

Review

Framing adaptive capacity of coastal communities: A review of the role of scientific framing in indicator-based adaptive capacity assessments in coastal social-ecological systems

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ABSTRACT

In the current context of climate and anthropogenic change, assessing the adaptive capacity of coastal communities, i.e., their ability to adapt, navigate and/or recover from the impacts of change is key in coastal management and decision-making processes. Framing in adaptive capacity assessments (i.e., what is highlighted) influences how coastal communities' adaptive capacity is perceived and understood, carrying profound ethical and political implications for governance. The significance of framing within assessments of adaptive capacity has been acknowledged, yet limited research delves into the dynamics of this process, particularly within coastal-social ecological settings. Through a systematic literature review, we address this knowledge gap by exploring how scholarly assessments frame adaptive capacity in social-ecological systems and analyzing their potential implications in coastal adaptation governance. We focus on adaptive capacity assessments using indicators, given their prominence as a frequently employed methodology by policy makers. Our results reveal that assessments are predominately framed under vulnerability frameworks, focusing on how adaptive capacity moderates the impact of climate-related variability using single-level data from individuals or households. Typically, these assessments rely on attributes related to socio-economic factors, access to assets and livelihood diversity to assess present adaptive capacity, with researchers and their paradigms playing a significant role in framing these assessments. We propose that this prevailing perspective may not support coastal communities in meeting the complex challenges they are facing. By providing this comprehensive review on the scientific framing of adaptive capacity assessments in coastal social-ecological systems, we contribute towards advancing frame-reflective adaptive capacity research.

1. Introduction

The growing impacts of climate change, along with complex social

and ecological changes, are severely affecting coastal ecosystems and the human system that depends on them, positioning coastal communities among the most vulnerable (Wong et al., 2014; Cooley et al.,

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2022). Understanding their adaptive capacity, defined as the ability of communities to adapt, navigate, and/or recover from the impacts of change (Gallopín, 2006; Smit and Wandel 2006), is essential for understanding how they can adapt. Despite different theoretical approaches to adaptive capacity, such as those focused on vulnerability, disaster risk, and resilience frameworks (for theoretical discussions, see Engle, 2011; Gallopín, 2006), there is a consensus that higher adaptive capacity enhances adaptation (Singh et al., 2021). While the importance of enhancing adaptive capacity is acknowledged since it was identified as a crucial aspect of vulnerability (Smit et al., 2001), the need to enhance it has become even more crucial in recent years. This urgency is driven by the need for effective adaptation (IPCC, 2022), prompted by an expected increase in sea level and societal challenges that escalate vulnerability in coastal communities (Oppenheimer et al., 2019; Cooley et al., 2022). As such, assessing adaptive capacity is vital for informed decision-making, as it helps identify who is vulnerable and how they can adapt. Indicator-based approaches continue to be the most favored method by decision-makers (Siders, 2019) as they simplify the complex nature of adaptive capacity with standardized and replicable metrics (Hinkel, 2011).

The increased policy relevance of adaptive capacity and its interdisciplinary nature have a substantially increased interest in understanding how it is measured and how it can facilitate effective adaptation. Reviews on adaptive capacity highlight the lack of consensus on the definition of adaptive capacity, uncertainty about factors that enhance it, as well as the gap between assessment findings and practical application (Siders, 2019; Whitney et al., 2017; Vallury et al., 2022; Barnes et al., 2020). Others have suggested how adaptive capacity should evolve to drive transformational adaptation by addressing issues of equity, agency, transfer, and power (Elrick-Barr et al., 2022; Dilling et al., 2023; Bartelet et al., 2023). A central insight from this literature is that how adaptive capacity is conceptualized and assessed shapes political and decision-making processes related to adaptation. Yet, few studies have investigated the prevalent assumptions in adaptive capacity assessments and how it is portrayed to decision-makers. This presents a challenge for adaptive capacity research and practice, as framing assessments in particular ways may lead to incomplete views of adaptation processes and outcomes (Whitney et al., 2017). Therefore, to respond to the need to effectively enhance coastal community adaptation, it is critical to examine how literature depicts adaptive capacity and its potential implications in policy.

Conducting adaptation-related scientific assessments involves making critical decisions at the outset, including selecting definitions, methods, and relevant stakeholders to be involved in the process (Fünfgeld and Mcevoy, 2011; McEvoy et al., 2013). This process of choosing specific aspects of an issue to highlight a problem, understand its causes, evaluate its significance, and suggest possible solutions is known as “framing” (Entman, 1993). By presenting a distinct interpretation of the world, and shaping individuals’ understanding of an issue (Carnahan et al., 2019), framing has profound ethical and political implications for environmental governance (de Boer et al., 2010), including adaptation (Morchain, 2018). Since indicator-based adaptive capacity assessments are widely used to provide knowledge in the adaptation field (Singh et al., 2021), including coastal adaptation management, understanding how scholars frame these assessments is crucial. This understanding will reveal what is obscured or emphasized in current dominant framings of adaptive capacity, advancing scientific knowledge and facilitating more informed decision-making in adaptation practices.

To meet this evidence need, we report on the results of a systematic literature review designed to examine how indicator-based adaptive capacity assessments are framed in coastal social-ecological systems. Using a “framing element” approach (Walter and Ophir, 2019; Matthes and Kohring, 2008), we ask: 1) which aspects are highlighted during the conceptualization, characterization, and operationalization of the

assessments? and 2) what potential perceptual outcomes arise from the dominant framing for decision making? This study aims to reveal the core assumptions and biases underpinning dominant ways of framing indicator-based adaptive capacity assessments in coastal social-ecological systems, and their challenges and potential implications for coastal adaptation governance. Informed by these findings we reflect on ways for the adaptive capacity field to move forward to more frame-reflective research. By doing so, this study addresses the call for deeper epistemological reflections in adaptation research (Klepp and Chavez-Rodriguez, 2018; Nightingale et al., 2020) and contributes to ongoing efforts for a more comprehensive understanding of adaptive capacity (Elrick-Barr et al., 2022; Mortreux et al., 2020; Siders, 2019; Vallury et al., 2022).

