Hindawi
Applied and Environmental Soil Science
Volume 2023, Article ID 6288288, 16 pages
https://doi.org/10.1155/2023/6288288

Research Article

The Perception of Farmers on Soil Erosion and Conservation Measures in the Surrounding Areas of Lake Ziway, Central Rift Valley of Ethiopia

Daniel Jaleta Negasa

Ethiopia Forestry Development, Central Ethiopia Center, P.O. Box 30708, Addis Ababa, Ethiopia

Correspondence should be addressed to Daniel Jaleta Negasa; danieljaleta1@yahoo.com

Received 10 November 2022; Revised 21 April 2023; Accepted 3 May 2023; Published 20 May 2023

Academic Editor: Shakeel Mahmood

The level of sediment deposited in the Lake Ziway is increasing through time as a result of soil erosion, and eventually the depth of the lake has decreased. Therefore, the objective of the study was to assess farmers' perception of soil erosion and the conservation measures to the surrounding areas of Lake Ziway in the central Rift Valley of Ethiopia. The survey was made using purposive sampling techniques. The survey has considered the 14 Kebeles from the 3 districts adjacent to the lake. From each Kebele, 10 respondents were selected randomly. Totally, 140 respondents were selected from the community. The descriptive statistic was used to compare the dependent variables. The majority of respondents (92.2%) have observed the presence of soil erosion in the study area. The hillsides and slope areas are the major sources of soil erosion, according to 80% of the respondents. The respondents that have identified the most and least susceptible soils to erosion by their textural classes are sand soil (*Biyyo Chirecha*) (57.1%) and soft clay soil (*Biyyo Bole*) (1.4%), respectively. The soil erosion is increasing in their cultivated land and surrounding areas. The study has found that most of the respondents (86.5%) are participating in soil and water conservation activities. *Leucaena leucocephala*, *Faidherbia albida*, *Azadirachta indica,* and *Schinus molle* are the dominant tree species planted in the study area for soil and water conservation purposes. In conclusion, there is heavy soil loss due to erosion on cultivated land from the upland which directly deposited to Lake Ziway as sediment which decreases the lake depth. The study recommends that appropriate soil and water conservation measures and land management should be implemented on erosion prone areas in the Lake Ziway watershed with full participation of all stakeholders including the local farmers.

1. Introduction

Soil erosion is a global and old phenomenon that is still happening in different parts of the world [1, 2]. It is a main soil degradation threat to land, oceans, and fresh water globally [2]. Soil erosion is a global problem as it critically affects the economy and the environment globally. Among the listed factors are human activities such as cultivating crops, shifting natural land covers, mining activities, and constructions of huge infrastructures [1, 2]. The major drivers of soil erosion are water and wind, but other factors must not be forgotten. The annual estimated soil eroded from cultivated land globally is about 75 billion tons which are equivalent to $400 billion loss every year [3]. Among the hot spot areas for soil erosion, China, Brazil, African countries near to the equator, and India are regions that recorded higher than 20 tons per ha per year [4].

Soil erosion is one of the major causes of land degradation and reduction of land productivity in the central Rift Valley and elsewhere in Ethiopia [5]. Land degradation comprises of processes that reduce the capacity of land resources to perform vital functions and services in ecosystems [6]. Deforestation and mismanagement of land resources are the cause of soil erosion [7, 8]. The cause of deforestation could be population increment, higher demand of forest resources, and agricultural land expansion [9]. In the central Rift Valley of Ethiopia, natural land cover such as woodland, forest land, wetland, and grassland are converted to artificial land cover, such as large commercial farms, irrigated farms, and small holders' farms and ranches [10].

The soil loss from different land use types varies according to the land management, land cover, slope, soil conditions, and rainfall characteristics of the area [7]. The soil loss from cultivated land is the highest, whereas the soil loss from grassland and forest land are the lowest in different part of the country [7, 11, 12]. Cultivated land, especially during ploughing and early stages of the cropping season, is susceptible to soil erosion [7, 11]. Similarly, the nutrient lost is higher in cultivated land [12]. This is an indication how the farm productivity is reduced as a result of the soil and nutrients lost from cultivated land.

Farmers are the main converter of land from natural ecosystems to artificial ecosystems for crop production and livelihood in Ethiopia. The farmers' land management style and manner can affect the soil erosion and sediment yield on the farm. Farmers have experiences with land management, crop production, forest utilization, soil erosion, and sediment loss in their surroundings [13]. It is believed that experienced farmers could have the ability of locating the source of sediment and could state the cause of the sediment and soil loss in their surroundings [14, 15]. Furthermore, farmers have the ability to forecast the possible consequences and impacts of land degradation, soil erosion, soil loss, and sediment loss from the farm through their experiences [14].

Understanding farmers' perception on locating the sources of sediment, types of erosion, types of best soil and water conservation, and cause of degradation could help the researchers and conservationist to find the best ways of adoption of new technologies that reduce sediment and soil erosion [14, 15]. On the contrary, ignoring the local farmers' knowledge and their perceptions of soil erosion and sediment sources could lead to low adoption of the suggested soil and water conservation technologies.

Lake Ziway is one of the best economic sites in the rift valley of Ethiopia [16]. The site is both important for intensified agricultural activities (big flower companies, wine factory, and agro-processing companies) and tourist attractive in the central rift valley of Ethiopia [17]. However, the lake specifically and the watershed in general are under the real treat of deterioration and degradation [18]. The level of sediment accumulated in the Lake Ziway is increasing through time and eventually the depth of the lake has decreased [19]. Consecutively, the water quality and fish productivity of the Lake have reduced continuously [18, 20–22].

Various studies have been done on the lake and surrounding watershed to understand the economic contribution of the lake, the sediment level, the water quality, and the hydrology of the feeder rivers of the lake [16–18, 20–27]. However, few studies have been done to understand the farmers' perception towards soil erosion and conservation measures. This is important in identifying the land use, land cover type, and the location of the major source of sediment contributors to the lake. The objective of the study was to assess farmers' perception of soil erosion and conservation measures to the surrounding areas of Lake Ziway in the central Rift Valley of Ethiopia.

2. Materials and Methods

2.1. Description of the Study Site. The study watershed is located 160 km South of Addis Ababa, Ethiopia. Lake Ziway watershed is the selected watershed to undertake this research project (Figure 1). The watershed is geographically located from 7°22′36″N to 8°18′21″N latitude and 37°53′40″E to 38°28′9″E longitude. The study site is found in the central Rift Valley of Ethiopia. The watershed is found in Oromia and Southern Nations, Nationalities and People (SNNP) regions of Ethiopia. The total area of the watershed is 7032 km^2, from this 73.6% is found in Oromia region and the remaining area is found in SNNP region.

The watershed has two rivers (Meki and Katar) flowing into the Lake Ziway from west and east directions, respectively. Lake Ziway, which is found in the watershed, is the largest fresh water lake found in the central Rift Valley of Ethiopia that encompasses 434 km^2 area of the water body. The watershed has one outlet river called Bulbula River. The altitude of the watershed varies from the mountainous areas of the rift floor, which ranges from 3500 to 1600 meters above sea level, respectively.

The climate of the study site is mainly characterized by alternating wet and dry seasons that vary distinctly with quite short spatial distances. The mean annual rainfall, temperature, and evaporation ranges are about 600 mm to 1200 mm, 10°C to 25°C, and 1000 mm to 2500 mm, respectively, corresponding to the changes in altitude. The watershed is known for its biodiversity richness, and the Lake Ziway is rich in fish resources. It is home to the endemic birds of the country. Recently, cultivation of crops both irrigated and rain fed overwhelmingly expands that has lead impact on the water resources of the watershed. The site is one of the touristic and industrial attraction areas in Ethiopia. The study site contains areas known for drought and water shortage. The site has also population pressure that has impacts on natural resources in the watershed. The watershed is inhabited by nearly two millions of people (CSA, 2019). The total population of the Lake Ziway surrounding 14 Kebele, which is the study site, is estimated to be 65,000 people.

