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Research Article

Biophysical Resource Characterization, Identification and Prioritization of Major Constraints and Potentials of Gara Ebanu Community Watershed in Sululta District, Ethiopia

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Abstract

Baseline characterization helps to understand the initial livelihood condition of the people in the watershed before and after the intervention of the project to measure the amount of change attained by the project. The objective of the study was to characterize baseline information on the existing biophysical resource used as benchmark for planning and impact monitoring and to identify and major constraints and potential in the watershed. The watershed was selected depending on agro-ecological representation, prevalence of resource management and land degradation problems and accessibility for intensive follow-up. Based on the preliminary outlet identified during the watershed selection process, the watershed boundary was delineated using GPS data and the map of watershed was geo-referenced and digitized for its contour, roads, rivers, and other features. Both primary and secondary data were used for the study and primary data was collected through field observation, household survey, focus group discussion and interview of the key informants. From the total 103 household heads living in the watershed, 62 household heads were selected as a respondent for the study. The collected data was managed and analyzed using Statistical Package for Social Sciences (SPSS) and Microsoft excel 2010. The results of the study showed that about 29.4% of the watershed slope was characterized by flat lands, 45.7% moderate slope and 24.9% steep lands. As well as soil fertility status of cultivated land in the watershed were 33.9% low, 55.9% moderate and 10.2% high. The results of the study showed that the major constraints identified by sampled household heads were decline of soil fertility, soil erosion, climate change, land shortage, and deforestation were significantly contributed to the low crop yield in the watershed. About 27.4% of the sampled households had encountered decline of soil fertility problems, 25.8% of sample farmers encountered soil erosion problem, and 22.6% of sample farmers encountered climate change problem in the watershed. From the identified major constraints, the highest priorities were given for decline of soil fertility, soil erosion problem, shortage of feed and fodder, and decline of crop productivity respectively. In the watershed, immediate short-term actions should be taken particularly participatory integrated watershed management were recommended.

Keywords

Watershed, Characterization, Identification, Prioritization

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1. Introduction

The worldwide agricultural production and productivity has been challenged with soil erosion related problems. Almost all lands in Sub-Sahara Africa (SSA) are prone to land degradation, and Ethiopia is among the most affected countries [1]. In a casing land degradation, in any form, in Ethiopia has direct impact on water resources, livestock and crop production and productivity, unemployment and rural-urban migration, incidence of drought and ultimately on food security [2]. Every year, about 10 million hectares of farm lands are abandoned globally [3] and 6.5 million hectares in Africa [4]. Due to water erosion, about 12 tons/ha of soils in lost every year in Ethiopia, and the economic impacts of this soil loss is estimated about $139 million which is 3–4% of agricultural growth domestic product (GDP) of the country [5]. Soil erosion affects soil physical properties, and chemical properties that affect agricultural production [6]. In addition, soil erosion causes adverse effect on atmosphere, agronomic productivity, food security and the overall life quality [7]. To address the problem of land degradation in the country, government and non-governmental organizations have introduced different soil and water conservation measures since the 1970's famine. However, due to the poor consultation and participation of local people in the planning and implementation of the practices, shortage of skilled human power and lack of state-of-the-art scientific approach, the natural resource management efforts were not as effective as desired to bring fundamental change [8-10]. Understanding these, Ethiopian government has been promoted a watershed based natural resource development and management in the country as a suitable strategy for improving productivity and sustainable intensification of agriculture since 1980s.

Watershed development program has emerged as a new paradigm for sustainable natural resource management and rural livelihoods and it occupied the central step of natural resource management and rural development in the fragile and semi-arid environments of the developing nations. Management of natural resources at watershed scale produces multiple benefits in terms of increasing crop production with minimum disturbance to the environment, improving livelihoods, protecting environment, addressing gender and equity issues along with biodiversity concerns. It encompasses the all-inclusive approach to manage watershed resources that integrates forestry, agriculture, pasture and water management, which can be broadened to rural development with a strong link to the livelihoods of the local people [11]. At the previous the idea of watershed management had a narrow emphasis primarily for controlling erosion, floods and maintaining sustainability of useable water yield. However, recently watershed management is not only for managing or conserving natural resources in a holistic manner, but also to involve local people for improvement of their lives. Its management is more people oriented and process based, than only physically target oriented [11].

