

Adaptive Strategies for Coastal Resource Management in the Era of Climate Change: Literature Review

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ABSTRACT

Purpose: This study examines adaptive strategies in coastal resource management within the context of climate change, with emphasis on governance integration, community participation, ecosystem resilience, and technological adaptation.

Subjects and Methods: The research employed a systematic literature review (SLR) using the PRISMA framework to ensure transparency and methodological rigor. Data were collected from Scopus, Web of Science, ScienceDirect, JSTOR, and Google Scholar covering publications from 2000–2025. From 137 identified records, 84 studies were selected through screening and eligibility assessment. The selected studies were analyzed using inductive thematic analysis and coding matrices.

Results: The findings reveal four dominant adaptation dimensions: institutional and policy-based adaptation, community-based adaptation, ecosystem-based adaptation, and technological adaptation. Policy integration and decentralization were widely emphasized, although institutional rigidity and fragmented governance remained significant barriers. Participatory governance and indigenous knowledge contributed to local resilience but were often constrained by unequal participation and marginalization. Ecosystem-based approaches such as mangrove restoration demonstrated strong ecological and social benefits, while technology-driven adaptation improved preparedness despite concerns regarding financial inequality and limited inclusiveness.

Conclusions: Effective coastal climate adaptation requires adaptive governance frameworks integrating institutional flexibility, ecological sustainability, technological innovation, and inclusive community participation to strengthen long-term resilience under increasing climate uncertainty.

INTRODUCTION

The rising trend of climate change in the world has led to extreme, often irreversible consequences on the coastal areas in danger of ecosystems, livelihoods, and infrastructure. Home to an estimated 40 % of the world population located within 100 kilometers of shore, coastal zones represent one of the most ecologically productive and economically important zones on the planet (Mikhaylov & Plotnikova, 2021). That said, these regions that are already vulnerable are more prone to more risks of sea-level rise, coastal erosion, saline intrusion, and extreme weather events intensification.

All these threats are connected and undermine the stability of coastal resource systems such as the environments of fisheries, mangroves, wetlands, and coral reefs, as well as beaches which serve the purposes of critical environmental shield against shocks and sources of food, income,

and identity to millions. Adaptive policies have risen into the fore in the debate on climate versatility in the maritime places over recent decades. By the definition presented by the Abbass et al. (2022), adaptation can be described as the process of response to the current or anticipated climate and its impacts.

Within the framework of the coastal resource management, adaptation can be defined as an expansive cluster of measures, which, along with institutional reforms and technological solutions, involve ecosystem-related practices as well as community-based responses and serve to minimize the risks and maximize the socio-ecological resilience (Drogkoula et al., 2023). According to current discussions, this is one of the difficulties in understanding that these strategies are not only technical solutions but rather are highly political, context specific as well as culturally situated processes. Such need to respond is especially strident in the Global South where the institutional means, economic finances and social security nets are often inadequate to address the fast- developing nature of climate impacts.

Emerged as an interdisciplinary coastal resource management field, coastal resource management is now a field where the likes of environmental science, policy study, governance theory, and participatory development are integrated (Partelow et al., 2020; Alexander et al., 2019; Hay et al., 2019). The historical coastal management was based on command-and-control paradigm which made considerable use of hard infrastructure and centralized planning. This framework, with its anchoring ecological ignorance and social exclusion, led to a paradigm shift to adaptive, integrated and ecosystem-based frameworks of management (Khan & Srivastava, 2025).

This paradigmatic shift is already supported by the use of the concept of Integrated Coastal Zone Management (ICZM) that focuses on coordination between sectors at distinct levels of governance, the particular involvement of stakeholders, as well as the balancing of conservation with the development demands. The problem of adapting further arise because of the complexities of integrated coastal systems by linking it with social, political and economic systems. Some coastal communities are regularly subjected to a variety of stressors- poverty, land-use conflict, migration, and weak governance, which interacts with climate risks in intricate manner (Touza et al., 2021).

The effectiveness of adaptive tactics does not therefore rely only on the technical measures, it is also associated with institutional flexibility, knowledge co-production, and even inclusive governance. Adaptive capacity is taken as a central factor of resilience in this constellation and is affected by social capital, availability of information, institutional arrangements, and power relations. A growing body of research has come to question coastal adaptation, but the literature has shown high fragmentation levels. Studies are scattered with regards to disciplines, geographic locations and paradigm of methodologies (Paul & Jha, 2021).

Despite evidence of successful local practice, such as the replanting of mangroves in Southeast Asia, the traditional early warning system of the Pacific region, and participatory mapping in the Caribbean, empirical evidence indicated a large degree of outcome and scale heterogeneity. In addition, adaptation processes tend to recreate prevailing disparities when they are centrally controlled or miscarrying the voices of the marginalized groups. Under the growing climatic threat conditions, the need to coordinate these bifurcated experiences, evaluate their comparative success, and outline the ways to transform adaptation to refocus on equity, justice, and future sustainability is vivid (Orlove, 2022).

