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IMPACT AND ASSESSMENT OF ILLEGAL FISHING ON RIVERINE BIODIVERSITY IN THE EASTERN CAPE, SOUTH AFRICA: A MIXED-METHODS STUDY.

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Abstract

Background

Subsistence fishing, while a livelihood source for many, significantly impacts freshwater and marine biodiversity through overexploitation and illegal practices. This study investigates the ecological and socio-economic effects of subsistence fishing, with a particular focus on the drivers and challenges of illegal fishing, despite existing regulatory efforts.

Methods

A mixed-methods approach was used, combining spatial analysis to identify ecologically sensitive fishing areas with quantitative survey data from 32 subsistence fishers across designated fishing zones. A structured questionnaire captured demographic profiles, fishing practices, permit status, and perceptions of fisheries regulations.

Results

This study confirms that illegal subsistence fishing continues to threaten biodiversity conservation, with 67% of participants acknowledging the use of unsustainable fishing methods such as gill nets and harvesting during breeding seasons. 59% of respondents were unemployed, and 72% lacked formal fishing permits. 62% were male and 38% female, with the majority citing poverty, limited alternative livelihoods, and poor policy awareness as key reasons for noncompliance. Additionally, 81% of fishers reported that they had never been engaged in community consultations or regulatory planning. Spatial mapping revealed several fishing hotspots overlapping with protected or sensitive aquatic habitats, intensifying the ecological risks. Weak enforcement, limited patrols, and a shortage of trained extension officers were cited by both fishers and local authorities as major obstacles to effective policy implementation.

Conclusion

Illegal subsistence fishing poses a direct threat to biodiversity, and current regulatory frameworks are inadequately enforced. Without community engagement and socio-economic support, conservation objectives are unlikely to be met.

Recommendations

To mitigate biodiversity loss and improve compliance, fisheries management must integrate community-based enforcement, expand awareness campaigns, and develop alternative livelihood programs. Strengthened institutional capacity and participatory governance are essential for sustainable resource use and inclusive policy outcomes.

Keywords: *Depletion, Overexploitation, Harvesting, Illegal, Subsistence, Permits, Unemployment.*
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Introduction

Fisheries play a crucial role in food security, economic development, and poverty alleviation, particularly in developing countries. However, these fisheries face increasing pressure from over-harvesting, driven by market and policy failures, weak management structures, and open-access conditions that make regulation difficult. The frequent collapse of fish populations has become a significant challenge, particularly in inland and coastal ecosystems, where fish stocks are declining at an alarming rate. Global data indicate that underutilized inland fish stocks have plummeted from 40% in 1990 to just 23% in 2004 (World Bank, 2021), highlighting the unsustainable exploitation of aquatic resources. The primary drivers of this decline include rapid population growth and increasing fish consumption, which has doubled in developing nations

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over the past three decades (FAO, 2020). Furthermore, the expansion of international fish trade has intensified local fishing pressures, as exporters drive up fish prices, incentivizing overexploitation and facilitating the entry of illegally captured fish into commercial markets (UNEP, 2019).

Among the most affected regions are African tropical freshwater lakes, which are vital for millions of people who rely on fisheries for employment, nutrition, and economic sustainability. Overfishing in these ecosystems has become a pressing concern, threatening both biodiversity and human livelihoods (FAO, 2020; FAO, 2019). Despite their critical importance, many African nations lack comprehensive data on the status and potential of their fisheries, making effective management and policy implementation extremely challenging (FAO, 2019). Illegal fishing practices, such as the use of small-mesh nets that indiscriminately capture juvenile fish, have significantly worsened stock depletion, leading to the collapse of several fisheries (Clark et al., 2020). A major challenge in managing fisheries across sub-Saharan Africa is noncompliance with fishing regulations, particularly within artisanal fishing communities. Studies suggest that actual fish catch volumes in sub-Saharan freshwater fisheries are two to three times higher than what is officially reported (World Fish Centre, 2018). This widespread underreporting and mismanagement make it difficult for policymakers to formulate and enforce sustainable fishing regulations. Additionally, the weak enforcement of existing policies, coupled with socio-economic pressures such as poverty and food insecurity, further complicates efforts to achieve sustainable fisheries management (Hatcher & Pascoe, 2017).

Background

Subsistence fishing plays a vital role in supporting food security and livelihoods in many rural South African communities. However, it also poses significant threats to freshwater and marine biodiversity, particularly when conducted outside legal frameworks. Illegal fishing practices, such as the use of prohibited gear, fishing during breeding seasons, and harvesting in protected areas, continue to undermine conservation efforts and the sustainability of aquatic ecosystems. Despite the introduction of regulatory policies and community-based management initiatives, enforcement remains weak, and compliance levels are low, often due to socio-economic pressures such as poverty, unemployment, and limited access to alternative livelihoods.

This study examines the ecological and socio-economic impacts of illegal subsistence fishing, particularly within riverine systems in the Eastern Cape. It explores the effectiveness of existing conservation policies, regulatory frameworks, and management strategies in mitigating biodiversity loss and promoting sustainable resource use. By incorporating spatial analysis and community-based qualitative insights, the study also investigates the alignment between policy enforcement and ecological protection goals.