The major soil type of the site is Luvisols, and other soil types such as Andosols, Cambisols, Fluvisols, Nitosols, Vertisols, and Leptosols are also present on the site (Figure 2). The major land form of the study site are flat lacustrine terrace, gently undulating, and nearly level lacustrine plain. Due to deforestation and the characteristics of the soil, there is large soil erosion pressure that is forming in gullies. The vegetation cover on the site is dominated by *Faidherbia albida* and other acacia species.

Both the quantity and quality of water have declined, raising the water-scarcity of the watershed to the highest level. The lacustrine conditions of the Lake Ziway are changing at alarming rates and several arguments are undergoing regarding the real causes of the changes. The main water users of the Lake Ziway are categorized into five, namely, small holder irrigated agriculture, commercial

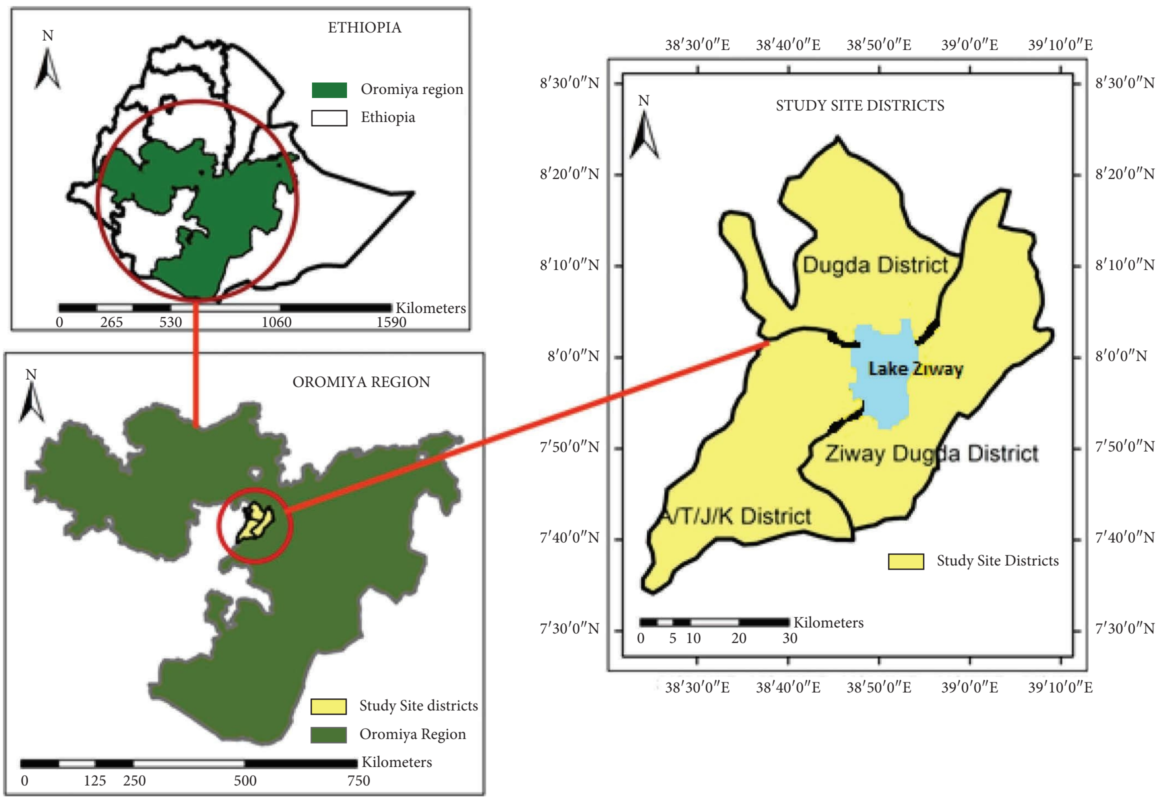

Figure 1: Map of the study site.

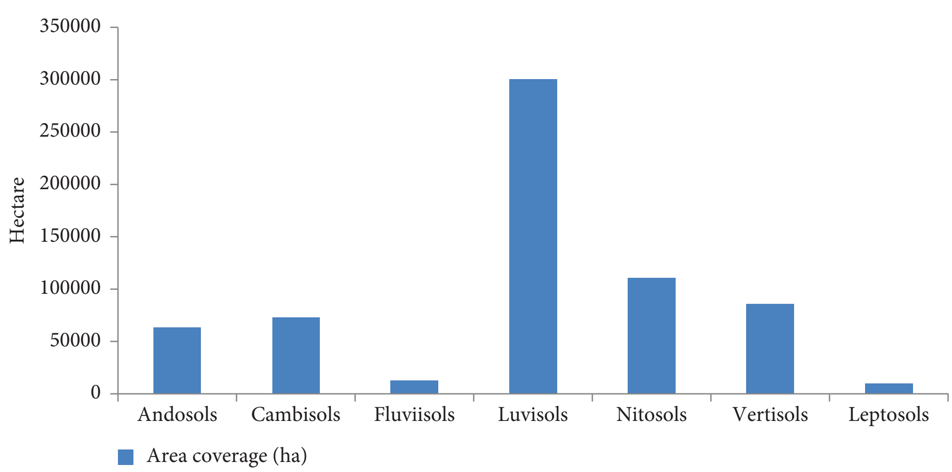

Figure 2: Area coverage of each soil type in Lake Ziway watershed.

agriculture, industrial water users, domestic water users, and tourism and recreational users.

2.2. Data Collection

2.2.1. The Sampling Technique. The survey has considered the 3 districts that share the Lake Ziway shoreline. The data were collected by using purposive sampling. The survey has considered 14 Kebeles (44%) out of 32 Kebeles in the 3 districts neighboring the lake. From each Kebele (lowest administrative unit in Ethiopia), 10 household heads respondents were selected randomly. The respondent should be an adult and who knows the area at least for more than a decade. For each respondent, a prepared and opened and closed-ended questionnaire has been presented to respond to it. Totally, 140 respondents were selected from the community.

2.2.2. Data Analysis. Data were tabulated and managed in an Excel spreadsheet. The data were analyzed by using SPSS (Statistical Package for Social Science) version 20.0 (IBM, 2011). The descriptive statistic such as the frequency and percentage were used to compare the dependent variables. The tables and graphs were used to display the number and percentage of household respondents for each question.

3. Results and Discussion

3.1. Socioeconomic and Demographic Characteristics. More than half of the household family size is between 6 to 10 persons per house (Table 1). The mean family size of the study area is 6.8 persons per household, which is higher than the nationwide average family size (CSA, 2019). The educational status of the majority of the population (72.9%) is lower grade elementary education and nearly one-third of the population is illiterate in the study site. The mean land holding size per household heads in the study area is 1.3 hectares. A quarter of the household heads had less than 0.5 hectares of land in the watershed.

More than 10% of the respondents had no animals kept in the household, whereas the majority of the respondents (67%) have animals more than 3 per household. The majority of the respondents (95%) are farmers and their permanent job for livelihood is farming.

3.2. Farming System and Production. Most of the population in the study area produces maize for feeding their households. Crops such as wheat, teff, beans, and vegetables are grown in the study area (Figure 3).

3.3. Agricultural Input Usage. Farmers in the study area are using different agricultural inputs for producing crops during the rainy season and irrigation period. Nearly two-third of the respondents are using 2 : 4D amine only as pesticides on their farm (Table 2). A quarter of respondents are not using both insecticides and herbicides on their farm. Various types of fertilizers are used for different purposes among farmers in the study area. Farmers (22%) are using diammonium hydrogen phosphate (DAP) fertilizer only on their farm. Among the respondents, 15% of respondents are not using fertilizers for cultivating crops on their farm. The most common types of fertilizers distributed in Ethiopia are DAP and urea, which are also used by more than 27% of the respondents. The majority of the respondents (82.3%) are using rain water as the source of water for crop cultivation in the study area. Irrigation practices are commonly near by the rivers and the Lake Ziway, so that 17.7% of the respondents are using irrigation water for crop production during the dry season.

