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Social-ecological vulnerability to climate change and risk governance in coastal fishing communities of Bangladesh

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In Bangladesh, fishing communities are one of the most climate-vulnerable groups, though they play an important role in economic development. The main objective of this study was to identify vulnerability by exploring exposure (i.e., lack of regulating services or household capitals), susceptibility (i.e., lack of access to provisioning services), and lack of resilience (i.e., lack of alternative livelihoods and capacity) and to explore adaptation options, and challenges to understand risk governance. The study considered 45 published research articles for analysis following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Keywords were used in combinations (e.g., fishing communities and Bangladesh) to identify and screen published articles. Articles published in English focusing on vulnerability and/or risk governance, published between 2011 and 2022, featuring original empirical data or a comprehensive systematic review, and published in peer-reviewed journals were included. Articles were excluded if vulnerability and risk governance were evaluated but did not fit or match the definition used in this study. The study found frequent disasters and ocean warming caused different stresses, such as reduced fish catch and income, and resulted in an increased risk of fisheries conflict. Moreover, fishing communities have limited access to properties, modern fishing equipment, financial institutions, and fisher-centered organizations. Adaptation strategies include ecosystem-based (e.g., plantation, payment for ecosystem services) and non-ecosystem-based (e.g., temporary migration, getting help from neighbors) approaches. To boost fish production, the Government of Bangladesh instituted fishing restrictions and social safety net programs (e.g., distributing rice during the fishing restrictions); both initiatives were helpful. However, the conservation policies are not being implemented properly, and there is no particular social welfare, such as banking systems, and low- or no-interest loans being provided that may support fishers to buy fishing equipment or generate alternative income sources. Considering the previous evidence of risks, this paper recommends that fisheries conservation policies be

implemented properly, and fishing communities be provided with insurance services and no- or low-interest loans. This will contribute to reducing the climate-induced social-ecological risk and improve sustainable livelihoods that can withstand any regional, national, or local crisis.

KEYWORDS

fishing community, social-ecological vulnerability, climate risk, adaptation, governance

1 Introduction

In Bangladesh, the fisheries sector is socially, economically, ecologically, and culturally crucial. Fish provides 60% of the country's animal protein needs, and the industry contributes 3.57% to the national GDP and 25.30% to the agricultural GDP, and 1.5% percent to foreign exchange profits through the export of fish and fish products (DoF, 2022). The fisheries sector employs 12% of the country's population while contributing to rural employment generation, poverty alleviation, and food security (DoF, 2020). Fisheries production in Bangladesh is mainly derived from open and closed inland capture and culture (84.69%) and marine capture (15.31%). More than 10 million people live along the coast and rely on fishing, including 1.5 million small-scale fishers (DoF, 2018).

The inability of fishing communities to adapt to global environmental problems, such as climate change, is exacerbated by the inherent seasonality of their income and the extreme lack of viable alternatives in this sector in Bangladesh. Changes in the seawater temperature, salinity, pH, precipitation, and coastal disasters (e.g., storm surges) are considered to impact social and ecological phenomena, such as fish yield, livelihood, and management (Barua et al., 2020). Disasters, including cyclones, floods, and droughts, have become more frequent and more severe in Bangladesh, wreaking on the country's agriculture, economy, and other sectors (Barua et al., 2017; Barua and Rahman, 2018; Barua et al., 2020). Climate change impacted fisheries in two ways: directly, by causing changes to their physiology, growth, reproductive capacity, and mortality, and indirectly, by bringing in changes to the composition of marine ecosystems and the food chain (Barua et al., 2020).

Fisheries constitute a critical social-ecological system (SES) (Islam et al., 2021a; Sultana et al., 2021) that involves coevolutionary, interrelated, and dynamic adaptive structures that constantly interact on a variety of scales (Ostrom, 2009; Salgueiro-Otero and Ojea, 2020). Understanding vulnerability is very crucial in SES research. Depietri (2020) defined vulnerability as "*the extent to which environmental degradation and climate change cause negative changes in exposure, susceptibility and the capacity of the social-ecological system to anticipate, cope and recover from the hazard.*"

In Bangladesh, climate change adaptation options are typically restricted due to a lack of financial and human capital, the latter of which is caused by low levels of education and healthcare; this limitation is exacerbated by the fact that many people in Bangladesh live in geographically unstable areas that are exposed to extreme weather (Smith et al., 2021). As a result, the country is putting together national adaptation plans (e.g., National Adaptation Plan of Bangladesh (2023-2050), 2022) and other climate action plans (e.g., draft Mujib Climate Prosperity Plan (2022-2041), 2022) to lower vulnerability to natural disasters and simultaneously reduce emissions of greenhouse gases (GHGs). Yet, some commonly adapted adaptation practices, such as structural measures (e.g., hard flood defenses) and traditional fishing practices, can be expensive, cost-inefficient, and unsustainable in this changing world. Moreover, since most fishers are poor and unskilled, they cannot take on other occupations to adapt to the changing world of fishing (Koya et al., 2017).

In fisheries sector, climate change features, particularly those connected to extreme weather events, are less understood, but have started receiving increased attention recently (Barua et al., 2017; Barua and Rahman, 2018; Deb, 2018). Some of the previous studies attempted to understand the climate vulnerability of the fishing communities in Bangladesh and specific responses to the climate risk in inland (Sunny et al., 2020) and coastal regions (e.g., Barua et al., 2020; Roy and Basu, 2020; Islam et al., 2021d). Most of these studies consider the social and economic aspects of vulnerability and climate responses (e.g., Barua et al., 2020; Sunny et al., 2020; Islam et al., 2021d). Few studies considered coastal fisheries as a social-ecological system, such as Mozumder et al. (2019) and Sultana et al. (2021), but ignored the climatic features and considered national policies (i.e., fishing ban) and natural disasters (i.e., COVID-19 pandemic) to understand that system. On the other hand, Barua et al. (2020) explored the livelihood-based vulnerability of the coastal fishing community in coastal Bangladesh and underlined the need for additional studies and policies that provide households and communities with the resources they need to deal with and adapt to climate change.

Moreover, the draft Mujib Climate Prosperity Plan (2022-2041), (2022), the latest plan of climate action of the Government of Bangladesh, highlighted the importance of a sustainable fisheries supply chain with minimal mention of implementing mangrove afforestation and artificial reef establishment as a nature-based solution (i.e., ecosystem-based adaptation to expand economic opportunities in fisheries. Similarly, to ensure capacity building for climate change adaptation, the National Adaptation Plan of

Bangladesh (2023-2050), (2022) considered the need for climate-resilient fisheries and adopting ecosystem-based adaptation (EbA) approaches for coastal resilience and indicated the need for research that contributes to climate change adaptation in the sector. EbA can support empowering local communities and enable sustainable development while reversing degradation and increasing climate resilience. However, recent climate adaptation policies have started incorporating EbA approaches, but yet, consideration of social-ecological vulnerability and integration of relevant good practices of climate change adaptation (Islam et al., 2021d) and risk governance strategies is minimal, partly due to insufficient recognition of their value (Huq et al., 2017) and limited documentation in the scientific arena. Thus, we aimed to explore social-ecological vulnerability features, relevant adaptation strategies, and risk governance for climate change through a systematic review of the literature on coastal fishing communities of Bangladesh to build our understanding of this issue. The specific questions attempted to answer within this study are below.

a) What factors influence the social-ecological vulnerability and risk of the coastal fishing communities to climate change?
b) What EbA and non-EbA strategies were adopted by them and for them?
c) What are the major features of social-ecological risk governance that prevail in relation to these communities?

