Volume 10, Issue No. 01

KENYA Aquatica

A Scientific Journal of Kenya Marine and Fisheries Research Institute

KMFRI

Editorial

Editorial: Kenya Aquatica Journal Vol 10(1) – *A Showcase of KMFRI's Pioneering Research in Freshwater Ecosystems*

The latest edition of Kenya Aquatica Journal, Vol 10(1) showcases pioneering research by KMFRI scientists on Kenya's freshwater ecosystems. This edition, supported by KMFRI and WIOMSA, covers ecological, socio-economic, and environmental challenges, providing valuable insights into sustainable management practices.

One notable study investigates disease surveillance and antimicrobial resistance in fish from lacustrine caged farms, emphasizing responsible antibiotic use to maintain fish health. Another study explores the impact of organochlorine pesticides on macroinvertebrates in Lake ecosystems, advocating for Rhagovelia spp. as a bioindicator for pesticide monitoring across food webs.

Research on Lake Baringo's small-scale fishery assesses the catch and effort composition, stressing the need for regulatory enforcement to avoid overfishing and advocating for capacity building among stakeholders for sustainable management. Additionally, a study on wild fish kills in Lake Victoria focuses on eutrophication and pollution, recommending integrated watershed management to protect the lake's fisheries and local livelihoods.

A comprehensive study on Lake Elementaita – one of Kanya's flamingos' sanctuaries, combines water quality, fisheries studies, and community surveys, calling for integrated watershed management, conservation, and sustainable agriculture. Research on fisheries co-management in Lake Baringo highlights the importance of local community involvement and sustained achievements in ecosystem management, despite challenges in law enforcement.

An article on the socio-economic dynamics of Lake Victoria proposes establishing a regulatory framework incorporating citizen science to manage the lake's resources for long-term sustainability. Addressing plastic pollution in Lake Turkana, a study recommends waste management solutions, public awareness, and better enforcement of regulations to tackle the issue.

The journal also features research on antimicrobial resistance (AMR), with a review exploring Kenya's aquatic biodiversity for potential novel antimicrobial agents. A genetic research study evaluates freshwater fish populations, identifying gaps and proposing future directions for conservation and management.

Lastly, the journal presents an evaluation of fish market dynamics in Lake Naivasha, recommending infrastructure development like fish markets and hatcheries to support the region's fishery sector.

This edition of Kenya Aquatica Journal provides crucial insights into Kenya's freshwater ecosystems, covering a wide range of research on sustainable management, environmental challenges, and the socio-economic factors influencing aquatic resources. The research highlights KMFRI's ongoing contributions to understanding and addressing these issues, fostering a deeper understanding of Kenya's aquatic biodiversity.

The preparation, compilation and production of this edition were co-funded by KMFRI in partnership with the Marine and Coastal Science for Management (MASMA) programme of the Western Indian Ocean Marine Science Association (WIOMSA). The Chief Editor and entire Editorial Board of Aquatica greatly appreciate their support.

About Kenya Aquatica

Kenya Aquatica is the Scientific Journal of the Kenya Marine and Fisheries Research Institute (KMFRI). The aim of the Journal is to provide an avenue for KMFRI researchers and partners to disseminate knowledge generated from research conducted in the aquatic environment of Kenya and resources therein and adjacent to it. This is in line with KMFRI's mandate to undertake research in "marine and freshwater fisheries, aquaculture, environmental and ecological studies, and marine research including chemical and physical oceanography", in order to provide sci entific data and information for sustainable development of the Blue Economy.

KENYA AQUATICA SCIENTIFIC JOURNAL OF THE KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

Volume 10, Issue No. 01 2025

Subscription Information

The Kenya Aquatica is published semi-annually. It is an open access journal available online at www.kmfri.co.ke

ISSN 2077-432X (print)

ISSN2077-432X-4-1

ISSN 2617-4936 (online)

ISSN2617-4936-4-1

Hard copies may be obtained free of charge from the Kenya Marine and Fisheries Research Institute.