3.4. Participation of Soil and Water Conservation Activities. The majority of the respondents (86.5%) are participating in soil and water conservation activities, generally based on watershed management practices in the study area (Table 2). One third of the respondents did not construct soil and water conservation structures on their farm. The most constructed soil and water conservation structures in the study area are soil bund (42.1%). Cutoff drains, stone bund, and diversion ditches were also constructed in the study area in different magnitudes.

Among the respondents, 21.4% did not grow trees in their farm or yards for conservation purposes. *Leucaena leucocephala, Faidherbia albida, Azadirachta indica, and Schinus molle* are the dominant tree species planted in the study area for conservation purposes. Tree species such as *Faidherbia albida*, *Euphorbia candelabrum*, *Maytenus arbutifolia*, *Croton macrostachyus*, *Cordia Africana*, *Dovyalis abyssinica*, and *Celtis Africana* are planted by some respondents. In the study area, some agroforestry trees with multipurpose are also planted (Table 3).

3.5. Sources and Causes of Soil Erosion. Among the respondents, 92.2% of them have observed the presence of soil erosion in the study area (Figure 4). The source of sediment deposited in the lake was located as hillsides and mountains by the majority of the respondents (80%). According to the respondents, cultivated land (29.3) and gully area (31.4) are the highest contributing land use type for sediment sources in the study area. In the study area, one-third of the respondents use wood and animal dung as a source of fuel for household cooking purposes. About 19% of the respondents use wood as the only source of fuel in the household.

3.6. Erosivity and Erodability. Erosivity and erodability characteristics are two important attributes to focus on during soil erosion and sedimentation process. The participants have identified the most susceptible soil to erosion and the least susceptible soil to erosion, namely, sandy soil (*Biyyo Chirecha*) (57.1%) and Soft clay soil (*Biyyo Bole*) (1.4%), respectively, in the study area (Figure 4). Heavy rain with hail and wind has been selected as the most erosive rain (85%) type for causing high soil erosion in the study area. According to the respondents (57.1%) of the survey, July and August are the peak erosion time and September to February are the low erosion months in the study area.

3.7. Perceptions of Cause, Impact, and Future of Soil Erosion. The majority of the respondents (75%) replied that soil erosion is increasing in their farm and surrounding areas (Table 4). Meanwhile, there are respondents (15%) who respond as soil erosion is decreasing in their farms and nearby areas.

The two major causes of soil erosion in the study area are the absence of afforestation, no soil bunds and flood protection to reduce yield, and absence of soil and water conservation measures according to the respondents' replay. Expansion of cultivated land and no forest, land degradation, flooding, erosion, and deforestation are also mentioned as a possible cause of soil erosion in the study area. Furthermore, exceptional to the study site, the expansion of temporary roads for heavy vehicle movement for mining purpose was also considered as cause for soil erosion in the site. The majority of the respondents (87.2%) perceive that there is local knowledge to protect soil erosion and soil loss in the study area. According to the respondents' response,

Table 1: Demographic and socioeconomic characteristics of the respondents ($n = 140$).

Characteristics	Category	Frequency	Percentage
Sex	Male	120	85.1
	Female	20	14.9
Age category	18–35	49	35
	36–50	58	41.4
	51–60	18	12.9
	>61	15	10.7
Marital status	Married	135	95.7
	Single	4	2.8
	Divorced	2	1.4
Education status	<1	40	28.6
	1–6	62	44.3
	7-8	15	10.7
	9–12	23	16.4
Family size	<3	8	5.71
	3–5	41	29.3
	6–10	76	54.3
	>10	15	10.7
Number of animals	0	15	10.7
	1–3	31	22.1
	4–10	61	43.6
	11–20	23	16.4
	>20	10	7.14
Land size	0	4	2.86
	>0.5	33	23.6
	0.5–1	44	31.4
	1-2	43	30.7
	>2	16	11.4
Job distribution	Farmer	133	95
	Water pump guard	1	0.7
	Daily worker	3	2.2
	Fisher	2	1.4
	Business	1	0.7
Income source	Agriculture	129	92.2
	Wage	7	5
	Fishery	3	2.1
	Sells	1	0.7

the majorly known local knowledge for the protection of soil erosion and soil loss are indigenous stone bund and soil bund construction and protection of trees from cutting and flood protection measures. Most respondents perceived that soil loss could carry soil nutrients during soil erosion processes in the study area.

3.8. Participation and Future Conditions after Soil Loss. Participation level of stakeholders in soil and water conservation varies in the study area. Government and communities take half of the stakeholder participation in the study area. The respondents (52.9%) perceived that the lake will take their land in the future as the lake filled with sediment (Table 5). According to 14.3% respondents, drought and loss of biodiversity could be caused as a result of lake sedimentation continues.

About one-third of the respondents suggested that constructing bunds, planting seedlings, and horizontal tillage could reduce soil erosion and sedimentation in the study area. About a quarter of the respondents suggested that specifically afforestation (planting trees), constructing soil bunds, and stone bunds could reduce soil erosion and lake sedimentation.

3.9. Activities to Reduce Soil Loss. According to 30% of the respondents, watershed management, soil and water conservation, and afforestation were preferred as activities undergone for reducing soil loss (Figure 5). Only watershed management and soil and water conservation are activities chosen by 21.4% of respondents as activities undergone for tackling soil erosion.