Socio-economic and biophysical resource characterization helps to understand the initial livelihood condition of the people in the watershed before and after the intervention of the project to measure the amount of change attained by the project. It allows those involved in the project to understand the initial livelihood conditions and what needs to be done to reach the goal of improving the livelihoods of the community in the watershed. Biophysical resource characterization of the watershed builds necessary foundation for the plan and obtains proper information for elective and effective planning, implementation, and monitoring of the research and development endeavors particularly in the field of natural resources [12]. The main purpose of biophysical resource characterization in the watersheds is to identify existing constraints and potential of the watershed for targeting technology transfer for sustainable development, and for enhancing productivity and sustainable development. The analysis from biophysical resource information in the watershed helps prioritize the problems with their appropriate management options and technologies which in turn leading to the implementation phase to make all the community in the watershed benefited from watershed management. However, in Gara Ebanu watershed biophysical resource characteristics was not assessed to identify major constraints, opportunities for more physical interventions and improve livelihood of the local community.

Therefore, the study was conducted to characterize, identify, prioritize, analyze, and document baseline information on biophysical resource aspects, which is used as a benchmark for planning and impact monitoring of the Gara Ebanu community watershed.

Objectives of the study

1) To characterize and document baseline information on existing biophysical resource in Gara Ebanu watershed used as benchmark for planning and impact monitoring.
2) To identify major biophysical constraints and potentials in Gara Ebanu watershed.
3) To recommend appropriate research intervention and action plans for the priority issues in the watershed.

2. Material and Methods

2.1. Description of the Study Area

2.1.1. Geographical Location

Gara Ebanu community watershed is in Sululta district of North Shewa zone of Oromia Regional State, Ethiopia. It covers an area of 670 hectare and the watershed is drain to abay basin. The study watershed is located around 5 kilometers north of chancho town and 45 kilometers north of Addis Ababa.

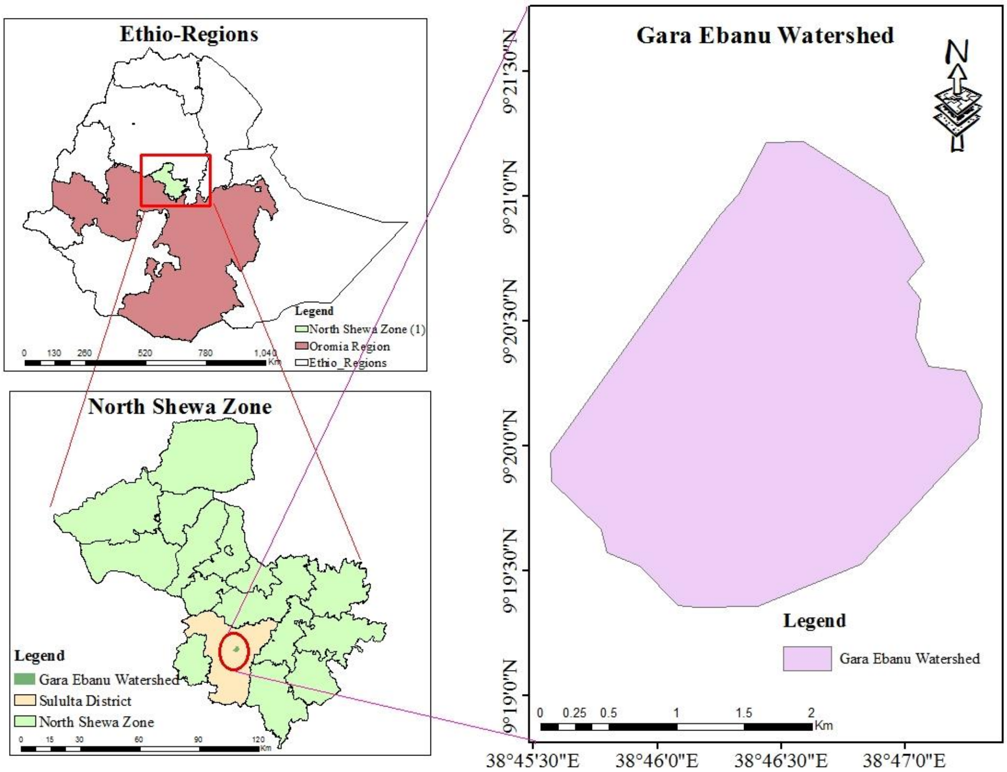


Figure 1. *Map of Gara Ebanu watershed.*

2.1.2. Topography and Climate

The land forms of the district are characterized by river, gorges, plateaus, mountains and plains. Thus, about 46% the area characterized by plains, 22% of the area characterized by rugged topography, 26% of the area characterized by plateaus and the remaining 6% of area characterized by mountain in the study area and the altitude varies between 1500m to 3571masl. The district exhibits three major agro-ecological conditions. These are low land (*gammojji*), high land (*baddaa*) and mid land (*badda-daree*) which account 3.6%, 71% and 25.4% of the district respectively. The district has an average annual rainfall of 1232mm. The mean monthly temperature varies from 6.2℃ to 22℃ with mean annual temperature of 15.4℃.

