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Vulnerability and adaptive capacity of fisheries-dependent communities on the Coast of Berbera to climate change

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ABSTRACT

Fisheries-dependent communities in the Horn of Africa, specifically Somaliland, are highly vulnerable to climate change. However, empirical research on their specific perceptions and adaptation strategies is limited. This study addresses this gap by focusing on the fisheries community in Berbera, Somaliland. Using a mixed-methods approach, this study combined a quantitative survey of 286 households with qualitative data from Key Informant Interviews, Focus Group Discussions, and observations to assess climate perceptions, document adaptation strategies, and identify key determinants and constraints. Descriptive statistics were used to analyze the participants' perceptions and strategies, while thematic analysis was applied to the qualitative data. Logistic regression was used to identify the key determinants of adaptation. The findings revealed a very high level of climate change perception (96%), with fishers primarily identifying increased wind strength and temperature fluctuations as major threats, leading to reduced production and equipment damage. In response, the community relies heavily on reactive coping mechanisms, such as the distress sale of household assets (99.3%), rather than proactive technical adaptation. Key constraints include financial, technical, and knowledge-based barriers, all of which are underpinned by significant institutional weaknesses. Regression analysis confirmed that education, income, access to services, and fishing experience are significant and positive determinants of adopting more proactive strategies. This study concludes that the Berbera fishing community exhibits high vulnerability, characterized by high awareness but constrained adaptive capacity. Targeted interventions are urgently needed to strengthen financial access, technical capacity, and institutional support to build long-term resilience in the fisheries sector.

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1. Introduction

Fisheries in sub-Saharan Africa are highly vulnerable to the effects of climate change, including rising temperatures, increasing rainfall variability, and the occurrence of extreme weather events (Muringai et al., 2021). These climatic shifts are expected to significantly impact the fisheries sector, intensifying existing pressures on Africa's coastal regions and increasing uncertainty in fish population distribution (Muchuru & Nhamo, 2018). Many coastal communities depend on marine resources that are already under stress from overfishing and pollution, and climate change adds another layer of pressure, threatening the stability of coastal ecosystems and the well-being of these communities (Hobday et al., 2016). This vulnerability is particularly acute in the Horn of Africa, where the fisheries community in Berbera, Somaliland, faces regional challenges such as droughts and food insecurity (Aswani et al., 2019).

Small-scale fisheries (SSFs) play a significant role in global food security and employment; however, their future is threatened by pressures such as climate change and the industrialization of fishing (March & Failler, 2022). These threats pose serious challenges to the livelihoods of millions of fisherfolk and the food security of over a billion people (Badjeck et al., 2010). In East Africa, many coastal communities

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depend on the ocean for their livelihoods and food, making marine resources vital for regional food security. However, rising populations, increased pressure on marine ecosystems, and climate-related changes have intensified food insecurity (Painter et al., 2022). In Somaliland, these global and regional challenges are further compounded by local issues, such as environmental degradation, recurring droughts, and floods, which threaten livelihoods and undermine poverty reduction efforts (Abdulkadir, 2017; Omer, 2024a). With nearly one-third of the population facing food insecurity, it is imperative to understand how frontline communities respond (Omer, 2024b).

Research across Africa confirms that fishing communities' perceptions of climate change directly shape their adaptation strategies. Studies from Ghana (Ayisi et al., 2024), Uganda (Musinguzi et al., 2016), Malawi (Limuwa et al., 2018), and coastal Tanzania, including Zanzibar (Makame & Shackleton, 2020), have shown that fishers are acutely aware of climatic shifts, identifying indicators such as altered rainfall, unpredictable seasons, extreme weather events, and declining fish catch. In response, communities adopt a diverse portfolio of coping mechanisms, including intensifying fishing efforts, migrating, and diversifying into non-fishing livelihoods (Mabe & Asase, 2020; Musinguzi et al., 2016). However, awareness does not always translate into effective action, as research in Tanzania has revealed that communities can possess a high perception but a low adaptive capacity (Sidi, 2015). This awareness-action gap highlights a critical puzzle that requires deeper investigation into the underlying systemic barriers. While these studies establish a pattern across Africa, recent studies in Somaliland have also begun to address climate adaptation; however, this work has largely focused on the national level or terrestrial sectors such as agriculture (Omar et al., 2024; Omer, 2024b, 2024a; Sharmake et al., 2022). This leaves the unique, local-level climate realities of the Berbera fisheries community situated at the nexus of climatic, institutional, and major development pressures empirically unexamined.

While the fisheries communities of Berbera are known to be vulnerable, existing research has not specifically examined their direct engagement with climate change. The literature establishes that these communities face a complex web of pressure. Internally, the predominantly small-scale sector is hampered by significant institutional challenges, including a lack of infrastructure, weak regulatory enforcement, and poor data collection systems. Externally, they face immense pressure from foreign fishing fleets, with frequent sightings of illegal vessels threatening their livelihoods (Cashion et al., 2018; Pollnac et al., 2018). This vulnerability is further exacerbated by large-scale geopolitical and economic transformations, such as the development of the Berbera Corridor, which is reshaping the region into a frontier for global logistics and state building, often sidelining traditional livelihoods (Stepputat & Hagmann, 2019). This dynamic, in which macro-level development projects create profound local-level disruptions, is not unique. Research on Gwadar Port in Pakistan, a similar geostrategic development, powerfully documents how such projects marginalize fishing communities by excluding them from decision-making, restricting their access to traditional fishing grounds, and failing to deliver promised benefits, thereby intensifying poverty and political resistance (Ullah et al., 2024). Consequently, a critical research gap persists at the intersection of climate, institutional, and economic pressures in Berbera.

To effectively diagnose the causes of this awareness-action gap, this study adopts the Sustainable Livelihoods Approach (SLA). This framework is crucial for moving beyond simply listing adaptation strategies to understanding *why* certain options are pursued while others are not, particularly in uncertain contexts such as small-scale fisheries, where policies often fail due to an incomplete understanding of complex livelihoods (Allison & Ellis, 2001; Ferrol-Schulte et al., 2013). The case of Gwadar is illustrative: political-institutional constraints, such as exclusion from development planning and the unchecked power of illegal trawlers, systematically erode the capital assets (natural, financial, and political) that communities need to move beyond reactive coping (Ullah et al., 2024). This process is often compounded by development-induced environmental degradation, which undermines traditional resilience (Ullah et al., 2023) Therefore, the SLA provides an ideal lens for this study to diagnose how the specific political and institutional constraints posed by the Berbera Corridor and Illegal, Unreported, and Unregulated (IUU) fishing may undermine the Berbera community's asset base, reduce its capacity to adapt to climate change, and ultimately weaken its resilience.

