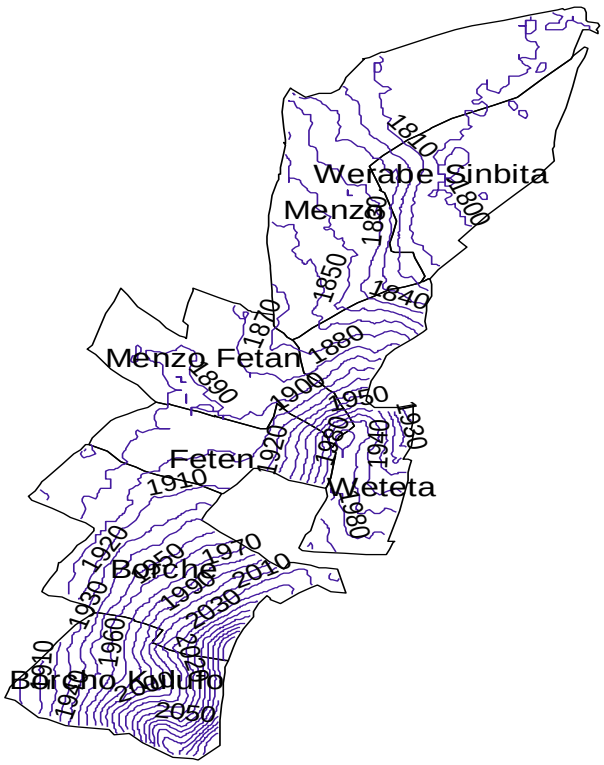
Landscape Management Plan For PIN Kebeles in Sankura Woreda

Kebeles: Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo *Kebeles* of Sankura Woreda



Biophysical and Socio-economic Analysis of the Seven *Kebeles* for LMP Development

Under the Project "Ecological Stability of Dijo and Bilate watershed of Sankura and Halaba Special Woredas"

For PIN

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1. INTRODUCTION

1.1. Land Degradation in Ethiopia and in the Seven Kebeles

Land degradation is the most notable phenomena in Ethiopia and particularly in the study area. Forest coverage is the main indicator of the level of resource degradation. The higher the percentage of land under forest cover, the lower the degree of resource degradation (Kebede, 1970). There is no reliable information on the degree of past or present forest cover in the area. However, located at the central part of the country, the level of deforestation in the seven Kebeles studied cannot be different from the general phenomenon happened in Ethiopia and can be extrapolated from it.

Studies suggest that at the turn of the present century the forest coverage of Ethiopia was about 40% (Thomas, 1991) of its total land area. But, "forest decline has been evident from the facts that forest cover of 16% in 1950s has declined to 3.6% in the early 1980s. Later in 1989, the forest cover was estimated to have reached below 2.7% (Million, 2002). Out of the estimated 60 million ha of agriculturally productive land in Ethiopia, about 27 million ha is experiencing erosion, 14 million ha considered eroded and requiring rehabilitation and 2 million ha considered lost, with an estimated total loss of 2 million m^3 of top soil per year with an average annual soil loss from cultivated lands of 100tons/ha (FAO, 1986).

The inherent dependence of sustained development on the conservation of resources is no yet appreciated, far less acted upon (Constable, 1984). ***In Ethiopia both at the national and farm level plans, strategies and polices are formulated and implemented without due***

consideration to conservation objectives. Soil conservation has not been a goal, nor has any attempt made to integrate and promote conservation as a means of agronomic improvement. Under these circumstances, farmers are unlikely to show much interest in conservation unless it is part of a package of improvements leading to increased output and incomes. Therefore, conservation has to be linked with improving farm productivity to increase incomes from conserving farmlands. Ultimately, peasants have to be convinced that conservation pays and this can only be done through conservation-based development (Constable, 1984).

It has become clear that soil conservation programs need not be separated from agricultural development in order to be effective. Soil is one of the most important resources of a nation. A person depends on the soil for the production of their subsistence's as well as development in other sectors. Ethiopia is an agricultural nation and agriculture alone accounts for almost all of the economy. It is of fundamental importance to protect soil from the menace of soil erosion (Constable, 1984).

Hans Hurni (1987) said that the efforts so far have been "expensively inadequate". He further warns that even if the conservation program continued to expand at a rate of 20% per annum, it would take 50 years to treat the areas, which are prone to erosion. Such efforts would be more effective if the farming system were changed. But it must be changed in a way that is profitable to the farmer's. He states "for conservation to be sustained on the required scale in the Ethiopian, it has to be achieved through increased agricultural production".

Land degradation is a major cause of poverty in Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo Kebeles of

Sankura Woreda. The focus group discussion implicated that, the farming populations have experienced a decline in real income due to soil erosion as a result of demographic, economic, social, and environmental changes. Land degradation is a result of several factors of both physical and socio-economic nature. The immediate consequence of land degradation is reduced crop yield followed by economic decline and social stress. The integrated process of land degradation and increased poverty has been referred as the *"downhill spiral of unsustainability"* leading to the "poverty trap" (Greenland et al., 1994).

Soil erosion is one facet of land degradation that affects the physical and chemical properties of soils. The physical parameters are primarily loss of land, shrinkage of farm size, reduction of organic matter content, destruction of the soil structure, change in bulk density, infiltration rate, rooting depth, and water-holding capacity of the soil. Changes in chemical parameters are largely a function of changes in physical composition. The consequence of topsoil erosion on soil productivity depends on the depth and quality of the topsoil relative to the subsoil. In all the Kebeles flowing towards Bilate River (Bercho Kulufo, Bercho and western tip of Feten) where the topsoil is highly eroded and the organic matter content is initially low, surface erosion exhibited a higher impact on the community in terms of yield reduction and decline in land productivity.

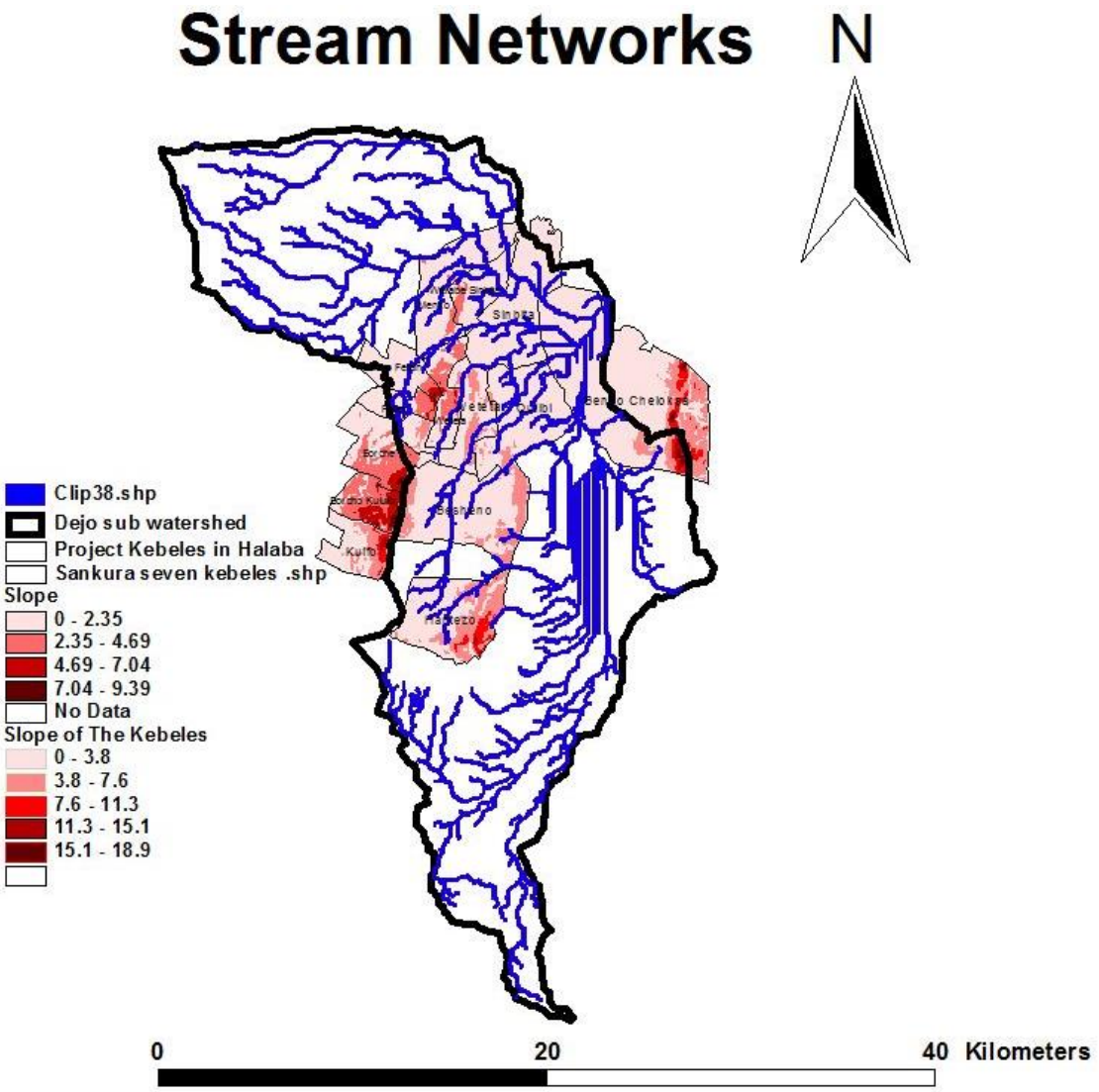


Figure 1. The study areas in Dijo watershed

1.2. Soil Conservation Activities in Sankura Woreda

Since land degradation attracted increasing awareness during the 1980's, many projects have contributed a lot in the in the area of soil conservation during their operational times, especially in physical structures in the Woreda. Different types of soil and water conservation measures were introduced to the seven Kebeles, such as soil bund, fanya

juu terrace, microbasin, check dams, waterways and cutoff drains. They were introduced with the objective of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production /availability/. Implementation of all soil and water conservation structures in the area was limited to dry seasons so as not to interfere with crop production and avoid difficulty of the work that arise from wetness of soil. Based on the land use system in which they were working with, soil and water conservation techniques introduced to the area were described in the base map and development map of the Kebeles. Their detailed descriptions were available in Annex 1 to 3.

1.3.The Demand for a Paradigm Shift

Currently, a paradigm shift took place from projects dealing mainly with physical and chemical aspects of degradation towards integration of a broader range of disciplines. The pre-1980 period was largely dominated by a "technical-fix approach", where a physical problem was identified and a physical solution prescribed (Stocking, 1992). The former Natural Resources Development and Environmental Protection Office in the area attempted to integrate different aspects of land degradation and rehabilitation. The terms used to identify problems and solutions have varied through "conservation", "desertification", "drought control", "agroforestry", "sustainable agriculture", "on-farm adaptive research" and so forth. Soil conservation activities had been implemented for the past 25 years to facilitate optimum level of production from a given area of land while keeping soil loss below a critical value. With all these years effort, however, the problem of soil degradation is the top challenge of the area know and the years to come.

1.4. Biophysical Attributes and Biophysical Soil Conservation Measures

The effect of a conservation measure in reducing soil loss generally varies with soil type, topography, climate and intensity of the measure, e.g., the distance between terraces or density of vegetation cover. Mitchell (1986) gives equations that can be used to calculate the required terrace spacing when the natural conditions and the required protection factor are known.

Indigenous soil and water conservation techniques can be divided into "ethno-engineering", agroforestry and agronomic practices. Quite frequently, a combination of these practices exists in the target Kebeles. The term "ethno-engineering" covers indigenous practices such as terracing, harnessing of runoff, and development of small drainage systems. The potential of these indigenous soil and water conservation practices have very often been ignored or underestimated by practitioners, soil conservationists and government staff (IFAD, 1992).

1.5. Benefits of Soil Conservation: Experiences in Ethiopia

Soil Fertility Improvement

There is no any study conducted to assess the effects of soil conservation on soil fertility in Sankura Woreda. Weigel (1986b) determined some physical and chemical characteristics of soils from the soil loss zone directly below contour bunds and the soil accumulation zone above the contour bunds in Amhara Regional State, Wello area. The concentration of plant available phosphorus was higher in the soil accumulation zone than in the soil loss zone down to 50 cm depth.

Terraced and none terraced land (up-slope) in the Hagere Selam uplands in Tigray Regional State was compared Vagen (1996). Surface soils from terrace benches and the soil loss zone of terraces had the highest clay contents, while soils from non-terraced land were more sandy. Cation exchange capacity and base saturation were high for all soil groups due to the influence of mafic/basic volcanic rocks in the area. Organic carbon and total nitrogen contents were very low for all soil groups, but slightly higher in soils from non-terraced land. The experimental design did not, unfortunately, permit a separation of the impacts of slope position, soil erosion and deposition, and agricultural history on soil fertility.

Non-terraced areas, which were located only on the concave upper part of the slopes, had been cleared much later than the terraced areas, leaving less time for depletion of organic matter and consequently nitrogen. Soils from terrace benches had higher concentrations of available P than soils from the soil loss zone of terraces and from non-terraced land. There were some variations, however, between plots with bean and wheat with respect to differences in concentrations of available P between soil groups. Phosphorus is normally strongly bonded to soil particles and are therefore easily transported down slope during erosion, giving higher concentrations of available P in the soil accumulation zone of terraces. The terraces were only 4 years old or younger. More time will probably lead to greater differences in available P between soil groups due to prolonged erosion, particularly between non-terraced land and soil accumulation zones on terraces.

Crop yield

The benefits of terracing on crop yields vary with the degree of degradation before terraces are built. The beneficial effect may be limited

to a prevention of further erosion or a slow but persistent increase in soil fertility. In either case, the relative increase in crop production may not be obvious to farmers.

Yohannes (1989) compared barley crop and biomass yields above the bund (soil accumulation area) and below the bund (soil loss area) of fanya juu terraces in the Andit Tid area of northern Shoa during three cropping seasons from 1986 to 1987. The average barley yield was 1650 kg ha-1 above the bund, which was 43 % higher than below the bund.

Prevention of runoff through tied ridging led to marked increases in sorghum and maize yields in the Harerghe highlands. Maize showed highest yield increase due to its sensitivity to moisture stress. Sorghum, on the other hand, is more drought-tolerant and did not show the same response as maize. Gebre Egziabher (1988) found that soil bunds are effective in controlling soil erosion in a study from the Gununo watershed, Sidamo Research Unit of Southern Ethiopia. Yields of maize were found to be higher in the soil accumulation zone (above bunds) than in the soil loss zone (below bunds). This is consistent with findings by Weigel (1986a).

