

Coastal Adaptation in Small Island Developing States: A Systematic Literature Review of Academic Research

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Abstract

Small Island Developing States (SIDS) are highly vulnerable to climate-related coastal hazards, including sea-level rise, storm surges, and coastal flooding, which are exacerbated by the concentration of their settlements and infrastructure in coastal zones. Although coastal adaptation research in SIDS has expanded, the evidence base remains fragmented, limiting what can be learned about effective adaptation in built-environment contexts. This study conducts a systematic literature review of peer-reviewed research on coastal climate adaptation in SIDS with a built-environment focus ($n = 60$). We assess the temporal, thematic, and geographic development of this literature and examine how adaptation effectiveness is framed across themes, strategies, and regions. Our findings show strong spatial and thematic concentration, with the evidence base dominated by Pacific and relocation and retreat emerging as the most prominent theme. Temporally, publications rise sharply around 2020–2021, and land raising appears mainly in later years, indicating that evidence for this strategy is drawn from a shorter window than for other strategies. Effectiveness is rarely assessed through explicit outcome indicators and is more often framed through process quality (e.g., governance capacity, contextual fit, social legitimacy, and resources). Effectiveness framings also vary by strategy: legitimacy-oriented criteria (e.g., equity and justice) are most explicit in relocation and retreat, whereas other strategies more often highlight feasibility, maintenance, and institutional and technical capacity. Overall, this study suggests that coastal adaptation in SIDS could be more effective by adopting a multi-criteria, multi-measure approach, in which choices involve negotiating trade-offs and sequencing interventions rather than selecting a single best or most effective strategy.

1. Introduction

It is widely acknowledged that Small Island Developing States (SIDS) are disproportionately vulnerable to climate change, although they contribute very little to the global greenhouse gas emissions (Betzold 2010; UNDP 2024; Climate Watch 2026). SIDS were recognized in the 1992 United Nations Conference on Environment and Development as a special group due to their unique social, economic, and environmental challenges (United Nations 2025). While there are several SIDS grouping (Bruckner 2013), the United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) identifies 39 States and 18 Associate Members across the Atlantic, Indian Ocean, Mediterranean, and South China Sea (AIMS), Caribbean, and Pacific regions (United Nations 2025). SIDS are currently experiencing and are projected to face multiple climate-related impacts (Nurse et al. 2014). Between 2000 and 2021, SIDS experienced 434 climate-related disasters (CRED 2024). In addition, structural constraints, including limited resources, geographic remoteness, dependence on environmentally sensitive economic sectors, and susceptibility to external shock (Briguglio 1995), further exacerbate their vulnerability to climate change impact. Among climate-related hazards, coastal ones such as sea-level rise (SLR), coastal flooding, and storm surges are projected to increase in many SIDS (Mycoo et al. 2022; Thomas et al. 2020). This increase has significant implications for their built environment, as most SIDS have high coastline-to-land ratios, so many of their economic assets, critical infrastructure, and settlements are concentrated along the coast and exposed to these hazards (Barnett and Waters 2016; Mycoo et al. 2022).

To address these coastal climate risks, SIDS have implemented a range of adaptation measures, often under conditions of limited resources and institutional capacity (Betzold 2015). These measures include hard protection, accommodation, advance, retreat, and ecosystem-based adaptation (Mycoo et al. 2022; Wong 2018; Laurent and Duvat 2024). However, adaptation interventions could result in maladaptation by increasing the existing vulnerabilities, shifting them across places or groups, or creating new forms of vulnerabilities (Schipper 2020). Consequently, while coastal interventions may provide important benefits, their overall effectiveness in reducing coastal climate risk remains uncertain across contexts (Mycoo et al. 2022). The ability of SIDS to plan and implement successful adaptation will shape long-term development pathways in these states (Robinson 2018).

Accordingly, empirical research in SIDS examines coastal adaptation from multiple perspectives. Some studies focus on coastal adaptation strategies and measures such as hard protection (Betzold and Mohamed 2017; Nunn et al. 2021; Klöck et al. 2022). Other scholars examine adaptation processes in terms of governance and policy (Anisimov et al. 2020; Gussmann and Hinkel 2021; Johnston and Cooper 2022), while others examine adaptation approaches, such as community-led and state-led processes (Nunn et al. 2014; Maldonado et al. 2021; Turner et al. 2025). However, this evidence base is often examined in isolation and remains dominated mostly by single-island case studies. This makes it difficult to identify broader patterns across SIDS in what the literature collectively suggests about effective coastal adaptation, both in terms of process (how decisions are made, governed, financed, and legitimized) and outcomes (which strategies perform and under what conditions). This gap is particularly important because SIDS are not homogeneous and are different in territorial size, governance systems, economic conditions, and cultural, social, and geographic characteristics (Robinson 2017; Thomas et al. 2020), all of which shape feasible adaptation processes and outcomes. Existing

syntheses of adaptation in SIDS have provided important foundations, but they incorporate coastal issues within wider hazard and sectoral landscapes (e.g., Klöck and Nunn 2019; Robinson 2017) or merely classify coastal adaptation strategies (e.g., Wong 2018). Therefore, there remains a need for a focused study on coastal adaptation that addresses both measures and processes in relation to the built environment across the diversity of SIDS contexts.

This paper addresses this gap through a systematic review of peer-reviewed research on coastal adaptation in SIDS with a focus on the built environment. It aims to (a) map the geographic distribution of the evidence base and identify where evidence is absent, (b) develop a thematic classification and identify dominant narratives and their spatial and temporal distribution to enable clearer comparison across themes that are often treated separately, and (c) examine how effectiveness and success are conceptualized and assessed across the coastal adaptation strategies and planning processes. This review is intended to support researchers, planners, and policymakers seeking to strengthen the process of coastal adaptation planning and to understand its existing challenges and opportunities. In addition, it tries to identify underexplored areas that require further attention in future research, adaptation practices, and decision-making. This review is guided by three questions:

1. Which regions and islands have most reflected in the literature?
2. Which key themes are dominate in the literature?
3. How are effectiveness and success conceptualized in the literature?

2. Methodology

We adopted a systematic literature review approach, consistent with prior SIDS adaptation syntheses (e.g., Klöck and Nunn 2019; Robinson 2020), to identify and analyse relevant research. Systematic reviews employ transparent, replicable procedures to identify, appraise, and synthesize all relevant studies, while minimizing bias and providing answers to a defined set of research questions (Petticrew and Roberts 2006). Our systematic literature review focuses on publications relating primarily to SIDS that specifically address coastal adaptation related to the built environment. The steps followed to conduct this systematic literature review are described below.

2.1. Step 1: Defining search strategy and conducting search

We adapted the approach of Sousa et al. (2023) to categorize our Boolean search terms into functional keyword groups (Table 1). The first block defines the climate change-related actions or responses by adopting terms like “adaptation” Or “risk reduction” Or “resilient” Or “resilience.” The second block defines the climate-change coastal focus, including, “coast” Or “coastal adaptation” Or “sea-level rise” Or “flood” Or “storm surge.” The third block defines the geography of the review by using “small island developing states” Or listing the 57 United Nation (UN) listed SIDS¹ country and territory names. These blocks were combined using the Boolean operator “AND” in order to extract studies that explicitly addressed coastal adaptation within SIDS contexts. We did not include “built environment” (or related terms) as a search keyword because many relevant studies discuss settlements, infrastructure, or planning implications without using that specific phrasing in titles, abstracts, or keywords. Excluding built-environment terms therefore reduced the risk of narrowing the search and helped ensure a comprehensive search. Therefore, the built-environment focus was applied subsequently through the screening and inclusion criteria. Next, we searched three databases of Google Scholar, Scopus, and Web of Science to ensure broad coverage and reduce database-related bias. We conducted the literature search between November and December. The initial search was restricted to the titles, abstracts, and keywords of peer-reviewed English-language articles published between 1992 (Recognition of SIDS at the United Nations Conference on Environment and Development) and 2025. This search yielded a preliminary list of 367 potentially relevant documents.

Table 1
Keywords and their functions and definitions

Keywords	Function	Definition
"adaptation" Or "risk reduction" Or "resilient" Or "resilience" And	Defines climate change related action and response	Adaptation: "In human systems, the process of adjustment to actual or expected climate and its effects to moderate harm or exploit beneficial opportunities" (IPCC 2022b, P.2898). Resilience: "The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity (IPCC 2022b, P.2920)
"coast" Or "coastal adaptation" Or "sea-level rise" Or "flood" Or "storm surge" And	Defines the climate change related hazards	Coast: "The land near to the sea. The term coastal can refer to that land (e.g., as in coastal communities)" (IPCC 2022b, P.2904) Sea-level-rise: "Change to the height of sea level, both globally and locally due to a change in ocean volume, changes in the shape of the ocean basins, local subsidence or uplift of the land" (IPCC 2022b, P.2922) Flood: "The accumulation of water over areas that are not normally submerged, including coastal flood" (IPCC 2022b, P.2909). Storm surge: "The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions" (IPCC 2022b, P.2924)
"small island developing states" Or "Antigua and Barbuda" Or "Haiti" Or "St. Kitts and Nevis" Or "Bahamas" Or "Jamaica" Or "St. Lucia" Or "Barbados" Or "Kiribati" Or "St. Vincent and the Grenadines" Or "Belize" Or "Maldives" Or "Seychelles" Or "Cabo Verde" Or "Marshall Islands" Or "Solomon Islands" Or "Comoros" Or "Micronesia" Or "Suriname" Or "Cook Islands" Or "Mauritius" Or "Timor-Leste" Or "Cuba" Or "Nauru" Or "Tonga" Or "Dominica" Or "Niue" Or "Trinidad and Tobago" Or "Dominican Republic" Or "Palau" Or "Tuvalu" Or "Fiji" Or "Papua New Guinea" Or "Vanuatu" Or "Grenada" Or "Samoa" Or "Guinea-Bissau" Or "São Tomé and Príncipe" Or "Guyana" Or "Singapore" Or "American Samoa" Or "Anguilla" Or "Aruba" Or "Bermuda" Or "British Virgin Islands" Or "Cayman Islands" Or "Commonwealth of Northern Marianas" Or "Curacao" Or "French Polynesia" Or "Guadeloupe" Or "Guam" Or "Martinique" Or "Montserrat" Or "New Caledonia" Or "Puerto Rico" Or "Sint Maarten" Or "Turks and Caicos Islands" Or "U.S. Virgin Islands"	Defines the geography of the review (AND/OR defines the relationship between keywords)	

Note 1. Table structure (keyword groupings by function) adapted from Sousa et al. (2023). Search terms keywords and definitions were defined by the authors for this review.

