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Original Article

Assessing the Anthropogenic Impacts on Natural Resource Utilisation and Socioeconomic Development along the Orugu River, Sierra Leone

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Sierra Leone.

Although their inappropriate exploitation frequently results in environmental degradation that threatens long-term livelihoods, natural resources continue to be essential to socioeconomic growth. In this study, four riparian communities, Jui, Lower Allen Town (Mayemie), Upper Allen Town, and Calaba Town, were evaluated for the socioeconomic and environmental effects of the patterns of natural resource utilisation along the Orugu River in Sierra Leone. Eighty randomly chosen respondents (33.8% fishermen, 30.7% sand miners, 26.3% traders, and 7.5% farmers) were given semi-structured questionnaires as part of the study's mixed-methods design. Personal interviews, field observations, and secondary data from peer-reviewed literature, workshop reports, and census data were also included. While qualitative data were thematically synthesised, quantitative data were examined using descriptive statistics in SPSS. The findings showed that the two main natural resource activities were fishing (35.0%) and sand mining (36.3%), with 87.5% of fishermen employing nets and 40-horsepower machines on a daily basis. For 55.0% of respondents, river-related activities accounted for 26–50% of household income, while for 33.8%, they accounted for 51–75%. Significantly, domestic garbage (61.3%), mangrove removal (27.5%), sand mining (5.0%), and agricultural runoff (5.0%) were the main causes of the worsening water quality, stated by 66.3% of respondents over a five-year period. Despite these environmental issues, 66.3% of respondents said that access to education had improved due to income from natural resources. Significant governance deficiencies were found. Meanwhile, with 97.5% without community-based organisations for managing natural resources, 97.5% receiving no outside money, and 97.5% lacking adequate medical care. The study comes to the conclusion that although the Orugu River sustains important economic activity, the current patterns of exploitation are not environmentally sustainable. It suggests sustainable fishing methods, such as seasonal bans and quotas, regulated sand mining with zones and rehabilitation requirements, conservation of mangroves through community-led restoration, promotion of alternative energy sources to lessen reliance on

firewood (currently 81.3%), creation of community-based management frameworks with outside technical assistance, and investment in infrastructure for healthcare and education.

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INTRODUCTION

The evolution of human society has depended on the continuous interaction between humans and their natural environment. It is impossible to overstate the importance of a country's natural resources, which include mineral, water, agricultural, forest, and atmospheric assets (Ausat *et al.*, 2023). Natural resources are essential to processes of socioeconomic development, as academics have long acknowledged. For example, Romer (1996) and Wright (1990) independently documented that the United States of America's rapid industrial and economic progress between 1879 and 1940 was largely due to the exploitation of plentiful non-renewable natural resources, particularly energy and mineral resources.

With a richness of mineral and natural resources that have contributed to the buildup of national wealth, Sierra Leone is one of the richest countries in Africa in terms of natural resource potential (Adekoya, 2003). However, using natural resources is crucial; their sheer existence is insufficient. Environmental resources have been used throughout human history in order to sustain growing populations (Liberty *et al.*, 2013).

Natural resources can be broadly divided into two categories. Exhaustible (like minerals) and inexhaustible (like forests and grasslands). Utilisation is the act of using something in a beneficial and efficient manner.

Before joining bigger river systems, the Orugu River rises in the eastern highlands of Sierra Leone and flows through tropical woods, farmland, and rural communities like Jui, Lower and Upper Allen Town, and Calaba Town. Both human populations and a variety of habitats are supported by the river's basin. The two distinct seasons of Sierra Leone's tropical climate, the dry season, which runs from November to April, and the rainy season, which runs from May to October, have a big impact on river flow, water availability, agricultural cycles, and fishing activities. Geological studies have revealed ore mineralisation in the Orugu River Tributaries Platinum Occurrence in Sierra Leone, which is near Freetown; nevertheless, no mining operations have yet occurred (The DiggingsTM, 2024).

Significant issues still exist despite the river's abundance of resources, such as resource overuse, declining environmental conditions, and social

disparity. Deforestation along rivers, pollution, and a decline in fish populations are all consequences of unchecked river resource exploitation. These issues jeopardise the river's ecological integrity and reduce long-term resource availability (Joseph *et al.*, 2018). The uncontrolled exploitation of the river's resources has led to significant environmental problems, including pollution, riverside deforestation, and fish population depletion. These problems diminish the long-term availability of resources in addition to endangering the river's biological level. Even with an abundance of natural resources, the local economy is still developing. The unsustainable nature of current practices will eventually deplete available resources and have a detrimental long-term effect on the environment and nearby communities. Therefore, this study looked into how the natural resources of the Orugu River are used and how this usage impacts the socioeconomic growth of the local community. The specific goals were to: (1) identify the kinds of natural resources that are available; (2) evaluate the current condition of natural resources along the Orugu River; (3) analyse the socioeconomic effects of resource utilisation on local communities; and (4) identify sustainable practices and policies that can improve socioeconomic benefits while maintaining the ecosystem of the river.

MATERIALS AND METHODS

Study Area

The Orugu River is situated at an elevation of 238 meters above sea level in the Eastern Area of Sierra Leone, with geographic coordinates of 8°24'49"N and 13°9'37"W. Four riparian settlements are included in the study region. Beyond Freetown's eastern boundary, Jui is a settlement in the Western Area Rural District. It is home to the Evangelical College of Theology and the China-Sierra Leone Friendship Hospital. Its economy is centred on small-scale trade, agriculture, and fishing (Default Parallels Plesk Panel Page, 2017). In Freetown's East End, Lower Allen Town (Mayemie) and Upper Allen Town

are residential neighbourhoods with economies based on small-scale commerce, services, and the unorganised sector. Constructed during the civil war (1991--2002) through rehabilitation efforts, Calaba Town is home to several ethnic groups that were displaced during the conflict. It lacks basic infrastructure, and the majority of its population make their living through small-scale trade (Mannah, 2022; Roosen *et al.*, 2024).