Tilahun (1996) estimated yields of wheat and *faba bean* grown on soil accumulation and soil erosion segments of terraces and on un-terraced (upslope) areas in Tigray Regional State. Yields were highest at the accumulation zone of terraces. Yields of wheat correlated positively with both silt contents and available P concentrations (Vagen, 1996). The positive correlation between yield and silt content in plots with wheat probably reflects the influence of silt on the moisture holding characteristics of the otherwise sandy soils. Available P seems to explain parts of the variability in yields between the soil groups, but is mainly a

group effect since the available P contents and yields are higher on the terrace benches.

1.6. Farmers Perception on Land Degradation and Soil Conservation in the Seven Kebeles

Although an understanding of the physical erosion phenomena is important for the formulation of erosion control plans, it is also vital to understand social relations influencing management choices. Traditional land resource utilization in many areas has followed an exploitative sequence consisting of clearing _ cultivation _ erosion _ abandonment (Kuru, 1986). This unsustainable farming practice is linked to a lack of choice due to poverty rather than linked to neglect. Interviews with farmers in Sankura Woreda verify that they are, in fact, concerned about the degradation of their land. However, there is apparently a widespread apathy due to the fact that they are living barely on a subsistence level. They do not have the economic or labor capacity to implement necessary conservation measures. In some cases farmers are aware that some of their actions are actually damaging the land, but the immediate benefits of these actions seem more important than long-term degradation.

The current survey indicated that farmers were aware of the problems of land degradation. Erosion was identified as the main cause for land degradation, followed by drought, deforestation, rainfall, and improper farming practices. According to the farmers, the effects of land degradation were famine, drought, reduced yield, and poverty.

Soil and water conservation activities undertaken by farmers prior to the food-for-work projects were mainly construction of drainage canals and ditches as well as soil bunds. Farmers also practiced fallowing, mulching

and crop rotation. Among the food-for-work activities, soil bunds, hillside terraces, reforestation, and fannya Juu were considered by farmers to be the most effective for soil and water conservation. An aggregation of the focus group discussion (a total of 91 participants in the seven Kebeles) showed that, 67 % of the farmers were of the opinion that soil bunds increase yields, 13 % responded that there is no change, 4 % did not know, and 16 % did not construct bunds or terraces at all.

From 49 farmers, 7 randomly met and interviewed on their farm from each Kebele on average showed that they and their families had participated in soil and water conservation implemented by campaign programs during the time of community mobilization. The individual time spent annually on such work effective 15 days with an average of 120 person-days per family. The conservation work done through the campaign was mainly building of terraces and check dams. Only 47 % of the farmers constructed soil conservation structures on their own, mainly graded bunds and traditional water ways. Some farmers also made check dams in order to control small gullies on their farm land. Most farmers were positive to building conservation structures, and 73 % said that soil and water conservation in-vestments were profitable. Seventy eight percent of the farmers were of the opinion that conservation practices led to increased yields in normal years. They were mostly in favor of building drainage structures on their own, but lacked the necessary material and labor.

The farmers in each studied Kebele (see the base map and development map of each Kebele) classified their Kebele into different groups according to degree of erosion. Most plots with well managed terraces (they area about 20% of the total farm lands assessed during transect

walk) were observed as having less soil erosion after the conservation structures were built.

Figure 2. Well managed terrace in Menzo Kebele, Sankura Wereda

The farmers were also asked what they perceived as the most important causes and effects of soil erosion. Deforestation and over-cultivation were rated as the most important causes in all Kebeles. Reduced productivity was by far the most frequently reported effect of erosion. According to the farmers, the most serious disadvantages of terraces include; (1) harboring rodents, (2) causing water logging, (3) making land preparation difficult, and (4) loss of land for terrace construction.

During the focus group discussion and key informant interview session, the farmers were also asked for the main reason for the failure of most soil and water conservation interventions in their area. DA's and Woreda staffs were also involved in the survey. According to their importance,

they perceive that the following are the main causes that soil and water conservation interventions failed to attain their objectives:

1. The structural interventions require high labor inputs and long term outcomes whereas farmers see the short term benefits and thus lack motivation;

2. The interventions were large scale and centralized that neglected the participatory approach;

3. Socio-economic factors and tangible benefits which attracted poor farmers (food for work activity considered as an income rather than an incentive for good performance);

4. It is top down approach and absence of demonstrable changes to the day-to-day lives of farmers;

5. Erosion prevention is seen as an end in itself and its effects on agricultural production is usually overlooked;

6. Lack of integration in addressing the problems on the ground;

7. The technologies focused narrowly on arresting soil erosion without fully considering the underlying causes and were following blanket recommendations;

8. Appreciation of indigenous knowledge is overlooked.

1.7. Traditional Soil conservation Practices in the Seven Kebeles

The objectives of traditional practices give us an understanding of farmers' way of thinking (Hudson, 1992). The aim of farmers does not necessarily correspond with the aim of the Woreda staff. Some practices

are simply good farming practices that happen to reduce soil erosion. At other times, conservation practices are applied where there is no recognition of erosion as a reducer of yields, but they are used for other purposes (Hallsworth, 1987).

Erosion is a natural process (Kebede, 1970). Being a natural process, farmers in the seven Kebeles studied were trying to minimize it mainly by vegetative cover, which is nature's way of controlling soil erosion. The indiscriminate human interference and the mismanagement of the soil, however, disturb this equilibrium and accelerated erosion occurs wherever proper precautions are not taken. This may be due to ignorance of consequences, indifference in favor of short-term gains or basic survival needs of their family and livestock. Examples of this interference include indiscriminate clearing of forests around Werabe Sinbita (Alemayehu Forest clearance for agriculture purpose) , excessive or incorrect cultivation (Weteta, Bercho, Bercho Kulufo and Menzo Feten Kebeles), persistent overstocking and open grazing observed in all Kebeles. Thus, the natural vegetation is removed and/or cultivation occurs on steep slopes one most naturally expect the soil to be washed during heavy storms***. It is observed that soil erosion problem in all the Kebeles observed, as any other places in the Woreda, is entirely man caused***. The solution to the various problems connected with soil erosion has, therefore, to be viewed from a human rather than an entirely technical perspective. In the area where human and animal population pressure on land is intense and where standards of living are low, it is difficult to promote "erosion" control programmes only. ***What the people need foremost is economic security before they can give attention to ecological problems (FAO, 1986)***.

2. OBJECTIVES

The general objective of this Landscape Management Plan (LMP) is to transform the current land degradation scenario of *Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho,* and *Bercho Kulfo Kebeles* of Sankura Woreda into a model sustainable agricultural site through preserving the ecological stability of Dijo and Bilate watershed of Sankura Woreda. The specific objectives of the LMP are:

- Development of a spatial framework containing the major functions/facilities, land use/cover, infrastructure networks, the green frame (including plant species) being the governing component in the plan;
- Assessment of the ecological dynamics in the overall area, function in the watershed
- Identification of degraded areas, source areas (upper catchment) and flood/silt prone areas
- Suggestion of solutions and projected goals in the landscape management in short-term (3 years) and mid-term horizon (10 years);
- Designing an implementation strategy that specifies the phasing, actors, resource requirements and institutional as well as legal aspects of the implementation process.

For each of the seven Kebeles in Sankura Woreda.

3. SCOPE OF THE LAND MANAGEMENT PLAN

This study involved both spatial and thematic scopes. The spatial scope of the study and planning task included Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo Kebeles of Sankura Woreda and their immediate environs.

Thematic scope of the study included the following issues in detail. Detail analysis of the Kebele's natural characteristics/setting (altitude, topographic configuration including slope, land cover, soil & rock, vegetation cover, gully , drainage etc.), development potential and constraints, identification of land degradation issues, socio-economic profile; and preparation of feasible landscape development plan and designing of full-fledged biophysical interventions as well as implementation strategies.

4. APPROACHES AND METHODOLOGY

4.1. Approaches

In this kind of specified study, it is important to apply the most widely used and contemporary planning approaches such as participatory, integrated and sustainable planning approaches. All stakeholders have been participated and contributed their parts in the plan making process of this plan. The participation of all concerned stakeholders would help to facilitate the implementation of all development proposals. Integrated development approach is a must as the development plan preparation involves multi-dimensional issues by its nature. Therefore, special emphasis has been given to make sure that different issues and spatial units are integrated to each other so as to bring about comprehensive, holistic and mutually re-enforced development outcomes.

Sustainability approach is important in the landscape development plan for the purpose of viewing development projects from nature friendly, public acceptance and feasibility stand points. Therefore, due emphasis/consideration have been given in planning and designing of the LMP for the ecological stability of Dijo and Bilate watershed of Sankura Woreda to enhance the agricultural potential of the Kebeles with special care in maintaining the natural elements of their ecosystem and its surroundings.

4.2. The Study Area

The seven Kebeles are found in Sankura Wereda of Silty zone, SNNPR state in Ethiopia, Easting between 407,000 m to 418,000 and Northing of

832,000 to 839,000 m . They are located approximately 97 kms from Hawassa City, the capital of SNNPR in the North East direction. The total area of the seven Kebeles are about 5165 hactars of which nearly 5% is affected by gullies.

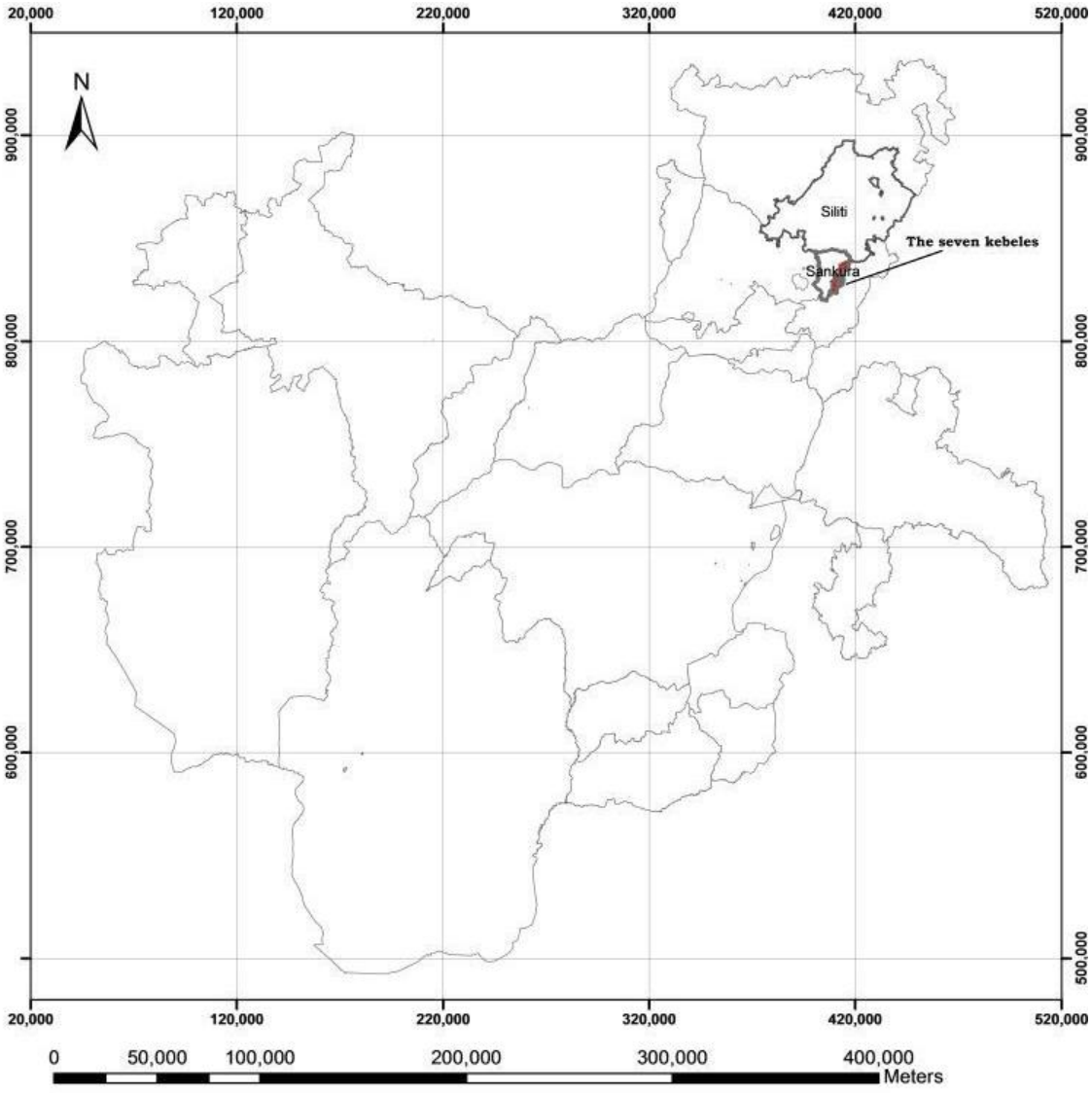


Figure 3. The study area in SNNPR State

Even though, no detailed soil surveys have been carried out in the area, the wide diversity in climate, topography and vegetation cover in the study area has given rise to marked variations in soils, even within relatively small area.

The soils of this area are highly susceptible to erosion with gradually declining productivity. Whereas the soils of flat slopes are grayish to dark with leaning to water-logging during rainy seasons, yet less susceptibility to erosion. Thus, management of the soils of the area is likely dependent on soil types, fertility, slope, workability, water holding capacity, and susceptibility to erosion.