2.1.3. Vegetation, Soil and Land Uses

The district covered by forest as widespread from the remnant tree species dominated by *Juniper procera, olea africana* and *podocarpus falcatus.* The surrounding mountain sides were sheltered by the forest dominated by *Juniperus procera* tree species, and the lower part of the watershed supported stands of *Acacia abyssinica*, but nowadays most of the hillsides are enclosed with plantations of *Eucalyptus.* Remnant indigenous vegetation such as *Juniper procera*, *Olea africana and* other species have scattered distribution.

The major soil types found in the district are Cambisols, Nitosols and Vertisols, which accounts for 49%, 24.5% and 0.5% respectively. The remaining soil types made up 26 percent of the land. There are three land use systems exist in the district: cultivated lands, controlled grazing lands, and communal open grazing land.

2.1.4. Population

According to the national census report conducted in 2007, the total population of sululta district was 129,000, from this, about 64,516 were men and around 64,484 were women; 15,145 or 11.74% of its population were urban dwellers with an estimated area of 3,900 square kilometers, sululta had an estimated population density of 47.8 people per square kilometer.

2.1.5. Site Selection and Mapping of the Watershed

Prior to watershed selection, multidisciplinary research team was established for reconnaissance survey, site selection, resource characterization, planning and implementation of the watershed research. Accordingly, the established research team was selected one model watershed in the district based on agro-ecological representation, prevalence of resource management and land degradation problems and accessibility for intensive follow-up and minimizing cost. Based on the preliminary outlet identified during the watershed selection process, the watershed boundary was delineated using GPS readings. The geographical map of delineated watershed was geo-referenced and digitized for its contour, roads, rivers, and other features. The preliminary defined boundaries were verified in the field using GPS and establish reference benchmarks for future operations. Finally, elevation ranges, area of watershed, land slopes, and aspect of land related information of the watershed were extracted using the Digital Elevation Model of 30 meters resolutions. The spatial input data were projected into the same projection's unit (UTM Zone 37N) before analysis. Map of the watershed was developed and delineated from 1:50,000 scale aerial photographs/satellite images.

2.1.6. Source of Data and Method of Data Collection

The study used a descriptive examination research design. Both qualitative and quantitative approaches were used to gather and evaluate primary and secondary data. The primary research data was collected through field observation, household survey method (questionnaires), focus group discussion and interview of the key informants. An intensive filed observation was conducted to identify detail information about biophysical and major terrain features such as topography and landforms, present land use, soils erosion status, vegetation, water resources and soil and water conservation practices in the watershed.

The household survey questionnaire was conducted to gather data about biophysical resource characteristics, plot level characteristics, and various sustainable land management (SLM) practices conducted by farmers of the study watershed. A structured interview questionnaire that involved both closed ended and open-ended questions were prepared and used to generate data from the respondents. Many spatial data were produced using a global positioning system with a positional error of ±3 m from digital elevation model and satellite images. Landsat imagery was used to generate land use land cover datasets. A maximum likelihood classifier was used in a supervised classification procedure to classify the images independently in ERDAS Imagine 15 software. To evaluate the accuracy of image classification, reference data points were used to confirm that all land use land cover classes were adequately represented based on their proportional area. The land use land cover map generated with ArcGIS environment was cross-checked and verified by field observation and knowledge of the elderly as well as Google Earth. Secondary data were gathered from published and unpublished information. The information was collected from regional, zonal and district level of agricultural and information and communication offices.

2.2. Sampling Design

Sample household farmers from the watershed were selected by using simple random sampling technique with some stratification based on watershed position considering upper, middle and lower position of watershed. The total household heads in the watershed were identified and then the representative sample was selected from the farmers living in the watershed. Accordingly, from the total 103 household heads living in the watershed, 62 household heads were selected as a respondent for the study. Key informants were selected purposely from the district agricultural experts, agricultural extension workers and watershed user cooperatives administrators. Accordingly, 3 key informants were employed. Eight knowledgeable participants were purposely selected for focus group discussion.

2.3. Data Analysis

The collected research data was managed and analyzed using Statistical Package for Social Sciences (SPSS) and Microsoft excel 2010. Descriptive tools like percentages and frequencies were presented in tables, graphs and charts.