2.2. Screening and selecting the literature

To maintain the relevance of included literature, we defined specific inclusion and exclusion criteria (Table 2). As shown in Fig. 1, screening and applying these criteria were conducted in two stages to identify the final sample for content analysis. First, we eliminated 145 articles based on title and abstract screening and downloaded the remaining 222 articles for full-text review. After reading the remaining articles in full, we excluded a further 161 articles. During this phase, we mainly excluded articles that centered on vulnerability, hazard, or risk assessment rather than adaptation itself (e.g., Shiiba et al. 2023; McCubbin et al. 2015). We also removed papers that were predominantly theoretical or conceptual (Wong 2018), as well as those that approached coastal adaptation only from an engineering or technical performance perspective (e.g., Best et al. 2025; Wang et al. 2025; Nguyen et al. 2022). The final sample comprised 60 articles that met the inclusion criteria and were applied for in-depth analysis. The list of final articles is represented in Online Resource 1.

Table 2
Inclusion and exclusion criteria

Inclusion
- Countries/territories in UN list of SIDS
- Peer-reviewed papers published in English
- Published between 1992 ^a and 2025
- Coastal adaptations to climate change in relation to built environment ^b
- Empirical focus
- Human adaptations to climate change
Exclusion
- Countries/territories not in UN list of SIDS
- Grey literature and book chapters
- Focused exclusively on vulnerability, risk, hazard, and impact assessment
- Theoretical or conceptual studies and review papers
- Not addressing climate change-related coastal hazards
- Not specifically addressing coastal hazards and related to other hazards (such as drought)
- Not relevant to built environment and settlement and addressing other sectors (e.g., fishing, agriculture, and health)
- Isolated technical and engineering or biophysical modelling studies (e.g., NbS performance modelling)
- Focus on non-coastal drivers of flooding, such as riverine flooding
- Not human adaptation to climate change
- Focus on mitigation

1. Recognition of SIDS at the United Nations Conference on Environment and Development
2. Built environment is considered both (i) what is exposed and targeted for protection (e.g., settlements, buildings, and infrastructure) and (ii) a domain through which risk reduction can be pursued via coastal protection, spatial planning, settlement change, and regulatory and design principles.

2.3. Data extraction and analysis

The articles identified in the previous step were analyzed in the fourth step through content analysis. First, we extracted bibliographic information, including author name(s) and journal title. Second, we coded the substantive characteristics of the articles, including the island(s) studied, region(s), SIDS status (SIDS or associate member), type of coastal hazard(s), built environment focus, main sector(s), geographical scale, type of coastal adaptation intervention(s), and primary and secondary theme(s). Third, we extracted information on how each paper addressed the success or effectiveness of coastal adaptation interventions. In this stage, we identified whether effectiveness or success was assessed explicitly or discussed implicitly; the type of assessment used (policy or institutional, measure-based, ex ante, or ex post); the level and type of evidence for supporting claims(e.g., measured indicators, stakeholder perceptions, or descriptive reporting); and the enabling and constraining mechanisms and other factors shaping outcomes. Fourth, effectiveness factors were identified inductively through an initial reading of all included articles, refined into a final set of factor labels, and then coded in a second round across the full sample to record whether each article explicitly mentioned a given factor (used to generate the heat map). Data extraction and coding were managed in Microsoft Excel and is provided in Online Resource 1.

3. Results

This review analyzed 60 peer-reviewed articles on coastal adaptation in UN-listed SIDS that engage the built environment. The results section is structured around three review questions. First, it presents a mapping of the literature to describe patterns in geographical

coverage. Second, it classifies the literature into thematic categories based on the primary theme and core arguments advanced in each study and their spatial and temporal distribution. Finally, it synthesizes how adaptation effectiveness and success are conceptualized across these articles and identifies factors that influence the coastal adaptation process and outcomes in SIDS.

3.1. Which region and island have most reflected in the literature?

The reviewed literature illustrates an uneven geographic distribution across SIDS (Table 3). Although the review scope encompasses all UN-recognized SIDS, research is concentrated in a limited number of islands. Fiji emerges as the most frequently studied case, with 10 articles, followed by the Solomon Islands with 5 articles, and Mauritius, the Maldives, Kiribati, and Barbados with 4 articles each. In contrast, 24 out of 57 Small Island Developing States are entirely absent from the peer-reviewed coastal adaptation literature addressing the built environment.

Coastal adaptation in relation to the built environment is not examined in 14 UN Member SIDS and in 10 of the 18 Associate Members of the United Nations. Some of these underrepresented islands appear only indirectly in regional-scale studies, which do not identify individual islands (see Laurent and Duvat 2024; Thomas and Benjamin 2018; Nunn et al. 2021). As shown in Fig. 2, most studies focus on a single island (n = 47), whereas a few adopt multi-island or regional comparative approaches (n = 13).

Among Associate Members of the United Nations, coastal adaptation is addressed in only 8 of the 18 SIDS. These include Anguilla (n = 1), Cayman Islands (n = 1), Guadeloupe (n = 1), Martinique (n = 1), New Caledonia (n = 1), Puerto Rico (n = 1), Sint Maarten (n = 1), and French Polynesia (n = 2). In comparison, 25 of the 39 UN Member SIDS are represented in the peer-reviewed coastal adaptation literature.

Concerning regional distribution (Fig. 3), research is most heavily concentrated in the Pacific SIDS (n = 27), followed by the Caribbean (n = 15) and the Atlantic, Indian Ocean, and South China Sea (AIMS) region (n = 13), with 5 articles adopting a multi-regional focus. Coastal adaptation is documented in 13 of the 20 Pacific SIDS, compared to 14 of the 29 Caribbean SIDS and 6 of the 9 SIDS in the AIMS region. Within each region, Fiji is the most frequently studied island in the Pacific, Barbados in the Caribbean, and Mauritius and the Maldives in the AIMS region.

Table 3
Distribution of peer-reviewed coastal adaptation articles across SIDS

Islands	Number of islands	Number of articles per island
Antigua and Barbuda, Cabo Verde, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Nauru, Niue, Palau, São Tomé and Príncipe, St. Kitts and Nevis, St. Lucia, Timor-Leste, American Samoa, Aruba, Bermuda, British Virgin Islands, Commonwealth of Northern Marianas, Curacao, Guam, Montserrat, Turks and Caicos Islands, U.S. Virgin Islands	24	0
Sint Maarten, Tonga, Jamaica, Cayman Islands, St Vincent & the Grenadines, Belize, Puerto Rico, Suriname, Bahamas, Anguilla, Seychelles, Guinea-Bissau, New Caledonia, Martinique, Guadeloupe,	15	1
Tuvalu, Samoa, Comoros, French Polynesia, Marshall Islands, Federated States of Micronesia, Papua New Guinea, Trinidad & Tobago, Vanuatu, Cook Islands,	10	2
Guyana, Singapore.	2	3
Mauritius, Maldives, Kiribati, Barbados,	4	4
Solomon Islands	1	5
Fiji	1	10

3.2. Which key themes are dominant in the literature?

To address research question two and identify dominant narratives and their spatial and temporal distribution, the included articles were classified into thematic categories based on their primary subject matter and the core arguments repeated and advanced in each paper (Table 4, Fig. 4, and Fig. 5).

3.2.1. Classification and frequency of themes

We identified 15 themes across the analyzed articles, which cluster into three broad thematic domains, as shown in Table 4 and Fig. 4: (a) coastal adaptation, (b) community-centered process, and (c) governance, policy, and implementation.

Coastal adaptation

7 themes are placed under the coastal adaptation domain, aiming to evaluate coastal adaptation measures and strategies. Within the coastal adaptation domain, several themes focus on a single strategy. Accordingly, “Hard protection” as the theme is represented by 3 articles. This theme often explains the continuity and diffusion of hard protection strategies despite the documented evidence that they often lead to maladaptation, mostly in rural and peripheral contexts (Betzold and Mohamed 2017; Klöck et al. 2022; Nunn et al. 2021). The “Ecosystem-based adaptation (EbA) and nature-based solutions (NbS)” theme appears in 3 articles. This theme addresses the uncertainty about the risk-reduction performance of this strategy, mainstreaming EbA into coastal governance and marine spatial planning (Khan and Amelie 2015), ex post evaluating (Duvat et al. 2025), and illustrating how to prioritise NbS for coastal and inland flooding (Soanes et al. 2023).

The “Land raising and reclamation” theme appears in 2 articles, with the focus in the AIMS region, and is framed as an emerging pathway with high technical ambition but major political-economic and ecological trade-offs (Brown et al. 2023; Jamieson 2024). The most frequently represented theme is “Relocation, retreat, and (im)mobility,” accounting for 13 articles and concentrated mostly in Fiji from the Pacific. These articles commonly frame relocation as a long-term, lived, and negotiated process shaped by place attachment, governance, and feasibility (McMichael and Katonivualiku 2020; Piggott-McKellar and McMichael 2021). Several studies challenge climate-migration narratives by showing how mobility decisions are embedded in everyday practices, political-economic conditions, and social identities rather than hazard exposure alone (Farbotko and Lazrus 2012; Santos and Mourato 2024).