2. Analytical framework

Framing analysis employs qualitative inductive approaches to examine how specific content related to an issue is represented in a text based on its significance and recurrence (Dewulf, 2013). The diverse nature of adaptive capacity assessments (Whitney et al., 2017; Siders, 2019) poses a challenge for conducting framing analysis this way (Goffman, 1974). To address this complexity, we applied the “framing element” approach, commonly used in media analysis and recently extended to climate change research (e.g., Wardekker and Lorenz, 2019). This approach focuses on uncovering how various components within a document are accentuated using a predefined set of framing elements (Matthes and Kohring, 2008).

Defining key framing elements for indicator-based adaptive assessments is experimental and somewhat subjective. To reduce subjectivity and enhance replicability, building on the approach of Wardekker and Lorenz (2019), we followed a three-step process: (i) analyzed adaptive capacity literature to pre-select potential framing elements, (ii) conducted and inductive, bottom-up analysis to identify additional framing elements from the sample, and (iii) validated these elements on a random sample. From this process, we identified seven framing elements that shape the conceptualization, characterization, and operationalization of adaptive capacity assessments in coastal social-ecological systems: (i) orientation of the problem and purpose, (ii) the theoretical focus, (iii) the societal level used; (iv) the temporal scale; (v) the attributes of adaptive capacity prioritized; (vi) how the results are used, and, lastly (vii) participation (Fig. 1). These framing elements are described below. Details on the process for selecting framing elements, including the final elements and associated codes, are provided in Supporting Material A. We recognize that the theoretical perspective is key in shaping the overall assessment framing (Whitney et al., 2017). Therefore, our analysis pays specific attention to how theoretical perspectives interconnect with other elements of framing.

2.1. Conceptualization

2.1.1. Problem and purpose

This framing element examines how adaptive capacity assessments frame the diagnosis of the problem, specifically: what the problem is (i.e., adaptive capacity to what) and who it affects (i.e., adaptive capacity of whom) (Whitney et al., 2017), as well as the purpose: characterize adaptive capacity in a single location/among locations or identify policy recommendations (Adger et al., 2004). This framing relates to responsibility in governance: what is causing the problems for whom (Nisbet, 2009), including whether the problem is thought to stem from physical impacts of climate change or contextual socio-environmental conditions (O’Brien et al., 2007).

2.1.2. Theoretical focus

Theoretical approaches help researchers understand the interconnectedness and underlying mechanisms of different system elements (Creswell and Creswell, 2018). Given that adaptive capacity in the

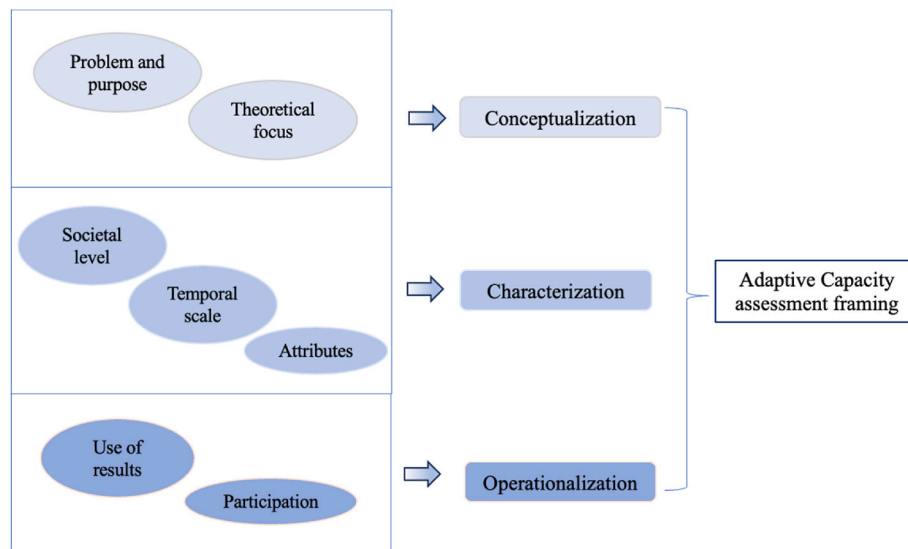


Fig. 1. Analytical framework. Seven framing elements used to analyze the framing of indicator-based adaptive capacity assessments. These shape the conceptualization, characterization, and operationalization of assessments, influencing adaptation decision-making approaches.

context of climate change draws primarily from the vulnerability and resilience literature (Gallopín, 2006; Smit and Wandel 2006), we examine how adaptive capacity is framed within this literature. Specifically, we investigate whether adaptive capacity is framed (i) within the risk-hazard vulnerability framework (IPCC, 2001, 2007), (ii) resilience frameworks (Cutter et al., 2008), (iii) livelihood and food security approaches (Allison and Horemans, 2006), or (iii) a combination of these frameworks. Additionally, since the selection of specific definitions of adaptive capacity influences an assessment's framing (Siders, 2019), we study whether adaptive capacity is defined in terms of adjustments, adaptation, coping, or resources (Kasperson and Kasperson, 2005; Gallopín, 2006; Mortreux and Barnett, 2017).

2.2. Characterization

2.2.1. Societal level

For this framing element, we explore the unit of society where adaptive capacity was assessed: (i) individual, (ii) community, (iii) or national/regional level (Gibson et al., 2000). These choices indicate which nuances and interconnections within social-ecological systems researchers considered to influence adaptive capacity (Vincent, 2007). Furthermore, the chosen level of assessment might affect how decision-makers perceive risk and responsibility, influencing their willingness to take action (Spence and Pidgeon, 2010).

2.2.2. Temporal scale

This framing element explores (i) whether adaptive capacity is assessed to learn from the past, understand the current status, or predict future capacities and (ii) if it is assessed in response to short-term changes (e.g. extreme weather events) or long-term ones (e.g. sea level rise). These choices influence the prioritization of specific characteristics of adaptive capacity and cross-scale interactions within social-ecological systems (Vallury et al., 2022; Whitney et al., 2017). Moreover, they may affect proposed adaptation strategies (Vink et al., 2013), including whether priority is given to present or future/past considerations (de Boer et al., 2010).