2 Conceptualizing social-ecological vulnerability, adaptation, and risk governance

The framework of social-ecological vulnerability, risk, and risk governance proposed by Depietri (2020) was considered as the basis for conceptualization in our study. Depietri's (2020) framework was adopted from the Birkmann's (Birkmann et al., 2013) MOVE framework, which is regarded as a generic and holistic framework applicable to disaster risk reduction and climate change adaptation studies. Depietri's (2020) framework considered the complexities and multiple ways in which ecological and social systems interact and affect each other and the hazard while shaping the vulnerability and risk of the exposed system, whereas MOVE's framework stated the link between the social-ecological system and the hazard (e.g., fisheries, agriculture).

2.1 Social-ecological vulnerability and risk

Indicators of the social-ecological vulnerability of human and natural systems include the degree to which a community depends on ecosystems for its economy and the quality of those ecosystems (Adger, 2000; Thiault et al., 2018). According to Depietri (2020), social-ecological vulnerability can be defined as the extent to which environmental problems, such as climate change, affect the exposure, susceptibility, and capability of the social-ecological system to predict, cope, and recover from the hazard. A system's social-ecological vulnerability is affected by the health of the ecosystem and its capacity to provide services across a range of spatial and temporal scales. Vulnerability includes three components exposure (i.e., "*the extent to which a unit of assessment falls within the geographical range of hazard event*" and lack of regulating services, susceptibility (i.e., "*the predisposition of elements at risk to suffer harm*" and limited access to provisioning services), and lack of resilience (i.e., "*limitation in access to and mobilization of the resources of a community or a social-ecological system*" and lack of alternative livelihoods) (Birkmann et al., 2013; Depietri, 2020). A degraded environment affects hazard patterns, ecosystems, and services and increases the local population's exposure, susceptibility, and lack of resilience, triggering social-ecological vulnerability and risk (Depietri, 2020).

First, the potential of ecosystems to buffer communities from climate-related dangers declines as the health of those ecosystems deteriorates. For instance, mangrove deforestation has been linked to increased coastal floods, cyclones, rainfall, salinity, sea level rise, and sea surface temperatures, all of which negatively affect coastal fisheries (Ahmed and Glaser, 2016). Second, the supply of fishing resources is impacted by environmental change, making populations more vulnerable to climate change and natural hazards. The vulnerability of malnourished populations to the effects of climatic stress might be exacerbated, for instance, by the overexploitation of fisheries resources, which has led to a drop in fish species and individual catches (Sowman and Raemaekers, 2018). Finally, as ecosystems and their services are threatened due to environmental degradation or change, it becomes more difficult for local people to prepare for, respond to, and recover from disasters. For example, some fishing community members adopt fish farming as an alternative livelihood, but frequent cyclones can wash away the pond fish, decreasing the community people's ability to cope (Sultana et al., 2022).

2.2 Concept of climate change adaptation and risk governance

Adaptation is the process of making changes in response to the current or anticipated climate change impacts. It is the key to lowering social-ecological vulnerability and bolstering the governing process. Climate change adaptation is possible for specific natural systems with human intervention. Country-specific strategies or options can provide co-benefits, such as biodiversity conservation, ecosystem services, and livelihoods, and reduce climate risk through climate change adaptation (Vázquez-González et al., 2021; IPCC, 2022). Recent literature (e.g., Scarano, 2017; Depietri, 2020; Jones et al., 2020) highlighted the importance of EbA in climate change adaptation. EbA involves conserving, managing, and restoring ecosystems, like mangroves and coral reefs, to address climate threats, such as altering rainfall patterns, changing maximum and minimum temperatures, harsher storms, and more unpredictable weather climatic conditions (Duarte et al., 2017; Raymond et al., 2017; CBD, 2018; Gattuso et al., 2018; IPBES, 2019; IPCC, 2022).

Risk governance is the coordinated effort of different institutions to develop and implement strategies to lessen vulnerability across varied socio-temporal scales (Depietri, 2020). Moreover, risk governance is the process by which both formally organized groups (e.g., governments) and informally organized groups (e.g., households) make decisions and take action to reduce risk (see, e.g., Renn, 2008; Birkmann et al., 2013; Depietri, 2020).

3 Methodology

3.1 Eligibility criteria

We followed the PRISMA guidelines for this systematic review. The guidelines include four steps: identification, screening, eligibility, and inclusion (Macusi et al., 2022). First, we identified key indicators to synthesize social-ecological vulnerability to climate change and risk governance. Four factors (i.e., social-ecological dimension of vulnerability, social-ecological risk, climate change adaptation, and risk governance) (Birkmann et al., 2013; Depietri, 2020) were identified and considered as a starting point of the systematic review process. All original articles focusing on the conceptual framework's components were eligible for this review (Figure 1; Table 1). The following are some additional eligibility requirements that we adopted: i) dates of publication between 2011 and 2022; ii) featuring original empirical data or a comprehensive systematic review of the relevant literature; iii) presentation in the English language; iv) publication in a journal that follows a rigorous peer-review process; and v) documented impacts that fit one or more conceptual framework's components. Articles were excluded if vulnerability and risk governance were evaluated but did not fit or match the definition used in this study.

3.2 Information sources and search

We found related papers in SCOPUS, Web of Science, and Google Scholar. We also hand-searched the retrieved studies' reference lists to incorporate relevant references omitted from the original search if they met the inclusion criteria. Keywords were used in combinations: fishing communities and Bangladesh; social-ecological vulnerability and Bangladesh; fishing communities and climate change and Bangladesh; fishing communities and vulnerability and Bangladesh; fishing communities and adaptation and Bangladesh; fisheries and governance and Bangladesh; fishing communities and risk and Bangladesh; climate change and fisheries and Bangladesh.

3.3 Study selection and data collection and analysis

After conducting the database searches, we manually reviewed each article for suitability and retrieved the full-text versions of all potentially useful references. Using the PRISMA flowchart (Figure 2), we describe the procedure we followed to determine which studies would be included in the review. Then, using a spreadsheet, we reviewed and recorded 45 references on Bangladesh that include data on i) fishing communities' vulnerability to climate change, ii) social-ecological risk, iii) climate change adaptation in the fishing communities, and iv) risk governance evaluation.

