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ADDRESSING VULNERABILITY AND ENHANCING RESILIENCE IN COASTAL AREAS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Coastal areas are regions that are susceptible to hazards due to the impact of climate change. In adapting to the vulnerability condition, it is necessary to understand the adaptive strategy which can enhance resilience in coastal areas. This study examines the integration of vulnerability and resilience in coastal areas to inform adaptive strategies in disaster management. Through a systematic literature review, the study highlights four key gaps: the integration of local knowledge and longitudinal studies, the impact of socio-economic factors, an interdisciplinary approach and technology innovation, and community-based approaches.

Keywords: Vulnerability, resilience, adaptation, disaster management, coastal area.

1.0 INTRODUCTION

Coastal areas are regions that act as a buffer between land and sea, providing people with essential life needs and interacting with their ecological systems (Arda et al., 2025). Coastal areas also host various activities, including economic, industrial, and tourist activities, to support regional development. Due to these activities, coastal areas are also threatened by increasing human activities and associated environmental pressure, such as climate change (O'Higgins et al., 2019). Climate change poses serious threats to coastal areas worldwide, with rising sea levels, increasing temperatures, and more frequent storms, which directly affect natural ecosystems and human settlements (Niu et al., 2023) and could make these areas more vulnerable.

Vulnerability could be described as the susceptibility of physical and social systems to hazards and their inability to cope with the adverse effects (Adger, 2006). This concept integrates multiple dimensions, including sensitivity, exposure, and adaptive capacity. In the context of coastal areas, vulnerability can also be understood as the combined sensitivity of physical, socio-environmental and socio-economic aspects. It reflects how these factors interact to determine resilience of coastal communities against hazards such as flooding, storms and erosion (Bevacqua et al., 2018; Roukounis et al., 2022). Factors such as population density, urbanisation, and socio-economic status have a significant influence on vulnerability. For instance, densely populated urban areas may experience greater risks during disasters due to congestion and limited escape routes.

Climate change increases vulnerability, rendering coastal areas less capable of withstanding hazards and leading to the loss of ecosystems and services that mitigate risks (Bevacqua et al., 2018). However, most coastal vulnerability assessments are limited to physical and geological parameters (Nigam et al., 2024). Current vulnerability indices often employ a static approach, failing to account for the dynamic nature of coastal environments and the evolving risks associated with climate change. Research is needed to develop indices that

can adapt over time and reflect changing conditions, such as population growth, land use changes, and climate impacts (Pantusa et al., 2022). Addressing coastal vulnerability to climate change requires disaster risk management that integrates ecological restoration, sustainable planning and community participation. Understanding vulnerability is fundamental for disaster management, as it identifies which populations, infrastructures and ecosystems are most at risk. Disaster management frameworks then build upon this knowledge to design preventive, mitigative and adaptive strategies that directly target the sources of vulnerability.

Disaster management (DM) can be broadly defined as the set of measures and programs that span from preventing disasters to addressing their impacts (Tay et al., 2022). DM efforts aim to strengthen the capacity and resilience of communities by assessing vulnerabilities, avoiding adverse effects, and providing reliable hazard forecasts. DM efforts also seek to mitigate risks and enhance resilience across communities, both in the public and private sectors (UNDRR, 2025). Effective DM must be comprehensive and inclusive, ensuring that no sector is overlooked. The integration of ecological, physical and social systems is essential to guarantee that climate adaptation in one sector does not undermine another. The interconnectedness of social (human community) and ecological (nature) components within the coastal environment emphasises the importance of local knowledge, cultural practices, and community participation in developing the solutions that resonate with residents' lived experiences. To reduce disaster risk, it is essential to address vulnerabilities directly, thereby achieving the goals of disaster risk reduction and supporting better planning for social, economic, and ecological aspects (Ahmad Basri et al., 2022). Policies for disaster risk management must consider the specific vulnerabilities of different populations. This includes addressing the needs of marginalised groups and ensuring that disaster preparedness plans are inclusive and equitable (Asih et al., 2023).