Apart from themes that address specific strategies or measures, the second-largest theme, “Examining coastal adaptation intervention,” includes 8 articles that do not focus on a single strategy and instead address multiple measures and interventions in their assessments. These studies mostly emphasize how historical development paths, tourism dependence, land scarcity, economic priorities, prior human disturbance, and colonial urbanization can generate lock-in effects (Naylor 2015; Magnan and Duvat 2020; Mycoo and Chadwick 2012; Robinson et al. 2023). Another theme is the “Ex-ante assessment of coastal adaptation measures”, with 2 articles in the Caribbean context. These articles aim to evaluate the potential effectiveness of adaptation measures before implementation. The last theme, “Urban form and coastal adaptation”, represented by two articles, is confined to Caribbean cases, indicating a small but emerging theme that tries to link exposure and lock-in to settlement form, densification, and coastal development patterns (Mycoo et al., 2021; Dhar and Khirfan 2023)

Community-centred process

Five themes form the community-centered process domain, with a main focus on the community in the process of coastal adaptation. The “Community-led and community-based adaptation” theme is the largest, accounting for 6 articles and concentrated largely in the Pacific, with one cross-regional case. These articles discuss that communities can generate locally appropriate responses (Asugeni et al. 2019), but autonomous adaptation frequently reaches limits (Monnereau and Abraham 2013; Cauchi et al. 2021; Maldonado et al. 2021), especially in peripheral communities (Nunn et al. 2014). The “community perceptions” theme comprises 5 articles and is similarly Pacific-dominant. This literature shows that adaptation choices are shaped by locally negotiated trade-offs, often diverging from dominant policy narratives and hazard framings (Narayan et al. 2020; Ruehr 2022). “Value-based approach” theme, addressed by 2 articles in just AIMS and Pacific. This theme addresses non-material loss and damage and emphasizes that adaptation outcomes depend on what is socially and culturally valued, not only on physical risk reduction (Nand et al. 2024; Ratter et al. 2016). In a similar vein, “Community engagement,” a theme represented by 2 articles in Pacific, illustrates that in state-led adaptation discontinuity and one-way communication during planning and implementation can produce maladaptive outcomes (Mannakkara et al. 2025). The “Knowledge-integration and participatory tool” theme, represented by 4 articles, shows that contested interpretations of coastal dynamics can shape which options are considered legitimate and can contribute to maladaptation where scientific and local knowledge systems are in tension (Nijbroek 2014; Petzold et al. 2018) and demonstrates that participatory tools can help bridge this gap (Leon et al. 2015; Nirwansyah et al. 2025).

Governance, policy, and implementation

The governance, policy, and implementation domain comprises three themes. “Governance and policy effectiveness” theme consists of 4 articles across AIMS and the Caribbean. These articles converge on the argument that the presence of policies does not

guarantee effective adaptation (Gussmann and Hinkel 2021; Johnston and Cooper 2022; Mycoo et al. 2021). “Mainstreaming” as a theme is represented by 2 articles and frames adaptation as a development and planning challenges across statutory and sectoral processes (Hassanali 2017; Leal Filho et al. 2020). The last theme within this broad domain in “constraints and limits” which is presented in 2 articles and discuss that adaptation stays limited not just due to budgets, but because of political and institutional barriers and major strategies (protection, land raising, relocation) far exceed national capacity (Hickey and Weis 2012).

3.2.2. Distribution of themes by year

After identifying the three broad thematic domains and their associated themes and their core arguments, Fig. 5 illustrates the temporal distribution of the 15 themes across the reviewed articles. The figure shows that 2020 and 2021 include the highest number of articles, while the lowest counts occur in the early years (e.g., 2016). Across the full-time span, community-centred process themes (e.g., community-led adaptation and knowledge integration) remain consistently visible. In contrast, within the coastal adaptation domain, themes focused on a single coastal adaptation strategy, such as land raising or reclamation, EbA or NbS, and hard protection are concentrated in the later years (mainly after 2021), rather than spanning the full review window, whereas relocation and retreat appear across multiple years throughout the review period. Themes such as “Ex-ante assessment of measures” and “Urban form and coastal adaptation” also become more apparent in the later period. Finally, the themes related to “Governance, policy, and implementation” appear less frequently than those related to community-process, and their visibility increases after 2018. Overall, Fig. 5 shows the sustained prominence of community-centred themes and the continued attention to relocation and retreat strategy across the review period.

Table 4

Thematic categories and core arguments across included articles, with associated islands and regions

Broad domain	Overarching themes	Core argument	Number	Islands	Region	Articles
Coastal adaptation	Hard protection	Hard protection persists due to diffusion, donor logics, political incentives, emulation, and local development pressures, even when it is maladaptive.	3	Comoros/ Fiji/ Federated States of Micronesia/ Maldives/ Mauritius	(AIMS) (1x) Pacific& (AIMS) (1x) Global SIDS(1x)	Betzold and Mohamed (2017); Klöck et al. (2022); Nunn et al. (2021)
	Ecosystem-based/ Nature-based solution	EbA/NbS effectiveness depends on institutional readiness, scale, and monitoring rather than being inherently no-regrets strategies.	3	New Caledonia/ French Polynesia/Martinique, Guadeloupe/ Seychelles/ Anguilla	Pacific & Caribbean (1x) (AIMS) (1x) Caribbean (1x)	Duvat et al. (2025); Khan and Amelie (2015); Soanes et al. (2023)
	Land raising and reclamation	Land creation and island raising are framed as long-term adaptation solutions but embed political-economic and environmental trade-offs.	2	Maldives/ Singapore	(AIMS) (2x)	Brown et al. (2023); Jamieson (2024)
	Relocation, retreat, and (im)mobility	Relocation and mobility are socially embedded, multi-stage processes rather than discrete technical solutions.	13	Solomon Islands (2x)/French Polynesia/ Kiribati/ Tuvalu/ Fiji (6x) / Guinea-Bissau/ Multiple	Pacific (11x) AIMS (1x) Pacific & Caribbean (1x)	Albert et al. (2018); Bertana and Blanton (2023); Birk & Rasmussen (2014); Duvat et al. (2022); Donner (2015); Farbotko and Lazrus (2012); McMichael and Katonivualiku (2020); McNamara and Des Combes (2015); Piggott-McKellar et al. (2019); Piggott-McKellar and McMichael (2021); Piggott-McKellar et al. (2021); Santos and Mourato (2024); Thomas and Benjamin (2018)
	Examining coastal adaptation intervention	Long-term development trajectories and spatial commitments create adaptation path dependencies that narrow future options.	8	Mauritius (2x)/ Kiribati /Caribbean coasts/ Maldives (2x)/ Barbados/ Guyana	(AIMS) (4x) Pacific (1x) Caribbean (3x)	Chacowry (2023); Duvat et al. (2020); Donner and Webber (2014); Laurent and Duvat (2024); Magnan and Duvat (2020); Mycoo and Chadwick (2012); Naylor (2015);

Broad domain	Overarching themes	Core argument	Number	Islands	Region	Articles
						Robinson et al. (2023)
	Ex-ante assessment of coastal adaptation measures	Modelling can compare adaptation options and inform priorities before implementation	2	Sint Maarten/ multi-island	Caribbean (2x)	Abebe et al. (2019); Bresch and Aznar-Siguan (2021)
	Urban form and coastal adaptation	Urban form itself shapes vulnerability, lock-in, and adaptation capacity, yet is rarely operationalised.	2	Jamaica/ Barbados	Caribbean (2x)	Dhar and Khirfan (2023); Mycoo et al. (2021)
Community-centered-process	Community-led and community-based adaptation	Community initiatives are necessary but insufficient without institutional and technical support.	6	Solomon Islands/ Kiribati (2x)/ Puerto Rico, Marshall Islands/ Micronesia/ Fiji (2x)/ Cook Islands / Vanuatu	Pacific (5x) Pacific & Caribbean (1x)	Asugeni et al. (2019); Cauchi et al. (2021); Monnereau and Abraham (2013); Maldonado et al. (2021); Nunn et al. (2014) ; Turner et al. (2025)
	Community perceptions	Adaptation choices reflect locally embedded priorities that often diverge from expert risk framings.	5	Tuvalu/ Samoa (3x)/ Tonga/ Papua New Guinea/ Solomon Islands/ Vanuatu/ Singapore	Pacific (4x) AIMS (1x)	Beyerl et al. (2018); Niusulu et al. (2024); Narayan et al. (2020) ; Ruehr (2022) ; Yousefpour et al. (2020)
	Value-based approach	Adaptation outcomes depend on protecting social and cultural values, not only physical assets.	2	Fiji/ Comoros	Pacific (1x) AIMS (1x)	Nand et al. (2024); Ratter et al. (2016)
	Community engagement	Participation quality and continuity strongly influence adaptation outcomes and weak engagement can produce maladaptation.	2	Guyana/ Belize/ Trinidad & Tobago/St Vincent & the Grenadines/ Cook Islands	Caribbean (1x) Pacific (1x)	Lane et al. (2013); Mannakkara et al. (2025)
	Knowledge integration and participatory tool	Conflicting knowledge systems shape adaptation outcomes and participatory tools can bridge these divides.	4	Solomon Islands/ Suriname/ Papua New Guinea/ Bahamas	Caribbean (2x) Pacific (2x)	Leon et al. (2015); Nijbroek (2014); Nirwansyah et al. (2025) ; Petzold et al. (2018)
Governance, policy, and implementation	Governance and policy effectiveness	The existence of coastal policies does not ensure effective adaptation and policies often remain symbolic due to fragmented institutions, weak integration and	4	Mauritius/ Maldives/ Cayman Islands/ Barbados	AIMS (2x) Caribbean (2x)	Anisimov et al. (2020); Gussmann and Hinkel (2012); Johnston and Cooper (2022); Mycoo et al. (2021)