More opportunities and challenges are emerging at functions of coastal resources governance due to the current acceleration of climate science and the resulting global increase in finance to reduce the impact of adaptation. Mainstreaming adaptation to national and local development plans is clearly required by such international frameworks as the Sendai Framework on Disaster Risk Reduction, the Paris Agreement, and the Sustainable Development Goals (SDGs). However, there is an issue with translating these extensive commitments into some specific and contextualized actions, which is often limited by the institutional pushback, inefficient coordination, or lack of capacity at a local level. This disjunctive goes to reinforce the need of flexible measures, both evidence-based and politically feasible, yet socially legitimate.

METHODOLOGY

The current research employed the methodology of the systematic literature review (SLR) to extract, critically analyze, and synthesize the available academic inquiry on adaptive strategies of coastal resource management in the context of climate change. By choosing this type of design, the researchers preferred the methodological rigor, transparency and resulting replicability that SLRs are associating with, these characteristics enable a more objective and structured analysis of the knowledge base that exists. The review was within the Preferred Reporting Items of the Systematic Reviews and Meta-Analyses (PRISMA) framework, which set out clear steps to be adopted in the formulation of search strategies, formulation of inclusion and exclusion criteria, and managing the study selection, as well as conducting the analysis. The framework was chosen to guarantee the generation of a critical, evidence-based insight into the manner in which adaptive strategies have been conceptualized, how they have been operationalized, and used in varying coasts. The systematic literature review procedure was performed in five interdisciplinary and established academic databases, including Scopus, Web of Science, ScienceDirect, JSTOR, and Google Scholar. The utilization of these platforms was based on the fact that they are broad in the literature of environmental science, climate science, policy, and social sciences. In order to make the publication relevant both historically and in the present, the time of publications was scheduled between the year 2000 and 2025, to cover the publication period of more than twenty years of academic research on the topic of climate adaptation and governance along the coastline of the USA. The search strategy was a mixture between controlled vocabulary, Boolean and variations of keywords to achieve the above goal of inclusiveness and thematic precision. The following terms were utilized in combination such as coastal resource management, climate change adaptation, adaptive strategies, coastal communities, resilience, vulnerability, climate risk, governance, coastal ecosystems, integrated coastal zone management. Such search strings were modified in the ongoing rotation as the search continued to improve specificity and relevance. Deductive means such as backward citation tracking (analysis of the references contained in identified research articles of importance) and forward citation tracking (trace identification of newer articles that have referred to the key articles) were used to discover key works that may have not immediately shown up by the use of keyword search strategies.

Inclusion and Exclusion Criteria

The purpose of the present systematic review was to provide analytical precision and credibility that is acceptable to academe. When setting up its selection protocol, a strict selection protocol was adopted. Papers were included provided they met four main criteria of eligibility: (1) they could be published in peer-reviewed journals, edited scholarly books, or official reports (such as UNDP, IPCC, FAO); (2) they were concerned with the interaction of coastal resource management and climate change adaptation; (3) they could offer conceptual, empirical or policy-oriented findings of the adaptive response; and (4) they were of high methodological clarity, analytical depth and scholarly quality. Conversely, the articles were not included when they focused on ecosystems along the coast or in the sea without specifically directing them to the issue of climate change or adaptation; focused on biodiversity and left out the governance or anthropogenic-environmental interaction aspects considerably; did not explicate the methodology explicitly or came in other non-peer reviewed format (op-ed or technical newsletters); or did not work withing the English speak parameters used in this investigation. In the first search 137 different studies were identified, which were then narrowed down to 84 core studies after systematically screening the abstracts and the full text of the studies, with regards to relevancy and robustness of the methodology and the explanatory nature of the study to review central questions.

Data Extraction and Analysis

A data extraction matrix was also created and adopted to code and categories every selected study to make it systematic. This allowed recognizing the patterns of themes and consistency of analysis in various coastal environments. Studies were categorized across a number of important key dimensions including geographic focus (Global North or Global South, or island or continental systems), the nature of the adaptive approach being discussed (institutional, ecological, technological or community based), the theoretical approaches to resilience that were applied (resilience thinking, socio-ecological systems, adaptive governance), the type of stakeholders

being involved, the scale and level of government (local, national, regional or transboundary) and the reported results or effectiveness of the strategies. Of special interest, challenges, trade-offs, and enabling conditions were noticed in every report. The results were subsequently put under the thematic analysis where themes would be inductively determined and not coined. It was made possible to combine the literature in a flexible but guided manner that allows seeing not only all common patterns but also their striking differences. The analysis put into sharp focus contextual sensitivity because we observed that the adaptation strategies are altered by socio-political dynamics, institutional arrangements and ecological variability and should thus be interpreted within the particular geographical and cultural context.