Current adaptation strategies predominantly focus on complex engineering solutions, such as seawalls and levees, which may not be sustainable in the long term and can exacerbate ecological degradation (Dedekorkut-Howes et al., 2020). It has been found that while adaptation strategies are abundant in policy and governance literature, very few works examine implementation, financial costs, or the management of uncertainty in exposure and hazard projections (Cabana et al., 2023). Moreover, temporal dynamics and potential maladaptive outcomes are overlooked, as a framework developed for metropolitan resilience in Taipei reveals that infrastructure investment does not necessarily lead to long-term reductions in vulnerability or resilience shortfalls (Hung et al., 2024). Adaptation efforts, however, should be comprehensive and should not exclude any sector. The integration of ecological, physical, and community aspects is essential to ensure that climate adaptation in one sector does not undermine efforts in another. The interconnectedness of social (human community) and ecological (nature) components within the coastal environment emphasises the importance of local knowledge, cultural practices, and community participation in developing the solutions that resonate with residents' lived experiences. Other gaps include inconsistent or vague definitions of resilience, underrepresentation of ecological and livelihood dimensions in vulnerability indices, and a lack of studies from regions with high vulnerability but low research output, such as small island states or parts of the Global South (Laidlaw & Percival, 2024; Sealey, 2024).

This review is guided by an integrated framework that connects vulnerability, disaster management and resilience as interrelated dimensions of coastal adaptation. Vulnerability serves as the diagnostic lens, identifying the degree of exposure, sensitivity and adaptive capacity of coastal socio-ecological systems (Adger, 2006; Bevacqua et al., 2018). It highlights where risks are most acute and which communities, infrastructures or ecosystems are most susceptible to climate hazards. On the other hand, DM represents the operational response to these vulnerabilities. It encompasses prevention, preparedness, mitigation, response and recovery efforts aimed at reducing risks and safeguarding communities (Tay et al., 2022; UNDRR, 2025). By directly addressing identified vulnerabilities, DM provides the mechanism through which adaptation strategies are designed and implemented.

Furthermore, resilience constitutes the desired outcome of this process. It reflects the capacity of coastal systems not only to absorb and recover from disturbances but also to adapt and transform in the face of long-term climate pressure (Cabana et al., 2023; Roukounis & Tsihrintzis, 2022). While vulnerability points to system weakness and DM provides interventions, resilience captures the extent to which those interventions translate into sustained adaptive capacity. Positioning these concepts together enables the systematic review to move beyond fragmented definitions and examine how the literature connects these dimensions. It also offers a structured lens for identifying gaps in current approaches, such as the tendency of vulnerability assessments to

remain static (Nigam et al., 2024), the limited integration of ecological and livelihood dimensions into DM strategies (Pantusa et al., 2022) and the insufficient attention to long-term transformative resilience (Dedekorkut-Howes et al., 2020).

This paper systematically reviews the existing literature on coastal vulnerabilities and adaptive strategies to identify key knowledge gaps and highlight directions for future research. The aim is to provide a comprehensive understanding of how vulnerabilities are addressed globally and to generate insights that can inform more inclusive and sustainable approaches for strengthening disaster management frameworks and resilience planning in coastal areas.

2.0 METHODOLOGY

Analytical Overview and Search Strategy

A systematic literature review (SLR) is employed in this research to understand the adaptive strategies of DM, addressing vulnerabilities and enhancing resilience in coastal areas. The literature review process is conducted through the Scopus and Dimensions databases, with a focus on articles published between 2015 and 2025. The limitation of literature reviews to the last 10 years will ensure inclusion of the most recent and relevant evidence, reflecting current knowledge, technologies and practices in dynamic vulnerability and DM fields (Furuya-Kanamori et al., 2023; Helbach et al., 2022). The string used in search terms included "vulnerability" AND "disaster management" AND "resilience" AND "coastal zone".

Data were synthesised using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to increase transparency and rigour in the reporting process (Hossain et al.,2024; Makbul et al., 2024). The articles were chosen using the following inclusion and exclusion criteria: 1) articles published at least 10 years ago or in 2015; 2) articles written in English; 3) articles in the form of journals or proceedings; 4) articles that conduct analyses and demonstrate methodological quality; 5) articles that primarily discuss adaptation strategies based on vulnerability conditions; and 6) studies that analyse DM strategies to enhance resilience. This research does not include the articles that do not meet those criteria.