3. Result and Discussion

3.1. General Site Information

3.1.1. Slope, Soil Fertility, Soil Color and Degree of Erosion

Table 1. *Slope of land, soil fertility, soil color and degree of erosion.*

Characters	Description	Plot of land	
		Frequency	Percent
Slope of land	Flat	72	29.4
	Medium	112	45.7
	Steep	61	24.9
Soil Fertility status	Low	83	33.9
	Moderate	137	55.9
	High	25	10.2
Soil Color	Red	132	53.9
	Black	17	6.9
	Gray	4	1.6
	Brown	92	37.6
Degree of Soil Erosion	Slight	84	34.3
	Moderate	108	44.1
	Severe	46	18.8
	Not recognized	7	2.9

Source: Household Survey, 2021

The characteristics of farm plots results (Table 1) showed that about 29.4% of the slope of farm plot was flat, 45.7% moderate and around 24.9% of farm plots were steep land. However, in terms of soil color, about 53.9% of farm plot soil color was red, 6.9% black, and 37.6% brown and only1.6% farm plot soil color was gray. According to farmers perception, from the total 245 cultivated farm plot owned by households, about 33.9% of farm plot had low soil fertility status, 55.9% moderate and only 10.2% of farm plot had a good soil fertility status. Also, in terms of soil erosion about 34.3% of cultivated farm plot in the study area experiences light soil erosion, 44.1% was moderate and 18.8% of cultivated farm plot experienced severe soil erosion and also about 2.9% of the respondents said that not recognize soil erosion status of the land.

3.1.2. Soil and Water Conservation Practices on Farm Sites

The results of the study summarized using descriptive analysis in Table 2 for different SWC measures practiced in each farm plot owned by households.

Table 2. Types of SWC measures practiced by farmers in the watershed.

Type of SWC practices	Frequency	Percent	Type of SWC practices	Frequency	Percent
A. Agronomic practices			B. Physical SWC practices		
Mono cropping	3	5	Soil bund	8	13
Rotation (cereals – pulse)	42	68	Stone bund	7	11
Rotation (cereal-cereal)	15	24	Terrace	5	8
Rotation (cereal – others)	2	3	Cut-off drain	9	15
Home garden	8	13	Water way	31	50
Broadcasting sowing	62	100	C. Biological SWC practices		
Conventional tillage practice	44	71	Using local grass	9	15
Conservation tillage practice	18	29	Road side plantation	6	10
0% crop residue left	54	87	Farm boundary plantation	9	15
50% crop residue left	8	13	Buffer stripe	1	2
D. Gully Control			Area closure (ha)	5	8
Stone Check dam	5	8			
Brush wood	1	2			
Others	1	2			

Source: Household Survey, 2021

The result of survey (Table 2) shows that agronomic conservation practices applied were crop rotation (95%), conservational tillage practices (29%), and only 13% of sampled farmers were left fifty percent crop residue on the land in the watershed without any practice of row planting, inter cropping and double cropping. The use of proper soil management practices such as crop rotation, left crop residue, cropping systems, vegetation cover, and conservation tillage at the farm level and eventually at the watershed scale have been suggested to be among the best approaches to address severe soil erosion and low crop productivity problem [13-16].

Physical soil and water conservation measures practiced by respondents in the watershed were waterways (50%), followed by the cut-off drains (15%), soil bund (13%), stone bund (11%) and terrace (8%) of sampled farmers in the watershed. Physical conservation measures such as terraces, check dams, stone or/and soil bunds, trenches and micro basins modify terrain through changing slope length, gradient and angle, which in turn reduce runoff velocity, enhance water infiltration and trap sediments washed down the terrain [17].

The biological soil and water conservation practices applied by farmers were plantation at different site (25.8%), followed by local grass strip (15%), and area closure (8%) of sampled farmers in the watershed. Others such as stone check dam (8%), brush wood and others (2%) of sampled farmers applied for gully control in the watershed.

As shown in Figure 2, farmers gave various reasons for not using structures on their farmlands., These includes, most sampled farmers (66.1%) said that no awareness about the construction of conservation structures followed by don't have labor to construct (19.4%), the farmland is not needed conservation structure (11.3%) and lack of material for the construction of conservation structure in the watershed. The key informant interview was also conducted to get additional information. They reported that the lack of awareness about the construction of conservation structures, and the farmland is not needed conservation structure are the key reasons for respondents not using conservation structures.