Submitting Articles

Submissions to the Kenya Aquatica Journal are accepted year round for review. Manuscripts may be submitted to the Chief Editor through aquatica@kmfri.go.ke

Featured front cover picture: Researcher sampling surface plankton in the Kerio River inlet to Lake Turkana. (Photo credit: Mr. John Malala)

Featured back cover picture: Chair of KMFRI Board of Management Amb. Dr. Wenwa Akinyi Odinga Oranga (seated middle), on her right, Ag. KMFRI CEO Dr. James Mwaluma, flanked by KMFRI Heads of Sections: Front (L-R) Dr. Victoria Tarus, Ms Caroline Mukiira, Dr. Jacob Ochiewo, Dr. Irene Githaiga, Mr. Abraham Kagwima. Back (L—R) Mr. Paul Waluba, Ms Jane Kiguta, Dr. Gladys Okemwa, Dr. Eric Okuku, Dr. Joseph Kamau, Mr. Isaac Kojo, Ms Joan Karanja, Mr. Milton Apollo. (Photo credit KMFRI)

Research Vessel MV Mtafiti in the background

Socio-economic dynamics and resource management challenges in Lake Victoria: Implications for Kenya's Blue Economy

Patrick Wanguche Otuo[1]*, Horace Owiti Onyango[1], Jane Fonda Awuor[1], Nathan Kemei[1], Bernard Omulo Owino[1], Derrick Onyango Ochieng[1], Christopher Mulanda Aura[1], Chrispine Nyamweya[1], Venny Mziri[1], Melckzedeck Osore[2]

[1]Kenya Marine and Fisheries Research Institute, P.O. Box 1881, Kisumu, Kenya

[2]Kenya Marine and Fisheries Research Institute P.O. Box 81651-80100, Mombasa, Kenya

***Corresponding Author:** partyotuo2009@gmail.com and pwanguche@kmfri.go.ke

Abstract

The Blue Economy, which encompasses sustainable use of aquatic resources for economic growth, improved livelihoods, and environmental health, has gained global recognition as a critical driver of sustainable development. Socio-economic studies play a fundamental role in enhancing the Blue Economy by providing insights into human interactions with marine and freshwater ecosystems, economic dependencies, and social dynamics that influence sustainable resource utilization. This paper highlights the critical role of socio-economic studies in shaping a sustainable and inclusive Blue Economy. This is because, these studies help in assessing the economic value of marine industries such as fisheries, tourism, and maritime transport, while identifying socio-economic challenges such as poverty, resource conflicts, and policy gaps. Additionally, socio-economic research informs evidence-based policymaking, promotes equitable benefit-sharing, and fosters community engagement in Blue Economy initiatives. Through integrating socio-economic analyses into Blue Economy strategies, governments and stakeholders can achieve sustainable resource management, job creation, and climate resilience, ultimately ensuring long-term economic and environmental benefits. The current paper showed that fishing dominated Lake Victoria uses and therefore the fishing activities led in encountering disputes with other users. The most dominant illegal activities were those mostly mentioned in previous literature and they were mainly resource use conflicts, illegal, unregulated and unreported (IUU) fishing and pollution, among others. The paper recommends the creation of a regulatory system or a policy framework for the Lake's uses that is crucial to lake management through the use of citizen science mechanisms.

Keywords: dynamics, Blue Economy, socio-economics, citizen science, studies

Introduction

As nations look to maximize the economic potential of seas, oceans, and other bodies of water while maintaining environmental sustainability, the idea of the "Blue Economy" has drawn a lot of attention recently. A variety of industries that support economic growth, job creation, and food security are included in the Blue Economy, such as biotechnology, fisheries, maritime transportation, coastal tourism, and renewable energy (Choudhary, 2021). A thorough grasp of the socio-economic elements influencing the management of freshwater and marine resources is necessary to achieve a sustainable and inclusive Blue Economy. Examining the social structures, economic relationships, and policy frameworks that influence how people interact with aquatic habitats, socio-economic studies are essential in this respect (Stojanovic *et al.*, 2016). Evaluating the economic worth of marine resources and industries is one of the main ways socio-economic

studies contribute to the Blue Economy. Policymakers and stakeholders can make better judgments about resource allocation and investment priorities if they have a thorough understanding of the economic importance of fisheries, aquaculture, and marine-based tourism (Payet, 2006). Socio-economic research helps to ensure that economic policies are in line with the sustainable development goals (SDGs) by shedding light on how the Blue Economy contributes to employment, livelihoods, and the Gross Domestic Product (GDP) at the national and regional levels.