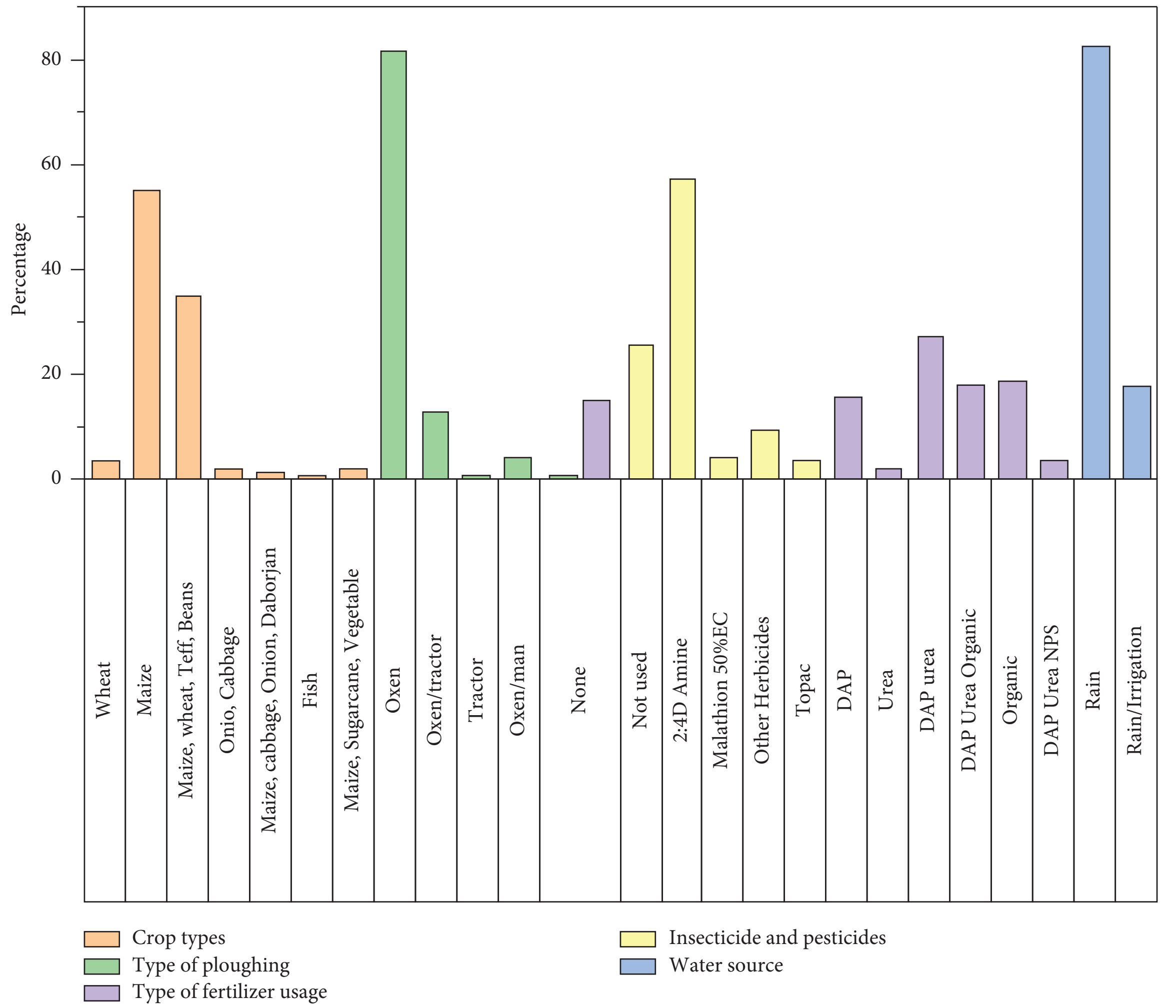

Figure 3: Farming system, crop production, and agricultural input on the study site.

The majority of the respondents (90.7%) have indicated that cultivated land on the hillside is the major source of sediment deposited to the Lake Ziway. About a quarter of the respondents have indicated that degraded land and cultivated land are the types of land use for the generation of soil erosion.

3.10. Ranking Land Use Types and Conservation Measures for Soil Erosion. Gully erosion was chosen by 17.1% of respondents as the type of erosion observed in the study area. Gully erosion, rill erosion, sheet erosion, and inter-rill erosion (16.4%) are the types of soil erosion equally indicated by the respondents. According to the rank of 27% of the respondents ranked, the land use land cover types in order of soil erosion generating level from highest to lowest is cultivated land > degraded land > plantation > floriculture > grassland > residential > forest/woodland (Table 3). The ranking of soil erosion management activities on the level of protection by 20.7% of respondents is listed as follows: soil and water conservation > watershed management > afforestation > rainwater harvesting > area closure > intercropping > reduced farming.

Table 2: Participation in soil and water conservation activities.

Characteristics	Category	Frequency	Percentage
Participation in WM	Participated	121	86.5
	Not participated	19	13.5
Type of SWC structures	Not constructed	45	32.1
	Soil bund	59	42.1
	Stone bund	2	1.4
	Flood protection ditches	12	8.6
	Soil bund, flood protection, diversion	10	7.1
	Planting trees	3	2.1
	Soil bund and planting trees	9	6.4
Type of SWC trees	No tree found	30	21.4
	Faidherbia albida	16	11.4
	Leucaena leucocephala, Faidherbia albida, Azadirachta indica, and Schinus molle	49	35.0
	Faidherbia albida Euphorbia candelabrum Maytenus arbutifolia,Croton macrostachyus, Cordia Africana, Dovyalis abyssinica, and Celtis Africana	22	15.7
	Carica papaya, Mangifera indica, and Persea americana	3	2.1
	Eucalyptus camaldulensis, Faidherbia albida, Azadirachta indica, Euphorbia candelabrum, and Cupressus lusitanica	16	11.4
	Euphorbia candelabrum and Agave sisalana	4	2.9

Table 3: Ranking of land use types and conservation measures for soil erosion.

Characteristics	Category	Frequency	Percentage
Type of soil erosion	None	10	7.1
	GE	24	17.1
	GE, RE, SE, IE,	23	16.4
	GE, SE	23	16.4
	SE, SG, GE, IE	13	9.3
	GE, RE, SE	12	8.6
	WE	8	5.7
	SE, GE	5	3.6
	RE, WE, SE	7	5.0
	GE, RE, WE, SE, IE	8	5.7
	Other	7	5.0
Rank of land use land cover types in order of soil erosion generating level	C > F > G > D> P > R > FC	12	8.6
	C > D > P > FC > G> R > F	38	27.0
	P > F > G> D> C > R > FC	21	15.0
	C > D> F > FC > P > R > G	20	14.3
	P > G> F > D> C > R > FC	11	7.9
	C > D > G> F > P > Rl > FC	16	11.4
	G > F > P > D> C > FC > R	7	5.0
	G > FC > P > R > C > D > F	6	4.3
	G > D> P > FC > C > R > F	5	3.6
	Other	4	2.9
Rank the soil erosion management activities in the level of protection	WM > SWC > AC > RWH > AF > RF > IC	18	12.9
	SWC > WM > AF > RWH > AC > IC > RF	29	20.7
	SWC > WM > AC > RWH > AF > RF > IC	17	12.1
	SWC > RWH > AF > WM > AC > RF > IC	9	6.4
	RWH > WM > SWC > AF > IC > RF > AC	8	5.7
	RWH > WM > AF > SWC > IC > RF > AC	8	5.7
	RWH > SWC > AF > WM > AC > RF > IC	22	15.7
	RWH > SWC > AC > WM > RF > IC > AF	17	12.1
	RF > WM > RWH > SWC > AF > AC > IC	9	6.4
	Other	3	2.1

Here, ≥: greater than, GE: gully erosion, RE: rill erosion, WE: wind erosion, SE: sheet erosion, IE: interrill erosion, C: cultivated land, D: degrade land, F: forest/woodland, G: grassland, P: plantation, R: residential, Fc: floriculture, RWH: rainwater harvesting, SWC: soil and water conservation, AC: area closure, WM: watershed management, RF: reduced farming, IC:intercropping, and AF: afforestation.