Objective

To assess the impact of illegal subsistence fishing on riverine biodiversity in the Eastern Cape and evaluate the effectiveness of current regulatory frameworks in promoting sustainable fisheries management.

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METHODOLOGY

STUDY AREA

Figure 1: Map of the Eastern Cape showing various rivers. 1 = Kei mouth region, 2 = Tyolomnqa river region, 3 = Hamburg region, 4 = Bushman's River region, 5 = Sundays River region and 6 = Jeffreys bay region (Google map)

Description of the Great Kei River

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Figure 2: Photograph of the mouth region of the Great Kei River

The Great Kei River is located in the Eastern Cape Province of South Africa (Fig. 2). It flows for 320 km and ends in the Great Kei Estuary at the Indian Ocean, with the small town Kei Mouth on the west bank. Historically, the Great Kei River formed the southwestern border of the Transkei region. The Kei Mouth is situated about 70 kilometers north of East London and about 20 kilometers off the N2 National Road. While middle to upper-income residents live closer to the coast and the river mouth, the subsistence fishers reside in Cwili Township, situated on the western outskirts of town. Subsistence fishers here experience a relatively low socio-economic status, with the majority being unemployed and a few having part-time work as domestics or gardeners. The community of Cwili lives in an informal settlement with homes built from wood and corrugated iron sheets. The fishers of Kei Mouth harvest a diversity of resources such as abalone, line fish, mussels, and oysters. Due to the influence of illegal buyers, fishers say that most of their effort is concentrated on the harvesting of abalone. Fishers from the Kei Mouth Fishery harvest a diversity of marine resources that may include abalone (said to be the most widely harvested resource), white.

Study Design

This study adopted a cross-sectional mixed-methods design, integrating both qualitative and quantitative approaches to assess the impact of illegal subsistence fishing on riverine biodiversity in the Eastern Cape, South Africa. The design enabled the simultaneous collection of ecological, socio-economic, and policy-related data to provide a comprehensive view of the research problem.

Study Setting

The research was conducted in Cwili, the only Black township in Kei Mouth, Eastern Cape. The area is located along the Kei River, a site of ecological and cultural significance. The study was carried out over ten months, from February to November 2023. Spatial analysis identified the Kei River and its fishing zones as areas of interest due to their biodiversity sensitivity and ongoing subsistence fishing activity

Participants

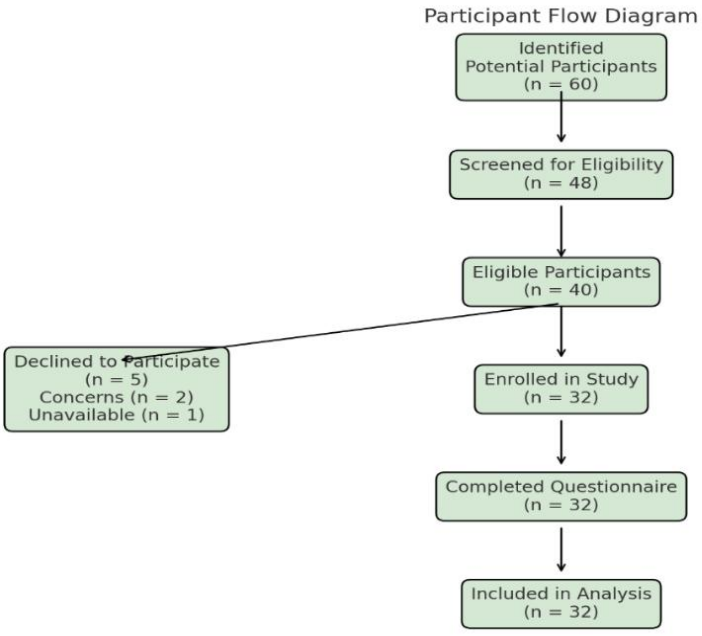

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Diagram 1: The **participant flow diagram** summarizes each stage of the study, from initial identification to final analysis.

Participants included subsistence fishers (both licensed and unlicensed), policymakers, fisheries extension officers, community leaders, and environmental NGOs. For surveys, eligible participants were those aged 18 and older, residing in the study area, and engaged in fishing activities for household consumption or small-scale trade. For interviews and focus groups, purposive sampling was used to select individuals with relevant experience and knowledge of policy implementation and subsistence fishing practices.

Bias

To mitigate bias, data collection tools were piloted before full deployment. Stratified and random sampling ensured representation from different age groups, genders, and fishing zones. Translation and interpretation services were provided to address language barriers, and anonymity was maintained to reduce social desirability bias, particularly around illegal fishing practices.

Study Size

The study involved 32 subsistence fishers from the Cwili community, selected through targeted outreach facilitated by extension officers. The sample size was guided by population size, data saturation in qualitative interviews, and logistical constraints. Additionally, 10 key informants participated in in-depth interviews, and 3 focus groups were held.

Data Collection

Data sources included:

- Structured questionnaires were administered to 32 fishers to collect demographic data, fishing frequency, permit status, and policy awareness.
- Semi-structured interviews with key stakeholders (n=10).
- Focus group discussions with fishers and community members.
- Field observations of fishing activities, gear types, and compliance behaviors.
- Document review of policy frameworks, including the Small-Scale Fisheries Policy (SSFP) and regulations from the Department of Environmental Affairs and Tourism.
- Spatial mapping to identify biodiversity-sensitive fishing hotspots.