The social aspects of the Blue Economy, including the roles and vulnerabilities of various stakeholder groups, are highlighted by socio-economic studies. Indigenous populations, coastal communities, and small-scale fishermen frequently rely significantly on marine resources for their livelihoods (Andrews, *et al.*, 2021). In order to ensure fair benefit-sharing and lessen socio-economic inequities, research on gender dynamics, access to marine resources, and social inequality helps advance inclusivity in Blue Economy projects. Policymakers can create initiatives that strengthen social resilience, empower marginalized communities, and boost general well-being by taking socio-economic factors into account (Jewett, *et al.*, 2021). Addressing environmental sustainability issues in the Blue Economy also heavily relies on socio-economic research. The long-term sustainability of ocean-based enterprises is threatened by overfishing, marine pollution, habitat loss, and climate change (Mekouar, 2023). By identifying the social and economic factors that contribute to these environmental problems, socio-economic assessments facilitate the creation of policies that support sustainable resource management. Strategies for encouraging sustainable seafood consumption and responsible use of marine resources, for instance, can be informed by research on consumer behavior, market incentives, and regulatory frameworks (Penca, 2020).

In the Blue Economy, socio-economic research backs evidence-based government and policymaking. Researchers assist governments in creating policies that strike a balance between environmental preservation and economic growth by offering data-driven insights into labor markets, economic trends, and the efficacy of policies. Informed by socio-economic research, effective governance processes support the creation of marine protected areas, international cooperation, and dispute resolution—all of which are essential for maintaining ecosystem services and biodiversity (DI Cintio *et al.*, 2023). Through offering a comprehensive understanding of the economic, social, and environmental linkages within freshwater and marine systems, socio-economic studies are essential for advancing the Blue Economy. Governments and stakeholders can support sustainable resource management, improve social fairness, and build economic resilience by incorporating socio-economic research into Blue Economy policies. Investing in socio-economic research will be crucial to securing the Blue Economy's long-term success and protecting marine ecosystems for coming generations, as the world increasingly turns to the seas as a source of sustainable growth. Given the role played by socio-economic research in policymaking, equitable benefit-sharing, and fostering community engagement in Blue Economy initiatives, the current paper highlights the critical role of socio-economic studies in shaping a sustainable and inclusive Blue Economy of Lake Victoria, Kenya in order to give room for specific mitigation measures and to foster value additions in areas that appear to have certain gaps.

Materials and methods

Study Area

The study was conducted in the five riparian counties: Kisumu, Siaya, Busia, Homabay, and Migori within Lake Victoria, Kenya whereby a total of 26 landing sites were sampled. Kisumu (2), Siaya (3), Busia (3), Homabay (12) Migori (5), and other lake users such as Luanda Kotieno ferry terminals, Mbita ice plant, Kenya Electricity Generating Company (KENGEN) station, Kisumu Water and Sewerage Company (KIWASCO), Siaya-Bondo Water and Sewerage Company (SIBOWASCO), Homabay Water and Sewerage Company (HOMAWASCO), Kenya Rural Roads Authority (KERRA), Kenya Urban Roads Authority (KURA) and Kenya National Highway Authority (KENHA).

Site selection

After stratification at several levels (administrative, landing site nature, and lake uses), the study sample was determined. The beach's level of activity and the availability of the necessary target groups of lake users were taken into consideration while selecting the landing spots. Scheduling restrictions and the limitations of available resources significantly limited the actual sample size. Both urban and rural landing options were considered in each county.

Data collection and analyses

Fisher communities, local administration, ward representatives, government officials in KURA, KERRA, and KENHA, as well as water abstraction and transport companies, hydroelectricity companies, and waste water discharge, were interviewed one-on-one to administer a structured online questionnaire anchored in Kobo to 317 respondents. Prior appointments for the interviews and the study's participative methodology, which entailed following up with respondents at their designated work stations, were credited with the high response rate. Depending on the predominant dialect in certain landing sites, the enumerators translated the interview questions into either Luo or Kiswahili, even though the data collection tool was recorded in English.