Data Extraction and Analysis

Thematic coding and narrative synthesis were used to extract and analyse the data. The thematic coding process was used to extract data, which was then coded to identify recurring themes and grouped into broader categories. These categories were organised into a structured narrative that compared findings across cases and linked them to theoretical frameworks of vulnerability, disaster management, and resilience. The data extraction and analysis process is illustrated in the PRISMA diagram in Figure 1. This diagram outlines the stages involved, beginning with the identification process, which involves identifying relevant studies, followed by the screening process, which assesses the article's eligibility based on established criteria. Although citation frequency was included in the results to illustrate the bibliometric significance of each study, the analysis primarily relied on qualitative synthesis rather than quantitative bibliometric mapping or meta-analysis.

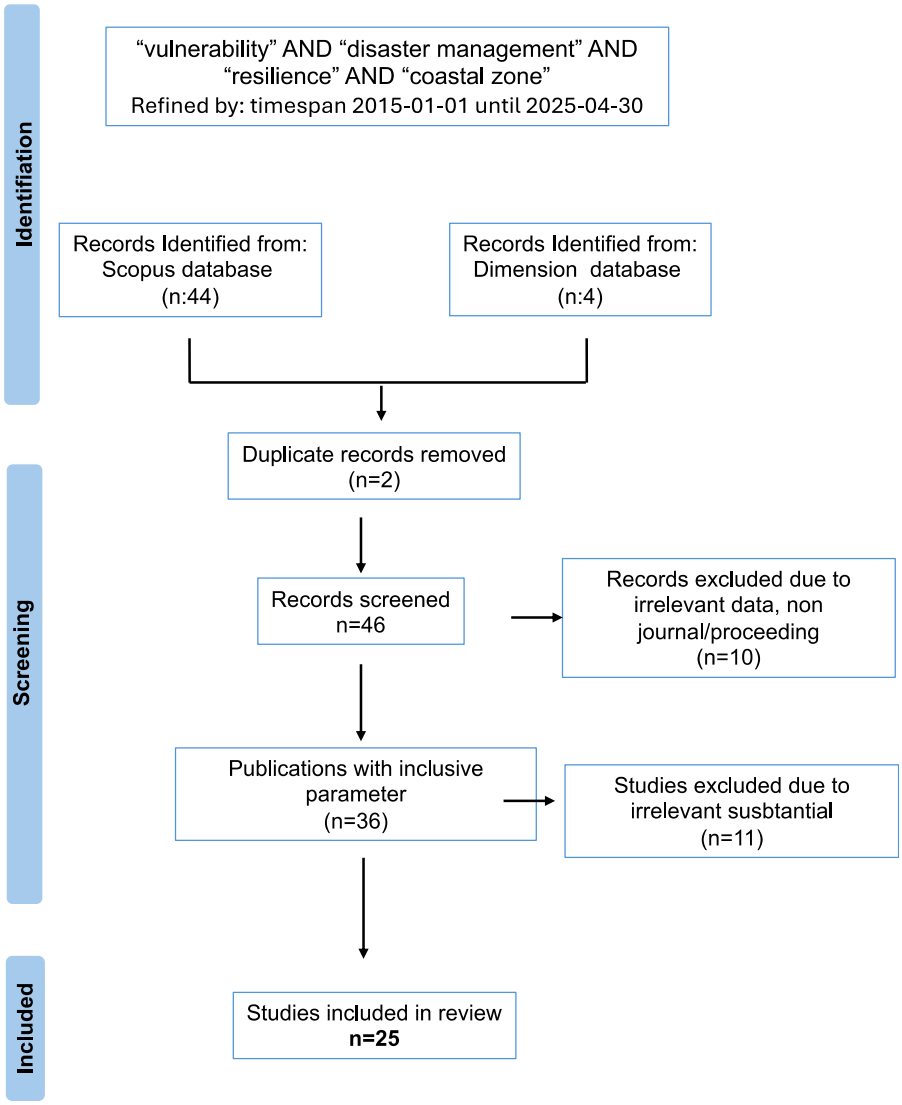

Fig. 1 PRISMA Diagram

Figure 1 illustrates the PRISMA diagram outlining the process of the systematic literature review conducted in this study. During the review, 48 articles were reviewed from databases such as Scopus and Dimensions. In the screening process, duplicate articles were removed, and 46 records remained. Additionally, 10 articles were excluded due to irrelevant data and those that were not in the form of a journal or proceedings, resulting in a total of 36 articles with inclusive parameters. After refining the eligibility of the articles using inclusion and exclusion criteria, this review included 21 articles for review. The summary of articles being reviewed is shown in Table 1.