We employed an inductive content analysis approach (Kyngäs, 2020) to analyze the retrieved studies. The studies were analyzed, and codes were created so that data could be extracted in different themes relevant to the elements of the conceptual framework (Figure 1; Table 1). First, in the preparation phase, the analysis

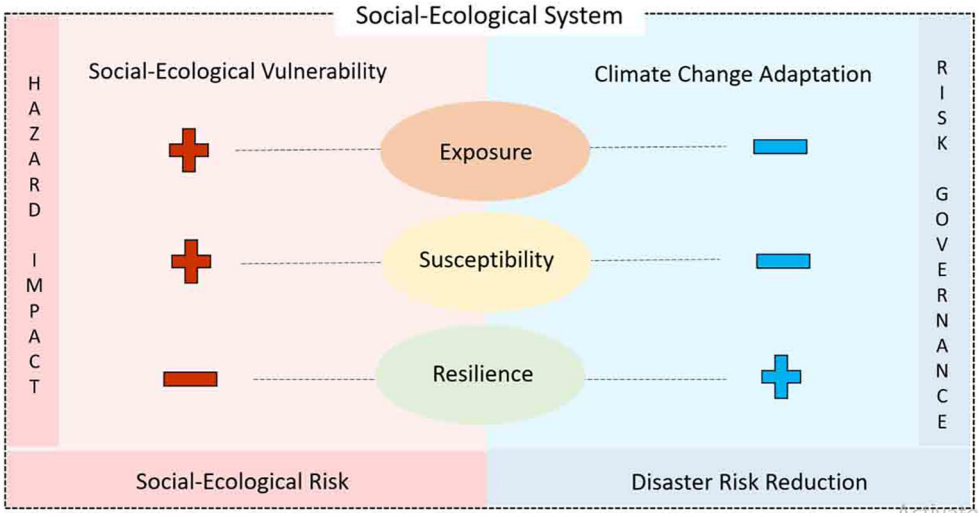

FIGURE 1
Framework presenting components that form social-ecological vulnerability and climate change adaptation in the context of risk governance (Adapted the concept from Birkmann et al., 2013; Depietri, 2020). Red plus symbols indicate existent, red minus symbol shows lack of, blue minus symbols indicate reduction, and blue plus symbol shows improvement.

TABLE 1 Conceptual framework components and indicators.

Components of the social-ecological vulnerability, risk, and adaptation	Indicators/ Strategies	References
Exposure	Lack of protection during coastal flooding and storm Change in rainfall pattern Variation in temperature Sea-level changes Altered pH level Saltwater intrusion	Das and Vincent (2009); Depietri (2020); Barua et al. (2020); Jara et al. (2020)
Susceptibility	Lack of fishery-related job opportunities Limited access to income from fisheries Food insecurity Limited nutrient consumption from fisheries	Barua et al. (2020); Jara et al. (2020)
Lack of resilience (coping capacity)	Lack of alternative Lack of local and traditional knowledge Lack of risk-sharing organization/ institution Lack of alternative food sources	Depietri (2020)
Adaptation	Fishing equipment Availability Co-management Restoring biodiversity Alternative livelihood option creation Technology application	Barua et al. (2020)

components, including exposure, susceptibility, lack of resilience, exposure reduction, susceptibility reduction, resilience improvement, and risk governance, were selected, and studies were deeply viewed to understand the scenarios for the coastal fishing communities of Bangladesh under changing climate. Finally, in the organization phase, information in the studies was coded into different themes and then categorized to describe the emerging themes (e.g., themes under the framework component exposure were heat stress, increased frequency of cyclones, altered water quality, and inaccessible weather information).

4 Results

Social-ecological vulnerabilities and adaptation strategies reported in selected articles overlap between different indicators, including exposure reduction, susceptibility reduction, and resilience features. For instance, extreme weather conditions, on the one hand, cause unfavorable conditions to perform fishing (exposure feature) and, on the other hand, pose pressure on food security (susceptibility feature) and livelihood options (lack of resilience). Similarly, adaptation strategies that reduce exposure are likely to reduce susceptibility and improve resilience (e.g., using traditional knowledge to understand fish behavior helps protect fish stock during extreme weather and increases food security and income). Thus, we discussed different social-ecological vulnerability features and adaptation strategies, mainly focusing on how they help reduce specific vulnerability features.

4.1 Social-ecological vulnerability and risk

This section covers vulnerabilities the coastal fishing communities confront, illuminating the complex effects of climatic changes, extreme weather, and associated socio-economic factors. We explored the exposure, susceptibility, and lack of resilience that combine to produce a complex situation for coastal fishers and their livelihood (Figure 3).

4.1.1 Exposure

The review revealed that most fishing community members in the coastal regions experienced increased temperatures and decreases or abnormalities in rainfall, and the major natural disasters faced by the communities are cyclones and floods (Ahmed et al., 2013; Barua et al., 2020). Cyclone is the most critical factor in the determination of exposure. Cyclones are usually followed by surges (floods) in many areas, which negatively affects people's ability to make a living and their access to resources (e.g., land, reserved money, farms). It impacts embankments, boats, nets, landing zones, marketplaces, cyclone shelters, and ice mills (Sharifuzzaman et al., 2018). Increased heat and the frequency of hot days cause fishers' health problems, domestic animals' health problems, and damage to aquaculture production (Shameem et al., 2015). Moreover, the shifts in temperature and the frequency of cyclonic activity have a detrimental effect on the fish's habitat and movement, and the persistent rains in the monsoon season interrupt fishing activities (Rahman and Schmidlin, 2014; Mozumder et al., 2019).

Environmental factors, such as increased water temperature and transparency, decreased dissolved oxygen, and pH levels in the rivers (e.g., Bakkhali River) adjacent to the Bay of Bengal, also influenced the distribution and diversity of fisheries species

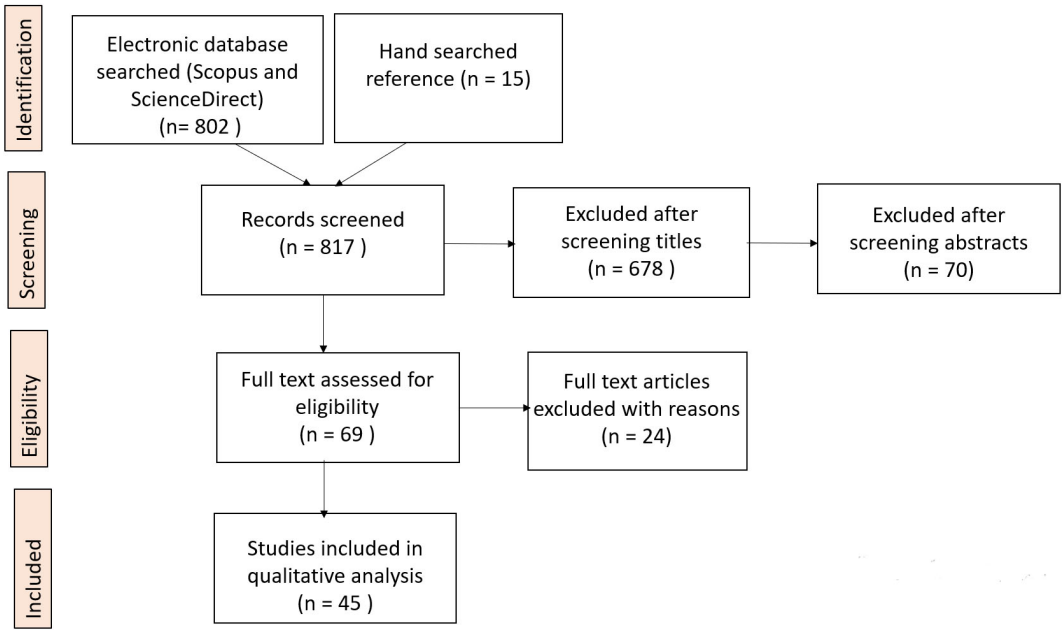

FIGURE 2
Flow diagram showing the articles selection process for the qualitative analysis.

