrastructure and central position astride Pacific transit routes. Super Typhoon Mawar (2023) led to over US$1 billion in disaster recovery requests, a scale that reveals the gaps in humanitarian assistance that still need to be addressed.[48] Our data show that Super Typhoon Mawar delivered damage worth 60.4% of Guam's GDP, a total that illustrates high volatility and where pre-positioning would benefit the most.
- **CFE-DM and regional partners should expand targeted capacity-building efforts focused on secondary effects and prolonged response needs.** The report's findings suggest that operational complexity in the Indo-Pacific is increasingly driven not only by primary hazards but also by the cascading secondary effects that

48 Society of American Military Engineers, "In Guam, Infrastructure Resilience, Integrated Response, and Collaboration," The Military Engineer, 24 July 2025, https://www.same.org/tmearticle/in-guam-infrastructure-resilience-integrated-response-and-collaboration/; Andrew Tilghman, Disaster Recovery Funding for Military Facilities on Guam, Congressional Research Service, CRS In Focus IN12434 (Washington, DC: Library of Congress, 1 October 2024), https://www.congress.gov/crs-product/IN12434.

follow them, including infrastructure breakdown, displacement, public health strain, and prolonged service disruptions. In the Small Pacific Island States, where infrastructure constraints and governance limitations are often acute, a single storm can evolve into a protracted strategic challenge. Joint training, scenario-based exercises, coordination mechanisms, and investments in health, sanitation, transport, and local response systems would improve preparedness for compounding demands while also reducing the potential need for large-scale external response in the early stages of a crisis.

Altogether, these recommendations support a broader shift in HA/DR planning toward a framework that captures where concentrated exposure, weak coping capacity, and cascading effects are most likely to produce severe operational consequences. This shift is especially important in the small island context, where even a single high-impact event can generate outsized humanitarian demand and place sustained pressure on already stretched response systems.

Further Research

CFE-DM should include cascading indicators in current analytical tools to improve anticipatory planning for cascading disaster risk. Current planning models still rely heavily on historical disaster counts and event-based response triggers, which are insufficient for capturing the downstream interactions that increasingly define complex disasters in the region. One useful next step would be to develop a probabilistic risk model, such as a Bayesian network, to formalize the historical relationships between primary hazards and likely secondary or tertiary effects. While such a model could not predict cascading events with certainty, it could strengthen research to support pre-positioning decisions and preparedness prioritization. This research would help to see how cascading disaster risks can be mitigated by anticipatory planning. Figure 5 illustrates a simplified cascade of secondary and tertiary effects from a single hazard event.

Building on the analytical framework in Figure 5, this report adopts a multifaceted approach to understanding disasters by incorporating the role of cascading effects. Rather than treating disaster events as isolated incidents, this approach recognizes that primary hazards can trigger a sequence of interconnected impacts that unfold over time. In these cascading scenarios, an initial event, such as a cyclone, can generate secondary hazards, including flooding, infrastructure damage, and displacement, which can collectively amplify the overall impact of the disaster.

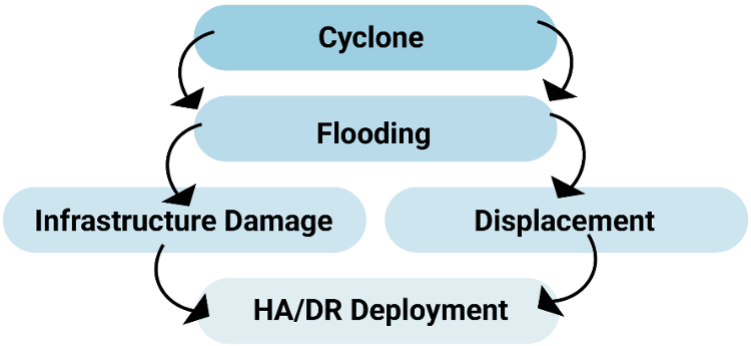


Figure 5: Example Cascading Hazard Effect Tiered Framework

For example, a typhoon or cyclone may directly cause damage to coastal settlements and transport corridors through wind speeds and rainfall. The more consequential effects, however, may emerge in the days and weeks that follow. Locations in the pathways of any or all hazards are considered exposed to this risk. Roads and ports may become inaccessible due to surface flooding; power and communications fail as infrastructure capacity is overtaxed; hospitals and water systems become degraded; populations are displaced; and local response capacity is strained or overwhelmed. A country's strength of infrastructure can determine the relevant vulnerability. The country's ability to address and "bounce back" from the subsequent primary and secondary hazards illustrates the notion of coping capacity.

