Impact of climate change on the fishing communities of lake Itezhi-Tezhi of Zambia

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Abstract

Climate change poses growing challenges to inland fisheries and the livelihoods of communities that depend on them. This study examined the impacts of climate change on fishing communities around Lake Itezhi-Tezhi located at latitude -15.7592 and longitude 26.0175 in Southern Zambia. A mixed-methods approach was used, combining household surveys, key informant interviews, field observations and review of secondary data. Data were collected from 51 participants drawn from fishing communities and relevant institutions, with emphasis on community perceptions of rainfall patterns, lake water levels, fish catch volumes and associated socio-economic effects over the period 2015 to 2025.The results show that most respondents perceived noticeable changes in rainfall patterns and lake water levels, with 82 percent reporting changes in rainfall and 78 percent observing changes in water levels in the lake. Perceptions of fish catch trends indicated a general decline, as the majority of respondents (86%) reported reduced catches over the past decade, although a small proportion of 8% perceived stability or improvement. These environmental changes were associated with declining income from fishing and increased food insecurity among fishing households where 74% of participants report decline in fisher men income. The findings highlight the vulnerability of artisanal fishing communities to climate variability and environmental change, while also underscoring the value of local knowledge in understanding climate impacts. The study emphasizes the need for integrated climate adaptation strategies, improved fisheries management and livelihood diversification to strengthen community resilience around Lake Itezhi-Tezhi.

Keywords: Climate change, Fishing communities, Fish catch volumes, Livelihoods, Lake Itezhi-Tezhi.

Introduction

Fishing has long served as a cornerstone economic activity for many communities, especially across generations in sub-Saharan Africa. The region's Great Lakes contribute significantly to fish production, yielding approximately 1.5 million tons annually and directly employing around 400,000 individuals, with countless more engaged along the value chain (World Bank, 2016; World Bank, 2025). Key fishing grounds include Lake Victoria, where over 200,000 fishers harvest close to one million tons per year (FAO, 2020), with recent reports highlighting that Kenya's aquaculture output from Lake Victoria rose to 33,423 tonnes in 2024, driven largely by cage farming (Kenya Fisheries Bulletin, 2024; The Conversation, 2025). Similarly, Lake Malawi produced an estimated 170,844 tons of fish in 2020 (FAO, 2020), but more recent assessments show production at around 240,000 tons annually, though catches are declining due to overfishing pressures (Times Group Malawi, 2025). Across the Great Lakes, fisheries continue to underpin food security and employment, with new policy frameworks emphasizing sustainable aquaculture and job creation to meet rising demand (ACARE, 2023; FAO, 2023).

In Zambia, fishing is predominantly practiced in major water bodies such as the Zambezi River and Lake Kariba, with species like tiger fish, bream, and trout forming the bulk of the catch. The fishing season typically spans May to October, aligning with the southern hemisphere winter, a period favorable to fish multiplication and growth. However, climate variability poses serious risks to this cycle and, by extension, to livelihoods dependent on fishing (WWF, 2020).

Globally, climate change presents an escalating threat to aquatic ecosystems and fisheries. Rising temperatures are disrupting ecological balances, threatening numerous flora and fauna species, and contributing to marine ecosystem degradation. In sub-Saharan Africa, fishing is increasingly compromised by global warming, which negatively impacts fish reproduction and growth, thereby reducing fish populations in lakes (World Bank, 2016). Concurrently, population growth has intensified demand for fish, leading to unsustainable fishing practices across the continent.

Recent observations around Lake Itezhi Tezhi in Zambia reveal declining fish catches and receding water levels, phenomena attributed to erratic rainfall patterns and prolonged dry seasons. Yet, the specific impacts on fishing communities and the adaptive responses of local fishers remain inadequately documented. This study aims to provide a nuanced understanding of how climate change is affecting fishing activities around Lake Itezhi Tezhi and the implications for community resilience and ecosystem sustainability (Kapembwa, 2020) [6].

Material and Methods

Study site description

Lake Itezhi-Tezhi is located at latitude -15.7592 and longitude 26.0175 in the southern region of Zambia within the Kafue River Basin, a sub-basin of the Zambezi River system. It lies within the administrative boundaries of Itezhi-Tezhi District in Southern Province. The lake was formed in the early 1970s following the construction of the Itezhi-Tezhi Dam, which was established to regulate water flow for the downstream Kafue Gorge hydroelectric power station (World Bank, 2010). At full capacity, the reservoir spans approximately 390 km^2 with an average depth of 9 meters. The lake is encircled by numerous rural communities that depend heavily on its natural resources. Fishing represents the dominant livelihood activity, engaging thousands of individuals both directly and indirectly. Artisanal fishing, characterized by the use of traditional gear and small boats, predominates, although some semi-commercial operations also exist. The primary fish species include bream (Oreochromis spp.), tiger fish (*Hydrocynus vittatus*), and catfish (*Clarias spp.*) (Musumali et al., 2009) [15].