Sampling Method and Population

Small-scale fishers, farmers, dealers, and sand miners who actively use natural resources as their main source of income were the researcher's target audience. In all four areas, 80 individuals who were at least 18 years old were targeted. The eighty respondents were divided into four groups using the sampling technique: Group A1 (fishermen, $n = 27$), Group A2 (sand miners, $n = 25$), Group A3 (traders, $n = 21$), and Group A4 (farmers, $n = 7$). For in-person interviews, respondents were chosen at random, and detailed answers were recorded with notes for future research.

Sources of Data and Collection Methods

Semi-structured questionnaires and in-person interviews were used to collect primary data. Internet resources, seminar papers, census reports, workshop papers, and prior publications pertinent to the study's objective were used to gather secondary data. Three distinct methods of gathering data were used by the researcher: questionnaires created in accordance with the study's objectives and given to each of the 80 participants; in-person interviews with stakeholders, augmented by notes and photos; and online resources and publications examined for artisanal fishing, agriculture, sand mining, and trade.

Data Analysis

Descriptive statistics using SPSS (Statistical Package for Social Science) and a desktop review of relevant literature were used to examine the data. Tables and charts were used to summarise and display the results.

Ethical Considerations

Ethical approval for this study was obtained from the relevant institutional review board at Njala University. Informed consent was obtained from all participants prior to data collection. Participants were informed of their right to withdraw from the study at any time without

consequence. Confidentiality of respondent information was maintained throughout the research process, and data were anonymised to protect participant identities. No personal identifying information was recorded in the final dataset.

Demographic Characteristics

Table 1: Demographic Variables of Respondents (N=80)

		Frequency	Percent
Age	20 - 30	26	32.5
	31 - 40	30	37.5
	41 - 50	17	21.3
	Above 50	7	8.8
	Total	80	100.0
Gender	Female	25	31.3
	Male	55	68.8
	Total	80	100.0
Marital Status	Divorced	4	5.0
	Married	60	75.0
	Single	12	15.0
	Widowed	4	5.0
	Total	80	100.0
Level of Education	No formal education	25	31.3
	Primary education	26	32.5
	Secondary education	27	33.8
	Tertiary education	2	2.5
	Total	80	100.0
Occupation	Farmer	6	7.5
	Student	1	1.3
	Fisherman	27	33.8
	Sand Miner	25	30.7
	Trader	21	26.3
	Total	80	100.0

The respondents' demographic information is shown in Table 1. The age distribution revealed a youthful to middle-aged workforce, with the majority being between 31 and 40 years old (37.5%), followed by 20 to 30 years old (32.5%), 41 to 50 years old (21.3%), and over 50 years old (8.8%). The distribution of genders showed that men predominated (68.8%) over women (31.3%). 75.0% of respondents were married, 15.0% were single, 5.0% were divorced, and 5.0% were widowed. There was a wide range in educational attainment: just 2.5% had a college degree, 33.8% had a secondary education, 32.5%

had a primary education, and 31.3% had no formal education. Fishermen (33.8%), sand miners (30.7%), traders (26.3%), farmers (7.5%), and students (1.3%) were among the occupations.

