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Research Article

Socio-Economic Assessment of Communities Along the Western Shore of Lake Dambal, Ethiopia

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Abstract

This study explores the socioeconomic features of communities surrounding Lake Dambal previously named Lake Ziway, the only freshwater lake in Ethiopia's Central Rift Valley basin, which is increasingly threatened by degradation. Using both quantitative and qualitative research methods, including household surveys, key informant interviews, and focus group discussions, the study assessed the socio-economic and environmental challenges impacting the western shore of Lake Dambal. A total of 420 respondents, predominantly male household heads in rural areas, revealed that most households depend on farming, yet face significant challenges such as water scarcity, soil erosion, pests, diseases, and market instabilities. Environmental degradation, driven by deforestation, chemical use, invasive weeds, overfishing, and urban waste pollution, further exacerbates the lake's deterioration and the communities' vulnerabilities. Despite these challenges, there are opportunities for sustainable development through the adoption of improved agricultural technologies, value-addition activities, and sustainable practices like beekeeping and reforestation. The study underscores the urgent need for holistic wetland conservation efforts, which include promoting alternative livelihoods, implementing land use planning, and enhancing market access. Strengthening policy enforcement, supporting smallholder farmers, and fostering private sector engagement are also crucial for improving the livelihoods and resilience of the community. By addressing these socio-economic and environmental issues, stakeholders can work towards the sustainable management of Lake Dambal and its surrounding wetlands, ultimately contributing to the well-being of local communities and the preservation of critical ecosystems.

Keywords

Lake Dambal, Wetlands Conservation, Socio-economic Challenges, Sustainable Development, Environmental Degradation

1. Introduction

Wetlands are among the most ecologically diverse and economically significant ecosystems globally, providing crucial ecosystem services like water purification, flood regulation, carbon sequestration, and habitat provision for numerous plant and animal species [9]. However, these valuable ecosystems are increasingly threatened by human activities, leading to rapid degradation and loss [3].

In Ethiopia, wetlands are vital for the livelihoods of millions, especially in rural areas where dependency on natural resources is high [6]. Lake Dambal, located in the Ethiopian Rift Valley, is a significant freshwater ecosystem with substantial ecological and socio-economic importance. It is the only natural freshwater lake in Ethiopia suitable for irrigation, supporting various economic activities such as agriculture,

fishing, and tourism, and serving as a crucial habitat for aquatic species [2].

Despite its significance, Lake Dambal faces numerous sustainability challenges that threaten the well-being of surrounding communities. Previous studies have identified drivers of wetland degradation, including climate change, land use change, pollution, invasive species, and unsustainable resource extraction [10, 12]. These factors not only reduce the lake's size and quality but also exacerbate socio-economic vulnerabilities, such as income inequality, lack of education, health disparities, unemployment, and environmental risks among local communities reliant on wetland resources [4].

Research has underscored the importance of understanding local perceptions, attitudes, and livelihood strategies related to wetland resources for effective conservation interventions [8]. Socio-economic factors like education level, income, access to resources, and institutional capacity significantly influence community engagement in conservation efforts [11]. Successful wetland conservation programs have integrated alternative livelihood options, participatory approaches, and community-based management initiatives [7].

There is growing recognition of the need for multidisciplinary approaches that combine ecological insights with socio-economic considerations to achieve sustainable wetland management goals [1]. Understanding the complex interactions between ecological processes, human activities, and socio-economic dynamics allows policymakers, researchers, and practitioners to develop holistic conservation strategies that promote both ecological integrity and community well-being.

Literature highlights the importance of addressing socio-economic factors in conservation efforts. Assessing the socio-economic features of the western shore of Lake Dambal is essential to understand local communities' economic activities, resource dependencies, and vulnerabilities. This assessment will help identify opportunities for sustainable development, address socio-economic challenges, and inform policy interventions to improve the livelihoods and resilience of populations in the area. By integrating local knowledge, engaging stakeholders, and promoting sustainable livelihood options, it is possible to safeguard wetland ecosystems and enhance the resilience of communities dependent on these valuable resources.