The same basic logic applies to earthquakes, droughts, volcanic eruptions, and extreme heat, though the pathways differ by hazard type. For rapid onset-hazards, the critical question is not only how destructive the event is at the point of impact, but also how quickly it generates cascading failures across infrastructure, governance, public health, supply chains, and social stability. For this reason, the study treats disaster impact as dynamic rather than static. Hazard occurrence is the trigger, but operational demand emerges through the interaction of that trigger with infrastructure fragility, population concentration, economic dependence, and institutional readiness.

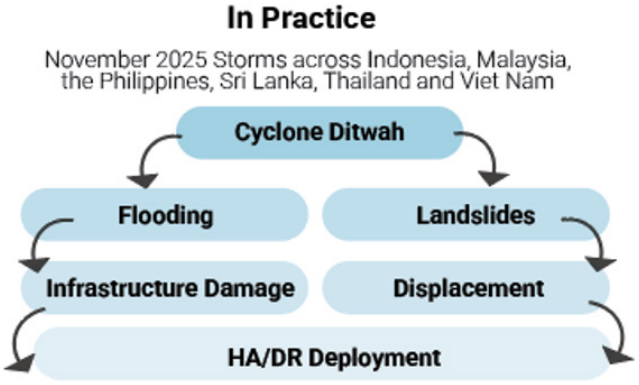
Although cascading effects have historically received less attention in disaster analysis, their importance has become increasingly evident. The interconnected nature of these events can produce compounding consequences across populations, infrastructure, and economic systems and thus intensify both the scale and duration of disruption. At the same time, the nonlinear and multi-event nature of cascading disasters presents analytical challenges, as overlapping impacts can be difficult to isolate and model.[49]

Despite these challenges, incorporating a cascading framework offers significant value for both risk assessment and operational planning, as greater awareness of how hazards interact and compound over time can inform

49 Laurie S. Huning and Manuela I. Brunner, "Cascading Impacts of Natural Disasters in a Connected World," Science 391, no. 6792 (26 March 2026): 1320–22, https://doi.org/10.1126/science.adn8744.

more proactive approaches to disaster response. By identifying patterns in hazard sequencing and understanding the likelihood of secondary impacts, planners can better anticipate downstream effects and allocate resources accordingly. This perspective also enables a shift from reactive response toward anticipatory planning, grounded in historical trends and probabilistic relationships between hazard events.

To illustrate the practical application of this framework, this report draws on recent disaster events in the Indo-Pacific. In late 2025, a series of severe flooding events, driven by Cyclone Ditwah and broader meteorological anomalies, affected multiple countries across the Indo-Pacific.[50] These events demonstrated how primary hazards can trigger cascading impacts that expose millions of people to compounding risks.[51] Figure 6 examines these floods through the lens of cascading disaster dynamics and highlights how such events can inform future assessments of interconnected risk and support more effective HA/DR planning.



Commentary on Disaster Preparedness Reflection

"As early as November 12, Sri Lanka's department of meteorology had publicly flagged the prospect of extreme rainfall later in the month. That should have triggered a process of preparations across the government at central, provincial, and local levels," [...] "Apparently, that did not happen, and an official response has mostly been reactive when Cyclone Ditwah was imminent or after it made landfall," [...] "The entire disaster management structure – from policymakers to state officials – should be held accountable for **cascading failures that made a bad disaster much worse**."