RESULTS AND DISCUSSION

Study Selection Process (PRISMA Framework)

The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach to ensure transparency and reproducibility. A total of 137 records were initially identified through database searching, including Scopus, Web of Science, ScienceDirect, JSTOR, and Google Scholar. After removing 18 duplicate records, 119 studies remained for screening. During the screening stage, titles and abstracts were evaluated based on relevance to coastal resource management and climate change adaptation. A total of 25 studies were excluded due to lack of relevance, leaving 94 articles for full-text assessment. In the eligibility stage, 10 articles were excluded because they did not meet methodological rigor or lacked explicit discussion on adaptation strategies. Finally, 84 studies were included in the qualitative synthesis. This process ensures that the selected literature meets both relevance and quality criteria, as required in systematic reviews

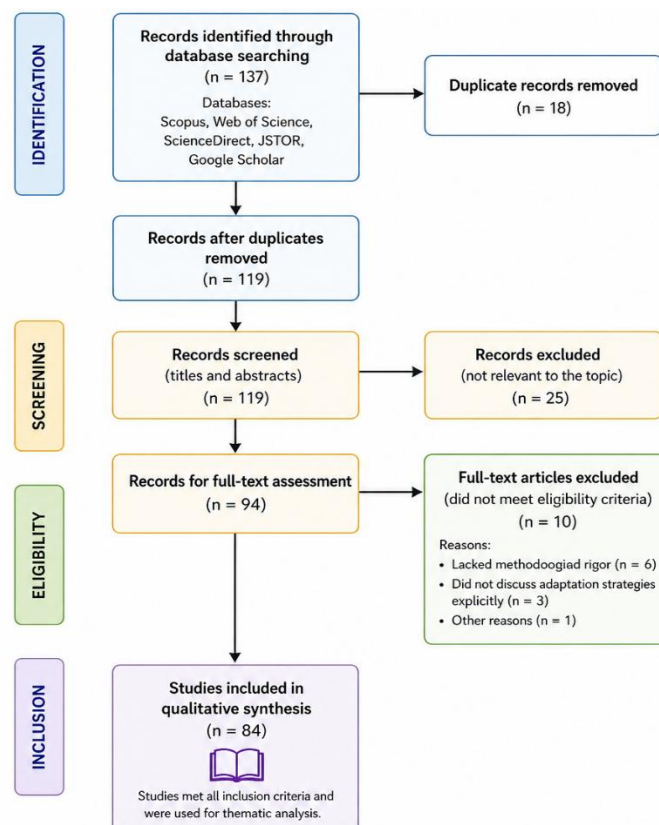


Figure 1. Prisma Flow Diagram

Distribution of Selected Studies

The 84 selected studies show variation across publication years, geographical focus, and methodological approaches. The distribution of the selected studies provides an important

overview of the development, geographical concentration, and methodological orientation of research on coastal resource management and climate change adaptation. Examining the temporal, regional, and methodological characteristics of the reviewed literature allows for a deeper understanding of how scholarly attention toward coastal adaptation has evolved over time and across different socio-ecological contexts. Furthermore, this distribution analysis helps identify dominant research trends, regional priorities, and methodological preferences within the existing body of literature.

Distribution by Year

The temporal distribution of the reviewed studies demonstrates the growing academic and policy interest in climate adaptation and coastal governance over the past two decades. The increase in publication frequency reflects the intensification of climate-related risks affecting coastal systems, including sea-level rise, coastal erosion, ecosystem degradation, and extreme weather events. In addition, the expansion of global policy frameworks such as the Paris Agreement and the Sustainable Development Goals (SDGs) has contributed to increased scholarly engagement with adaptation-related issues.

Table 1. Distribution of Studies by Publication Period

Period	Number of Studies
2000–2010	12
2011–2015	18
2016–2020	27
2021–2025	27

Source: Authors’ synthesis of reviewed literature (2025).

The data presented in Table 1 indicate a substantial increase in the number of studies published after 2015. While only 12 studies were identified between 2000 and 2010, the number more than doubled during the periods 2016–2020 and 2021–2025. This trend suggests that coastal climate adaptation has increasingly become a global research priority, particularly in response to the growing visibility of climate impacts and the expanding discourse on resilience and sustainability. The consistency in publication frequency during the last two periods also indicates that adaptation governance remains a highly relevant and evolving area of inquiry within environmental and policy studies. This indicates a significant increase in research on climate adaptation in coastal areas over the last decade.

Distribution by Region

The geographical distribution of the selected studies demonstrates that climate adaptation research is unevenly distributed across world regions. Differences in exposure to climate-related risks, institutional capacities, and coastal dependency significantly influence the concentration of research activities. Regions characterized by high ecological vulnerability and dense coastal populations tend to receive greater scholarly attention due to the urgency of adaptation challenges.