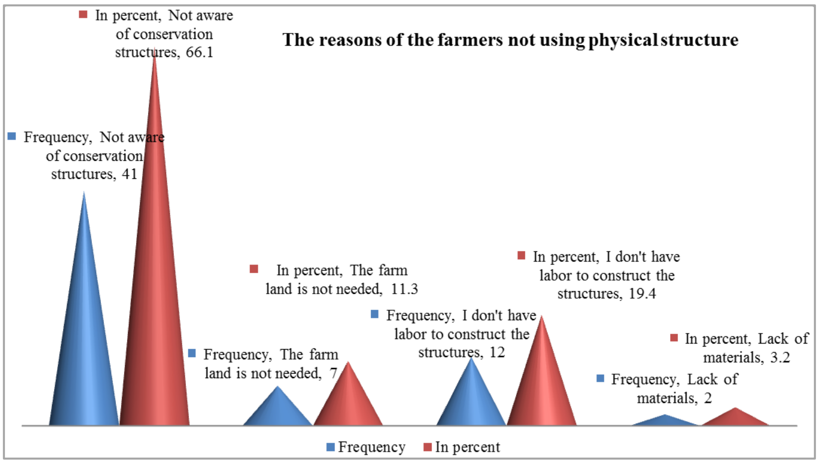


Figure 2. The reasons of farmers not using structures in their farm lands in the watershed.

Farmers' awareness on the importance of appropriate land management and SWC practices as well as recognition that human activities and soil erosion are drivers to the current degradation is an important step towards sustainable exploitation and utilization of land resources [18].

3.2. Land Use Land Cover and Natural Resource in the Watershed

3.2.1. Land Use and Land Cover

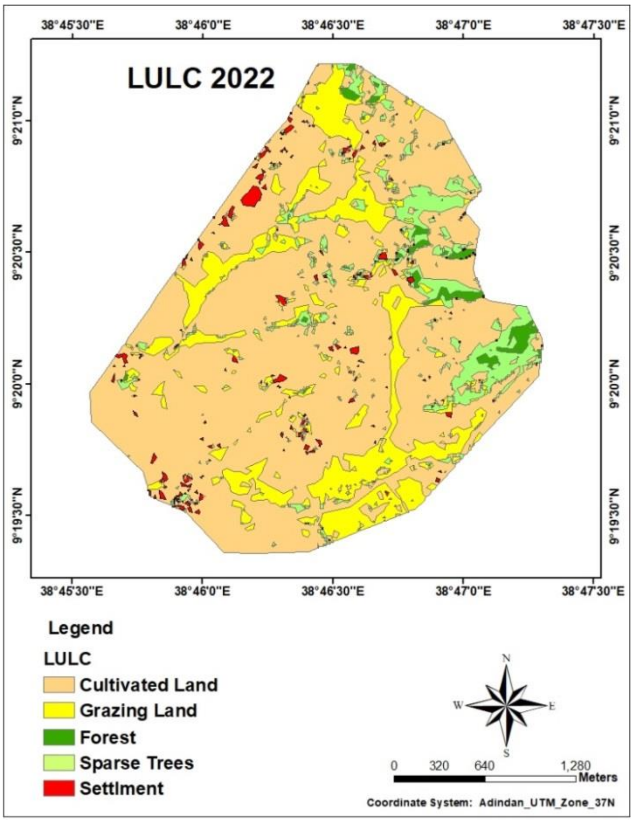


Figure 3. Land use land cover map of Gara Ebanu watershed.

Table 3. Area coverage of each land use land cover in the watershed.

Land use/ land cover	Area coverage in 2022	
	In (ha)	In (%)
Forest land	10.48	1.6
Cultivated land	490.87	73.2
Grazing land	111.26	16.6
Scattered tree on the farm	48.62	7.2
Settlements	9.43	1.4
Total land	670.67	100

The land-use land cover patterns of the watershed are highly dynamic, currently around 490.87 hectares are cultivated land, 111.26 ha are used for grazing land, 48.62 ha and 10.48 ha are covered by sparse trees and forest land, respectively and also 9.43 ha are used for settlements. The distribution of these land use land cover of the watershed (Table 3) indicated that, most of land (73.2%) in the watershed used for cultivated land followed by grazing land (16.6%).

3.2.2. Topography and Slope Characteristics in the Watershed

The land slope gradient (S) influences flow velocity and the rate of soil erosion. Increase in slope steepness and slope length of the land will increase soil erosion as a result of respective increases in velocity and volume of surface runoff. The effects of topography on land degradation depends on the effects of land slope steepens and slope length.

