

Ecological Benefits of Participatory Watershed Management Practice in the Case of Chenetaly Watershed, Guagusa Shikudad Woreda, Ethiopia

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Abstract: The rapid global population growth and increasing impacts of climate change have resulted water and food shortage. Due to the increasing pressure from anthropogenic activities the terrestrial and aquatic ecosystems and their interrelation are largely disrupted. As the result, the benefit we get from the ecosystem has reduced, this calls for a shift in the management of ecosystems and the use of water for food security. The objective of this study was focus Ecological Benefits of Participatory Watershed Management Practice; Case Study of Chenetaly Watershed, Guagusa Shikudad Woreda, Amhara Regional State, Ethiopia. The data were collected from 84 randomly selected households through household survey. In addition to household survey, focus group discussion, key informant interview and observation were used to collect additional data and used for triangulation and present detail explanations. Relevant information was also gathered from secondary sources (e.g., watershed management planning and implementation documents and annual reports) available in Guagusa Shiudad Woreda Agricultural Office. Based on the result Chenetaly watershed was severely degraded due to inappropriate cultivation, over grazing, gully formation and deforestation factors before the implementation of watershed management practices. Due to presence of high watershed degradation, there was high ecological high decline of ecological balance like soil formation and gully formation. To overcome this problem, watershed management program was introduced in Chenetaly Watershed and many physical and biological conservation measures were highly practiced to reduce soil erosion, rehabilitate gully formation and decrease loss of soil fertility. The finding of this study confirmed that the introduction of watershed management has been brought some important changes in local ecosystem. Some of the major ecological changes include decrease in soil degradation, increase soil capability and agricultural productivity, increase forest rehabilitation and firewood availability; increase the availability of grass and other livestock fodder. Based on the finding of study the following conclusion has made participatory watershed management can play significant role to improve the ecological condition of the area. Based on foundation of study I recommend that effective watershed management intervention has been undertaken in Chenetaly Watershed such best practices should extend to neighboring watersheds.

Keywords: Ecological Balance, Watershed Degradation, Watershed Management

1. Introduction

The rapid global population growth and increasing impacts of climate change have resulted water and food shortage. Due to the increasing pressure from anthropogenic activities the terrestrial and aquatic ecosystems and their interrelation are largely disrupted. As the result, the benefit we get from the ecosystem has reduced, this calls for a shift in the management of ecosystems and the use of water for food security [13].

Watershed is a complex system that different human and natural resources uses practice and interact and that is perfect spatial unit to make effective and integrated resource management activities. Because watershed degradation has negative effects on environmental and socioeconomic condition of upstream and downstream area [5].

Over the past several decades many countries have been given high priority for conservation and management of watershed resources in order to meet the demands of growing

population. Particularly in the 1990s integrated watershed management by participate population has become widely accepted as appropriate approaches for conserving natural resources such as land, water, and biodiversity to enhancing livelihoods condition and improving the economy of upland inhabitants and people living in downstream areas [5].

Watershed management look as sustainable natural resources management way that integrated and made link between natural resources management and socioeconomic condition, such as agricultural production, livelihoods in and around protected areas and it also provides a base line for organizing different land uses in the area and contributes to the reduction of risks of natural risks, such as landslides, gully formation and local floods, and creates local suitable climate condition that resilient to climate change and diversify adaptation options [6]. Watersheds degradation in recent decades has brought the long-term reduction on quality and quantity of natural resources. Changes in watersheds are the outcome of different natural and anthropogenic factors, including natural soil erosion, land use /land cover change like (over abstraction of water, overgrazing, deforestation, and pollution) [9].

Watershed has been considering as best way for integrated resource management, whereas management is not only limited to natural resources (land, water and biomass) but it also worried carried out integration for self-reliance and comprehensive development of the rural poor and different uses and management of resources, different parties with sectoral interest through inter-disciplinary strategies, and towards alleviation of poverty [12, 3]. Multiple environmental social, and economic worthiness derived from land based resources has increased in recent years. proper management of these resources is therefore precondition to sustainable resource based production systems, watershed management which issue is the implementation of land resource management systems that considered by many the most appropriate approach to ensuring preservation, conservation and sustainability of all land based resources and improving the living conditions of people in the uplands and lowlands [1].