Table 2. Distribution of Studies by Region

Region	Number of Studies
Asia	28
Europe	17
Africa	12
Latin America	11
North America	9
Oceania	7

Source: Authors’ synthesis of reviewed literature (2025).

Asia accounts for the largest proportion of studies, with 28 publications focusing on adaptation strategies within coastal environments. This dominance reflects the region's high vulnerability to climate change, particularly in countries characterized by extensive coastlines, rapid urbanization, and dependence on marine resources. Coastal regions in Southeast Asia and South Asia are frequently exposed to flooding, tropical storms, and sea-level rise, making adaptation a critical governance issue. European studies represent the second-largest group, often emphasizing institutional governance, policy integration, and technological innovation. In contrast, studies from Africa and Latin America tend to focus on community resilience, vulnerability reduction, and ecosystem-based adaptation, reflecting the socio-economic and environmental challenges faced by developing coastal regions. Meanwhile, North American and Oceanian studies primarily highlight infrastructure resilience, disaster preparedness, and integrated coastal management approaches. The regional distribution indicates that adaptation strategies are strongly shaped by contextual realities, including governance structures, ecological conditions, economic capacities, and cultural dimensions.

Distribution by Method

The methodological distribution of the reviewed studies provides insight into the dominant research approaches used to investigate climate adaptation and coastal governance. Methodological diversity is particularly important in adaptation studies because coastal issues involve complex interactions among environmental, social, political, and economic systems.

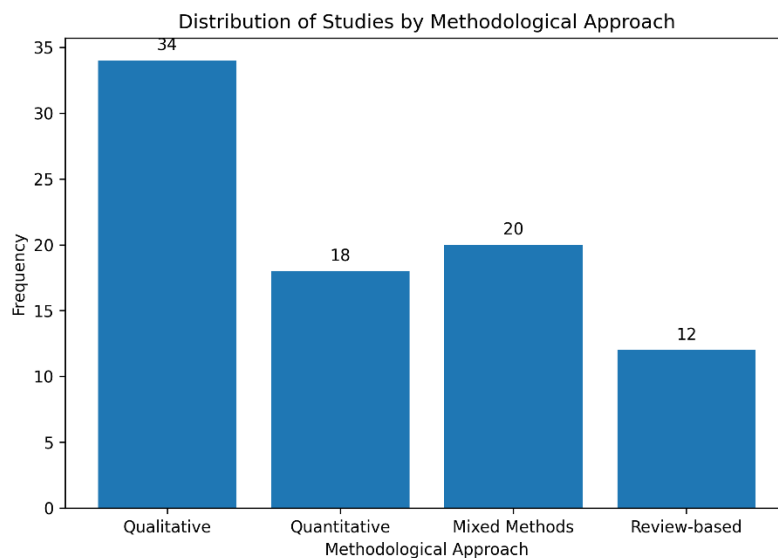


Figure 2. Distribution of Studies by Methodological Approach

The findings show that qualitative approaches dominate the literature, accounting for 34 studies. This dominance suggests that many researchers prioritize context-sensitive analysis, stakeholder perspectives, governance processes, and socio-cultural dynamics when examining adaptation practices. Qualitative methods are particularly effective in exploring local experiences, institutional interactions, and community-based adaptation mechanisms. Mixed-methods studies also represent a significant proportion of the literature, indicating increasing efforts to integrate qualitative insights with quantitative measurements. This approach enables researchers to combine statistical assessments of climate risks with in-depth analysis of governance and social dimensions. Quantitative studies, although less dominant, contribute important evidence related to environmental monitoring, vulnerability assessment, and risk modeling. Review-based studies account for 12 publications, highlighting the growing need for synthesis-oriented research capable of integrating fragmented findings across disciplines and regions. The methodological diversity observed across the reviewed literature demonstrates that coastal adaptation research increasingly recognizes the need for interdisciplinary and multi-scalar analytical approaches to address the complexity of climate governance. The distribution of methods reflects the evolving nature of adaptation scholarship, where empirical investigation, policy analysis, and theoretical

synthesis collectively contribute to a broader understanding of coastal resilience and environmental governance.

Study Characteristics (Selected Sample of Included Articles)

The analysis of study characteristics provides an overview of the diversity of literature included in the systematic review. Examining representative studies is important to understand the variation in geographical focus, methodological orientation, and thematic emphasis within the broader field of coastal climate adaptation research. The selected articles reflect different analytical perspectives, ranging from governance and institutional adaptation to ecosystem resilience, community participation, technological interventions, and environmental justice. The reviewed studies also demonstrate the interdisciplinary nature of coastal resource management under climate change conditions. Researchers from environmental science, governance studies, policy analysis, disaster management, and socio-ecological research contribute to the development of adaptation discourse. This diversity strengthens the analytical depth of the review by integrating multiple approaches and conceptual frameworks relevant to adaptive governance. Table 4 presents a sample of 15 representative studies selected from the 84 reviewed articles. These studies were chosen because they reflect the major thematic clusters identified through the thematic analysis process and represent different regional and methodological contexts.