"Sri Lanka's **preparedness** for the recent Cyclone Ditwah has been **a subject of significant debate**. While the government activated emergency protocols, **the sheer scale of the disaster – the worst flooding in decades – overwhelmed many existing systems.**"

Figure 6: Cascading Risk of Cyclone Ditwah

In this analysis, primary hazards refer to the initial large-scale disaster events, including cyclones, storms, earthquakes, and other major hazard events. Secondary hazards refer to the cascading effects that arise from these primary events; they include flooding, landslides, and storm surge, which often generate additional layers of disruption beyond the initial impact.

50 "Asia Floods of 2025," Encyclopaedia Britannica, accessed 16 April 2026, https://www.britannica.com/event/Asia-Floods-of-2025.

51 United Nations Economic and Social Commission for Asia and the Pacific, "Asia and the Pacific Preparing for a New Era of Disaster Risks," 9 December 2025, https://www.unescap.org/blog/asia-and-pacific-preparing-new-era-disaster-risks; Staff Sgt. Wren Fiontar, "U.S. Forces Deliver Critical Aid to Sri Lanka Following Cyclone Ditwah," U.S. Air Force, 5 January 2026, https://www.af.mil/News/Article-Display/Article/4381710/us-forces-deliver-critical-aid-to-sri-lanka-following-cyclone-ditwah; Murali Krishnan, "Sri Lanka Cyclone Tragedy Exposes Government Failures," DW, 2 December 2025, https://www.dw.com/en/sri-lanka-cyclone-tragedy-exposes-government-failures/a-74985337; Dilanthi Amaratunga and Lahiru Kodituwakku, "Cyclone Ditwah: What Next for Sri Lanka beyond the Storm," Progress in Disaster Science 29 (January 2026): 100518, https://doi.org/10.1016/j.pdisas.2026.100518.

A simplified cascade pathway illustrates how these dynamics unfold.[52]

> ***Tropical cyclone → flooding, landslide, storm surge → drainage system failure → secondary flooding → coastal erosion, water contamination, infrastructure disruption → hazardous health conditions, weakened health services → disease outbreaks***

Primary Disaster Events

- **Geological**: Ground movement (earthquakes), volcanic activity
- **Hydrological/Meteorological:** Tropical cyclone, drought, severe weather, cold wave, heat wave, lightning/ thunderstorms, hail, tornado, sand/dust storm
- **Fire**: Wildfire, forest fire, land fire

Secondary Disaster Events

Hydrological/Geological Cascades:

- Tsunami (often triggered by ground movement/undersea earthquakes)
- Flooding (riverine, flash, and coastal flooding, often linked to cyclones and storm surge)
- Storm surge (associated with tropical cyclones)
- Landslide (wet/dry), mudslide, rockfall (triggered by heavy rain, flooding, or earthquakes)
- Volcanic cascades (lahars, pyroclastic flows, ashfall)
- Glacial lake outburst flood (linked to warming or geological movement)
- Avalanche (triggered by seismic activity or rapid temperature changes)
- Infectious diseases (viral, bacterial, parasitic)[53]
- Lava flows (direct extensions of volcanic activity)

It is important to note that this cascading framework remains an evolving analytical approach and requires further refinement from a probabilistic perspective. While historical data can identify common hazard sequences, the precise occurrence of secondary and tertiary events cannot be predicted with certainty. To address this limitation, future research may incorporate probabilistic modeling techniques, such as Bayesian network structures, to better capture the relationships between primary hazards and their cascading counterparts.[54]

Such models would enable the use of probabilistic reasoning to assess the likelihood of interconnected hazard events and their downstream impacts. When applied to disaster risk analysis, this approach could support the development of cascading hazard systems that provide a structured understanding of how disasters unfold across multiple stages. Although uncertainty will remain inherent and it is impossible to know with certainty if secondary or tertiary hazards will occur, establishing a baseline of historically informed relationships can help shift HA/DR planning toward more anticipatory and proactive approaches.

52 United Nations Office for Disaster Risk Reduction (UNDRR), "Systemic Risk," PreventionWeb, accessed 16 April 2026, https://www.preventionweb.net/understanding-disaster-risk/key-concepts/systemic-risk.