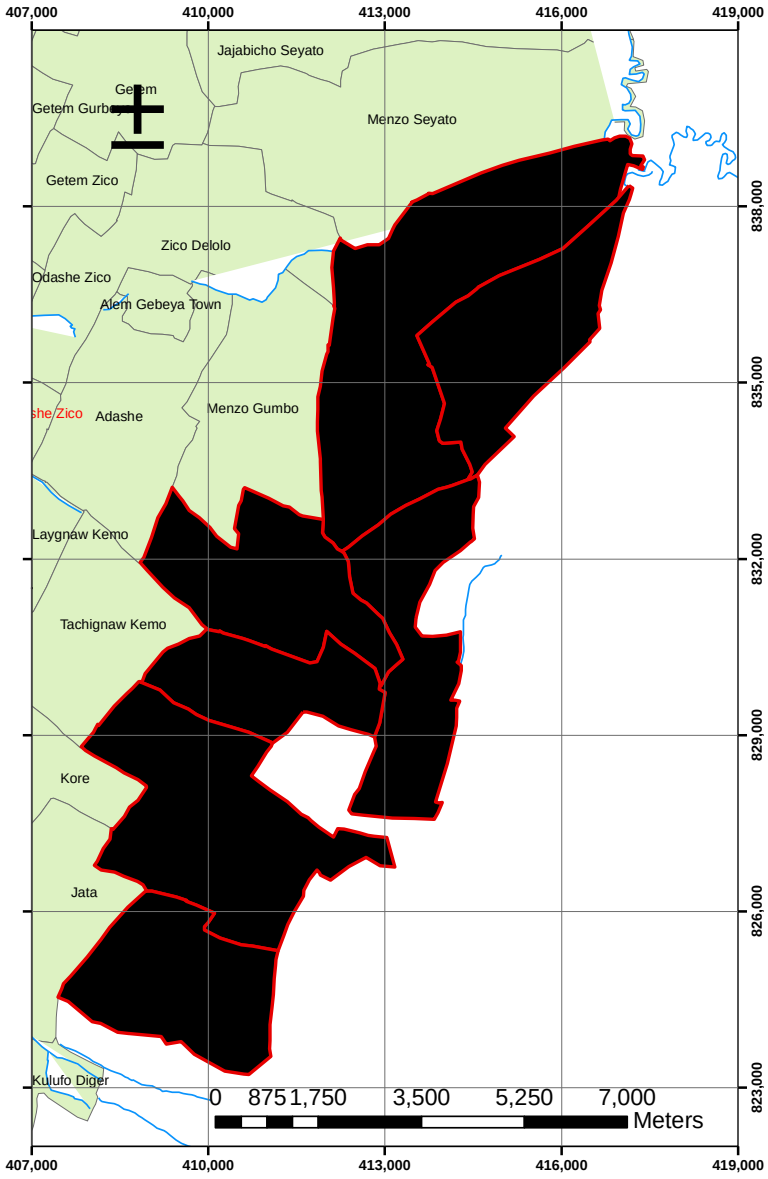


Figure 4. The study area inside Sankura Woreda

4.3. Methodology

Understanding the assignment and goals intended to be achieved; and then decide on coherent approaches, develop the methodology on how to carry out the assignments is the crucial step in the planning processes.

This methodology in general shows how the current assignment have been approached for the development plan preparation tasks practically from the very start to the making of desired and agreed outputs. It comprises the overall details of logical procedures followed by employing variety of methods for different components of the study to produce the expected outputs. The study involved both qualitative and quantitative data collection, analysis and presentations methods.

Pre-data Collection

After the client handed over the sites and all important data at hand, clear understanding was created between the two parties about the projects. Hence, Kebele wide Base Maps, geo-referenced raster and vector data, socio-economic and secondary data were acquired from the PIN office in Hawassa and Halaba. Having all the necessary information, the next steps were to commence the actual tasks in the following procedures.

Base Map Updating

The seven Kebeles are found in SNNPR, in Silti Zone, Sankura Wereda, South of Addis Ababa. To update the base map, DEM analysis and ground surveying was conducted and contours are generated. The exact location of man-made and natural features are also identified on the site that have been done during the base map development activity together with the community. Having an initial full-fledged base map, the next step were site observation and field survey.

Data Collection Methods

Primary Data Collection

i. **Socioeconomic data:** Socioeconomic data were collected by DA's in each Kebele using structured questioners in three major categories:

- Socioeconomic information of farmer resident households,
- Information on domestic and farmland resources owned and
- Information on land acquisition and housing conditions.

The Socioeconomic data include: household structure (size, sex, religion), employment, income, etc.., and others. The coverage was adequate enough to generalize the socioeconomic characteristics of the resident population in each Kebele.

ii. Physical and Environmental Data collection:

The physical and environmental data were collected based on the prepared base map of the project site which gives basic information on both man-made and natural elements on the ground. Man-mad elements include the location and characteristics of farm lands, degraded areas, access roads, social and technical infrastructures, planted and natural vegetation etc. In general existing land use was identified on the base map. Natural features that cover the location of endogenous trees, rocky areas, soil type, exposed areas/bare lands, environmental sensitive areas etc. were identified and mapped. The existing urban activities and land uses in the vicinity of the Kebele were assessed and mapped to integrate with the upcoming development of the Kebele.

During physical data collection, field measurements, frequent observations, photographing and filming were involved. Consequently, the above collected physical information was updated in GIS database which ultimately led to the production of the development map.

Secondary data

Secondary data sources such as policy documents; regulations, proclamations, manuals, cultural elements, and other relevant literatures on Landscape development have been reviewed, valid lessons were drawn and considered in the preparation of the plan.

Data Analysis and Presentation

To analyse and present the socio-economic and physical data, various tools were utilized. The socio-economic data were encoded and analysed using spreadsheet tool and presented using tables, graphs and texts. The physical data were analysed using GIS and Remote sensing technologies and presented using maps, diagrams and drawings. All outputs of the components of the study were organized together for LMP development for each Kebele and presented in the next section for each Kebele.

5. RESULTS: SITUATION ANALYSIS AND LMP

Situation analysis and development map preparation were prepared and presented for each of the Kebele in the following sections.

5.1.Worabe Sinbita Kebele

General

Worabe Sinbita Kebele is situated in Silti Zone of SNNP Regional State, Easting between 413,500 m to 417,500 and Northing of 833,400 to 838,000 m covering an area of 1138.25 ha of which 10 hectares of arable land is highly degraded. For Land Management Planning purpose the Kebele is structured by 3 development clusters of having about 33% of the total land for each.

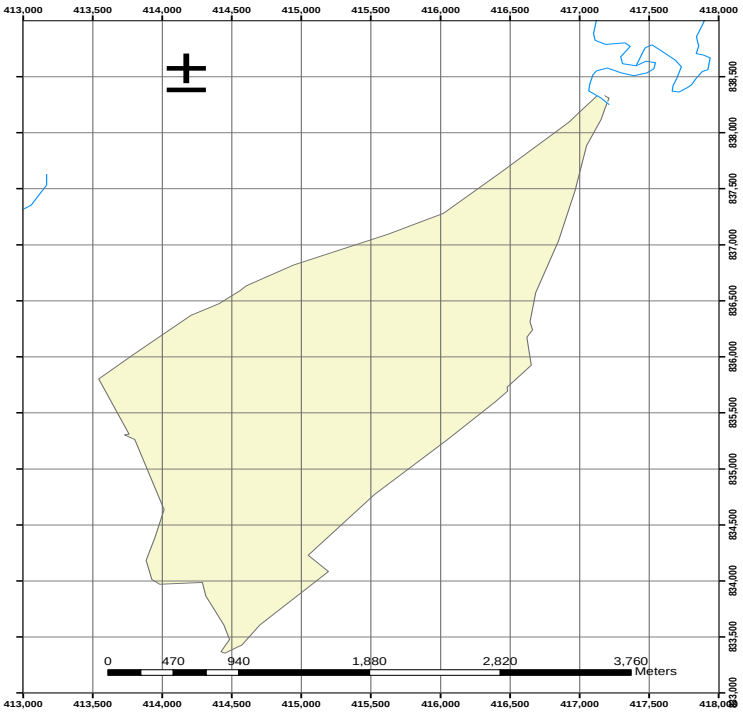


Figure 5. Political boundary of Worabe Sinbita Kebele

The Kebele is bordered on the East by Halaba Special Woreda on the West and North by Menzo Kebele and on the South Weteta Kebele.

Basic Infrastructure

1.Water supply

There are 139 hand dug wells, one pond and 86 water harvesting troughs are found in the Kebele. These water supply schemes provide water for both livestock and human consumption purpose. The hand dug wells are mainly used for irrigation purposes. However improved water supply for domestic consumption is one of the major problems of the Kebele.

2.Health

One health center for humans and one veterinary medicine center for livestock is found in the Kebele. According to the Kebele health workers report the Kebele latrine coverage for the year 2016 was 95%, which does not indicate the whole aspects of sanitation. The majority of the households have latrine for their family. Those households who have no latrine at their backyard use open field, bush and backyard defecation that is the main source for pollution of unprotected water source and main source for transmission of diseases.

3.Education

There is one first cycle (1-4) school at the center of the Kebele to give teaching -learning service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 7.5 kms away from the Alem Gebeya town.

Demographic overview

According to the information obtained from the Kebele administration office the total population of the Kebele for the year 2016 was about 1748 out of this the males are 869 (49.7%) while the females are 879(51.3%). There are various community based organization in the Kebele such as *"Equb"* and *"Edir"* to help each other in terms of social and economic aspects. Two types of "Edir" namely "higher Edir" for the purpose of solving major social issues of the members. "Lower Edir" participate for organizing funereal services in the Kebele. In addition with other social duties, "Higher Edir" participates on agricultural inputs distribution in the Kebele.

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

Agriculture (farming as well as livestock rearing) is the main stay of the Kebele's population. The major crops in the Kebele are cereals (maize,

wheat barley, sorghum), pulses (beans, peas, and chick peas), root crops, pepper (green and red pepper), vegetables and fruits. Maize is the main food crops. The Kebele specializes in the production of red and it is the major pepper surplus producing areas from the region. Very few households depend on trade activity for their livelihood. Pump irrigation is practiced on 78 ha of land during the off seasons. Onion, cabbage and tomato are the major vegetables on irrigated fields.

Biophysical Conditions

1.Soil

Majority of the farm lands have vitric andosols mainly composed of very fine textured sandy loam soil easily affected by both wind and water erosion. The minimum soil depth is 3 cm observed at the Western boundary of the Kebele with Menzo Kebele and a maximum of 86 cm at the boundary between Halaba Special Woreda. Significant proportion of the top soil also covered with very fertile luvisols transported and deposited on the low lying areas of the Kebele where majority of irrigated agriculture is practiced.

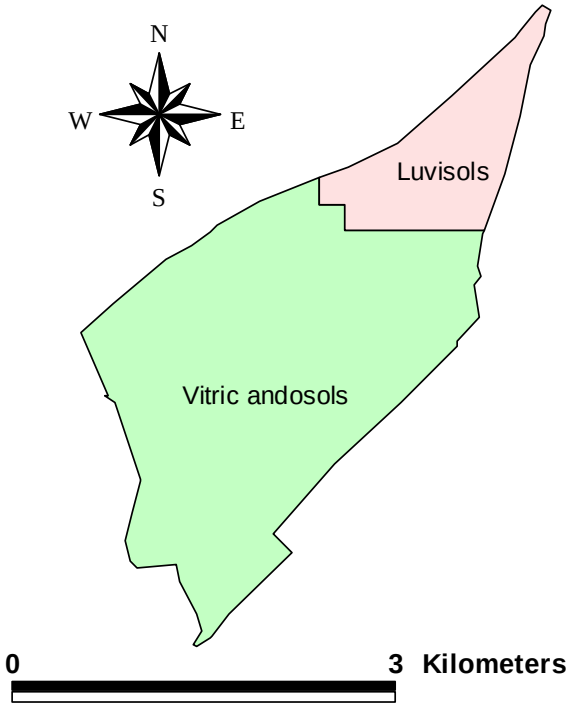


Figure 6. Soil Map of Worabe Sinbita Kebele

2.*Land use/land cover and settlement*

Majority of the land is used for agriculture. The land cover in the Kebele is dominated by scattered trees and shrubs which are found around the homesteads and cemeteries. Small patches of shrubs, trees, and grasses are observed on farmlands. The vegetation in the area has been categorized under the semi-humid woodland with a mixture of broad and narrow-leaved species. *Accasia abyssinica*, eucalyptus tree, *Acacia tortolis* and *Accasia albida*, are the dominant tree types on off farm plots. Deforestation mainly for the purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.

Acacia abyssinica

Acacia tortolis

Figure 7. Tree species adaptable to Worabe Sinbita Kebele

On the hills, the vegetation is extremely threatened because of grazing and fuel wood extraction.

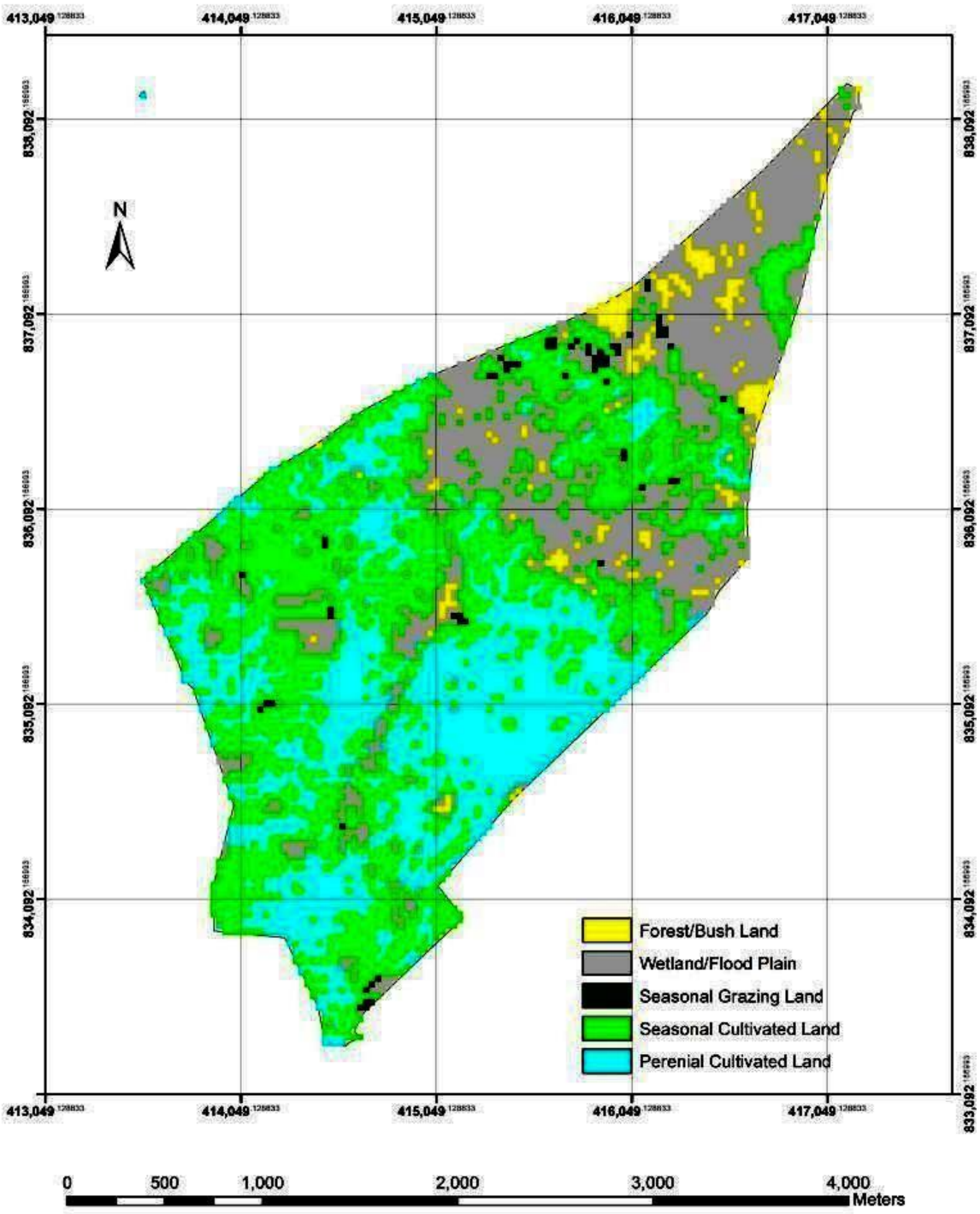


Figure 8. Land use Map of Worabe Sinbita Kebele

Table 1. Land use of Worabe Sinbita Kebele

Land use	Area (ha)
Arable land	751.5
Grazing land	200
Forest	165
Degraded land	10
Infrastructures	11.75

3. Slope

Directly or indirectly; slope contributes to the formation of gully in the study area and consequently facilitate its formation to a very large extent as it affect the current and speed of running water. Erosion may also occur even on gentle topography because of poor infiltration and inadequate storage of surface water due to surface crusting of cultivated fields. The maximum slope of the Kebele is less than 5%. However, due to poor land cover and wrong tillage practices, this gradient facilitated soil erosion and gully formations. The soil is very fragile and week to cope with the smallest errrosive runoff current coming during the rainy season.