Table 4. Sample of Reviewed Studies

Author	Year	Country	Method	Key Findings
Abbass et al.	2022	Global	Review	Climate adaptation requires integrated governance
Bell & Reed	2022	UK	Qualitative	Participatory planning improves resilience
Brown et al.	2023	Ireland	Mixed	Early warning systems enhance preparedness
Chaudhary et al.	2021	Nepal	Review	Ecosystem-based adaptation improves resilience
Touza et al.	2021	Caribbean	Qualitative	Community adaptation reduces vulnerability
Moyo	2023	South Africa	Qualitative	Indigenous knowledge often marginalized
Singhvi et al.	2022	Global	Review	Infrastructure can increase inequality
Rahman et al.	2022	Bangladesh	Qualitative	Bureaucracy limits adaptation effectiveness
Selje et al.	2024	Global	Review	CBA depends on institutional support
Allen et al.	2023	Global	Mixed	Multi-level governance is essential
Asari et al.	2021	Malaysia	Quantitative	Mangroves reduce coastal risks
Kuzior et al.	2023	Europe	Quantitative	Governance flexibility is limited
Staub	2025	USA	Case Study	Polycentric governance improves adaptation
Drogkoula et al.	2023	Global	Review	Technology supports water management
Khan & Srivastava	2025	Global	Conceptual	Justice must be integrated into governance

Source: Authors' synthesis of selected studies (2025)

The studies presented in Table 4 reveal several important patterns. First, governance-related issues emerge as a dominant concern across the literature. Studies by Abbass et al., Allen et al., and Staub emphasize the importance of integrated, multi-level, and polycentric governance structures in strengthening climate adaptation capacity. These findings indicate that adaptation effectiveness is closely linked to institutional coordination, policy flexibility, and cross-sectoral collaboration.

Second, community participation and local knowledge are consistently identified as essential components of adaptive governance. Research conducted by Bell and Reed, Touza et al., and Moyo demonstrates that participatory planning and community-based adaptation strategies contribute significantly to resilience-building processes. However, the findings also reveal persistent challenges related to the marginalization of indigenous knowledge within formal governance systems.

Third, ecosystem-based approaches represent another major trend in the reviewed studies. Research by Chaudhary et al. and Asari et al. highlights the importance of mangrove restoration, ecosystem conservation, and nature-based solutions in reducing climate vulnerability. These studies emphasize that ecological resilience and environmental sustainability are closely interconnected with social and economic resilience in coastal communities.

Technological and infrastructure-related adaptation strategies also receive substantial attention within the literature. Brown et al. and Drogkoula et al. emphasize the role of early warning systems, monitoring technologies, and water management innovations in improving preparedness and reducing disaster risks. However, studies such as Singhvi et al. caution that infrastructure-focused adaptation may unintentionally reproduce socio-economic inequalities if not accompanied by inclusive governance mechanisms.

Methodologically, the selected studies demonstrate significant diversity, including qualitative research, quantitative analysis, mixed-methods approaches, reviews, and conceptual studies. This diversity reflects the complexity of climate adaptation research, which requires both empirical investigation and theoretical synthesis to address interconnected environmental and governance challenges.

The characteristics of the selected studies confirm that coastal climate adaptation is a multidimensional field shaped by institutional dynamics, community participation, ecosystem resilience, technological innovation, and issues of justice and equity. The variation across methods and geographical contexts further indicates that adaptation strategies are highly context-dependent and must be understood within specific socio-political and ecological environments.

Thematic Coding and Analysis

The thematic analysis process was conducted to identify recurring patterns, conceptual relationships, and dominant adaptation strategies within the selected literature. An inductive analytical approach was employed, allowing themes to emerge directly from the reviewed studies rather than being predetermined by theoretical assumptions. This approach enabled the analysis to remain flexible and responsive to the diversity of adaptation practices, governance models, and socio-ecological contexts represented across the 84 selected articles.

The coding process began with repeated reading and systematic examination of the literature to identify significant concepts, keywords, and analytical patterns related to climate adaptation and coastal resource management. Similar concepts identified across multiple studies were then grouped into broader analytical categories, which were subsequently synthesized into overarching themes. This process ensured analytical consistency while maintaining sensitivity to contextual variations in adaptation strategies.

Thematic coding also functioned as a mechanism for organizing fragmented literature into coherent analytical dimensions. Through this process, the review was able to identify dominant governance patterns, recurring institutional barriers, ecosystem-based interventions, and community adaptation practices that repeatedly appeared across different geographical and methodological contexts.