2.2.3. Attributes

An indicator-based approach to assessing adaptive capacity involves first identifying a set of determinants to characterize adaptive capacity and then selecting indicators to measure each determinant. This framing element examines (i) the attributes chosen to characterize adaptive

capacity and (ii) whether these attributes consider cross-scale dynamics. Given the lack of consensus on indicators for adaptive capacity, it can be challenging to determine if two papers are assessing the same or different determinants (Siders, 2019). Consequently, to assess the first framing aspect, we categorized the indicators proposed in the reviewed papers under seven pre-selected common types of determinants. These determinants represent various aspects commonly suggested by literature to assess adaptive capacity, including in coastal-social ecological systems (Whitney et al., 2017, Brooks and Adger, 2005; Yohe and Tol, 2002; Siders, 2019, Barnes et al., 2020). Categorizing indicators within these determinant categories allowed for comparison across studies and a better understanding of the framing trends. The types of determinants and their main indicators are shown in Table 1 in Supplementary Material A. While this standardized method was designed to cover a wide range of indicators and reveal differences, interactive coding was allowed to incorporate new categories or eliminate others if necessary. For cross-scale dynamics, we identified whether indicators measure adaptive capacity within a single social level (e.g., access to resources) or across multiple levels (e.g., cooperation among groups). Differences among scales within indicators of adaptive capacity may shape the efficiency of interventions supporting transformational action (Elrick-Barr et al., 2022).

2.3. Operationalization

2.3.1. Use of results

This framing element explores (i) the specific stage of the policy processes the assessments intend to influence (Weible and Sabatier, 2018), (ii) whether and how the assessments were shared (e.g., online dissemination, written reports or others), and (iii) the nature of policy recommendations or governance approach offered to address change (e.g., technical solutions, social enhancement, institutional action). These framing aspects encompass notions of responsibility (Dirix and Gelders, 2010), raising explicit or implicit questions about who is responsible for enhancing adaptive capacity and what types of improvements are believed to strengthen it.

2.3.2. Participation

This framing element analyzes whose worldviews, knowledge, and perspectives were highlighted during different stages of the assessment and how. Specifically, we examine: (i) when participation was considered during the assessments; (ii) who participated; and (iii) how

Table 1
Types of adaptive capacity (AC) definitions across the sample.

Type of definition	Sample	Example articles
AC as the ability to adjust	“the ability of a system to adjust to climate change, to take advantage of opportunities or to cope with the consequences”	Evariste et al. (2018), Hadipour et al. (2020), Johnson et al. (2016), Koomson et al. (2020), Maiti et al. (2014), Maina et al. (2016), Mohammed et al. (2017), Maina et al. (2016), Saroar and Routray (2015), Dzoga et al. (2018), Bennett et al. (2014), Cinner et al. (2015), Tran et al. (2021), Mukherjee and Siddique (2020), Uddin et al. (2019), Tull et al. (2016).
AC as the ability to cope	“ability of the fishing communities to cope with the dynamics of fisheries resources due to climate variability impacts”	Freduah et al. (2019), Weis et al. (2016), Marshall et al. (2009), Frusher et al. (2016), Metcalf et al. (2015), Islam et al. (2014).
AC as resources	“different forms of capital and the interconnections among them in response to climate change and other socio-economic stressors (...) adaptive capacity helps to reduce potential risk and take advantages of opportunities to deal with stressors to respond and adapt to a changing global environment”	Bennett et al. (2014), Himes-Cornell and Kasperski (2015).
AC as the ability to adapt	“adaptive capacity is a community’s ability to adapt and recover after a negative event and still retain their desired characteristics of the community”	Chang and Huang (2015), Tonmoy and El-Zein (2018).
Others	“adaptive capacity is the system’s ability to attract emergent inflows to recover and to adjust from the impacts of hazards”	

participation was conducted (i.e. surveys, discussions, interviews). This framing element is susceptible to power dynamics (Eriksen et al., 2015; Pelling, 2011), influencing who holds the power to shape the adaptation agenda (Woroniecki et al., 2019).

3. Materials and methods

The systematic literature review followed broadly the procedure by Luederitz et al. (2016) and was informed by PRISMA reporting guidelines (O’Dea et al., 2021). A detailed description of the article selection, coding, and analysis process, including examples of excluded articles, is provided in Supplementary Material B. The list of studies reviewed is included in Supplementary Material C.

In brief, we developed a search string using terms that cover the breadth of social-ecological research on adaptive capacity assessments in coastal socio-ecological systems. Recognizing that research on adaptive capacity intersects with various theoretical grounds, including vulnerability, adaptation, resilience and disaster risk, we included terms related to “adaptive capacity” (“adapt* cap*”) and keywords pertinent to these theoretical areas. To improve specificity, we combined these with terms such as assessment, indicators, climate change, and coast* to reflect our review’s focus. We searched English peer-reviewed scientific publications from 2014 to 2021 using Scopus and Web of Science. We chose 2014 as the starting point, as “adaptive capacity” gained prominence post-Intergovernmental Panel on Climate Change AR5. Based on a decision tree outlining our study’s eligibility criteria (See Supplementary Material B, Fig. 1) we conducted data screening. First, the title and abstract of the articles were screened by two independent reviewers, yielding 29 eligible and 70 potentially eligible articles. Afterward, six reviewers performed a full-text screening of the potentially eligible articles. Following these steps, 42 relevant articles were identified. For data coding and analysis, we developed a codebook, based on the

analytical framework and other bibliometric information from the assessments (See Supplementary Material B, Table 2). An Excel data extraction sheet was developed based on the codebook to facilitate qualitative and quantitative analysis. The codebook and Excel data extraction sheet were tested and validated. Each of the 42 articles was fully read and coded in the Excel sheet based on the codebook for qualitative and quantitative analysis.

4. Results

4.1. General observations

Almost half of the papers (48%) in our sample focused on Asia, primarily South and Southeast Asia, followed by Africa (17%), mainly East Africa. The Pacific and Oceania accounted for 14%, of the papers America for 12%, the Caribbean (Trinidad and Tobago, and Grenada) for 5% and Europe (Greece) for 2%. One paper covered various countries, including Australia, Brazil, India, South Africa, the Solomon Islands, and Madagascar (Aswani et al., 2019). We found that in 74% of the studies, the researchers’ home institutions and the locations of their empirical studies were in the same country.