53 For the purposes of this study, biological events were omitted from Primary Disaster Events and added to Secondary Disaster Events. While traditionally, biological events can and have been primary disaster events, in the context of this study, it is categorized as a consequence of other disasters' cascading trends.

54 Sun, Baodan, Xinyi Zhang, Junhui Jiang, Jianguang Gong, and Dan Lin, "Bayesian Network Structure Learning by Opposition-Based Learning," Scientific reports, 27 May 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC12106786.

Conclusion

This research report seeks to examine whether rising disaster impacts are driven by changes in hazard frequency and severity or by underlying socioeconomic dynamics that expand exposure and vulnerability. Overall, the findings indicate that the Indo-Pacific has not experienced a uniformly dramatic increase in disaster frequency over the last 25 years. Rather, the changing severity of disaster impacts is better explained by the interaction of hazard type, expanding exposure, structural vulnerability, and uneven coping capacity. The central issue is not simply that more disasters are occurring but that more people, infrastructure, and economic assets are concentrated in hazard-prone areas where the ability to absorb and recover from shocks remains highly uneven.

The cluster analysis reinforces this conclusion. Mainland and Coastal Asia faces rising exposure linked to urbanization and economic concentration. Maritime Southeast Asia experiences recurring multi-hazard stress across a complex operating environment. The Small Pacific Island States emerge as the most operationally vulnerable cluster, as even less frequent events can generate severe and prolonged consequences in contexts with limited infrastructure and response capacity. In contrast, the Western Pacific Region demonstrates that high exposure does not necessarily translate into severe impacts when preparedness systems, institutions, and infrastructure are strong.

The report also highlights the importance of cascading effects in shaping disaster severity and HA/DR demand. The consequences of disasters often extend well beyond the initial hazard event. For military planners, this facet poses the risk of increased insecurity and reduced operational capabilities in the region. For humanitarian planners, these events impose increased risk of human suffering and long-term damage to communities. Infrastructure failure, displacement, public health strain, food insecurity, and prolonged service disruption can significantly expand humanitarian need and complicate response operations. Understanding disaster risk as a broader operational system, rather than as an isolated event, is essential for future planning.

For USINDOPACOM and its partners, the policy implication is clear: HA/DR readiness should be guided less by disaster counts alone and more by where concentrated exposure, weak coping capacity, and cascading effects are most likely to produce severe humanitarian and operational burdens. A planning posture built on that understanding will be better aligned with the realities of disaster risk in the Indo-Pacific and better prepare responders to meet the demands of future HA/DR operations.

Appendix I: Acronyms and Initialism

AOR	Area of Responsibility
CFE-DM	Center for Excellence in Disaster Management and Humanitarian Assistance
CRED	Centre for Research on the Epidemiology of Disasters
DoD	Department of Defense
EM-DAT	Emergency Events Database
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
HA/DR	Humanitarian Assistance and Disaster Response
INFORM	Index for Risk Management (Risk Profile)
PDC	Pacific Disaster Center
SIPA	School of International and Public Affairs (Columbia University)
USINDOPACOM	United States Indo-Pacific Command
WDI	World Development Indicators