The acquired electronic data was downloaded into MS Excel before being processed and exported to Statistical Package for Social Sciences (SPSS) for further analyses. The SPSS Version 28.0.1.1 was employed for statistical analysis, focusing on relationships between key variables such as socio-demographics, uses, regulatory frameworks, conflicts and challenges. Descriptive statistics including means, frequencies, and percentages, were calculated to summarize the data.

Results and discussion

Socio-demographic characteristics

Table 1 provides a summary of the respondents' attributes. For the study, a sample of 319 lake users was selected. The majority of respondents (n = 114; 36.5%) were in the 36–45 age range, and there were comparatively more men (n = 241; 76%) than women (n = 76; 24%). The bulk of users only had O-level education (n = 153; 48.4%) and A'Levels (n = 109; 34.5%), and about 85.2% (n = 271) were married.

Table 1. Socio-demographic characteristics of various users of Lake Victoria, Kenya.

Variable	Categories	n	Proportion
Gender	Male	317	76.0%
	Female		24.0%
Age	18-25	310	10.0%
	26-35		26.8%
	36-45		36.5%
	46-55		17.4%
	>56		9.4%
Marital status	Married	317	85.2%
	Separated/Divorced		0.6%
	Single		10.1%
	Widow/er		4.1%
Education Level	None	316	1.6%
	O Level		48.4%
	A Level		34.5%
	Tertiary		15.5%

Uses of Lake Victoria

In Lake Victoria, a variety of activities occur (Fig. 1). The lake is mostly utilized for fishing and household tasks. According to the majority of respondents (n = 294; 93%), the lake is crucial to their livelihoods and should be managed appropriately (n = 302; 95.3%). Nearly 40 million people in riparian nations depend on the Lake Victoria basin for domestic purposes, fishing, and agricultural output (Okungu *et al.,* 2005). Food, energy, drinking and irrigation water, shelter, maritime transportation, leisure, and a place to dispose off industrial, agricultural, and human waste are all provided by the Kenyan basin. Additionally, it serves as a destination for tourism and biodiversity conservation. Large populations live in the basin and depend on it for industrial development, sale and export, subsistence farming and fishing. Inspite of the lake's significance to the surrounding towns, the respondents reported a sharp rise in lake usage which has degraded the water quality and limited their ability to utilize it efficiently. Therefore, it is crucial that the nation and the different stakeholders work together through concerted effort to guarantee the lake's survival for better livelihoods. Some of the lake's observed usage within the riparian counties are depicted in figure 3.

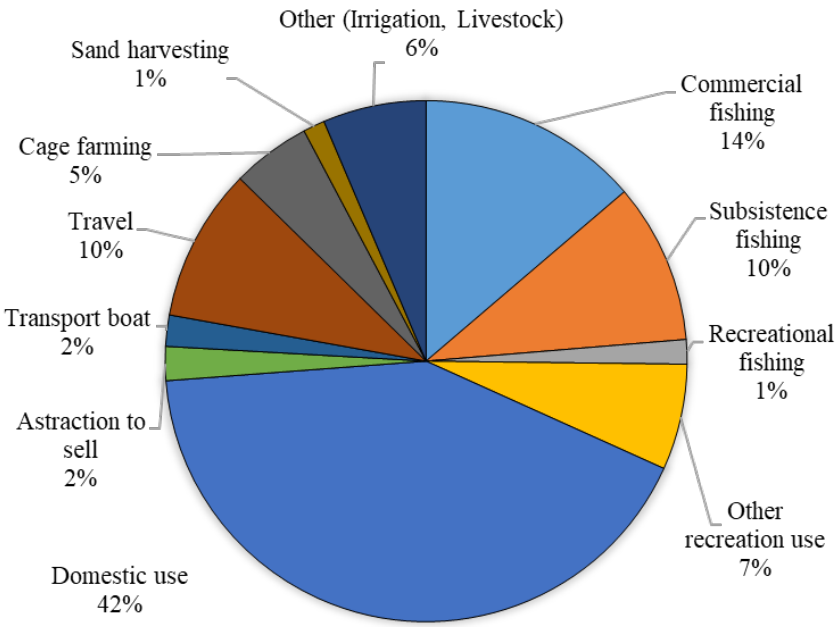

Figure 1. Various uses of Lake Victoria, Kenya.