2. Methodology

2.1. Study Area

The study was conducted in 2023 on the western shore of Lake Dambal, located in the Great Rift Valley of Ethiopia, about 160 kilometers south of Addis Ababa. It falls within the administrative boundaries of the Dugda and Adami Tulu Jido Kombolcha (ATJK) districts (see Figure 1).
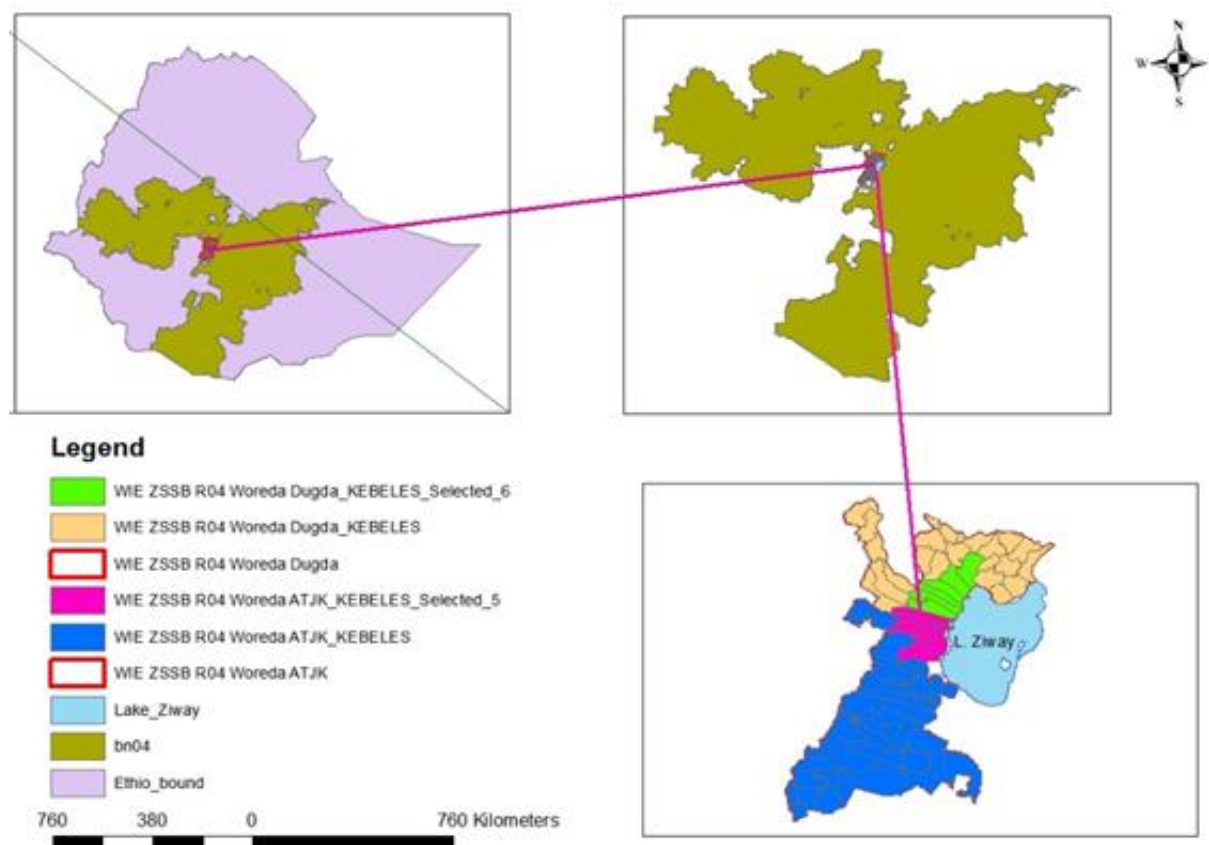

Figure 1. Study area map.

The western shore of Lake Dambal is a diverse and dynamic area with a moderate climate, fertile soils, and abundant natural resources, making it a vital hub for agriculture and biodiversity. The altitude ranges between 1,600 and 1,700 meters above sea level. The area experiences a bimodal rainfall pattern typical of the Ethiopian highlands, with the main rainy season ("kiremt" or summer) occurring from June to September and a shorter rainy season ("belg" or spring) from February to April. The predominant soil types are fertile alluvial and volcanic soils.

The major crops grown include grains (maize, teff, wheat, barley, sorghum, millet), legumes (beans, peas, lentils, chickpeas, sesame seeds), fruits (bananas, papayas, pineapples, avocados, citrus fruits, berries), vegetables (potatoes, sweet potatoes, carrots, radishes, cabbage, lettuce, spinach, kales), spices (garlic, ginger, turmeric, cardamom, cloves, nutmeg, cinnamon, vanilla), and various herbs (parsley, dill, basil, mint).

2.2. Study Design (Data Source, Sampling Design, and Data Collection)

The study utilized a combination of quantitative and qualitative research methods, including household surveys, key informant interviews, observation, and focus group discussions. Secondary data were also collected from published and gray literature. The sampling frame consisted of 11 Peasant Associations (PAs) bordering the western shore of Lake Dambal: six PAs from Dugda District and five from ATJK District (Table 1).

