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Review

Climate change adaptation frameworks in fishing communities: A systematic review

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ABSTRACT

Climate change has had profound effects on coastal ecosystems, including sea level rise, ocean acidification, and extreme weather events. These impacts have left vulnerable populations in coastal areas, particularly fishing communities, struggling to maintain their livelihoods, subsistence, and cultural practices that rely on a healthy ecosystem. The existing body of research has examined the impacts of climate change on fishing communities and their perceptions and responses to environmental issues. However, these studies have employed diverse conceptual and methodological approaches. Therefore, our study aimed to identify the key concepts, frameworks, challenges, and trends evident in these previous studies. To achieve this objective, we conducted a comprehensive literature review of 34 papers and employed both quantitative and qualitative analyses to evaluate them. Our analysis revealed several primary challenges encountered in these studies, including insufficient data availability, variations in data quality, difficulties in effective communication with local communities, and inadequate inclusion of women's knowledge and perspectives. By recognizing these challenges, we can highlight areas for improvement and further research.

The findings of our study indicate that the most prevalent frameworks utilized in the selected studies can be classified into three groups: "Local knowledge," which focused on understanding the perceptions of climate change impacts among small-scale fishers; "Vulnerability," which aimed to comprehend the components and measurements of vulnerability in fishing communities; and "Adaptation and Resilience," which explored how these communities respond to climatic events. Furthermore, our study identified emerging trends in the development of research on local knowledge, gender roles, and adaptive capacity within fishing communities. In conclusion, this study serves as a general guide and starting point for refining and enhancing frameworks used to investigate the effects of climate change on small-scale fisheries.

1. Introduction

An estimated 10–12% of the world's population depends on fisheries and aquaculture for their food security, which directly impacts the well-being of aquatic environments, such as the marine and freshwater systems (Barange et al., 2018; Galappaththi et al., 2019a,b). Small-scale artisanal fishing is considered to be a sustainable method of food production and may represent a solution to the challenges in food systems (e.g., hunger and diet-related diseases, depletion of natural resources, environmental degradation, and climate change; FAO, 2022). Recognizing the importance of fisheries in the global food production chain, the United Nations General Assembly determined the year 2022 to be the International Year of Artisanal Fisheries and Aquaculture (FAO, 2022).

Small-scale artisanal fisheries face complex challenges, such as habitat degradation, illegal, unreported, and unregulated fishing, and overfishing (FAO, 2022). Along with power imbalances in value chains, barriers to trade, and a lack of appropriate skills and services to access markets with healthy products at fair prices (FAO, 2022). An additional challenge is the recognition of the role that women play in fisheries. Although they represent up to half of all fisheries and aquaculture workers (FAO, 2018), women suffer from invisibility, restrictions to access and control of resources, and discrimination when it comes to participation and decision-making (Koralagama et al., 2017).

Climate change further adds pressure to marine ecosystems (Brander, 2010). As a result of global warming, ocean, and coastal fauna

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have been moving toward higher latitudes, therefore forcing fishers to also move poleward, or to broaden their catch diversity and modify their gear and strategies to maintain harvests (Barange et al., 2018; Townhill et al., 2019). Studies have shown that among the vulnerabilities that fishery-dependent people and communities face as a result of climate change impacts are poor or reduced nutrition, employment, and income (Muringai et al., 2019; Pinnegar et al., 2019; Martins et al., 2019). Understanding the impacts of climate change on fishing communities and associated ecosystems requires an understanding of the socio-ecological system.

Many studies have previously sought to understand the relationship between climate change impacts and fishing communities (Chen et al., 2014; Lindegren and Brander, 2018; Green et al., 2021). However, these previous studies have all applied concepts with different conceptual and methodological approaches. Defining an appropriate framework to study the relationship between fishing communities and climate change impacts is difficult when there are many approaches available, and this diversity poses a challenge to replicating and comparing studies. An appropriate approach should be aligned with the characteristics of the study, considering methods, theories, goals, and core concepts.

One well-known approach is the use of conceptual frameworks (CF), which helps organize the notions, concepts, and ideas of a given study. The role of a CF is to integrate the relationship between the context, theory, and the various aspects of a given research study, and explain why a specific topic is both practically and theoretically important (Ravitch and Carl, 2019). The application of CFs relies on researchers either using established frameworks or combining or modifying existing ones. This paper aims to identify the CFs applied in the examination of interactions and relationships between climate change impacts and fishing communities. Additionally, the study seeks to identify prevailing trends and ongoing debates surrounding these concepts and their application in articles worldwide.

We hypothesize that such CFs are related to perspectives of socio-ecological systems and, thus, integrate natural and social components. Through a systematic literature review, we observed the main associated concepts, gaps, challenges, and trends for further studies. In summary, our paper contributes to the existing body of literature by providing a comprehensive overview of frameworks and concepts applied in the study of climate change impacts on fishing communities. It serves as a valuable resource for researchers, policymakers, and stakeholders interested in improving their understanding of this critical issue and working towards sustainable solutions.

2. Methodology

2.1. Literature review

First, we identified papers using CAPES (High-Education Personnel Improvement Coordination)[1] and Google Scholar electronic databases. The following keywords were used in combination: i. “climate change”, ii. “conceptual framework” or “framework”, and iii. “fishing communities” or “fisheries communities”. The literature search was finalized on November 18, 2021. The decision to include or exclude studies in the literature review was determined according to specific criteria (Table 1), among which were the criteria that all papers included had to contain all three terms in either the title, abstract, and/or keywords, have been published between 2011 and 2021, and be peer-reviewed. Papers from journals that are not peer-reviewed, and grey literature, conference proceedings, book chapters, and editorial letters were excluded.

The process used to select relevant literature is presented in Fig. 1. A total of 14,821 records were found (1315 from the CAPES database and 13,506 from Google Scholar). A total of 14,760 works were excluded as they did not fit the search criteria, i.e., they were either non-peer-reviewed, grey literature, conference proceedings, book chapters, editorial letters, or papers that did not contain the three searched terms in the title, abstract, or keywords, or were papers that had not published between 2011 and 2021. This left a total of only 61 articles. However, among these were 27 duplicated articles, therefore after removing these, we were left with a total of 34 articles to read.

Table 1
Inclusion and Exclusion selection criteria for literature review.

Criteria	Decision
Academic papers	Included
Papers must contain three terms searched in full in the title, abstract, or keywords	Included
Papers must have been published between 2011 and 2021	Included
Papers must have been peer-reviewed for publication	Included
Papers must have been written in English	Included
Duplicated papers	Excluded
Grey literature, conference proceedings, book chapters, and editorial letters	Excluded

2.2. Synthesis and analysis phases

In this phase, the selected articles were downloaded and organized in the *Mendeley* software. Next, data were exported to the *VOSviewer* software to demonstrate bibliometric relations among publications (Einecker and Kirby, 2020). VOSviewer applies similarity measure known as the association strength to analyze the co-occurrence of keywords within a set of articles. It calculates co-occurrence frequencies, association strengths, and co-occurrence networks to identify prominent research themes and the relationships between different keywords (van Eck and Waltman, 2010).

A co-occurrence analysis was used to create links between words. Lines-related terms and thicker lines represent a more robust link. For *VOSviewer,* association strength is “a proportion of total co-occurrences between items to the expected total co-occurrences between those items, assuming they are statistically independent” (Van Eck et al., 2010). Furthermore, data were extracted from the selected articles using pre-determined criteria and categories specified to enable comparison among approaches. These criteria and categories were used to summarize information from the selected articles, and they were defined based on Mengist et al. (2020). Relevant data were organized in a database, and descriptive statistics were used.

For analysis of the articles, nine criteria were applied: i. year of publication, ii. name of journal, iii. study site, iv. types of data source, v. the study site scale, vi. conceptual frameworks applied, vii. concepts, components or dimensions, viii. challenges and difficulties mentioned, and ix. gender approach (Table 2).