3.0 RESULT

Table 1 provides an overview of the research articles focusing on vulnerability, DM and the resilience of coastal settlements around the world. These studies, published over several years, appeared in journals indexed by both Scopus and the Dimensions database. These articles explore topics such as the impacts of coastal floods, social and economic vulnerability, disaster strategies, and community resilience, highlighting their academic significance. Regional differences emerge in emphasis, for example, studies in Asia (Añasco, et al., 2021; Park, et al., 2024) tend to highlight community preparedness and the role of local adaptive capacity, while research in Europe (Chu, et al., 2021; De Risi, et al., 2022) focuses on technical tools such as stress testing and simulation models. In contrast, studies from Africa (Bello et al., 2024; Odunsi et al., 2024) point to household-level variation in resilience and the role of geospatial technology, while research from the Americas (Martinez et al., 2018; Qin

et al., 2017) emphasises socio-economic systems and governance structures. These comparisons illustrate how geographic context shapes both vulnerability framing and resilience strategies.

Table 1: Summary of Articles' Results

Author	Citation	Result
Park et al., 2024	0	The impacts of coastal floods triggered by SLR and other hazard factors can be reduced by aligning practical regulatory measures with adaptive strategies and enhancing the disaster resilience of coastal communities
Al-Maruf et al., 2023	8	The importance of human capital in disaster resilience strategies, highlighting that investments in education and skills development can lead to more effective responses to environmental threats
Añasco et al., 2021	21	The study revealed that Guimaras Island has disaster risk preparedness and effective community initiatives, in which the adaptive capacity of the local community was a key factor
Uddin et al. 2020	109	The findings demonstrate that community resilience attributes function interactively rather than independently, and require a clear understanding of network functioning that drives institutional structures, relations, and outcomes
Qin et al., 2017	59	The findings emphasised several critical elements necessary for enhancing community resilience, including a developed economic system, an excellent education program, infrastructure investment, and good policies
Bello et al., 2024	1	The findings revealed that the Delta coastal State has extensive medium to high-risk flood zones and emphasised the critical role of geospatial technology in enhancing DM and community resilience
Risi et al., 2022	5	The use of simulation-based procedures will allow for stress testing of communities to assess their resilience against multiple cascading hazards, ensuring that they have adequate resources to cope with extreme events
Chu et al., 2021	5	The social resilience to flooding hazard in Vancouver at the Census Tracts and Dissemination Areas census scales can have contradictory results depending on the census scale adopted
Martinez et al., 2018	40	The qualitative approach is used to understand the knowledge, values and behaviours of institutional and non-institutional stakeholders in formulating appropriate risk reduction
Mojtahedi & Oo, 2016	23	The understanding of socio-economic and built environment vulnerabilities is essential for effective DM and resource allocation
(N. Lam, et al., 2016)	235	The research revealed that the resilience inference measurement (RIM) model can be applied to derive resilience indices at different spatial and temporal scales
Barquet et al. 2018	7	The integrated approach in assessing disaster risk can be effective for triggering local dialogue, disseminating information, and achieving greater ownership and local acceptance of DRR
Lee et al., 2022	9	The environmental degradation has increased the vulnerability of coastal areas and highlights that integrated Nature-based Solutions could be implemented as disaster resilience strategies in Jamaica
Cai et al., 2016	22	Communities with higher resilience were generally located in the northern part of the study area, while lower-resilience communities were found along the coastline and in lower elevation areas