The number of respondents for the household surveys was determined using the equation provided by [5]:

$$n = \frac{z^2 * P * q}{e^2} * \frac{no}{1 + \frac{no-1}{N}} + 10\%$$

where:

Z = 1.96 from a Normal probability distribution at 95% confidence

P = estimated proportion of an attribute of interest, set as 0.5

q = 1 - p = 0.5

e is the desired degree of precision, set at 5%

N is the total population to sample from

no is the calculated sample size before adjusting for the finite population correction

According to the Bureau of Agriculture, the estimated total number of households and population were 10,000 and 50,000 (25,342 males and 25,582 females), respectively. Accordingly, 420 households were selected for surveys, with a proportional number from each PA. Quantitative survey data were collected electronically using tablets/smartphones with KoBo Collect.

Table 1. Study District, Peasant association (PA) and number of respondent's summary.

District	Peasant association (PA)	Number of respondents
ATJK	Edo gojola	39
	Abine Germama	39
	Elka celemo	38
	Negalign	36
	Waliin bula	36
	District total	188
Dugda	Wayo Gabreli	39
	Abono Gabreli	39
	Dodota Dembel	36
	Giraba korke adi	33
	Tuchi Dembel	44
	Tepho coroke	41
	District total	232
Total		420

Four focus group discussions (FGDs), two in each district, were conducted with district advisory committees (5 members each) and 10 model farmers (5 male and 5 female-headed households). The FGDs were used to triangulate information from the survey. Key informant interviews were conducted with 16 stakeholders in the target districts.

Qualitative interviews were recorded after obtaining informed consent. In cases where participants did not wish to be recorded, facilitators took notes. Both voice recordings and field notes were securely stored. Survey questionnaires and interview guides were prepared in English, with discussions conducted in Afaan Oromo.

The questionnaire included both open-ended and closed-ended questions, covering topics such as changes in agricultural systems, factors driving these changes, coping mechanisms, educational levels, and how respondents are utilizing opportunities and the like.

2.3. Data Management and Analysis

Data generated from fieldwork through surveys, interviews, and consultations were categorized into thematic areas like demographic and socio-economic status, Asset ownership and economic condition, Agricultural practices and labor, Environmental and ecosystem impact, Shocks and coping mechanism, Access to service and infrastructure, Community perception and attitude, and opportunities and recommendations for improvement. For qualitative datasets, patterns were identified among the themes and issues. Conclusive remarks were

drawn based on these themes and situational meanings. Quantitative data analysis of the survey was conducted using the Statistical Package for Social Sciences (SPSS). Qualitative data were transcribed and translated to English after each interview.

2.4. Ethical Consideration

Institutional Review Board (IRB) or ethics committee approval was not obtained for this study as our institution does not have an established system for such reviews. However, we ensured that ethical standards were upheld by obtaining written informed consent from all participants prior to their involvement in the research.

3. Results

3.1. Demographics and Socio-economic Status of Respondents

The study surveyed a total of 420 respondents, with the majority (87%) residing in rural areas and the remaining 13% located in urban towns. The average family size of the respondents is 6.51. Analyzing the demographic and socioeconomic characteristics of the respondents provides valuable insights into the sample composition. Firstly, the gender distribution indicates a significant imbalance, with males constituting 92% of the sample, largely due to the fact that household heads, who were the respondents in this study, are predominantly male in the area, reflecting societal norms and gender roles. Regarding education, most respondents have completed primary education (65%), while illiterate individuals represent 21% of the sample. Secondary education and above are less prevalent, accounting for 12% and 2% respectively, suggesting limited access to higher education opportunities in the region.

In terms of marital status, monogamous married individuals make up the largest proportion (78.33%), followed by polygamous married individuals (14.29%). Single, divorced, and widowed individuals each represent smaller proportions. Religion-wise, the majority of respondents identify as Orthodox (53.57%) or Muslim (37.38%), with smaller proportions adhering to Protestant, Catholic, or traditional religions. In terms of main occupation, most household heads, comprising 410 individuals (97.62%), list farming as their main occupation. (Table 2).

Table 2. Demographic Characteristics of Respondents (n=420).

Characteristic	No. of Respondents	Percentage
1. Sex of respondents		
Male	388	92%
Female	32	8%

Characteristic	No. of Respondents	Percentage
2. Place of residence		
Rural	368	87%
Urban	52	13%
3. Education level of respondents		
Illiterate	87	21%
Primary (up to grade 6)	275	65%
Secondary (up to grade 12)	50	12%
Above secondary (college/University)	8	2%
4. Marital status of Household head		
Monogamy Married	329	78.33%
Polygamy married	60	14.29%
Single	19	4.52%
Divorced	6	1.43%
Widower	6	1.43%
5. Religion		
Orthodox	225	53.57%
Muslim	157	37.38%
Protestant	23	5.48%
Catholic	9	2.14%
Traditional	6	1.43%
6. Main occupation		
Farming	410	97.62%
Marchant	4	0.95%
Nonskilled employe	5	1.19%
Skilled employe	1	0.24%