3. Results

3.1. Overview of selected articles

Application of the search criteria outlined in the previous section resulted in a total of 34 articles published between 2011 and 2021. Fig. 2 illustrates these results according to their (a) year of publication, (b) continent of the author’s institution, (c) scale of the study site, and, (d) study site location.

Given that none of the selected studies were published in 2011, we began by examining the percentage of publications starting in the year 2012. Fig. 2a shows the percentage of selected papers in frameworks to assess the impacts of climate change in fishing communities between 2012 and 2021. Although the rate of publications decreased between 2014 and 2016, the graph shows a slightly increasing tendency of

[1] CAPES database is one of the most significant scientific databases in Brazil, which includes 455 diverse kinds of databases, such as references and patents, and it is signed with international publishers (SCOPUS, Web of Science, DOAJ, and more).

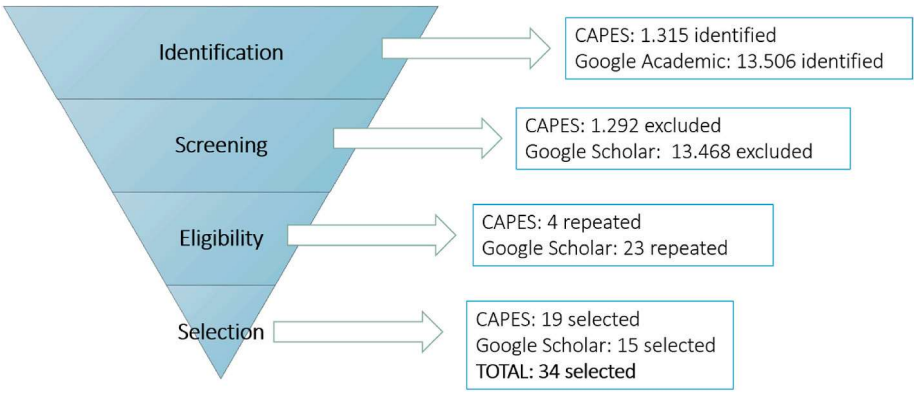

Fig. 1. Methodological approach for selecting papers.

Table 2
Criteria and categories used for information extraction from the selected articles.

No	Criteria	Categories considered	Justification
1	Year of publication	<year>	Only studies between 2011 and 2021 were considered
2	Name of journal	<name>	To describe the geographical distribution of articles
3	Study site	<continent>	Geographical reach
4	Types of data sources (Mengist et al., 2020)	Primary data	Data derived from sampling in the field (e.g., surveys, field data)
		Secondary data	Data derived from other sources or databases, and not verified in the field (e.g., remote-sensed data, socioeconomic data)
		Mixed data	Database, bibliography, modeling, surveys, and field data
5	The study site scale(Martínez-Harms and Balvanera, 2012)	Patch	10–10^2 km^2
		Local	10^2–10^3 km^2
		Regional	10^3–10^5 km^2
		National	10^5–10^6 km^2
		Global	>$10^6$$km^2$
6	Conceptual framework applied	<Name>	Conceptual frameworks used to develop the study
7	Concepts, components, or dimensions	<terms>	Key concepts used in the study
8	Challenges and difficulties mentioned	Data	Availability and quality of data sources that challenged the study
		Communication and access	Difficulties in communication and access to the communities
		Methods	Barriers mentioned about the methodological approach (e.g., lack of statistical representativeness)
		Others	General barriers mentioned in the study (e.g., how to codify qualitative data for a quantitative assessment)
		None	No challenge was mentioned in the study
9	Gender approach	Presence or absence of gender perspective	The publication included at least one result, variable, or data disaggregated by sex

articles overall. The number of articles reached a peak in 2020 and might be related to the pandemic, as many researchers had reduced access to fieldwork, and stayed at home, thereby creating a favorable environment to write papers.[2]

Most of the papers selected were published in North America (35%), followed by Asia (24%) and Europe (18%; Fig. 2b). When examining scientific production from a Global North and Global South perspective, it is noteworthy that 59% of the identified studies originate from institutions located in the Global North, while the remaining 41% come from the Global South.[3] This distribution indicates a predominant concentration of research output in the Global North, highlighting potential disparities in research capacity and resource allocation between these two regions.

Patch scales were the most used scale in the studies (26%), followed by regional scales (24%), and local scales (23%), with far fewer studies, carried out at national or global scales (Fig. 2c). For the most part, studies were conducted at the community level and involved small-scale fisher and indigenous communities. The most common study site locations for articles included in the systematic review are in Asia (26%), followed by North America and Central and South America. It is important to note that although Europe ranks third in terms of institutions producing articles on this issue, it is in sixth position when it comes to study location. Africa, on the other hand, contributes to only 6% of the articles produced, but accounts for nine percent of the study locations.

It is worth highlighting the disparity between the geographic distribution of institutions conducting research and the actual study locations. This imbalance suggests, for example, that although European institutions are actively engaged in producing articles on the topic, the focus of their studies may be primarily based on locations outside of Europe. Conversely, Africa contributes a smaller percentage of articles, but a higher proportion of the research is conducted within the continent.

Primary data were the type of data more commonly used (38%), compared to secondary data (32%) and mixed data (29%). Papers based on primary data mainly made use of interviews and respondent surveys. Articles that used secondary data were based on climate data, census data, model projections, and literature reviews. Papers that used mixed data applied interviews with communities and crossed the findings with previously collected data, such as grey documents, national, regional, and local assessments in fishing and climate fields, interviews, and model projections. Primary data were the most common source of data in the studies and included interviews and field observations.

[2] How a torrent of COVID science changed research publishing — in seven charts. https://www.nature.com/articles/d41586-020-03564-y.

[3] The term was used to identify countries in the regions of Latin America, Africa, Asia and Oceania (not including Australia).

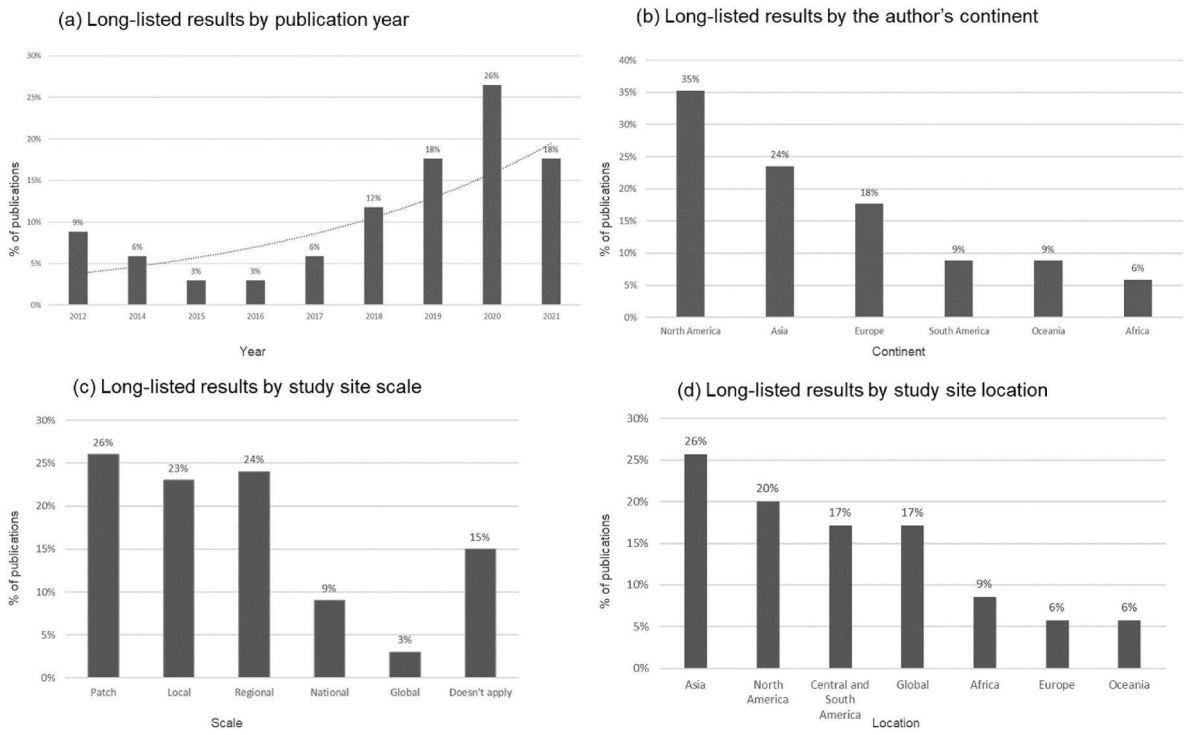

Fig. 2. Summary of long-listed results by (a) publication year, (b) continent of author's institution, (c) study site scale, and (d) study site location.