Perceptions on lake use

Despite the rise in users, respondents reported that there was still adequate room in the lake for their activities (Table 2). However, owing to human-wildlife conflicts and shoreline erosion, safety along the lake was a major concern.

Table 2. Percentage score of uses of Lake Victoria based on the perceptions of the lake-users.

Statement	Percentage	Description
Ability to conduct activities in the lake	82.9	Strongly agree
Unavailability of enough space in the lake to conduct activities	52.1	Neither agree nor disagree
Safety along the shores of the lake	69.0	Agree
Safety in the lake	58.5	Neither agree nor disagree
Conflict with other users when using the lake	68.1	Agree

Challenges of lake uses

Disparities in Lake Victoria's management across ecological, social, economic, and political contexts lead to difficulties in a number of areas. Global environmental change, transboundary problems, human and social aspects, governance structure flaws, and environmental sustainability concerns were all mentioned by respondents (Fig. 2). Deteriorating water quality as a result of rising pollution from human activity is one of the environmental challenges mentioned, which could lead to major health problems. Increased siltation from upstream sources has been noted by cage farmers, interfering with the water depth needed for cage installation. Fish stocks are deteriorating as a result of increasing fishing effort brought on by the lake's free access scheme.

According to several respondents, the co-management regime's poor governance mechanisms made it more difficult for stakeholders to use lake resources sustainably. Because their functions overlapped, the users did not fully comprehend the multi-agency management system. Fishermen stated that other fishermen were destroying and stealing their gear, resulting in financial losses. Attacks by humans on wildlife were also common, resulting in financial and societal damages. Fishermen who fish near the cages have also been accused by cage farmers of stealing fish.

The claimed transboundary problems included Ugandan border patrol agents harassing them and arresting them, which prevented them from using the lake. Additionally, they reported that because they were not following fishery regulations, the local authorities were harassing them. Reduced water levels, severe winds, and temperature variations brought on by global climate change have been shown to contribute to fish mortality and escapees as well as water abstraction for residential and commercial applications. Additionally, floating islands obstructed fish landing sites and cage water abstraction points.

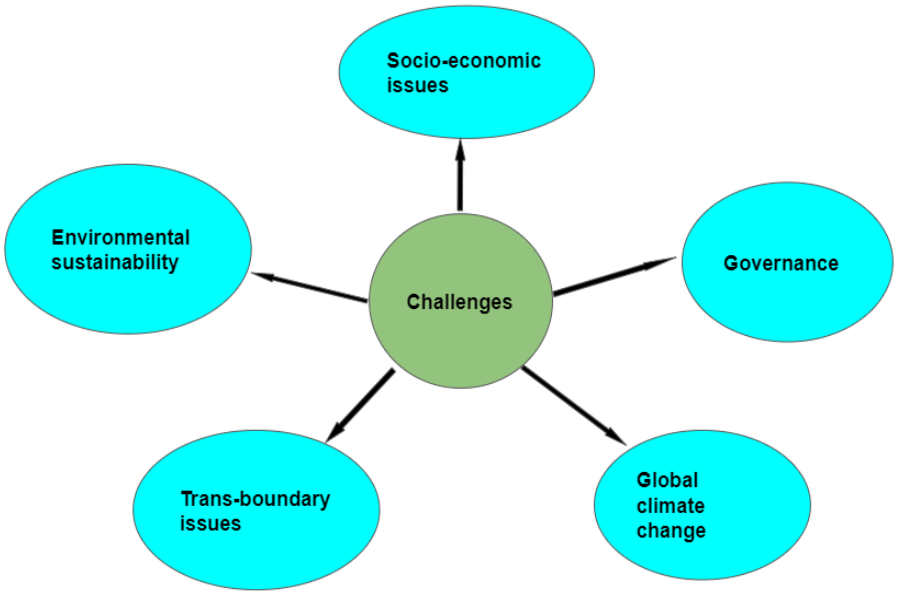

Figure 2. Challenges linked to the use of Lake Victoria, Kenya.