Specifically, to achieve this, the research provides the first targeted analysis of (1) fishers' perceptions of climate change risks, (2) their portfolio of adaptation strategies, and (3) the socio-economic determinants that shape their adaptive capacity. By documenting this crucial local knowledge, this study

provides actionable insights for policymakers and development practitioners, helping formulate targeted, sustainable strategies to strengthen the resilience of this vital coastal community in the future.

2. Materials and methods

2.1. Study area

This study was conducted in Berbera, the primary seaport and economic hub of Somaliland. Located in the Sahil Region on the coast of the Gulf of Aden, Berbera is a strategic center for trade and infrastructure, hosting the nation's main port, oil terminals, and a significant fishing harbor (Figure 1). The city's climate is classified as hot semi-arid, characterized by high average temperatures that can exceed 40 °C in the summer months and minimal annual rainfall. This arid coastal environment provides a critical baseline for understanding community perceptions of climatic shifts, such as rising temperatures and changes in precipitation, which are central to this study. The fisheries sector in Berbera exists in a state of contrast. Historically, fishing in Somaliland has been a small-scale activity, constrained by a lack of modern gear, skills, and adequate cold chain infrastructure like ice makers and freezers. The sector also faces institutional challenges, including the absence of robust regulatory frameworks for quality control and sustainable management. Despite these limitations, the sector is widely considered to have vast untapped potential, with current harvesting levels representing only a small fraction of what the waters could sustainably support. This context of a historically underdeveloped but high-potential sector makes Berbera's fishing community a crucial case study for examining vulnerability and adaptation to climate change.

2.2. Research design, approach, and sampling procedure

This study employed a mixed-methods approach to investigate climate change perceptions and adaptation strategies of the fisheries community in Berbera, Somaliland. The design integrated quantitative survey data, qualitative interviews, and secondary climate data to allow for triangulation of the findings, enhancing their validity and richness.

To establish an empirical climate baseline, we sourced historical data from reputable providers. Annual rainfall data for the period 2007–2024 were obtained from the instrumental records of the Berbera

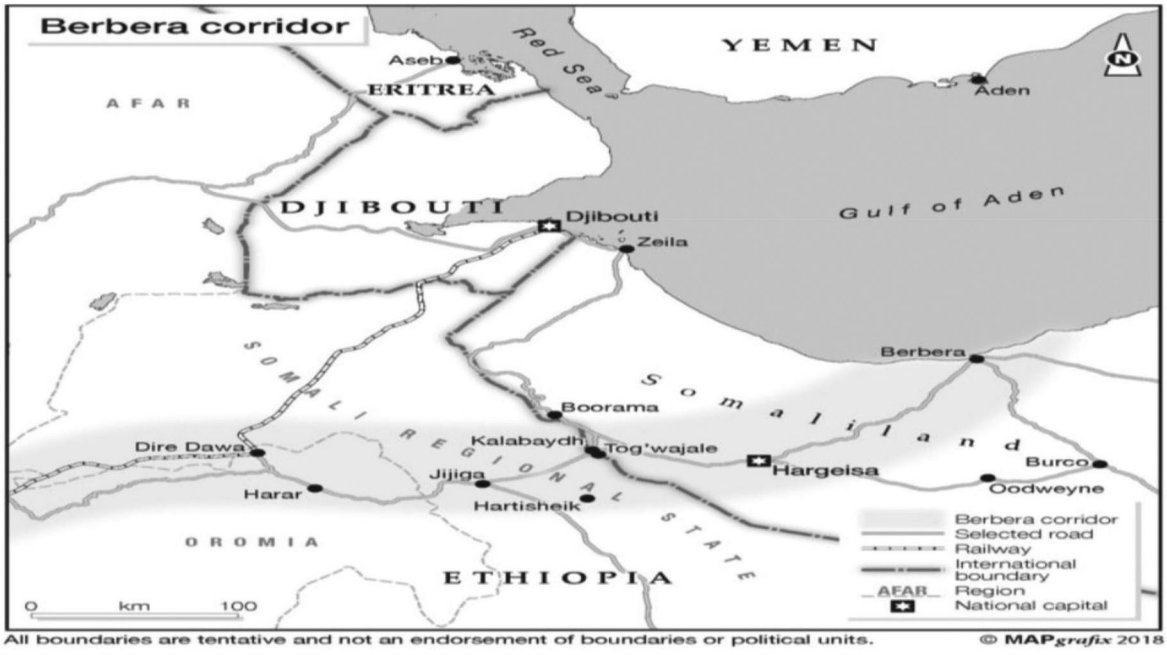

Figure 1. Map of the Study Area (Source: Stepputat & Hagmann (2019). Map showing the study area linking the Port of Berbera in Somaliland to the Ethiopian cities of Jijiga, Harar, and Dire Dawa.

weather station (ID: MRS_WGBER) via the Food and Agriculture Organization's Somalia Water and Land Information Management (FAO-SWALIM) public data portal (FAO-SWALIM, 2024). Mean annual temperature data for the period 2015–2024 were derived from the ERA5 global reanalysis dataset (Hersbach et al., 2020), which was accessed via the Meteoblue climate data interface.

The primary data collection targeted fisheries-dependent households, with the sampling frame, based on an informal 2022 list of 1,008 households obtained from the Ministry of Livestock and Fisheries Development (MoLFD). A two-stage sampling procedure was used to select the participants. First, a representative sample of 286 households was determined from a population of 1,008 using Yamane's formula (95% confidence level, 5% margin of error). These households were selected using a systematic random sampling technique, in which a constant sampling interval was applied after a randomly chosen starting point was selected. The household list provided by the Ministry was not ordered by location or cooperative membership, ensuring that the systematic selection produced spatially dispersed coverage across different fishing areas and cooperatives in the region. The demographic composition of the sample closely mirrored the 2022 household frame, with similar distributions of gender, age structure, and household size, indicating that the selected households were broadly representative of the wider fishing population. In addition, purposive sampling was used to select participants for eight Key Informant Interviews (KIIs) and four Focus Group Discussions (FGDs), targeting individuals with specific knowledge and experience, such as community leaders, ministry officials, and fishers.

$$n = \frac{N}{1 + N\left(e^2\right)}$$

$$\mathrm{n} = \frac{1008}{1 + 1008\left(0.05^2\right)} = 286$$

where n is the sample size, N is the total number of registered fishers, and e is the error margin.