Appendix II: Background Data

Mortality Rank (per 100,000) by Period

Mortality Rank (per 100k)		ALL	2000-2005	2006-2010	2011-2015	2016-2020	2021-2025
1	Samoa	4.93	0.89	15.46	1.22	7.91	0.00
2	American Samoa	2.76	1.76	12.25	0.00	0.00	0.00
3	Micronesia	2.47	9.94	0.00	0.92	0.00	0.00
4	Nepal	2.11	1.15	0.86	7.28	0.72	0.75
5	Bhutan	1.47	5.58	0.66	0.03	0.00	0.26
6	Solomon Islands	1.37	0.00	2.96	2.41	1.74	0.00
7	Philippines	1.10	0.80	1.41	2.51	0.43	0.43
8	Papua New Guinea	0.75	0.56	1.14	0.22	0.50	1.39
9	Thailand	0.68	2.31	0.19	0.19	0.07	0.17
10	Fiji	0.66	0.63	0.75	0.37	1.37	0.15
11	Sri Lanka	0.64	0.29	0.48	0.74	0.89	0.89
12	Vanuatu	0.62	0.34	0.00	1.75	0.20	0.85
13	Tonga	0.61	0.00	1.68	0.75	0.00	0.76
14	Myanmar	0.47	0.14	0.20	0.20	0.19	1.67
15	Marshall Islands	0.46	1.97	0.00	0.00	0.00	0.00
16	Indonesia	0.39	0.30	0.96	0.06	0.47	0.18
17	Cambodia	0.35	0.60	0.31	0.68	0.07	0.04
18	Bangladesh	0.31	0.39	0.86	0.09	0.14	0.06
19	Timor-Leste	0.30	0.46	0.02	0.02	0.05	0.90
20	Vietnam	0.26	0.38	0.45	0.11	0.20	0.15
21	Lao PDR	0.26	0.19	0.10	0.46	0.45	0.09
22	New Zealand	0.20	0.02	0.00	0.85	0.09	0.06
23	Australia	0.16	0.03	0.55	0.15	0.04	0.04
24	Japan	0.12	0.07	0.08	0.17	0.15	0.17
25	Guam	0.09	0.20	0.00	0.00	0.00	0.24
26	South Korea	0.09	0.19	0.04	0.09	0.05	0.07
27	Malaysia	0.08	0.11	0.08	0.04	0.01	0.15
28	Singapore	0.00	0.01	0.00	0.00	0.00	0.00
29	Kiribati	0.00	0.00	0.00	0.00	0.00	0.00
30	Nauru	0.00	0.00	0.00	0.00	0.00	0.00
31	Palau	0.00	0.00	0.00	0.00	0.00	0.00
32	Tuvalu	0.00	0.00	0.00	0.00	0.00	0.00

Table 3-1: Disaster Mortality Rates for All Countries (per 100,000)

Note: Countries highlighted in yellow indicate the top two impact countries in each cluster, as identified in Table 3 (Top Impact Countries by Cluster) in the Disaster Trend Analysis. The numeric values are presented as a heatmap, with higher values shown in red.

Damage Rank (% of GDP) by Period

Damage Rank (% of GDP)		ALL	2000-2005	2006-2010	2011-2015	2016-2020	2021-2025
1	Tonga	3.16%	4.72%	0.61%	1.55%	4.38%	4.24%
2	Vanuatu	2.63%	0.00%	0.00%	11.88%	0.00%	1.79%
3	Guam	2.47%	0.64%	0.00%	0.00%	0.00%	12.07%
4	American samoa	1.50%	6.50%	0.00%	0.00%	0.00%	0.00%
5	Samoa	1.44%	0.09%	3.95%	3.44%	0.00%	0.00%
6	Nepal	1.00%	0.02%	0.10%	4.26%	0.60%	0.21%
7	Myanmar	0.94%	0.79%	0.02%	0.04%	0.01%	3.86%
8	Fiji	0.90%	0.24%	1.04%	0.49%	2.72%	0.15%
9	New Zealand	0.79%	0.11%	0.89%	2.26%	0.44%	0.39%
10	Thailand	0.64%	0.20%	0.02%	2.37%	0.07%	0.65%
11	Vietnam	0.58%	0.54%	1.02%	0.79%	0.40%	0.16%
12	Cambodia	0.47%	0.92%	0.10%	1.16%	0.06%	0.00%
13	Bangladesh	0.38%	0.85%	0.66%	0.03%	0.21%	0.05%
14	Philippines	0.36%	0.08%	0.25%	1.21%	0.15%	0.15%
15	Sri Lanka	0.29%	0.03%	0.04%	0.17%	0.43%	0.82%
16	Lao PDR	0.23%	0.01%	0.34%	0.22%	0.25%	0.40%
17	Australia	0.19%	0.14%	0.32%	0.13%	0.19%	0.19%
18	Japan	0.17%	0.20%	0.08%	0.05%	0.34%	0.18%
19	Micronesia	0.14%	0.04%	0.00%	0.71%	0.00%	0.00%
20	Indonesia	0.14%	0.07%	0.35%	0.12%	0.08%	0.07%
21	Marshall Islands	0.10%	0.00%	0.00%	0.53%	0.00%	0.00%
22	Solomon Islands	0.09%	0.00%	0.00%	0.45%	0.00%	0.00%
23	South Korea	0.07%	0.25%	0.00%	0.01%	0.03%	0.02%
24	Malaysia	0.06%	0.07%	0.10%	0.02%	0.01%	0.08%
25	Timor-Leste	0.05%	0.00%	0.00%	0.05%	0.18%	0.00%
26	Papua New Guinea	0.03%	0.00%	0.00%	0.08%	0.05%	0.04%
27	Bhutan	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
28	Kiribati	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
29	Nauru	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	Palau	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	Tuvalu	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 3-2: Disaster Economic Damage for All Countries (% of GDP)