Author	Citation	Result
Bukvic, 2015	19	The RPACC framework encourages the inclusion of local perspectives and preferences, which can significantly impact the decision-making process regarding relocation
Giang et al., 2024	1	The study locations are generally well-prepared for climate change, and by focusing on social capital development and land-use planning, the coastal communities can further strengthen their resilience
Odunsi et al., 2024	5	The household resilience to flood disasters varies depending on the specific dimensions within each component in different flood zones
Dakey et al., 2023	6	The research identified vulnerabilities in human systems and the impact of governance strategies on critical SES components
Imani et al., 2022	9	The framework integrates the concepts of capability and resilience into four main sectors: resource, reason, roadmap, and response.
Tasnuva et al., 2024	2	The study underscores the importance of evolving from traditional approaches to advanced data-driven tools to understand disaster risks
Saravanan, 2016	2	The various disaster pre- and post-activities and their effect during a disaster, with the various mitigation steps

Table 1 presents a summary of the results derived from the various articles included in this systematic literature review, providing a detailed overview of the key findings. The table also presents the citation frequency of each article, which indicates the publication's significance based on its high number of citations (Ibrahim et al., 2024). It is essential to recognise that citation frequency should be viewed as a measure of academic influence, rather than direct relevance to practice. For example, N. Lam et al. (2016) is widely recognised for its methodological innovation in measuring resilience, with 235 citations. More recent contributions, such as those by Bello et al. (2024) and Giang et al. (2024), provide critical, region-specific insights into contemporary challenges, but have received fewer citations. Both types of contribution are significant but serve different roles in advancing the field.

4.0 DISCUSSION

As the integrated zone between land and sea, the coastal area is the zone with the most frequent human activities and the most vital area for the sustainable development of the global economy (Zhang et al., 2023). This zone is prone to disaster risk due to the impact of climate change, which has an adverse effect not only on the environment but also on the physical and economic aspects. Furthermore, disaster risk can be expressed as the loss of life, destruction and damage from a disaster in each period (Ahmad Basri et al., 2022). An adaptation strategy is needed to overcome the risk and minimise the damage. Many coastal cities tend to implement adaptation measures reactively, primarily in response to high-impact events such as floods and storms, rather than proactively planning for future risks. This reactive approach limits the effectiveness of DM strategies and fails to address long-term vulnerabilities (Wannewitz et al., 2024).

In the context of coastal areas, adaptation to climate change is a critical strategy to address the unique challenge of increased storm intensity and other environmental hazards. Climate adaptation refers to the process of adjusting to the actual or expected effects of climate change. This includes actions taken to prevent or minimise damage from climate impacts, as well as exploiting potential beneficial opportunities that may arise. In essence, adaptation aims to reduce vulnerability and enhance resilience in human and natural systems facing climate change challenges.

These findings demonstrate how the concepts of vulnerability, DM and resilience are interconnected yet unevenly addressed in current scholarship. Vulnerability is often assessed through physical and socio-economic indicators, but translation into proactive DM strategies remains limited. Moreover, while many studies highlight adaptive or absorptive resilience, fewer explore transformative resilience, which requires systemic change. This indicates a theoretical imbalance that needs to be addressed to operationalise resilience frameworks fully.

Several gaps were found from a systematic literature review regarding addressing vulnerabilities and enhancing resilience to conduct adaptive strategies and DM. The gaps are divided into four sections, which elaborate on the keywords used as a string in systematic literature reviews. The gaps will help us to understand the current literature and the future research that can be adopted.

Integration of Local Knowledge and Longitudinal Studies

Adaptation to enhance resilience can't be done without involving local communities
since the adaptive capability is defined as the capacity to adjust the system to minimise the adverse impact of climate change (Zen et al., 2019). This adaptive capability should involve the community as the subject that is critically influenced by climate change. While some studies reference local knowledge or community involvement, there is a lack of systematic integration of local knowledge into resilience planning. On the other hand, assessing the resilience of coastal communities, which involves understanding their connectedness, risk levels, disaster planning procedures, and available resources, is a crucial step that communities should undertake (Añasco et al., 2021; Park et al., 2024). The integrated approach in assessing resilience and disaster risk can be effective for triggering local dialogue, disseminating information, and achieving greater ownership and local acceptance of disaster risk (Barquet et al., 2018; Bukvic, 2015; Imani et al., 2022; Tasnuva et al., 2024). It can influence community recovery and adaptation strategies.