Primary data were collected directly from the field using three instruments. For the quantitative component, a structured questionnaire was administered to the 286 selected households to gather data on socio-demographics, climate change perceptions, impacts, and adaptation strategies. For the qualitative component, semi-structured topic guides were used to facilitate the KIIs and FGDs, while non-participant observation was employed to record behavioral patterns, fishing practices, and environmental conditions at landing sites and markets. This triangulation of methods allowed for a more comprehensive understanding of fishers' adaptive behaviors and contextual realities.

2.3. Data analysis

The data collected were analyzed using descriptive and inferential statistics in STATA version 17.0. Descriptive statistics were used to summarize the respondents' demographics, climate change perceptions, and adaptation strategies. A binary logistic regression was employed to identify the factors influencing adaptation. This methodological choice was made to directly address the study's central research question: why the Berbera fisheries community's high awareness of climate change has not translated into widespread proactive adaptation. In this context, the adoption of 'switching fishing gear' (coded as 1 = yes, 0 = no) was selected as the dependent variable because it serves as a robust proxy for high-barrier, proactive adaptation, which is distinct from lower-cost, reactive coping mechanisms. While a multinomial logistic model could analyze the choice between various strategies, it would be less effective in isolating the specific factors that enable fishers to break from a short-term coping. Therefore, a focused binary model was chosen for its conceptual clarity and superior ability to investigate the substantial barriers hindering such proactive measures.

A set of independent variables, gender, age, household size, education, income, access to services, and fishing experience, was initially selected based on the literature review. However, a rigorous multicollinearity assessment revealed that sex, age, and household size were empirically redundant with other predictors, threatening the model's stability. Alternative methods, such as Principal

Component Analysis (PCA), were explored, but the resulting components lacked the conceptual clarity needed for actionable policy recommendations. Therefore, these redundant variables were excluded to ensure a parsimonious, stable, interpretable model. Crucially, the four variables retained: education and fishing experience (Human Capital), monthly income (Financial Capital), and access to services (proxy for Physical and Social Capital) were the most directly representative of the core livelihood capitals defined by the Sustainable Livelihoods Approach (SLA). The final model included four key predictors: education (low vs. high), monthly income (less than $200 vs. $200 and above), access to services (low vs. moderate to high), and fishing experience (low vs. high). To ensure the absence of multicollinearity among the predictors, the Variance Inflation Factors (VIF) were computed, and all values were found to be below the conventional threshold of 10, indicating acceptable levels of multicollinearity.

Qualitative data from the Key Informant Interviews, Focus Group Discussions, and observations were analyzed using thematic analysis. This involved a systematic process of organizing the data, coding it to identify recurring concepts, and grouping the codes into broader, explanatory themes. The resulting themes were then used to interpret and provide narrative context to the quantitative findings, offering deeper insights into the fishing community's lived experiences.

3. Results

3.1. Socio-demographic of the respondents

The socio-demographic profiles of the respondents (n = 286) revealed a community with distinct characteristics that shape its vulnerability and adaptive capacity (Table 1). The fishery is predominantly male (79.37%), which is a common feature in the sector. A significant portion of respondents (61.88%) had a lower level of formal education, and the majority (63.30%) earned less than 200 USD per month, indicating widespread economic vulnerability in the community. Households were often large, with 38.50% having eight or more members, suggesting reliance on extended family structures. While most respondents (55.24%) reported moderate to high access to operational services such as mobile phones and electricity, nearly half (44.76%) had limited access to essential needs such as credit, healthcare, and safe drinking water. Notably, most fishers (62.60%) had 15 years or less of fishing experience, indicating a predominance of new entrants in the sector.

3.2. Perceptions and lived experiences of climate change

An overwhelming majority of respondents (96%) reported that they had personally experienced the effects of climate change (Figure 2), indicating that climate change was not an abstract concept but a lived reality. This high level of awareness was further illuminated by the specific climatic changes observed (Table 2). The most frequently reported high-impact phenomena were increased wind strength (72.1%), temperature fluctuations (62.9%), recurrent cyclones (61.9%), and intense storm surges

Table 1. Socio-demographic characteristics of respondents.

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Female	59	20.63
	Male	227	79.37
Education Level	Lower Education	177	61.88
	Higher Education	109	38.12
Age Group	Young (≤35 years)	104	36.40
	Middle (36–50 years)	119	41.60
	Older (≥51 years)	63	22.00
Household Size	1–4 Members	75	26.20
	5–7 Members	101	35.30
	8 Or More Members	110	38.50
Monthly Income	Incomes less than 200 USD	181	63.30
	Incomes above 200 USD	105	36.30
Access to Service	Limited Access	128	44.76
	Moderate to High Access	158	55.24
Fishing Experience	Low Experience (≤15 years)	179	62.60
	High Experience (≥15 years)	107	37.40