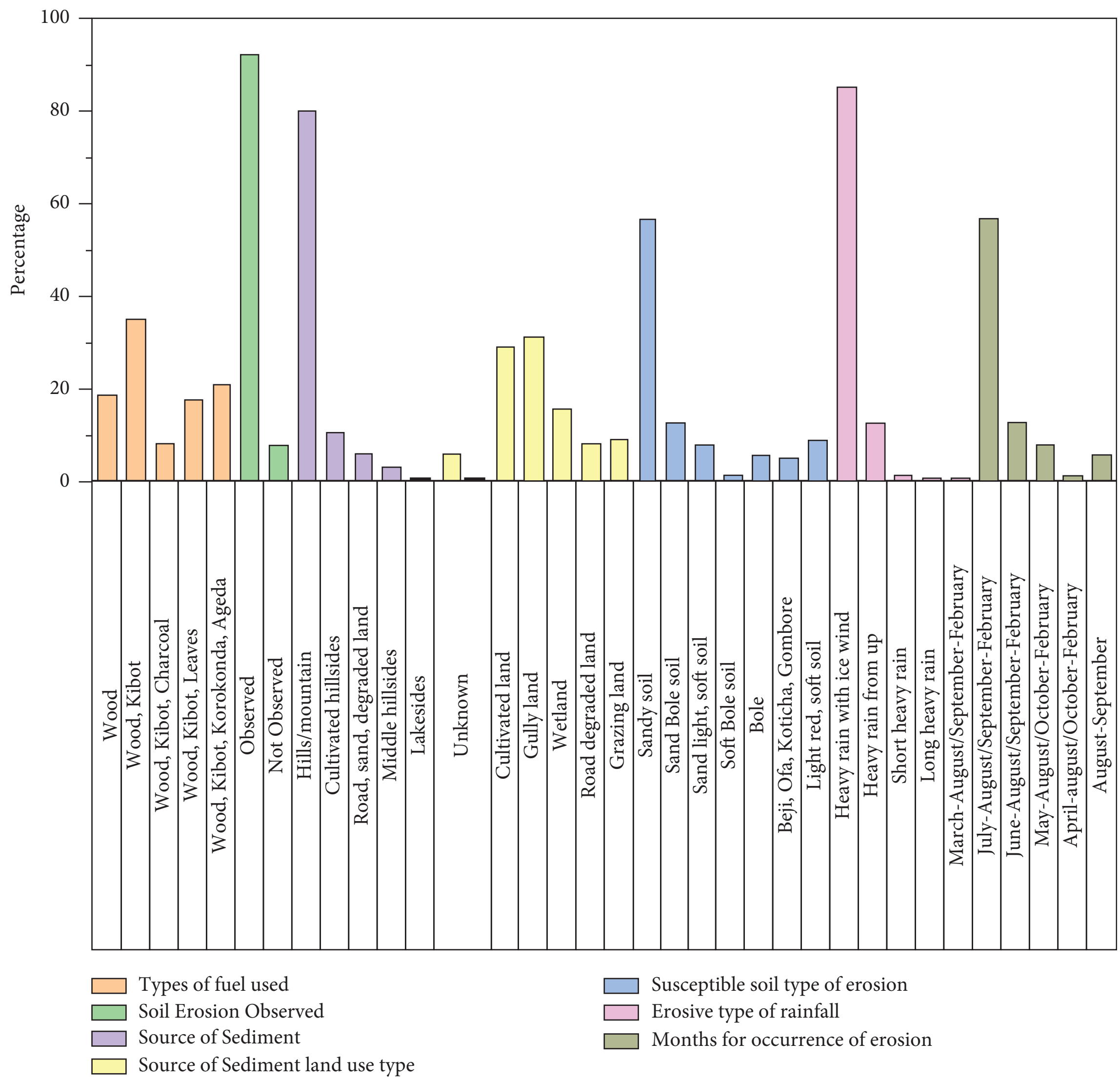

Figure 4: Type of fuel used and different characteristics of soil erosion. Kibot = dried animal dung used as fuel for cooking, Korokonda = maize cob, Ageda = dried maize stalk, Gombore = moderately fertile soil with brown color, and Ofa = less fertile soil near marsh land.

Table 4: Perceptions towards cause, impact, and future of soil erosion.

Characteristics	Category	Frequency	Percentage
Current condition of soil erosion	Increasing	105	75
	Decreasing	21	15
	Not changed	14	10
Cause of soil erosion	Deforestation	24	17.1
	Absence of afforestation, no soil bunds, and flood protection to reduce yield	41	29.3
	No soil and water conservation measure	37	26.4
	Climate change, no rain, erratic rain, and dry season	12	8.6
	Expansion of cultivated land and no forest, land degradation, flooding, and erosion	23	16.4
	Road expansion for heavy vehicle, erosion, and degradation	3	2.1
Local knowledge to protect soil erosion and soil loss	Present	122	87.2
	Absent	18	12.8
A type of local knowledge to protect soil loss and sedimentation	Unknown	18	12.9
	Constructing indigenous soil bund and planting trees	6	4.3
	Indigenous stone bund and soil bund construction	30	21.4
	Horizontal tilling, indigenous soil bund, and afforestation	26	18.6
	Planting trees and protection of hillsides by filling bags with soil and *Euphorbia candelabrum* planting	19	13.6
	Do not cut trees, flood protection, deforestation, and land degradation from up	41	29.3
Soil loss could carry nutrients	Yes	136	97.2
	No	4	2.8

Table 5: Participation and future of soil loss.

Characteristics	Category	Frequency	Percentage
Participation of stakeholders in SWC	No one	4	2.9
	Government and NGO	26	18.6
	Government, community, and farmer	74	52.9
	Community and farmer	20	14.3
	Government, NGO, community, and farmer	12	8.6
	Farmer	4	2.9
Future impact of sedimentation	Filled by sediment depth reduced dry disappear	4	2.9
	Migration of people and animal to other places	26	18.6
	The lake will take our land	74	52.9
	Drought and loss of biodiversity	20	14.3
Suggestions of respondents to reduce erosion and sediment	No suggestion	1	0.7
	Soil and water conservation activities, watershed management, and natural resources management should be done	19	13.6
	Afforestation (planting trees) + soil bund + stone bund	33	23.6
	Constructing bunds, planting seedling, and tilling horizontal	48	34.3
	Environmental protection activities	7	5.0
	Sediment protection and soil bund	7	5.0
	Protection of forest and land conservation	1	0.7
	Flood protection activities, soil bund, planting trees upland, and buffering the lake	18	12.9
	The flower company and irrigation fields sack water from the lake should be managed	2	1.4

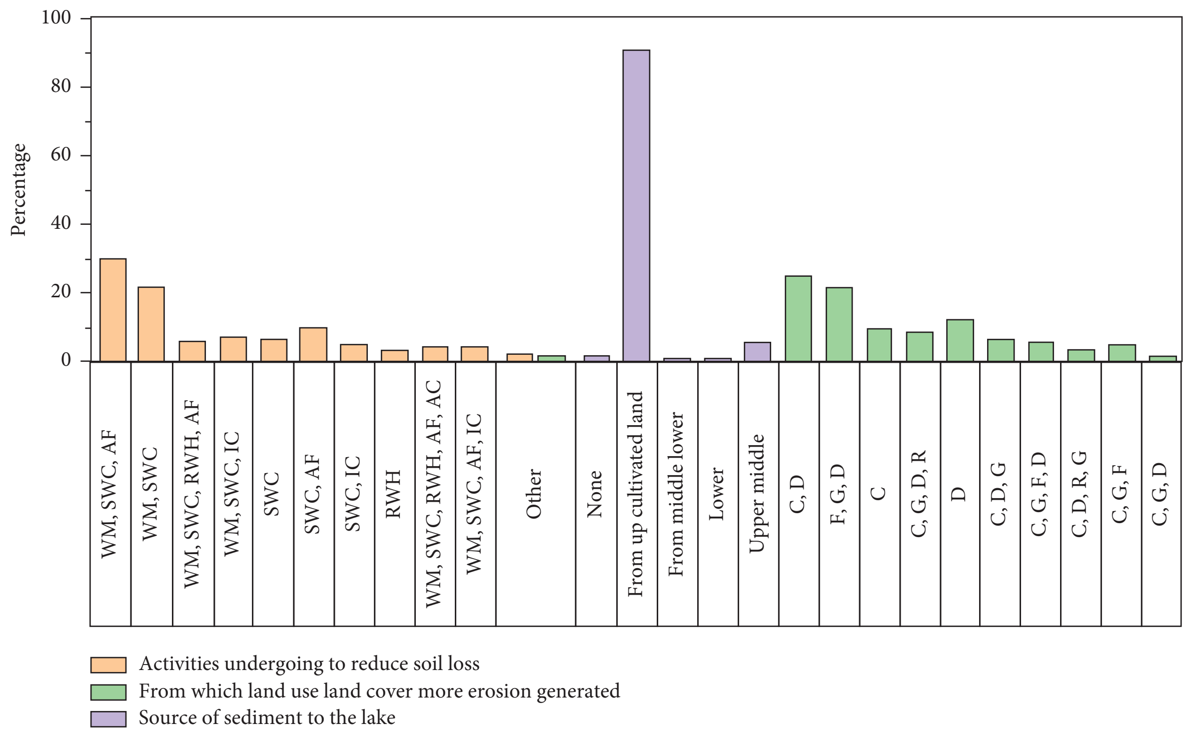

Figure 5: Activities, land use type and source of soil erosion. Where C = cultivated land, D = degrade land, F = forest/woodland, G = grassland, P = plantation, R = residential, SWC = soil and water conservation, WM = watershed management, AF = afforestation, IC = intercropping, RWH = rainwater harvesting, and AC = area closure.