Statistical Methods

Quantitative data were analyzed using descriptive statistics (frequencies, percentages) and inferential statistics, including chi-square tests to explore associations between compliance levels and socio-economic factors, and regression analysis to assess predictors of illegal fishing behavior. Missing data were addressed using listwise deletion if less than 5% of responses were incomplete; otherwise, data imputation methods were applied. Qualitative data were analyzed thematically using an inductive coding approach.

Ethical Consideration

Ethical approval for this study was granted by the Mangosuthu University of Technology Research Ethics Committee. The research adhered to MUT's ethical standards. All participants provided informed consent, were briefed on the study's aims, and assured of their right to withdraw without penalty. Confidentiality and anonymity were strictly maintained throughout.

Result

Table 1: Fish and Bait resources available at the Great Kei River estuary and mouth region

Fish resources	Bait Resources
Kabeljou	Mud prawn
Steenbras	Sand prawn
Spotted Grunter	swimming prawn
Galjoen	Pencil
Shad	Mussel
Mussel Cracker	Red bait
Garrick	Octopus

Lining fish, mussels, and oysters are harvested for their consumption and sales, while abalone isharvested

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Table 2: Socio-demographic characteristics and fishing practices of small-scale fishers, including age, gender, residence status, employment status, duration, equipment used, estimated catch, purpose for fishing, and bait type.

No.	Age	Age/M	Age/F	Residence	Employment	Duration (Hrs.)	Equipment	Est Catch	Purpose	Bait type
1	52	52		CT	Unemployed	3-4 Hours	RR	4	SF	Various
2	43		43	CT	Unemployed	Whole day	RR	3	SF	Various
3	38	38		CT	Unemployed	3-4 Hours	Net	20	SF	N/A
4	18	18		CT	Unemployed	Whole day	RR	3	SF	Mud prawn
5	37		37	CT	Unemployed	3-4 Hours	RR	3	SF	Mud prawn
6	50	50		CT	Unemployed	Whole day	Net	15	SF	N/A
7	43	43		CT	Unemployed	Whole day	Net	20	SF	N/A
8	31		31	CT	Part-Time	3-4 Hours	RR	4	SF	Mud prawn
9	37	37		CT	Unemployed	3 to 4 Hours	RR	6	SF	Various
10	39	39		CT	Unemployed	6-8 Hours	RR	5	SF	Various
11	42		42	CT	Part Time	3-4 hours	RR	4	SF	Mud prawn
12	55	55		CT	Unemployed	Whole day	Net	18	SF	N/A
13	48	48		CT	Unemployed	Whole day	RR	3	SF	Various
14	40		40	CT	Part Time	6-8 Hours	RR	2	SF	Various
15	37		37	CT	Part Time	6-8 hours	RR	4	SF	Various
16	49	49		CT	Unemployed	Whole day	Net	15	SF	N/A
17	32		32	CT	Part Time	3-4 hours	RR	5	SF	Mud prawn
18	50	50		CT	Unemploye	3-4 hours	Net	20	SF	N/A

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					d					
19	44	44		CT	Unemployed	Whole day	RR	8	SF	Various
20	38	38		CT	Part Time	6-8 Hours	RR	5	SF	Mud prawn
21	34		34	CT	Unemployed	3-4 hours	RR	3	SF	Various
22	47	47		CT	Unemployed	6-8 Hours	Net	15	SF	N/A
23	59	59		CT	Part Time	6-8 Hours	Net	20	SF	N/A
24	39		39	CT	Part Time	3-4 Hours	RR	5	SF	Various
25	41	41		CT	Part Time	3 to 4 hours	RR	5	SF	Various
26	40		40	CT	Unemployed	3-4 Hours	RR	4	SF	Various
27	45	45		CT	Part Time	3-4 hours	RR	3	SF	Various
28	47	47		CT	Unemployed	3-4 hours	RR	4	SF	Mud prawn
29	40		40	CT	Unemployed	6-8 hours	RR	5	SF	Sand prawn
30	32		32	CT	Part Time	3-4 hours	RR	4	SF	Mud prawn
No.	Age	Age/M	Age/F	Residence	Employment	Duration (Hrs.)	Equipment	Est Catch	Purpose	Bait type
31	38	38		CT	Part Time	3-4 hours	Net	15	SF	N/A
32	36	36		CT	Part Time	3-4 hours	RR	4	SF	Various

CT = Cwili Township, Age/F = Age of female respondent, Est Catch = Estimated catch, RR = Rod and Reel, Age/M = Age of malerespondent, SF = Sales and Food, Whole day = above 9 hours of fishing.