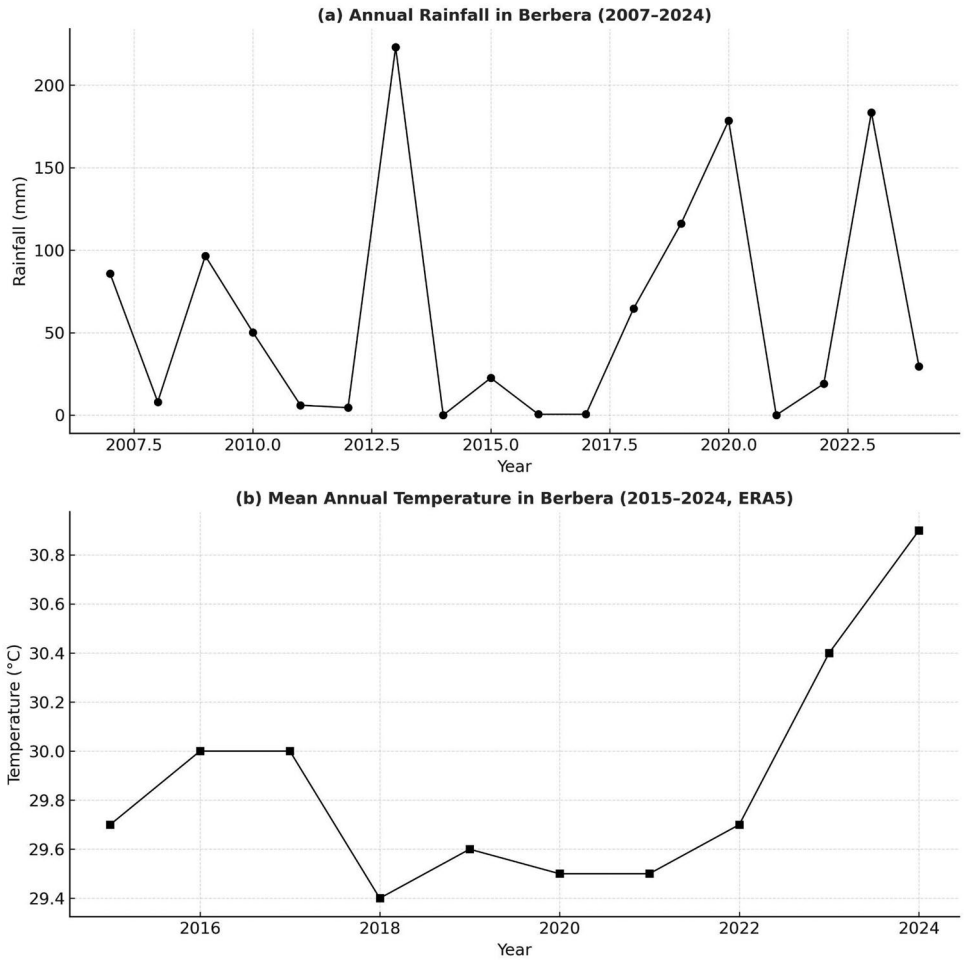

Figure 2. Climatic Trends in Berbera, Showing Annual Rainfall Variability and Rising Mean Annual Temperature.
(a) Annual rainfall (2007–2024) showing high interannual variability.
(b) Mean annual temperature (2015–2024, ERA5) shows a warming trend.

Table 2. Perceived ranking of coastal climate change effects on fisheries in berbera, somaliland.

Climate change and variability pattern	Low freq (%)	Moderate freq (%)	High freq (%)
Winds strengths	11 (3.8%)	69 (24.1%)	206 (72.1%)
Temperature fluctuation	26 (9.1%)	80 (28.0%)	180 (62.9%)
Recurrent cyclones	46 (16.1%)	63 (22.0%)	177 (61.9%)
Strong storm surge	45 (15.7%)	77 (27.0%)	164 (57.3%)
Floods	44 (15.4%)	94 (32.9%)	148 (51.7%)
Water currents and tides	86 (30.1%)	83 (29.9%)	117 (41.0%)
Sea level changes	64 (22.4%)	132 (46.2%)	90 (31.4%)

(57.3%). Overall, the rankings illustrate that sudden and extreme weather events are viewed as the most immediate and damaging climate risks to fisheries, aligning with local observations and lived experiences.

Qualitative data from the KIIs and FGDs provided a deeper context for these perceptions of the participants. Long-term fishers, particularly those with over 20 years of experience, described noticeable shifts in the timing and intensity of seasonal weather patterns in the area. One key informant stated, 'The seasons are no longer predictable. The winds are stronger than before, and they come at the wrong times, making it dangerous to go to sea'. This local ecological knowledge confirms that sudden and extreme weather events are viewed as the most immediate and damaging climate risks, disrupting traditional fishing cycles and creating greater uncertainty.

Climatic data for Berbera confirms a pattern of increasing variability and warming, corroborating the community's perception of environmental change. Instrumental records from 2007 to 2024 show

marked inter-annual rainfall fluctuations, with extremely dry years (e.g., 2008, 2011, and 2017) contrasting with significantly wetter years (e.g., 2009, 2016, and 2018), underscoring the region's precipitation unpredictability (Figure 2). Concurrently, ERA5 reanalysis data revealed a statistically significant warming trend ($p < 0.05$), with the mean annual temperature rising from 29.4 °C in 2018 to 30.9 °C in 2024 and consistently exceeding 30 °C since 2022. These empirical findings closely align with local accounts of stronger winds, recurrent cyclones, and storm surges (Table 2), demonstrating that climate change in this region is a tangible, experiential phenomenon. This convergence of scientific evidence and lived experience validates local perceptions of risk and underscores the heightened vulnerability of coastal livelihoods, particularly fisheries, to extreme events and long-term climatic shifts.

3.3. Perceived impacts on fisheries and livelihoods

When asked about the effects of these climatic changes, the most significant impact perceived by the respondents was reduced production (28.0%), followed by damage or destruction of equipment (22.0%) (Figure 3). Other critical impacts included submerged or sunken boat gears (11.2%) and damage to landing sites (9.8%), highlighting the direct threat posed to fishing operations.

The FGDs emphasized the cascading economic consequences of these impacts. Participants explained that erratic weather leads to fewer fishing days, while declining fish stocks require longer trips, increasing the operational costs for fuel and supplies. As one fisher in an FGD noted, 'We spend more on fuel to go further out, but we come back with fewer fish. Sometimes our nets are destroyed by the strong currents or cyclones, and we have no money to replace them'. The lack of supporting infrastructure, such as cold storage and stable market access, has been consistently cited as a factor that exacerbates these economic challenges and deepens community vulnerability.

During field observations conducted along the Berbera coast, several important visual insights were noted that reinforce the quantitative and qualitative findings. Most fishers were observed using small, open boats that are highly vulnerable to strong winds and turbulent sea conditions. The landing sites lacked adequate infrastructure, such as cold storage facilities, boat repair sheds, and protective shelters. Damaged nets and worn-out fishing gear were commonly seen along the shore, reflecting the limited financial capacity of fishers to maintain or replace essential equipment. These direct observations confirm the community's heavy reliance on traditional, low-technology practices and their exposure to the growing climatic risks described in the survey and interview data.

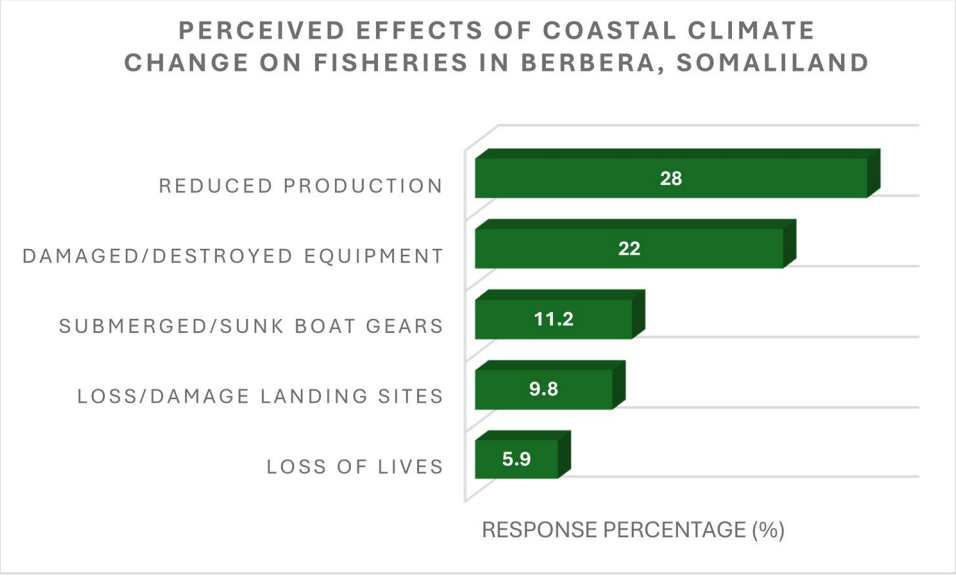

Figure 3. Perceived Effects of Climate Change on Fisheries in Berbera.