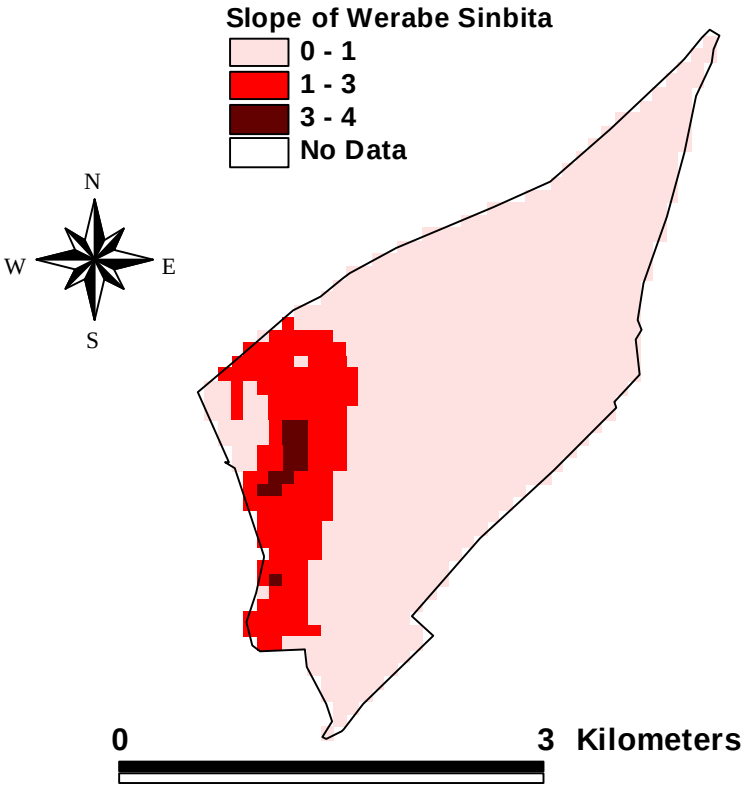


Figure 9. Gradient of Worabe Sinbita Kebele

Runoff on low slopes flows slowly and quickly forms a water layer deep enough to act as surface mulch. Increasing slope length enhances soil loss as more runoff can accumulate on long slopes.

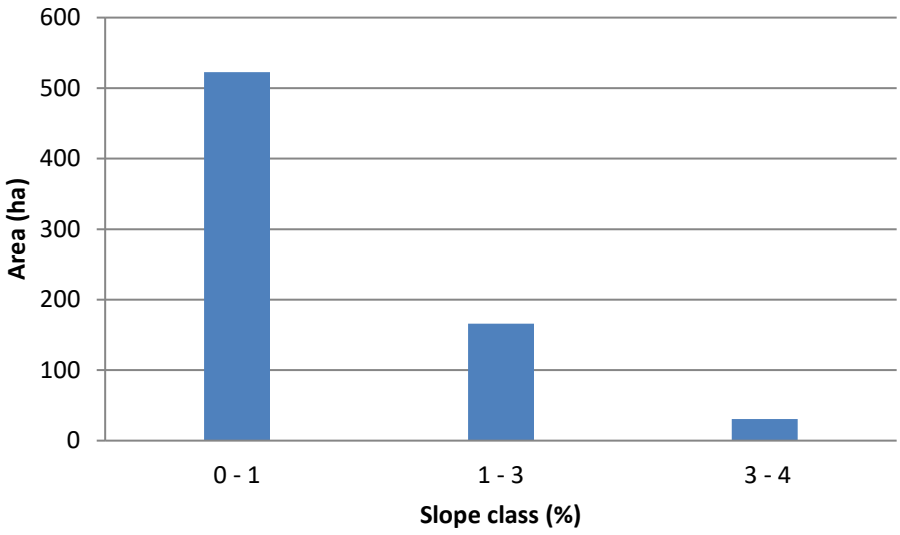


Figure 10. Slope class of Worabe Sinbita Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 1835 and 1795 meters above sea level. The flow is from South West to North East direction. Together with the flood coming from Menzo Kebele, South West part of the Kebele is the source of erosion and North East is a place of sedimentation. North East part of the Kebele, specifically, all locations downstream direction of the first cycle school is affected by flooding at least for five months every year.

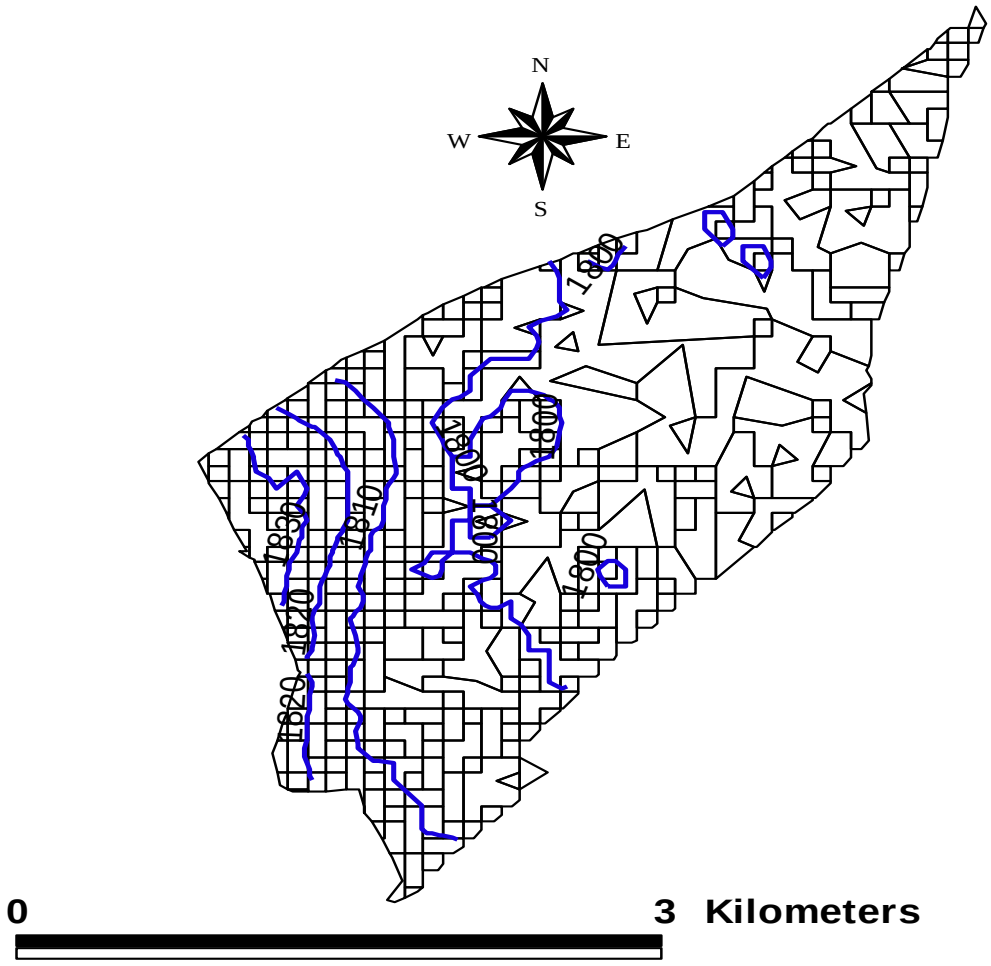


Figure 11. Contour Map of Worabe Sinbita Kebele

5.Gully distribution

Majority of the gullies in the Kebele is originated from Menzo and Weteta Kebeles. About 6.41% (46.17 ha) of the Kebele is threatened by gully erosion. The relatively steep slopes in the Northern part of the Kebele enhance gully processes, accelerate sediment transfer from uplands to bottoms, and generate overflowing of heavily loaded floods, and silting up

of farm lands downstream. It resulted in the loss of fertile soil from cultivation land and damage to agricultural land and agricultural infrastructure too.

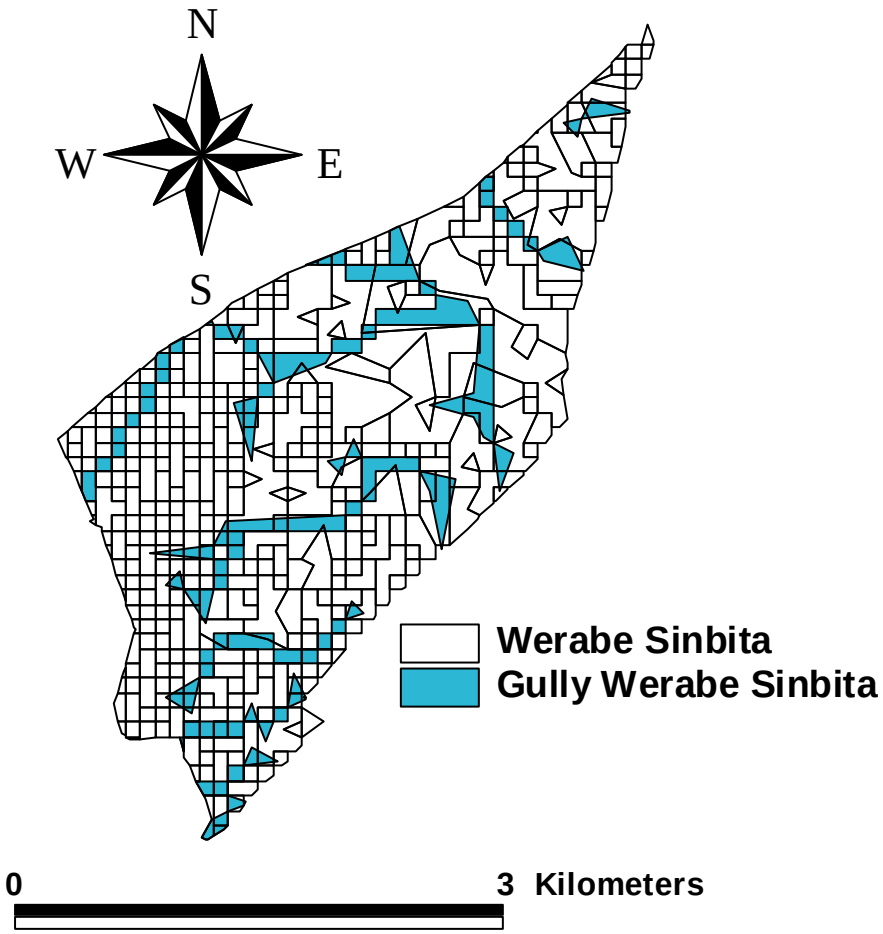


Figure 12. Gully map of Worabe Sinbita Kebele

Among five sets of gullies, about 3 km of them, namely Worabe and Darimo demands immediate intervention to rehabilitate there progressive development.

Table 2. Major gullies that demand immediate interventions

Name of gullies	Width In meter	Depth In meter	Length In km	Direction from center of Kebele
Worabe	3	3	1.5	South
Darimo	3	3	1.5	South East

6.Base Map of the Kebele

The way how the community perceive their Kebele is presented below.

Even though, there is transcription and scaling errors, they showed clearly the main social and technical infrastructure including the degraded area and land rehabilitation activities in the Kebele.