Broad domain	Overarching themes	Core argument	Number	Islands	Region	Articles
		coordination, scale mismatches, and weak enforcement.				
	Mainstreaming	Adaptation is framed as a development issue, but mainstreaming often fails institutionally.	2	Trinidad and Tobago/ Solomon Islands	Caribbean (1x) Pacific (1x)	Hassanali, (2017); Leal Filho (2020)
	Constraints and limits	Adaptation stays limited due to financial, political, institutional barriers.	2	Guyana/ Marshall Islands	Caribbean (1x) Pacific (1x)	Hickey and Weis (2012); Ishiwatari et al. (2025)

Note 2

Although the search timeframe was 1992–2025, no publications prior to 2012 were identified in the final sample as meeting the inclusion criteria

3.3. How are effectiveness or success conceptualized in the literature?

Across the reviewed literature, adaptation success and effectiveness are mostly conceptualized in terms of enabling conditions and process quality rather than explicit outcome indicators. Four evaluation approaches were identified in the literature that assess effectiveness more directly: (1) policy and institutional assessments, which examine to what extent they can manage current and future coastal risk (e.g., Gussmann and Hinkel 2021; Johnston and Cooper 2022); (2) ex-post evaluations of implemented measures (e.g., Duvat et al. 2020); (3) assessment of single strategy, such as seawalls, NbS, or relocation (e.g., Nunn et al. 2021; Klöck et al. 2022; Duvat et al. 2025; Piggott-McKellar et al. 2019); and (4) comparisons of different approaches, including NGO-led, community-led, and state-led processes (e.g., Chacowry 2023; Albert et al. 2018). Across these studies, evaluations are predominantly qualitative, drawing on perceptions, expert judgement, and reported outcomes rather than consistent quantitative metrics.

3.3.1. Cross-cutting effectiveness factors across process

Building on the review of how effectiveness is conceptualized and assessed in the literature, this section synthesizes the cross-cutting factors that studies associate with coastal adaptation effectiveness. Most studies discuss effectiveness indirectly, by describing process-related factors that influence adaptation outcomes, success, performance, or implementation results. These factors were inductively extracted from the included articles (not predefined) and refined into 19 factor labels grouped under four categories: (1) Social legitimacy, (2) Context, (3) Governance and institutions, (4) Resources and capacity. The “Social legitimacy” category covers community-led approaches (CL), hybrid governance (HG), community engagement (CE), socio-cultural fit (SC), local knowledge (LK), and equity and justice (EJ). “Context” refers to geographical and environmental fit (GF), time horizons and sequencing (TH), risk and vulnerability framing (FR), and data and knowledge (DK). “Governance and institutions” include institutional support (IS), mainstreaming (MS), governance (GV), aid modality (AM), and increasing awareness (IA). Finally, “Resources and capacity” relates to local resources (LR), finance and budget (FB), technical and human capacity (TC), and maintenance and monitoring (MN).

The heat map (Fig. 6) reports the percentage of articles within each theme that mention a given factor as influencing coastal adaptation effectiveness (cell values), alongside the number of articles per theme (n) and an overall weighted prevalence across the full sample (n = 60). Across the full dataset, as shown in Fig. 6, the weighted prevalence values indicate that “context” factors are reported most consistently. “Governance and institutional” factors also show high prevalence, particularly factors related to institutional support (IS) and governance conditions (GV). In the “social legitimacy” category, factors such as socio-cultural fit (SC) and community engagement (CE) are among the most prevalent, while some factors, for example, equity and justice (EJ), are less consistently linked to the effectiveness across themes. Regarding the “resources and capacity” factors, finance and budget (FB) and

technical and human capacity (TC) are more frequently linked to effectiveness. Use of local resources (LR) is the least prevalent factor across the full sample (18%), while geographical and environmental fit (GF) is the most prevalent (88%).

In addition, variation across themes shows that certain topics draw on a broader range of factor categories than others. For example, “Relocation and retreat”, “Examining coastal adaptation interventions”, and “Community-led adaptation” span multiple factor categories. In contrast, the narrowest factor coverage appears in the smallest, more specialized themes, such as “Ex-ante assessment of coastal measures” and “Urban form and coastal adaptation”. Moreover, some factors are mostly linked to the specific strategies. For example, local knowledge (LK) appears in over 60% of articles within the “Relocation and retreat” theme, while it is not associated with the “land raising and land reclamation” strategy. Likewise, equity and justice (EJ) are most strongly connected to “Relocation and retreat” and are not linked to the NbS/NbA or hard protection strategies. The importance of local resources (LR) is reported more prominently in relation to “land raising and land reclamation” than to other coastal adaptation strategies.

Figure 7 shows the weighted prevalence of each effectiveness factor and the regions that contribute to it, indicating how the evidence base for each factor is geographically distributed. Across most factors, the Pacific has the highest overall prevalence, consistent with the regional distribution of the sample (Fig. 3). However, the degree of regional concentration varies by factor. Factors with high prevalence in the “context” and “governance and institutions” domains show more balanced contributions across regions. In contrast, several social legitimacy factors (e.g., community-led process, socio-cultural fit, and local knowledge) show more evidence from the Pacific, with comparatively smaller contributions from Caribbean and AIMS studies. Multi-regional studies contribute a smaller but consistent share across most factors.

Note 3

Coding rule: Factor was coded “Yes” only when an article linked it to adaptation effectiveness, success, or outcomes. It is coded “No” when factors are described or mentioned solely as part of the method. Ambiguous cases were coded “No.”

Percentages

Because theme sizes vary, percentages should be interpreted alongside the “n” column (e.g., 100% may reflect a small number of articles in that theme).

Weighted prevalence

Weighted prevalence is computed as $\sum c_j / 60 \times 100$, where c_j is the number of unique articles coded “Yes” for factor j .

3.3.2. Cross-cutting effectiveness factors across strategies

Section 3.3.1 focuses on the factors related to the adaptation process that the literature links to the effectiveness of the outcomes across themes. This section shifts to a measure-based lens and provides a synthesis of how the literature characterizes effectiveness, enabling conditions, and trade-offs across major coastal adaptation strategies (Table 5). Regarding ecosystem-based and nature-based strategies, the literature converges that they offer co-benefits, but their effectiveness depends on site conditions and long-term monitoring (Duvat et al. 2025; Khan and Amelie 2015; Soanes et al. 2023). Regarding hard protection strategies, studies commonly emphasize the maintenance requirements and their longer-term path-dependency or lock-in effects (Betzold and Mohamed 2017; Klöck et al. 2022; Nunn et al. 2021). For accommodation, papers highlight the role of enforcement mechanisms and statutory authority in shaping implementation and performance (Mycoo and Chadwick 2012; Mycoo 2014). Concerning relocation, the literature most frequently links outcomes to land access, livelihood impacts, participation processes, and sustained institutional support (Albert et al. 2018; Piggott-McKellar et al. 2021; McNamara and Des Combes 2015). For land reclamation and land raising, studies report potentially high physical protection but emphasize feasibility constraints (especially on atolls) and trade-offs related to high costs, material supply, and ecological impacts (Brown et al. 2023; Duvat et al. 2022; Jamieson 2024).

Table 5

coastal adaptation strategy type, enabling conditions, constraints, and reported outcomes across included SIDS studies.

Strategy	Effectiveness	Enabling conditions	Key limitations / trade-offs	Representative articles & islands
Ecosystem-based/ Nature-based solution	- Offers co-benefits - Evidence of hazard-risk reduction is uneven and often not measured - Many projects track ecological outputs rather than erosion/flood metrics - It needs to be treated as a foundation or complement, not a single solution	- Restorable ecosystems - Space to restore - Suitable wave/sediment conditions - Policy mainstreaming - Technical/ecological expertise - long-term funding and monitoring	- Slow to provide protection (require years to mature) - Limited performance on high energy/open-ocean shores and dense urban coasts - Scaling/maintenance constraints - Uncertain long-term performance under SLR and extreme events - Risk of romanticization.	Kiribati (Donner and Webber 2014); Pacific SIDS (Narayan et al. 2020); Suriname (Nijbroek 2014); Seychelles (Khan and Amélie 2015); Anguilla (Soanes et al. 2023); Mauritius (Duvat et al. 2020); French overseas tropical islands (Duvat et al. 2025); Solomon (Leal Filho et al. 2020)
Hard protection	- Can provide short-term local protection when properly designed and maintained - In many rural/peripheral SIDS it is frequently maladaptive	- Engineering design standards - stable funding for life cycle - Technical monitoring - Institutional capacity for planning/design/procurement - Governance that discourages copy-paste diffusion and integrates coastal processes - Integration with soft measures	- High costs and dependence on external finance/knowledge - Maintenance burdens - Can intensify erosion and cause coastal squeeze - Ecological harms and livelihood impacts - Can lock-in development in risky zones and delay other options (NbS/relocation) - False sense of security and delaying transformation	Kiribati (Donner and Webber, 2014); Pacific SIDS (Narayan et al. 2020); Suriname (Nijbroek, 2014); Comoros (Ratter et al. 2016; Betzold and Mohamed 2017); Maldives/Mauritius/Fiji (Klöck et al. 2022); Mauritius(Duvat et al. 2020); Barbados (Mycoo and Chadwick 2012); Malé, Maldives (Naylor 2015); Micronesia (Monnereau and Abraham 2013); Guyana (Robinson et al. 2023); Global SIDS (Nunn et al. 2021)
Accommodation	- Effective for exposure reduction (keep assets out of hazard zones) and damage reduction (elevation/flood-proofing) - Benefits are uneven where coasts are already built out	- Clear statutory authority and enforcement - Governance capacity for compliance - Reliable shoreline baselines and permitting rules - Integration into land-use planning - Political support to constrain coastal development - Building-code capacity (inspection, compliance) - Technical guidance - Space/land availability to maintain buffers	- Residual risk remains - Can normalize continued exposure - Equity issues if costs fall on households - May be insufficient under high SLR - Legacy development inside setbacks (especially hotels) limits feasibility - Stricter setbacks under higher SLR are hard in land-scarce coasts	Barbados (Mycoo and Chadwick 2012; Mycoo 2014)