RESULTS

Natural Resource Utilisation

Figure 1: Primary Natural Resources Used by Respondents

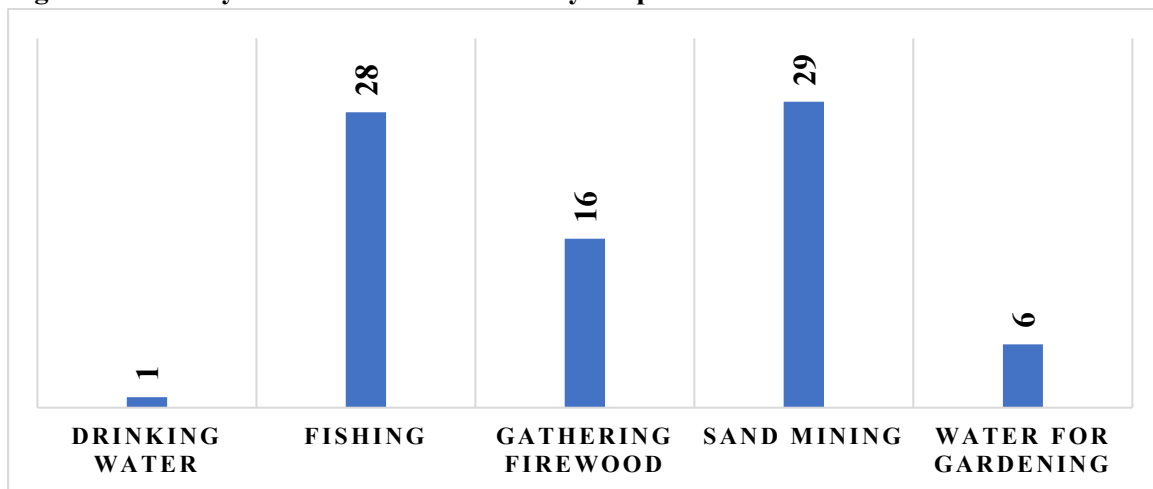


Figure 2: Fishing Methods Employed

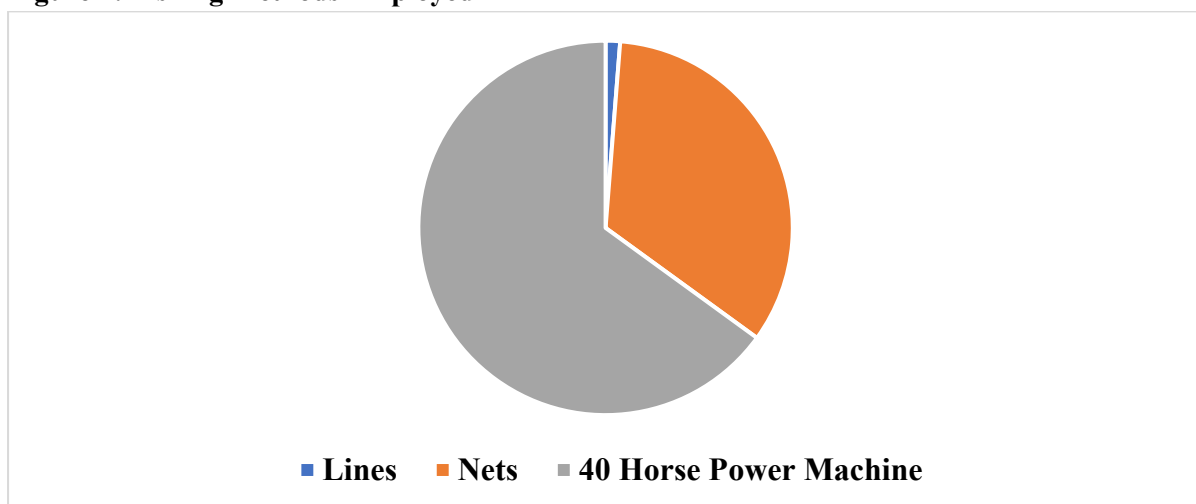


Figure 3: Frequency of Fishing Activities

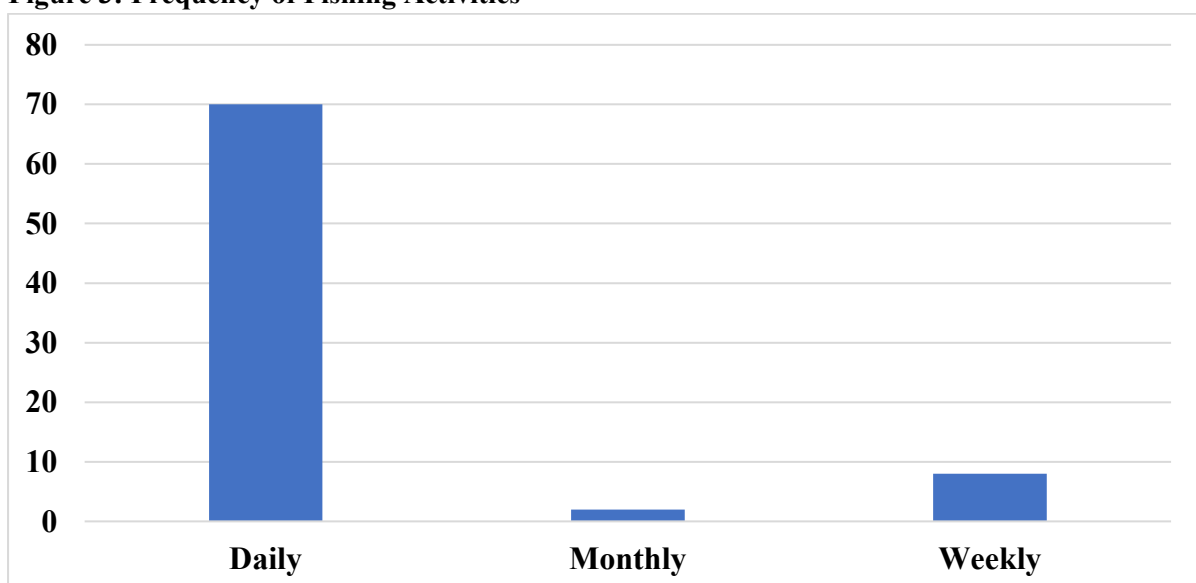
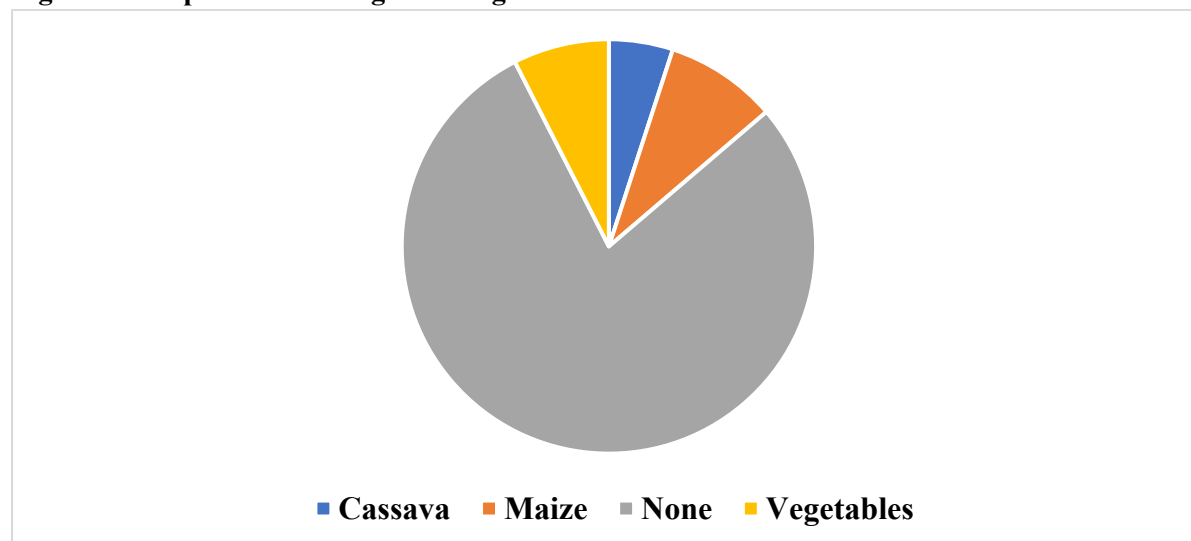


Figure 4: Crops Grown Using the Orugu River Water



According to Figure 1, the main natural resources utilised were fishing (35.0%) and sand mining (36.3%), followed by harvesting firewood (20.0%), water for farming (7.5%), and drinking water (1.3%). In terms of fishing techniques (Figure 2), 33.8% used nets and 65.0% used 40-horsepower machines. According to Figure 4, 87.5% of people fished every day, 10.0% every week, and 2.5% every month. Crop cultivation with river water (Figure 4) revealed that 8.8% grew maize, 7.5% vegetables, and 5.0% cassava, while 78.8% did not grow crops.