4. Discussion and Conclusion

There is a family size of greater than 10 persons per household, which is more than 10% of the population. According to [17], the average family size in the Ziway watershed is 5.9 persons per household. The finding of this study could indicate the low distribution of education in rural areas of Ziway watershed. Similar findings were observed in [17, 24]. The majority of respondents are married. The age of two-third of the respondents are found more than 36 years of age. The majority (85%) of the respondents were male. Opposite to this study, more than 10% of the household heads have more than 2 hectares. According to [17], the average land holding size is 1.59 hectares per household. This could indicate how land resources are distributed in the watershed. The income source of the respondents varied, but agriculture, mainly crop cultivation, took the lion's share. Studies, which were done in Ziway watershed, have found a similar finding with this study [17, 21, 24, 29].

Similar to this study, Desta et al. [17] have found that crops such as wheat and maize are the main crops produced in the Ziway watershed. Maize is the predominant staple food crop for the rural population in the region [30]. As there are perennial rivers together with fresh water from Lake Ziway in the study area, farmers are known for irrigation-dependent vegetable production. The majority of the farmers are using oxen pulled ploughing farming tools called Maresha [30]. However, quite a number of farmers are using the tractor for the first time tilling and oxen for the second time tilling during the cropping season.

Agmas and Adugna [31] stated that the pesticides were mainly used for the treatment of insect infestation, weed control, and fungus treatment in their agricultural crops. Farmers in Northwest Ethiopia are using pesticides such as 2–4D Amine (96.4%) and Primagram gold (17.4%) as herbicides in their farm [31]. Similar to the finding, DAP and urea types of fertilizers are predominantly used both in irrigated and rain fed farms in the region [32, 33]. With the finding of this study that indicates the expansion of irrigation farms through year, Putter et al. [32] indicated that the area under irrigation in the central Rift Valley is estimated to have increased roughly 10 times, of which the majority is managed by smallholders.

The study on participation of farmers on soil and water conservation in the watershed varies according to the locality in Ethiopia; 76.2% of the respondents at Gusha Temela watershed, Arsi [34] and 43% of the respondents at Chemoga watershed, and Gojam [35] have willingly participated in soil and water conservation activities. According to [35], in Chemoga watershed, Fanya juu bunds were constructed mainly in cultivated land and the farmers considered Fanya juu as the most effective in a semiarid climate. Tree and grass species such as Sesbania (*Sesbania grandiflora*), vetiver grass (*Chrysopogon zizanioides*), elephant grass (*Pennistum purpureum*), and Pigeon Pea (*Cajanus cajan*) were planted on the bunds to support the physical structures in Debre Mawi Watershed, Gojam, Ethiopia [36]. According to [37], the trees were planted for firewood and construction purposes, although farmers mentioned the use of tree planting in soil and water conservation.

Similar to the study, 72% of the respondents in Beressa watershed, North Shewa, Ethiopia, have reported soil erosion problems on their farmland [37]. Biratu and Kidane [34] found that majority of the respondents (93.1%) perceived that there is a soil erosion problem on their farmlands at Gusha Temela watershed, Arsi Zone, Ethiopia. Similar study has found that high amount of soil erosion generated from cultivated land than forest and grazing lands [34]. Soil loss for grassland dominated catchment (2.3–3.7 g/L) was lower than the cultivated land dominated catchment (3.1–4.3 g/l) [38].

The fuel wood is the main energy sources in the study area. Similarly, in Dera woreda of central Ethiopia, 87.3% of the households use fuel wood only as a source of energy, while 12.2% of the households use animal dung in combination with fuel wood [39]. According to Bewket [40] about 36% of the households consumed more than the average amount of fuel wood (2,252 kg), and dung accounts for 33.5% of the total biofuel consumption of the surveyed households in Northwestern highlands of Ethiopia. The primary cooking fuel share of rural Ethiopia in 2011 was 90.9% for fuel wood and 8.6% for dung, sawdust, and crop residue [41].

The soils vary in their vulnerability to erosion from the highest for Mollisol (*Biyyo Gurracha*) to Sandy soil (*Biyyo Chirecha*), Boolalee (red soils with low organic matter content,), and Vertisol (*Koticha*), respectively [42]. According to [38], by improving the permeability of the topsoil (by enhancing soil macro porosity either with deep-rooted plants) and improving the structure of the soil, it can reduce the surface runoff from the cultivated land.

Higher rainfall leads to significant soil loss and higher rainfall conditions on farm plots will exhibit a higher erosion potential [37]. Similar to the finding of the study, Amsalu and de Graaff [37] stated that most of the respondents observed the prevalence of erosion damage during the first rain showers when the soil is bare (before plant growth) and loose due to tillage.

Similar to the finding, 91.1% of the respondents responded that the extent of soil erosion has been increasing over time in Gusha Temela Watershed [34]. Biratu and Kidane [34] found that runoff (73.3%), improper tillage and lack of contour ploughing (56.4%), deforestation (40.6%) and steep land without conservation structure (24.8%), lack of conservation structure (12.9%), livestock track (10.9%), and poorly constructed diversion ditches (5.9%) was considered as the cause of soil erosion according to the respondents. Similarly, erosive rains, steep slopes, damaged conservation structures, and tillage were the major causes of soil erosion mentioned by farmers [37].

The study has found the presence of local knowledge of soil conservation measures. Similarly, Erkossa and Ayele [42] stated that farmers have developed several indigenous technologies to tackle the soil erosion problem in western Ethiopia since ancient times. There are indigenous knowledge of constructing structures to reduce soil erosion in western Ethiopia; the structures are cutoff drains, locally called "*Boraatii* and drainage furrows called "*Bo'oo*' or "*yaa'a*" (similar to *Golenta*, but smaller, and *Boi*) [42]. In addition to the conservation structures mentioned above, several traditional soil fertility maintenance techniques have been identified in the area, including "*Ciirata*" or manuring, crop rotation, fallowing, and *Kosii* (human and livestock residues/leftovers) [42]. Farmers perceived that due to soil erosion, the following characteristics shift occur: it reduces infiltration and smoothens the land surface and low surface storage leading to high runoff and soil loss [42]. Taye and Megento [43] have suggested that most of the farmer's indigenous knowledge recognized soil erosion problems.

As it is stated in the result section, the engagements of different actors varied. The government, which is Ministry of Agriculture, has introduced several soil and water conservation works that have been demonstrated for the last ten years to transfer the practice to the farmers [42]. Government and nongovernment organizations take one-fifth of the participation in the study area. Ariti et al. [44] found that 62% and 66% of the NGOs are engaged in afforestation/reforestation and forest conservation, respectively, while 73% and 35% of the NGOs are involved in soil/water conservation, area closure and conservation of protected areas in Ethiopia, respectively.

The Lake Ziway condition has been worsening according to the perception of the respondents. Similar study in Ziway watershed has found that the majority (66%) of respondents reported to have some information heard of deterioration and decrements in the lake status; and almost 87% of respondents felt that the lake environment is a threat to their feature health and wellbeing [45].

The respondents recommends various conservation measures such as constructing physical structures (soil bunds, stone bunds) together with biological measures. Oppositely, farmers recommended traditional soil and water conservation practices such as ridges, water diversion, ditch, and contour ploughing for future reduction of soil erosion in the field, and they were less interested in agroforestry system that raised trees for conservation of soil, but they more preferred the trees for its products [37, 43]. In general, farmers accept and use conservation technologies that enhance productivity and offer short-term benefits rather than technologies requiring long term investments [37].