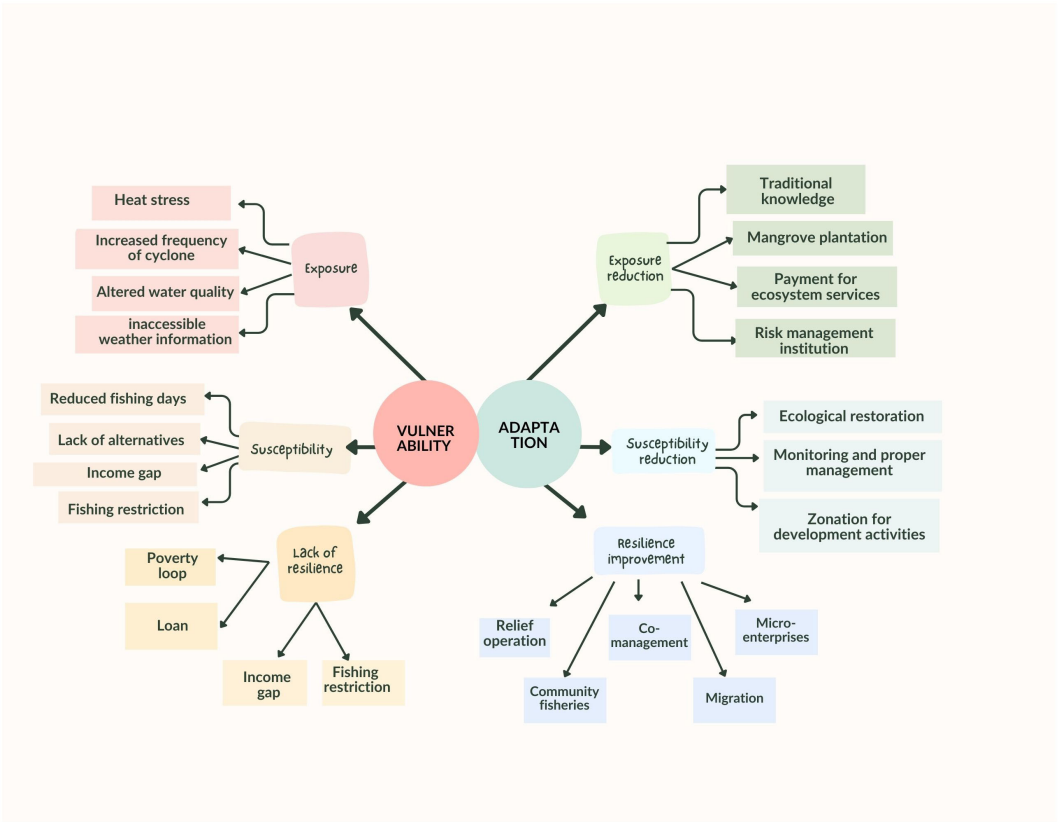

FIGURE 3
Thematic map showing the emerged themes under vulnerability and adaptation components of the conceptual framework (Figure 1).

(Barua et al., 2020). Salinity intrusion is another issue caused by cyclones and tidal surges mentioned in many studies, including Shameem et al. (2015) and Sharifuzzaman et al. (2018). Coastal erosion causes saltwater to flow inland through a network of minor rivers, canals, and water inlets, contaminating ponds, groundwater, and agricultural land (Shameem et al., 2015). Consequently, fishing becomes a final resort for farm workers, while many locals are impacted by coastal erosion. Yet, this increases pressure on coastal fisheries by forcing community people into open-access fisheries (Islam et al., 2021c).

Due to adverse weather situations, fishers' health and life are often at high risk (Barua et al., 2020). Fishers often fear fishing at night because they are unaware of weather forecasting or experience difficulties in obtaining weather information (Ahmed et al., 2013; Rahman and Schmidlin, 2019). Fishers are frequently forced to leave their traditional houses made of earth, bamboo, and jute sticks to protect themselves from cyclones. Additionally, strong cyclones and associated storm surges destroy fishing gear and crafts, affecting their way of life and preventing them from going on essential fishing expeditions. Tragically, extreme cyclones (e.g., Cyclone Sidr in 2007) not only lead to the destruction of physical assets, like fishing gear and crafts but can also result in loss of life (Islam et al., 2021d). Moreover, set-bag net fishers are more exposed to cyclone disasters than fishers using pull nets due to fishing in the deeper areas of the river. However, both groups of fishermen are worried about their lack of earnings due to low production, illustrating the oblique effects of climate change (Ahmed et al., 2013; Barua et al., 2020).

4.1.2 Susceptibility

Coastal fishers typically only work during the full and new moons and have the rest of the time off. Moreover, the number of fishing days are being reduced because of the reduced fish catch, and in most cases, changing weather pattern (e.g., cyclones and high winds) are considered to be the reason behind reduced fish catch and reduced fishing days (Rahman and Schmidlin, 2014; Barua et al., 2020). However, in some cases, fishers felt the number of available fish might increase during disasters as very few fishers are fishing, allowing them more catch even though their appetites frequently cause untimely deaths (Islam et al., 2018a).

Younger generations are drawn to fishing because of a lack of alternatives and uncertainties posed by temperature rise, untimely and heavy rain, and abnormal wind. No specialized social protection measures are in place to help the fishing community in adverse weather conditions, including food or cash for work or the distribution of fishing equipment (Sharifuzzaman et al., 2018).

The noticeable pay gap between fishing boat skippers known as *Majhi* (usually the boat owner or most experienced fisher) and crews impacts fishers' sensitivity to climatic stressors. Boat owners earn more than crew members, and age, education, and crew size affect fishing crew's pay. Moreover, crew fishers often suffer economic hardship without a buffer (e.g., savings), and the fishing ban severely impacts fishing communities' income, food security, health, and children's education (Islam et al., 2018b).

Marginal fishers are also affected by government conservation measures like fishing bans. Some commercially important fish species are protected from fishing during breeding seasons. There is a nationwide seasonal prohibition on hilsa shad fishing for 22 days. To safeguard juvenile hilsa, a new two-month prohibition has been enacted (Islam et al., 2021c). Furthermore, fishing in the Bay of Bengal is hampered by another 65-day ban (Islam et al., 2021c). When marginal fishers were hit with three bans in a row, it devastated their livelihood.

4.1.3 Lack of resilience

In coastal fisheries, poverty and natural resource overuse mutually reinforce each other, creating an unfavorable condition in the SES (Mozumder et al., 2019). Poverty influences fishers' ability to adopt alternative means of livelihood. Additionally, inadequate or non-existent regulatory structures and specific choices may increase the degree to which local communities depend on the fisheries, which may result in overfishing and, eventually, changes to the fishery.

Impacts from climate change and decreased fish productivity also affect those in the fishing community who work in retail, maintenance, processing, and ice manufacturing. Roy and Basu (2020) demonstrated that the increased frequency of disasters was the most perceived barrier to diversifying fishers' households' income sources. Other associated barriers are poor road conditions, lack of job sources, limited access to bank loans, and lack of infrastructure.