3.4. Adaptation strategies and constraints to adaptive capacity

3.4.1. Adopted adaptation strategies

In response to these impacts, the fishing community adopted a range of adaptation strategies (Table 3). The most common was a distress strategy: selling assets or livestock (99.3%) to cope with financial shocks. Other frequently used strategies included changing fishing locations (77.3%), seeking safe shelter during extreme weather (70.1%), and adjusting or extending fishing time (59.1% and 58.0%, respectively). The qualitative findings confirmed that these strategies are largely reactive and informal. A fisher explained, 'When the weather is bad for a week, we have no choice but to sell a goat or borrow money to feed our families. There is no formal support'. Engagement in more technical or long-term adaptation, such as using more efficient gear (49.3%) or switching gear types (45.5%), was less common, suggesting constraints in accessing technology and resources.

3.4.2. Constraints to adaptive capacity

Our quantitative findings identified financial barriers (31.0%), technical and material limitations (28.2%), and knowledge and awareness gaps (28.0%) as the primary constraints to proactive adaptation (Figure 4). While institutional weaknesses were ranked lowest in the survey (12.8%), our qualitative findings consistently revealed this to be a foundational cause that underpins and exacerbates the more highly ranked barriers. Qualitative data allowed for a systematic assessment of these institutional failures, which manifested in three critical areas: First, the participants consistently cited governance failures related to the lack of long-term, coordinated planning. This issue is exemplified by the prevalence of short-term, top-down projects that fail to build sustainable capacity. As a community elder remarked, 'The government and NGOs come with short-term projects, but they do not ask us what we need. When the project ends, we will be back where we started'. This cycle of temporary interventions directly contributes to financial

Table 3. Respondents' adaptive strategies to climate variability and change.

Adaptation strategy	Description	Frequency	Percentage
Selling assets or livestock	Selling assets to cope with shocks.	284	99.3%
Changing fishing location	Relocating fishing activities to target alternative species	221	77.3%
Seeking safe shelter	Seeking immediate refuge during extreme weather, events, and climate.	203	70.1%
Adjusting fishing days	Changes in the number of fishing days, response, climate, and driven variability are observed.	169	59.1%
Extending fishing time	Spending extended hours at sea, maintaining catch levels, and addressing environmental issues.	166	58.0%
Using efficient gear	Employing advanced gear, offset, impacts, and reduced fish availability.	141	49.3%
Switching fishing gear	Switching, modifying, gear, suit, altered, marine, conditions, climate.	130	45.5%

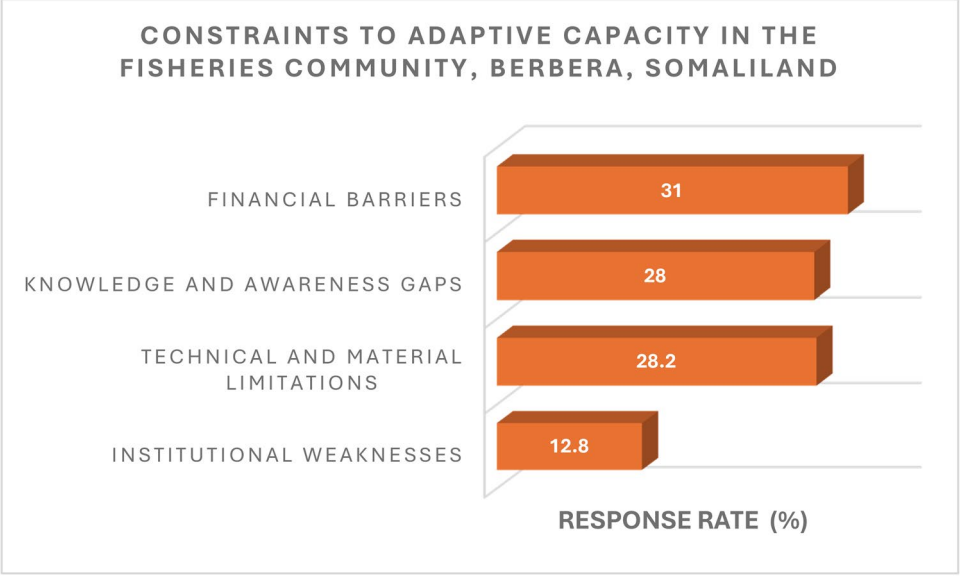

Figure 4. Constraints to Adaptive Capacity.

barriers (31.0%) by preventing the accumulation of capital and fostering dependency rather than self-sufficiency. Second, a significant regulatory and implementation gap was identified in the provision of training and extension services in the sector. The absence of sustained institutional support for skills development directly perpetuates the knowledge (28.0%) and technical (28.2%) limitations reported in this survey. This connection was clearly articulated by an FGD participant who noted, 'We are willing to learn new ways, but we need someone to teach us and help us get the right tools'. Finally, these issues highlight how the adaptive potential of the community is constrained by institutional inaction. While factors such as education and income are important, our integrated findings show that this potential remains largely untapped. Addressing specific governance and implementation failures is therefore critical to unlocking the community's ability to overcome the financial, technical, and knowledge barriers they face.

3.5. Determinants of the adoption of climate change adaptation strategy

The binary logistic regression model (Table 4) provides a clear empirical answer to the study's central question, demonstrating a strong fit (Pseudo R^2 = 0.705) and high significance (χ^2 = 277.81, $p < 0.001$). The results reveal that the transition from climate awareness to proactive adaptation is contingent on four key socioeconomic factors. The odds of switching gear—our proxy for high-commitment adaptation were 7.9 times higher for fishers with higher education ($p = 0.017$) and 11.7 times higher for those with a monthly income above $200 ($p = 0.021$). The effect was even stronger for access to services, which increased the odds by a factor of 16.9 ($p = 0.001$). Most strikingly, high fishing experience increased the odds of adoption by 57.1 times ($p = 0.002$). These findings demonstrate that overcoming the barriers to proactive adaptation is not merely a matter of awareness but a function of having the necessary human and financial capital to invest in long-term resilience.