Note: Countries highlighted in yellow indicate the top two impact countries in each cluster, as identified in Table 3 (Top Impact Countries by Cluster) in the Disaster Trend Analysis. The numeric values are presented as a heatmap, with higher values shown in red.

Average of Lag Days by Cluster

Start Year	Mainland and Coastal Asia	Maritime Southeast Asia	Small Pacific Island States	Western Pacific Region	Grand Total
2000	6.11	10.30	158.50	20.53	12.94
2001	10.56	12.10	61.80	26.93	17.19
2002	16.07	9.33	47.00	36.10	18.25
2003	11.27	10.17	71.20	30.92	17.88
2004	10.06	8.41	45.33	22.25	14.25
2005	9.49	15.04	115.67	32.82	18.69
2006	10.29	7.46	123.33	42.60	15.60
2007	13.24	7.96	71.80	61.40	16.60
2008	9.64	8.51	69.20	62.67	16.56
2009	13.59	7.74	45.00	66.00	16.66
2010	11.77	12.59	93.50	35.40	20.28
2011	10.43	6.62	75.00	44.25	14.16
2012	19.26	8.32	57.33	57.33	18.93
2013	12.59	8.90	74.20	63.00	18.26
2014	10.74	9.60	65.60	57.71	16.65
2015	10.34	8.62	30.42	33.00	14.65
2016	10.35	9.63	58.22	40.50	18.10
2017	9.91	11.63	140.50	54.17	18.06
2018	13.16	9.89	40.88	78.40	18.85
2019	6.75	7.37	53.86	44.63	13.53
2020	8.52	7.40	49.86	34.45	13.78
2021	8.40	7.43	91.25	28.42	13.39
2022	7.31	8.93	141.33	36.30	15.46
2023	10.03	9.86	43.71	34.92	16.10
2024	9.33	8.19	176.00	47.57	15.03
2025	6.20	7.98		52.00	9.59
Grand Total	**10.13**	**8.91**	**64.82**	**39.22**	**15.88**

Table 4: Average Lag Days between Disasters by Cluster

Appendix III: Disaster Trend Analysis

Imputation Methods for Missing Data

This section provides supplementary details regarding the methods used within the Disaster Trend Analysis to impute missing data for GDP, total population, and urban population data, sourced from the World Bank database. It also addresses the actual impacts of specific disasters that were defined as outliers and subsequently excluded from the dataset.

First, regarding the GDP data, countries were categorized into three types based on their specific patterns of missing values, and a consistent imputation method was applied to each category. For countries where only the data for 2025 was missing, forward extrapolation was performed using the simple average of the annual growth rates from the preceding three years. Specifically, the annual growth rates for the period from 2021 to 2024 were calculated, and the average of these rates was multiplied by the 2024 GDP figure to estimate the value for 2025. This approach yields an estimate based on short-term trends reflecting the most recent economic developments.