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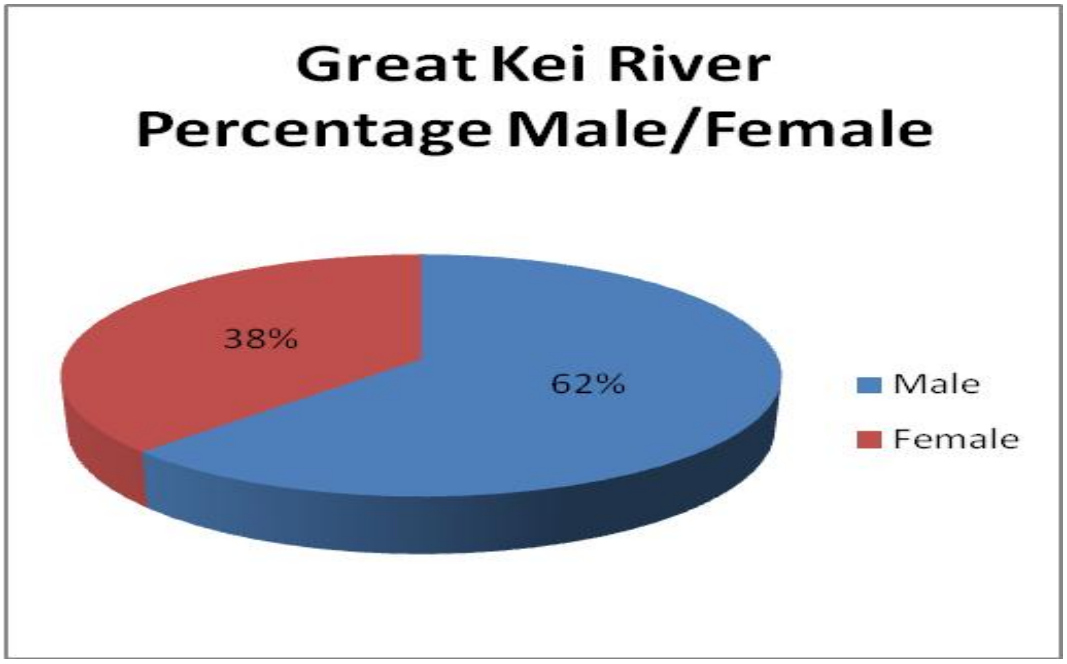

Figure 3: Graph indicating the percentage of male and female fishers along the Great Kei River.

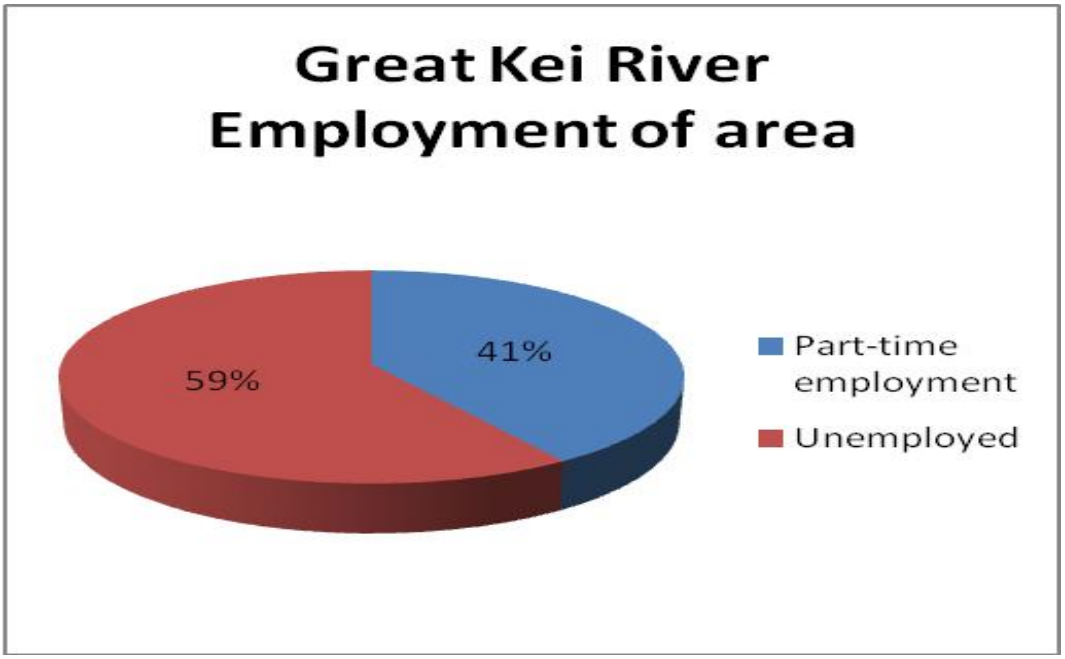

Figure 4: Graph indicating the employment of the community of the fishers along the Great Kei River.