3.2. *Conceptual framework and key concepts*

To identify the patterns and relationships among the included articles, we conducted a statistical analysis of similarity using the *VOSviewer* software (Fig. 3). VOSviewer applies statistical algorithms to calculate various measures of similarity and generated visual representations of the bibliographic relationships (van Eck and Waltman, 2010). These results allowed us to identify research clusters and emerging themes within the literature.

We ignored the analysis of the search terms, given that the software always considers only the most frequent term, name of the study area, and name of studied species. The closer the terms, the higher the

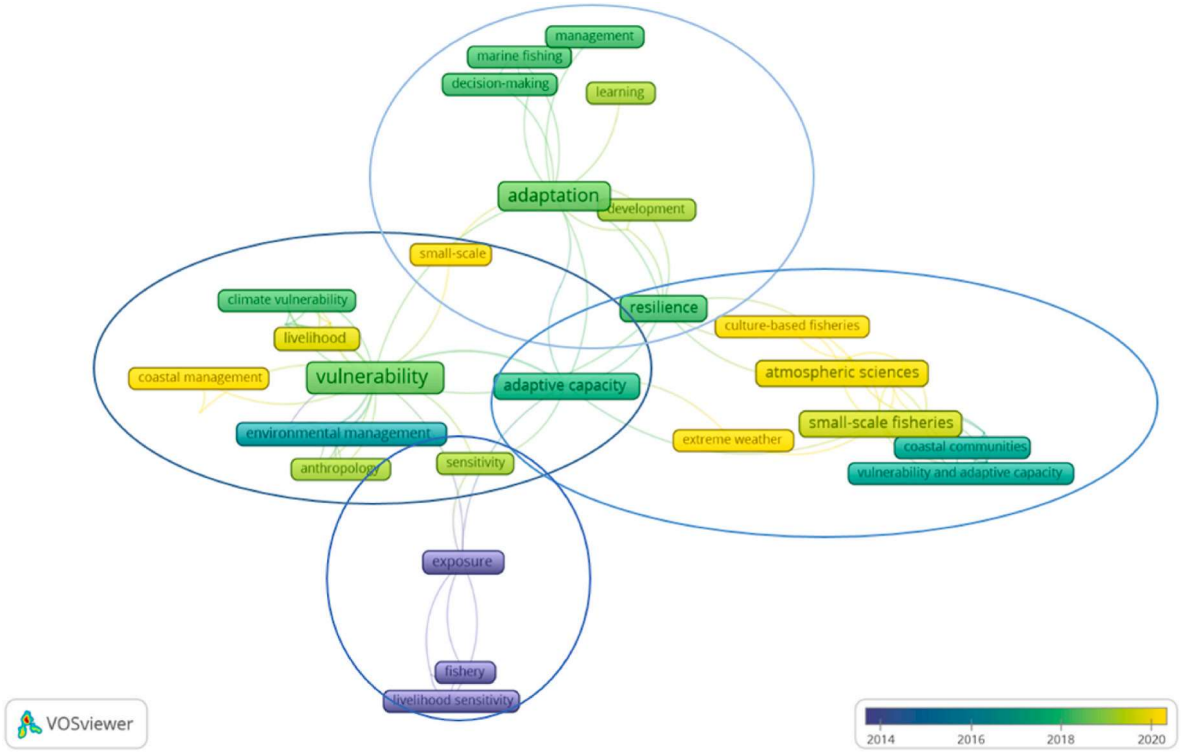

Fig. 3. Scientific network mapping of the most used terms in the selected papers. Colors indicate the year in which each keyword was used. Lines represent co-occurrence link strength among terms. The size of the frames is proportional to the frequency of appearance.

indication of co-occurrence between them. Thus, to interpret the clusters, we assessed the most closely associated keywords and the largest nodes, given that the size of the nodes reflects the frequency of appearance.

By analyzing the co-occurrence patterns of these keywords, we gain insights into the relationships and trends within the research area. This mapping allows us to identify the key concepts that researchers have been focusing on and how they are interconnected. Furthermore, by considering the most recent applications, we can identify emerging themes and areas of active research.

After analyzing the network map of the co-occurrence terms and clusters, we identified four major groups with relevant keywords. In the first group, we identified the term "vulnerability" to be the central concept, and observed that it is connected to other terms, such as "coastal management", "anthropology" and "adaptive capacity". In the second group, we identified "adaptation" to be the central concept and noted that it is connected to "decision-making", "development", and "resilience", among others. In the third group, we identified "small-scale fisheries" and "atmospheric sciences" to be the central concepts and noted that they are linked to, "resilience", "adaptive capacity" and "culture-based fisheries", among others. The latter group included the most recent terms applied in the literature. In the fourth group, we identified "exposure" to be the central concept and noted that it is linked to "sensitivity", "fishery", and "livelihood sensitivity". "Adaptive capacity" was found to be the term that connects all the identified groups.

Concerning frameworks, we identified three groups from our analysis of articles. Fundamentally, these groups were formed by the similarity of either components or approaches (Table 3). The "Local knowledge" group represented 8,82% of the analyzed articles and included frameworks that aimed to understand the perceptions of local fishing communities surrounding climate change impacts. The "Vulnerability" group represented 35,29% of the analyzed articles and included frameworks that aimed to assess vulnerability in either fishing communities or around fishing resources and infrastructure. Finally, the "Adaptation and Resilience" group represented 23,52% of the analyzed articles and included frameworks to assess how fishing communities experience and respond to change.

A portion of the articles (11.7%) did not fit into any specific group due to their unique approaches and components. These studies introduced alternative frameworks that shed light on specific aspects of climate change and fishing communities. For instance, Clausen and Longo (2012) employed "The Tragedy of the Commodity" framework to analyze the influence of genetically engineered salmon on the dynamics of salmon ecology in the United States, focusing on the role of capitalist market forces. Tulone et al. (2020), on the other hand, utilized the Conceptual Framework of Willingness to Pay to investigate the motivation and willingness of inhabitants in a Sicilian fishing community to pay for mitigating the impacts of climate change on fish resources. Additionally, Miller et al. (2020) presented a Participatory Impact Assessment (PIA) Framework, which evaluated the outcomes of a community-led conservation initiative aimed at managing a mud crab fishery in West Kalimantan, Indonesia. These studies demonstrate the diversity of frameworks applied in understanding and addressing climate change impacts on fishing communities.

Table 3 provides an overview of the CFs groups identified in the study, along with the key components of each group. It also includes the frameworks that were applied in selected articles, along with their corresponding references.

Table 3
Groups of frameworks and components were identified in the study.