Strategy	Effectiveness	Enabling conditions	Key limitations / trade-offs	Representative articles & islands
Resettlement, retreat, relocation	- Can reduce exposure when land, services, and livelihoods are secured - Outcomes are highly variable and can shift or reproduce vulnerability (new hazards, livelihood loss) - Unpopular due to strong place attachment	- Secure land access/tenure and legal framework - Sustained state capacity and inter-agency coordination - Inclusive participation (women and marginalised groups) - Livelihood transition planning and service provision - Long-term funding and monitoring/feedback channels	- Deep cultural/place loss risks - Inequality and exclusion in decisions - Land scarcity and political - Governance weakness (no clear mandate/funding) - Destination vulnerabilities (informal settlements, insecure tenure, new hazards) - Long time horizons can clash with short-term politics	Fiji (McNamara and Jacot Des Combes, 2015; Piggott-McKellar et al. 2021; Piggott-McKellar et al. 2019; Bertana and Blanton 2023; McMichael and Katonivualiku 2020); French Polynesia (Duvat et al. 2022); Solomon Islands (Birk and Rasmussen 2014); Kiribati Donner 2015); Micronesia (Monnereau and Abraham 2013); Tuvalu (Farbotko and Lazrus 2012); Guinea-Bissau (Santos and Mourato 2024); Solomon Islands (Albert et al. 2018); Pacific SIDS (Narayan et al. 2020).
Land raising	- Potentially high physical effectiveness if built to sufficient elevation and scale - Treated as conditional and uncertain on atolls - Viewed as a “last resort” in some atoll settings due to geotechnical/permeability concerns	- Strong multi-level governance and financing - Broad stakeholder legitimacy - Long-term planning, monitoring, and learning - Technical/engineering capacity and material supply chains	- Very high costs and resource intensity - Dependence on sediment/material extraction networks with externalized harms - Geopolitical/ethical issues (sand trade) - Ecological impacts and lock-in - Feasibility limits on permeable atoll substrata - May deepen inequality by protecting valuable zones first	Maldives (Brown et al. 2023); Singapore (Jamieson 2024); French Polynesia (Duvat et al. 2022)

4. Discussion

This review synthesizes 60 peer-reviewed studies on coastal adaptation in UN-listed SIDS with a built-environment focus. The discussion delves into the biases in where and when dominant narratives are produced (Figs. 3, 5, and 7). Then it addresses the conditional and multi-measure character of coastal adaptation effectiveness or success (Fig. 6; Table 5). Next, it discusses the persistence and importance of multi-process approach and social legitimacy in the coastal adaptation literature. Finally, it highlights the implications of these patterns for knowledge transferability and future research priorities.

4.1. Biases in what the literature knows

Figures 2, 5, and 7 illustrate that the peer-reviewed evidence base on coastal adaptation in SIDS in relation to built environments is shaped by a set of overlapping biases, where case studies are located, when they were published, and which themes they prioritize. Our review shows that coastal adaptation knowledge in SIDS is concentrated in a few islands, mostly in the Pacific (Fig. 2 and Table 1), aligning with Klock and Nunn's (2019) finding. For instance, Fig. 4 and Table 2 demonstrate that most of the documented relocation cases analysed in the literature are from the Pacific region, with almost half specifically from Fiji, and that all the cases analysed for land raising and reclamation are from the AIMS. Therefore, much of the knowledge and widely cited narratives about coastal

adaptation reflect the unique environmental, social, economic, political, and governance contexts of the most researched locations. Although regional-scale articles could partially address regional gap, most studies focus on single islands, and only 13 out of 60 articles adopt a multi-island or regional comparative approach (Fig. 1). This emphasis on place-specific studies highlights the value of local context but limits the transferability of lessons across SIDS.

The temporal biases are also reflected in Fig. 5, where the concentration of NbS and EbA and land raising and reclamation after 2022 suggests that current knowledge of these strategies is drawn from a shorter and more recent period of study than themes such as relocation, which have been examined over a much longer time span. This implies that evidence about them is currently developing and may be sensitive to short-term trends in global discourse. This does not diminish the value of the newer evidence, but it does suggest that knowledge about these measures is still emerging. It is likely that this trend is shaped by recent project cycles, funding and research priorities, and the rising prominence of NbS in global adaptation discourse.

Moreover, our review, which established links between strategy and effectiveness factors (Fig. 6), found that certain effectiveness factors are repeatedly discussed alongside particular coastal adaptation strategies and regions. Figure 7 indicates that many of these factors are reported predominantly in Pacific studies. As a result, even when a factor appears highly prevalent, the underlying evidence may be shaped by a particular region. Moreover, the evidence base emphasizes technical performance and feasibility for some measures and social legitimacy for others, rather than consistently applying a comprehensive view that considers how context, institutions, resources, and legitimacy interact to shape outcomes over time. For example, as shown in Fig. 6, equity and justice factors are mostly bundled with the retreat strategy, whereas EbA, NbS, and hard protection are more closely linked to factors such as maintenance and technical capacity, even though they also could redistribute benefits and burdens and create uneven impacts. Therefore, the heat map patterns (Fig. 6) do not imply that some factors are not significant for increasing the effectiveness of certain strategies; rather, they illustrate that the literature often addresses different strategies through emphasizing certain criteria or lenses.

These findings imply that our understanding of coastal adaptation in relation to the built environment might not temporally, spatially, and thematically even. As a result, perceptions or dominant narratives about what makes coastal adaptation effective, successful, constrained, or enabled in SIDS could become biased and improperly generalized to all SIDS.

4.2. Multi-measure and effectiveness

Based on the reviewed literature, the effectiveness and success of coastal adaptation depend on process-related factors (Fig. 6), such as governance and institutional capacity; mainstreaming adaptation; social, cultural, geographical, and environmental fit; vulnerability and risk framing; data availability; defining time horizons and sequencing; capacity and resource environments, rather than any specific coastal adaptation strategy. In addition, across strategy or measure-related factors, each coastal adaptation strategy has its own enablers, constraints, and trade-offs (Table 5). A consistent implication is that what works cannot be separated from how adaptation is planned, regulated, funded, maintained, and socially authorised. This condition also explains why the performance of coastal adaptation measures varies across contexts. For example, in Mauritius, Duvat et al. (2020) illustrate that hard protection, soft measures, and retreat lead to different outcomes across sites. These conditions also influence how implemented measures evolve over time. For example, hard protection can provide short-term defence but is frequently maladaptive in the long term due to weak maintenance and governance capacity (Nunn et al. 2021; Klöck et al. 2022). NbS often deliver co-benefits but have uneven evidence on risk reduction (Duvat et al. 2025). This aligns with broader literature, such as Adger et al. (2005, p. 80), who argue that success cannot be judged solely by whether the objectives of adaptation are met, because actions can create negative “spillovers” across space and time. Accordingly, multi-measure strategies and their sequencing are considered for effective coastal adaptation in SIDS, as a single measure might not address short to long-term risks simultaneously (Donner and Webber 2014; Mycoo 2014). Diversification of measures emerges both as a response to the limits of single strategy and as a way to balance protection and long-term flexibility under uncertainty (Betzold and Mohamed 2017; Laurent and Duvat 2024). These approaches avoid treating any single strategy or intervention as inherently effective.

4.3. Social legitimacy and multi-process approach and effectiveness

Consistent with broader adaptation scholarship, adaptation intervention can benefit some groups while harming others (Adger et al. 2005; Araos et al. 2021). The persistence of community-related themes across the entire time period (Fig. 5) indicates that questions of social legitimacy, participation, knowledge, and local meaning have remained central in coastal adaptation in SIDS. In the reviewed articles, assessments are mainly based on community perceptions, expert judgement, and reported outcomes. Therefore, it raises questions about whose criteria define success and which knowledge systems are treated as legitimate and authoritative in evaluation. The community's perception of adaptation effectiveness can be different from Western and external indicators (Turner et al. 2025).

Therefore, preferred and valued adaptation responses might differ from what is implemented (Narayan et al. 2020; Donner and Webber 2014).

Our review shows that, as there is no universally effective coastal adaptation measure, there is no universally effective adaptation process approach. Some articles evaluate strategies (hard protection, NbS or EbA, and land raising), while others evaluate process approaches (community-led, NGO-led, and state-led). A number of articles illustrate that community-led processes can face limits related to financing, technical capacity, regulatory constraints, coordination challenges, and uneven institutional support (Monnereau and Abraham 2013; Cauchi et al. 2021; Maldonado et al. 2021), particularly in peripheral communities distant from administrative centres (Nunn et al. 2014). As a result, Fig. 6 shows that the literature more consistently emphasizes meaningful community engagement (68%) than a fully community-led (25%) process as a factor influencing effective outcomes. Comparative analyses of relocation processes illustrate that both community-led and state-led adaptation processes involve trade-offs (e.g., Albert et al. 2018). Therefore, different social, cultural, economic, environmental, and political characteristics could help explain why the same approach (e.g., community-led adaptation) can be effective in one context but face limits or generate maladaptive outcomes in another.

Overall, these findings suggest that the effectiveness or success of coastal adaptation in SIDS is mostly the outcome of social legitimacy, governance and institutional capacity, alignment with context, and availability of resources and capacity, rather than following an inherent successful strategy or a particular approach. Accordingly, evaluating what works requires specifying for whom, by what criteria, and under which contextual conditions, and applying these criteria consistently across strategies and approaches.