Watershed is a rational land unit for management of natural resources and logical planning area for sustainable resource management. Sustainable watershed management is appropriate utilization natural resources for optimum production to fulfill the present need people without compromising the needs of future generations with minimal degradation of natural resources such as environment, water and land [10]. Based [11] watershed management has contribution of promoting economic development of the rural area, employment generation, and keeping ecological balance with other objectives of:

1. Environmental: protecting vegetative cover for the whole year, create ecological balance in the watershed area, protecting fertile top soil, utilize the land based on its capabilities, in situ conservation of rain water, increasing ground water recharge/water table.
2. Economic: It gives due attention for increase in

cropping intensity through inter and sequence cropping, maximizing farm income through agricultural related activities such as dairy, poultry, sheep and goat farming, improved and sustained livelihood status of the watershed community with special emphasis on the poor people.

3. Institutional: focus formation of watershed committees, different self-help groups and establishing sustainable community organization.
4. Social: It considers alleviation of poverty, capacity building, awareness creation, improving skills of the local community, women's participation in decision-making process, empowerment of the community and etc.
5. Equity: To improve equitable distribution of benefits on land and water resources development and the consequent biomass production, involvement of village communities in participatory planning, implementation, social and environmental arrangement, maintenance of assets and it also operate in a more socially inclusive manner. Degradation watershed in Ethiopia is one of the main obstacles for agricultural productivity that resulting from the interaction of natural and anthropogenic factors, including erratic rainfall, rugged topography and unsustainable land management system, both in food crops and grazing lands areas [6]. Ethiopia has been largely practiced in natural resources conservation, particularly following the 1970s and 1980s unpopular famines that smash the country, following this different developmental projects and program have been basined and implemented by Ethiopian governments and in collaboration with communities and NGOs (Non-Governmental Organization). Most of ahead of implementation focused on physical soil and water conservation works to increase agricultural productivity and forest cover of watersheds. These early works are also focus on use of an approach commonly called Food for Work relief assistance [6].

Food for Work relief approach focused mainly to mitigate soil erosion through the construction of physical soil and water conservation such as construction of terraces, check dams, cut-off drains and micro-basins, limited extent afforestation and rehabilitation of degraded and fragile hillside areas and a large volume of works have been done and some ecological benefits obtained from it [8]. 'According to FAO, in 2000 long-term national natural resource management program called Sustainable Land Management Program (SLMP) was started [6]'. The objective of SLMP was to provide facilitation for smallholder farmers to adopt sustainable land management activities on a wider scale that can finally result in reversing land degradation in agricultural landscapes, increase agricultural productivity, income growth and protect ecosystem functions. SLMP is taking more systematic intervention approach by targeting small watersheds. Important feature of SLMP is the explicit and clear focus on

enhancing ecological benefit through watershed based conservation. Therefore, the objective of this paper to assess ecological benefits of participatory watershed management intervention in Chenetaly Watershed.

2. Materials and Methods

2.1. Description of the Study Area

Latitudinal location of Chenetaly Watershed is located

between 10°44'0"N to 10°48'0" N and 37°0'30" E to 37°3'30" E in Gusha Shinkurita *Kebele*, Guagusa Shikudad *Woreda*, Awi Administration Zone in Amhara National Regional State. It is one of the form 54 watersheds found in Guagusa Shikudad *Woreda*. Watershed surrounded by Gibgedel and Samuel *Kebeles* in the north, Gusha *Kebele* in the west, Gusha *Kebele* in the south and Samuel *Kebele* in the east. The total area of the land in watershed is estimated 483.6 hectares [9].