Nigussie et al. [15] stated that site-specific factors, such as plot shape, soil depth, and plot position on the hills and exposure to rainfall during the cropping season can affect soil erosion severity according to the farmers' perception study. Weldu Woldemariam and Edo Harka [46] strengthen the findings from the perception of farmers, which found that cropland, bare land, and settlement had become the main causes of soil erosion on the study landscape of eastern Ethiopia. According to [34] and similar to this finding, farmers are aware of the highly visible gully erosion in the area.

According to Adimassu et al. [47], farmers have several criteria to select soil and water conservation practices and they usually assign the highest preference for criteria related to economic efficiency and prefer soil and water conservation practices that have the highest economic benefits.

In conclusion, Lake Ziway and its watershed is an important site of both for ecological service and socioeconomic benefits to the people of the central Rift Valley of Ethiopia. The farmers, who are living in the three districts of the surrounding Lake Ziway, are well aware of the land and water resources degradation in their region. Soil erosion in the form of rill erosion and gully erosion was identified by the farmers as a cause for soil resource degradation in the area. The study has observed that the average family size is 6, the average landholding size is 1.2 ha, and the majority of the respondents are farmers whose livelihoods depend on farming. The most dominant crop produced is maize, 2 : 4D amine is dominantly used as pesticide, 15% of the respondents are not using fertilizer for crop production, and the majority of the respondents are practicing rain-fed farming in the study area. *Leucaena leucocephala*, *Faidherbia albida*, *Azadirachta indica,* and *Schinus molle* are the dominant tree species planted in the study area for conservation purposes. One third of the respondents use wood and animal dung as a source of fuel for household cooking purposes. The respondents have identified the most susceptible soil to erosion and the least susceptible soil to erosion, sandy soil (*Biyyires*) (57.1%), and soft clay soil (*Biyyo Bole*) (1.4%), respectively. Heavy rain with hail and wind has been selected as the most erosive rain (85%) type for causing high soil erosion in the study area. The major causes of soil erosion in the study, majorly known as local knowledge for the protection of soil erosion and soil loss, are indigenous stone bund and soil bund construction and protection of trees from cutting and flood protection measures. Most respondents perceived that soil loss could carry soil nutrients during soil erosion processes in the study area. Government and communities take half of the stakeholder participation in soil and water conservation implementation in the study area. About one-third of the respondents suggested that constructing bunds, planting, seedling, and horizontal tillage could reduce soil erosion and sedimentation in the study area. The study has observed the presence of ample indigenous knowledge about locating the source of soil erosion and management of soil and water resources among farmers.

The study recommends that appropriate soil and water conservation measures and land management should be implemented on erosion prone areas in the Lake Ziway water-shed with full participation of all stakeholders including the local farmers. Further study should be done on identifying the best type of soil and water conservation measures for cultivated land in the study area.

Data Availability

The data used to support the findings of this study are available upon request.

Conflicts of Interest

The author declares that he has no conflicts of interest.

Authors' Contributions

This work was carried out solely by the author. The author designed the study, managed the literature searches, analyzed the data, and wrote the first draft of the manuscript.

Acknowledgments

The author is grateful for the support given by the three districts and their experts during data collection. The author acknowledges Mr Yared Worku for his support during data collection. The author highly recognizes the financial and logistic support given by his employer, Ethiopian Forestry Development, Central Ethiopia Center. The author is a researcher in Central Ethiopia Center, Ethiopian Forestry Development in Ethiopia, and the research was performed as part of the employment of the author. He recognizes the financial and logistic support given by the center.

References

[1] S. Issaka and M. A. Ashraf, "Impact of soil erosion and degradation on water quality: a review," *Geology, Ecology, and Landscapes*, vol. 1, pp. 1–11, 2017.

[2] P. Borrellia, D. A. Robinsonc, P. Panagosd et al., "Land use and climate change impacts on global soil erosion by water (2015-2070)," *Proceedings of the National Academy of Sciences*, vol. 117, no. 36, pp. 21994–22001, 2020.

[3] Global Soil Partnership, "Global Soil Partnership Endorses Guidelines on Sustainable Soil Management," 2017, http://www.fao.org/global-soil-partnership/resources/highlights/%20detail/en/c/416516/.

[4] P. Borrelli, D. A. Robinson, L. R. Fleischer et al., "An assessment of the global impact of 21st century land use change on soil erosion," *Nature Communications*, vol. 8, no. 1, p. 2013, 2017.

[5] T. Gashaw, A. Bantider, and H. G/Silassie, "Land degradation in Ethiopia: causes, impacts, and rehabilitation techniques," *Journal of Environment and Earth Science*, vol. 4, no. 9, pp. 98–105, 2014, https://www.iiste.org/Journals/index.php/JEES/article/view/12963/13288.

[6] H. Hurni, S. Abate, A. Bantider Debele et al., "Land degradation and sustainable land management in the highlands of Ethiopia," in *H. Hurni, U. Wiesmann, Global Change and Sustainable Development: A Synthesis of Regional Experiences from Research Partnerships, Perspectives of the Swiss National Centre of Competence in Research (NCCR) North-South,* vol. 5, Bern, Switzerland: Geographica Bernensia, University of Bern, pp. 187–207, 2019.

[7] G. Girmay, B. R. Singh, J. Nyssen, and T. Borrosen, "Runoff and sediment-associated nutrient losses under different land uses in Tigray, Northern Ethiopia," *Journal of Hydrology*, vol. 376, no. 1-2, pp. 70–80, 2009.

[8] A. P. E. Van Oudenhoven, C. J. Veerkamp, R. Alkemade, and R. Leemans, "Effects of different management regimes on soil erosion and surface runoff in semi-arid to subhumid rangelands," *Journal of Arid Environments*, vol. 121, pp. 100–111, 2015.

[9] G. Dessie and J. Kleman, "Pattern and magnitude of deforestation in the South Central Rift Valley region of Ethiopia," *Mountain Research and Development*, vol. 27, no. 2, pp. 162–168, 2007.

[10] D. Tsegaye, S. R. Moe, P. Vedeld, and E. Aynekulu, “Land-use/cover dynamics in Northern Afar rangelands, Ethiopia,” *Agriculture, Ecosystems & Environment*, vol. 139, no. 1–2, pp. 174–180, 2010.

[11] D. Jaleta, B. P. Mbilinyi, H. F. Mahoo, and M. Lemenih, “Effect of Eucalyptus expansion on surface runoff in the central highlands of Ethiopia,” *Ecological Processes*, vol. 6, no. 1, p. 1, 2017.

[12] J. Daniel, P. M. Boniface, F. M. Henry, and L. Mulugeta, “Comparative assessment of soil and nutrient losses from three land uses in the central highlands of Ethiopia,” *International Journal of Water Resources and Environmental Engineering*, vol. 9, no. 1, pp. 1–7, 2017.

[13] T. Beshah, *Understanding Farmers: Explaining Soil and Water Conservation in Konso, Wolaita and Wello, Ethiopia*, Wageningen University and Research, Wageningen, Netherlands, 2003.

[14] A. Moges and N. M. Holden, “Effects of wildfire, salvage logging, and slash,” *Land Degradation & Development*, vol. 607, pp. 591–607, 2007.

[15] Z. Nigussie, A. Tsunekawa, N. Haregeweyn et al., “Farmers' perception about soil erosion in Ethiopia,” *Land Degradation & Development*, vol. 28, no. 2, pp. 401–411, 2017.

[16] Y. Desta and M. Bersisa, “Recreational use value of Lakes an application of travel cost method: a case of Lake Ziway,” *International Journal of Economy, Energy and Environment*, vol. 4, no. 3, pp. 56–62, 2019.

[17] H. Desta, B. Lemma, and T. Stellmacher, “Farmers' awareness and perception of Lake Ziway (Ethiopia) and its watershed management,” *Limnologica*, vol. 65, pp. 61–75, 2017.