4.4. Gaps

This section alludes to the three gaps that, considering them, could inform both scholarship and coastal adaptation planning practice. First, the results show that many UN-listed SIDS are absent from the evidence base in the built-environment coastal adaptation literature, increasing the risk of generalizing dominant narratives from a small set of repeatedly studied islands and regions (Table 3).

Second, gaps remain in the empirical literature on adaptation planning and decision-making processes. The results show that some articles examine policy and governance effectiveness and implementation barriers (e.g., Gussmann and Hinkel 2021; Johnston and Cooper 2022) and others evaluate the persistence and diffusion of specific measures (e.g., hard protection: Betzold and Mohamed, 2017; Klöck et al. 2022; Nunn et al. 2021; NbS/EbA: Duvat et al. 2025; Khan and Amelie 2015). However, limited empirical research addresses adaptation as an integrated planning sequence, from risk assessment, option identification and prioritisation, implementation, and monitoring (see Robinson 2017). Addressing this gap is important, as broader adaptation research has identified gaps in adaptation planning and practice in SIDS and has emphasized a shift from reactive responses to proactive, planned adaptation (e.g., Robinson 2017; Thomas et al. 2019). Moreover, the results indicate that adaptation effectiveness depends on multiple process-related factors (Fig. 6), and there is no inherent successful coastal adaptation strategy, since they entail distinct enabling and constraining conditions and trade-offs (Table 5). Therefore, future research could examine planning and decision-making processes, including which criteria are prioritized (e.g., risk reduction, feasibility, maintenance, distributional impacts, and alignment with local values), how trade-offs are negotiated, whose knowledge is considered legitimate, and how measures are selected and sequenced over time.

Third, few studies discuss urban development, coastal morphology, and built form as drivers of vulnerability and long-term resilience (e.g., Mycoo et al. 2021; Dhar and Khirfan 2023). In addition, accommodation (e.g., setbacks, building codes, elevation) is rarely addressed as a primary theme of articles despite being one of the coastal adaptation strategies in broader frameworks (e.g., IPCC 2022a). Instead, accommodation instruments are often mentioned as sub-themes and are seldom examined for how they reshape exposure and vulnerability through planning and design. The built environment is frequently treated as an exposed object to be protected through coastal adaptation strategies, such as hard protection or relocation. However, it could be a component of adaptation through land-use change, settlement reconfiguration, and regulatory and design pathways (see Dhar and Khirfan 2023). Overall, there is a need for more empirical evidence on how risk and vulnerability analysis inform settlement, infrastructure, and urban form development, and on how coastal adaptation is operationalised through land-use planning, urban design, spatial planning, and building regulation in SIDS.

5. Limitation

This review has several limitations that should be considered when interpreting the findings. First, we included only peer-reviewed journal articles; therefore, we do not address the evidence and adaptation practices reported mainly in the grey literature, such as

national plans, donor and NGO reports, and project evaluations. Second, we conducted our search by adopting three databases of Google Scholar, Scopus, and Web of Science to ensure broad coverage; however, relevant studies may have been missed due to differences in terminology and indexing. Third, many included articles include single-island case studies and qualitative evaluations, which limit the strength of judgments about regional differences and adaptation effectiveness factors. Finally, the results describe patterns in the documented evidence in the published articles rather than the full spectrum of adaptation activity across SIDS, so they should not be interpreted as comprehensive on-the-ground measures or outcomes.

6. Conclusion

Our systematic literature review synthesized 60 peer-reviewed articles on coastal adaptation in UN-listed SIDS with a focus on the built environment. It found that the spatial distribution of evidence base is uneven and concentrated in a limited set of repeatedly studied islands, particularly in Fiji in the Pacific, leaving many SIDS absent from the peer-reviewed literature. The thematic synthesis identified 15 themes, classified into three domains: coastal adaptation measures and strategies; governance, policy, and implementation; and community-centred processes. “Relocation and retreat” is the most prominent single-strategy theme across the review period, while NbS, EbA and land raising appear more recently and in fewer cases.

The review also illustrates that adaptation effectiveness is rarely assessed using explicit outcome indicators, in line with broader studies of adaptation in SIDS (Klock and Nunn's 2019). Instead, the reviewed literature most often conceptualizes success or effectiveness in terms of enabling conditions and process quality, such as institutional capacity, contextual fit, social legitimacy, resources and capacity, and long-term maintenance and monitoring. Moreover, the finding indicates that effectiveness framings also vary by strategy. In this regard, social legitimacy-oriented criteria (e.g., equity and justice) are most prominent in relocation and retreat, whereas other strategies (e.g., EbA, NbS, and hard protection) are more often linked to the feasibility, maintenance, and institutional and technical capacity. Further, the synthesis of coastal adaptation measures and strategies indicates that each strategy entails distinct enabling conditions and trade-offs, underscoring that no single strategy is universally effective. Therefore, the emerging body of literature emphasizes a multi-measure approach and sequencing the coastal adaptation strategies. These findings suggest that coastal adaptation in SIDS is a multi-criteria decision-making process. The identification of suitable strategies requires transparent negotiation of trade-offs, for example, risk reduction, feasibility, maintenance, distributional impacts, and alignment with local values and knowledge, rather than selecting a single best or most effective strategy.

The review also identifies three priorities for strengthening the evidence base and its relevance to planning. First, there is a need for broader empirical attention to SIDS that are not reported in the literature, to reduce the risk of generalizing dominant narratives and knowledge from a small set of repeatedly studied cases (Table 3). Second, more empirical work could address adaptation as an integrated planning sequence and examine how decisions are made, since adaptation effectiveness depends on multiple process-related factors (Fig. 6; Table 5). This includes clearer evidence on which criteria are prioritized, how trade-offs are negotiated, whose knowledge is treated as legitimate, and how measures are selected and sequenced over time. Third, the thematic classification indicates a need for greater attention to built-environment mechanisms (including accommodation instruments) as a main focus of research and for clearer empirical evidence on how coastal adaptation is operationalised through land-use planning, urban design, spatial planning, and building regulation in SIDS.

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Footnotes

1. For a list of SIDS as recognized by the United Nations, see List of SIDS | Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States. We considered all 39 Small Island Developing States and 18 Associate Members of United Nations Regional Commissions