Qualitative findings from personal interviews revealed additional insights beyond the quantitative data. Community members expressed concerns about declining fish catches, increased difficulty accessing clean water, and conflicts

between sand miners and other resource users. Respondents also reported that children no longer swim in the river like they once did, and the river is no longer a place for community laundry. One respondent from Calaba Town stated that the colour of the river was initially clear, and the change occurred only during the intervention of sand mining activities. Regarding the possibility of improving the river's colour, some respondents suggested that authorities should stop the harmful practice of sand mining or create alternative livelihoods, while others indicated that no improvement is possible since the majority of inhabitants rely on the river for their livelihood.

Economic Impact

Figure 5: Percentage of Household Income from River-Related Activities

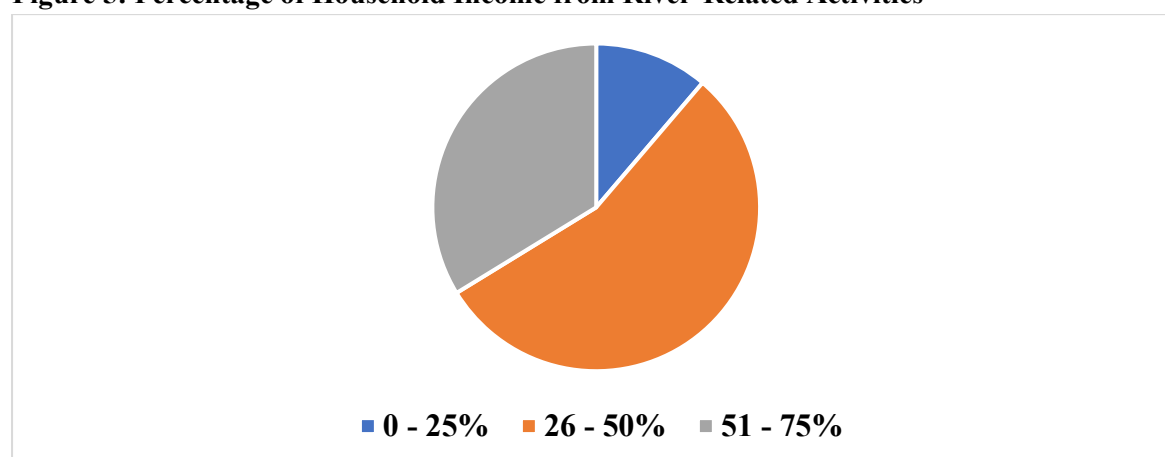


Figure 6: Sales Channels for River-Derived Products

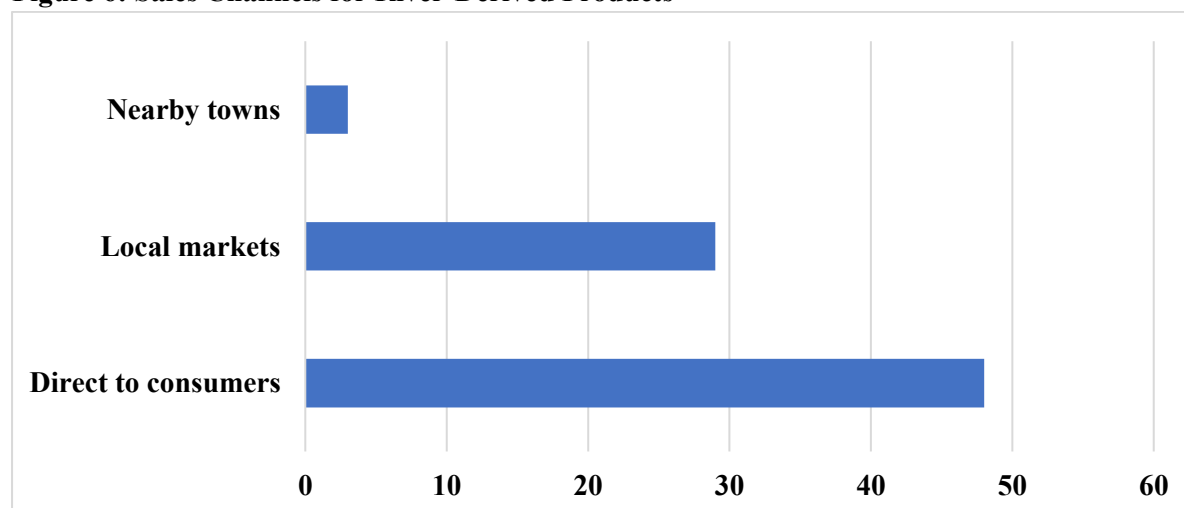


Figure 7: Main Challenges in Natural Resource Utilisation for Business