The region falls under a tropical savanna climate, marked by three distinct seasons: a rainy season from November to April, a cool dry season from May to August, and a hot dry season spanning September to October. Rainfall is highly seasonal and has become increasingly erratic, largely influenced by climate variability, particularly the El Niño-Southern Oscillation (ENSO) phenomenon (Mulenga et al., 2017) [14].

Research design

The study adopted a mixed-methods research design combining both qualitative and quantitative approaches to gain a holistic understanding of the impacts of climate change on fishing communities. The rationale for this design was to triangulate findings for credibility and provide both empirical and narrative insights.

Data collection methods

1. Household survey

Household surveys were used to collect quantitative information from community members involved in fishing and related livelihood activities around Lake Itezhi-Tezhi. Structured questionnaires were administered to respondents to capture demographic characteristics as well as their perceptions of changes in rainfall patterns, lake water levels, and fish catch volumes over the past ten years. Respondents were also asked about how these perceived changes affected their fishing activities and household livelihoods. The survey responses formed the basis for calculating frequencies and percentages that were later presented in the results section.

2. Catch and effort monitoring

Information on catch and fishing effort was gathered through discussions with active fishermen. They described their typical practices, including fishing frequency, gear used, and species caught, and compared current catch levels with those of previous years. These perception-based accounts provided insights into trends in fish catch volumes between 2015 and 2025.

3. Environmental measurements

Environmental data were collected mainly through community observations and supported by available institutional records.

Respondents described observed changes in rainfall, lake water levels, and general lake conditions based on their daily interaction with the environment. These observations were used to understand local perceptions of climate variability rather than to generate precise measurements. Where available, secondary information from meteorological and fisheries institutions was consulted to provide background context to the community-reported changes.

4. Social-economic assessment mechanism

Socio-economic information was collected through interactions with fish traders and fishers around the lake. Respondents described perceived changes in fish prices and the costs of fishing inputs such as nets and fuel, and how these shifts affect their daily household management and overall livelihoods. These insights clarified the economic implications of declining fish catch volumes and informed the discussion on livelihood impacts.

5. Key informant interviews

Key informant interviews were conducted with fisheries officers, community leaders and fish traders who possessed detailed knowledge of fisheries management and local environmental changes. These interviews focused on governance issues, observed climate-related challenges, and changes in fishing practices. Insights from these discussions were used to support and interpret the findings from household surveys.

6. Participatory rural appraisal

Participatory approaches were used during community engagements to explore seasonal patterns, risk periods, and areas most affected by environmental change.

Participants described how fishing activities, rainfall and lake conditions varied across seasons. These exercises helped to contextualize survey findings and strengthened understanding of local adaptation strategies.

7. Narrative interviews

Narrative interviews were conducted through informal conversations with fishers who shared personal experiences of extreme weather events, poor fishing seasons, and changing lake conditions. These accounts offered deeper insight into how environmental changes were felt at the household level and enriched the interpretation of results.

8. Secondary data

Secondary data were reviewed from government institutions, meteorological records, and existing academic and development reports. These sources provided background information on fisheries management, climate variability, and livelihoods in the region. While not used for direct statistical analysis, the secondary data helped place the study findings within a broader regional and scientific context.

Sampling technique

A purposive sampling approach was used to identify individuals with extensive experiential knowledge of the lake and its transformations over time. Fifty-one key informants were intentionally selected for their unique longitudinal perspectives. This method suited the study's exploratory, community-centered design, where depth of insight was prioritized over statistical representativeness, consistent with the advantages outlined by Palinkas et al. (2015) [16].

Data analysis

Data was analysed using the Chi square goodness of fit test. The formula used to analyse the data is given below:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

χ^2 = chi squared

O_i = observed value

E_i = expected value

Fig 1: X^2 test for data collection: The formula was used to determine significance difference with in the results obtained.