4.2. Conceptualization

We found that 41% of assessments (n = 17) use risk-hazard vulnerability frameworks, typically based on the IPCC 2001, and 2007. These studies treated adaptive capacity as moderating the impacts of climate variability and extremes, usually examining it alongside exposure and sensitivity. A further 26% (n = 11) drew on vulnerability-resilience frameworks, specifically drawing on social-vulnerability frameworks by Cutter et al. (2008) or Adger (2009). These assessments saw adaptive capacity as a dynamic process shaped by prior conditions and external influences (Cutter et al., 2008). A fraction of these assessments (n = 3) integrated socio-ecological frameworks such as those proposed by Marshall et al. (2009) and Metcalf et al. (2015) (e.g., Cochrane et al., 2019). The remaining 33 % (n = 14) used sustainable livelihood approach, but combined with either risk-hazard (n = 8) or social vulnerability frameworks (n = 6). Usually, these studies used the sustainable livelihood approach (SLA) (Scoones, 1998) to detail further what constitutes adaptive capacity, emphasizing its link with livelihood strategies, assets, and activities. The list of articles and their theoretical framing is provided in Supplementary Material C.

In our analysis, 67 % (n = 28) of the assessments provided a specific definition for adaptive capacity; however, none used the same definition. Most assessments that provided a definition broadly defined adaptive capacity as the “ability to adjust” to climate variability and change (n = 10), sometimes including response, recovery and/or taking advantage of opportunities. These assessments typically used the risk-hazard vulnerability theoretical framework. Other definitions included “resources” (n = 8), “ability to cope” (n = 6), “ability to adapt” (n = 2) or other definitions (n = 2). Definitions emphasizing “resources”, highlight the importance of possessing or mobilizing various resources (e.g., Weis et al., 2016), including their interconnections (e.g., Freduah et al., 2019), or the capability to mobilize these assets (e.g., Frusher et al., 2016). These assessments usually frame adaptive capacity by considering sustainable livelihood approaches. Those defining adaptive capacity as “ability to cope” often equated it with “ability to respond” (Bennett et al., 2014), “ability to recover” (Tran et al., 2021), or “ability to moderate changes” (Uddin et al., 2019) (Table 1).

We found that the majority of studies (76%) diagnose the need to strengthen a community’s adaptive capacity to face the adverse effects of climate variability and change, including sea level rise (e.g., Gravittani et al., 2018; Hadipour et al., 2020), coastal flooding (e.g. Chang and Huang, 2015), and extreme weather events (e.g., Weis et al., 2016). These assessments typically framed adaptive capacity within vulnerability frameworks. Conversely, 24 % of assessments focused on

Table 2
Types of indicators of adaptive capacity considered across the sample according to types of determinants.

Determinant	# articles	Types of indicators	Description	Example of indicators
Socio-demographic dimensions	36	Mixed	Social and economic status, commonly related to demographics, including income, employment, crime, education, demographic profile, poverty rates, gender, and age.	Percentage of population in the workforce, average income, size of the community (members, age structure, gender), percentage of people educated, people with highschool diploma, life expectancy, population growth rate, economic dependency ratio, population density, fraction of household heads with female members
Access to assets	25	Access to material assets	Related to access to material goods and infrastructure, including the ones that support services/production activities (e.g., drainage and flood control infrastructure, fishing assets).	Household material possessions (television, cooking stoves), housing characteristics, fishing gear and processing, groundwater development, access to transport and communication.
	16	Access to finance or economic resources	Related to the financial capital available (or access to those capitals) to mitigate potential risks.	Household material possessions (television, cooking stoves), housing characteristics, fishing gear and processing, groundwater development, access to transport and communication.
	14	Access to security	Related to both access to and possession of secure conditions, including food security and health security.	Access to social safety nets, access to medical institutions, access to governance assistance, food security (e.g., availability of fish, milk, egg), percent of the population with property/health insurance, and access to water services, social security recipients.
Livelihood diversity and mobility	12	Natural capital	Related to access to natural assets, including soil, water, and all living things, as well as the services derived from these assets.	Changes in resource base, diversity of natural resources, fish abundance, rainfed agriculture, livestock/crop types and density.
	25	Livelihood and income diversity	Related to means of supporting life, including dependency on specific livelihoods and diversification.	Alternative source of livelihood, experience in fishing, income diversification, commercial fishing reliance index, diversification of fishing areas, occupational multiplicity, types of occupations, years of fishing and/or trading experience.
Learning and knowledge	9	Mobility	Related to the ability to move freely, movement of people from one place to another.	Place attachment, occupational mobility, migration patterns, percentage of a households whose family members work outside the community/outside the city, percentage of households where family members migrate for work.
	8	Knowledge	Related to the access, acquisition, or holding of different types of knowledge	Weather and sea conditions information, disaster awareness, knowledge of disturbance sources, knowledge of climate change, ideas to sustain local fisheries, knowledge good fishers possess, situation awareness, and business knowledge.
Socio-cognitive constructs	3	Information sources	Related to the access to spaces for learning processes to provide additional sources to enhance knowledge and skills or medium through which are disseminated.	Sources of climatic/weather information, household heads who did not have access to disaster preparedness training.
	5	Risk behavior and flexibility	Related to belief about the change of risk, magnitude of risk, as well as associated behavior to avoid that risk, and capacity to modify to face that risk.	Risk behavior, perceptions of who/what is at risk, and ability to anticipate change.
Cooperation through networks	3	Trust	Related to the ability of someone (individuals, community leaders, institutions).	Trust in local government/local leaders/police/organizations who respond to climate change impacts, neighbors.
	8	Cooperation	Related to the act of working together among individuals, organizations, and other informal relationships.	Cooperation among friends and family, reciprocity of support/assistance, partnerships for responding to climate change impacts, assistance from family members residing outside the village, and community participation in decision making.
Governance and institutions	6	Networks	Related to the possibility of access to existence of one or several groups or systems of interconnected people usually for one specific aim, as well as membership into these groups.	Access to networks for cooperation among locals, membership in community organizations, communication among networks, non-state actors or entities involved in fisheries sustainability initiatives.
	6	Quality of governance	Related to mechanisms that may contribute to a system of regulation and/or management, including formal or informal institutions and regulations.	Ability to secure resources from government officials, improve relations and communication between officials and community, innovation in governing, leadership, budgeting for adaptive actions, political stability, levels of corruption, and government expenditure.
	2	Leadership	Related to the act of providing direction, influencing others and organizing. Could be related to informal or formal organizations/institutions.	Leadership in governance, strength of community leadership.
	3	Local institutions	Related to the existence of institutions that enable individuals and society in general to function effectively, as well as the rules that govern these institutions.	Number of environmental agencies, resource management organizations, insurance companies, national and private banks.

strengthening communities' capacity to face impacts resulting from multi-dimensional climate-ecological-society interactions. For example, Bennett et al. (2014) evaluated adaptive capacity in response to fisheries declines due to climate change, while Cinner et al. (2015) examined the capacity of marine resource users to cope with changes in coral reef fisheries from temperature-induced climate change. These assessments

often used vulnerability-resilience frameworks, particularly the ones that consider socio-ecological approaches (e.g., Marshall et al., 2009; Metcalf et al., 2015; Cochrane et al., 2019). Regarding who is affected, 74% of assessments broadly referred to coastal communities, while 26 % specified particular social group, such as fishing communities. Most assessments did not distinguish among different demographic groups.