Group	Major Components	Frameworks	Reference
Local knowledge	Climate change impacts; Perception about the impacts; Livelihood characteristics	Cultural consensus framework	Carothers et al. (2014)
		Ethno-oceanographic framework	Martins and Gasalla (2018)
Vulnerability	Vulnerability; Exposure; Adaptive Capacity; Sensitivity	Livelihood Vulnerability Index (LVI)	Chen et al. (2014) Sadekin et al. (2018)
		Vulnerability Index	Himes-Cornel and Kasperski (2015) Blasiak et al. (2017)
		Framework to Calculate Socio-economic Vulnerability	Tull et al. (2016)
		Sustainable Livelihood Approach (SLA) framework	Muringai et al. (2019)
		United Nations IPCC Vulnerability Framework	Hoang et al. (2020) Bhashani et al., 2021
		Social Vulnerability Framework	Martins et al. (2019) Martins and Gasalla (2020)
		Climate Vulnerability Assessments (CVAs)	Pinnegar et al. (2019) Dudley et al. (2021)
		Coastal Infrastructure Vulnerability Index (CIVI)	Greenan et al. (2019)
		Indicator-based Vulnerability Assessment Framework	Huynh et al. (2021)
Adaptation and Resilience	Adaptive Capacity (Diversity and Flexibility; Access to assets; Learning and Knowledge; Governance and Institutions; Agency)	Local Adaptation Framework	Nambi and Bahinipati (2012)
		Framework to Investigate Drivers of Adaptation Decisions in Marine Fishing	Malakar et al. (2018)
		Resilience-based Conceptual Framework	Galappaththi et al. (2019a,b) Galappaththi et al. (2020)
		Adaptive Capacity Framework	Turner et al. (2020)
		Framework Social Adaptive Capacity	Wongbusarakum et al. (2021)
		Adapt, React, Cope Framework	Green et al. (2021)

3.3. Challenges and gender approach

A significant majority of the selected articles (62%) highlighted various challenges or barriers encountered in their research endeavors, as illustrated in Fig. 4. Among these challenges, 29% of the articles specifically mentioned difficulties related to accessing data, the lack of data availability, or issues pertaining to data quality. In terms of research methods, 12% of the articles indicated encountering barriers, while 9% identified challenges in effectively communicating with or gaining access to the target communities.

The gender approach was presented in 35,29% of the analyzed articles, either as a variable, component, or the presence of data disaggregated by sex. Women play an important role in both the fisheries production chain and in food security. However, studies did not include a fair representation of women among the interviewed. For example, there was a study that evaluated community adaptation options without interviewing any women (Nambi and Bahinipati, 2012). Difficulties in accessing women for interviews were also indicated, given cultural differences associated with gender roles (Wongbusarakum et al., 2021).

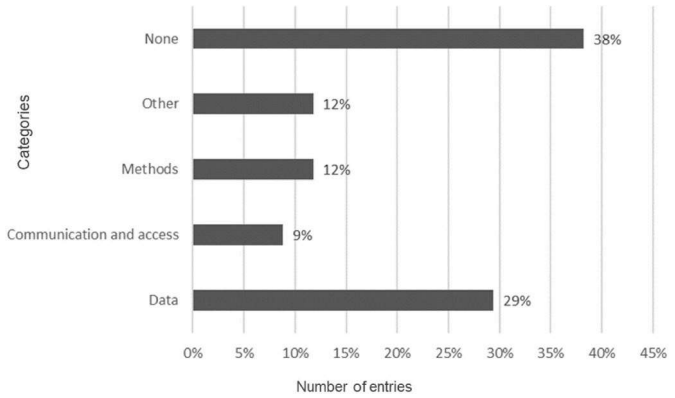

Fig. 4. Difficulties or barriers were mentioned in the selected studies.

4. Discussion

This review highlights an important observation regarding the geographic distribution of authors and institutions conducting research on climate change impacts in fishing communities. The majority of existing articles on this topic are produced by authors from institutions in the Global North. This could be attributed to either lower academic production in the Global South on this specific topic or the possibility that perspectives from the Global South are more prevalent in other types of academic sources such as books, reports, or grey literature.

It is also important to consider the disparity between the geographic distribution of institutions conducting research and the actual study locations. As mentioned by Kane and Boulle (2018), it is essential to move beyond the Global South being solely a source of data, empirical work, or case studies, and instead focus on incorporating perspectives and theorizations from these regions. Connell (2014) emphasizes the role of the periphery in supplying data and applying knowledge, while the metropole's role involves processing data, developing theory, and exporting applications to the periphery.

Therefore, fostering collaborations and knowledge-sharing among institutions from the Global South can improve South-South dialogues and enhance the understanding of indigenous knowledge. By embracing a more inclusive and collaborative approach to research, we can bridge the gap between different regions and ensure that knowledge production and theorization are not confined to a specific geographic location.

Concerning conceptual frameworks (CF), this study identified three main CF groups to understand the relationships between fishing communities and climate change impacts: "Local knowledge frameworks", "Vulnerability frameworks" and "Adaptation and Resilience frameworks". CFs provide systematic approaches to support and interpret complex environmental issues by demonstrating either links or relationships between their components (Ravitch and Carl, 2019).

A general conceptual framework was created to describe "Local knowledge frameworks" (Fig. 5). In this CF, climate impacts are initially identified by either consulting community members or through a literature review. Next, the livelihood characteristics, which are identified from previous literature, local archives, or field observations, are evaluated. Finally, surveys are developed and applied within the community to collect local perceptions and knowledge of climate impacts or responses. Both results and the available observed data may influence policies, such as management options or the creation of adaptation plans. For example, Martins and Gasalla (2018) used available scientific data to compare perceptions among small-scale fishers in seven locations in Southeastern Brazil and identify climate impacts. The authors found that fishers identified reduced rainfall and, consequently, increased droughts that were explained by recent scientific observations surrounding the rainfall deficit in the state of São Paulo. These identified impacts can support coastal management and the development of local adaptation plans.

The second CF group identified was "Vulnerability frameworks" (Fig. 6) and was the most present in the literature review. Concerning climate change, the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports describe vulnerability as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC et al., 2007) and "the propensity or predisposition to be adversely affected encompassing a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC and Field, 2014). Within these definitions, it is possible to identify the key components of vulnerability, i.e.: exposure, sensitivity, and adaptive capacity (Adger, 2006). In this sense, vulnerability can be considered the sum of exposure and sensitivity variables minus adaptive capacity variables.

The articles included in this group have applied the "Vulnerability Framework" in various assessments, demonstrating its versatility and applicability in understanding climate change impacts on fishing communities. For instance, Chen et al. (2014) developed a Livelihood Vulnerability Index (LVI) to identify and measure drivers of vulnerability among sea urchin fishermen in California for a more comprehensive socioeconomic impact analysis for a better marine spatial planning. Blasiak et al. (2017) utilized the IPCC framework to calculate a vulnerability index for 147 countries based on the impacts of climate change on marine fisheries. Their findings highlight the high vulnerability of Small Island Developing States and several African countries.

On the other hand, Martins et al. (2019) employed a standardized vulnerability framework to compare the vulnerability of small-scale fishing communities under climate change pressures in South Africa

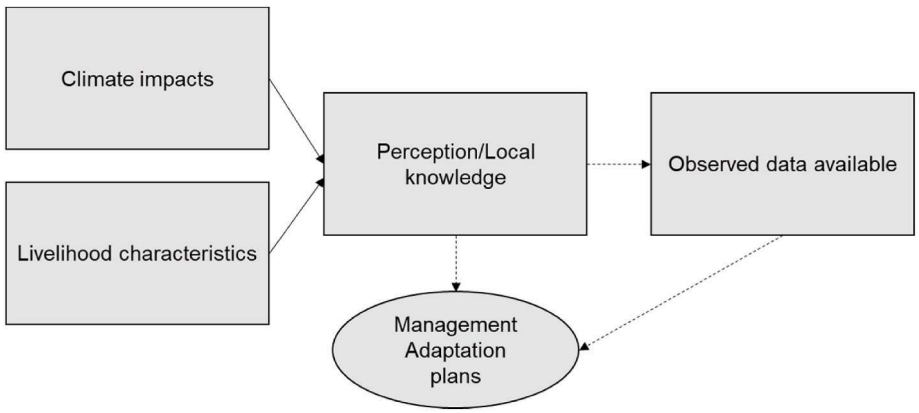

Fig. 5. "Local knowledge framework" based on the studies of Carothers et al. (2014) and Martins and Gasalla (2018), which aimed to analyze the perceptions of climate change impacts among fishing communities.