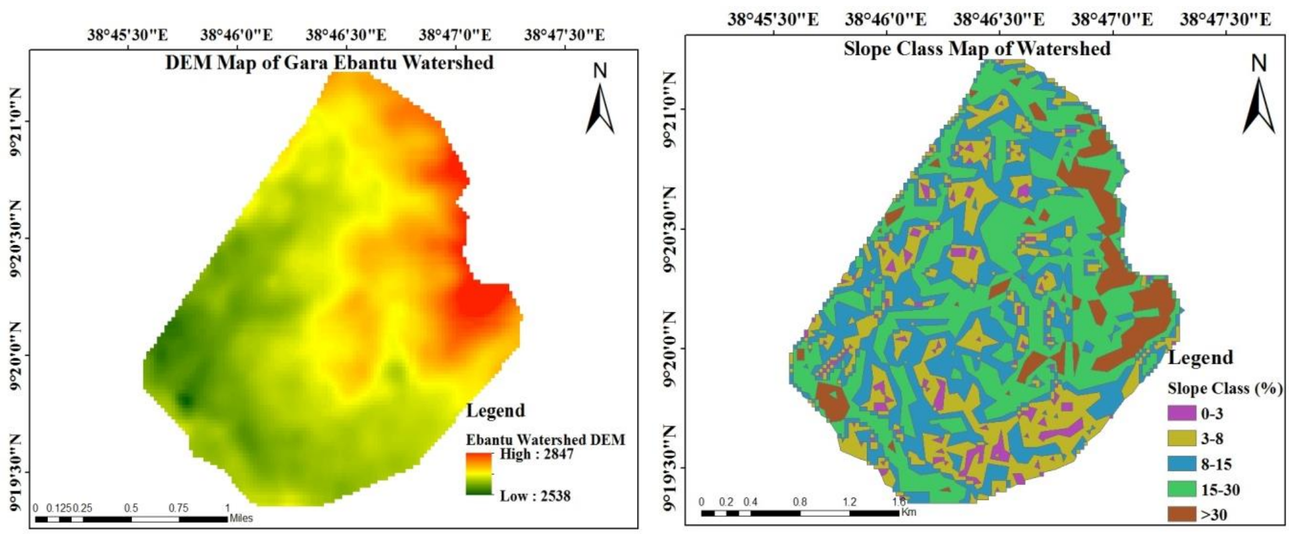


Figure 4. DEM and slope class map of Gara Ebanu watershed.

Table 4. Area coverage of each slope classes in the watershed.

Slope Class	Area (ha)	Area (%)
Flat (0-3%)	23.9	3.6
Gently Sloping (3-8%)	140.8	21.0
Moderately Steep (8-15%)	202.8	30.2
Sloping (15-30%)	242.9	36.2
Steep (>30%)	60.27	9.0
Total	670.67	100

Slope gradient of the study watersheds are classified into five classes. About 60.27 ha (9.0%) of the watershed land slope was categorized under steep slope (above 30%) and 66.4% of watershed slope classified under moderately steep to sloping slope land (8-15% and 15-30%), respectively, (Table 4). Distribution of these slope classes of watershed indicated that, 75.4% of land in the watershed classified under moderately steep to steep slope and only 3.6% of land was categorized under flat slope (0-3%). This indicate that more of the watershed landscape might be exposed to extreme flooding at time of high rain fall occurrences which implies that the need of soil and water conservation structures for sound natural resources conservation in the area. This is agreed with the findings of [19] stating that the slope configuration provides few depositional sites within the hill slope. However, where excessive slope lengths occur, off slope transport of sediment (erosion) can be anticipated.

3.3. Soil and Water Conservation Practices in the Watershed

As observed by field observation, due to the absence of proper land management, sheet and rill erosion in most of farm lands has developed in the farm lands with neglected conservation measures and also gully formation is common along the edges of farm land boundaries, cattle tracks and roads in the watershed. According to [20] report rill erosion is a result of surface runoff and associated sheet wash, which selectively removes fine material and organic matter that are very important determinants of land productivity. This problem might cause by destruction of forest, improper land use, high amount of annually rainfall and run off, presence of steep and uneven slopes, presence of mountains and hillside topography, no vegetation covers, cultivation of steep lands without adequate conservation measures.

The expansion and formation of gully is one of the main difficulties in degraded watersheds, it reduces the cultivable area and grazing lands, assist erosion from upstream degraded landscapes and carry a huge volume of sediment to posing a problem of siltation in downstream dams, rivers [11]. This has significantly increased land degradation in the watershed with gullies seen in open grazing lands in the lower part of the watershed. Key informants indicated that, steep lands were increasingly being cultivated without adequate soil conservation measures. Population burden was fairly mentioned to have led to clearing of forests, bushes and depletion of natural vegetation cover to increase crop production for food needs in the families. Land fragmentation to accommodate young generation and subdivision of land has contributed to degradation of the land in the watershed, with majority of new farms increasingly being used without proper and adequate conservation measures increasingly encroaching into fragile ecosystems.

Key informants and focus groups also indicated that, steep lands were increasingly being cultivated without adequate soil conservation measures.