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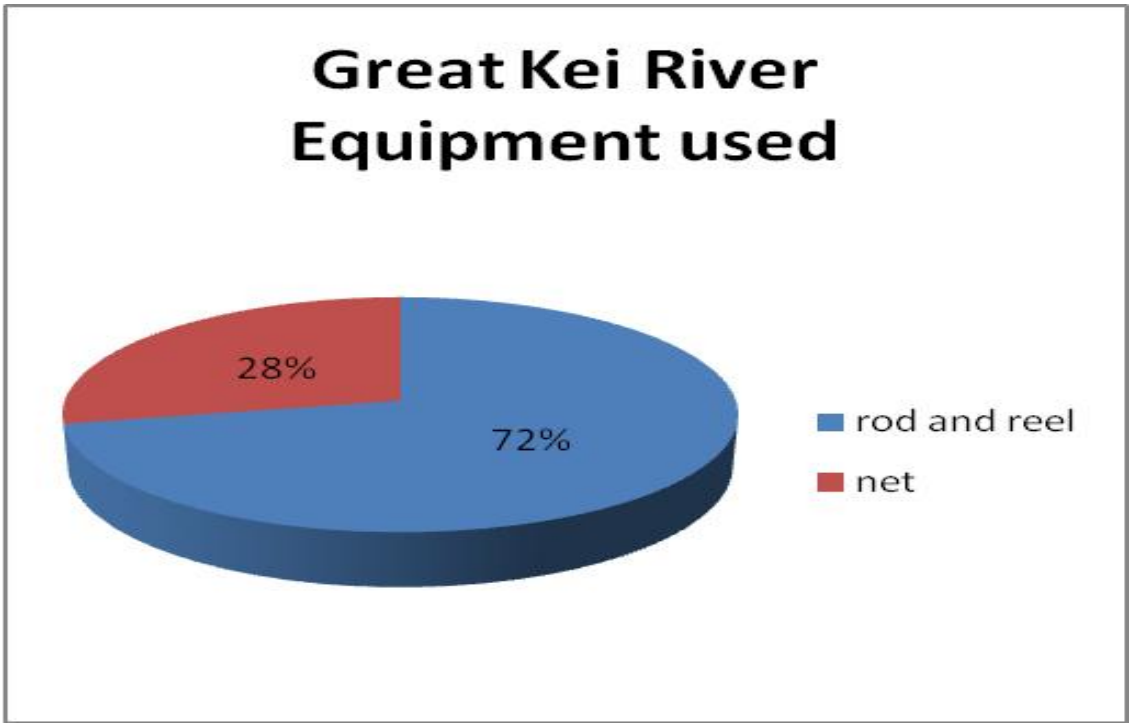

Figure 5: Graph indicating the different equipment used by fishers along the Great Kei River.

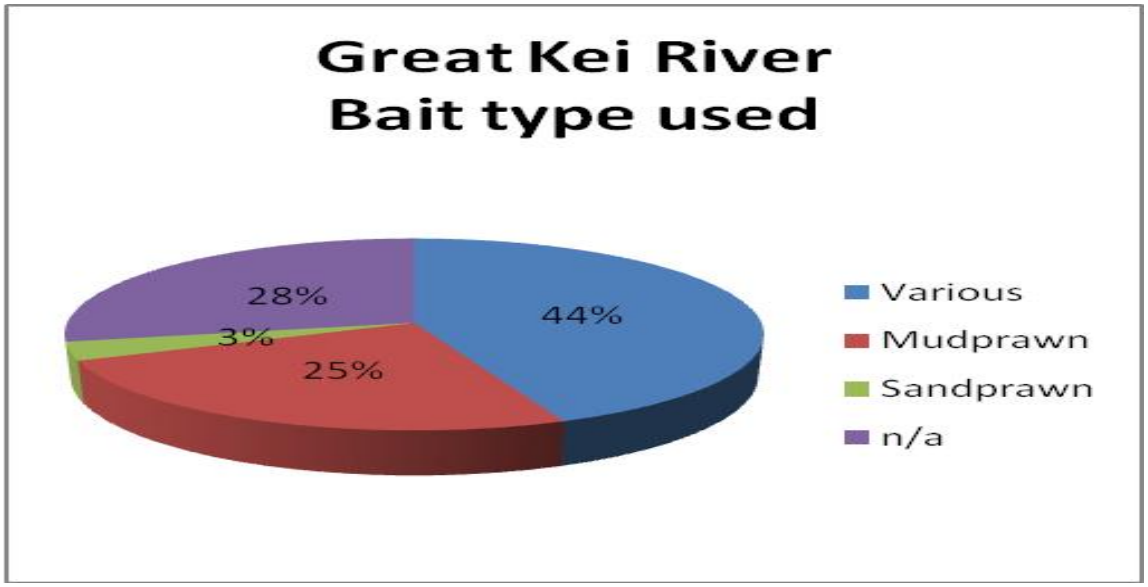

Figure 6: Graph indicating different bait species used by the fishers along the Great Kei River.

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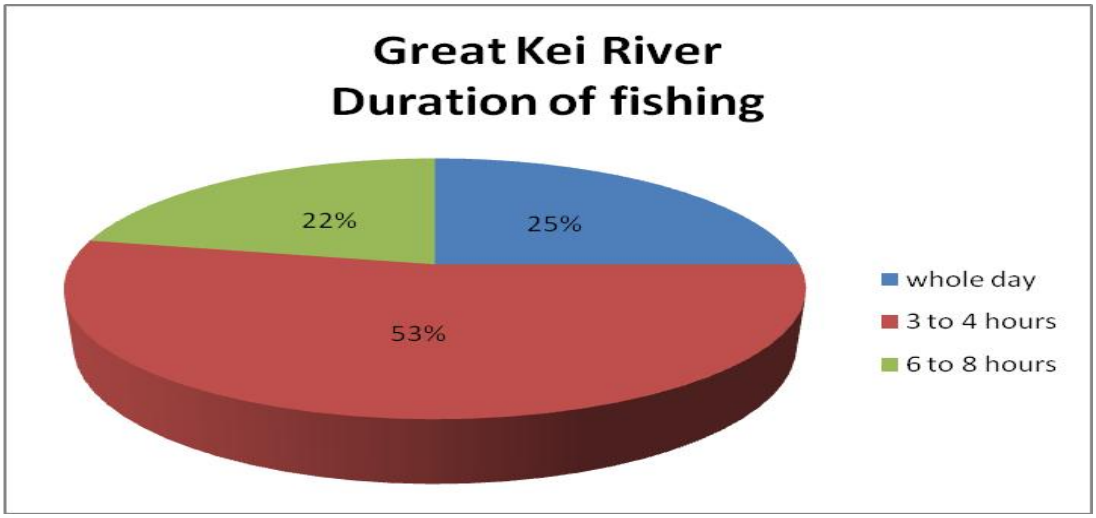