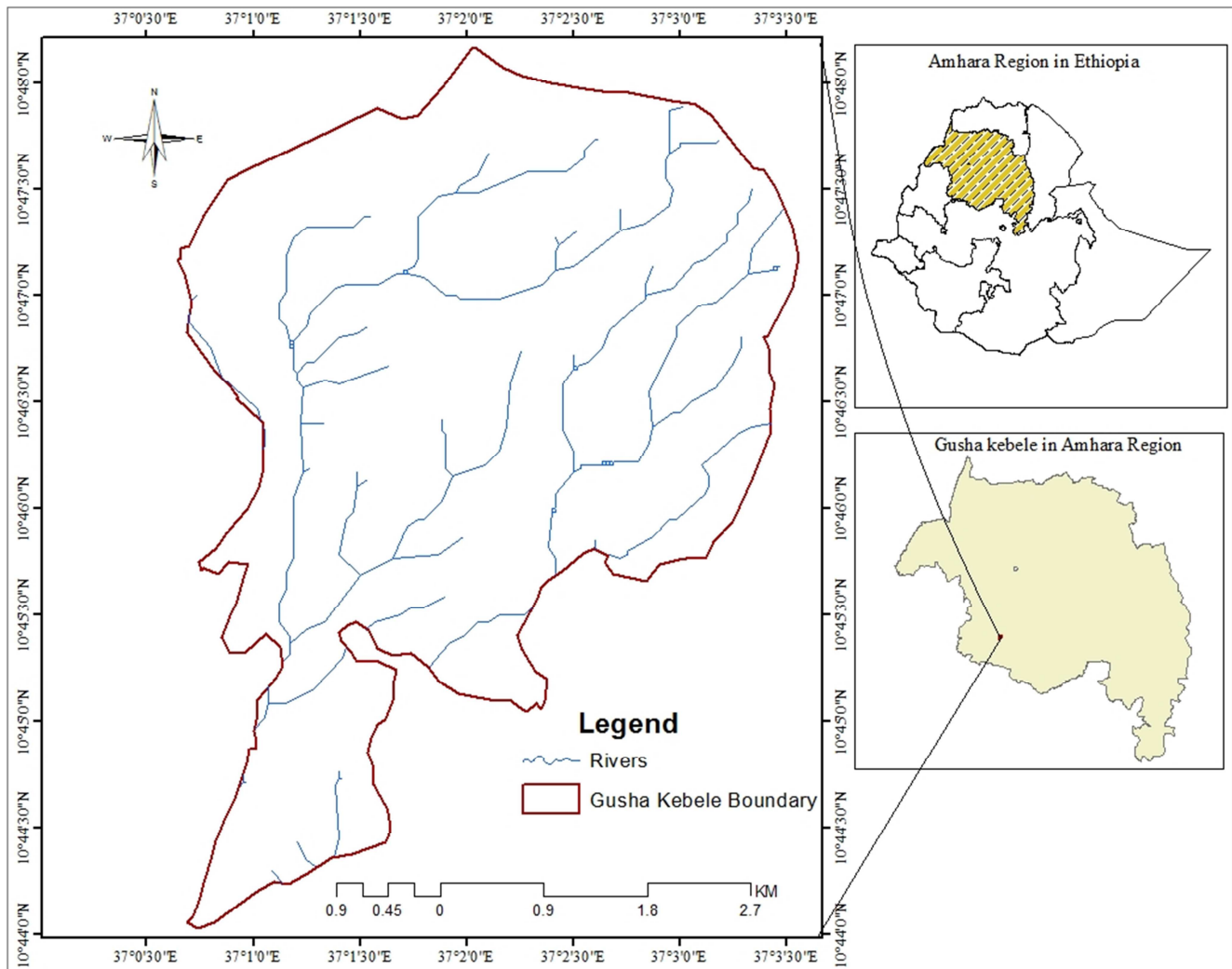


Figure 1. Map of study area.

2.2. Research Design

In the study mixed research design (both qualitative and quantitative) method was used. Cross-sectional survey method was employed to collect data from sample households. The qualitative methods that include observations, focus group discussion and key informant interview were used for purpose of compensation and data triangulation. The qualitative approaches were used to sketch the status of watershed management, regarding to watershed degradation, watershed management. Data collection and

analysis were conducted concurrently.

2.3. Data Sources and Types

Both primary and secondary data sources were used for this study. Primary data sources were household heads, 'kebele' and 'woreda' natural resource experts through household survey, key informant interview and focus group discussions. On the other hand, secondary data sources for this study were books, internet, research papers, journals and reports on watershed management degradation and the role of watershed management on ecosystem.