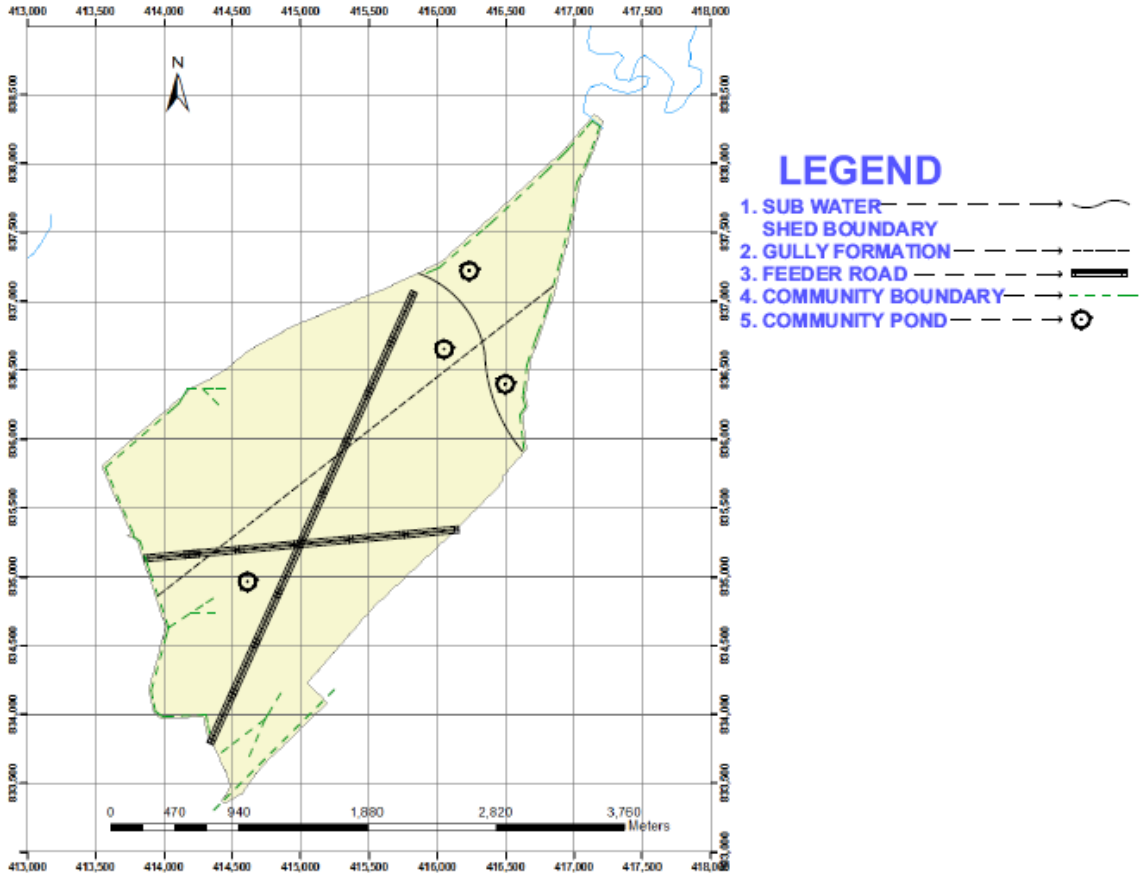


Figure 13. Base map of Worabe Sinbita Kebele

7.Development Map of the Kebele

Seasonal flooding is the major treat in the Kebele. The focus of the development map presented below is to protect low lying areas in the Kebele from seasonal flooding and develop all the delineated area as important soil and water conservation intervention sites in the Kebele. Conceptually the map is developed by the farmers with an implication of the need for forest cover, landscaping of the hill slope areas and creating productive options for highly flood prone places with irrigated agriculture with the use of shallow ground water created after flooding in the low lying areas.

More than 124 households are practicing surface pump irrigation system in the Kebele. The water use efficiency of the system is poor. It demands urgent interventions through training and field visit to improve their water use efficiency.

The areas of higher slope on the hill sides (3% and above) are proposed to be covered by forest which is helpful to erosion and land degradation. The total area of this land use is about 32 hectares and includes the already forest and bushes covered areas and areas to proposed to be afforested. The forestation process needs avoiding the species which are of weeds character and also exotic and planting the indigenous trees. The selection of the trees should be in consideration of the erosion protection and dense growths. In addition, the major gullies (drainage lines) will be rehabilitated and channel the storm water from upstream Kebeles safely disposed to Dijo River.

The other type of forest proposed (in and around Alemayehu Forest) on the area reserved for medicinal plants development purposes. The area is located on the northern side of the Kebele and has an area of about 28.7 hectares. This forest area is expected to be filled with medicinal plant species and used by the community.

The zoological park is the other larger land use proposed on the Northern part of the forest land area which took an area of about 130 hectares. This is a completely new type of land uses for the area and highly important for the required forest protection and eco-tourism purpose. The location proximity advantage of the Kebele shall be used as an alternative income generation for the poor member of the community with this eco-tourism attractions. During the focus group discussion session, farmers claimed the presence of diverse wild life in the forest near Dijo River. Advertisement of the area can create attraction and minimizes the influence of humanity on the existing small patch of wood lands in the Kebele. It is proposed to be subdivided to accommodate different wild life species. The area is also organized so that viewers can watch the animals at close distance while they are coming to the artificially constructed water supply area located along side of the viewer platform.

Different interventions were also suggested/recommended based on the level of soil degradation, slope, land use and farmers experience. The following list presents those interventions that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains, water ways

Soil fertility management:

- Composting

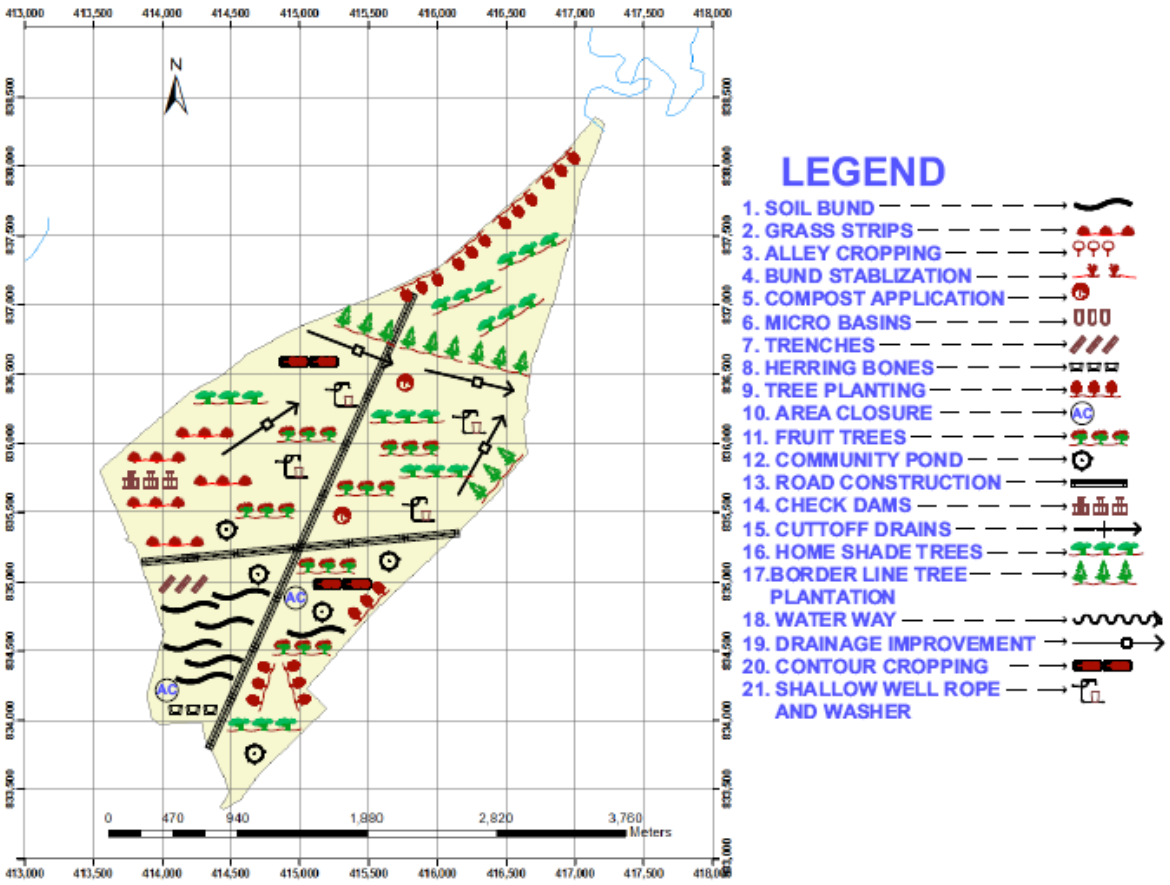


Figure 14. Development map of Worabe Sinbita Kebele

5.2. Menzo Kebele

General

Menzo Kebele is situated in Silti Zone of SNNP Regional State covering an area of 843.65 ha of which 12 hectares are highly degraded.

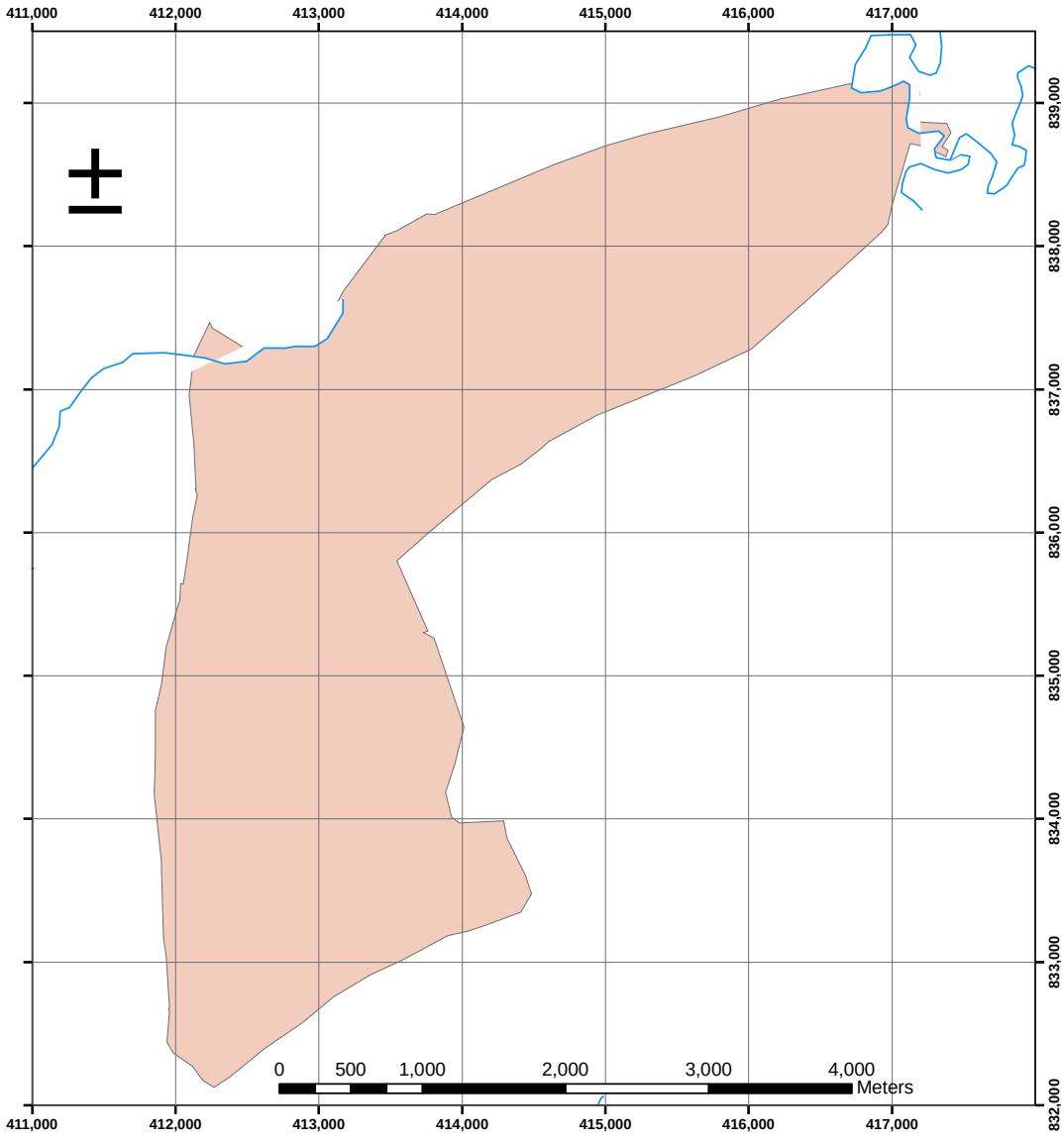


Figure 15. Political map of Menzo Kebele

Geographically, the area is situated at an Easting between 411,500 m to 417,500 and Northing of 832,200 to 839,500 m.

The Kebele is bordered on the East by Werabe Sinbita Kebele, on the West by Menzo Gumbo and Zico Delolo Kebeles, on the North by Menzo Seyato Kebele; and on the South with Weteta Kebele.

Basic Infrastructure

1.Water supply

Even though, there is clean water supply water points found in the Kebele, the coverage is very poor. Still the Kebele is categorized among the non water sufficient Kebeles of the wereda. Each village have water harvesting structures of different scales. They are mainly used for cattle drinking purpose. Roof water harvesting is not yet practiced in the Kebele due to lack of awareness of the technology. Few hand dug wells are found in the Kebele mainly used for cattle drinking and irrigation purposes. Generally improved water supply for domestic consumption is one of the major problems of the Kebele.

2.Health

A health center for humans and a veterinary medicine center for cattle are found in the Kebele located inside the compound of the FTC. According to the Kebele health worker, hygiene and sanitation coverage is significantly higher that other surrounding Kebeles. The majority of the households have latrine for their family.

3.Education

There is one first cycle (1-4) school at the center of the Kebele to give the service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 6 kms away from Alem Gebeya town.

Demographic overview

According to the information obtained from the Kebele administration office the total population of the Kebele for the year 2016 was about 3637 out of this the males are 1982 (54.5%) while the females are 1655(45.5%). *"Equb"* and *"Edir"* are some of the community based organizations found in the Kebele. Women support groups are common in the Kebele. They support each other on social and economic issues among themselves.

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

The dominant economic activity in the study area is crop production integrated with livestock rearing. A wide variety of crops are grown in the

Kebele. However, crop production is at subsistence level. The major factors responsible for the low productivity are increase in population growth, land scarcity, loss of soil fertility and erosion problem, shortage of farm oxen, lack of agricultural inputs, occurrence of drought, erratic nature of rainfall and pest occurrence. The major crops growing the area includes maize, wheat, barley, sorghum, finger millet, beans and peas. Pepper is the main cash crop in the Kebele

Biophysical Conditions

1.Soil

Majority of the farm lands have vitric andosols mainly composed of very fine textured sandy loam soil easily affected by both wind and water erosion. The minimum soil depth is 20 cm observed at the central and southern part of the Kebele as well as at the boundary of the Kebele with Werabe Sinbita Kebele and a maximum of 8O cm at the Northern part of the Kebele. The dominant soil texture is sandy loam. However small patches of rocky texture observed on South Eastern part of the Kebele where the gradient is about 4%. Significant proportion of the top soil also covered with very fertile luvisols transported and deposited on the low lying areas of the Kebele near Dijo River.