Figures

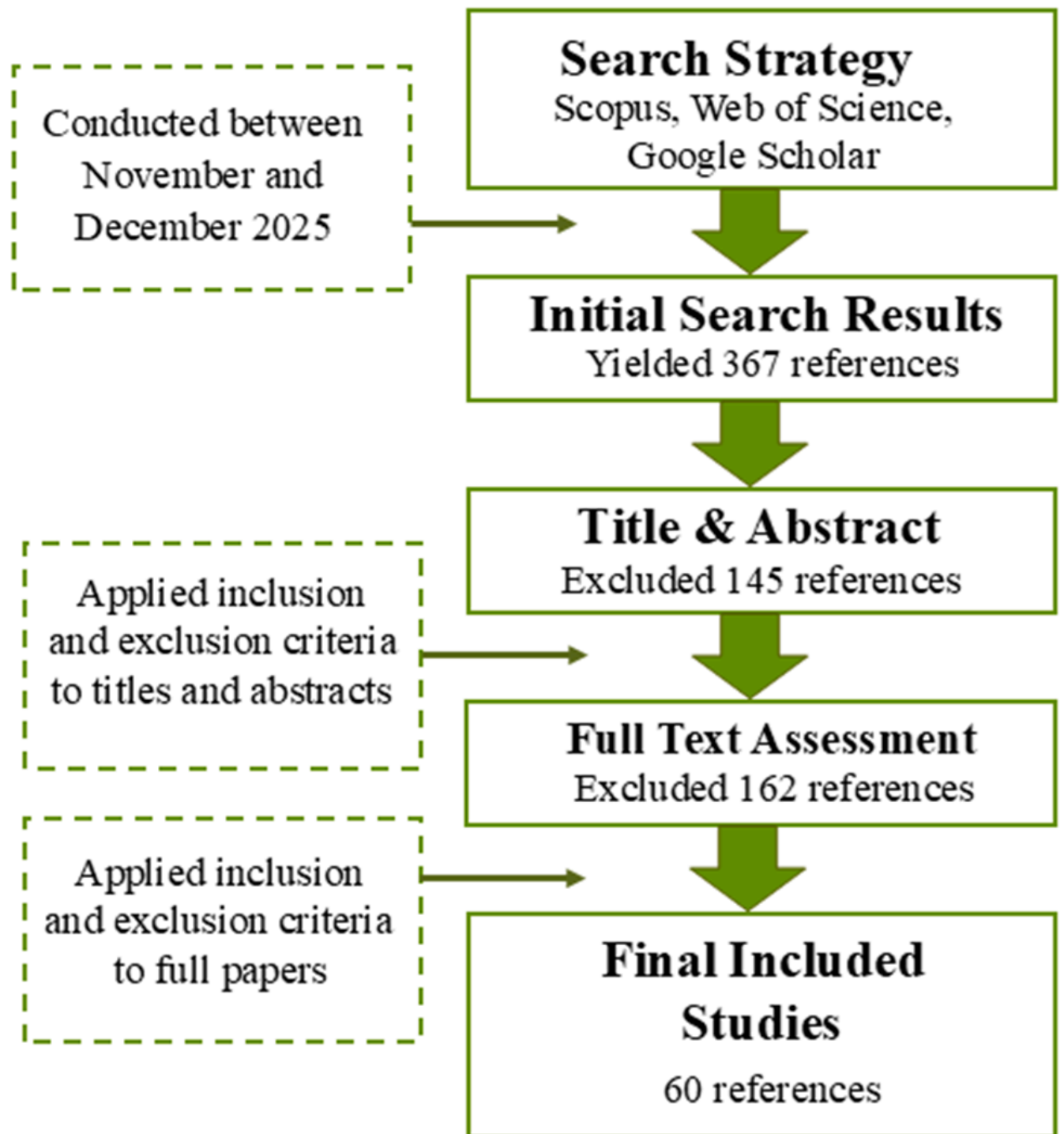


Figure 1

PRISMA diagram of database search, screening, and selection of articles

■ Single Island ■ Multi island

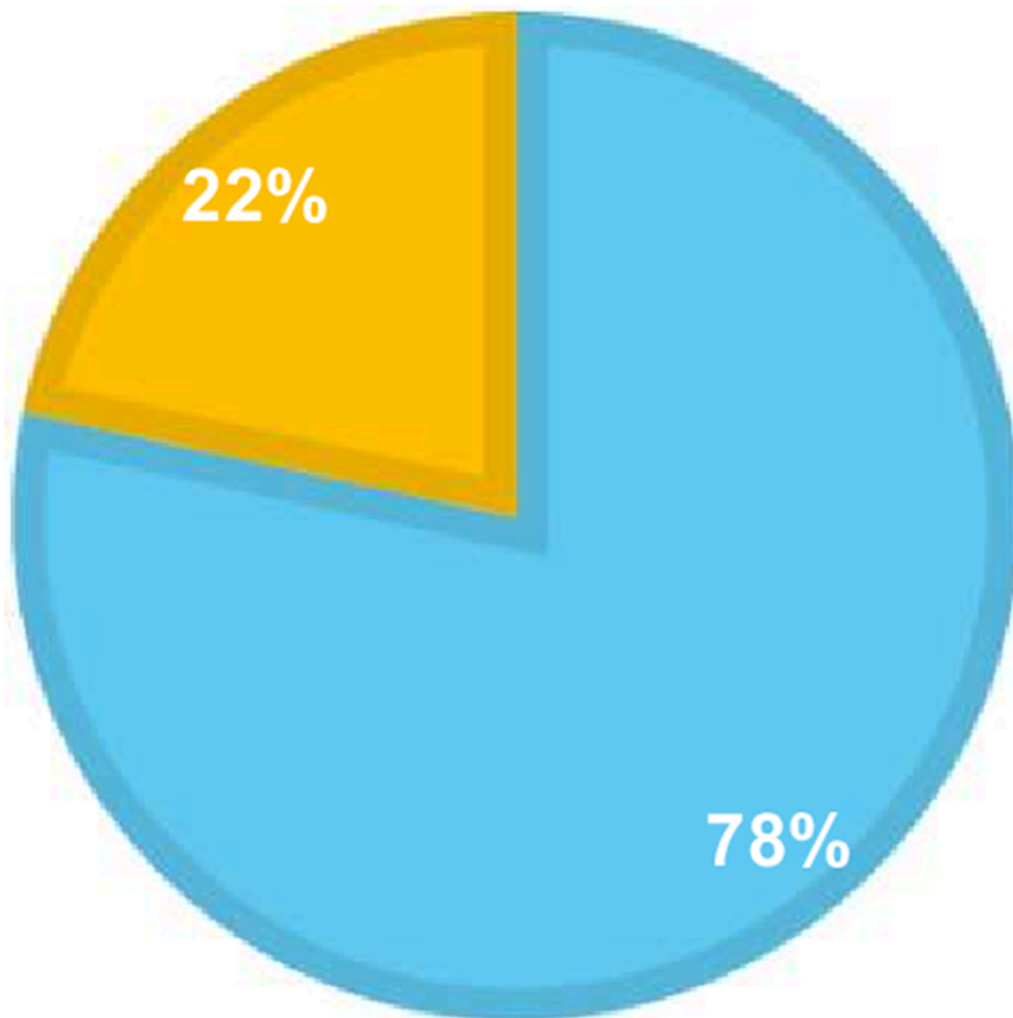


Figure 2

Geographic scope of included articles

■ Caribbean ■ Pacific ■ AIMS ■ Multi

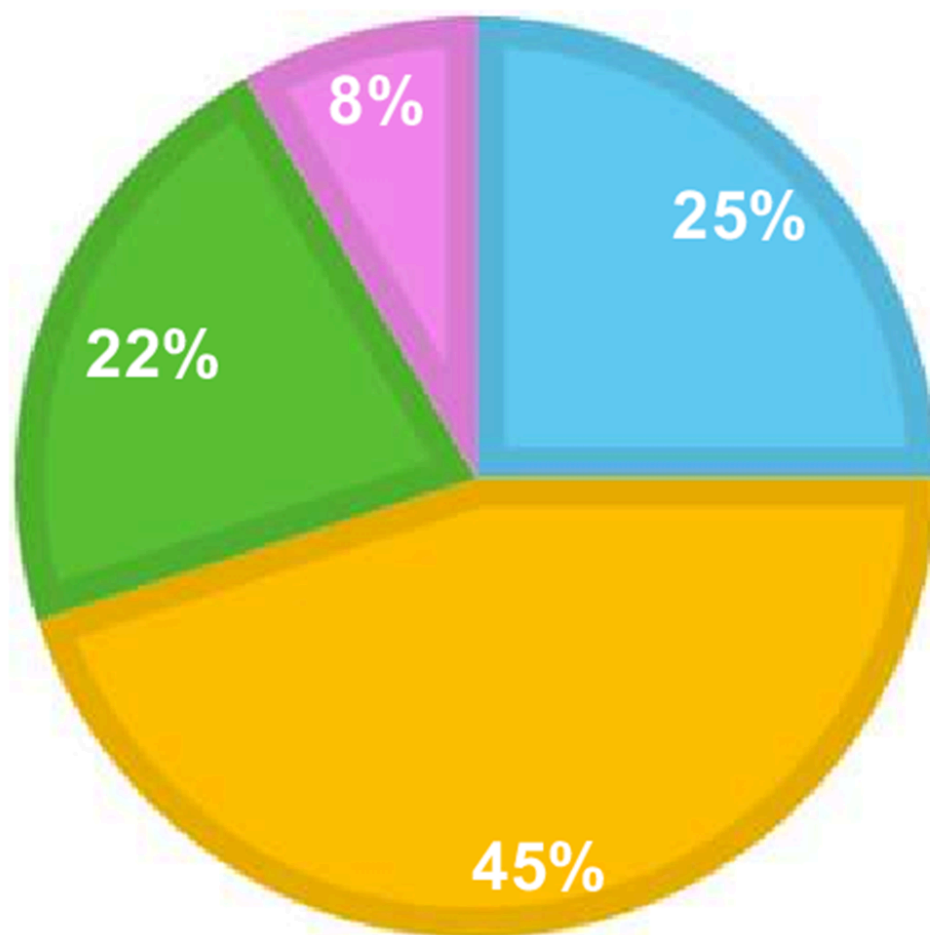


Figure 3

Regional distribution of included articles

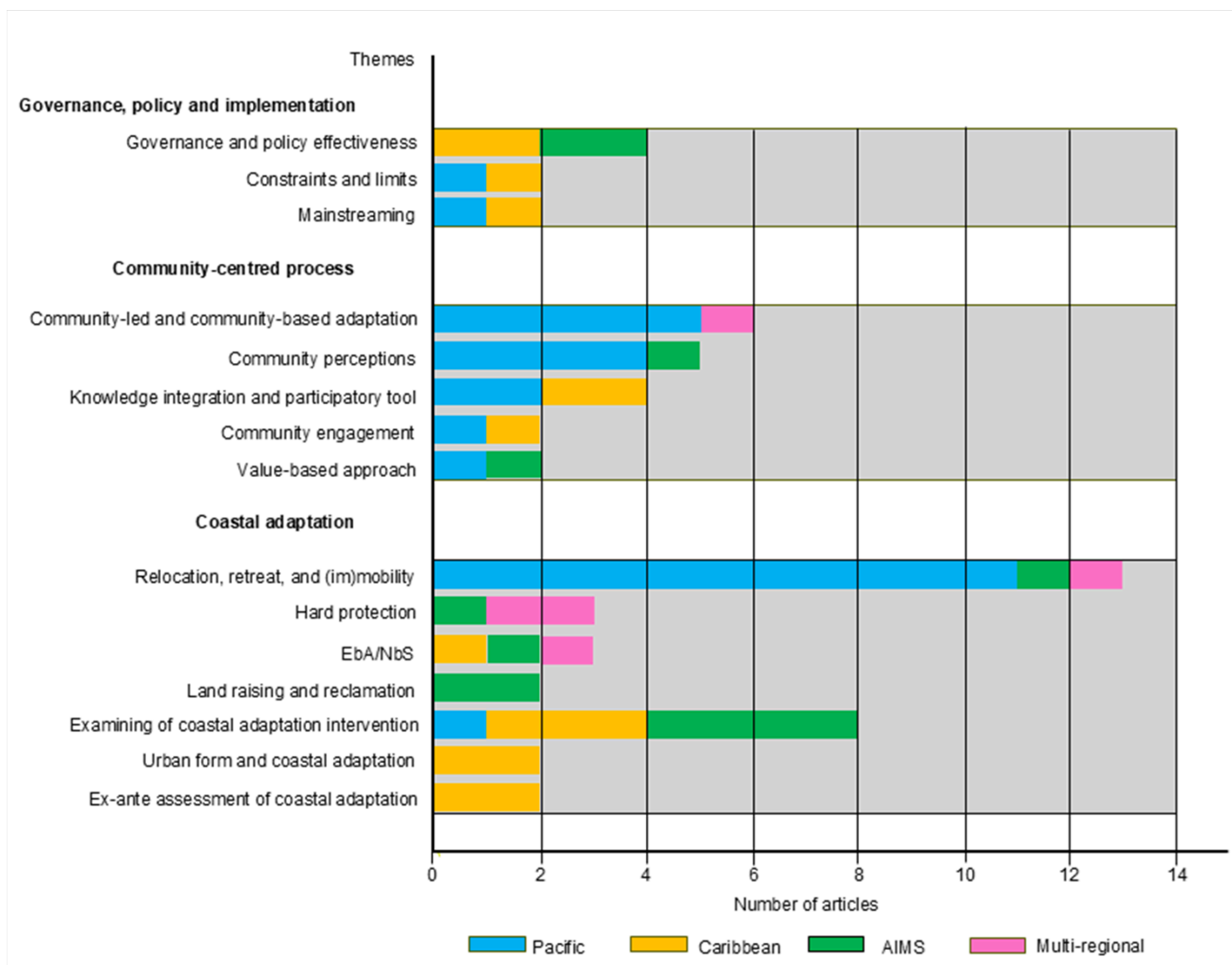


Figure 4

Distribution of coastal adaptation research themes by region

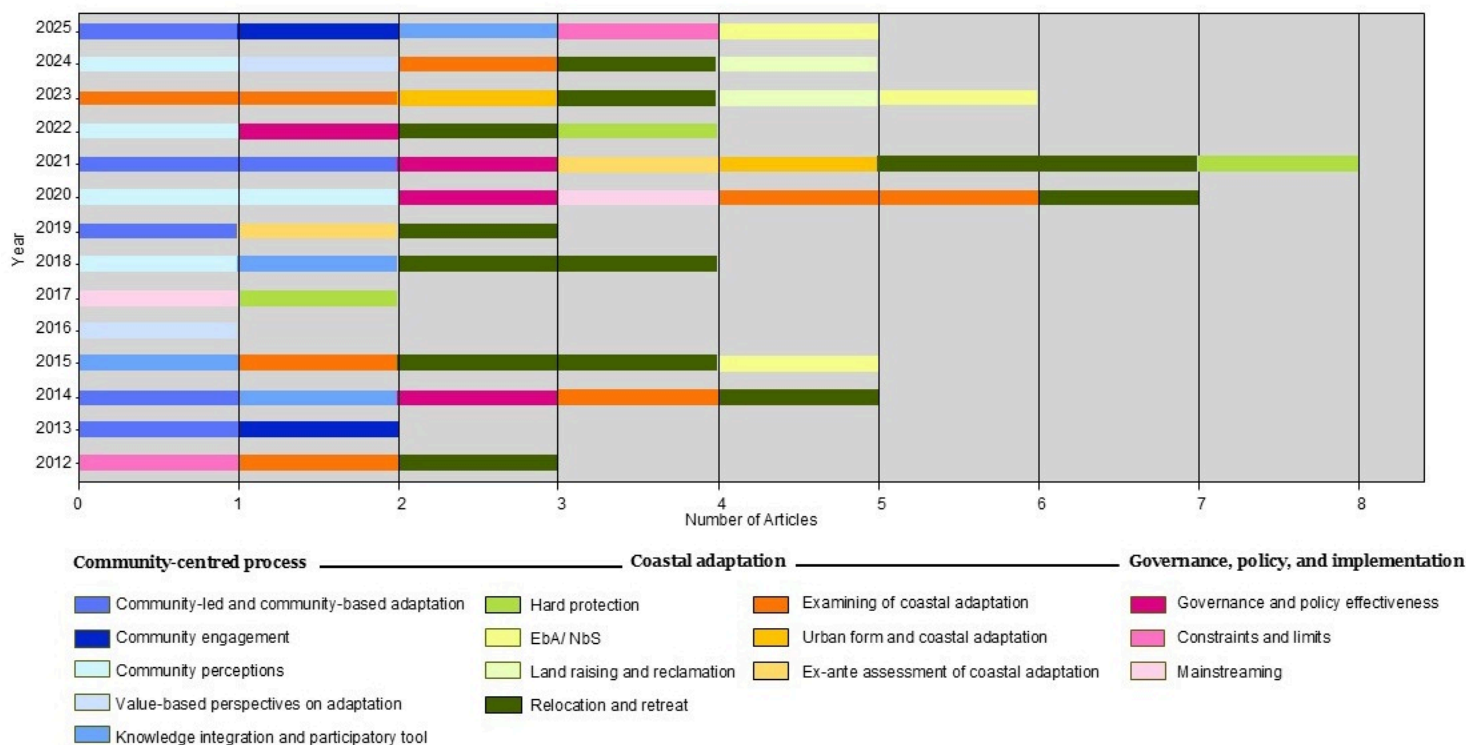


Figure 5

Distribution of themes by year