4. Discussion

This study assessed the vulnerability and adaptive capacity of the Berbera fisheries community to climate change, revealing a cycle of high vulnerability driven by climate impacts and a constrained adaptive capacity rooted in socioeconomic and institutional factors. The overwhelming consensus among respondents who have personally experienced climate change aligns with the research across the African continent. Fishers from West Africa, including Senegal (Diouf et al., 2020) and Togo (N'Souvi et al., 2024), and East Africa, such as Uganda (Musinguzi et al., 2016)), consistently report high levels of perception. In Senegal, for instance, Diouf et al. (2020) found that 96% of fisherfolk perceived climate shifts, such as coastal erosion and changing winds, whereas in Togo, fishers noted rising temperatures and erratic rainfall (N'Souvi et al., 2024). This confirms that fishers are on the front line of climate impacts. However, the specific threats perceived in Berbera, such as strong winds, temperature fluctuations, and recurrent cyclones, are uniquely associated with its semi-arid coastal environment. This high perception is not merely an observation; it is a lived reality, compounded by the community's socioeconomic profile. With most earning less than $200 per month, having low formal education, and supporting large households, their capacity to absorb climate-related shocks is inherently limited. This combination of high perception

Table 4. Binary logistic regression results for factors influencing the adoption of switching fishing gear.

Predictor	Odds ratio (or)	Std. Err.	z	p-value	95% conf. Interval
Education					
Higher Education	7.87	6.80	2.39	0.017*	[1.45, 42.79]
Monthly Income					
Above $200 USD	11.71	12.47	2.31	0.021*	[1.45, 94.42]
Access to Services					
Moderate to High Access	16.94	14.96	3.20	0.001***	[3.00, 95.67]
Fishing Experience					
High Experience	57.14	73.62	3.14	0.002**	[4.57, 713.92]
N = 286	LR χ^2 (4) = 277.81 Pseudo R^2 = 0.7049		Prob > χ^2 <0.001		

***$p < 0.001$.
**$p < 0.01$.
*$p < 0.05$.

and acute vulnerability confirms that climate change is a direct and immediate threat to their precarious livelihoods, rather than a distant issue.

This pattern mirrors the findings from Somaliland's agricultural sector, indicating a broader 'awareness–adaptation gap' within the nation's primary livelihood sectors. For instance, a study of smallholder farmers in the Gabiley Region found that while awareness of climate change was remarkably high (86.5%), the adoption of adaptation strategies remained low (45%) (Omer et al., 2025). This parallel between Berbera's fisheries and Gabiley's farms suggests a systemic barrier preventing awareness from translating into effective action across different contexts in Somaliland.

This awareness adaptation gap is starkly reflected in the strategies employed by the Berbera community, which are heavily skewed towards reactive, short-term coping mechanisms rather than proactive, long-term adaptation. The near-universal reliance on selling assets or livestock is a distress indicator, pointing to a severe lack of financial resilience. While strategies like changing fishing locations and fishing time highlights their reactive approach are common adaptive responses in communities from Togo (N'Souvi et al., 2024) and Ghana (Mabe & Asase, 2020), their dominance in Berbera, coupled with the low adoption of more technical adaptations like switching gear (45.5%), highlights a significant 'adaptation deficit'. This situation contrasts sharply with the findings from coastal Tanzania, where Silas et al. (2020) documented a widespread shift from nearshore to more productive offshore fishing, a move enabled by a corresponding switch in gear from beach seines to ring nets. The Berbera community's limited ability to make similar shifts suggests they are trapped in a cycle of prioritizing immediate survival over long-term sustainability.

Applying the Sustainable Livelihoods Approach (SLA) highlights that the adaptive capacity of the Berbera fisheries community is shaped by the conditions and interactions of key livelihood capitals. Human capital, manifested through education and fishing experience, enhances the ability to interpret climate signals and implement adaptive strategies. Financial capital, reflected in household income, determines the feasibility of investing in improved gear, diversification, and risk-reducing measures. Access to services, which represent both social and physical capital, facilitates market participation, information exchange, and institutional support. Deficiencies across these capitals collectively constrain proactive adaptation, reinforcing dependence on short-term coping strategies. Addressing these imbalances is therefore central to strengthening livelihood resilience and fostering sustainable adaptation. The dominance of these reactive coping mechanisms can be explained by deficits in multiple livelihood capital. Our logistic regression analysis confirmed the critical role of human capital (measured through education and fishing experience) and financial capital (measured by income). Access to services, which can be considered a proxy for both physical capital (infrastructure) and social capital (networks and support systems), is also a key enabler. This demonstrates that the ability to adopt proactive strategies is fundamentally contingent on a household's existing asset base, consistent with the literature from Malawi and Ghana, which also identified socioeconomic factors as critical determinants of adaptive capacity (Ayisi et al., 2024; Limuwa et al., 2018). Conversely, the identified constraints, financial barriers, technical limitations, and knowledge gaps explain why most fishers remain trapped in the reactive cycles of poverty. This is a common theme, with N'Souvi et al. (2024) similarly finding that a lack of financial assets and technology in Togo prevents fishers from moving beyond basic coping, despite their expressed desire for training and more sustainable practices.

These socioeconomic constraints (financial, technical, and knowledge gaps) are fundamentally rooted in a systemic and institutional vacuum. This failure is corroborated by recent regional research demonstrating that Somaliland's Early Warning Systems (EWS) are only partially functional, suffering from fragmented coordination, resource inadequacy, and communication failures (Omer et al., 2026). The EWS analysis further confirmed that the system disproportionately fails to reach the most vulnerable women and less-educated individuals, mirroring the demographic disparities that limit adaptive capacity in the fisheries sector. Institutionally, while quantitative data ranked governance weakness as the lowest, qualitative findings revealed it as a foundational barrier that shapes all other constraints. The mismatch between local cooperatives, whose capacity and authority are limited, and national policy frameworks that emphasize industrial growth have created structural disconnects. This misalignment reduces the ability of local institutions to channel resources, enforce regulations, and effectively represent fishers' interests. Strengthening institutional linkages across these scales is essential for enabling community-driven

adaptations. The structural disconnect described here is a direct consequence of the broader development context: the state's immense focus on large-scale infrastructure, such as the Berbera Corridor (Stepputat & Hagmann, 2019), likely diverts attention and resources away from the needs of traditional livelihoods. This marginalization leaves the small-scale fishing sector unsupported against external pressures from foreign fleets (Pollnac et al., 2018), creating an environment where individual efforts to adapt are consistently undermined.