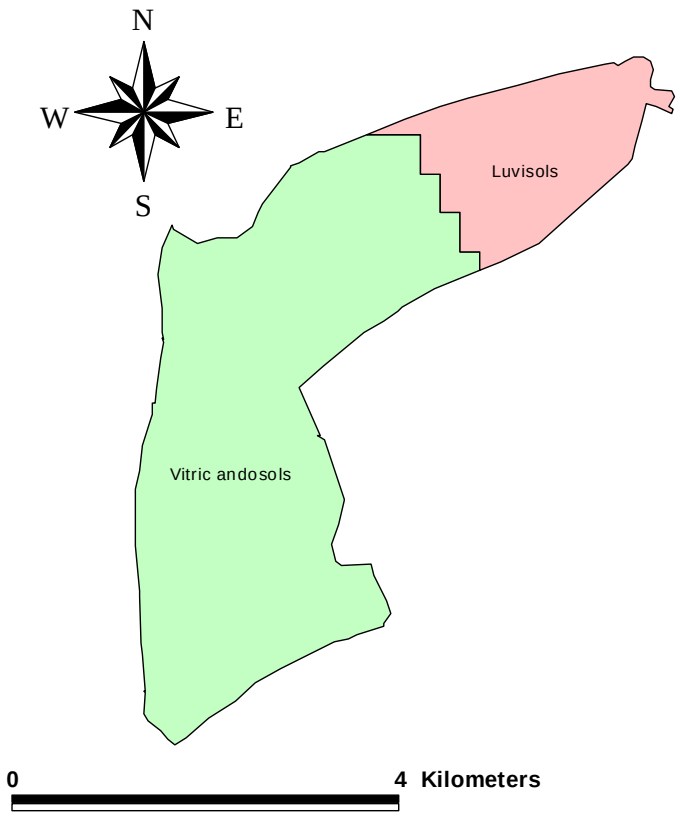


Figure 16. Soil map of Menzo Kebele

2.*Land use/land cover and settlement*

The land cover in the Kebele is dominated by arable land (85.46%), with scattered trees and shrubs which are found around the homesteads and cemeteries. Ggrazing land (3.70), forest (2.86%), degraded land (1.42%) and infrastructures (6.56%) made the overall composition of the land use system. Majority of the arable land is used for rainfed agriculture and affected by tillage erosion. Small patches of shrubs, trees, and grasses are observed on farmlands too. Similar with Werabe Sinbita Kebele, the vegetation in the area has been categorized under the semi-humid riverian woodland with a mixture of broad and narrow-leaved

species. Patches of indigenous trees including *Cordia african, Junipurus procera* and *Accasia abyssinica* are sparsely populated throughout the Kebele. Eucalyptus tree, and *Accasia albida* are among the exotic species on farm plots and homesteads. On the hills, particularly on communal lands, the vegetation is extremely threatened because of grazing and fuel wood extraction. Deforestation mainly for the purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.

Figure 17. Soil map of Menzo Kebele

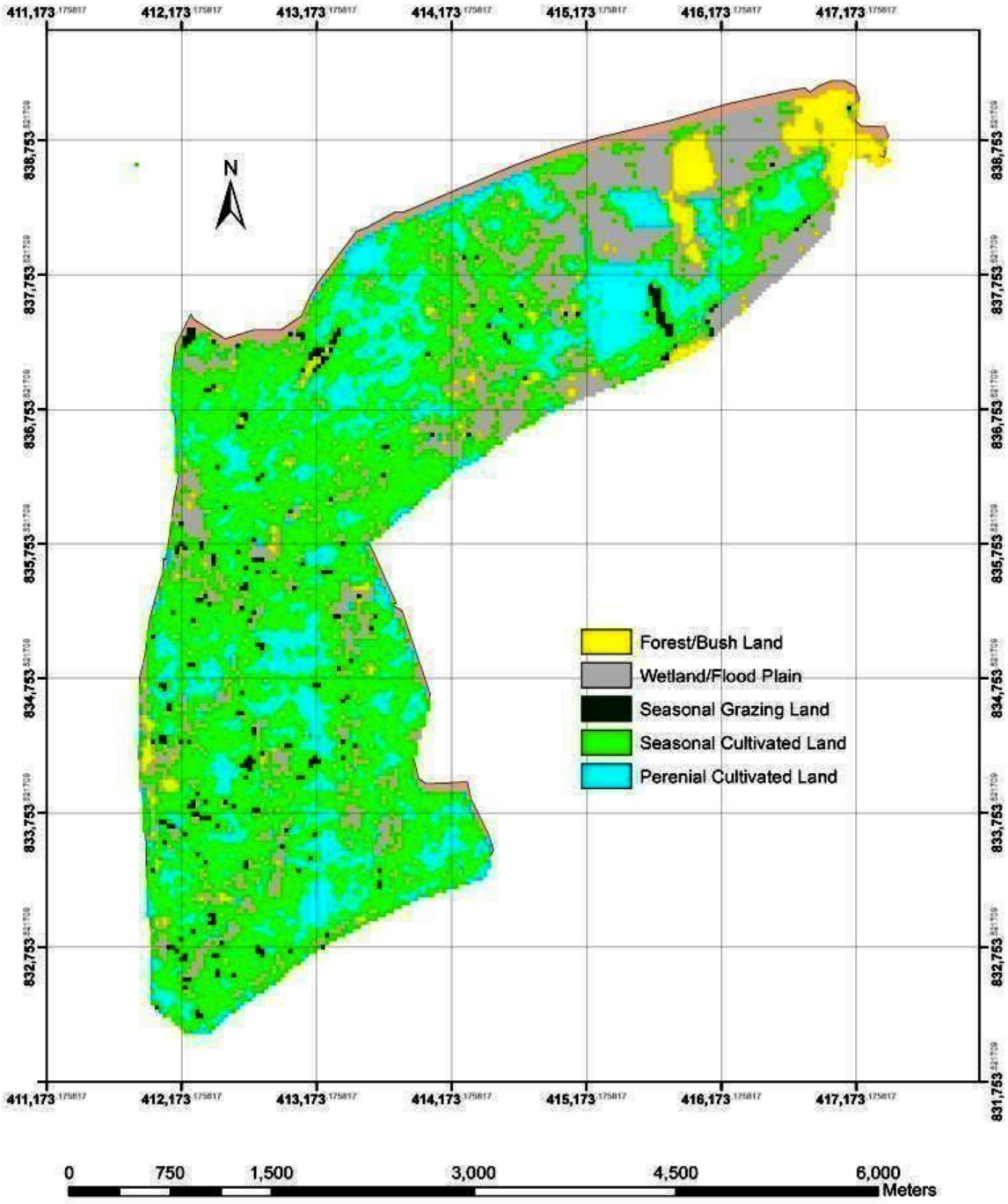


Figure 18. Land use map of Menzo Kebele

Table 3. Land use distribution of the Kebele

Land use	**Area (ha)**
Arable land	721
Grazing land	31.245
Forest	24.1
Degraded land	12
Infrastructures	55.305

3. Slope

During the main rains, rainfall often exceeds the maximum infiltration capacity of the soil profile, resulting in runoff from fields, and the Kebele as a whole. It starts as sheet flow and gathers within fields in small rills, further concentrating from a field or fields in small gullies. Each stage increases flow and flow velocity as a function of the slope and surface roughness thereby increasing the danger of soil erosion. As we go down in the Kebele, more fields will contribute increasing the runoff volume, which reaches a maximum at the flood plains North of the Kebele.

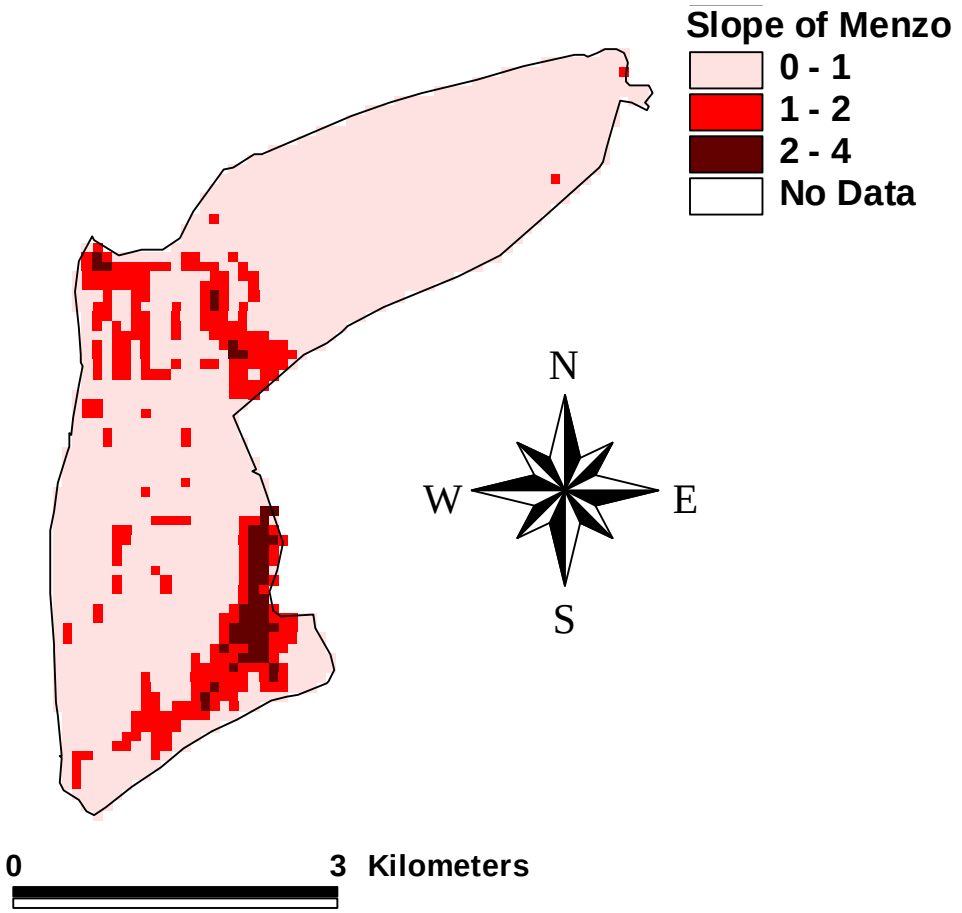


Figure 19. Slope map of Menzo Kebele

An active gullies were observed where the erosion is actively moving up in the landscape by head cut migration on unprotected gradients. Stabilized gullies have ceased widening and head cutting, and sometimes begin to fill with sediment. Coupled with slope length, improper disposal system, and land use practice contribute to the formation of concentrated runoff which are initiated and developed along the traditional on farm drainage waterways. Runoff on low slopes flows slowly and quickly forms a water layer deep enough to act as surface mulch. Increasing slope length enhances soil loss as more runoff

can accumulate on long slopes comprising about 100 hectares of land in the Kebele.

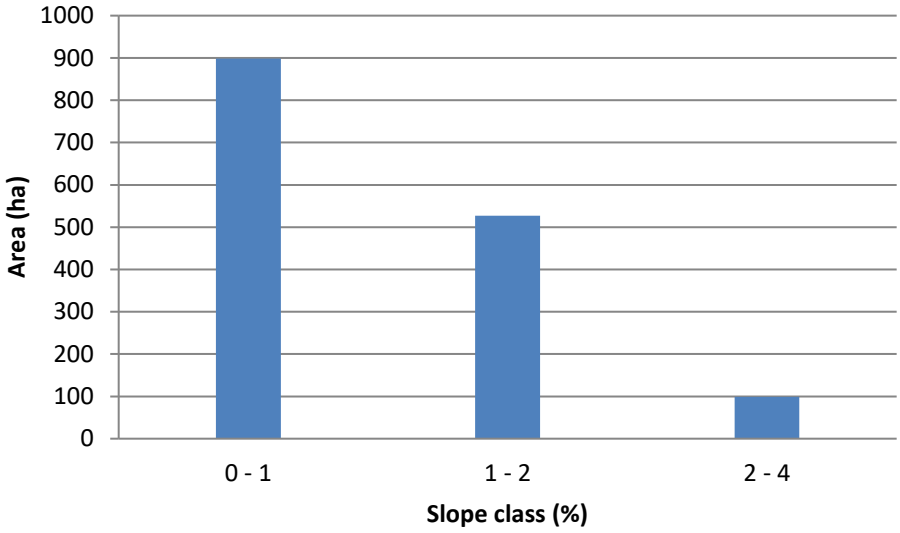


Figure 20. Slope distribution of Menzo Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 1874 and 1795 meters above sea level. The flow is from West to North East direction. Together with the flood coming from upstream Kebeles, South West part of the Kebele is the source of erosion and North East is a place of sedimentation. North East part of the Kebele, specifically, all locations downstream direction is affected by siltation coming from upstream landscapes.

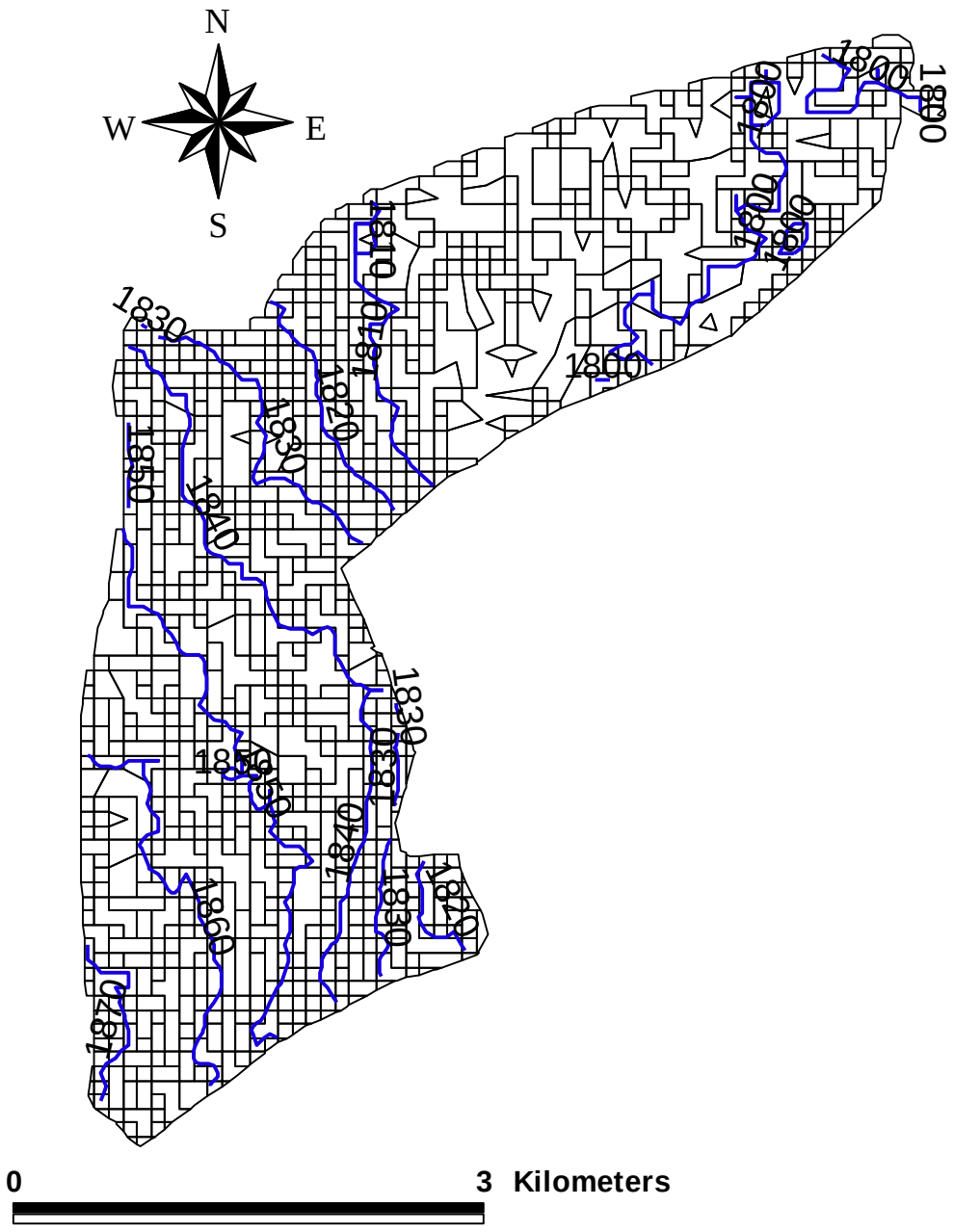


Figure 21. Contour map of Menzo Kebele

5.Gully distribution

The development of gullies in the Kebele is attributed to human interferences (ditches and waterways) and pipes or tunnels formed after vegetation removal. They probably developed down slope by the piping process when pipes on the upper slopes developed faster and collapsed earlier than on the lower slopes. Majority of the gullies in the Kebele is originated from upstream Kebeles. About 14.6% (123 ha) of the Kebele is threatened by gully erosion.