3.2. Asset Ownership and Economic Condition

3.2.1. Asset Ownership

The average farm size was 1.3 hectares. A significant majority (71.19%) of respondents own land bordering Lake Dambal, highlighting their strong connection to the lake and its surrounding areas (Table 3). Livestock ownership is prevalent among respondents, with 84.52% reporting ownership, indicating the importance of animal husbandry in the study area. Additionally, ownership of assets such as houses, mobile phones, and TVs/radios is common among respondents, while ownership of luxury items like sofas, refrigerators, and washing machines is relatively low, suggesting socioeconomic disparities and varying access to modern amenities among the surveyed population.

Table 3. Distribution of sampled respondents (n=420) by possession of assets.

Asset procession	No. of Respondents	Percentage
1. Having land bordering Lake Dambal		
Yes	299	71.19%
No	121	28.81%
2. Owning livestock		
Yes	355	84.52%
No	65	15.48%
3. Owning house		
Yes	410	97.62%
No	10	2.38%
4. Owning TV/radio		
Yes	242	57.62%
No	178	42.38%
5. Owning Mobile phone		
Yes	343	81.67%
No	77	18.33%
6. Owning Sofa		
Yes	92	21.90%
No	328	78.10%
7. Owning Refrigerator		
Yes	22	5.24%
No	398	94.76%
8. Owning Washing machine		
Yes	5	1.19%
No	415	98.81%

3.2.2. Monthly Savings and Expenses

In terms of income, 58.1% of households earned less than 10,000 birr annually, while 41.9% earned between 10,000 and 50,000 birr. 307 respondents (73.1%) report having a savings account at a bank, with 251 of them (59.6%) actively saving. Estimated average lowest and highest monthly income from all sources (Income obtained from crop sales, livestock and livestock products sale, Fishery, remittance, off-farm and non-farms, and other sources) and expenses of the household member is indicated in table 3 bellow.

For saving, the median monthly saving is 2000 Birr, indicating that half of the communities save less than this amounts each month. However, the mean monthly saving is substantially higher at 6960.74 Birr, influenced by communities with much higher saving amounts, as indicated by the highest recorded value of 5000 Birr. This suggests that the average saving amount is skewed by a few communities that save significantly more than others do. Additionally, the large standard deviation of 20158.23 Birr indicates a wide variation in the saving amounts among the communities, with some saving substantially more than the mean.

Similarly, for expense, the median monthly expense is 2000 Birr, indicating that half of the communities spend less than this amount each month. The mean monthly expense is higher at 5170.17 Birr, influenced by communities with higher expense amounts, as indicated by the highest recorded value of 3000 Birr. This suggests that some communities that spend more influence the average expense amount. The standard deviation of 14565.07 Birr indicates a considerable variation in the expense amounts among the communities (Table 4).

Overall, it is observed that the mean saving for each category is higher than the corresponding median saving showing the influence of few higher values on the mean. In addition, the measures of variation in the data, Standard deviation is large for most categories implying that amount of respondents' saving is widely dispersed. A more representative average then is median saving.

Table 4. Monthly savings and expenses of respondents in birr.

Factor	Median monthly saving	Mean monthly saving	Standard Deviation
Saving lowest (highest)	2000 (5000)	6960.74 (19217.00)	20158.23 (54040.76)
Expense lowest (highest)	2000 (3000)	5170.17 (10476.71)	14565.07 (29081.75)

3.3. Agricultural Practices and Labor

3.3.1. Farm Types Owned

Among the respondents (420), the breakdown of farm ownership is as follows: 55.95% own both rain-fed and irrigated farms, comprising 235 individuals. Additionally, 37.86% exclusively own rain-fed farms, which equates to 159 participants. Finally, 6.19% of all respondents, totaling 26 individuals, exclusively own irrigated farms.

3.3.2. Crop Production

Crop production was the primary livelihood activity for the majority of respondents. Maize was the dominant crop, grown by all respondents, followed by teff (98.57%), wheat (86.67%), and sorghum (78.1%). Other crops included beans, barley, and vegetables (Table 5). The average farm size was 1.3 hectares. Most respondents practiced mixed farming, combining crop production with livestock rearing.

Table 5. Major Crops Cultivated by Sampled Respondents.