Figure 7: Graph indicating the duration of fishing done by the fishers along the Great Kei River.

Figure 8 presents the key qualitative themes identified from interviews and focus group discussions. The most frequently mentioned issue was lack of enforcement capacity (78%), followed by limited alternative livelihoods (72%) and poor community engagement (69%). Other notable challenges included low awareness of fishing regulations (65%), elite capture of fishing rights (54%), and weak implementation of the Small-Scale Fisheries Policy (SSFP) (50%). These findings highlight systemic and socio-economic barriers undermining effective fisheries management and biodiversity conservation efforts.

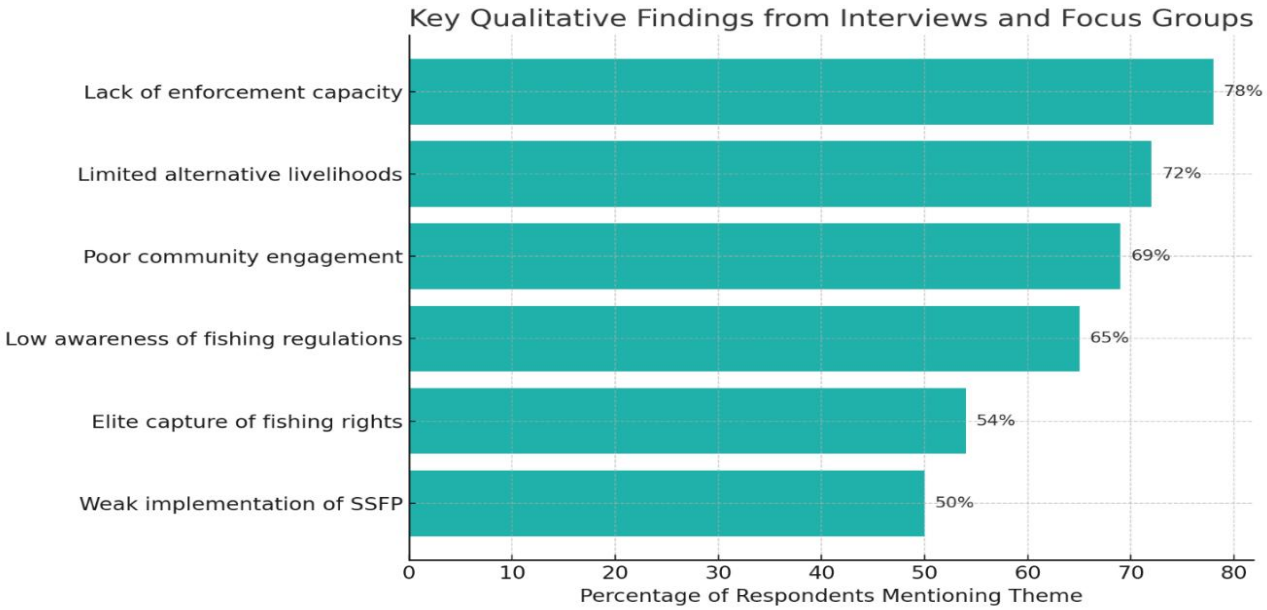

Figure 8: The graph above presents the key qualitative themes identified from interviews and focus group discussions.

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Figure 9 displays the quantitative findings from the survey of 32 subsistence fishers in the Cwili community. A majority of respondents (72%) did not possess formal fishing permits, while 59% were unemployed, indicating high economic dependence on fishing. 67% reported using illegal fishing gear, and 65% lacked knowledge of existing regulations, highlighting significant awareness gaps. Only 19% had ever participated in policy consultations, pointing to minimal community engagement in governance. These results underscore the urgent need for targeted interventions, including regulatory education, permit reform, and inclusive policy-making processes.