[18] B. M. Teklu, A. Hailu, D. A. Wiegant, B. S. Scholten, and P. J. Van den Brink, “Impacts of nutrients and pesticides from small- and large-scale agriculture on the water quality of Lake Ziway, Ethiopia,” *Environmental Science and Pollution Research*, vol. 25, no. 14, Article ID 13207, 13216 pages, 2018.

[19] A. Osore, “Modeling sediment yield, transport and deposition in the data scarce region of Ethiopian rift valley lake basin,” 2019, https://www.researchgate.net/publication/339781200_MODELING_SEDIMENT_YIELD_TRANSPORT_AND_DEPOSITION_IN_THE_DATA_SCARCE_REGION_OF_ETHIOPIAN_RIFT_VALLEY_LAKE_BASIN_ETHIOPIA.

[20] T. Wondimu, A. Ataro, and B. S. Chandravanshi, “Trace metals in selected fish species from lakes Awassa and Ziway, Ethiopia,” *Sinet: Ethiopian Journal of Science*, vol. 26, no. 2, pp. 103–114, 2005.

[21] H. Desta, B. Lemma, G. Albert, and T. Stellmacher, “Degradation of Lake Ziway, Ethiopia: a study of the environmental perceptions of school students,” *Lakes & Reservoirs: Science, Policy and Management for Sustainable Use*, vol. 20, no. 4, pp. 243–255, 2015.

[22] T. Wondimu, A. Ataro, and B. Chandravanshi, “Trace metals in selected fish species from lakes Awassa and Ziway, Ethiopia,” *Sinet: Ethiopian Journal of Science*, vol. 26, no. 2, 2005.

[23] L. Zeray, J. Roehrig, D. Alamirew, L. Abiyata, and L. Shala, *Climate change impacts on Lake Ziway watershed water*, University of Applied Science, Cologne, Germany, 2007.

[24] H. Zegeye, D. Teketay, and E. Kelbessa, “Socio-economic factors affecting conservation and sustainable utilization of the vegetation resources on the islands of Lake Ziway, South-Central Ethiopia,” *Natural Resources*, vol. 5, no. 14, pp. 864–875, 2014.

[25] A. O. Aga, B. Chane, and A. M. Melesse, “Soil erosion modelling and risk assessment in data scarce Rift Valley lake regions, Ethiopia,” *Water (Switzerland)*, vol. 10, no. 11, p. 1684, 2018.

[26] T. Abraham and B. Nadew, “Impact of Land Use Land Cover Dynamics on Water Balance Lake Ziway Watershed,” *Hydrology: Current Research*, vol. 9, p. 309, 2018.

[27] T. Wondimu, A. Ataro, and B. Chandravanshi, “Trace metals in selected fish species from lakes Awassa and Ziway, Ethiopia,” *Sinet: Ethiopian Journal of Science*, vol. 26, no. 2, 2005.

[28] H. Desta and B. Lemma, “Journal of Hydrology: regional Studies SWAT based hydrological assessment and characterization of lake,” *Journal of Hydrology: Regional Studies*, vol. 13, no. March, pp. 122–137, 2017.

[29] F. Dechasa, F. Senbeta, and D. Diriba, “Determinants of household wetland resources use and management behavior in the Central Rift Valley of Ethiopia,” *Environmental Sustainability*, vol. 2, no. 4, pp. 355–368, 2019.

[30] G. Sime, J. B. Aune, and H. Mohammed, “Agronomic and economic response of tillage and water conservation management in maize, Central Rift Valley in Ethiopia,” *Soil and Tillage Research*, vol. 148, pp. 20–30, 2015.

[31] B. Agmas and M. Adugna, “Attitudes and practices of farmers with regard to pesticide use in NorthWest Ethiopia,” *Cogent Environmental Science*, vol. 6, no. 1, Article ID 1791462, 2020.

[32] H. D. Putter, H. Hengsdijk, T. Samuel, and A. Dedefo, “Scoping study of horticulture smallholder production in the Central Rift Valley of Ethiopia,” 2012, https://library.wur.nl/WebQuery/wurpubs/fulltext/249787.

[33] E. Etissa, N. Dechassa, T. Alamirew, Y. Alemayehu, and L. Desalegne, “Household fertilizers use and soil fertility management practices in vegetable crops production: the case of Central Rift Valley of Ethiopia,” *Science, Technology and Arts Research Journal*, vol. 2, no. 4, p. 47, 2014.

[34] A. A. Biratu and D. Kidane, “Farmer's perception of soil erosion and participation in soil and water conservation activities in the Gusha Temela watershed, Arsi, Ethiopia,” *International Journal of River Basin Management*, vol. 14, no. 3, pp. 329–336, 2016.

[35] W. Bewket and G. Sterk, “Farmer's participation in soil and water conservation activities in the Chemoga watershed, Blue Nile basin, Ethiopia,” *Land Degradation & Development*, vol. 13, no. 3, pp. 189–200, 2002.

[36] D. C. Dagnew, C. D. Guzman, A. D. Zegeye et al., “Impact of conservation practices on runoff and soil loss in the subhumid Ethiopian Highlands: the Debre Mawi watershed,” *Journal of Hydrology and Hydromechanics*, vol. 63, no. 3, pp. 210–219, 2015.

[37] A. Amsalu and J. de Graaff, “Farmers' views of soil erosion problems and their conservation knowledge at Beressa watershed, central highlands of Ethiopia,” *Agriculture and Human Values*, vol. 23, no. 1, pp. 99–108, 2006.

[38] D. C. Dagnew, C. D. Guzman, A. T. Akale et al., “Effects of land use on catchment runoff and soil loss in the subhumid Ethiopian highlands,” *Ecohydrology and Hydrobiology*, vol. 17, no. 4, pp. 274–282, 2017.

[39] D. Amare, A. Endeblhatu, and A. Muhabaw, “Enhancing biomass energy efficiency in rural households of Ethiopia,” *Journal of Energy and Natural Resources*, vol. 4, no. 2, p. 27, 2015.

[40] W. Bewket, “Biofuel consumption, household level, tree planting, and its implications for environmental management in the Northwestern highlands of Ethiopia,” *Eastern Africa Social Science Research Review*, vol. 21, no. 1, pp. 19–38, 2005.

[41] F. X. Johnson and A. T. Mengistu, *Alternative Future Pathways for Household Biomass Use in Ethiopia*, Stokholm Environment Institute, Stockholm, Sweden, 2013.

[42] T. Erkossa and G. Ayele, "Indigenous knowledge and practices for soil and water management in East Wollega, Ethiopia," in *Proceedings of the Conference on International Agricultural Research for Development*, Göttingen, Germany, October 2003.

[43] A. Taye and T. L. Megento, "The role of indigenous knowledge and practice on water and soil conservation management in Albuko Woreda, Ethiopia," *International Journal of Bonorowo Wetlands*, vol. 7, no. 2, pp. 95–107, 2017.

[44] A. T. Ariti, J. van Vliet, and P. H. Verburg, "What restrains Ethiopian NGOs to participate in the development of policies for natural resource management?" *Environmental Science & Policy*, vol. 89, pp. 292–299, 2018.

[45] K. H. Aschale and S. Esmael, "The psycho-social context of Lake ziway/dembel: Oromia regional state, Ethiopia," *International Journal of Sociology and Anthropology*, vol. 12, no. 1, pp. 18–28, 2020.

[46] G. Weldu Woldemariam and A. Edo Harka, "Effect of land use and land cover change on soil erosion in Erer subbasin, Northeast Wabi Shebelle Basin, Ethiopia," *Land*, vol. 9, no. 4, p. 111, 2020.

[47] Z. Adimassu, B. Gorfu, D. Nigussie, and J. Mowo, "Farmers' preference for soil and water conservation practices in the central highlands of Ethiopia land degradation has been a major global agenda because of its adverse impact on the environment and food security and quality of life (Slegers, 2008)," *African Crop Science Journal*, vol. 21, pp. 781–790, 2013.