For countries missing data for the two-year period 2023–2024 (Bhutan, Palau, Tonga, and Tuvalu), a similar approach was adopted: forward extrapolation was conducted using the average growth rate of the preceding three years, based on actual observed data up to 2022. Specifically, the average of the annual growth rates for the period from 2019 to 2022 was calculated, and this fixed growth rate was then applied sequentially to estimate the values for 2023, 2024, and 2025. To avoid potential distortions caused by estimates relying on prior estimated values, this single, identical growth rate was applied consistently throughout the process.

For territories missing data for both the early years (2000 and 2001) and the later years (2023 and 2024), specifically Guam and American Samoa, a combination of different methods was employed for the respective periods. Missing values at the beginning of the time series were imputed using linear extrapolation based on the first available actual data points (2002 and 2003). Conversely, for the latter part of the time series (from 2023 onward), estimates were derived using forward extrapolation based on the average growth rate of the preceding three years, the same method described above.

Regarding total population and urban population figures, data are missing for the year 2025 across all countries; however, complete data exist for all preceding years. Consequently, we adopted the "last observation carried forward" method, specifically carrying forward the 2024 values to serve as the values in 2025. The rationale for employing a different imputation method than that used for GDP lies in the fact that total and urban populations are indicators that change gradually over short periods, exhibiting only limited year-to-year fluctuation.

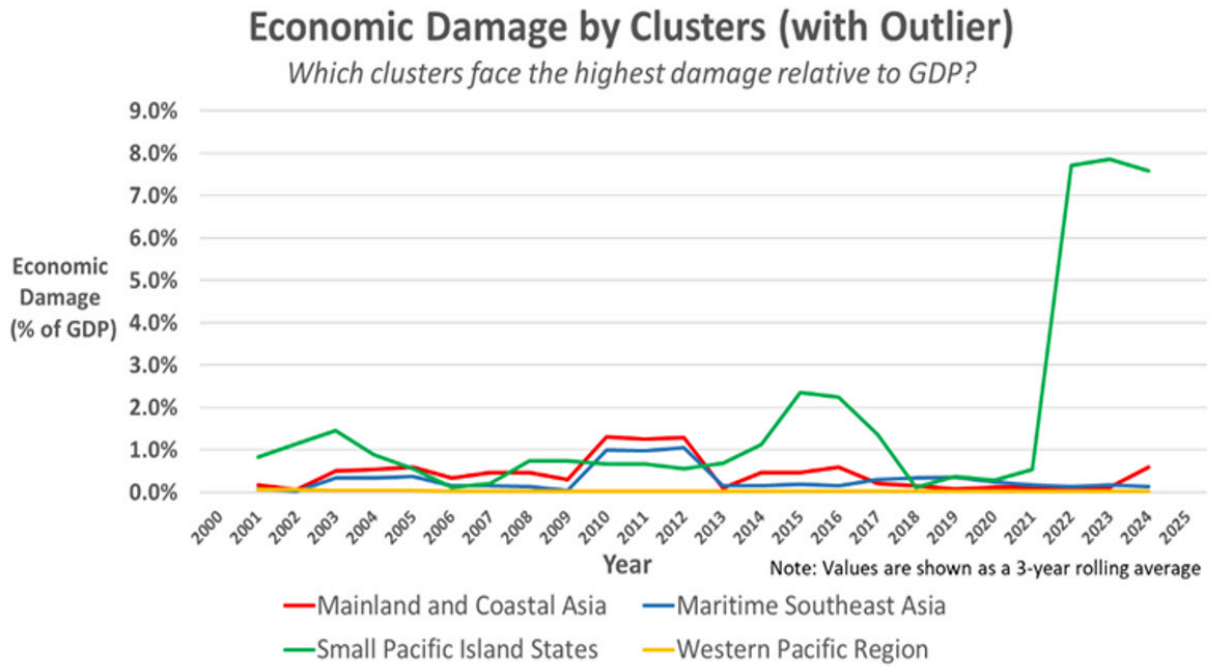
Disaster Event Outliers

Regarding outliers in the disaster trend analysis, we present graphs based on datasets that include these outliers, and we outline the impact that these exceptionally large-scale disasters have on the overall trends. Table 5 details these outliers.