2.4. Sample Size and Sampling Technique

Sampling technique was used to select representatives from total population. In Guagusa Shikudad *Woreda* the implementation of watershed management activities was practiced in four different watersheds. Chickietie, Wagishitie, Washintie and Chenetaly are the four watersheds that found in this *woreda* and experienced SLMP. Among these watersheds Chenetaly Watershed was selected purposively from four watersheds for this study purposes due to the fact that Chenetaly Watershed has experienced effective watershed management practices compared to the other watersheds. The total population of watershed is 1140 from those 210 are households living in Chenetaly Watershed from these 84 household heads select through simple random techniques to administer questionnaires. Sample size was determined using the following method as used in [4]:

$$no = z^2 \times p \times q / d^2 \rightarrow n = \frac{no}{1 + \frac{no-1}{N}} = \frac{(1.96)^2 \times 0.1 \times 0.9}{(0.05)^2}$$

$$no = \frac{0.345744}{0.0025} = 138.2976,$$

$$n = \frac{138.2976}{1 + \frac{138.2976-1}{210}} = \frac{138.2976}{1.6537981} = 83.624 \approx 84$$

Where; n_0 is the desired sample size when the population is greater than 10000, n is number of sample size when population is less than 1 0000, Z is 95% confidence limit i.e. 1.96, p is 0.1 (proportion of the population to be included in the sample i.e. 10%) q is 1 - 0.1 i.e. (0.9), N is total number of population that is 210 and d is margin of error or degree of accuracy desired (0.05). Thus, the sample size to this study was 84 households.

2.5. Methods of Data Collection

Multiple data collection methods were used in this study. These include household survey through questionnaire, focus group discussion, and key informant interview and field observation. Full description of these methods was given below.

2.5.1. Questionnaire

For this study closed-ended and open-ended questions were designed in order to accomplish the objectives of the study. Questionnaire was employed to collect respondents' socioeconomic and demographic information, watershed management practices, the role of watershed management on the ecological condition of the study watershed.

2.5.2. Focus Group Discussion

Two focus group discussions were under taken; one with watershed committee and other with community. Each group contained ten members comprising of both males and females. The type of data collected through this method include drivers of watershed degradation before watershed management intervention, community participation on watershed management, status of watershed management and ecological benefits of watershed management intervention.

2.5.3. Key Informant Interviews (KII)

Different key informant interviews were conducted with different individuals at different levels. Key informants selected purposively who generated appropriate information regarding to the watershed management intervention and its role. At the *kebele* level, interview was made with two elderly people, who are living in the watershed, *kebele* chairperson and one development agent. In addition to these, interview was made with natural resources management expert from *Woreda* Agricultural and Rural Development Office.

Table 1. Key informant sample size.

No	Key informants	Sample size
1	<i>Kebele</i> chairperson	1
2	Elderly people	2
3	Development agent	1
4	<i>Woreda</i> Agricultural and Rural Development Office	1

2.5.4. Field Observation

This method was used to understand the overall watershed management practices and its current status. Observations of the environment can provide valuable background information about ecological setting of watershed. Besides, this method was used to investigate the main natural resources conservation mechanisms and methods that have been implemented by the local communities in the watershed.

2.6. Methods of Data Analysis

Both qualitative and quantitative techniques were used to analyze the data. Descriptive statistics such as mean, percentages and frequency were employed to analyze quantitative data collected through questionnaire and the data was summarized by using table and chart. This study also applied comparative analysis to examine the contribution of watershed management on food security and ecological conditions of the study watershed in the last decade or 1990s before watershed management intervention and after watershed management intervention. Qualitative data gathered thorough key informant interview, FGDs and observation were categorized and organized in line with research objectives for the purpose of analysis and presentation. Data obtained from FGDs and key informants interview were analyzed descriptively. Qualitative data were used validate findings of quantitative data.

3. Results and Discussions

3.1. Farmers' Perception on Watershed Degradation

Understanding farmers' perception on watershed degradation is a vital step to take appropriate planning and management intervention measures at a given area [11]. According to [7], it is necessary to understand the attitudes of local people on resources degradation in order to design a useful plan of action for environmental protection. This is because, farmers' decision to conserve natural resources are determined by their knowledge on problems. In this study, sample household heads were asked to indicate existence and

extent of resources devalue or reduction in watershed before intervention of watershed management practice. Accordingly, all respondents (100%) indicated that there was severe natural resources degradation in Chenetaly Watershed before the introduction of watershed management activity.