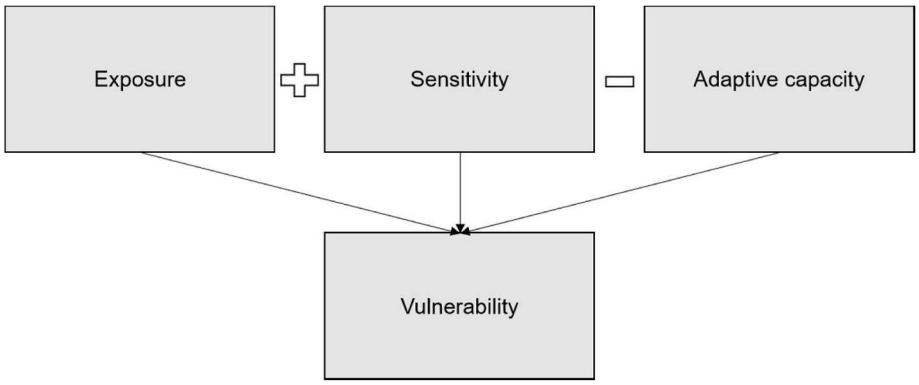

Fig. 6. "Vulnerability framework" based on Adger (2006).

and Brazil. Their study revealed that in Brazil, high dependence on fishing and attachment to place increased vulnerability, while in South Africa, strong reliance on markets for food procurement posed threats to food security among fishers. In summary, the vulnerability framework applications range from developing vulnerability indices and measuring drivers of vulnerability to comparing vulnerabilities between different regions. By considering multiple dimensions of vulnerability, including adaptive capacity, the framework offers insights that can inform targeted interventions, policy development, and adaptive strategies to enhance the well-being of fishing communities in the face of climate change.

The third CF group was interpreted as "Adaptation and Resilience frameworks" (Fig. 6). The articles included in this group aimed to either understand how fishing communities respond to climate change impacts or to identify or propose adaptation options. Moreover, the articles in this group all included the common concept of "Adaptive capacity". Here, we identified three common reference articles cited among articles in this CF group: Cinner et al. (2015; 2018) and Galappaththi et al. (2019a).

Cinner et al. (2015) examined the variation of adaptive capacity indicators in Kenyan fishing communities and found that community infrastructure and credit availability influenced climate change responses. In a separate article, Cinner et al. (2018), proposed five domains to build adaptive capacity in tropical coastal communities, "the assets that people can draw upon in times of need; the flexibility to change strategies; the ability to organize and act collectively; learning to recognize and respond to change; and the agency to determine whether to change or not" (p. 1). Galappaththi et al. (2019a) went a step further and developed a framework that integrates these five domains of adaptive capacity and resilience.

Fig. 7 provides a visual representation of the "adaptation and resilience" framework. This framework acknowledges that both climatic and non-climatic stressors have an impact on fishing communities, thereby influencing their adaptive capacities at the household level. The framework incorporates five key domains proposed by Cinner et al. (2018): "agency", "learning and knowledge", "access to assets", "governance and institutions", and "diversity and flexibility". These domains collectively shape the adaptive response of fishing communities to various stressors.

Within this framework, there are three distinct adaptive responses depending on the nature of the impact and its effect on adaptive capacity. The first response is coping, which involves passively accepting the consequences of an environmental stressor (Bennett et al., 2014). Coping mechanisms are typically reactive and may not lead to long-term solutions. The second response is adaptation, which refers to the proactive planning of individual or collective actions based on knowledge of past or anticipated future environmental changes (Bennett et al., 2014). Adaptation strategies aim to increase the resilience of fishing communities by enabling them to respond effectively to changing conditions.

The third response is transformation, which represents a radical action of resilience that goes beyond adapting to specific shocks. Transformation involves creating changes in power structures, social and economic behaviors, and redefining drivers of risk and vulnerability, irrespective of specific shocks (Bahadur et al., 2016; Galappaththi et al.,

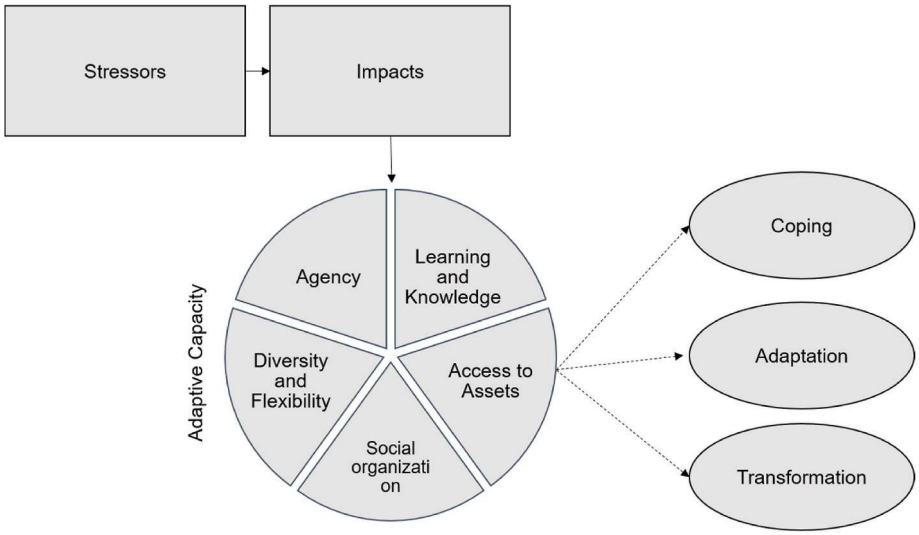

Fig. 7. "Adaptation and Resilience framework" based on Cinner et al. (2018), Galappaththi et al. (2019a), and Green et al. (2021).

2019a). By incorporating these three adaptive responses within the framework, Fig. 7 provides a comprehensive understanding of how fishing communities can navigate and respond to climate and non-climate stressors. It highlights the importance of building adaptive capacities, adopting proactive measures, and fostering transformational changes to enhance the resilience of these communities in the face of environmental challenges.

As illustrates Figs. 6 and 7, adaptive capacity is a crucial concept within the "Vulnerability framework" and "Adaptation and Resilience framework" when assessing the impacts of climate change on fishing communities. In Fig. 3, the scientific network mapping shows that the term connects all the identified groups.

Within the "Vulnerability framework", adaptive capacity is a key component in determining the ability of a system or community to adjust, learn, and respond effectively to changing conditions and disturbances (Adger, 2006; Chen et al., 2014; Martins et al., 2019). It recognizes that not all communities have the same ability to cope with or adapt to changes. Communities with higher adaptive capacity are better equipped to anticipate, absorb, and recover from the impacts of climate change (Cinner et al., 2015). Factors influencing adaptive capacity can include social, economic, institutional, and technological resources, as well as governance structures and access to information (Chen et al., 2014; Cinner et al., 2018; Martins and Gasalla, 2020).

In the "Adaptation and Resilience framework", adaptive capacity plays a central role in understanding the capacity of a system to persist, adapt, and transform in the face of disturbances (Folke, 2006). It encompasses the ability of a system to maintain its essential functions, absorb shocks, and reorganize in response to change. Adaptive capacity is crucial in building resilience, as it enables communities to adjust their practices, institutions, and strategies to reduce vulnerability and enhance their ability to cope with and recover from climate change impacts.

The application of adaptive capacity within both frameworks emphasizes the importance of considering the socio-ecological dimensions of vulnerability and resilience. By understanding and enhancing adaptive capacity, policymakers and stakeholders can identify measures to support communities in building resilience and reducing vulnerability to climate change (Engle, 2011). This may involve interventions such as improving access to resources, strengthening social networks, enhancing education and awareness, fostering participatory decision-making process, and promoting sustainable livelihood practices.