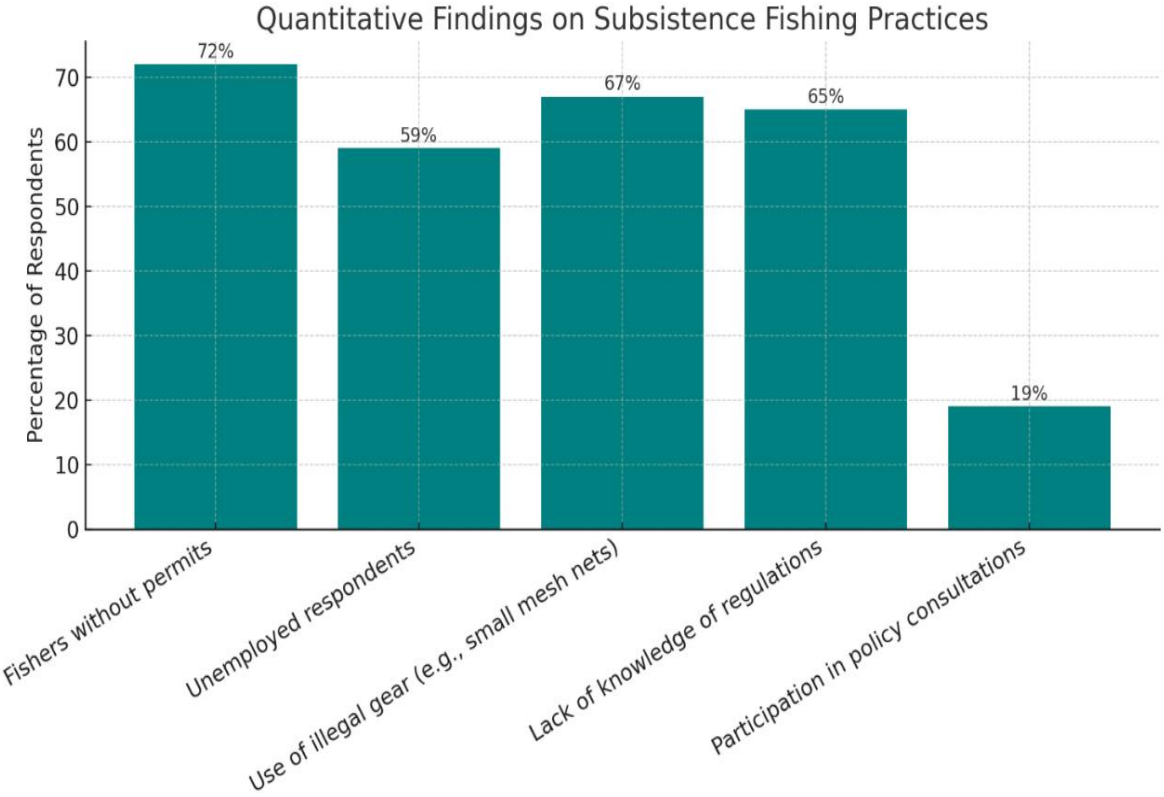

Figure 9: The bar chart displays the quantitative findings from the survey of 32 subsistence fishers in the Cwili community.

Discussion

This study explored the ecological and socio-economic implications of illegal subsistence fishing on riverine biodiversity in the Eastern Cape, with a focus on the challenges facing fishers and fisheries governance. The quantitative and qualitative results provide critical insight into the policy enforcement gaps, fisher behavior, and structural barriers to sustainable resource management. The quantitative findings (Figure 9) reveal that 72% of fishers did not possess legal fishing permits, highlighting widespread noncompliance. This is further compounded by the 59% unemployment rate, indicating a strong socio-economic dependency on fishing for livelihood. Notably, 67% of participants admitted to using illegal fishing gear, such as small mesh nets, and 65% lacked knowledge of existing fishing regulations. Only 19% of fishers had ever participated in policy consultations, suggesting minimal community involvement in decision-making. These figures reflect a clear disconnect between policy frameworks and the lived realities of subsistence fishers, contributing to ongoing illegal practices and undermining biodiversity conservation.

The qualitative results (Figure 8) further contextualize these challenges. The most frequently cited issue, reported

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by 78% of respondents, was lack of enforcement capacity, followed by limited alternative livelihoods (72%) and poor community engagement (69%). These themes align with the survey findings, reinforcing the notion that weak implementation of the Small-Scale Fisheries Policy (SSFP), limited awareness campaigns, and the exclusion of local communities are central to the ongoing crisis. Additionally, elite capture of fishing rights (54%) was highlighted, suggesting that existing regulatory frameworks may disproportionately benefit better-connected individuals, further marginalizing vulnerable subsistence fishers.

Conclusion

The study highlights the complex relationship between socio-economic vulnerability, weak enforcement, and noncompliance in the context of illegal subsistence fishing in the Eastern Cape. While regulatory frameworks like the SSFP have been introduced to address these issues, gaps remain in community engagement, resource allocation, and alternative livelihood support. The findings underscore that illegal fishing practices are often driven by survival rather than disregard for regulation and that sustainable biodiversity management must be linked with inclusive, locally adapted policies.

Limitations

Several limitations may affect the interpretation of the findings. First, the sample size was relatively small (n=32) and limited to the Cwili community in Kei Mouth, which may not fully capture the diversity of subsistence fishing practices in other parts of the Eastern Cape or South Africa. Second, language barriers and the sensitive nature of illegal fishing may have led to underreporting or guarded responses during interviews. Although translation support was provided, nuances could have been lost. Third, the lack of historical data on fish stock trends limited the ability to assess long-term ecological impacts. Lastly, observational data were collected over a short period, which may not reflect seasonal variations in fishing practices or enforcement dynamics.