Due to climate change impacts (e.g., cyclones), debts are on the rise among small-scale fishers as fishers cannot go fishing. Many fishers went to micro-credit organizations for loans to rebuild their homes, provide food and medicines to their family members, and reestablish their economic survival. However, due to frequent disasters, fishers face the loss of income and cannot repay the loans they received from the micro-credit organizations. So, they can only get loans through informal money lenders (locally known as *dadon*) with high interest (Hossain et al., 2018; Islam et al., 2021c). However, receiving loans from informal money lenders brings more challenges as they often become bound to go fishing during unfavorable weather conditions and even in the ban periods so that the loans can be repaid.

Finally, the vulnerability analysis underlines the many issues coastal fishing communities confront, including rising temperatures, irregular rainfall, cyclones, and floods. After such disasters, resource access, infrastructure, and fishing operations are hindered, hurting these communities' livelihoods. Additionally, climate-induced health problems, disturbances in aquaculture, and habitat changes make fishers more vulnerable. Water temperature, salinity intrusion, and coastal erosion exacerbate these issues, affecting fish distribution and diversity. Fishers are stressed by weather, lack of social protection, and economic inequities. Poverty and overfishing intertwine, causing unsustainable practices. Climate change-driven debts and restricted repayment choices aggravate cyclical issues, pushing fishers to informal money lenders. Lack of resilience perpetuates

the fragile balance of coastal fishing communities in this complex web of interconnected forces.

4.2 Climate change adaptation and risk governance

Current climate change adaptation practices addressing social-ecological vulnerability encompass EbA (e.g., mangrove plantation) and non-EbA (e.g., micro-enterprise development) strategies (Table 2). Moreover, strategies bring different outcomes (Table 3) regarding vulnerability reduction. This section explains climate change adaptation options and strategies that help to address specific vulnerability features (i.e., exposure, susceptibility, and lack of resilience) and risk governance (Figure 3).

4.2.1 Exposure reduction

Strategies linked to reducing exposure are primarily adopted at the institutional and government levels (Barua et al., 2020) through fishers' engagement. Fishers often use their traditional knowledge to understand fish movement, the fluctuation of the fish stock depending on the changes in the weather, and the reproductive and feeding behaviors of the fish (Mozumder et al., 2018). Incorporating fishers' traditional knowledge in setting boundaries for sanctuaries is an important strategy that can help reduce exposure.

Mangrove plantation by government and development agencies in the coastal zone is one of the key adaptation strategies to protect against exposure features such as cyclones, storm surges, and erosion and limit saltwater intrusion. However, implementing these strategies required zoning (i.e., allocating areas and time management) and integrating an integrated and participatory approach (Barua et al., 2020).

TABLE 2 Adaptation strategies identified in the review to address exposure, susceptibility, and lack of resilience through EbA and non-EbA practices following individual or institutional approaches.

Adaptation Strategies	Addresses			Through			
	Exposure	Susceptibility	Lack of resilience	EbA practices	Non-EbA practices	Individual/ farmer level approach	Institutional/ collaborative approach
Using local traditional knowledge	×	×	×	×		×	
Mangrove plantation in the coastal zone	×	×	×	×			×
Payment for ecosystem services that offer financial incentives to encourage the preservation	×	×	×	×			×
Relief operations		×			×		×
Community-supported fisheries allow selling fish locally		×	×		×		×
Micro-enterprise development		×	×		×		×
Temporary migration			×		×	×	
Aquaculture			×		×	×	×
Management of coastal fisheries collaboratively by stakeholders and the government			×		×		×
Community networks			×		×		×
Building community institutions	×		×		×		×
Reforming present laws and strategies		×	×		×		×
Generating alternative livelihood option		×	×	×	×	×	×
Co-management of resources			×		×		×
Getting help from neighbors and friends during a crisis		×	×		×	×	
Changing occupation (e.g., floating agriculture, cattle rearing)		×	×	×	×	×	×

× denotes functionality specific to individual column components.

TABLE 3 Adaptation outcome, adaptation strategies, and governance approach as mapped based on the literature review.

Adaptation outcome	Adaptation Strategies	Governance approach	References
Securing fish stock	Using local traditional knowledge to understand fishing grounds and stock	Local knowledge is being implemented at the fisher level, yet to be considered in the governance	Islam (2021)
	Mangrove plantation in the coastal zone	Internationally funded and co-implemented by the government and NGOs; and fishing communities are engaged as beneficiaries	Barua et al. (2020)
Food security	Offering rice in the form of payment for ecosystem services	Planned and implemented by the Ministry of Disaster Management and Relief	Porras et al. (2017a); Islam et al. (2021b)
	Relief operations	Planned and implemented by the government with the help of local government organizations and INGOs	Islam et al. (2021b)
	Selling fish by creating a local market by adopting community-supported fisheries	Implementation is required by government and non-government organizational collaboration	Mozumder et al. (2019)
Diversified livelihood	Micro-enterprise development in fisheries-associated sectors, such as ice mill, fish storage, and fish transportation	Implementation is required by government and non-government organizational collaboration	Mozumder et al. (2019)
	Temporary migration to towns and cities to work as a laborer	Mainly performed by individual fishing community members with limited integration in governance plans and policies	Hossain et al. (2018); Alam et al. (2021)
	Aquaculture	Fishing community members engage in non-fishing activities mainly with an individual effort; in some cases, NGOs engage them in development projects	Hossain et al. (2018); Alam et al. (2021)
	Women are sometimes encouraged and sometimes forced to engage in income-generating activities	Women start working considering household situation mostly and, in some cases, receive support from NGOs	Alam et al. (2021)
Support network	Government, NGO and community collaboration for co-management	Management of coastal fisheries collaboratively by stakeholders and the government through formal agreement	Barua et al. (2020); Mozumder et al. (2019)
	Community-supported fisheries by developing local market	Indicated as important in the literature, but not initialized yet	Mozumder et al. (2019)
Social harmony	Helping friends and neighbors during a crisis	No institutional efforts have been reported yet. Mainly carried out by individual fisher	Sharifuzzaman et al. (2018)
Occupational transformation	Practicing floating agriculture and hydroponics	Mainly initiated at the individual level with no formal institutional engagement, but in some cases, NGOs initiated the practice	Deb and Haque (2017)
	Home gardening and nurseries development		
	Relying on cattle rearing		

(Continued)

Another crucial adaptation strategy is payment for ecosystem services that offer financial incentives to encourage the preservation of essential habitats that act as a buffer against the destructive effects of natural disasters and other aspects of climate change (Porras et al., 2017a). Government risk management institutions and forest offices have a crucial role in collaboration with NGOs and development agencies to identify target beneficiary groups, determine compensation scales for environmental insurance, and use funds for climate or environmental policies and actions. Moreover, this collaborative endeavor plays a pivotal role in harnessing resources and expertise to address pressing environmental and climate challenges on a local scale.