Conflicts between lake users

Figure 3 shows mapping of some of the reported conflicts. About 65.2% (n = 208) of respondents reported having had disagreements with other lake users. Because fisherman are the predominant users of the lake, disputes between them and other users were the most common. Due to the lake's several uses and the lack of information provided by stakeholders regarding its different users, disputes also developed between other users. The Beach Management Units (53.6%), observation (25.4%), National Government officials (13.5%), County Government officials (5.6%), chiefs and elders (0.9%), friends, family, and neighbors (0.6%), fliers, and radio (0.3%) were the primary sources of information. In terms of knowledge about new users of the lake, majority (n = 227; 71.2%) cited Beach Management Unit (BMU) to be the main source of information, followed by observation (n = 73; 22.9), with the least being national government officials (0.5%). This was probably due to the fact that majority of the users of the lake reside within the fishing villages where the BMU is the main policy implementor.

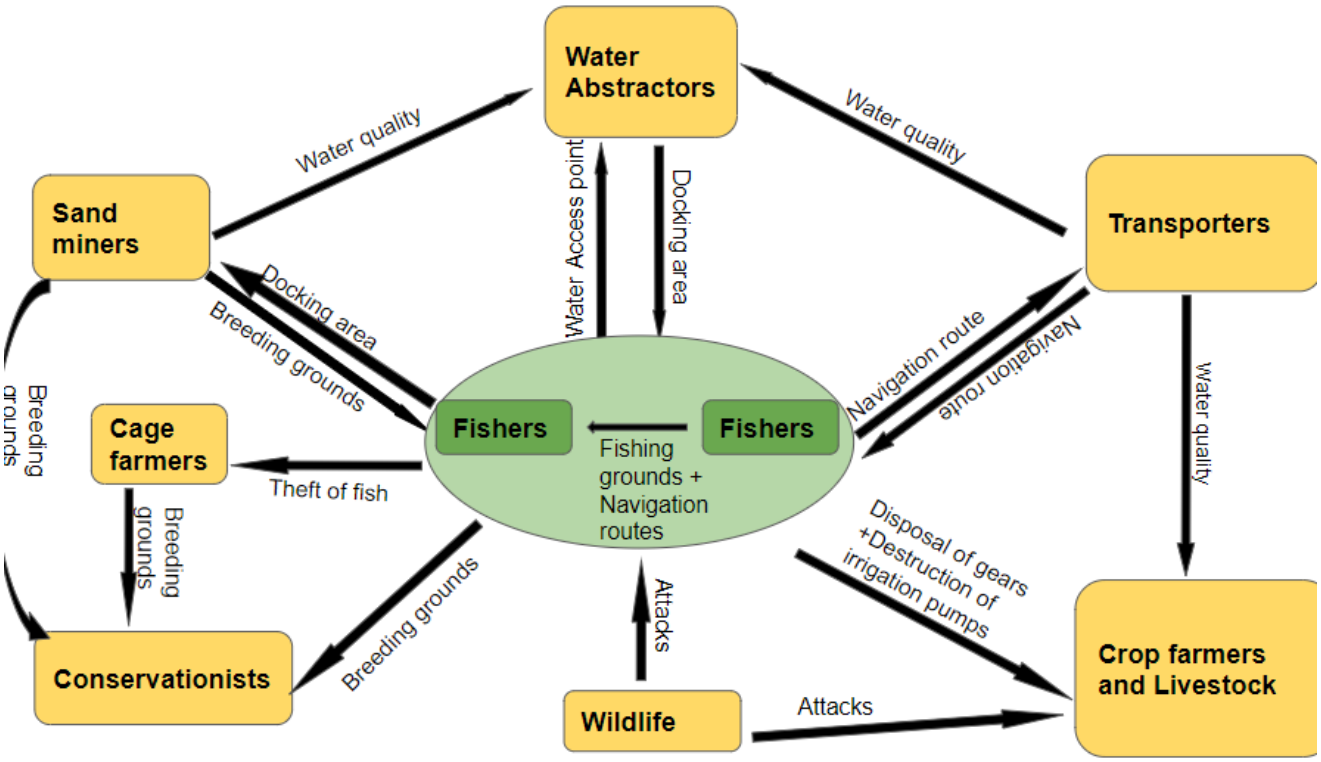

Figure 3. Prominent conflicts amongst the various users of Lake Victoria, Kenya.