Generalizability

Due to the localized nature of the study, generalizability is limited to similar rural, riverine communities facing comparable socio-economic and regulatory conditions. However, the themes identified, such as poverty-driven noncompliance, weak enforcement, and exclusion from policymaking, are widely applicable to other small-scale fisheries in South Africa and across the Global South. Therefore, while the exact findings may not be universally transferable, the core insights can inform broader fisheries policy and conservation strategies in contexts where community-based resource use and institutional capacity are key concerns.

Recommendations

The establishment of Local Management Committees has proven effective in the past for managing the subsistence fisheries of the Kei River region (Nelson & Barrow, 2022). Expanding this model to other regions facing similar challenges can empower local communities to take an active role in the conservation of their natural resources. These committees should be supported with adequate training, funding, and resources to improve their effectiveness in managing fishing practices, enforcing regulations, and educating the public about sustainable fishing practices (Henning et al., 2019). The committees should also work closely with government agencies to ensure that policies and legislation are aligned with the needs and realities of the local population. The continued prevalence of illegal fishing practices, including the harvesting of protected species such as abalone, calls for more stringent enforcement of existing fishing regulations (Ihle et al., 2020). This includes regular monitoring, patrols, and collaboration with law enforcement to curb illegal activities. Additionally, the government should work with local communities to increase their understanding of the laws governing fishing and the ecological importance of adhering to these rules. Financial and legal support systems should be developed to encourage the reporting of illegal fishing activities, providing whistleblowers with protection and incentives. Given the high levels of unemployment within the fishing communities and their dependence on subsistence fishing for survival (Lutz & Pires, 2019), it is crucial to provide alternative livelihood options. Programs aimed at improving education, skill development, and job opportunities should be prioritized. This could include vocational training in sustainable agriculture, eco-tourism, and small-scale aquaculture. Such alternatives would reduce the community's reliance on unsustainable fishing practices, mitigating the pressure on local fish stocks and ensuring the long-term sustainability of the environment (Ingram et al., 2021). There is a significant gap in the available data on the state of fish stocks and the socio-economic contributions of subsistence fishing (World Bank, 2020). Establishing a comprehensive monitoring system that collects data on fish populations, fishing methods, and the economic impact of fisheries is crucial. This data should be used to inform decision-making processes and to develop evidence-based policies. Collaboration with local universities, research institutions, and NGOs can enhance data collection efforts and improve the overall

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understanding of subsistence fishing practices (Vidal & Naughton-Treves, 2020).

Educational initiatives aimed at both local fishers and the broader public can help shift perceptions about the importance of sustainable fishing. Community workshops, media campaigns, and partnerships with schools and universities can promote understanding of biodiversity conservation and the consequences of overfishing. Incorporating these educational programs into local curricula or community gatherings could also enhance long-term behavioral changes and create a culture of sustainability within fishing communities (Lutz & Pires, 2019). Governments should work to create and implement policies that balance the socio-economic needs of subsistence fishers with the preservation of biodiversity. This includes creating frameworks that recognize and integrate the informal subsistence fishing sector into formal management systems. By granting fishing rights and permits based on sustainable practices, and by creating closed seasons or no-fishing zones in critical habitats, governments can encourage responsible fishing (Garcia et al., 2021). Furthermore, incorporating Fisher's input into policy decisions can foster more inclusive and practical regulations that have a higher chance of compliance.

Collaboration among local communities, government agencies, NGOs, and research institutions is essential for developing effective management strategies for subsistence fisheries (Henning et al., 2019). Multi-stakeholder platforms can be created to ensure that diverse perspectives and knowledge are integrated into decision-making processes. These platforms can also serve as a means for sharing resources, best practices, and lessons learned from successful initiatives in other regions. Encouraging the use of sustainable fishing gear and techniques, such as larger mesh sizes and selective harvesting methods, can reduce the negative impact of fishing on biodiversity (Clark & Turpie, 2007). Extension officers should provide training to local fishers on the use of such technologies and promote the adoption of best practices that protect fish stocks and improve catch quality. These efforts can be supported by offering financial incentives or subsidies for the purchase of eco-friendly equipment. By implementing these recommendations, the management of subsistence fisheries in areas like the Great Kei River can be improved, ensuring the long-term sustainability of fish populations and the livelihoods of the people who depend on them. Ultimately, these measures will help to mitigate the detrimental effects of illegal and unsustainable fishing practices and support the preservation of biodiversity.

Biography

Dr. Sibonelo Thanda Mbanjwa is a dedicated lecturer in the Department of Nature Conservation at Mangosuthu University of Technology (MUT), South Africa. He holds a Ph.D. in Environmental Science and specializes in biodiversity conservation, sustainable development, and environmental education. Dr. Mbanjwa is deeply committed to community engagement, student mentorship, and the integration of indigenous knowledge systems into conservation practices. His work bridges academia and practical application, empowering students and communities through innovative teaching, research, and outreach initiatives.

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

I, the author, contributed to the study conception and design. Material preparation, data collection, and research were performed by Mbanjwa S.T. The first draft was written by Mbanjwa S.T.

Data Availability

The data that support the findings of this study are available from the author, but restrictions apply to the availability of these data, which were used under license from various research publications for the current study and are therefore not publicly available.

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