Crop	Number of Respondents	Percentage
Maize	420	100%
Teff	414	98.57%
Wheat	364	86.67%
Sorghum	328	78.1%
Beans	292	69.52%
Barley	224	53.33%
Vegetables	160	38.1%

3.3.3. Livestock Production

Livestock production was a significant component of the farming systems, providing supplementary income and serving as a form of insurance against crop failure. Cattle were the most commonly owned livestock, with 86.67% of respondents owning cattle, followed by goats (79.52%) and sheep (72.38%). The average livestock holding per household was 5.3 Tropical Livestock Units (TLU), with cattle accounting for the largest proportion (Table 6).

Table 6. Livestock Ownership Among Sampled Respondents.

Livestock	Number of Respondents	Percentage
Cattle	364	86.67%
Goats	334	79.52%
Sheep	304	72.38%
Poultry	280	66.67%
Donkeys	112	26.67%

3.3.4. Beekeeping Practice

According to the survey results, only 6% of the respondents, specifically 25 out of 420 participants, reported engaging in beekeeping activities. However, among the respondents in the study area surrounding Lake Dambal, 100% of the 420 individuals regarded beekeeping as a favorable opportunity for buffer zone management. The respondents highlighted several reasons for viewing beekeeping as an advantageous prospect, including its potential for honey production, income generation, and its requirement of minimal resources.

3.3.5. The Availability of Labor and Seasonal Variation

The availability of labor and its seasonal variation among respondents is as follows: 63.33% reported having enough labor throughout all seasons, while 27.86% experienced shortages in some seasons, and 8.81% faced insufficient labor in all seasons.

3.3.6. Challenges and Opportunities for Farmers

Farmers encounter several challenges in their daily agricultural activities. These challenges include soil erosion, which can degrade the quality of farmland over time. Water scarcity poses another significant hurdle, making it difficult for farmers to irrigate their crops adequately. Pests and diseases also threaten crop yields, requiring farmers to invest in pest control measures. Furthermore, the effects of climate change, such as unpredictable weather patterns, can disrupt farming schedules and reduce harvests. Market instabilities contribute to uncertain income for farmers, while high input costs and low prices for produce further strain their financial resources. Poor infrastructure, limited access to finance, and insufficient technical support compound these challenges, making it challenging for farmers to improve their agricultural practices and increase productivity.

Despite these challenges, farmers have opportunities to enhance their farming methods and livelihoods. They can utilize improved seeds and planting materials to boost crop yields and resilience to pests and diseases. Adoption of new agricultural technologies can streamline farming processes and improve efficiency. Improved marketing channels offer farmers better access to buyers and higher prices for their produce. Better storage facilities help prevent postharvest losses and maintain the quality of crops. Expansion of value-addition activities allows farmers to increase the value of their products and diversify their income streams. Enhanced farmer organization enables collective action and advocacy for their rights and interests. Greater access to markets provides opportunities for farmers to sell their products to a wider customer base. By making more efficient use of inputs and improving soil fertility, farmers can optimize their resources and achieve sustainable agricultural practices.

Over the past five to ten years, there has been an increase in the adoption of high-value crops, mechanization, and the use of agrochemicals. These changes have led to improvements in yields but also pose risks to the environment and public health. The drivers behind these changes include government policies, international trade agreements, consumer preferences, technological advancements, and climate change.

The consequences of these changes on productivity and livelihoods vary depending on the context, but generally lead to higher profits for large-scale producers while smallholders

may face greater vulnerability due to price volatility and limited access to markets. There is also concern about the long-term sustainability of intensive agricultural practices and the potential for negative ecological impacts.

To address these concerns, there is a need for more equitable distribution of benefits, better regulation of agribusiness, and stronger support for smallholder farmers.

3.4. Environmental and Ecosystem Services and Impact

3.4.1. Resource Flow

Respondents identified various uses derived from Lake Dambal and its buffer zone. These include providing clean drinking water for humans and livestock, offering bathing facilities for personal hygiene, engaging in fishing activities to sustain livelihoods and food sources, utilizing the lake and surrounding areas for energy production, harvesting medicinal plants for traditional healthcare practices, and additional uses such as organic fertilizer, weed and grass resources, and other services as identified by the respondents. These diverse uses underscore the importance of Lake Dambal and its buffer zone as a critical resource for the surrounding communities, supporting various aspects of their daily lives and economic activities.