Unsustainable activities in the lake

Approximately 85% (n = 272) of respondents said they had seen activities occurring in their lake usage region that they believed shouldn't be occurring (Table 3). These included sand harvesting, illegal fishing, garbage disposal, riparian vegetation removal, an uncontrolled number of cages and fishermen, and lake infrastructure development. They were concerned about the potential long-term health effects of cage farming's using metal frames. Additionally, some crop farmers asserted that they owned the riparian areas they occasionally cleared for farming, which was said to have an adverse effect on water quality due to the use of chemical fertilizers. Waste was also reported to be released into the lake through cleaning in the lake, oil spills, haphazard cage placement, and a shortage of restrooms at landing sites. Another factor contributing to the rise in lake pollution was the washing of cars and motorcycles along the shores of the lake.

Table 3. Activities that were perceived as unsustainable in Lake Victoria.

Activity	Description
Illegal fishing	• Use of monofilament nets • Fishing in breeding grounds • Use of poison • Beach seining
Waste disposal	• Open defecation • Dumping of diapers/sanitary materials/plastic bottles • Bathing/ washing in the lake • Industrial sewage release • Oil spills from boats
Clearing of riparian vegetation	Crop farming along the shores using fertilizers
Sand harvesting	Near breeding grounds
Cage fish farming	• Use of metallic cage frames • Unconsumed feeds • Unregulated number of cages
Fishing	• Unregulated number of fishers • Use of unseaworthy boats
Infrastructure	Construction of hotels near the shore

Regulatory framework

Respondents pointed to a lack of policies and lax implementation of available frameworks, which are necessary for effective governance to gurantee a sustainable Blue Economy. The majority of them (n = 288; 90.3%) recommended the creation of a legal/regulatory system or a policy framework for the lake's uses and proposed the development of a spatial plan is guide lake management and resource utilization (n = 286; 89.7%). Additionally, the respondents expressed willingness to contribute to the plan through community mobilization (n = 140; 43.9%), awareness creation (n = 81; 25.4%), indigenous knowledge (n = 62; 19.4%), and technical skills (n = 36; 11.3%). They also find it important to be involved in the various stages of the plan, such as planning (31.8%), development (20%), implementation (21.9%), and monitoring (26.2%). Obtaining stakeholder feedback was very important to the respondents (n = 287; 90%), with the proposed feedback mechanisms presented in figure 4.

Conclusion and recommendations

Socio-economic studies play a critical role in enhancing the Blue Economy by providing insights into human interactions with marine resources in form of economic dependencies, and social dynamics that influence sustainable resource utilization. The current paper showed that Lake Victoria basin is dominated by an energetic and literate population that can advance Blue growth in the region. Fishing dominates the lake use with majority of the respondents showing an ability to conduct activities in the lake, and with disputes between fishers and other users being the most common. The respondents mentioned the most dominant illegal activities being undertaken in the lake such as IUU, pollution, among others that have similarly been noted in most literature. The paper recommends the creation of a legal/regulatory system or a policy framework for the lake's uses that is crucial to lake management through community mobilization, awareness creation and by applying citizen science mechanisms for lake conservation such as use of indigenous knowledge.