4.2.2 Susceptibility reduction

Susceptibility reduction involves options such as increasing access to food security and fisher community members using their local knowledge to catch fish at an appropriate time and place. Particularly, at the policy level, the government's fishing ban

initiative is considered to restore fish stock and ensure food security throughout the year (Rahman, 2017; Arafat et al., 2021). The government has established a compensation plan to help low-income fishing households with a fisher identification card to compensate for the loss of fisheries income during the ban period. The government provides 40 kg of rice to the fishing households as payment for ecosystem services to not go fishing during the breeding period (Porras et al., 2017a; Porras et al., 2017b). For some fishers, this initiative was found helpful in coping with the ban period, and broader satisfaction among the fishers can help regenerate fish stock and cope with climate change-related depletion of the fish stock. However, there is politicization, nepotism, and delay in support involved in picking and approving recipients and then handing out payments. Many impoverished fishers are excluded from the benefits, while those with political ties reap the rewards (Islam et al., 2021b).

Monitoring and properly managing coastal development activities can reduce the loss of resources and impact on ecosystems and reduce unplanned structure. Few studies mentioned this and found it critical to reduce the development activities' environmental impact (e.g., Shamsuzzaman and Islam, 2018). This strategy can be well-governed with the development of the coastal development code of contact and zonation for development activities, including aquaculture farms and coastal embankments. Moreover, environmental impact assessments are critical to properly managing this strategy (Barua et al., 2020).

4.2.3 Resilience improvement

Improving resilience in fishing communities encompasses a spectrum of initiatives, spanning from emergency relief operations to micro-enterprise development and the promotion of co-management solutions. Studies have shown that traditional relief activities (e.g., distributing food and clothing) have far less impact on the resilience of fishing communities after natural disasters, such as tropical storms and tidal surges (e.g., Sharifuzzaman et al., 2018). Instead, local communities need access to fishing gear, boat-building and -repairing facilities, fish landing, and fish-drying infrastructure (Sharifuzzaman et al., 2018).

Community-supported fisheries for selling fresh and locally obtained fish could be one approach to lessen reliance on money-lenders when attempting to adjust to the effects of natural disasters, such as cyclones and tidal surges (Mozumder et al., 2019). In community-supported fisheries, members pay an upfront fee and earn a share of the production. This program can help coastal fishers prepare for the future by saving money for boats and gears, so that they can sell their catch at a fair price.

Developing micro-enterprises is vital to boosting income and reducing pressure in coastal areas (Mozumder et al., 2019). Besides the development of marine fish (e.g., hilsa), selling other micro-enterprises, such as boat making, net repairing, processing, icing, transportation, and marketing, can be developed and practiced by ensuring strong linkage between different groups.

Temporary migration is one of the ways to survive climate change impacts. It involves one or two family members moving temporarily to nearby towns (e.g., Cox's Bazar) or big cities (e.g., Dhaka) to find work. Migrated fishers are generally involved in the informal sector (e.g., rickshaw-pulling and construction laboring) or other activities, including working in salt farms, food stores, and earthworks. Salt farming has emerged as a preferred alternative income source as farmers face less hardship to earn more money than fishing (Rahman and Schmidlin, 2019). In salt farming, farms are inundated with seawater and allowed to evaporate to gather and sell salt. The number of fishers leaving vulnerable fishing villages has increased in recent years due to the increased frequency of natural disasters (e.g., cyclones and storm surges), pressured permanent migration exceeding temporary relocation (Barua et al., 2020).

Aquaculture is stated in many studies as a means of diversifying livelihood and alternatives to open-catch fishing (Ahmed et al., 2013). Moreover, due to saltwater intrusion in the agricultural land, many community people changed their occupation to fishing, particularly aquaculture, mainly shrimp farming, putting increased pressure on fish resources. Aquaculture is being practiced and initiated in different coastal regions with the support of development organizations and the government. However, this sector is challenged by a lack of knowledge about up-to-date culture systems, disease prevention, and feed production.

Co-management can improve fishing communities' social resilience by giving them more control over how their natural resources are utilized with the involvement of different stakeholders (Mozumder et al., 2019). Through such engagement, fishery-based communities' power relations can be improved; thus, social-ecological resilience can be restored.

Mozumder et al. (2019) explored drivers-pressure-state-impact-responses (DPSIR), indicating the complex relationship between ecology, management, and governance. Factors like exploitation, non-compliance with policies and regulations, and conflicts over resource use lowered the resilience of fishing communities. Possible responses include strengthening community networks, revising rules and regulations, and providing alternative ways for fishers to generate income during crises (e.g., fishing ban periods and disasters). These flexible strategies, rooted in sustainable fisheries management, are crucial parts of a comprehensive process to build coastal communities' resilience in the face of the complex interactions between environmental, economic, and regulatory issues.

4.2.4 Risk governance

Bangladesh has a well-structured system of organizations and partnerships involving government agencies, non-governmental organizations, and communities, all working together to lessen the risks and increase the country's capacity to respond to them. For instance, Bangladesh's Department of Fisheries (DoF) implements fisheries governing policies under the Ministry of Fisheries and Livestock (Ahamed et al., 2012). Besides, disaster risk reduction is the responsibility of the Department of Disaster Management (DDM), which is part of the Ministry of Disaster Management and Relief (MoDMR). However, risk reduction through implementing an appropriate governance process is still challenging in the fisheries sector. The fisheries sector's viability and

the long-term conservation of marine, coastal, and estuarine environments depend on the execution of policies, rules, and regulations.

Government and non-government organizations are initiating reforestation with the coastal communities to reduce the negative impacts of climate change. Moreover, those organizations introduced river osmosis plants in some coastal areas (e.g., Mathurapur village) with salinity intrusion problems (Islam et al., 2021d). However, those plants are very costly to establish, and lack of technical expertise and institutions to maintain the plants; the technologies' benefit has become limited.

Governance in fisheries involves balancing the needs of different stakeholders. Power, interests, values, priorities, and resource exploitation often cause conflicts among fisheries stakeholders (Murshed-e-Jahan et al., 2014). Moreover, institutional failures in fisheries management and law enforcement also cause conflicts. Corruption, bribery, lack of coordination, and overlapping government agencies' roles and jurisdictions fuel this type of conflict associated with weak governance, lack of transparency, and no institutional fisheries management or conflict resolution systems. Murshed-e-Jahan et al. (2014) found that weak governance in coastal fisheries includes encroachment of net/boat drying areas by influentia individuals connected to law enforcement agencies, pirate attacks at sea, and corruption in boat licensing. Furthermore, fishers' conflict with law enforcement agencies, especially government fisheries officers, who are supposed to safeguard them.

Development projects by different international organizations (e.g., UNDP) helped fishers unite and initiate village-level organizations, network with local government power sources, and restore confidence to address the negative impacts of climate change (Deb and Haque, 2017). For example, DoF and WorldFish jointly conducted internationally funded (e.g., USAID-supported) projects to help coastal fisher communities to practice co-management (Mozumder et al., 2019).

System-wide changes or changes in more than one system were demonstrated to reduce the impact of climatic hazards. For example, since the last few decades, cyclone shelters have been considered an important strategy to reduce disaster risk and allow system-wide intra- and inter-sectoral cooperation amongst several government agencies to use cyclone shelters for various purposes. Islam et al. (2021d) mentioned that cross-sectoral collaboration or collaboration between departments is more effective than individual institutes' efforts in risk reduction.