Although this study offers valuable baseline insights, it has several limitations. First, the cross-sectional design provides a 'snapshot' in time and cannot establish causality or capture the dynamic nature of adaptation processes that unfold seasonally or over longer periods of time. Second, reliance on self-reported data introduces the potential for recall errors and social desirability bias, particularly concerning income and adaptive behaviors. Third, the sampling frame, an informal 2022 list, may not fully capture recent demographic shifts due to migration, which is a potential source of sampling bias. Fourth, while this study documents the portfolio of adaptation strategies, it does not quantify their frequency or intensity (e.g., how many days fishing was adjusted), which is an important area for future longitudinal research. Finally, the sample included a limited number of women, which may not fully capture the unique adaptation challenges and capacities related to gender roles. Despite these constraints, this study serves as a critical foundational assessment, highlighting clear directions for future longitudinal and sex-disaggregated studies.

5. Conclusion and recommendations

This study concludes that the fisheries community in Berbera is characterized by a dangerous paradox of high vulnerability to climate change coupled with low adaptive capacity. The community's vulnerability is evident in their acute perception of climate risks, such as increased wind strength and temperature fluctuations, and the tangible consequences they face, including reduced production and damaged equipment. This vulnerability is exacerbated by their reliance on reactive, short-term coping strategies, particularly distress asset sales, which underscore a severe lack of financial resilience. This situation is compounded by a severely constrained adaptive capacity, driven by significant financial barriers, technical limitations, and knowledge gaps, all underpinned by foundational institutional weaknesses. Ultimately, this study fills a critical empirical gap by revealing a community that understands the crisis but lacks the necessary resources and support to build long-term resilience. They are trapped in a cycle where immediate survival needs consistently override the potential for proactive and sustainable adaptation. Based on this study of high vulnerability and low adaptive capacity, a two-pronged strategic approach is recommended to address the challenges facing Berbera fisheries. First, to reduce immediate vulnerability to climate-related shocks, development partners and NGOs should provide targeted short-term support. As an immediate priority, this should include training in financial literacy, the establishment of community-based savings and loan groups, improved post-harvest handling techniques to reduce waste, and basic equipment maintenance skills to prolong the life of essential assets in the fisheries sector. These interventions are designed to build foundational household resilience and provide a buffer against the most immediate effects of climate variability. Simultaneously, to build long-term systemic adaptive capacity, a comprehensive strategy led by government bodies is essential. Policymakers must collaborate with fisher cooperatives to develop and implement a localized fisheries co-management plan in Berbera. This plan should include clear zoning, sustainable gear regulations, and public investment in critical infrastructure such as cold storage facilities and improved landing sites. Furthermore, to ensure sustainability, this strategy should be complemented by initiatives that support viable livelihood diversification into related fields such as boat repair, fish processing, and net making. These long-term actions are crucial for moving the community from a state of coping to a state of robust and sustainable adaptation. Finally, future research should expand on this work through comparative studies along the Somaliland coast to inform and refine policy changes over time.

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Ethical approval

The Ethical approval was granted by the Research Ethics Review Committee at the University of Hargeisa (Ethical Clearance No. DRCS/39/08/2022). The committee approved the use of verbally informed consent, which was chosen due to low literacy rates and cultural appropriateness for the community. All data were anonymized to protect participant confidentiality.

Author contributions

CRediT: **Mohamed Abdullahi Omer**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing; **Hamud Ali Mohamoud**: Conceptualization, Data curation, Methodology, Project administration, Validation.

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Data availability statement

Data supporting this study are available from the corresponding author upon reasonable request.

References

Abdulkadir, G. (2017). Assessment of drought recurrence in Somaliland: Causes, impacts and mitigations. *Journal of Climatology & Weather Forecasting*, *05*(02). https://doi.org/10.4172/2332-2594.1000204

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine Policy*, *25*(5), 377–388. https://doi.org/10.1016/S0308-597X(01)00023-9

Aswani, S., Howard, J. A. E., Gasalla, M. A., Jennings, S., Malherbe, W., Martins, I. M., Salim, S. S., Van Putten, I. E., Swathilekshmi, P. S., Narayanakumar, R., & Watmough, G. R. (2019). An integrated framework for assessing coastal community vulnerability across cultures, oceans and scales. *Climate and Development*, *11*(4), 365–382. https://doi.org/10.1080/17565529.2018.1442795

Ayisi, C. L., N'souvi, K., Baidoo, K., Asare-Nuamah, P., Larbi, I., Asiamah, T. A., Alhassan, E. H., & Ayeh, S. O. (2024). Perception of climate change and adoption of climate smart fisheries among artisanal fishers. *Sustainable Technology and Entrepreneurship*, *3*(3), 100072. https://doi.org/10.1016/j.stae.2024.100072

Badjeck, M.-C., Allison, E. H., Halls, A. S., & Dulvy, N. K. (2010). Impacts of climate variability and change on fishery-based livelihoods. *Marine Policy*, *34*(3), 375–383. https://doi.org/10.1016/j.marpol.2009.08.007

Cashion, T., Glaser, S. M., Persson, L., Roberts, P. M., & Zeller, D. (2018). Fisheries in Somali waters: Reconstruction of domestic and foreign catches for 1950–2015. *Marine Policy*, *87*, 275–283. https://doi.org/10.1016/j.marpol.2017.10.025

Diouf, N. S., Ouedraogo, I., Zougmoré, R. B., & Niang, M. (2020). Fishers' perceptions and attitudes toward weather and climate information services for climate change adaptation in Senegal. *Sustainability*, *12*(22), 9465. https://doi.org/10.3390/su12229465

FAO-SWALIM. (2024). *Somalia water and land information management (FAO-SWALIM)* https://Climseries.Faoswalim.Org/Rainfall/Data/Mrs/MRS_WGBER

Ferrol-Schulte, D., Wolff, M., Ferse, S., & Glaser, M. (2013). Sustainable livelihoods approach in tropical coastal and marine social–ecological systems: A review. *Marine Policy*, *42*, 253–258. https://doi.org/10.1016/j.marpol.2013.03.007

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., Nicolas, J., Peubey, C., Radu, R., Schepers, D., Simmons, A., Soci, C., Abdalla, S., Abellan, X., Balsamo, G., Bechtold, P., Biavati, G., Bidlot, J., Bonavita, M., … Thépaut, J. (2020). The ERA5 global reanalysis. *Quarterly Journal of the Royal Meteorological Society*, *146*(730), 1999–2049. https://doi.org/10.1002/qj.3803