Research ethical consideration

This study adhered to established ethical principles to ensure the protection and respect of all participants involved in the research process. Key measures included:

1. **Informed consent**: All participants were clearly briefed on the study's objectives, procedures, and their right to voluntary participation. Consent was obtained prior to engagement, with emphasis placed on the ability to withdraw at any stage without consequence.
2. **Confidentiality and Anonymity**: To safeguard participant identity, personal information was anonymized and handled with strict confidentiality. No names or identifying details were included in the final analysis or dissemination of findings.
3. **Cultural sensitivity**: The study respected the cultural norms, languages, and traditions of the communities involved. Research activities were conducted in a manner that honored local customs and minimized potential disruption or misunderstanding.
4. **Ethical clearance**: Approval to conduct the study was obtained from the relevant institutional review board prior to data collection, ensuring that the research met formal ethical standards for human subject research.

Results and Discussion

Trends in rainfall and water levels at lake Itezhi-Tezhi

Table 1: Observable Changes in Rainfall lowering

Response Category	Value
YES	82^a
NO	18^b
X^2 Value	40.96
Critical Threshold Value	3.841

Means with the same Superscript are not statistically different at P= 0.005, X^2 refers to Chi square value used to test hypotheses

The study revealed that 82% of respondents observed changes in rainfall patterns over the past 5–10 years as shown in table 1, indicating a perceptible departure from historical norms. This widespread recognition is likely linked to regional climatic fluctuations and broader global climate change dynamics. Importantly, these community-based observations correspond with hydrometeorological records that document erratic rainfall distribution across parts of Southern Africa (Makwata et al., 2017) [12]. The strength of this perception highlights disruptions in local ecological cues such as the timing and intensity of rains, raising concern among stakeholders whose livelihoods depend on rainfall stability. Furthermore, the significant chi-square result ($X^2 = 40.96 > 3.841$) as shown in table 1 demonstrates that the majority view, that rainfall declining, is not attributable to random variation but represents a statistically meaningful difference in perception. This reinforces the argument that rainfall decline is widely recognized and deeply felt among

On the other hand, 18% of the respondents did not notice a change in the rainfall pattern. This minority group, however, suggests that climatic impacts are not experienced uniformly, possibly due to localized microclimates, differing reference frames, or variations in ecological cues. Statistically, the chi-square test result ($X^2 = 40.96$) in table 1 far exceeds the critical threshold value of 3.841, confirming that the difference between the majority and minority responses is highly significant and not due to random variation. This means the widespread recognition of rainfall decline represents a real, meaningful perception among respondents. While the majority view strengthens the argument that rainfall instability is a pressing issue, the 18% minority response adds nuance, reminding researchers and policymakers that climate change impacts can be unevenly distributed and that adaptation strategies must account for diverse local experiences.

Table 2: Observable changes in water Levels at Lake Itezhi-Tezhi

Response Category	Value
YES	78^a
NO	22^b
X^2 Value	31.36
Critical Threshold Value	3.841

Means with the same Superscript are not statistically different at P= 0.005, X^2 refers to Chi square value used to test hypotheses

The perception of reduced water levels in Lake Itezhi-Tezhi, reported by 78% of respondents, underscores a visible environmental change with direct socio-economic implications. Given the lake's importance for fisheries, irrigation, and domestic water supply, declining levels signal potential stress on freshwater availability and ecosystem services. The statistical significance of the chi-square test ($X^2 = 31.36 > 3.841$) as shown in table 2, confirms that this majority view is not due to random variation but represents a meaningful difference in community perception. These local insights resonate with hydrological assessments that show climate change and upstream catchment dynamics are altering water regimes in the Zambezi Basin. For instance, the Joint Research Centre (2022) highlights that future climate change could reduce reservoir inflows and increase evaporation, affecting hydropower and water storage across dams such as Itezhi-Tezhi and Kariba. Similarly, Mayer (2024) [13] notes that the basin's highly variable climate, with erratic rainfall and flood events, has profound impacts on water availability and local livelihoods. Pfister and Godet (2007) [17] further emphasize that the construction and operation of Itezhi-Tezhi Dam itself altered the Kafue River's flow regime, with consequences for both ecological systems and communities dependent on fishing and grazing. Taken together, these findings highlight the importance of participatory monitoring, where indigenous knowledge and community observations complement satellite-based measurements and hydrological models, providing a more holistic understanding of environmental change.