3.4.2. Community Impact on the Lake and Buffer Zone

The community's activities around Lake Dambal and its surrounding wetlands have various impacts on the ecosystem, resulting in harm and significant changes. Deforestation, primarily for agricultural expansion, contributes to habitat destruction, loss of biodiversity, and soil erosion, leading to a decline in vegetation cover and ecosystem balance. Chemical use, including fertilizers and pesticides, for crop cultivation poses risks such as water contamination, environmental pollution, and potential health hazards, which degrade water quality and affect aquatic life. Siltation, caused by soil runoff, results in sediment buildup, reducing water quality and impacting aquatic habitats by decreasing water clarity and affecting aquatic flora and fauna. Additionally, unsustainable fishing practices can deplete fish populations and disrupt the aquatic ecosystem, leading to a decline in fish stocks and disrupting the lake's natural balance. Ground destruction, through activities like land degradation and construction, further disrupts natural habitats, impacting soil stability, vegetation growth, and overall ecosystem health. These cumulative impacts underscore the need for sustainable management practices to preserve Lake Dambal's delicate ecosystem and ensure the well-being of the surrounding communities reliant on its resources.

3.4.3. Drivers for Changes

The observed changes in benefits derived from Lake Dambal and its surrounding wetlands are driven by several factors that have evolved over time. Droughts and climate change have played a significant role, affecting precipitation patterns and temperature fluctuations, consequently reducing water availability and altering the ecological conditions of the lake and wetland system. Overexploitation of resources, including excessive fishing and unsustainable agriculture practices, has led to declines in fish stocks and reductions in plant species diversity. Pollution, stemming from agricultural runoff and industrial wastewater, further exacerbates the degradation of the lake and wetland ecosystems, posing threats to their sustainability. Additionally, population growth, urbanization, and industrial development have heightened the demand for resources, straining the capacity of the lake and wetlands to support the needs of the surrounding communities.

These changes have significant consequences on the ecosystem and the livelihoods of those dependent on its resources. Reductions in fish stocks not only limit the protein available to local communities but also diminish the economic value of fisheries, impacting the income of fishermen. Decreases in plant species diversity not only affect wildlife's food sources but also reduce the ecosystem's ability to absorb pollutants, exacerbating environmental degradation. Such degradation, coupled with habitat fragmentation, results in long-term damage to the lake and wetland ecosystems, compromising their ability to provide essential goods and services. Ultimately, these disruptions to the ecosystem have profound effects on the livelihoods of communities reliant on the lake and wetlands for sustenance, water, and income generation, highlighting the urgent need for sustainable management practices to mitigate further damage and ensure the long-term resilience of Lake Dambal and its surrounding wetlands. To mitigate these issues, strategies should focus on sustainable resource management, conservation efforts, and improved governance structures to ensure the continued provision of goods and services from the lake and wetlands.

3.5. Shocks and Coping Mechanism

The community faced both climatic and non-climatic shocks and respondents adopted various coping mechanisms to deal with the shocks they faced. Climatic shocks are categorized in two shocks related to increased water level and shocks related to decreased water level. The climatic shocks related to increase Lake Water Level around Lake Dambal include flooding events, erosion, and water contamination and shocks when water level decrease is water scarcity, far from irrigation farm, biodiversity loss and non-climatic shocks they identified are Siltation, deforestation and chemical use.

3.6. Access to Service and Infrastructure

3.6.1. Access to Productive Services

The survey reveals the extent of respondents' access to

various productive resources as follows: Credit services were available to 53.33% of respondents, while 46.67% lacked access. A significant majority had access to extension services, with 96.9% reporting access, leaving only 3.1% without. Water resources were widely accessible, with 99.29% of respondents having access, while a mere 0.71% did not. Similarly, access to health services was nearly universal, with 99.76% reporting access, while only 0.24% did not. Regarding education, 89.29% had access, leaving 10.71% without. Access to markets was also widespread, with 99.76% reporting access, while only 0.24% did not. In summary, the majority of respondents had access to credit services, extension services, water resources, health, and education, while a smaller percentage had access to markets.

3.6.2. Housing Conditions

The housing conditions of the respondents reveal a variety of materials used for roofs, walls, and floors. The majority of houses had corrugated iron sheet roofs, accounting for 60.95% of respondents, followed by thatched roofs at 35%. Cement or concrete roofs were less common, representing only 0.71%, while 3.33% fell under the category of 'other,' which included unspecified materials. Regarding wall materials, wooden walls were prevalent among 45.95% of respondents, followed closely by blocked walls at 39.76%. Other wall materials constituted 14.29%, with unspecified materials falling under this category. As for flooring, the majority of respondents had mud floors (82.38%), while 17.14% had cement floors. Ceramic floors were rare, making up only 0.24%, and the 'other' category included one respondent with an unspecified floor material. Additionally, the majority of respondents either owned their homes or were in the process of buying them, indicating a sense of ownership and stability within the community.