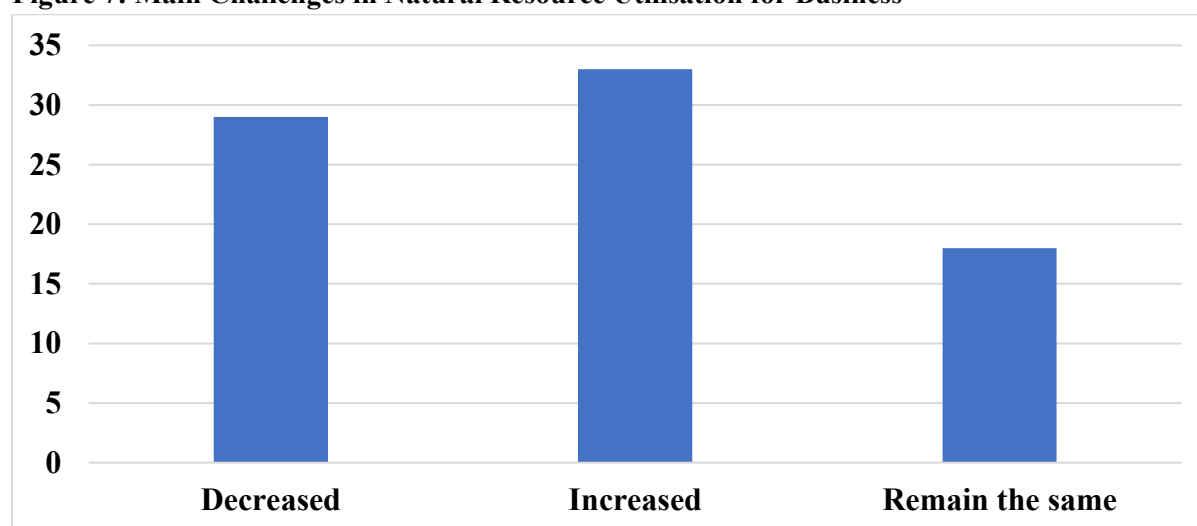


Figure 5 shows that 55.0% of households earned 26--50% of their income from river-related activities, 33.8% earned 51--75%, and 11.3% earned 0--25%. Regarding sales channels (Figure 6), 60.0% sold products directly to consumers, 36.3% to local markets, and 3.8% to neighbouring towns. This indicates a localised economy with a limited external market reach. Over a five-year period, income changes showed 41.3% increases, 36.3% declines, and 22.5% no change. The primary obstacles encountered when employing natural resources are listed in Figure 7 as follows:

lack of tools or equipment (28.8%), reduced pricing for goods (28.8%), environmental deterioration (15.0%), lack of market access (13.8%), and debtors refusing to pay (13.8%). Regarding food security, 60.0% of respondents reported no impact from river resource availability, 27.5% reported a positive impact, and 12.5% reported a negative impact (Figure 10).

Environmental Impact

Figure 8: Perceived Changes in Orugu River Water Quality (past five years)

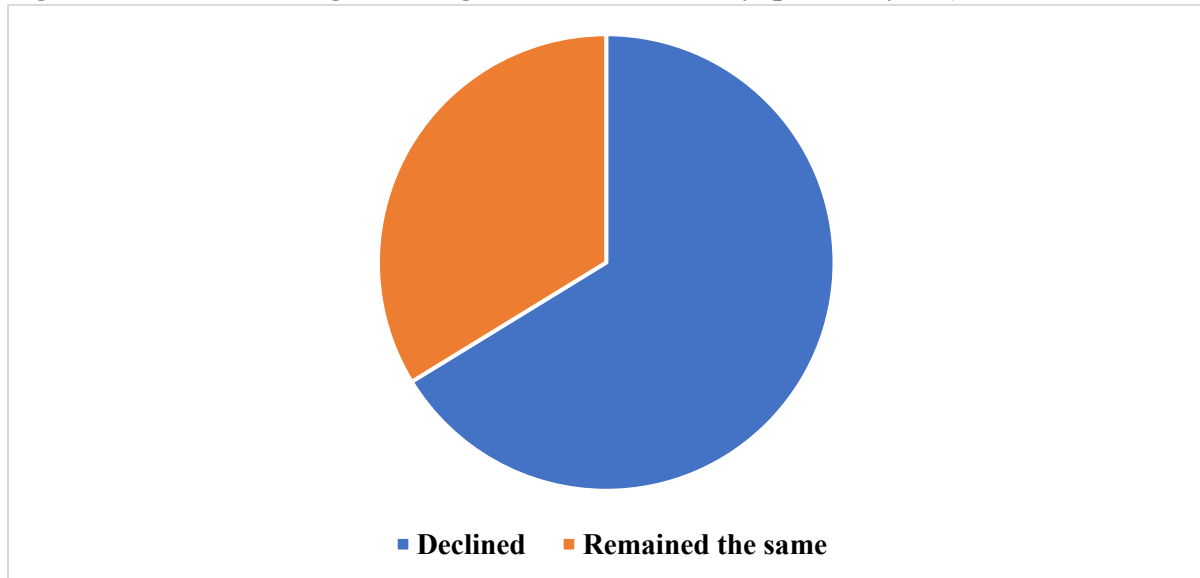
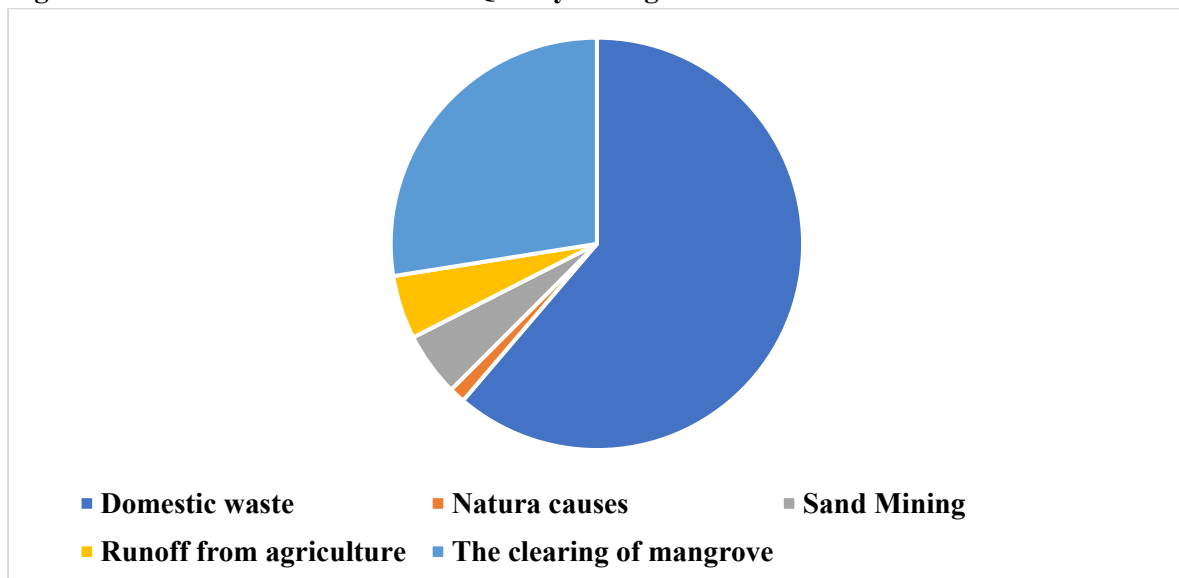