3.4. Vegetation Coverage in the Watershed

Vegetation coverage has excessive contribution in interception rainfall, keeping sediment loss and manages soil fertility. As the responses of sampled farmers, the major tree species found in the watershed were *Juniperus procera, Olea eurpaea, Eucalyptus globulus, Acacia lahai, Ficus sur, Dodonaea angustifolia, Otostegia fruticosa, Croton macrostachyus, Podocarpus falcatus, Maesalanceolata, Carissa edulis, Maytenus senegalensis. Juniperus procera, Eucalyptus globulus and Olea eurpaea* in which they were densely distributed tree species and *Acacia lahai, Ficus sur* and *Dodonaea angustifolia* dispersed tree species in the watershed. However, some of the indigenous tree species were extinct from the watershed.

Deforestation and agricultural land expansion were the major cause of extinction of native tree species such as *Ekebergia capensis* and *Cordia Africana* which are being replaced by *Eucalyptus spp.* The elders also said that with time and coming up of new generation they were forced to distribute part of forested land as part of land inheritance. This resulted to further clearing of hilltops, ridge summits and slope lands. Decreasing of forest and vegetation cover due to expansion of agricultural land and grazing activities has led to increase in soil erosion and depletion of soil fertility [21], which has negative impact on crop and livestock production, and the livelihood approaches [22]. According to the previous study assessment reported show that universally about 13 million hectares of forest were changed to other uses or loss through natural as well as anthropogenic activities that cause reduction in forest area coverage and native species [23].

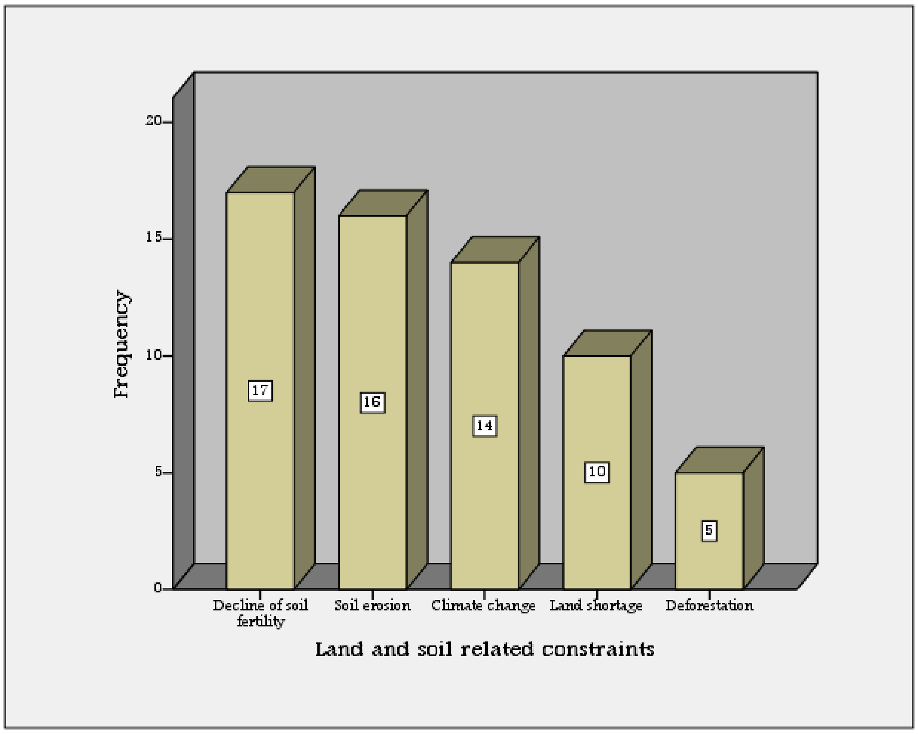
3.5. Identification of Major Constraints in the Watershed

Identifying of the major constraints in the watershed help to find alternative solution in tackling the constraints for the successfulness of the watershed management measures and improve the livelihood of people living in the in the watershed. Accordingly, different constraints were identified and ranked by farmers, key informants, and focus group during this baseline survey as the major constraints encountered in the watershed.

The results of the study show that the major constraints related with land and soil as identified by sampled farmers were decline of soil fertility, soil erosion, climate change, land shortage, and deforestation were major constraints significantly contributed to the low crop yield in the watershed. The results of survey (Table 5) discovered that around 27.4% of the sampled respondents had encountered decline of soil fertility problems, 25.8% of sample farmers encountered soil erosion, 22.6% of sample farmers encountered climate change and land shortage problem (16.1%) on their farms. The majority of the respondents perceived that crop production in the study area is decreasing due to low soil fertility, and soil erosion problem.