Note 2. Although the search timeframe was 1992–2025, no publications prior to 2012 were identified in the final sample as meeting the inclusion criteria

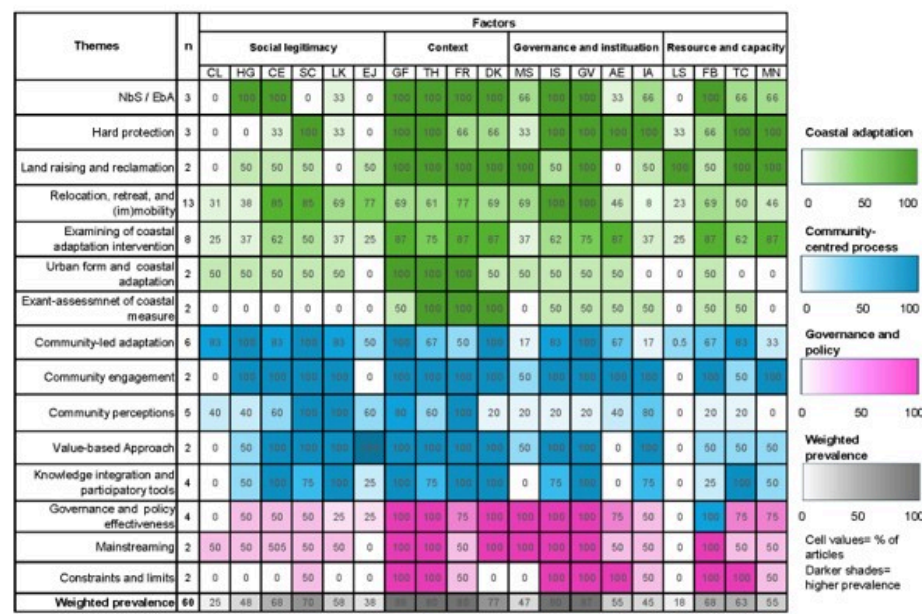


Figure 6

Heat map showing cross-cutting factors associated with coastal adaptation outcomes across the 15 themes identified in the review (cell values = % of articles within each theme referencing the factor; n per theme)

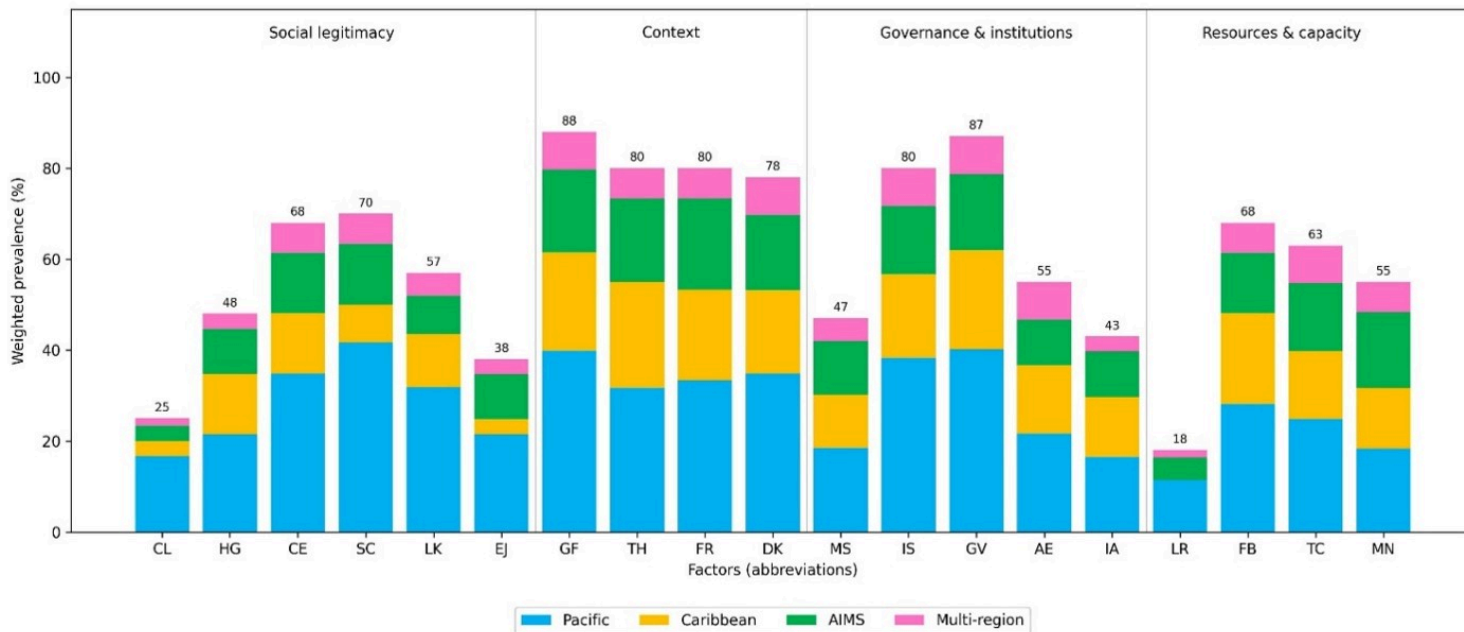


Figure 7

Regional composition of weighted factor prevalence across SIDS coastal adaptation studies (n=60)

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