The time series studies or longitudinal studies are still rare in the articles found. Most studies employ a short-term or cross-sectional approach. Longitudinal studies can be used to understand the evolution of climate impacts and community adaptation over time. Communities can use the simulation-based procedure to assess their resilience against multiple cascading hazards, ensuring that they have adequate resources to cope with extreme events (De Risi et al., 2022).

Impact of Socio-economic Factors

Socio-economic status directly affects access to adaptive resources, the ability to relocate, and even participation in planning processes. Although studies often mention vulnerabilities, many do not deeply explore how socio-economic disparities (e.g., income, education, access to services) influence resilience capacity. There is limited discussion of marginalised groups (e.g., informal settlers, women, youth) in policy frameworks and planning processes. Assessing vulnerabilities to enhance resilience in disaster risk management requires considering socio-economic characteristics as indicators (Chu et al., 2021). Some scholars reveal that when both socio-economic and built environment factors are considered together in determining resilience, the results show a higher percentage of greater resilience rather than neglecting those aspects (Cai et al., 2018; Mojtahedi et al., 2016).

The need for a comprehensive resilience approach that goes beyond mere physical infrastructure (structural resilience). Human capital is a critical resource that not only enables households to respond to floods and storm surges but also facilitates the effective use of other resources available to them. By focusing on enhancing human capital, policymakers can create targeted interventions that strengthen the adaptive capacity of vulnerable communities in coastal areas (Al-Maruf et al., 2023). The findings emphasised several critical elements necessary for enhancing community resilience, including a developed economic system, an excellent education program, infrastructure investment, and good policies. While the overall level of resilience improved, the study found that regional differences in CRI also increased. This indicates that some areas may be advancing more rapidly in resilience than others, highlighting the need for targeted interventions. Resilience is not uniformly distributed across the coastal areas, and there are pockets of both high and low resilience (De Risi et al., 2022; Imani et al., 2022; Odunsi et al., 2024; Qin et al., 2017; Tasnuva et al., 2024).

Interdisciplinary Approach and Technology Innovation

Climate resilience is inherently multi-dimensional; tackling it from a single discipline limits the scope of solutions. Technology can significantly enhance data collection, monitoring, forecasting, and participatory planning (e.g.,

real-time flood warnings, crowd-sourced vulnerability mapping). The use of technological innovation (e.g., GIS, remote sensing, AI for predictive modelling) is underrepresented or underutilised in planning and monitoring efforts. Several studies remain confined to single-discipline perspectives (e.g., urban planning, environmental science), with limited collaboration across disciplines like social science, economics, or information technology. The lack of a universally accepted definition of risk emphasises that risk analyses must consider uncertainties and provide probabilistic descriptions of potential adverse events affecting a specific region. The use of simulation-based procedures, such as geospatial technology, will enable stress testing of communities to assess their resilience against multiple cascading hazards, ensuring they have adequate resources to cope with extreme events (Bello et al., 2024; De Risi et al., 2022). Integrating qualitative and quantitative data from various disciplines can enhance the understanding of how societies cope with risks and manage disasters (Mojtahedi et al., 2016). This collaboration can lead to unexpected insights and a more comprehensive understanding of disaster risk management (Martinez et al., 2018).

Constructing a community resilience index that addresses vulnerabilities can be conducted through several approaches, one of which is using city-level social and economic data (Qin et al., 2017). The other approach is the Resilience Inference Measurement (RIM) model, which can be used to assess community resilience to coastal hazards (Cai et al., 2016; N. Lam et al., 2016). The integrated approach in evaluating disaster risk can be effective for triggering local dialogue, disseminating information, and achieving greater ownership and local acceptance of disaster risk reduction. An interdisciplinary and technology-supported approach is crucial for integrating local knowledge systematically, monitoring changes over time, and designing inclusive strategies that account for socio-economic realities.

Community-based Approaches

Communities are the first responders to climate events. Their involvement ensures that adaptation measures are relevant and sustainable. Without robust participation, planned interventions may face resistance or become ineffective. While community participation is referenced, very few studies offer clear frameworks or evidence on how community-based adaptation is operationalised, funded, or sustained. There is also a lack of evaluation on the effectiveness of these approaches in achieving long-term resilience.