Figure 9: Perceived Causes of Water Quality Changes



66.3% of respondents reported a reduction in water quality over a five-year period, while 33.8% said it stayed the same (Figure 8). Domestic trash (61.3%), mangrove removal (27.5%), sand mining (5.0%), agricultural runoff (5.0%), and

natural sources (1.3%) were identified as the causes of water quality changes (Figure 9).

Socioeconomic Impact

Figure 10: Impact of River Resource Availability on Household Food Security

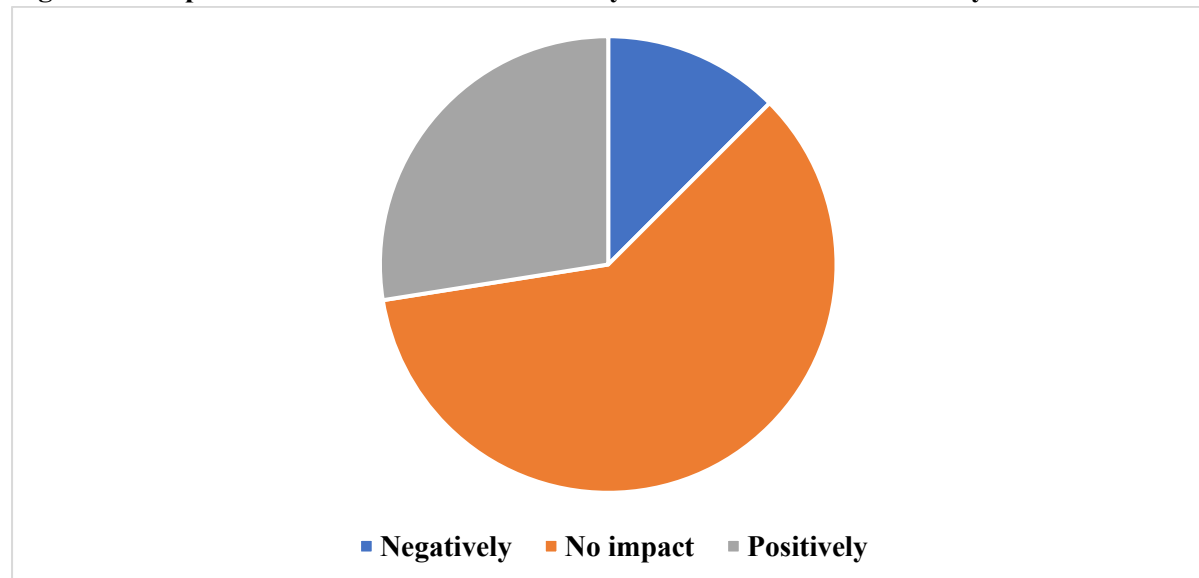


Figure 11: Availability of Sufficient Medical Services

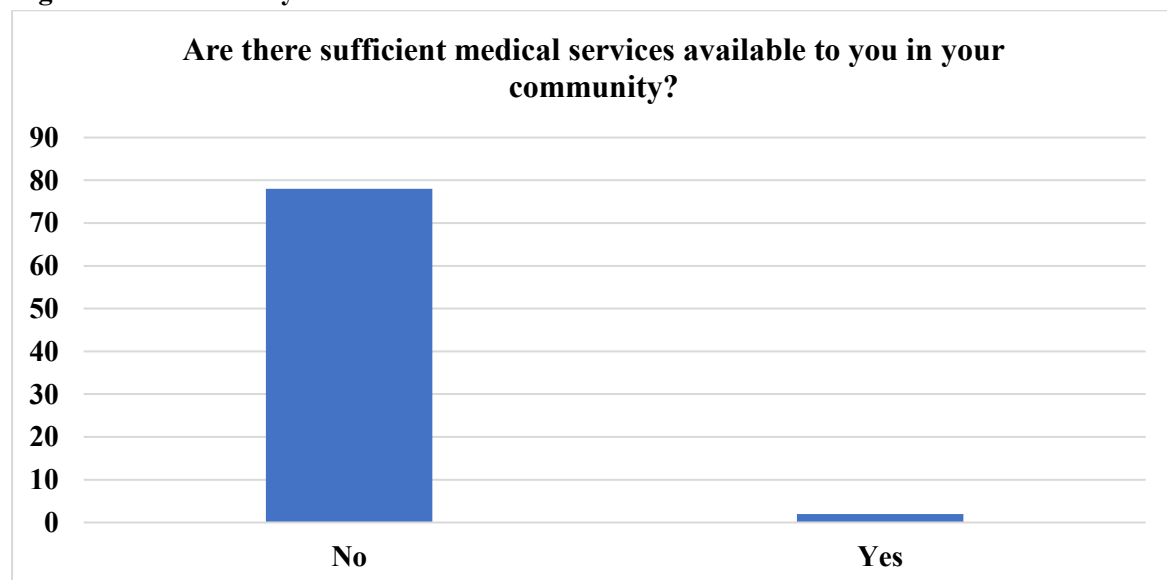


Figure 10 shows that 60.0% of respondents said river resource availability had no effect on food security, 27.5% said it had a positive influence, and 12.5% said it had a negative impact. 97.5% of people did not have access to enough medical care, according to Figure 11. Regarding energy

sources for lighting and cooking, 81.3% of respondents rely on firewood, while 18.8% use charcoal.