Only one study addressed differences based on age and migration status (Cinner et al., 2015). In terms of purpose, 48% of assessments focused on characterizing adaptive capacity within a single location, 42% compared it among different locations and 10% aimed to advance assessment methodology by showcasing indicators or proposing new frameworks. Additionally, 45% of the studies emphasized providing policy recommendations to enhance adaptive capacity.

4.3. Characterization

We found that most assessments assessed adaptive capacity at the “community level” (88 %), followed by the national or regional level (12%). However, while the aim was to assess adaptive capacity at this societal level, the data used were primarily aggregated from the individual or household level (83%) (e.g., education level, access to social networks or credit). Notably, the term “community” was inconsistently defined across the sample: sometimes based on specific livelihood boundaries (e.g., fishing communities) and other times on geographical boundaries.

Regarding the temporal framing of adaptive capacity, most studies focused on how current levels of adaptive capacity handle varying levels of exposure. This is done using either data on past or current climatic conditions (74%) (e.g. Himes-Cornell and Kasperski, 2015) or climate projections (21%) (e.g., Maina et al., 2016; Mafi-Gholami et al., 2020). Only two studies considered other temporal scales when assessing adaptive capacity. One of them assessed the adaptive capacity of fishing communities over two periods and compared them to evaluate changes over time (Cinner et al., 2015). The other evaluated how adaptive capacity may change over time considering perception and participatory mapping surveys *in situ*, and considering potential future scenarios (Cochrane et al., 2019). Most studies assessed adaptive capacity to long-term climatic changes (74%) (e.g., changes in sea surface temperature, precipitation, sea level rise), while 26% combined long-term with and short-term changes, such as floods, storms or droughts (e.g., Aswani et al., 2019), or changes in institutional conditions (e.g., Bennett et al., 2014).

Regarding the attributes considered to determine adaptive capacity, we identified 16 main types of indicators across 7 types of determinants for adaptive capacity (See Table 2, and Supplementary Material C for a list of indicators used in each study). “Socio-demographic dimensions” and “access to assets” were the most common, appearing in 86% and 60% of assessments, respectively. Among those considering “access to assets”, material assets were prioritized. “Livelihood diversity and mobility” appeared in 59 % of the assessments, mainly through indicators of livelihood diversification. Fewer assessments considered factors related to “governance and institution” (30%), “socio-cognitive conditions” (12%), such as risk behavior and flexibility, “learning and knowledge” (19%), including access to knowledge and climate awareness; and attributes related to “cooperation and networks” (19%).

Because most assessments collected data at the individual or household level (societal level framing), the attributes for measuring adaptive capacity focused on single-level data, such as access to education, income level, access to credit, and membership in community organizations. Only 17% considered cross-level interactions, such as inter-governmental resource allocation, decision-making authority distribution, and cooperation between community and government (e.g., Bennett et al., 2014; Maina et al., 2016). Regardless of the theoretical framework used, most highlighted socio-economic indicators, access to assets, livelihood diversity and mobility, and governance. Assessments using vulnerability-resilience and vulnerability-livelihood approaches more frequently included determinants related to socio-cognitive factors, learning and knowledge, and cooperation through networks (Fig. 2).

4.4. Operationalization

We found that while 45% of the assessment suggested they aimed to provide policy recommendations, only 10% explicitly identified the policy-making stage they intended to inform (i.e., policy formulation) (e.g., Cochrane et al., 2019; Aswani et al., 2019). Most assessments did not mention a reporting phase where results were shared with the target audience or community. Only three articles reported sharing the results with the public or local communities through methods like community meetings or online dissemination tools (Weis et al., 2016; Frusher et al., 2016; Metcalf et al., 2015). Finally, we found that 40 % of the assessments offered specific policy or practical recommendations (Table 3). These included technological/physical improvements (n = 7), such as improvement of general conditions for accessibility and sanitation; livelihood enhancement (n = 9), such as promotion of flexible livelihood strategies; and socio-economic conditions (n = 8), including access to credit facilities and increased levels of education. Seven papers provided recommendations related to knowledge management, such as raising climate change awareness among fishers and knowledge transfer, while seven also offered institutional/governance-related recommendations, like improving governance and leadership.

In examining participation, we found that stakeholders were involved in 69% (n = 29) of the assessments. This involvement was primarily during the data collection process to inform the indicators (n = 19), with some studies also considering stakeholders during the selection of adaptive capacity attributes (n = 10). During the conceptualization phase (i.e., theoretical focus and problem framing), researchers were typically the ones involved, often drawing on specific research paradigms. One exception to this was Tonmoy and El-Zein (2018). In assessments involving stakeholder participation, local community members (i.e., individuals, households, fishers, fish traders) were the primary stakeholders considered (62%, n = 18), while government officials and community leaders were involved in 38% of the studies (n = 11). Community members mainly participated as informants for data

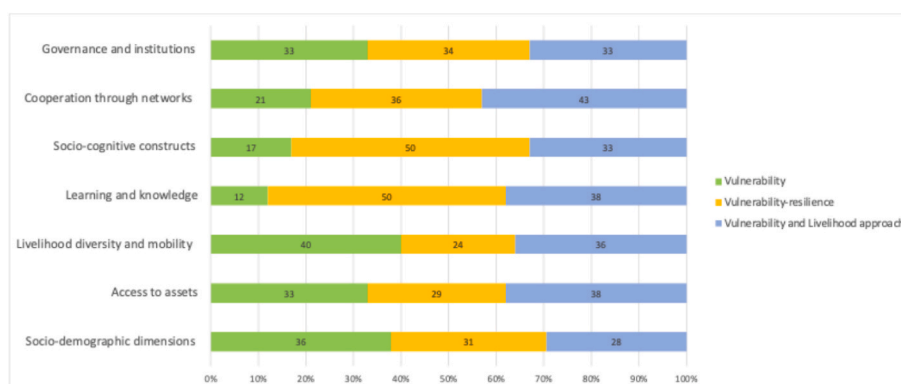


Fig. 2. Variation in proposed adaptive capacity determinants across the three distinct theoretical frameworks used in the sample.