3.7. Community Perception and Attitude About Environmental Safeguarding

About 92% of respondents (n=420) believe that the size and quality of Lake Ziway and its associated natural resource base are decreasing from time to time. Climate change, siltation, inorganic farm inputs, expansion of invasive weeds, deforestation, overfishing, extensive farming, over-abstraction of water for irrigation, urban wastes and the like were raised as the drivers for the decrease in lake size and quality. It was noted that the socio-economic condition of the community surrounding the lake was influenced by a reduction in the size and quality of the lake and other factors like shortage of rainfall, pests of livestock and crop, farm input in availability, and price increase, in access to central market due to brokers, shortage of farm machinery.

The community recognizes the negative impacts of their activities on Lake Dambal and its surrounding wetlands. They acknowledge issues such as deforestation, chemical use, and siltation, which contribute to habitat destruction and envi-

ronmental pollution. They are also aware of the effects of climate change, including altered precipitation patterns and temperature fluctuations. They perceive these changes as contributing to water scarcity and biodiversity loss, affecting both their livelihoods and the local ecosystem.

The community shows a favorable attitude towards adopting sustainable practices, such as beekeeping, which they perceive as a viable opportunity for resource management and income generation. This indicates a willingness to engage in environmentally friendly activities that also provide economic benefits. There is a growing awareness of the need for sustainable resource management to preserve the lake's ecosystem and ensure the long-term availability of resources. However, there is also recognition of the challenges in balancing immediate economic needs with long-term conservation goals.

There is a positive attitude towards adopting improved agricultural techniques, such as high-value crops and mechanization, which are seen as ways to increase productivity and income. However, there is also concern about the environmental and health risks associated with increased agrochemical use.

The community perceives various challenges, including soil erosion, water scarcity, and market instabilities, but also sees opportunities in improved seeds, marketing channels, and value-addition activities to enhance their agricultural practices.

There is a moderate level of community engagement in conservation and resource management initiatives. While some respondents actively participate in such activities, others are less involved, indicating a need for increased awareness and capacity-building efforts. The community expresses a desire for more knowledge-sharing opportunities and access to education and extension services to improve their understanding of sustainable practices and enhance their capacity to manage resources effectively.

3.8. Opportunities for Improvement

There is an openness to adopting improved seeds, planting materials, and technologies that can boost crop yields and resilience. Using these technologies can enhance productivity and support sustainable agricultural practices.

Expanding access to better marketing channels can provide farmers with better prices for their produce and open new markets. This can improve their income and reduce financial strain.

Encouraging farmers to engage in value-addition activities can increase the value of their products, diversify income streams, and reduce postharvest losses.

There is an opportunity to increase community engagement through targeted training and capacity-building programs. This can improve understanding of sustainable practices and resource management among community members.

The community views beekeeping favorably for its potential

in buffer zone management, honey production, and income generation. This presents an opportunity to promote beekeeping as a sustainable alternative to more destructive practices.

Promoting sustainable fishing practices can help protect fish populations and maintain the ecological balance of Lake Dambal.

Initiatives for reforestation and soil conservation can address deforestation and soil erosion issues, improving overall environmental health and agricultural productivity.

Improving and enforcing environmental policies and regulations can help mitigate the negative impacts of agricultural and industrial activities on the lake and surrounding wetlands.

4. Discussion

The survey highlights the intricate relationship between local communities and the wetland ecosystem of Lake Dambal, emphasizing the significant socio-economic and environmental challenges they face. The study reveals that the community is predominantly agrarian, with 97.62% of household heads engaged in farming. Over the past 5-10 years, agricultural practices have shifted towards mechanization, cluster farming, improved seed varieties, and increased use of fertilizers and irrigation. These changes have contributed to higher crop market values, improved food self-sufficiency, and better access to irrigation water, indicating a trend towards modernized and sustainable farming.

However, the findings also underscore the community's vulnerabilities due to limited educational attainment—21% of respondents are illiterate, and only 2% have education beyond secondary school—and a significant gender imbalance, with males constituting 92% of the sample. These factors, along with socio-economic disparities, suggest a need for targeted educational programs and gender-sensitive interventions to enhance agricultural knowledge and resilience.

Environmental challenges, such as deforestation, chemical use, and unsustainable fishing practices, threaten the ecological balance of Lake Dambal. The community's reliance on the lake for resources like clean drinking water, energy, and medicinal plants further exacerbates the pressure on the ecosystem. The degradation of the lake's wetlands, driven by human activities, poses a risk to the sustainability of these vital ecosystem services. Research on wetlands globally emphasizes that these ecosystems are among the most biologically productive and valuable yet vulnerable to human activities [9]. Prior research related to Lake Dambal's socio-economic and environmental challenges highlights the critical role of sustainable management for wetlands in Ethiopia. Studies have shown that Lake Dambal, a valuable freshwater ecosystem, faces multiple threats, including pollution, climate change, and unsustainable resource extraction, which impact both ecological health and community livelihoods [4].