The three CF groups identified are applied in studies with different purposes. Although all of them include data collection via interviews in their methodologies, they do so with different objectives. The "Local knowledge" framework is mainly interested in examining fishing-dependent community perceptions from an anthropological perspective and corroborating these with scientific findings. The "Vulnerability" framework seeks to understand community exposure, sensitivity, and adaptive capacities to determine their degree of vulnerability. To that end, this CF uses both secondary data sources and interviews to validate and understand results. Finally, the "Adaptation and Resilience" framework aims to understand how communities adapt to climate change and how they maintain their resilience. This approach uses primary data to understand community adaptation capacities.

All the CF groups identified included examples of gender perspectives, either through disaggregated data collected between men and women or through the inclusion of variables that measured gender differences. For example, in the "Local knowledge framework", Carothers et al. (2014) included data disaggregated by sex to document local observations of climate change and its impacts on fishing communities in three communities in Alaska. In the "Vulnerability framework", Sadekin et al. (2018) developed a livelihood vulnerability index to assess the climate vulnerability status of small-scale fishing communities and included the variable "percentage of households where women family members are not allowed to work outside the house" as one of the unique sub-components of the socio-demographic profile of fishing communities in Malaysia. Pinnegar et al. (2019) conducted a Climate Vulnerability Assessment (CVA) on the small island of Dominica and reflected on the relationship between poverty and women in fisheries and highlighted that adaptive capacity differed by gender.

In the "Adaptation and Resilience frameworks", Galappaththi et al. (2019a) included "perceptions, equality, and gender roles" as measures of human agency to assess community adaptation to climate change in fishing communities. In a subsequent study of an indigenous community in Sri Lanka, Galappaththi et al. (2020) adopted the term "fisherwomen" and identified set gender roles among Coastal-Vedda fishers. For example, women are not directly involved in commercial activities, but rather are responsible for subsistence aquaculture. Green et al. (2021) conducted a global meta-analysis of adaptive capacity metrics to understand how they translate to human responses in small-scale fishing communities. They highlighted that women represent key linkages between fisheries and food security, however, adaptation measures that consider gender equity has not been widely documented. Thus, these examples highlight that it is possible to include gender perspectives in the CF groups identified.

For gaps and challenges, both the absence and quality of secondary data were expressive in the analyzed articles. According to Himer-Cornell et al. (2015), there is a lack of adequate subsistence data at the community level. Moreover, some papers identified that there is limited data available (Tull et al., 2016; Pinnegar et al., 2019; Miller et al., 2020) and others showed that there is variation in data quality (Blasiak et al., 2017). Part of the main secondary data sources identified in these studies was collected at the national level, for example, from censuses and climate forecasts. However, data and information management capacities were perceived as challenges at the national level (Turner et al., 2020). For example, an institutional crisis in the Brazilian fishing sector resulted in a cessation of relevant statistical data collected by the federal government (Martins et al., 2019). Thus, through this review, we identified the need to strengthen fishing statistics data, socioeconomic and livelihood datasets among fishing communities, and climate forecast data, and to improve data management to develop more precise studies.

Most of the studies reviewed here were based on primary datasets (e.g., data collected from interviews, focus group discussions, etc.), which represents another significant challenge: the risk of misinterpreting local knowledge as a result of language and cultural barriers (Carothers et al., 2014; Galappaththi et al., 2020). For example, Carothers et al. (2014) cited difficulties associated with identifying local experts who hold valuable knowledge about climate conditions. Additionally, several studies (Nambi and Bahinipati, 2012; Shemdoe and Jacob, 2012; Wongbusarakum et al., 2021) cited that they faced difficulties in recruiting women to interview due to locally perceived gendering of fisheries activities. Consequently, these challenges result in a lack of representation of women's knowledge about climate change impacts and responses in fishing communities. Nevertheless, recent studies applying the "Adaptation and resilience frameworks" have explored components, such as "agency" (e.g., the ability of people to have free choice in responding to environmental change), that require both an understanding of gender roles in fishing communities and the differentiated impacts among women, men, youth and elderly people. Thus, we argue that future studies should seek to be more inclusive when analyzing adaptive capacity and adaptation in fishing communities.

One of the limitations of our study is the search strategy employed, while extensive, could have potentially missed relevant studies, thereby limiting the comprehensiveness of our review. As this is a systematic review, we employed specific keywords that may have restricted the accessibility and scope of the articles that we were able to review. However, we understand that such limitations are inherent to the nature of the process. Furthermore, our review focused exclusively on studies published in English, which might have resulted in the exclusion of valuable research published in other languages.

5. Conclusions and implications of this study

Here, we identified three main Conceptual Framework (CF) groups applied in studies examining the impacts of climate change in fishing communities. The main objective of the first CF group, "Local knowledge frameworks", is to understand the perceptions of small-scale fisheries communities on the impacts of climate change and, when possible, to cross-reference these perceptions with observed scientific data. The second CF group, "Vulnerability framework", was applied in studies seeking to understand the vulnerability of fishing communities to the impacts of climate change by evaluating the following components: exposure, sensitivity, and adaptive capacity. Finally, the third CF group "Adaptation and Resilience framework" is more aligned with understanding how fishing communities adapt and resist climate change according to the interaction between stressors, impacts, and components of adaptive capacity. Such interactions lead to different adaptive responses from the community. The CFs have different applications, according to the objectives of each given study.

The results demonstrate that adaptive capacity is a fundamental concept in both the vulnerability and resilience frameworks, highlighting the ability of communities to adapt and respond effectively to climate change impacts. By addressing adaptive capacity, stakeholders can work towards enhancing resilience and reducing vulnerability, thus promoting sustainable livelihoods in the face of a changing climate.

Further studies will need to overcome challenges, such as a lack of data and data quality issues from collected socio-economic data related to fishing activities and fishing communities. Despite difficulties when it comes to data production, management, and governance, efforts must be made to better comprehend the impacts of climate change and ecosystem degradation on small-scale fishing communities, including the impacts on their livelihoods and culture.

Another barrier to effectively directing climate change adaptation and mitigation policies towards fishing communities in the Global South is the underrepresentation of studies from this part of the world. It has been observed that there has been an increase in the number of publications examining the relationship between fishing communities and climate change impacts since 2017. However, most of these publications originate from universities or institutes in North America, while Africa remains the least represented region.

To overcome this barrier and ensure a more inclusive perspective, South-South dialogues can play a crucial role. Encouraging collaboration and knowledge-sharing among institutions and researchers in the Global South can help amplify southern perspectives on the issue. By actively engaging researchers from the Global South in the discourse on climate change impacts in fishing communities, we can broaden the scope of research and incorporate diverse voices and experiences.

A possible solution to both the absence of data and lack of quality data is to strengthen and increase financial incentives to improve data collection and management and, subsequently, policies directed toward improving the resilience of small-scale fisheries to climate change, especially, in the Global South. The International Year of Artisanal Fisheries and Aquaculture (IYAFA) 2022 Global Action Plan "advocates for governments to develop a national emergency fund for small-scale artisanal fisheries and aquaculture adaptation and mitigation strategies in case of environmental degradation, shocks, disasters, and climate change" (FAO, 2022). Furthermore, financial mechanisms, such as monetary policy actions, implementation of green fiscal policies, carbon taxes, and subsidies may support the development of data production, management, and governance to mitigate the effects of climate change in fishing communities.

The IYAFA 2022 Global Action Plan presented a pillar called "Resilience: Increase the preparedness and adaptive capacity of small-scale artisanal fisheries and aquaculture to environmental degradation, shocks, disasters, and climate change" (FAO, 2022), which is linked to SGD (Sustainable Development Goal) 13 - Climate Action. This pillar states the need to strengthen the science-policy interface to increase the preparedness and adaptive capacity of small-scale artisanal fishers, fish farmers, and fish workers. One of the indicative activities is the increase of research on the impacts of climate change on small-scale artisanal fisheries and aquaculture to facilitate their response to political, social, and economic changes.