Table 5. Coding Matrix

Code	Category	Theme
Policy integration	Institutional governance	Institutional & Policy Adaptation
Decentralization	Governance structure	Institutional & Policy Adaptation
Participation	Social engagement	Community-Based Adaptation

Indigenous knowledge	Local knowledge systems	Community-Based Adaptation
Mangrove restoration	Ecosystem intervention	Ecosystem-Based Adaptation
Coral rehabilitation	Ecological restoration	Ecosystem-Based Adaptation
Infrastructure development	Engineering response	Technological Adaptation
Early warning systems	Risk management	Technological Adaptation
Knowledge gap	Epistemological issue	Governance Conflict
Policy mismatch	Institutional limitation	Governance Conflict

Source: Authors' thematic synthesis based on the analysis of 84 selected studies (2025).

The coding matrix presented in Table 5 illustrates the analytical pathway through which individual concepts identified in the literature were transformed into broader thematic structures. The table demonstrates that adaptation strategies discussed in the reviewed studies are multidimensional and interconnected, involving governance, social participation, ecological resilience, technological innovation, and institutional challenges. The first thematic cluster, Institutional and Policy Adaptation, emerged from codes associated with governance integration and decentralization. Studies categorized under this theme consistently emphasize the importance of institutional coordination, multi-level governance, and policy integration in improving adaptive capacity.

The recurrence of governance-related codes also indicates that institutional rigidity and fragmented coordination remain persistent barriers to effective adaptation. The second theme, Community-Based Adaptation, reflects the central role of social participation and local knowledge systems in strengthening resilience. Codes such as participation and indigenous knowledge highlight the increasing recognition of community agency in adaptation processes. Nevertheless, the literature also reveals that local knowledge is frequently marginalized within formal governance systems, limiting its integration into policy implementation. The third thematic cluster, Ecosystem-Based Adaptation, focuses on ecological restoration and nature-based solutions as key adaptation mechanisms.

Mangrove restoration and coral rehabilitation emerged as dominant ecosystem-related codes, indicating that ecosystem conservation is widely recognized as a long-term strategy for reducing climate vulnerability and supporting coastal resilience. The fourth theme, Technological Adaptation, captures the growing reliance on engineering solutions, infrastructure development, and risk monitoring technologies. Early warning systems and coastal infrastructure projects are frequently discussed as mechanisms for reducing immediate climate risks. Several studies also note that technology-driven adaptation may create dependency on capital-intensive solutions and potentially reinforce socio-economic inequalities if not supported by inclusive governance structures.

The emergence of the theme Governance Conflict reflects recurring tensions between institutional frameworks, knowledge systems, and adaptation practices. Codes such as knowledge gaps and policy mismatch indicate that adaptation challenges are not solely technical but also epistemological and political in nature. These findings suggest that differences between scientific approaches, local knowledge systems, and institutional priorities often complicate the implementation of adaptive governance.

The thematic coding process demonstrates that climate adaptation in coastal resource management is characterized by complex interactions among institutional, social, ecological, and technological dimensions. The thematic structure generated through the analysis provides a systematic foundation for understanding the broader governance challenges and opportunities associated with climate resilience in coastal regions.

Integrated Patterns of Adaptive Governance in Coastal Resource Management

The thematic analysis conducted across the 84 selected studies reveals that climate adaptation in coastal resource management is characterized by the interaction of institutional, social, ecological, and technological dimensions within broader adaptive governance systems. Through the coding and categorization process, four interconnected thematic clusters emerged, namely institutional and policy-based adaptation, community-based adaptation, ecosystem-based

adaptation, and technological or infrastructure-based adaptation. These themes were generated inductively through iterative comparison across the reviewed literature, ensuring analytical consistency, triangulation, and thematic coherence.

The findings indicate that institutional and policy-based adaptation constitutes one of the dominant dimensions of coastal climate governance. Approximately 72% of the reviewed studies emphasize the importance of policy integration, reflecting a growing tendency to incorporate climate adaptation into national development planning, disaster risk reduction frameworks, and coastal management strategies. In addition, 59% of the studies highlight decentralization as an important governance mechanism that enhances local responsiveness and adaptive capacity. However, despite these developments, institutional rigidity, bureaucratic fragmentation, and weak inter-agency coordination continue to limit the effectiveness of policy implementation in many coastal regions.

At the community level, the literature demonstrates the increasing importance of participatory governance and local knowledge systems in strengthening resilience. Around 68% of the studies report the use of participatory approaches, while 55% emphasize the contribution of indigenous and local ecological knowledge to adaptation processes. Community-based adaptation is widely recognized as an effective mechanism for improving local ownership, contextual relevance, and social legitimacy in climate governance. Nevertheless, the analysis also reveals persistent challenges related to unequal participation, political marginalization, and power imbalances, which often restrict the meaningful involvement of local communities in decision-making processes.