Despite these challenges, the community recognizes opportunities for sustainable development. Beekeeping emerges as a promising livelihood option, particularly for buffer zone

management, due to its minimal resource requirements and income-generating potential. The adoption of improved agricultural practices, including high-yield crop varieties and new technologies, offers another avenue for enhancing productivity. However, these practices must be carefully managed to avoid negative environmental impacts.

The discussion suggests that future interventions should focus on supporting adaptive strategies, strengthening farmer organizations, improving market access, and promoting sustainable management practices. Research further emphasizes the importance of integrating local knowledge with scientific approaches for wetland conservation [7]. By addressing these socio-economic and environmental issues, stakeholders can work towards ensuring the sustainable development of Lake Dambal and the well-being of the surrounding communities. Additionally, the study by [6] highlights the need for enhanced institutional support and community engagement to promote sustainable wetland management practices in Ethiopia. Future research should explore the complex interactions between human activities and ecosystem dynamics to inform effective management strategies.

By placing these findings in context, this study contributes to the body of knowledge by identifying socio-economic factors specific to Lake Dambal, which affect wetland preservation efforts. The results provide a foundation for recommending policies and practices that prioritize both environmental conservation and socio-economic resilience, aligning with the broader goals of sustainable development for Ethiopia's critical wetland ecosystems.

5. Conclusion

Lake Dambal stands as a natural treasure, offering both ecological and socio-economic benefits to the people of Ethiopia. Its diverse habitats, abundant wildlife, and cultural significance make it a unique and asset worthy of protection and conservation. By addressing the challenges facing Lake Dambal and promoting sustainable management practices, we can ensure the continued health and vitality of this vital freshwater ecosystem for years to come.

The survey provides valuable insights into the socio-economic and environmental dynamics surrounding Lake Dambal. Addressing the identified challenges requires a multi-faceted approach that integrates ecological, socio-economic, and institutional considerations. By implementing the recommended strategies, it is possible to safeguard Lake Dambal's ecological integrity while enhancing the resilience and well-being of the communities that depend on this vital resource.

6. Recommendations

Based on the survey findings, the following recommendations are proposed to enhance the sustainability of Lake

Dambal and improve community livelihoods:

Promote Sustainable Agricultural Practices: Encourage the use of environmentally friendly agricultural practices that minimize chemical use and soil degradation. Training programs and extension services can support farmers in adopting these practices.

Enhance Community Awareness and Education: Implement educational initiatives to raise awareness about the importance of wetland conservation and the potential long-term benefits of sustainable resource management.

Foster Gender-Inclusive Development: Address gender imbalances by promoting women's participation in decision-making processes and ensuring that development programs are inclusive and equitable.

Strengthening Institutional Capacity and Stakeholder Engagement: Enhance the capacity of local institutions to manage and protect wetland resources effectively. Engage multiple stakeholders, including government agencies, non-governmental organizations, and local communities, in collaborative conservation efforts.

Develop Alternative Livelihoods: Support the development of alternative livelihoods, such as beekeeping, sustainable fishery and eco-tourism, to reduce dependency on lake resources and diversify income sources.

Improve Infrastructure and Market Access: Invest in infrastructure improvements, such as roads and storage facilities, to enhance market access and reduce post-harvest losses for farmers.

Abbreviations

Acronym	Full Form
ATJK	Adami Tulu Jido Kombolcha
FGD	Focus Group Discussion
PA	Peasant Association
IRB	Institutional Review Board
SPSS	Statistical Package for Social Sciences
SDC	Swiss Agency for Development and Cooperation
IWMI	International Water Management Institute
TLU	Tropical Livestock Unit

Author Contributions

Desalegn Regassa is the sole author. The author read and approved the final manuscript.

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Conflicts of Interest

The author declares no conflicts of interest.

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Biography

Desalegn Regassa Luba, Affiliation: Agricultural development, landscape restoration, and environmental conservation Research and Academic Experience: Extensive research experience in agricultural science, particularly in plant breeding, seed technology, and landscape restoration. Has held senior roles in agronomy and field coordination, working with rural communities and government institutions to improve sustainable agriculture practices. Actively involved in scientific writing and manuscript preparation Research Specialization: I specialize in plant breeding, seed technology development, sustainable agricultural practices, and the intersection of agriculture and environmental conservation, especially related to wetlands and rural economies Number of Published papers: 7. Special Award (If any): Any other remarkable points(s) Experienced in leading multi-stakeholder projects aimed at improving smallholder farmers' welfare. Developed and implemented successful projects focused on promoting sustainable agricultural practices like agroforestry, vermicompost production, and organic farming. Demonstrated leadership in coordinating large-scale research and development projects for organizations such as Wetlands International