Table 3
Types of governance approaches suggested by the articles reviewed to enhance the adaptive capacity of coastal communities across the sample.

Governance approach	Characteristic	Policy suggestions	Literature reviewed
Technological/physical	Infrastructures and accessibility related to transportation, communication, health, settlements in high-risk areas.	Improvement of general conditions of accessibility and sanitation, provide safe drinking water facilities, support technological transfer for renewable energy, provision of community infrastructure such as transportation and communication.	Bennett et al. (2014), Cinner et al. (2015), Dzoga et al. (2018), Mohammed et al. (2017), Saldaña (2015), Tran et al. (2021), Zacarias (2019).
Livelihood enhancement	Promote alternative livelihood, especially to no-agricultural sources	Promote alternative livelihood in tourism and aquaculture, supporting flexible livelihood by employing fishers to safeguard the habitat.	Bennett et al. (2014), Cochrane et al. (2019), Hadipour et al. (2020), Huynh and Stringer (2018), Marshall et al. (2009), Metcalf et al. (2015), Saroar and Routray (2015), Shah and Dulal (2015).
Socio-economic	Education and sources of credit	Increase credit facilities, levels of education/access to education, improve levels of homeownership, and increase financial capital.	Bennett et al. (2014), Cinner et al. (2015), Evariste et al. (2018), Hadipour et al. (2020), Saldaña (2015), Shah and Dulal (2015), Tull et al. (2016).
Knowledge management	Enable knowledge exchange among communities, increase awareness/education to climate variability and impact on resources	Enhance relationships with other communities and partnerships, enable knowledge exchange among community leaders, increase awareness of the impact of climate change, improve information on vulnerable fisheries and fishing areas, and nurture local/traditional knowledge on adaptation.	Bennett et al. (2014), Dzoga et al. (2018), Maina et al. (2016), Mohammed et al. (2017), Saldaña (2015), Saroar and Routray (2015), Zacarias (2019).
Institutional/governance	Stronger leadership, representing community, institutional capacity building, promote investment in research and education, include vulnerability maps into governance	Promote capacity building programs, networking, improve governance and leadership, empower local level institutions, integrate adaptation strategies into the policy development, include scenario maps into governance, promote post-impact assistance,	Bennett et al. (2014), Cochrane et al. (2019), Maina et al. (2016), Dzoga et al. (2018), Evariste et al. (2018), Hadipour et al. (2020), Huynh and Stringer (2018), Martins and Gasalla (2020), Saldaña (2015), Shah

Table 3 (continued)

Governance approach	Characteristic	Policy suggestions	Literature reviewed
		investment in research.	and Dulal (2015), Tran et al. (2021); Tull et al. (2016).

gathering (indicators of adaptive capacity), while officials and leaders were involved in selecting adaptive capacity indicators. Participation was usually carried out primarily through interviews and surveys (80%, n = 24), followed by focus group discussions (20%, n = 5) (e.g., Cochrane et al., 2019; Johnson et al., 2016). Government officials and community leaders were primarily engaged through focus group discussions.

5. Discussion

5.1. Dominant framings of adaptive capacity assessments and their challenges

Our study has revealed the ways in which indicator-based adaptive capacity assessments in marine-coastal social-ecological systems are scholarly framed (Fig. 3). Here, we emphasize the key implications of these findings and their significance for coastal adaptation governance.

First, our findings suggest that in indicator-based assessments of adaptive capacity, researchers primarily consider vulnerability lenses to understand adaptive capacity and its relations to coastal-social ecological systems. In the literature we reviewed, the most commonly used vulnerability framework was the risk-hazard vulnerability framework based on the IPCC 2001, 2007 guidelines. This framework was applied in 41% of the assessments, while in 26% of the cases it was integrated with a sustainable capital framework. The choice to use these frameworks in coastal adaptation studies, especially in fishing communities, has been attributed to their flexibility and effectiveness in measuring and comparing drivers of vulnerability (de Carvalho et al., 2023). Independent of their analytical flexibility, we found that the dominance of this theoretical approach influenced researchers to emphasize understanding systems' adaptive capacity for their ability to cope with climatic shocks and stressors. This is shown in our analysis, where dealing with climatic shocks was identified as the main problem the assessment aimed to address in 76% of the cases, all of which utilized this analytical framework.

We argue that framing adaptive capacity primarily under risk-hazard vulnerability frameworks may lead to a focus on adaptive capacity as the ability to respond to climatic stressors, which is believed to benefit the entire system (Thiault et al., 2021; McDowell et al., 2016). This understanding might result in adaptation recommendations that overlook the interconnectedness and trade-offs among social, ecological, and climatic components, potentially causing maladaptive outcomes (Schipper, 2020) while neglecting crucial questions about the values driving adaptation (Kythreotis et al., 2024). For instance, under this theoretical lens, increasing material wealth to help communities cope with hazards is often seen as enhancing adaptive capacity. While this can help manage climatic risks, such as floods, not considering the trade-offs among ecological and social conditions can be challenging. In fishing communities, for example, increased access to financial resources may lead fishers to acquire larger boats or expand their fishing methods, which could decrease fish biodiversity or abundance (Coulthard, 2012). Thus, addressing adaptive capacity by solely focusing on climatic risks without considering their interactions with other social-ecological components could potentially exacerbate existing sustainability challenges (Cinner and Barnes, 2019).