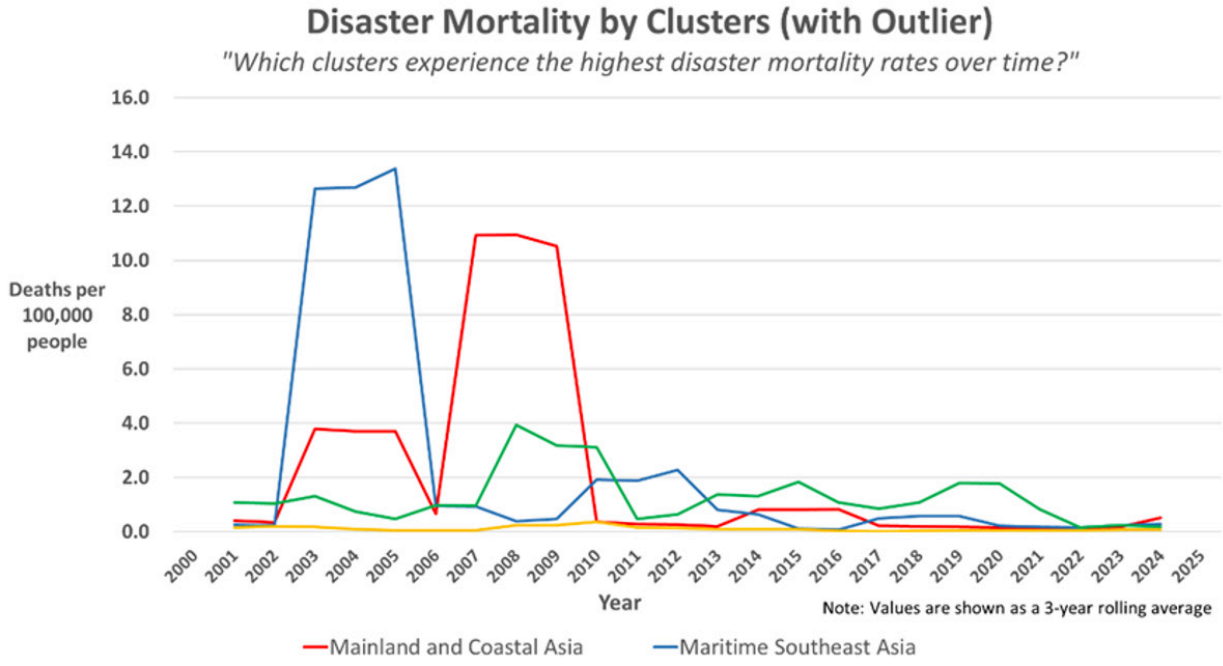
Regarding the economic damage (depicted in Graph 8), a distinct spike centered around the year 2011 is evident in the Maritime Southeast Asia cluster, a cluster that had previously experienced consistently low levels of damage; this spike is due to the inclusion of the massive economic losses caused by the 2011 earthquake and tsunami in Japan. Moreover, in Graph 9, the impact of outliers on the graph is particularly pronounced; the red and blue lines representing the Mainland and Coastal Asia cluster and the Maritime Southeast Asia cluster, respectively, display spikes that far exceed the peak observed in 2008 for the Small Pacific Island States cluster, which had been the largest spike in the dataset excluding outliers. As noted in the main text, these four specific disaster events account for approximately 75% of the total fatalities and about 30% of the total economic damage recorded during the study period; consequently, they have generated changes of a magnitude that is clearly discernible in the graphs.

Country	Year	Type	Deaths	Damage (US$)
Sri Lanka	2004	Tsunami	35,399	1,316,500,000
Indonesia	2004	Tsunami	165,708	4,451,600,000
Myanmar	2008	Tropical Cyclone	138,366	4,000,000,000
Japan	2011	Tsunami	19,846	210,000,000,000

Table 5: Outliers Table



Graph 8: Economic Damage by Clusters (with Outlier)



Graph 9: Disaster Mortality by Clusters (with Outlier)

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