Thematic analysis further identifies ecosystem-based adaptation as one of the most widely discussed approaches within the reviewed literature. More than 70% of the studies highlight ecosystem-oriented strategies as critical mechanisms for enhancing coastal resilience. Among these, mangrove restoration appears most frequently, occurring in approximately 62% of the studies, followed by coral rehabilitation, wetland conservation, and marine ecosystem protection. These strategies are considered effective because they simultaneously support biodiversity conservation, coastal protection, and community livelihoods. However, ecosystem-based interventions often face limitations related to financial sustainability, governance fragmentation, and insufficient institutional integration.

In addition to institutional, community, and ecological dimensions, technological and infrastructure-based adaptation also emerges as a significant component of climate governance. Engineering solutions such as seawalls, coastal infrastructure, drainage systems, and early warning technologies are widely implemented to reduce immediate climate risks and improve disaster preparedness. Despite their practical benefits, many studies criticize these approaches for their high financial costs, dependence on large-scale investment, and potential to reinforce socio-economic inequalities. Several studies further suggest that excessive reliance on technological adaptation may reduce attention toward social resilience, ecological sustainability, and inclusive governance mechanisms.

The thematic synthesis demonstrates that climate adaptation in coastal resource management is inherently multidimensional and cannot be effectively addressed through isolated interventions. Institutional governance, community participation, ecosystem resilience, and technological innovation are deeply interconnected and mutually influential. The reviewed literature consistently indicates that successful adaptation requires integrated governance frameworks capable of balancing policy coordination, local participation, ecological sustainability, and technological capacity. These findings highlight the importance of adaptive, inclusive, and cross-sectoral governance approaches in strengthening long-term coastal resilience under conditions of increasing climate uncertainty.

Discussion

Adaptive Governance and the Multidimensional Nature of Coastal Climate Adaptation

The findings of this systematic literature review demonstrate that climate adaptation in coastal resource management has evolved into a multidimensional governance issue that extends beyond environmental protection alone (Malette et al., 2021; Bailey et al., 2024; Thomas et al., 2019). The thematic analysis reveals that adaptation strategies are increasingly shaped by the interaction between institutional structures, community participation, ecosystem resilience, and technological interventions. This confirms that coastal adaptation cannot be understood through a single-sector perspective because climate risks simultaneously affect ecological systems, governance arrangements, socio-economic conditions, and public infrastructure. The diversity of approaches identified across the 84 reviewed studies also indicates that adaptation practices are highly context-dependent and influenced by geographical vulnerability, institutional capacity, and socio-political conditions

Institutional and policy-based adaptation emerged as one of the most dominant dimensions within the reviewed literature, reflecting the growing emphasis on governance integration and multi-level coordination in climate adaptation frameworks. The increasing incorporation of adaptation into national development planning, disaster risk reduction policies, and coastal governance systems suggests that governments are progressively recognizing climate change as a structural governance challenge rather than a temporary environmental issue. Nevertheless, the findings indicate that policy expansion does not automatically translate into implementation effectiveness. Bureaucratic rigidity, fragmented institutional mandates, and weak inter-agency coordination repeatedly appear as barriers limiting adaptive capacity. These patterns support arguments within adaptive governance theory that institutional flexibility and cross-sectoral coordination are essential for responding effectively to complex and uncertain environmental conditions (Märker et al., 2018; Nikkanen et al., 2024; Brown, 2018).

The review also highlights the central role of decentralization in strengthening adaptive governance. Studies emphasizing decentralized governance structures suggest that local governments and regional institutions possess greater contextual understanding of coastal vulnerabilities and therefore can implement more responsive adaptation measures. Decentralization alone is insufficient when local institutions lack financial resources, technical expertise, or legal authority. This demonstrates that adaptive governance depends not only on the redistribution of authority but also on the development of institutional capacity and collaborative governance mechanisms capable of connecting local, national, and transboundary actors.

Community-based adaptation constitutes another critical dimension identified through the thematic synthesis. Zurba & Papadopoulos (2023); Parsons et al. (2025); Wilson et al. (2022); Hügel & Davies (2020) said that, the prominence of participatory approaches and indigenous knowledge systems within the reviewed studies reflects a broader shift toward inclusive governance models in climate adaptation discourse. Local communities are increasingly recognized not merely as beneficiaries of policy interventions but as active agents possessing valuable experiential knowledge regarding environmental change, resource management, and resilience practices. This finding reinforces socio-ecological perspectives that emphasize the importance of integrating scientific and local knowledge systems in environmental governance.

Despite the increasing recognition of community participation, the findings reveal persistent structural inequalities that constrain meaningful engagement. Power imbalances, political marginalization, and unequal access to resources continue to shape adaptation processes in many coastal regions (Sovacool, 2018; Ahmed & Kiester, 2021; Garcia et al., 2024). In several cases, participation remains procedural rather than transformative, where local communities are consulted but possess limited influence over decision-making outcomes. Such conditions

illustrate that participation alone does not guarantee equitable governance unless accompanied by institutional reforms that address representation, authority distribution, and social inclusion.