Community-Based Management and Support

Figure 12: Presence of Community-Based Organisations

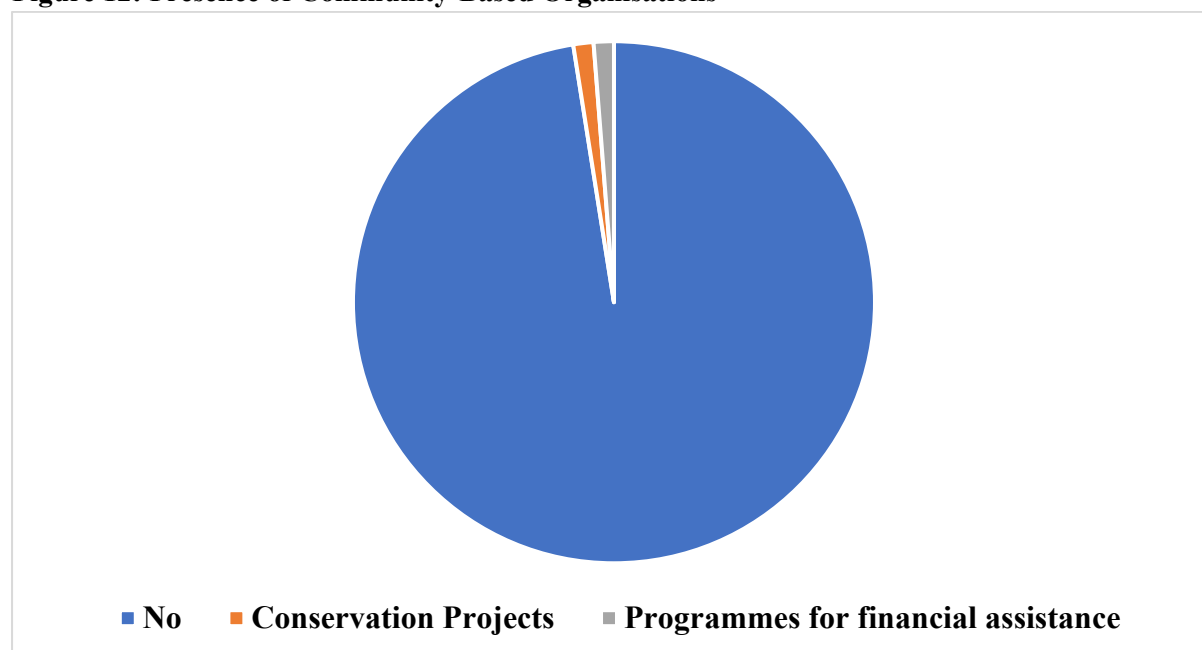
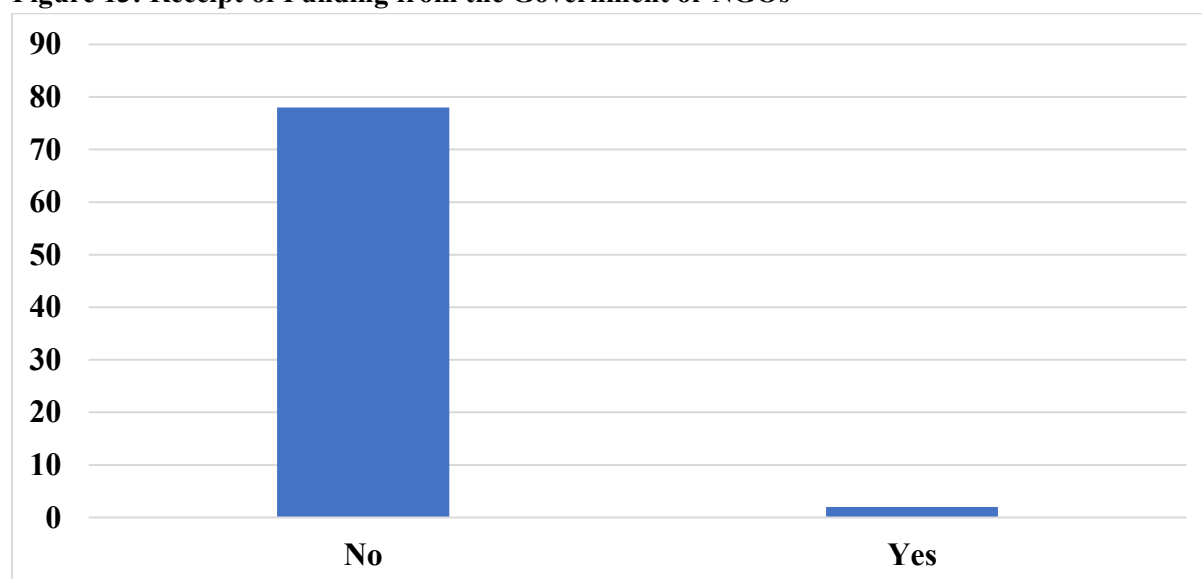


Figure 13: Receipt of Funding from the Government or NGOs



97.5% of community-based organisations engaged in natural resource management (Figure 12) did not report any. 97.5% did not get government or non-governmental organisation support for resource management or socioeconomic development (Figure 13).

DISCUSSION

In line with findings showing fishing plays a crucial role in West African livelihoods, the demographic data showed a youthful to middle-aged workforce (69.9% between the ages of 20 and 40) involved in river-related activities

(Allison *et al.*, 2002). According to Cox (2021), women are active in post-harvest activities like fish processing and trading, whereas males are largely responsible for fishing and sand mining. This is reflected in the prevalence of male engagement (68.8%).