Second, we show that while most studies (88%) aim to assess

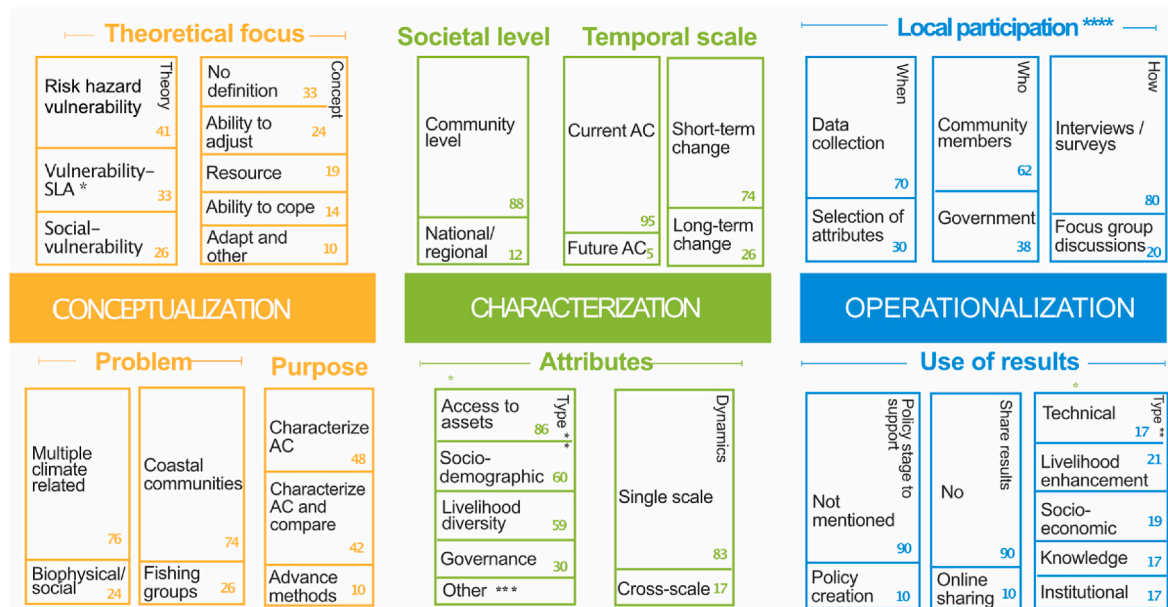


Fig. 3. Framing of adaptive capacity assessments from our sample during the conceptualization, characterization, and operationalization stages. Numbers reflect the percentage in our sample. * SLA (Sustainable Livelihood Approach), 10 of these studies combined SLA with risk-hazard vulnerability frameworks and 4 with social-vulnerability frameworks.

** Percentage of papers considering each category.

*** Other: socio-cognitive (12%), learning and knowledge (19%), and cooperation (12%).

**** From the studies that considered stakeholder participation (69%).

adaptive capacity at the community level, the data used for these assessments primarily come from aggregating single-level data from individuals or households (86%). Additionally, these assessments primarily viewed adaptive capacity in terms of socio-economic opportunities, access to assets, and livelihood options, with 30% considering governance and only around 20% considering socio-cognitive conditions, learning, knowledge, and cooperation. This trend likely results from the dominance of risk-hazard vulnerability frameworks, which assume that adaptive capacity is a universal process replicable at various predetermined levels (Hulme, 2010). Regardless of their theoretical link, assessing adaptive capacity by measuring access to and conditions for mobilizing socio-economic and livelihood options at the individual level may not reflect the broader conditions that influence individuals' ability to adapt (Elrick-Barr et al., 2022). For instance, studies have shown that financial programs to increase credit access for small-scale fisheries often benefit fishing elites, while poorer, more vulnerable fishers rarely see the same benefits (Green et al., 2021). Power dynamics within formal and informal institutions, conditions facilitating the movement of adaptive capacity among individuals and groups, collaboration through networks, attitudes toward risk and knowledge sharing and building have been proposed as more accurate indicators of why some coastal communities cannot adapt (Mortreux et al., 2020; Elrick-Barr et al., 2022). These factors should be considered when framing adaptive capacity assessments.

Our results also show that assessments mainly examine present adaptive capacity, with only two studies comparing different periods (Cinner et al., 2015) or focusing on future capacity (Cochrane et al., 2019). However, this framing may lead to seeing coastal communities' adaptive capacity as static, rather than highly dynamic, where future uncertainties significantly impact their ability to adapt. For example, changes in seasonality directly affect fishing practices and food security in these communities (Singh, 2014), while shifting institutional structures can significantly influence urban and disaster planning in coastal areas (Henly-Shepard et al., 2015). Therefore, it is necessary to expand adaptive capacity assessments to include how future conditions might influence the capacity to adapt.

Finally, our findings suggest that scientific knowledge, shaped by researchers' paradigms and theoretical frameworks, greatly influences decisions about the problems addressed by assessments and how adaptive capacity is defined and measured. Given that our focus is on scholarly adaptive capacity assessments, it is not surprising that they play a significant role in determining methodological and conceptual approaches. However, it is crucial to recognize that coastal communities and their institutions possess valuable empirical knowledge about environmental and social dynamics. Integrating this knowledge is key for adaptive processes and reducing their vulnerability (IPCC, 2022; Pörtner et al., 2022), including coastal ecosystem management (Loch and Riechers, 2021). Limiting local participation to informants during data gathering (as shown in 69% of the assessments reviewed) may restrict valuable insights during the assessment's conceptualization, including understanding social-ecological-climate relations.

5.2. Towards a more frame-reflective adaptive capacity research

The generation of scientific knowledge is not normatively innocent, but whether, unintended or intentional, it influences the conditions under which decisions are made and discussions are held. Based on our results and their implications, we argue that the current dominant framing of adaptive capacity assessments in coastal social-ecological systems may not adequately address the complex challenges facing coastal communities. To better address these issues, we emphasize two aspects: (i) of the content of the framing and (ii) who does the framing.