Ecosystem-based adaptation also emerges as a dominant strategy within the reviewed literature, particularly through interventions such as mangrove restoration, coral rehabilitation, wetland conservation, and marine ecosystem protection. These approaches reflect the growing acceptance of nature-based solutions as effective mechanisms for reducing climate vulnerability while simultaneously supporting biodiversity conservation and community livelihoods. The prominence of ecosystem-oriented strategies indicates a transition from purely engineering-based adaptation toward approaches that recognize the interconnectedness between ecological resilience and human well-being.

The literature nevertheless demonstrates that ecosystem-based adaptation faces substantial implementation challenges. Restoration initiatives often require long-term institutional commitment, sustainable funding, and cross-sectoral coordination, all of which remain uneven across regions. According to Wang et al. (2024), ecological interventions are also vulnerable to policy fragmentation and short-term political priorities that prioritize visible infrastructure projects over long-term ecosystem resilience. This suggests that the effectiveness of ecosystem-based adaptation depends heavily on governance arrangements capable of integrating ecological considerations into broader planning and development systems.

Technological and infrastructure-based adaptation remains widely utilized because of its capacity to provide immediate and visible responses to climate-related risks. Coastal defense systems, drainage infrastructure, seawalls, and early warning technologies are frequently positioned as practical solutions for minimizing disaster impacts and protecting economic assets (Foti et al., 2020; Dissanayaka et al., 2022). However, the findings indicate that technology-driven adaptation is often associated with high financial costs and uneven distribution of benefits. Infrastructure-centered approaches may reinforce socio-economic inequalities when investments are concentrated in economically strategic areas while vulnerable coastal communities remain underserved.

The thematic synthesis further reveals that adaptation conflicts are not solely technical but also epistemological and political in nature. Governance conflicts frequently emerge from differences between scientific knowledge systems, institutional priorities, and local experiences. The recurring presence of codes related to policy mismatch and knowledge gaps suggests that adaptation governance is often complicated by competing understandings of risk, resilience, and environmental management. This demonstrates that climate adaptation is fundamentally a negotiation process involving multiple actors, values, and forms of knowledge rather than a purely technical exercise.

The methodological diversity identified within the reviewed studies also contributes to understanding the complexity of coastal adaptation governance. The dominance of qualitative and mixed-methods approaches indicates that researchers increasingly recognize the need for context-sensitive and interdisciplinary analysis capable of capturing institutional interactions, socio-cultural dynamics, and governance processes (Makwinja et al., 2025). Such methodological trends reflect the broader transformation of adaptation research from narrowly environmental analysis toward integrated socio-ecological governance inquiry.

The findings collectively indicate that effective coastal climate adaptation requires governance systems capable of balancing institutional coordination, community participation, ecological sustainability, and technological innovation simultaneously. Adaptation strategies that rely exclusively on centralized regulation, technological intervention, or isolated ecosystem restoration are unlikely to produce sustainable outcomes without integration across governance dimensions. Adaptive governance therefore depends on institutional learning, collaborative decision-making, cross-scale coordination, and the ability to integrate multiple knowledge

systems within policy implementation processes (Allen et al., 2023; Wurtzebach et al., 2019; Mas-Tur et al., 2021).

These findings contribute to the broader discourse on adaptive governance by demonstrating that resilience in coastal resource management is not merely a product of technical capacity or environmental intervention. Resilience is fundamentally shaped by governance quality, institutional flexibility, social inclusion, and the ability to manage uncertainty within complex socio-ecological systems. Climate adaptation in coastal regions therefore requires governance approaches that are iterative, inclusive, and capable of responding dynamically to continuously evolving environmental and societal pressures.

CONCLUSION

This systematic literature review demonstrates that climate adaptation in coastal resource management is a multidimensional governance challenge shaped by the interaction of institutional, social, ecological, and technological factors. Through the analysis of 84 selected studies using the PRISMA framework and thematic analysis, the study identified four dominant adaptation dimensions, namely institutional and policy-based adaptation, community-based adaptation, ecosystem-based adaptation, and technological adaptation. The findings indicate that policy integration, decentralization, participatory governance, indigenous knowledge, ecosystem restoration, and technological infrastructure all play significant roles in strengthening coastal resilience. The review also reveals persistent barriers, including bureaucratic rigidity, fragmented governance structures, unequal participation, institutional limitations, and socio-economic disparities that constrain the effectiveness of adaptation initiatives. Ecosystem-based approaches such as mangrove restoration provide long-term ecological and social benefits, yet their implementation often depends on institutional coordination and sustainable support systems. Technology-driven adaptation offers immediate protection against climate risks but may reinforce inequality when implemented without inclusive governance mechanisms. The study concludes that sustainable coastal adaptation requires adaptive governance frameworks that integrate institutional flexibility, community participation, ecological resilience, and technological innovation within collaborative and context-sensitive policy systems capable of responding to increasing climate uncertainty.

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