Hobday, A. J., Cochrane, K., Downey-Breedt, N., Howard, J., Aswani, S., Byfield, V., Duggan, G., Duna, E., Dutra, L. X. C., Frusher, S. D., Fulton, E. A., Gammage, L., Gasalla, M. A., Griffiths, C., Guissamulo, A., Haward, M., Jarre, A., Jennings, S. M., Jordan, T., … van Putten, E. I. (2016). Planning adaptation to climate change in fast-warming marine regions with seafood-dependent coastal communities. *Reviews in Fish Biology and Fisheries*, *26*(2), 249–264. https://doi.org/10.1007/s11160-016-9419-0

Limuwa, M. M., Sitaula, B. K., Njaya, F., & Storebakken, T. (2018). Evaluation of small-scale fishers' perceptions on climate change and their coping strategies: Insights from Lake Malawi. *Climate*, *6*(2), 34. https://doi.org/10.3390/cli6020034

Mabe, F. N., & Asase, A. (2020). Climate change adaptation strategies and fish catchability: The case of inland artisanal fishers along the Volta Basin in Ghana. *Fisheries Research*, *230*, 105675. https://doi.org/10.1016/j.fishres.2020.105675

Makame, M. O., & Shackleton, S. (2020). Perceptions of climate variability and change in relation to observed data among two east coast communities in Zanzibar, East Africa. *Climate and Development*, *12*(9), 801–813. https://doi.org/10.1080/17565529.2019.1697633

March, A., & Failler, P. (2022). Small-scale fisheries development in Africa: Lessons learned and best practices for enhancing food security and livelihoods. *Marine Policy*, *136*, 104925. https://doi.org/10.1016/j.marpol.2021.104925

Muchuru, S., & Nhamo, G. (2018). Climate change adaptation and the African fisheries: Evidence from the UNFCCC National Communications. *Environment, Development and Sustainability*, *20*(4), 1687–1705. https://doi.org/10.1007/s10668-017-9960-6

Muringai, R. T., Mafongoya, P. L., & Lottering, R. (2021). Climate change and variability impacts on Sub-Saharan African fisheries: A review. *Reviews in Fisheries Science & Aquaculture*, *29*(4), 706–720. https://doi.org/10.1080/23308249.2020.1867057

Musinguzi, L., Efitre, J., Odongkara, K., Ogutu-Ohwayo, R., Muyodi, F., Natugonza, V., Olokotum, M., Namboowa, S., & Naigaga, S. (2016). Fishers' perceptions of climate change, impacts on their livelihoods and adaptation strategies in environmental change hotspots: A case of Lake Wamala, Uganda. *Environment, Development and Sustainability*, *18*(4), 1255–1273. https://doi.org/10.1007/s10668-015-9690-6

N'Souvi, K., Adjakpenou, A., Sun, C., & Ayisi, C. L. (2024). Climate change perceptions, impacts on the catches, and adaptation practices of the small-scale fishermen in Togo's coastal area. *Environmental Development*, *49*, 100957. https://doi.org/10.1016/j.envdev.2023.100957

Omar, A. O., Alasow, A. A., Farah, A. A., & Shahid, S. (2024). Spatiotemporal analysis of agricultural drought severity and hotspots in Somaliland. *International Journal of Sustainable Development and Planning*, *19*(11), 4135–4146. https://doi.org/10.18280/ijsdp.191104

Omer, M. A. (2024a). Climate variability and livelihood in Somaliland: a review of the impacts, gaps, and ways forward. *Cogent Social Sciences*, *10*(1). https://doi.org/10.1080/23311886.2023.2299108

Omer, M. A. (2024b). Climate variability, food security, and adaptation strategies in Somaliland a review. In *Regional Environmental Change*, *24*(3). https://doi.org/10.1007/s10113-024-02270-z

Omer, M. A., Abdi, A. M., & Mohamed, A. J. (2026). Assessing the effectiveness of early warning systems in Somaliland: Functionality, community response, and system gap. *European Journal of Sustainable Development Research*, *10*(1), em0344. https://doi.org/10.29333/ejosdr/17281

Omer, M. A., Muhumed, S. M., Mohamed, A. J., & Ahmed, M. E. (2025). Perceptions of climate variability, adaptation strategies, and their determinants among smallholder farmers in the Gabiley Region, Somaliland. *Discover Sustainability*, *6*(1), 1012. https://doi.org/10.1007/s43621-025-01543-9

Painter, S. C., Popova, E., & Roberts, M. J. (2022). An introduction to East African Coastal Current ecosystems: At the frontier of climate change and food security. *Ocean & Coastal Management*, *216*, 105977. https://doi.org/10.1016/j.ocecoaman.2021.105977

Pollnac, R. B., Hagos, K. W., Crawford, B. R., Dahir, A. M., Yusuf, H. H., & Hussein, A. M. (2018). Chaos, conflict and change: The reemergence and evolution of fishery governance in the small scale fisheries of Somalia. *Ocean & Coastal Management*, *162*, 193–201. https://doi.org/10.1016/j.ocecoaman.2017.09.004

Sharmake, M. A., Sultan, K., Zaman, Q., Uz, Rehman, R., & Hussain, A. (2022). Decadal impacts of climate change on rainfed agriculture community in Western Somaliland, Africa. *Sustainability*, *15*(1), 421. https://doi.org/10.3390/su15010421

Sidi, L. S. (2015). *Adaptive capacity to climate change and food security among artisanal fisher folk in Rorya District, Tanzania*. Sokoine University of Agriculture. https://www.suaire.sua.ac.tz/handle/123456789/918

Silas, M. O., Mgeleka, S. S., Polte, P., Sköld, M., Lindborg, R., de la Torre-Castro, M., & Gullström, M. (2020). Adaptive capacity and coping strategies of small-scale coastal fisheries to declining fish catches: Insights from Tanzanian communities. *Environmental Science & Policy*, *108*, 67–76. https://doi.org/10.1016/j.envsci.2020.03.012

Stepputat, F., & Hagmann, T. (2019). Politics of circulation: The makings of the Berbera corridor in Somali East Africa. *Environment and Planning D: Society and Space*, *37*(5), 794–813. https://doi.org/10.1177/0263775819847485

Ullah, S., Khan, U., Begum, A., Han, H., & Mohamed, A. (2024). Indigenous knowledge, climate change and transformations of Gwadar fishing community. *International Journal of Climate Change Strategies and Management*, *16*(3), 298–317. https://doi.org/10.1108/IJCCSM-06-2022-0069

Ullah, S., Khan, U., Ma, J., Rahman, K. U., & Turi, J. A. (2023). Reflections on development and fishermen's survival in Gwadar, Pakistan. *Journal of Infrastructure, Policy and Development*, *7*(2), 1957. https://doi.org/10.24294/jipd.v7i2.1957