Impacts of climate change on Fish Catch Volumes

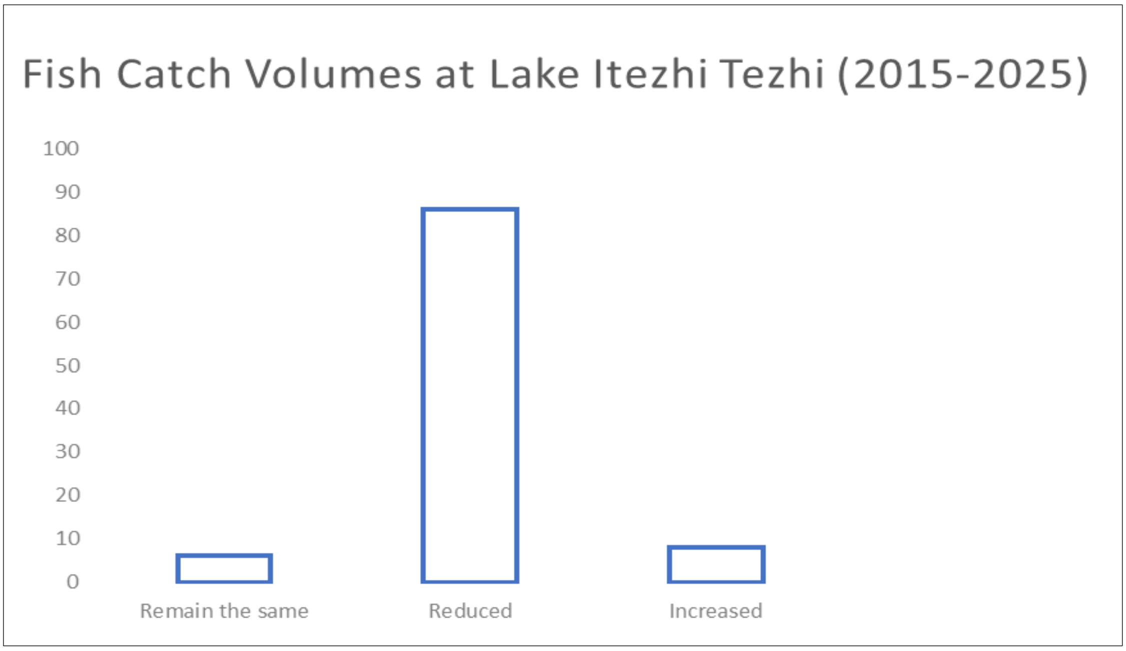

Fig 2: A bar graph showing fish catch volume perspectives for the past ten years (2015-2025)

When asked about fish catch volumes between 2015 and 2025, 86% of respondents perceived a decline, while 8% reported an increase and 6% indicated catches had remained the same as shown in figure 2. The predominance of perceived declines suggests that local communities believe fisheries productivity has reduced over the past decade, likely reflecting concerns about ecological changes, fishing pressure, or other environmental stressors. Importantly, the Chi-square test statistic ($\chi^2 = 126.5$, df = 2) far exceeds the critical threshold value of 5.991 at the 0.05 significance level, confirming that the differences in responses are statistically significant and not due to random variation. This means the majority perception of decline represents a real and meaningful difference in community experience.

The minority of respondents who perceived stable or increasing catches (6 %and 8 % respectively) indicate that experiences of fish availability are not uniform across the lake. These perceptions may reflect differences in fishing locations, seasonal variations, or localized practices that help maintain fish stocks. Such heterogeneity is consistent with findings by Kapembwa, Gardiner, and Pétursson (2021) [8], who noted that while overall productivity has declined, localized resilience strategies and governance structures can create uneven outcomes. Similarly, Pfister and Godet (2007) [17] emphasize that dam operations and hydrological variability influence fishing grounds differently, leading to diverse community experiences.

Overall, the opinions collected point to a widely held perception of declining fish productivity, statistically validated by the chi-square results, while also acknowledging minority perspectives. This dual recognition offers insight into potential areas for targeted management and adaptation strategies, reinforcing the importance of integrating community perceptions with scientific assessments (Kapembwa, Pétursson, & Gardiner, 2022) [7]