Our paper contributes to identifying an appropriate framework for data collection and the development of instruments to understand the impacts of climate change on fishing communities and their responses. Based on a literature review, this paper identified the key concepts and frameworks that researchers worldwide have applied to that end. Thus, it is possible to know what has been developed by science and which frameworks are most suitable for a particular purpose. CFs provide an overall structure that might lead to the development of new solutions and policies by articulating and examining goals, challenges, and opportunities (Ravitch and Carl, 2019). In other words, the present paper serves as a general guide or starting point to build on and improve frameworks to better understand the impacts of climate change on small-scale fisheries and identify possible pathways and responses.

Our paper makes a significant contribution by identifying an appropriate framework for data collection and the development of instruments to understand the impacts of climate change on fishing communities and their responses. Through a comprehensive literature review, we have identified the key concepts and frameworks that researchers worldwide have applied to address this issue. This enables us to gain insights into the existing scientific developments and identify the most suitable frameworks for specific research purposes.

By providing an overall structure, these frameworks offer a foundation for the development of new solutions and policies. They allow us to articulate and examine the goals, challenges, and opportunities associated with climate change impacts on fishing communities. Drawing on the work of Ravitch and Carl (2019), it is evident that conceptual frameworks (CFs) provide a valuable tool for organizing and guiding research in this field.

In essence, our paper serves as a general guide or starting point for researchers and policymakers to further refine and enhance existing frameworks. It lays the groundwork for better understanding the complex impacts of climate change on small-scale fisheries and identifying potential pathways and responses. By building upon the insights and findings presented in this paper, future studies can contribute to the advancement of knowledge and the development of more effective strategies to address the challenges faced by fishing communities.

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.

Data availability

Data will be made available on request.

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References

Adger, W.N., 2006. Vulnerability. Global Environ. Change 16 (3), 268–281. https://doi.org/10.1016/J.GLOENVCHA.2006.02.006.

Bahadur, A., Lovell, E., Pichon, F., 2016. Effectiveness in building resilience: synthesis report for oxfam's resilience outcome area. Oxfam Int. 80.

Barange, M., et al., 2018. Impacts of Climate Change on Fisheries and Aquaculture: Synthesis of Current Knowledge, Adaptation and Mitigation Options. Food and