About 78.6% and 21.4% of the respondents rated the prevalence of soil erosion before the introduction of watershed management as very high and high, respectively (Table 2). Due to this, the fertility of soil at Chenetaly Watershed has declined as confirmed by 98.8% of the respondents. About 79.8% of respondents have confirmed that there was very high gully formation before the introduction of watershed management practice (Figure 1). As shown in Table 2, about 48.8% and 45.2% of the respondents indicated prevalence of animal fodder shortage as very high and high before the implementation of watershed management intervention, respectively. The productivity of land was also declined at a very high rate as confirmed by 85.7% of the respondents. About 81.1% of the household heads confirmed the presence of very high flood hazards in Chenetaly Watershed. Furthermore, 76.2% of respondents reported that presence of very high water shortage in study area before the introduction of watershed management intervention. The destruction of biodiversity in the watershed was also very high as confirmed by 72.4% of the respondents.

Table 2. Respondents' perception on watershed degradation before the introduction of watershed management at Chenetaly Watershed.

Indicators of watershed degradation	Response (%)				
	1	2	3	4	5
Soil erosion	78.6	21.4	-	-	-
Loss of soil fertility	78.6	20.2	1.2	-	-
Gully formation	79.8	19	1.2	-	-
Shortage of grazing land	48.8	45.2	4.8	-	-
Deforestation	76.2	20.2	1.2	-	2.4
Reduce land productivity	85.7	11.9	2.4	-	-
Flood hazard	81.1	16.5	1.2	1.2	-
Water shortage	76.2	21.4	2.4	-	-
Loss of biodiversity	72.4	22.6	4.8	-	-

Key: 1= very high 2=high 3= low 4=very low 5= not a problem, own survey 2021.

According to information obtained from FGDs and key informant interviews, Chenetaly Watershed has experienced very high level of soil erosion and gully formation. They also indicated that due to shortages of land and poor agricultural productivity on the existing farmlands, most households were forced to use hillsides or steep slope areas for farming purpose. According to [12], the formation of gully and its

expansion is one of the major challenges in degraded watersheds that reduce the agricultural lands (cultivable area and grazing lands). It facilitates surface runoff from upstream degraded landscapes and carrying large amount of sediment and posing problem of siltation in downstream dams, rivers and cultivated or grazing lands.



Source: [9]

Figure 2. Gullies formed in Chenetaly Watershed due to soil erosion before the intervention of watershed management that taken in 1999 E.C.

3.2. Farmers' Participation in Watershed Management Activities

Farmers' local knowledge and active participation are relevant in the field of watershed management intervention at a given area [8]. This study attempted to see the participation of sample respondents in watershed management activities and their perception on benefits of watershed management activities. All respondents have responded that watershed management is the best solution to conserve natural resources in the Chenetaly Watershed. The result indicated that all the sample households were participated in the watershed management activities (Table 3). Participants in the FGDs and key informant interviews also confirmed that all households in the watershed were participated in the management activities. The household participated from problem identification, planning, management and monitoring activities. Participants have indicated that, inhabitants in the watershed were actively engaged in management activities as they aware of watershed management intervention. They mentioned that "we actively engaged in watershed management activities, since it helps to enhance our living condition by rehabilitating the degraded lands and increasing agricultural productivity". The result of this study was consistent with [2] who indicated that farmers' decision to conserve natural resources affected by their knowledge of problem and perceived benefits of conservation.

Table 3. Households' participation and perception on watershed management activities.

Questions	Response					
	Frequency			Percent		
	Yes	No	Total	Yes	No	Total
Did you or any member of your family participate in watershed management activities?	84	0	84	100	0	100
Do you think that watershed management intervention can be a solution for resource degradation in the watershed?	84	0	84	100	0	100

Source: Own survey, 2021.

This study has also identified different biological and physical soil and water conservation measures practiced in Chenetaly Watershed. From some of them conservation measures are soil bunds, tree planting, terraces, area closure and stone bund. As confirmed by data from household survey, almost all household heads were participated in area closure and terracing works (Table 4). On the other hand, 57.5%, 56% and 4.8% of the respondents confirmed as they were participated in tree planting, soil bund and stone bund constructions, respectively. According to information obtained from FGDs and key informant interview farmers in study area were participated in implementation of different physical and biological soil and water conservation measures such as soil bund, stone bund, trench, terrace, closure of grazing land, crop rotation, mulching, contour plough and agro forestry.

Table 4. Types of watershed management measures implemented in Chenetaly Watershed.

Types of conservation measures implemented in the watershed	Response	
	Frequency	Percent
Area closure	82	97.5
Tracing	84	100.0
Planting trees	48	57.5
Soil bund	47	56.0
Stone bund	4	4.8

Source: Own survey, 2021.