Our analysis of adaptation and risk governance highlights strategies used to address coastal fishing communities' complex issues. Community participation and institutional and governmental initiatives strive to alleviate climatic pressures. Using traditional knowledge in conservation, planting mangroves for natural calamity resistance, and paying for ecosystem services were key. Fishing infrastructure, community-supported fisheries, and micro-enterprises also develop resilience. Despite these efforts, weak governance, corruption, and stakeholder conflicts make these communities more vulnerable.

5 Discussion

Through a systematic review of the published peer-reviewed literature, the study revealed the social-ecological vulnerability (i.e., exposure, susceptibility, and lack of resilience), adaptation (i.e., exposure, education, susceptibility reduction, and resilience improvement), and risk governance in the coastal fishing communities of Bangladesh. The results of this study show that some pre-existing conditions, such as a lack of alternatives to fishing as a source of income and climate change, cause fishing communities to become more vulnerable and adopt adaptation strategies that are either ecosystem-based or not, and with or without assistance from governmental and non-governmental organizations. Fishers' limited ability to exercise decision-making and access to top-down governance processes have already stifled bottom-up governance. Considering these key findings, a discussion was made to reflect the scenario in Bangladesh.

5.1 Social-ecological trap increasing fishing communities' vulnerability

Fishers in the coastal regions are in a social-ecological trap where fishers have limited access to alternative livelihood options, and climatic threats to the ecosystem and the community reinforce each other, pushing the social-ecological system (i.e., fisheries) into an undesirable state.

Climate change affects coastal fishing communities at diverse scales. Invasive species, sickness in the caught fishes, shifts in fish distribution (including reproductive patterns), and a general decline in catches are all common examples. The study by Jara et al. (2020) sheds light on an unsettling reality; climate change threatens to usher the amplification of warm water species at the expense of their colder counterparts. This indicates major ecological disruptions that could occur in the coming decades. In Bangladesh, where similar circumstances exist, a similar fear is pervasive, causing a sense of shared worry about the impending change.

Moreover, for fishing communities, periodic or permanent reduction of fishing days may hurt the economic condition as it is their main livelihood option (Islam et al., 2021b). Lower literacy rates than the national average, and inadequate education and fishing skills make it challenging for them to switch occupations. Besides, finding temporary work during a crisis is difficult because most jobs demand a long-term commitment, and fishing villages are generally far from economic centers. Because of this, fishers often accept income losses after natural catastrophes because they can't find other work. cyclones and surges destroy fishing equipment, suspending fishing and perhaps causing a food crisis and increased conflict. Similar to the study in the Brazilian coastal communities (i.e., Gamarra et al., 2023), we found that fishers' income influences the reception of economic benefits. The situation of small-scale fishers who earn less, becomes worse by the limited access they have to credit, and as a result, many fisher families lack adequate supplies

of food, clothing, and shelter. This effect discourages fishers from passing their profession to their offspring (Sultana et al., 2021).

Similar to Bangladesh, other countries' (e.g., the Philippines, India, and Brazil) studies on coastal fishing communities revealed that fishing communities lack skills other than fishing, mostly marginalized and trapped by the negative consequences of environmental changes, including climate change (Leite et al., 2019; Umamaheswari et al., 2021; Wakita et al., 2022). Macusi et al.'s (Macusi et al., 2020; Macusi et al., 2021) study in Philippines, demonstrated the threat of illegal fishing, the intrusion of industrial fishing operations, and the spread of water-borne pollution increased coastal fishers' vulnerability consequently forcing these communities to embark on an adaptation journey. Some fishers have turned to a subtle strategy of part-time fishing engagements in response to declining catch yields. Along with this pragmatic change, there has been diversification into other livelihoods, from agriculture to construction. Such transformative adaptation has also been evident in our systematic review. However, transitioning from fishing to farming and building construction posed numerous difficulties for the fishing community members. Additionally, there is an additional uncertainty due to the threat of losing their valued fishing traditions. The anxiety and impending sense of loss that accompany this turbulent change serve as a potent reminder of the challenging decisions people must make to embrace adaptation.

5.2 Exogenous and endogenous EbA and non-EbA strategies implementation

Our results revealed that most fishing community members endogenously without organizational support use non-EbA strategies (e.g., migration and construction laboring) to reduce vulnerability and improve resilience. On the other hand, exogenous strategies by the government and national and international NGOs encompass both EbA (e.g., mangrove plantation) and non-EbA strategies (e.g., relief operation and community-supported fisheries). Systemic challenges are reported in most of the articles reviewed regarding implementing the strategies.

Mangrove plantation projects in Bangladesh are led by the government and carried out with the help of international non-governmental organizations (INGOs) and non-governmental organizations (NGOs) following top-down approaches. However, such implementations are often questioned because of not incorporating communities' opinions (Saroar et al., 2019). Similarly, the current practice of compensating with 40 kg of rice as payment for ecosystem services) to address the temporary loss of fishing income during the fishing prohibition period is also not reasonable for the fishing community members (e.g., Porras et al., 2017a; Bhowmik et al., 2021; Sultana et al., 2021). The study by Sorice et al. (2018) reveals that payment for ecosystem services initiative becomes fruitful when it considers fisher demand and provides confidence about the expected outcome.

Limited availability (due to geographic location) and accessibility (due to lack of skills) to alternative livelihood options often force fishing community members to migrate to nearby towns and cities. Similarly, migration has been reported as a crucial adaptation option in many parts of the Global South (e.g., West Africa), and seasonal migration has become prominent (Ilosvay et al., 2022). A shifting trend of more temporary basis migration to permanent migration is associated with the exhaustion of local coping strategies, and it requires monetary investment and can break transforming relationships and community networks (Ilosvay et al., 2022). For example, climate-induced alteration of biophysical factors (e.g., abnormal precipitation, pH levels, and temperature) not only impacted the fisheries sector but also impacted the agriculture sector, an alternative income source for many fisher families, by affecting households' ability to grow diversified and seasonal crops throughout the year. However, conflicts flared up frequently due to the widening employment gap between the places of origin and destination. Fishers can support, and local ecological understanding can improve fishery and conservation aims. However, the unfair allocation of responsibilities and benefits challenges equity and social justice. Thus, the significance of resolving social justice concerns related to fisheries governance was highlighted in the current review. The missing collaboration between the government and fishing communities regarding resource management planning and policy implementation can only lead to conflicts (e.g., Islam, 2021).

5.3 Risk governance lacks inclusion

Many EbA initiatives have struggled to involve key stakeholders effectively. For instance, the beneficiary selection for coastal afforestation programs has been primarily top-down, frequently ignoring local communities' specific requirements and preferences (Saroar et al., 2019). Efforts to preserve breeding grounds and fish stocks have resulted in implementing fishing bans or restrictions without adequately incorporating the perspectives of fishing communities or investigating viable alternative livelihood opportunities (Bhowmik et al., 2021).