Socio-economic effects

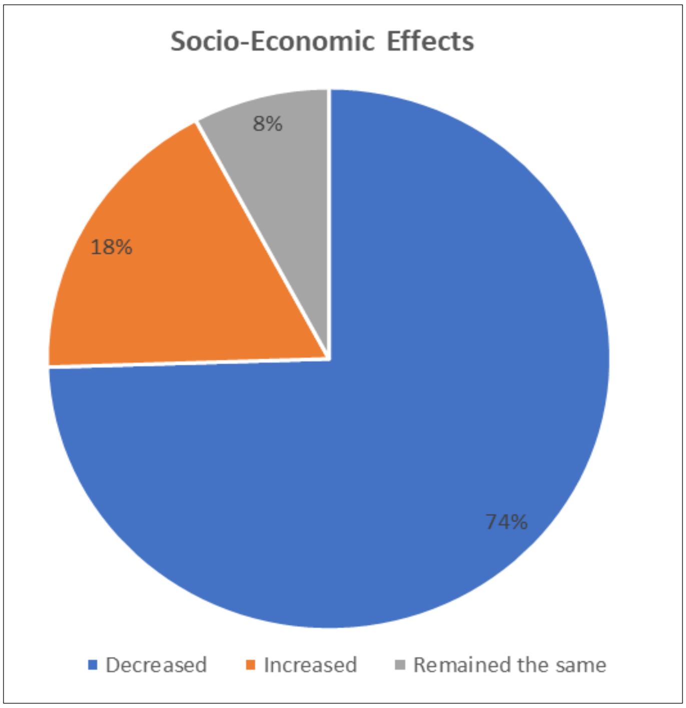

Fig 3: Pie chart illustrating the socio-economic impacts of climate change on fishing communities

The finding in figure 3 reveal that **74%** of respondents reported a drop-in income from fishing. This might illustrate the economic vulnerability of households dependent on aquatic resources. In regions such as Lake Itezhi-Tezhi, artisanal fisheries often serve as a primary source of livelihood; thus, diminished catch volumes translate directly into reduced earnings. Importantly, the Chi-square test statistic ($\chi^2 = 75.93$, df = 2) far exceeds the critical threshold value of 5.99, confirming that the differences among the categories (increase, decrease, remained the same) are statistically significant and not attributable to random variation. This strengthens the conclusion that declining fishing income is a widespread and meaningful perception among the community.

This trend mirrors broader regional concerns, where climate-induced ecological shifts are undermining informal economies reliant on natural resource exploitation (Kapembwa et al., 2020) [6]. Income instability threatens not only financial wellbeing but also the resilience of fishing communities in navigating broader environmental and economic shocks. In addition, the report that 41% of respondents experienced food insecurity due to reduced catches reveals a troubling intersection between environmental degradation and public health. Fish is a vital source of protein and essential micronutrients in the region; its scarcity may disproportionately affect vulnerable groups, particularly children and women. This aligns with emerging literature that links declining fish availability to increased malnutrition and dietary insufficiencies in inland communities (Golden et al., 2016) [4].

Reduced access to fish protein also raises questions about market dynamics, whether fish prices have increased, distribution channels weakened, or substitutes have failed to compensate for the nutritional gap. The statistically significant chi-square result underscores that these socio-economic hardships are not isolated perceptions but represent a collective reality for the majority of households. This linkage between declining fish catch and economic vulnerability suggests a need for integrative frameworks that assess ecological stress not in isolation, but in terms of community resilience, coping strategies, and institutional response

Implications of the study

The findings provide empirical support for the development of localized climate adaptation policies that incorporate traditional knowledge and fisher perceptions. Policymakers should prioritize investment in early warning systems, climate-resilient infrastructure and alternative livelihood programs.

Evidence of declining fish stocks due to climate change and overfishing highlights the need for stricter regulatory frameworks, including seasonal fishing bans, gear restrictions and habitat conservation efforts. With a direct link established between reduced fish catch and food insecurity, the study calls for targeted nutrition interventions and diversification of local food sources to prevent malnutrition in vulnerable populations.

The study shows that local communities are aware of the changes taking place, suggesting an opportunity for deeper engagement through environmental education, participatory monitoring and community-led conservation initiatives. The study also opens avenues for longitudinal research on fish population dynamics, climate modelling and the socio-economic resilience of fishing communities. More granular data could inform better planning and investment decisions.

Conclusion

This study highlights the growing vulnerability of artisanal fishing communities around Lake Itezhi-Tezhi to the impacts of climate change. Community perceptions, supported by environmental data, point to clear changes in rainfall patterns, water levels and fish catch volumes over the past decade. These changes are disrupting local ecosystems, reducing fish biodiversity and threatening livelihoods dependent on the lake's fisheries. The decline in economically and nutritionally important species such as bream and catfish signal deeper ecological stress, while the economic fallout is being felt in the form of reduced income and increased food insecurity.

The multifaceted nature of these challenges, rooted in both climatic and anthropogenic stressors, underscores the urgent need for integrated approaches to fisheries management and climate adaptation. Furthermore, the recognition by local communities of climate change as a major driver of ecological shifts suggests a growing environmental awareness that could be leveraged for participatory and sustainable resource management strategies.

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