Source: field photo and [9]

Figure 3. a) Agro forestry and b) Farm lands plough with crop residues.

3.3. The Contribution of Watershed Management Intervention on Ecosystems

Watershed management intervention at a given area likely contributes to improve biodiversity and natural environment [3]. The study attempted to identify ecological benefits of

watershed management based on perception of local people. Accordingly, this study found that watershed management intervention at Chenetaly Watershed has brought some important promising results that have significant positive impacts on the ecosystem of the area. Table 5 presents farmers' observation on the benefits obtained from watershed management intervention at Chenetaly Watershed. About 63.1% of the respondents were strongly agreed that watershed management intervention has reduced soil erosion, flood hazards and increased soil fertility and crop productivity in the study area. Similarly, 31.9% of the respondents have observed and agreed on these benefits. In addition to these, 50% of respondents were strongly agreed that watershed management intervention has increased forest cover and firewood availability in the study area. The other 46.4% of respondents have also agreed on positive effect of watershed management on forest cover and firewood availability.

Furthermore, about 33.3% of the sample households strongly agreed that watershed management intervention has increased the availability of pasture for their livestock in the watershed. The other 53.6% of the respondents were agreed that the positive effect of watershed management on pasture availability. Although small in number (8.3%), there were some household heads who disagreed on positive effects of watershed management on pasture availability in the study watershed. As indicated in Table 5, degraded lands were rehabilitated due to implementation of watershed management in Chenetaly Watershed. As an evidence, about 63.1% of household heads strongly agreed on this effect as they have currently used the previously degraded lands for crop cultivation. The other 35.7% of the respondents have also observed and agreed the positive effect of watershed management on degraded lands. Participants in the FGDs and key informant interview assured that before the implementation of watershed management, the ecosystem of this watershed was highly degraded. They mentioned forest reduction, high gully formation and resource degradation are major indicators of watershed. According to these people after the introduction of watershed management program, the ecosystem of this watershed was highly changed because of the conservation works, area closure to rehabilitate degraded lands and planting trees.

Table 5. Farmers' observation on the benefits of watershed management intervention on Ecological systems.

Benefit of watershed management intervention	Response (%)				
	SA	A	N	D	SD
Decrease soil erosion and flood hazards	63.1	36.9	-	-	-
Increase soil fertility and agricultural productivity	63.1	31.9	-	-	-
Increase forest cover and firewood availability	50	46.4	2.4	1.2	-
Increase the availability of grass and other livestock feed resources	33.3	53.6	8.3	4.8	-
Enable to cultivate crop on previously degraded land	63.1	35.7	1.2	-	-

Key: SA=Strongly, A=Agree, N=Neutral, D=disagree, SD=Strongly Disagree.

There were also evidences that the practice of watershed management activities has improved surface and ground water availability. Based on information obtained from key

informant interview about seven natural springs and one perennial river were rehabilitated due to the effect of watershed management practice. Sixteen hand pumps were