In relation to the first aspect, while theoretical decisions will vary according to the assessment's objectives, we suggest considering frameworks that better capture the complexity of how coastal communities experience and respond to change, especially in relation to the interrelations and trade-offs within social-ecological systems where coastal communities operate. From our review, we noticed that studies using social-vulnerability frameworks, especially those integrated with social-ecological approaches like those proposed by Marshall et al. (2009) and Metcalf et al. (2015), were more likely to consider this complexity (e.g., Maina et al., 2016; Cochrane et al., 2019). If using such

frameworks is not feasible due to their data demands, participatory approaches that consider attributes like resource dependence, conflict or cooperation over resources, and power relations may be effective alternatives. Examples from our review include Cinner et al. (2015) Cinner et al. (2015) and Freduah et al. (2019). Moreover, we suggest framing adaptive capacity assessments with metrics that address the underlying reasons behind individuals' challenges in adapting to changes (Mikulewicz, 2018). These include attributes proposed to capture cross-scale dynamics, such as cooperation among individuals and social organizations (Elrick-Barr et al., 2022), socio-cognitive constructs such as risk attitude, personal experiences (Mortreux et al., 2020) and learning, and power through agency (Cinner and Barnes, 2019). From the literature reviewed, we found that studies by Freduah et al. (2019), Cinner et al. (2015) and Bennett et al. (2014) considered these attributes and, as such, can serve as good examples.

Finally, we suggest expanding the framing of adaptive capacity to a more dynamic concept that allows for understanding future adaptation strategies within coastal social-ecological systems. At its core, adaptation is about envisioning the future (Bauriedl and Müller-Mahn, 2018). Therefore, assessments that help understand how adaptive capacity may be shaped by the dynamics and changing nature of coastal social-ecological systems would be beneficial. For this purpose, future envisioning approaches, increasingly use in adaptation science (Nalau and Cobb, 2022) may be helpful. A good example from our review that considers future dynamics through these approaches is Cochran et al. (2019).

Regarding who does the framing, we suggest increasing efforts to balance scientific and local knowledge when assessing adaptive capacity in coastal-social ecological systems. While we found a parity between the geographical distribution of the institutions conducting the assessments and the study locations (74% of assessments), as suggested by García-del-Amo et al. (2020), climate research should not solely rely on single narratives. Instead, climate research should consider diverse perspectives, including those from locals (Petzold et al., 2020; Orlove et al., 2023) and women (Azad and Pritchard, 2023). Increased dialogue between local and scientific stakeholders can enhance understanding of the social-ecological complexity of coastal communities (Loch and Riechers, 2021), including those of marginalization underlying their vulnerability (IPCC, 2022). Additionally, it may allow for adaptation strategies that are more likely to incorporate alternative perspectives and preserve cultural diversity perspectives (Bremer and Meisch, 2017). Therefore, embracing a more collaborative approach can advance adaptive capacity assessments toward a more inclusive perspective. A good example from our review is Tonmoy and El-Zein, 2018, who used participatory approaches at different stages of the assessments. Finally, consistent with other research (Whitney et al., 2017; Vallury et al., 2022; Siders, 2019), we advocate for greater transparency in the rationale and methodology behind selecting framing elements, including why certain framings of adaptive capacity are prioritized over others. This approach entails researchers to critically reflect that their values, biases, and theoretical assumptions are not apart from influencing decisions taken within the research process (Fazey et al., 2014).

This study has limitations, such as focusing on peer-reviewed literature in English. Expanding the scope to include adaptive capacity assessments from non-academic sources and others in other languages could add to the knowledge presented here. Additionally, we did not examine how different framing elements affect the implementation of adaptive capacity responses in practice. Thus, we call for more studies to follow up on how specific framings of adaptive capacity assessments shape the effectiveness of responses to change in specific contexts.

6. Conclusion

How researchers highlight and present an issue, i.e. framing, affects how the issue is perceived and which aspects are overlooked, ultimately influencing governance. Scholarly indicator-based adaptive capacity

assessments provide knowledge to support coastal adaptation, making it important to understand how these assessments are framed and the potential implications. Employing a framing element approach, we examined the framing of 42 scholarly assessments of adaptive capacity in coastal social-ecological systems. Our analysis suggests that these assessments are predominantly framed under vulnerability frameworks, focusing on how adaptive capacity moderates the impacts of climate-related variability using data from individual and household levels. Furthermore, these assessments typically rely on socio-economic factors, access to assets and livelihood diversity to assess present adaptive capacity, while researchers and their paradigms play a significant role in setting how these assessments are framed. These dominant framings may hinder coastal adaptation to meet the complex challenges facing coastal communities.

We advocate for a more reflective approach to indicator-based adaptive capacity assessments in coastal social-ecological systems. This involves considering how the framing content and who does the framing shape the interpretation of adaptive capacity within these assessments. To advance this we recommend using theoretical frameworks that capture the dynamics between adaptive capacity and social-ecological systems and employing indicators that reflect people's everyday experiences and cross-level relationships. Additionally, we suggest adopting a more future-oriented understanding of adaptive capacity while balancing local and scientific knowledge during assessment framing. Moving forward, further efforts should be made to evaluate how individual adaptive capacity assessments shape responses to enhance adaptive capacity in specific contexts. This will help clarify the potential governance implications of the specific framings discussed in this study.

Rising sea levels, global warming, and changing conditions are expected to continue threatening coastal communities in the coming decades (Kulp and Strauss 2019). In this context, generating knowledge to support these communities in adapting is a key challenge for advancing ocean and coastal governance, as highlighted in the UN Ocean Decade (Challenge 5). Our paper contributes to this challenge by increasing awareness of the different frames used in indicator-based approaches in coastal social-ecological systems literature, their potential governance implications, and suggesting ways to move forward. This work lays the foundation for enhancing adaptive capacity assessments in coastal systems, ultimately contributing to more effective coastal adaptation and governance.

CRedit authorship contribution statement

Fabiola Espinoza Córdova: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Torsten Krause:** Writing – review & editing, Formal analysis. **Elisa Furlan:** Writing – review & editing, Formal analysis. **Elena Allegri:** Writing – review & editing, Formal analysis. **Bethan C. O'Leary:** Writing – review & editing, Formal analysis. **Karima Degia:** Writing – review & editing, Formal analysis. **Ewan Trégarot:** Writing – review & editing, Formal analysis. **Cindy C. Cornet:** Writing – review & editing, Formal analysis. **Silvia de Juan:** Writing – review & editing, Formal analysis. **Catarina Fonseca:** Writing – review & editing, Formal analysis. **Rémy Simide:** Writing – review & editing, Formal analysis. **Géraldine Perez:** Writing – review & editing, Formal analysis.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ocecoaman.2024.107455>.

Data availability

Data will be made available on request.

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