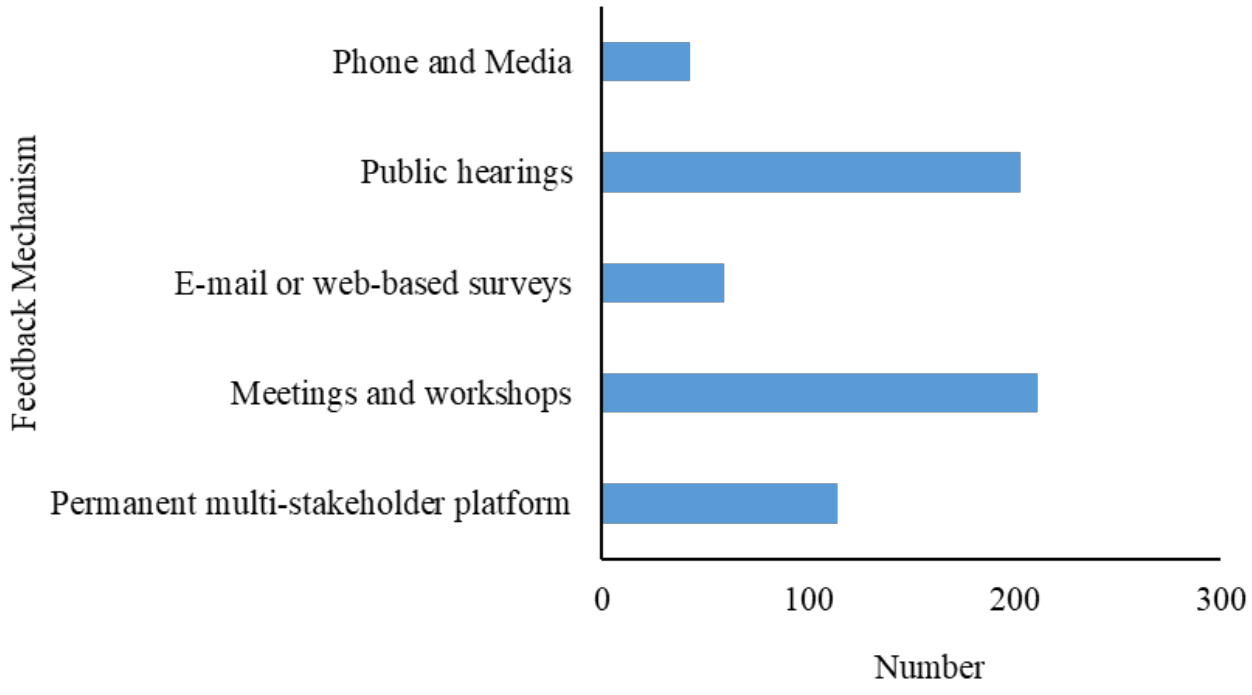

Figure 4. Recommended stakeholder feedback mechanisms.

References

Andrews N, Bennett NJ, Le Billon P, Green SJ, Cisneros-Montemayor AM, Amongin S, Sumaila UR (2021) Oil, fisheries and coastal communities: A review of impacts on the environment, livelihoods, space and governance. *Energy Research & Social Science*, 75: 102009

Choudhary P, Khade M, Savant S, Musale A, Chelliah MS, Dasgupta S (2021) Empowering blue economy: From underrated ecosystem to sustainable industry. *Journal of environmental management*, 291: 112697

Di Cintio A, Niccolini F, Scipioni S, Bulleri, F (2023) Avoiding "paper parks": a global literature review on socio-economic factors underpinning the effectiveness of marine protected areas. *Sustainability*, 15(5): 4464

Jewett RL, Mah SM, Howell N, Larsen MM (2021) Social cohesion and community resilience during COVID-19 and pandemics: A rapid scoping review to inform the United Nations research roadmap for COVID-19 recovery. *International Journal of Health Services*, 51(3): 325-336

Mekouar MA (2023) Food and Agriculture Organization of the United Nations (FAO). *Yearbook of International Environmental Law*, *34*(1): yvae031

Okungu JO, Njoka S, Abuodha JOZ, Hecky RE (2005) An introduction to Lake Victoria catchment, water quality, physical limnology and ecosystem status (Kenyan sector). *Frontiers Media SA*: 5

Payet R (2006) Decision processes for large marine ecosystems management and policy. *Ocean & coastal management*, 49(3-4): 110-132

Penca J (2020) Mainstreaming sustainable consumption of seafood through enhanced mandatory food labeling. *Frontiers in Marine Science*, 7: 598682

Stojanovic T, McNae HM, Tett P, Potts TW, Reis J, Smith HD, Dillingham I (2016) The "social" aspect of social-ecological systems: a critique of analytical frameworks and findings from a multisite study of coastal sustainability. *Ecology and Society*, 21(3)