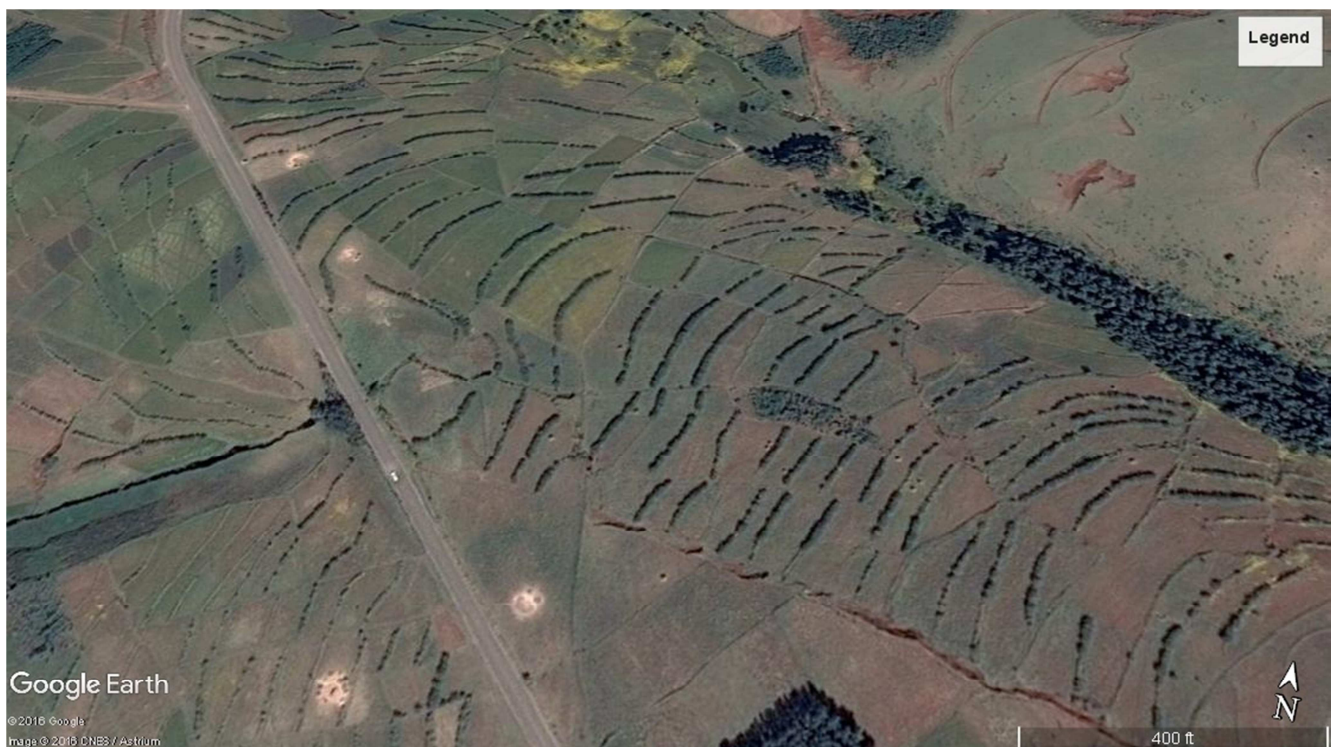
constructed in Chenetaly Watershed as part of watershed development program, and could be indicator of groundwater availability (Table 6). The results of this study is in agreement with [12] who reported, proper land management likely decrease land degradation, keeping and increasing the productive capacity of land in both cropping and grazing

areas and it also sustaining productive forest areas and maintaining the integrity of watershed for water supply. [13] also has identified an improved vegetation cover along hillsides and sloppy areas, reduced high-runoff, controlled gully development and expansion, reduction in soil erosion and siltation due to SWC activities.

Table 6. The contribution of watershed management program on water resources.

Water resources	Number of water resources	
	Before the introduction of watershed management intervention	After the introduction of watershed management intervention
Perennial rivers	1	2
Natural springs	3	10
Hand pump from ground water	1	17

Source: [9].



Source: Google earth satellite image

Figure 4. Satellite map of treated gully and farmland in Chenetaly Watershed.



Source: [9]

Figure 5. Gully treatment activities in Chenetaly Watershed.

4. Conclusions

Watershed based natural resources management has been

implementing as one of the main strategies to enhance ecological balance. Due to this fact the government of Ethiopia in collaboration of NGOs has put huge investment for watershed management activities across the country.

Chenetaly Watershed which is located in Guagusa Shikudad *Woreda* is one of the watersheds where effective watershed management activities have implemented during the last nine years through Sustainable Land Management Project.

Chenetaly Watershed was highly degraded before the introduction of this watershed management program. among some of the main indicators of resource degradation in the watershed were soil erosion, loss of soil fertility and reduced agricultural productivity, gully formation, deforestation, declined groundwater table and surface water resources, shortage of fodder for livestock, flood hazards and loss of biodiversity due to poor management of land, poor agricultural productivity and farming of steep slope areas. To reduce and/or mitigate the observed watershed problems many physical and biological conservation practices like soil bund, trench, terrace, afforestation, area enclosure (protection and management), water conservation, spring development and grazing land management were implemented in the watershed during the last years by the community in collaborate with Sustainable Land Management Project.

Finding of the study indicated that introduction of watershed management has brought some important changes in local ecosystem. Some of the major ecological changes include decrease in soil erosion, increase soil fertility and agricultural productivity, increase forest cover and firewood availability.

5. Recommendations

Based on the findings of the study, this recommendation was drawn for better success of the watershed management intervention and its contribution for ecological balance. Based on result of this study effective watershed management intervention has been undertaken in Chenetaly Watershed such best practices should extend to neighboring watersheds.

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