A recent narrative review by Islam and Chuenpagdee (2022) analyzed 20 global case studies and found that small-scale fisheries vulnerability is a complex result of complex interactions among different threats and stressors. These include biophysical dangers resulting from dynamic marine ecosystems, environmental instability caused by variables like climate change, unstable political environments, and weakly constructed governance institutions. In line with this study, our review indicates that the participation of fisher community members in the governance process relies on the availability of educational, training, and demonstration programs and the development of viable alternatives to fishing as a profession. On the other hand, fishing communities tended not to be involved in any formal organization beyond the family. They lack a cultural tradition of group effort due to an absence of prior associations and institutions. Community capacity building remains challenging because of the long-term implications of centralized governance practices, which suppress fishing communities' ability to govern themselves. Long-term top-down resource management can weaken or even dismantle community institutions and mechanisms for rule creation,

enforcement, and monitoring. Caceres et al. (2023) demonstrated that in the Galapagos small-scale fishing system interaction happens across levels and sectors and well-placed actors and networks whose interactions could be key to strengthening the small-scale fishing sector's ability to work together and adapt to future crises caused by climate change, or other human-made and natural drivers of change and improve collaborative governance.

5.4 Strengths and limitations of the review

To the best of our knowledge, this is the first comprehensive systematic analysis of the social-ecological vulnerabilities of Bangladesh's coastal fishing communities concerning climate change and risk governance. It shows how different features of exposure, susceptibility, and lack of resilience influence the social-ecological vulnerability of the coastal fishing communities and how different EbA and non-EbA practices (Table 2) are adapted and outcomes (Table 3) with associated governance issues.

However, some limitations we couldn't address in this study. We did not consider the articles, which were not written in English. However, most of the peer-reviewed articles in the internationally accepted journal are in English, so we believe not much information has been lost by adopting this method. We only covered social-ecological vulnerability features, adaptation strategies, and governance in Bangladesh. During the search, we found some interesting, relevant articles from other countries, such as the Philippines, India, and Indonesia, but we did not include those in the analysis process. However, we considered incorporating those articles in the discussion section for better understanding.

6 Implication and the way forward

We have identified many promising adaptation initiatives and effective risk governance strategies in the fisheries sector of Bangladesh. However, considerable untapped potential exists to significantly enhance the benefits by implementing these actions nationwide and embracing best practices to optimize gains. Drawing from the findings of this study, we have identified three priority areas that need immediate attention to reducing social-ecological vulnerability within Bangladesh's coastal fishing communities and hold relevance for other low and lower-middle-income countries.

6.1 Improving the evidence base and knowledge

The current interest in sustainable fisheries management on a national and worldwide scale, especially in Bangladesh, presents a huge opportunity. By supporting evidence-based policies and approaches, it is possible to improve the sustainability of the fisheries sector and the standard of living of coastal fishing communities. There is a strong evidence base of the effectiveness of fisheries management programs, including community-based co-management systems, community-supported fisheries, protection of important fish habitats, and alternative livelihood generation. We recommend monitoring, evaluating, and reporting on the procedures and results of upcoming fisheries management initiatives more methodically so that effective pathways to reducing vulnerabilities can be properly recorded and accessed for improved understanding, leading to scaling up.

Moreover, our research provides the foundation for understanding the social-ecological vulnerability of the fishing communities to climate change and risk governance. Collaboration between government agencies, research institutions, and fishing communities is required to foster fisheries knowledge and evidence base. It involves transparency in gathering, processing, and reporting data and information. All stakeholders, such as researchers, policymakers, and the public, should be able to access fisheries data and information. It builds trust and encourages people to work together to find the best adaptation options for vulnerability reduction and capacity development.

6.2 Incorporating good practices into policy and implementation

Best management practices need to be adopted in the fisheries and aquaculture sector to safeguard against extreme climate events, such as altered precipitation, temperature, and increased frequency of natural disasters. Improving the culture system, preventative and curative measures for disease control, quality fish hatchery development, and on-farm feed production are crucial for ensuring proper adaptation measures in aquaculture.

In open-water fisheries, resilience can be increased by using measures, such as area allocation, zone restriction based on depth and carrying capacity, gear specification, craft modification taking disaster impacts into account, day limits, and allowing bycatch and small-size fish and shellfish to escape. Governance of these practices needs proper planning for licensing and communicating a code of conduct from the appropriate government agencies operating at different levels.

Our finding shows that eco-tourism practices are ignored in fishing communities' social-ecological risk governance planning and alternative income generation strategies. Thus, infrastructure, tourist facilities, accommodation, restaurants, and recreation transportation (e.g., sight-seeing) development are required for resilience improvement. Moreover, governance involves the integration of community participation to address climate change efficiently (Barua et al., 2020).

Coastal fisheries are still threatened primarily because of inadequate collaboration and the lack of policy integration regarding the traditional knowledge held by fishers. Consequently, the government and external agencies must enhance their efforts in leveraging the local traditional knowledge of fishing communities. This strategic approach can considerably boost their resilience and adaptive capacities in the face of climate change.

6.3 Strengthing inclusive governance through capacity building

Strengthening inclusive governance requires the creation of an adaptable social-institutional interface. Establishing such an interface would catalyze the continuous evolution and development of institutional frameworks and coastal policies, allowing them to maintain their relevance and responsiveness amidst the ever-changing and heightened consequences of climate change. This adaptability ensures that these policies and governing institutions can efficiently confront emergent challenges and continuously changing environmental conditions in coastal areas.

Increasing the representation of fishing community members in disaster management-related committees, both government and non-government, is a promising strategy to improve their involvement in the governance process. In order to identify and evaluate vulnerability features, these representatives can be extremely helpful in assisting policymakers in developing a greater grasp of regional environmental, social, cultural, and political challenges. Their participation is crucial for setting adaptation program priorities that meet the community's particular needs. Our findings indicate government and community partnerships can promote progress toward more efficient methods of conflict management and good governance. Furthermore, engaging fishermen in decision-making, power sharing, and fishery co-management would improve local resource management initiatives. The fishing community's voice and views can enhance more knowledgeable and cooperative governance processes by increasing their representation.

The comprehensive development of the fishing community relies heavily on the active participation of community members in governance processes. The need is in the empowerment of fishermen, encompassing the enhancement of their abilities in fishery product preparation and marketing. Besides, enhancing linkages among micro-enterprises, such as those involved in fish storage and shipping, is equally important. This can be achieved by providing specialized training programs that focus on topics such as product development and values orientation. Requiring community members to participate in these training programs prior to initiating micro-enterprises establishes a condition that promotes active engagement in their own economic development, fostering a sense of collective responsibility for the community's well-being.

It is critical to improve fishing community members' access to and capacity to participate in governance processes. Boat owners and government agencies must ensure that adequate safety equipment is available for all fishermen, as well as a commitment to timely updating of fishing safety legislation. Recognize that fishing communities may lack basic organizational skills to strengthen the community's ability to fully engage. As a result, policies should be structured to promote social and economic fairness, improved community involvement, and ecological restoration, all of which are critical components for supporting participatory planning in the face of climate change issues. Furthermore, the formation of a dedicated task force to analyze fishermen's vulnerability and investigate socially and ecologically just solutions is necessary. This task group can serve as a link between the fishing community and governance procedures. Finally, communicating the study's findings to fishermen, government agencies, and NGOs is essential to generate informed dialogue and empower stakeholders to shape policy recommendations based on empirical insights.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

RS, HI, SS, designed the research. RS, and MA developed the article selection method and selected the articles for review. RS, HI and MA managed and analyzed data. RS and HI compiled the draft. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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