Agriculture Organisation of the United Nations, Rome, Italy, p. 628. FAO Technical Report No. 627.
Bennett, N.J., Dearden, P., Murray, G., Kadfak, A., 2014. The capacity to adapt? Communities in a changing climate,environment, and economy on the northern Andaman coast of Thailand. Ecol. Soc. 19 (2).
Bhashani, N.S.M., Islam, R., Ali, J., Ghani, A.B.A., 2021. Assessing the impact of climate change on small-scale fisheries livelihood vulnerability index. Acad. Strat. Manag. J. 20 (4), 1–13.
Blasiak, R., Spijkers, J., Tokunaga, K., Pittman, J., Yagi, N., Österblom, H., 2017. Climate change and marine fisheries: least developed countries top global index of vulnerability. PLoS One 12 (6). https://doi.org/10.1371/JOURNAL.PONE.0179632.
Brander, K., 2010. Impacts of climate change on fisheries. J. Mar. Syst. 79 (3–4), 389–402. https://doi.org/10.1016/j.jmarsys.2008.12.015.
Carothers, C., Brown, C., Moerlein, K.J., López, J., Andersen, D.B., Carothers, C., Brown, C., Moerlein, K.J., Andrés López, J., Andersen, D.B., Retherford, B., 2014. Measuring perceptions of climate change in northern Alaska: pairing ethnography with cultural consensus analysis. Ecol. Soc. 19 (4), 2014. https://doi.org/10.5751/ES-06913-190427. Published Online: Nov 06.
Chen, C., López-Carr, D., Walker, B.L.E., 2014. A framework to assess the vulnerability of California commercial sea urchin fishermen to the impact of MPAs under climate change. Geojournal 79 (6), 755–773. https://doi.org/10.1007/S10708-014-9543-0, 2014 79:6.
Cinner, J.E., Adger, W.N., Allison, E.H., Barnes, M.L., Brown, K., Cohen, P.J., et al., 2018. Building adaptive capacity to climate change in tropical coastal communities. Nat. Clim. Change 8 (2), 117–123. https://doi.org/10.1038/s41558-017-0065-x.
Cinner, J.E., Huchery, C., Hicks, C.C., Daw, T.M., Marshall, N., Wamukota, A., Allison, E. H., 2015. Changes in adaptive capacity of Kenyan fishing communities. Nat. Clim. Change 5 (9), 872–876. https://doi.org/10.1038/nclimate2690, 2015 5:9.
Clausen, R., Longo, S.B., 2012. The Tragedy of the commodity and the farce of AquAdvantage salmon®. Dev. Change 43 (1), 229–251. https://doi.org/10.1111/J.1467-7660.2011.01747.X.
Connell, R., 2014. Using southern theory: decolonizing social thought in theory, research and application. Plann. Theor. 13 (2), 210–223. https://doi.org/10.1177/1473095213499216.
Dudley, P.N., Rogers, T.L., Morales, M.M., Stoltz, A.D., Sheridan, C.J., Beulke, A.K., Pomeroy, C., Carr, M.H., 2021. A more comprehensive climate vulnerability assessment framework for fisheries social-ecological systems. Front. Mar. Sci. 8, 674. https://doi.org/10.3389/FMARS.2021.678099/BIBTEX.
Einecker, R., Kirby, A., 2020. Climate change: a bibliometric study of adaptation, mitigation and resilience. Sustainability 12, 6935. https://doi.org/10.3390/su12176935.
Engle, N.L., 2011. Adaptive capacity and its assessment. Global Environ. Change 21, 647–656. https://doi.org/10.1016/j.gloenvcha.2011.01.019.
FAO, 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the Sustainable Development Goals. Food and Agriculture Organisation of the United Nations, Rome, p. 211.
FAO, 2022. International year of artisanal fisheries and aquaculture 2022 global action plan. Available in: https://www.fao.org/artisanal-fisheries-aquaculture-2022/home/en/. Accessed in June, 2022.
Folke, C., 2006. Resilience: the emergence of a perspective for social–ecological systems analyses. Global Environ. Change 16, 253–267.
Galappaththi, E.K., Ford, J.D., Bennett, E.M., 2019a. A framework for assessing community adaptation to climate change in a fisheries context. Environ. Sci. Pol. 92, 17–26. https://doi.org/10.1016/J.ENVSCI.2018.11.005.
Galappaththi, E.K., Ford, J.D., Bennett, E.M., Berkes, F., 2019b. Climate change and community fisheries in the arctic: a case study from Pangnirtung, Canada. J. Environ. Manag. 250, 109534 https://doi.org/10.1016/J.JENVMAN.2019.109534.
Galappaththi, E.K., Ford, J.D., Bennett, E.M., 2020. Climate change and adaptation to social-ecological change: the case of indigenous people and culture-based fisheries in Sri Lanka. Climatic Change 162 (2), 279–300. https://doi.org/10.1007/S10584-020-02716-3, 2020 162:2.
Green, K.M., Selgrath, J.C., Frawley, T.H., Oestreich, W.K., Mansfield, E.J., Urteaga, J., Swanson, S.S., Santana, F.N., Green, S.J., Naggea, J., Crowder, L.B., 2021. How adaptive capacity shapes the Adapt, React, Cope response to climate impacts: insights from small-scale fisheries. Climatic Change 164 (1), 1–22. https://doi.org/10.1007/S10584-021-02965-W, 2021 164:1.
Greenan, B.J.W., Shackell, N.L., Ferguson, K., Greyson, P., Cogswell, A., Brickman, D., Wang, Z., Cook, A., Brennan, C.E., Saba, V.S., 2019. Climate change vulnerability of American lobster fishing communities in atlantic Canada. Front. Mar. Sci. 6, 579. https://doi.org/10.3389/FMARS.2019.00579/BIBTEX.
Himes-Cornell, A., Kasperski, S., 2015. Assessing climate change vulnerability in Alaska's fishing communities. Fish. Res. 162, 1–11. https://doi.org/10.1016/J.FISHRES.2014.09.010.
Hoang, H.D., Momtaz, S., Schreider, M., 2020. Assessing the vulnerability of small-scale fishery communities in the estuarine areas of Central Vietnam in the context of increasing climate risks. Ocean Coast Manag. 196, 105302 https://doi.org/10.1016/J.OCECOAMAN.2020.105302.
Huynh, P.T.A., Le, N.D., Le, S.T.H., Nguyen, H.X., 2021. Vulnerability of fishery-based livelihoods to climate change in coastal communities in central Vietnam. Coast. Manag. 49 (3), 275–292. https://doi.org/10.1080/08920753.2021.1899927.
IPCC, 2007. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds.), Climate Change 2007: Impacts, Adaptation and vulnerability. Contribution ofWorking Group II to the Fourth Assessment Report of the Intergovernmental Panel on ClimateChange. Cambridge University Press, Cambridge, UK, p. 976.
IPCC, 2014. Summary for policymakers in. In: Field, C.B. (Ed.), Climate Change 2014: Impacts, Adaptation, andVulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to theFifth Assessment Report of the Intergovernmental Panel on Climate Change, 1–32. Cambridge University Press.290P. T. A. HUYNH ET AL, Cambridge.
Kane, L., Boulle, M., 2018. 'This was different': transferring climate mit- igation knowledge practices south to south with the MAPS pro- gramme. Clim. Pol. 18 (9), 1–12. https://doi.org/10.1080/14693062.2017.1421520.
Koralagama, D., Gupta, J., Pouw, N., 2017. Inclusive development from a gender perspective in small scale fisheries. Curr. Opin. Environ. Sustain. 24, 1–6. https://doi.org/10.1016/J.COSUST.2016.09.002.
Lindegren, M., Brander, K., 2018. Adapting fisheries and their management to climate change: a review of concepts, tools, frameworks, and current progress toward implementation. Rev. Fisheries Sci. Aquacult. 26 (3), 400–415. https://doi.org/10.1080/23308249.2018.1445980.
Malakar, K., Mishra, T., Patwardhan, A., 2018. A framework to investigate drivers of adaptation decisions in marine fishing: evidence from urban, semi-urban and rural communities. Sci. Total Environ. 637–638, 758–770. https://doi.org/10.1016/J.SCITOTENV.2018.04.429.
Martins, I.M., Gasalla, M.A., 2018. Perceptions of climate and ocean change impacting the resources and livelihood of small-scale Fishers in the South Brazil Bight. Climatic Change 147 (3), 441–456. https://doi.org/10.1007/S10584-018-2144-Z, 2018 147:3.
Martins, I.M., Gasalla, M.A., 2020. Adaptive capacity level shapes social vulnerability to climate change of fishing communities in the South Brazil bight. Front. Mar. Sci. 7, 481. https://doi.org/10.3389/FMARS.2020.00481/BIBTEX.
Martins, I.M., Gammage, L.C., Jarre, A., Gasalla, M.A., 2019. Different but similar? Exploring vulnerability to climate change in Brazilian and South African small-scale fishing communities. Hum. Ecol. 47 (4), 515–526. https://doi.org/10.1007/S10745-019-00098-4, 2019 47:4.
Martinez-Harms, M.J., Balvanera, P., 2012. Methods for mapping ecosystem service supply: a review. Int. J. Biodiversity Sci., Ecosyst. Serv. Manag. 8 (1–2), 17–25. https://doi.org/10.1080/21513732.2012.663792/SUPPL_FILE/TBSM_A_663792_SUP_25134876.PDF.
Mengist, W., Soromessa, T., Legese, G., 2020. Method for conducting systematic literature review and meta-analysis for environmental science research. MethodsX 7, 100777. https://doi.org/10.1016/J.MEX.2019.100777.
Miller, A.E., Davenport, A., Chen, S., Hart, C., Gary, D., Fitzpatrick, B., Muflihati, Kartikawati, Sudaryanti, Sagita, N., 2020. Using a participatory impact assessment framework to evaluate a community-led mangrove and fisheries conservation approach in West Kalimantan, Indonesia. People Nat. 2 (4), 1061–1074. https://doi.org/10.1002/PAN3.10133/SUPPINFO.
Muringai, R.T., Naidoo, D., Mafongoya, P., Lottering, S., 2019. The impacts of climate change on the livelihood and food security of small-scale Fishers in lake kariba, Zimbabwe. J. Asian Afr. Stud. 55 (2), 298–313. https://doi.org/10.1177/0021909619875769.
Nambi, A.A., Bahinipati, C.S., 2012. Adaptation to climate change and livelihoods: an integrated case study to assess the vulnerability and adaptation options of the fishing and farming communities of selected east coast stretch of Tamil Nadu, India. RPS/AJEDM-J. Asian J. Environ. Disaster Manag. 19 (3), 297–321. https://doi.org/10.3850/S1793924012001691.
Pinnegar, J.K., Engelhard, G.H., Norris, N.J., Theophille, D., Sebastien, R.D., Hidalgo, M., 2019. Assessing vulnerability and adaptive capacity of the fisheries sector in Dominica: long-term climate change and catastrophic hurricanes. ICES (Int. Counc. Explor. Sea) J. Mar. Sci. 76 (5), 1353–1367. https://doi.org/10.1093/ICESJMS/FSZ052.
Ravitch, S.M., Carl, N.M., 2019. Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological. SAGE Publications, Thousand Oaks, CA.
Sadekin, M.N., Ali, J., Islam, R., 2018. Livelihood vulnerability index: an application to assess the climatic vulnerability status of inland small scale fishing livelihood. Int. J. Sustain. Dev. 21 (1–4), 75–101. https://doi.org/10.1504/IJSD.2018.100826.
Shemdoe, Silas, R., Jacob, K., 2012. Understanding community based adaptation strategies to climate variability in fishing communities of Rufiji River basin in Tanzania. Afr. J. Hist. Cult. 4 (2), 17–26. https://doi.org/10.5897/AJHC11.041.
Townhill, B.L., et al., 2019. Marine recreational fishing and the implications of climate change. Fish Fish. 2 20 (5), 977–992. https://doi.org/10.1111/faf.12392.
Tull, M., Metcalf, S.J., Gray, H., 2016. The economic and social impacts of environmental change on fishing towns and coastal communities: a historical case study of Geraldton, Western Australia. ICES (Int. Counc. Explor. Sea) J. Mar. Sci. 73 (5), 1437–1446. https://doi.org/10.1093/ICESJMS/FSV196.
Tulone, A., Crescimanno, M., Vrontis, D., Galati, A., 2020. Are coastal communities able to pay for the protection of fish resources impacted by climate change? Fish. Res. 221, 105374 https://doi.org/10.1016/J.FISHRES.2019.105374.
Turner, R., McConney, P., Monnereau, I., 2020. Climate change adaptation and extreme weather in the small-scale fisheries of Dominica. Coast. Manag. 48 (5), 436–455. https://doi.org/10.1080/08920753.2020.1795970.
van Eck, N.J., Waltman, L., 2010. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics 84 (2), 523–538. https://doi.org/10.1007/S11192-009-0146-3/FIGURES/7.
van Eck, N.J., Waltman, L., Dekker, R., van den Berg, J., 2010. A comparison of two techniques for bibliometric mapping: multidimensional scaling and VOS. J. Am. Soc. Inf. Sci. Technol. 61 (12), 2405–2416. https://doi.org/10.1002/ASI.21421.
Wongbusarakum, S., Gorstein, M., Pomeroy, R., Anderson, C.L., Mawyer, A., 2021. Mobilizing for change: assessing Social adaptive capacity in Micronesian fishing communities. Mar. Pol. 129, 104508 https://doi.org/10.1016/J.MARPOL.2021.104508.