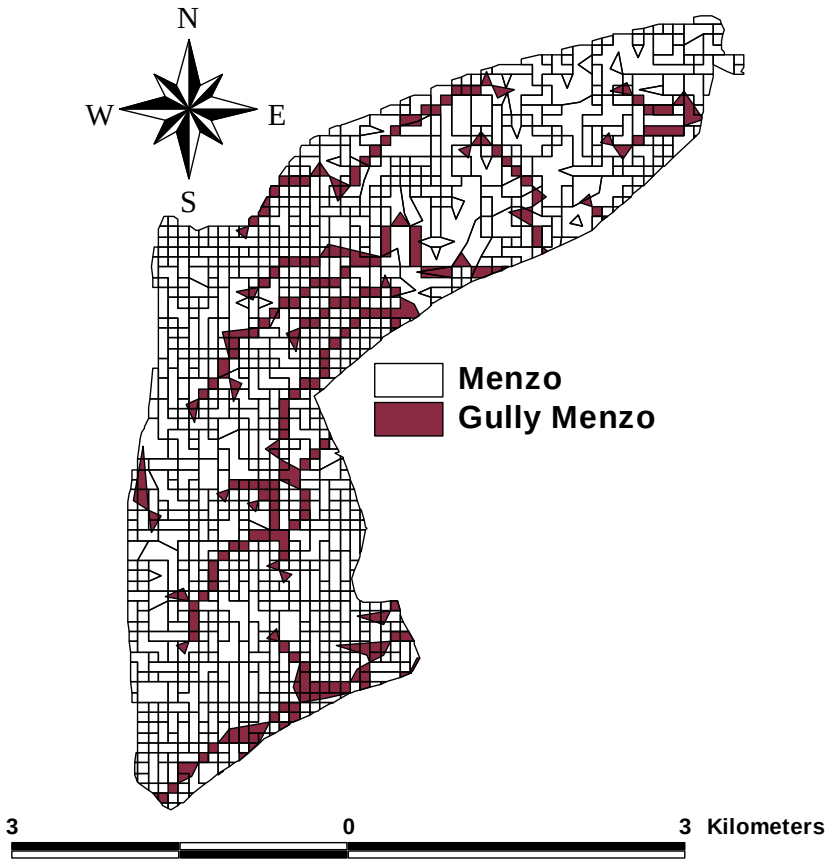


Figure 22. Gully distribution of Menzo Kebele

The following network of gullies demand immediate interventions to sustain the agrarian livelihood system of the Kebele.

Table 4. Major gullies in Menzo Kebele

Name of gullies	Width in meter	Depth in meter	Length in km	Direction from center of Kebele
Koro Senko	3.5	2	4	North West
Eresha	3.5	2	3	South East
Eresh Atoko	3.5	2	6	South East

6. Base Map of the Kebele

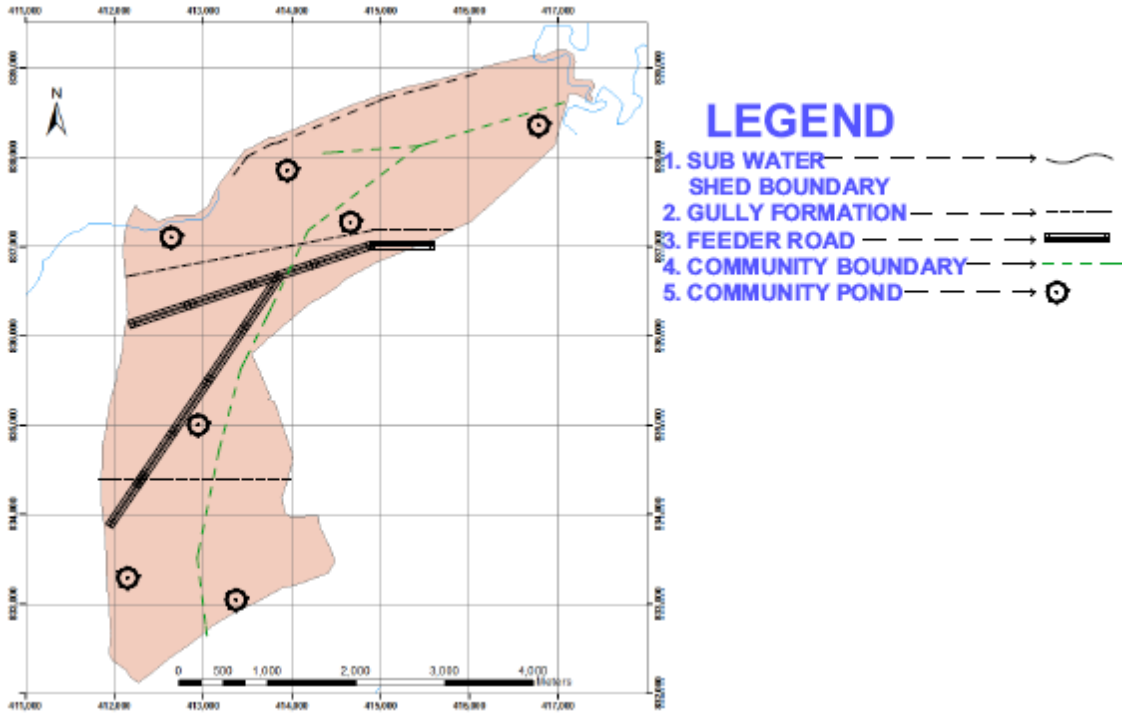


Figure 23. Base map of Menzo Kebele

7. Development Map of the Kebele

Different interventions were suggested/recommended based on the level of soil degradation, slope, land use and farmers experience. The following

list presents those interventions that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains

Soil fertility management:

- Composting

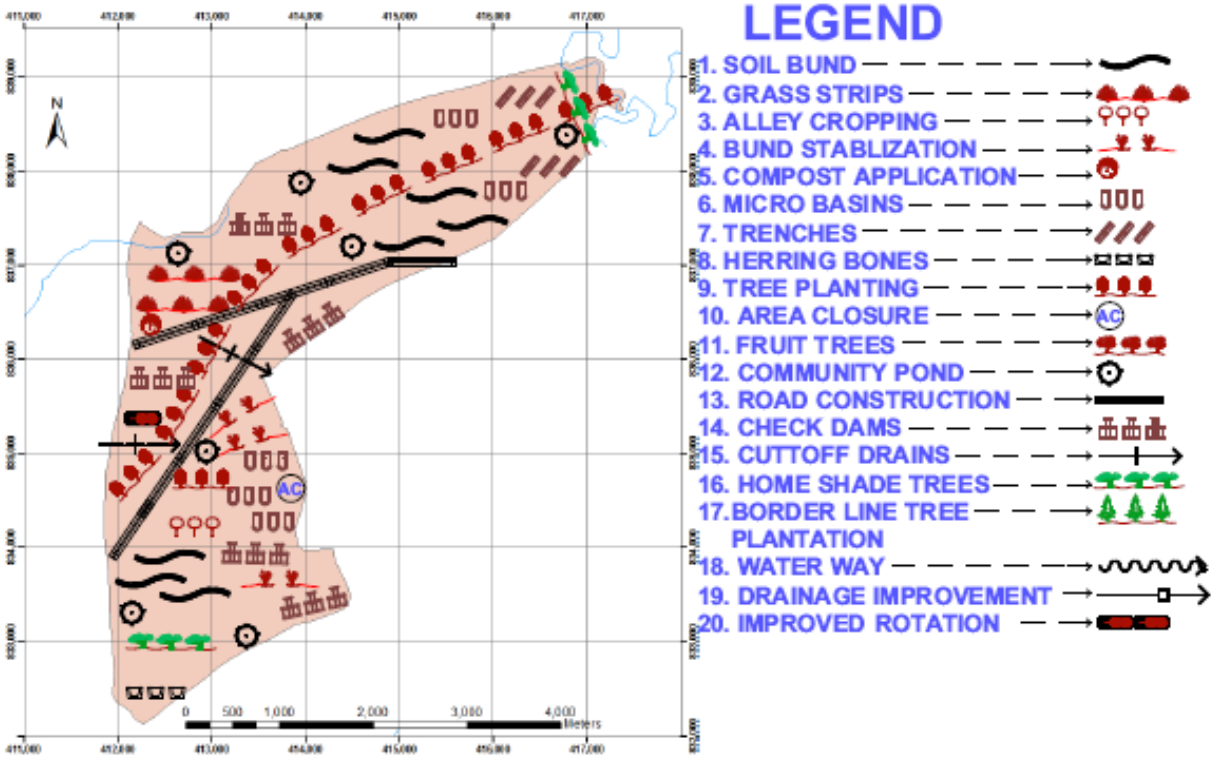


Figure 24. Development map of Menzo Kebele

5.3. Menzo Feten Kebele

General

Menzo Feten Kebele is situated in Silti Zone of SNNP Regional State covering an area of 731.25 ha of which 32.5 hectares is highly degraded. For Land Management Planning purpose the Kebele is structured by 2 watershed development clusters of having 432.6 hectares of erosion prone areas.

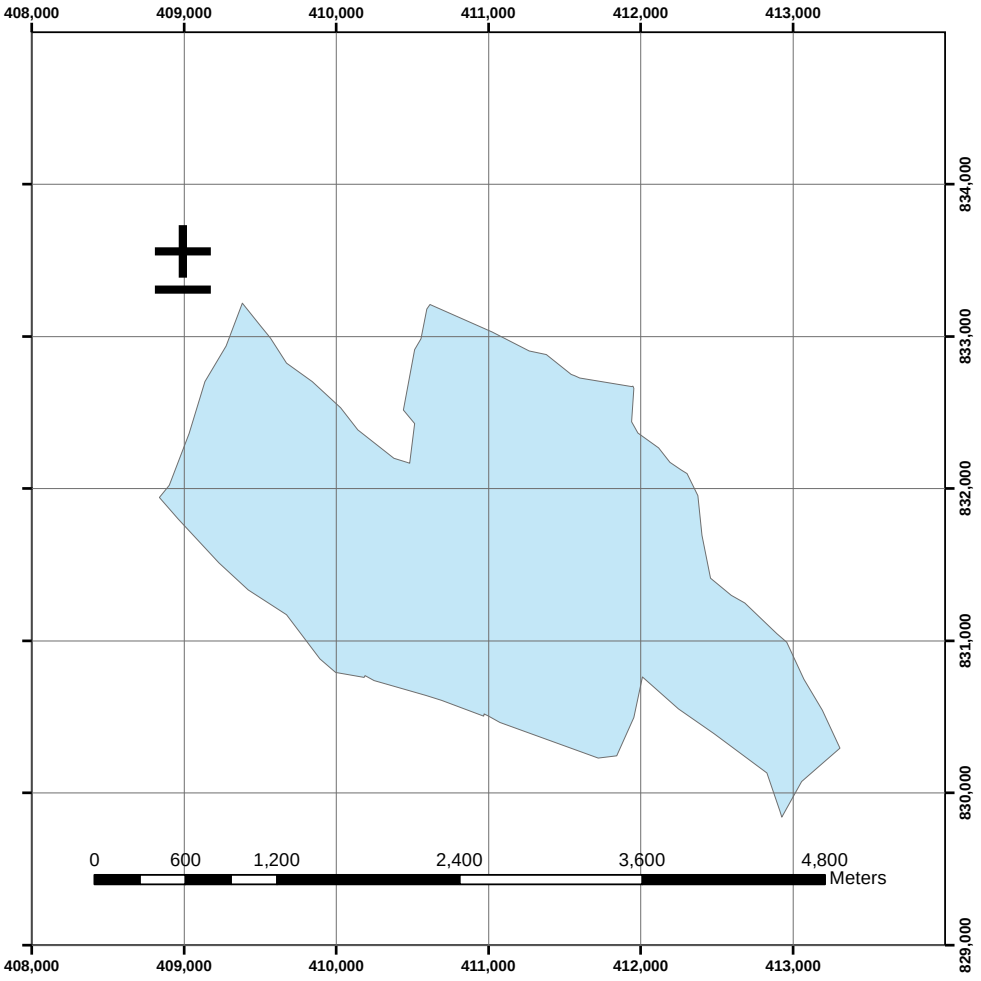


Figure 25. Political map of Menzo Feten Kebele

Geographically, the area is situated at an Easting between 408,000 m to 414,000 m and Northing of 830,000 to 835,000 m.

The Kebele is bordered on the East by Adashe Kebele, on the West by Weteta Kebele, on the North by Menzo and Menzo Gumbo Kebeles and on the South by Feten and Tachignaw Kemo Kebeles.

Basic Infrastructure

1.Water supply

Domestic water supply in the Kebele mainly fulfilled with water point pumping from aquifers. Water harvesting structures of different scales are found in the Kebele.