***Table 5.** Major constraints related to land and soil in the watershed.*

Land and soil related constraints	Frequency	Percent
Decline of Soil Fertility	17	27.4
Soil Erosion	16	25.8
Climate Change	14	22.6
Land Shortage	10	16.1
Deforestation	5	8.1
Total	62	100.0



Source: Household Survey, 2021

***Figure 5.** Graph of major constraints related to land and soil in the watershed.*

3.6. Prioritization of Identified Constraints in the Watershed

Once a list of constraints was identified, the farmers, key informants and focus group ranked the overall major constraints identified as major constraints in the watershed for prioritization. Based on these methods, all participants gave rank for all identified major constraints of watershed. Then, repetition was eliminated to decrease the list to a controllable number of problems for successive ranking and planning. Accordingly, 10 major constraints were taken for pair-wise ranking method. By using pair-wise ranking method participants were asked to give a '1' to the first rank, a '2' to the second rank. When using pair-wise ranking, each the watershed issues were compared with all the other problems to systematically separate their comparative importance. Finally, pair-wise ranking was converted to priorities by giving a '1' to the high priority and '0' to the low priority (Table 6)

Table 6. *Prioritized constraints in the watershed.*

	Decline of soil fertility	Soil erosion	Climate change	Shortage of agricultural inputs	Decline of crop productivity	Crop disease	Shortage of feed and fodder	Lack of employment opportunity	Inflation	Lack of drinking water	Score	priority
Decline of soil fertility		0	1	1	1	1	1	1	1	1	8	1
Soil erosion	1		1	1	1	1	0	1	1	1	8	1
Climate change	0	0		0	0	1	0	0	0	1	2	5
Shortage of agricultural inputs	0	0	1		1	1	0	1	0	1	5	4
Decline of crop productivity	1	0	1	0		1	0	1	1	1	6	3
Crop disease	0	0	0	0	0		0	0	1	1	2	5
Shortage of feed and fodder	0	1	1	1	1	1		0	1	1	7	2
Lack of employment opportunity	0	0	1	0	0	1	1		1	1	5	4
Inflation	0	0	1	1	0	0	0	0		0	2	5
Lack of drinking water	0	0	0	0	0	0	0	0	1		1	6

Source: Household Survey, 2021

According to the social group ranking survey result (Table 6), the highest priorities were given for decline of soil fertility, soil erosion problem, shortage of feed and fodder, and decline of crop productivity respectively. Low consideration was given for climate change, and crop disease. While, intermediate priorities were given to the high cost and shortage of agricultural inputs, and lack of employment opportunity problem.

3.7. Major Potentials/Opportunities in the Watershed

The results of major potentials/opportunities in the watershed related with natural resource, socio-economic and institution were presented in table 7.

Table 7. *Major potentials in the watershed.*

Potentials	Frequency	Percent
A. Natural resource potentials		
Sand and coble stone	27	43.5
Permanent river	13	21.0
Forest	12	19.4
Suitable agro-ecology	10	16.1
Total	62	100.0

The result shows that, about (43.5%) of sample farmers were said that the presence of sand and coble stone followed by permanent river (21%), forest (19.4%) and suitable agro-ecology (16.1%) were the major potentials related to natural resource in the watershed.

4. Conclusion and Recommendation

Based on the result of the study it can be concluded that, there is poor level of awareness of farmers on integrated natural resource management in watershed. In the watershed, decline of soil fertility, soil erosion, deforestation, high cost of agricultural inputs, decline of crop productivity, crop disease, deficiency of animal feed and fodder, inflation, lack of employment opportunity and other income source were addressed as the highest priority issues by the community that are contributing to the crop productivity reductions and low level of their livelihood in the watershed.

Based on the aforementioned findings, the following suggestions were given for further improvement and research intervention: Attention should be given to awareness creation and strength capacity of local people on integrated natural resource management and wisely use of natural resource to overcame the problem of land degradation, deforestation, soil loss due to erosion, climate change and resource depletion which finally decreases production and productivity and increase drought & famine and to increase the awareness of peoples about the long-term benefits of soil conservation measures and plan a strategy to protect land degradation. And also, the training should be given for the community on crop production and livestock production technologies participatory degrade land rehabilitation by construction of appropriate soil and water conservation measure and planting of multi propose trees. As well as Participatory gully rehabilitation and reclamation and promotion of integrated conservation agriculture and different agronomic practices with improved crop varieties.

Generally, preparing intervention of different technologies and development plans for the identified and prioritized problem by participating communities and different potential stakeholders to solve the problems by considering the existing opportunities of the watershed.

Abbreviations

°C	Degree Centigrade
GDP	Gross Domestic Product
GPS	Global Positioning System
ha	Hectare
Km	Kilometers
km^2	Square Kilometers
mm	Millimeters
SPSS	Statistical Package for Social Sciences

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Data Availability Statement

All the data stated here are available from the authors upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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