High-intensity fishing operations that could have an effect on the river ecology are suggested by the high daily fishing frequency (87.5%) and use of 40-horsepower equipment (65.0%). This level of intensity is consistent with findings that small-scale fisheries can yield substantial profits but

necessitate sustainable management (Bene *et al.*, 2007). For 88.8% of respondents, river-related activities accounted for 26--75% of household income, highlighting the fisheries industry's vital role in reducing poverty and ensuring food security (Beveridge *et al.*, 2013; Belton & Thilsted, 2014). The sales channel data revealed that 60.0% of respondents sell products directly to consumers and 36.3% to local markets, with only 3.8% reaching nearby towns, indicating a localised economy with limited external market reach. This limited market access, identified as a challenge by 13.8% of respondents, constrains potential income growth for resource-dependent households.

According to 36.3% of respondents, sand mining was a key natural resource activity. This is in line with global trends, which show that sand is the second most used raw material after water (UN Comtrade, 2014). According to NEMA (2004), the economic advantages include the development of jobs and a local supply of building materials. However, there are serious environmental repercussions. An important environmental worry is the result that 66.3% of respondents saw a worsening in water quality during a five-year period. The main culprit, according to respondents, was domestic trash (61.3%), followed by mangrove removal (27.5%), sand mining (5.0%), and agricultural runoff (5.0%). These results are consistent with those of Joseph *et al.* (2018), who found that sand mining results in erosion, poor water quality, destruction of vegetation and farmlands, and a decline in fishing. Dharkwa *et al.* (2005), who discovered that river sand mining affects fish communities in Ghana's Offin River Basin, are supported by the altered river flow patterns and increased sedimentation.

There were found to be three main causes of anthropogenic pollution. Erosion and plant loss result from artisanal sand mining's disruption of riverine ecosystems, destruction of aquatic habitats, and instability of banks. By increasing sedimentation, the disturbance lowers oxygen levels and light penetration, both of which are essential for the survival of aquatic animals

(Akagi *et al.*, 1995). Fertiliser and pesticide discharge from agricultural operations contribute, while nutrients that reach the river through soil erosion and runoff encourage microbial development, lower dissolved oxygen levels, and kill fish (Tilman *et al.*, 2001; Lake Champlain Basin Program, 1998). According to David *et al.* (2012) and Drolic *et al.* (2007), domestic sewage discharge introduces high molecular weight substances that organically contaminate water, causing unpleasant odours, colours, and tastes while promoting algal growth. Sewage effluents also contain high levels of nitrogen and phosphorus, which increase eutrophication and diminish river functionality.

The community showed a remarkable ability to adapt in spite of environmental difficulties. Positive socioeconomic results are indicated by the finding that 66.3% of respondents reported enhanced educational access through income from natural resources, which is in line with findings showing small-scale fisheries significantly reduce poverty (Bene *et al.*, 2007). Regarding food security, 60.0% of respondents reported no impact from river resource availability, while 27.5% reported positive impact and 12.5% negative impact, suggesting that for the majority, river resources are sufficient to maintain food security. There are still large governance gaps, though. Healthcare infrastructure deficiencies are evident in the inability of 53.8% of respondents to use revenue from natural resources for medical care and the lack of medical services for 97.5% of respondents. Critical governance constraints that impede sustainable resource management include the lack of external finance (97.5%) and the absence of community-based groups for natural resource management (97.5%). A feedback loop where environmental deterioration decreases resource availability while increasing strain on remaining resources is created by the heavy reliance on firewood (81.3%) for energy.

CONCLUSION AND RECOMMENDATIONS

Conclusion

For local populations in Sierra Leone, the Orugu River is a vital lifeblood that supports socioeconomic growth via domestic energy supply, agriculture, fishing, and sand mining. This study documented the environmental problems brought on by exploitation while illuminating the complex balance between the use of natural resources and socioeconomic advantages. Sand mining offered significant economic potential for 30.7% of respondents, but fishing continued to be the main source of income and food security for 33.8% of respondents. However, resource extraction resulted in significant environmental degradation: 66.3% of respondents reported a reduction in water quality, which they attributed to domestic trash (61.3%), mangrove removal (27.5%), sand mining (5.0%), and agricultural runoff (5.0%). Socioeconomic results were mixed: while there were improvements in educational access for 66.3% of households, there were still major obstacles, such as a lack of community-based resource management organisations (97.5%), no outside funding (97.5%), and inadequate medical services (97.5%). Regarding food security, 60.0% of respondents reported no impact from river resource availability, 27.5% reported positive impact, and 12.5% negative impact. Regarding sales channels, 60.0% of respondents sell products directly to consumers, 36.3% to local markets, and only 3.8% to nearby towns, indicating a localised economy with limited external market reach. Mangrove loss and unsustainable resource use patterns were caused by the excessive reliance on firewood (81.3%). Finding a balance between financial gains and environmental protection is crucial to ensuring a sustainable future. By putting strong rules and sustainable practices into place, it will be possible to live in harmony with the environment and guarantee that the Orugu River will continue to support and benefit nearby communities for many generations to come.

Recommendations

The following suggestions are put out in light of the findings:

Regulated Sand Mining

Promote sustainable mining methods like site rotation and mined area restoration, build monitoring systems with fines for infractions, and enact and implement regulations governing sand mining areas and quantities.

Sustainable Fishing Practices

Establish closed seasons and fishing quotas to stop overfishing, control the types of fishing gear to cut down on bycatch, and assist community-based fisheries management initiatives.

Agricultural Management

Encourage soil conservation strategies like crop rotation and agroforestry, support water-efficient irrigation techniques, and offer agricultural extension services on sustainable practices.

Alternative Energy Sources

Introduce energy-efficient stoves to cut consumption and encourage the use of renewable energy sources (biogas, solar) to lessen reliance on firewood.

Community-Based Management

Create local governance frameworks for the management of natural resources, offer instruction in sustainable practices, and carry out environmental education initiatives.

Infrastructure for Healthcare and Education

To increase local capacity, improve educational facilities and healthcare infrastructure and services.

Policy Support and Funding

Create policies that support ecosystem preservation and sustainable development, and look for financial and technical support from the government and non-governmental organisations.

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