In terms of risk and vulnerability, the community had some awareness of hazards, but not all local people had access to hazard maps. Households actively engaged in disaster planning and response procedures, with community members participating in drills and planning activities (Añasco et al., 2021; Lee et al., 2022; Martinez et al., 2018). Community members became more organised and better connected, which enhanced their ability to respond to disaster (Uddin et al., 2020). By focusing on the identified areas for improvement, such as social capital development and land-use planning, the coastal communities can further strengthen their resilience against climate change impacts (Giang et al., 2024). The importance of involving local stakeholders in the assessment process revealed that local actors and institutions often operate without a shared strategy for DRR, leading to fragmented decision-making (Barquet et al., 2018). The interviews indicated a desire among community members to participate in DRR activities, such as volunteering for dune vegetation planting, which suggests potential for greater community involvement. The findings emphasised the importance of education and building trust between local authorities and residents. Many community members expressed a lack of knowledge about emergency procedures, indicating a gap that needs to be addressed to enhance resilience (Martinez et al., 2018).

Across regions, different emphases in resilience strategies were observed. In Asia, community-based initiatives and social capital development are central (Añasco et al., 2021; Park et al., 2024), while European studies focus more on technical stress-testing and modelling (Chu et al., 2021; De Risi et al., 2022). In Africa, resilience research highlights household-level disparities and the application of geospatial technology (Bello et al., 2024; Odunsi et al., 2024). Meanwhile, as mentioned before, the Americas emphasise governance structure and socio-economic systems (Martinez et al., 2018; Qin et al., 2017). This variation reflects how contextual vulnerabilities shape strategies, underscoring the importance of adaptive governance that bridges global frameworks with local realities.

Understanding people's resilience to flood disasters highlights that different households exhibit varying levels of vulnerability, which can lead to different material and human losses during such events (Odunsi et al., 2024).

The importance of community involvement in DM activities, including training and awareness programs, will engage local populations in disaster preparedness, can enhance resilience and ensure that communities are better prepared for future disasters (Saravanan, 2016).

For policymakers and practitioners, three priorities emerged: (1) systematically integrating local knowledge into DM and resilience planning; (2) ensuring equitable inclusion of marginalised and vulnerable groups; and (3) fostering interdisciplinary collaboration supported by technological innovations. Collectively, these priorities point toward more inclusive, adaptive and context-sensitive approaches that can strengthen resilience and reduce risks in coastal settlements.

5.0 CONCLUSION

Coastal zones serve as critical interfaces between terrestrial and marine systems, hosting vibrant human activity and underpinning global economic sustainability. However, these areas face escalating risks from climate change-induced hazards such as sea-level rise, coastal flooding, and intensified storms. Although numerous adaptation measures have been implemented, they often remain reactive, fragmented, and insufficiently integrated into long-term planning frameworks. This undermines the capacity of coastal communities to withstand and recover from future climate impacts. A systematic review of the literature reveals four key gaps that limit the effectiveness of disaster risk management and climate adaptation in coastal regions: (1) Integration of Local Knowledge and Longitudinal Studies, (2) Impact of Socio-economic Factors, (3) Interdisciplinary Approach and Technology Innovation, and (4) Community-Based Approaches. These gaps are deeply interconnected and highlight systemic challenges in current resilience strategies.

Beyond mapping gaps, this study contributes to advancing both theory and practice. Theoretically, it reframes vulnerability, DM and resilience not as linear stages but as an iterative cycle in which lessons from resilience feed back into future vulnerability assessment. Empirically, it shows that despite the prominence of highly cited works, many continue to reinforce static framings while more integrative approaches remain underutilised. Practically, the findings underscore the need for context-specific and actionable pathways, particularly in the Southeast Asian context, where hybrid approaches that combine community-led initiatives with formal governance frameworks can yield transformative resilience outcomes.

Future research and policy must move beyond reactive measures to proactively design and implement inclusive, forward-looking adaptation pathways. By bridging these four key gaps in a coordinated manner, stakeholders can enhance the adaptive capacity and resilience of coastal communities in the face of accelerating climate challenges.

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