2.Health

One health center for humans and one veterinary medicine center is found in the Kebele. According to the Kebele health workers report the Kebele latrine coverage for the year 2016 was 95% this does not indicate the whole aspects of sanitation. The majority of the households have latrine for their family. Those households who have no latrine at their backyard use open field, bush and backyard that is the main source for pollution of unprotected water source and main source for transmission of diseases.

3.Education

There is one first and second cycle (1-8) school at the center of the Kebele to give the service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 8 kms away from Alem Gebeya town.

Demographic overview

370 male headed and 35 women headed households are found in the Kebele. According to the information obtained from the Kebele administration office the total population of the Kebele for the year 2016 was about 3788 out of this the males are 1666 (43.98%) while the females are 2122(56.02%).

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

Agriculture (farming as well as livestock rearing) is the main stay of the Kebele's population. Very few households depend on trade activity for their livelihood. The table below summarizes the cattle population in the Kebele.

Table 5. Livestock population in the Kebele

Cattle type	**Number**
Cow	400
oxen	350
Heifer	150
Calf	350
Bull	203
Donkey	448
Horse	200
Sheep	1056
Goat	875

Biophysical Conditions

1.Soil

Soils that are predominantly available in the Kebele are vitric andosols at the majority of farm lands North of the Kebele; and luvic phaeozems on small patches of farm lands in the South. From these two soil groups vitric andosols have a high potential for agricultural activity because of their fertility, ease of cultivation and ease of root penetration. The infiltration capacity of the soil depends, among others, on the porosity of the soil, which determines its storage capacity and affects the resistance of the water to flow into deep layers. Since the soil infiltration capacity depends on the soil texture, the highest infiltration rates are observed in sandy soil. This shows that, surface runoff is higher in heavy clay and loamy which has low infiltration rate. The minimum soil depth is 10 cm observed at the South Eastern boundary of the Kebele with Weteta Kebele and a maximum of 70 cm at the boundary between Menzo Kebele.

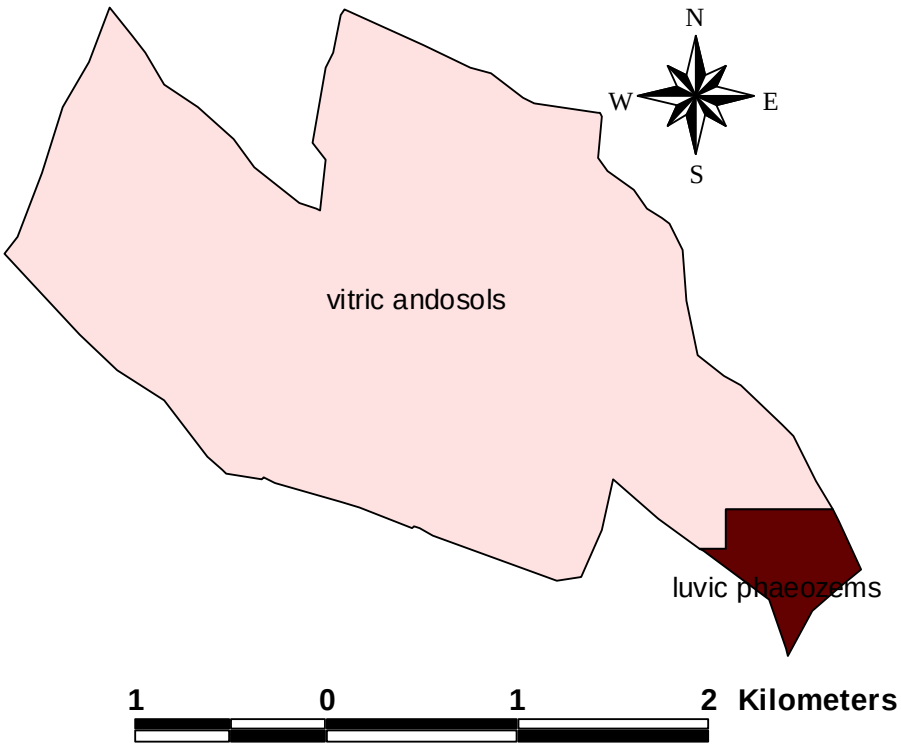


Figure 26. Soil map of Menzo Feten Kebele

2.*Land use/land cover and settlement*

Similar with all the other Kebeles, patches of bushes and indigenous woody species were identified around the homesteads and cemeteries that includes *Acacia abyssinica, Ficussycomorus, Ficussur, Croton macrostachyus, Acacia tortolis, Balanitesa egyptiaca , Juniperus procera ,Bersama abyssinica ,Cordia Africana ,Erytherina abysinica ,Entada abysinica, Euphorbia tirucalli and Euphorbia abyssinica*. The land cover in the Kebele is dominated by arable lands covered with seasonal crops. Including *chat/Kat,* small patches of fruit trees are observed around home gardens. On the hills, the vegetation is extremely threatened because of grazing and fuel wood extraction. Deforestation mainly for the

purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.

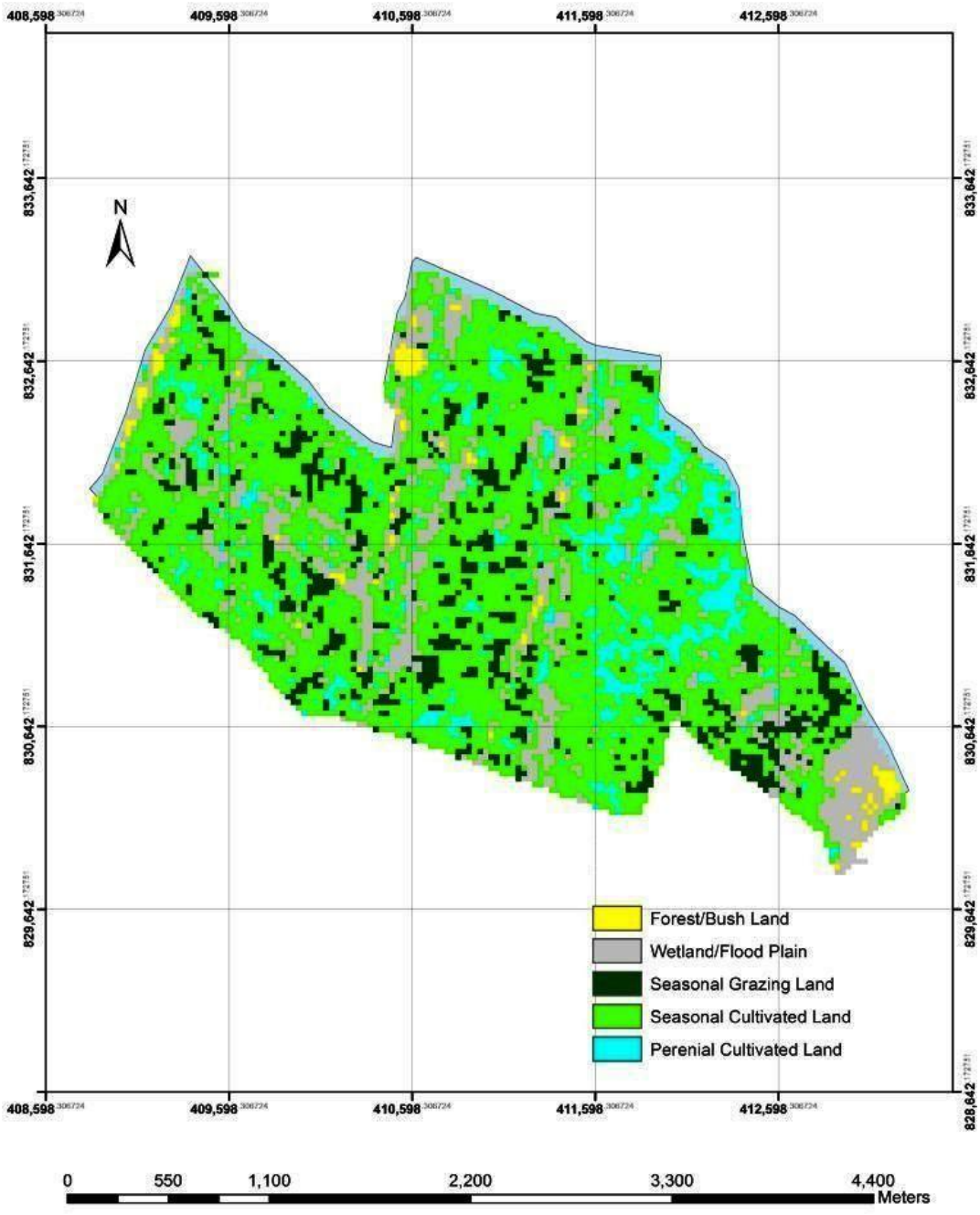


Figure 27. Land use map of Menzo Feten Kebele

Table 6. Land use of the Kebele

Land use	**Area (ha)**
Seasonal Crops	560.35
Perrienials	20
Grazing land	24
Forest	20.2
Degraded land	32.5
Bushes	5
Infrastructures	69.2

3. Slope

Directly or indirectly; slope contributes to the formation of gully in the study area and consequently facilitate its formation to a very large extent as it affect the current and speed of running water. Erosion may also occur even on gentle topography because of poor infiltration and inadequate storage of surface water due to surface crusting of cultivated fields. The maximum slope of the Kebele is about 7%. However, due to poor land cover and wrong tillage practices, this gradient facilitated soil erosion and gully formations. The soil is very fragile and week to cope with the smallest errrosive runoff current coming during the rainy season.

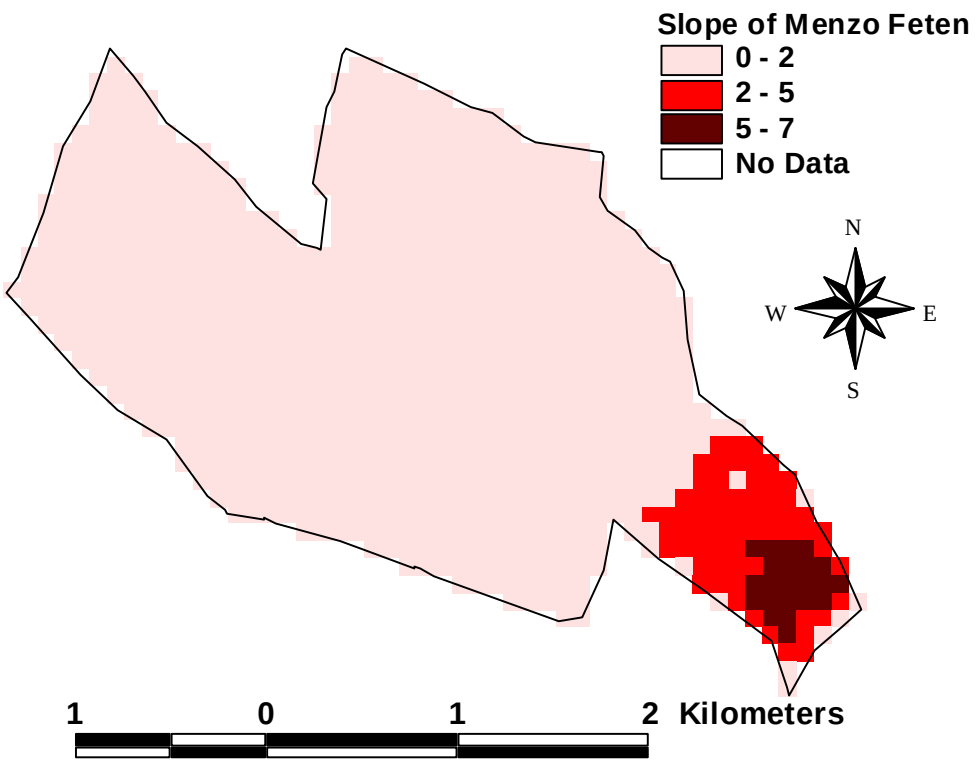


Figure 28. Slope of Menzo Feten Kebele

Runoff started to flood fields down slope of farm lands more frequently following cultivation of farm lands that migrated up slope for different reasons replacing trees and shrubs. Farmers managed this situation by channeling runoff water using bunds around fields. The remedial work, as a result of micro-topography, caused flooding of neighboring fields downstream. To cope with such challenges, the community worked together to dig ditches, which eventually grew into gullies or encouraged pipe formation within a short time following the relative steep gradient. Left, right and central part of cattle and human footpaths were also observed as a factor for initiation of gullies in the Kebele.

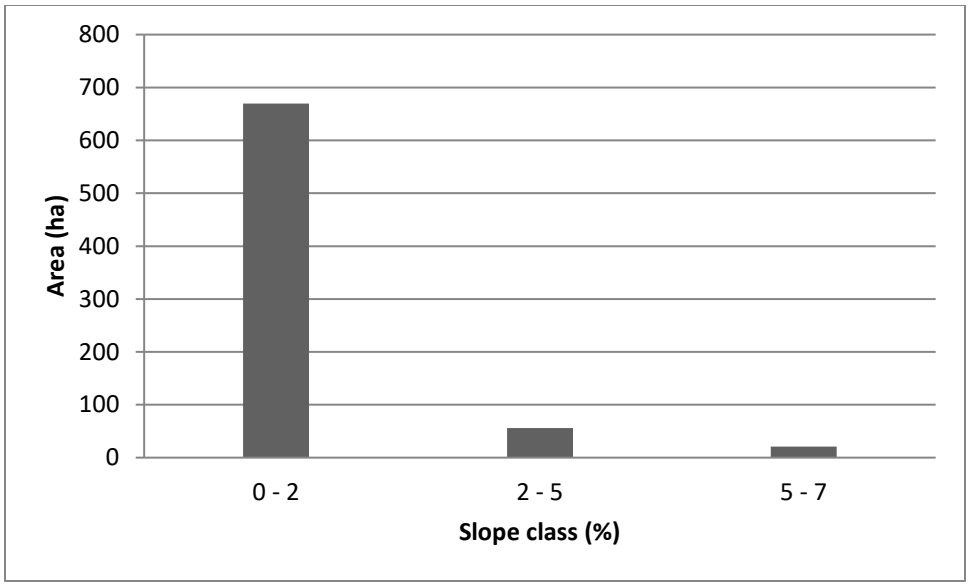


Figure 29. Slope distribution of Menzo Feten Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 1982 and 1864 meters above sea level. The flow is from South East to North West direction of the Kebele. Together with the flood coming from the neighboring Kebeles, South East part of the Kebele is the source of erosion and North West is a place of sedimentation. Hence, soil conservation activities are suggested at South Eastern part of the Kebele and drainage structures are at the North Eastern part.

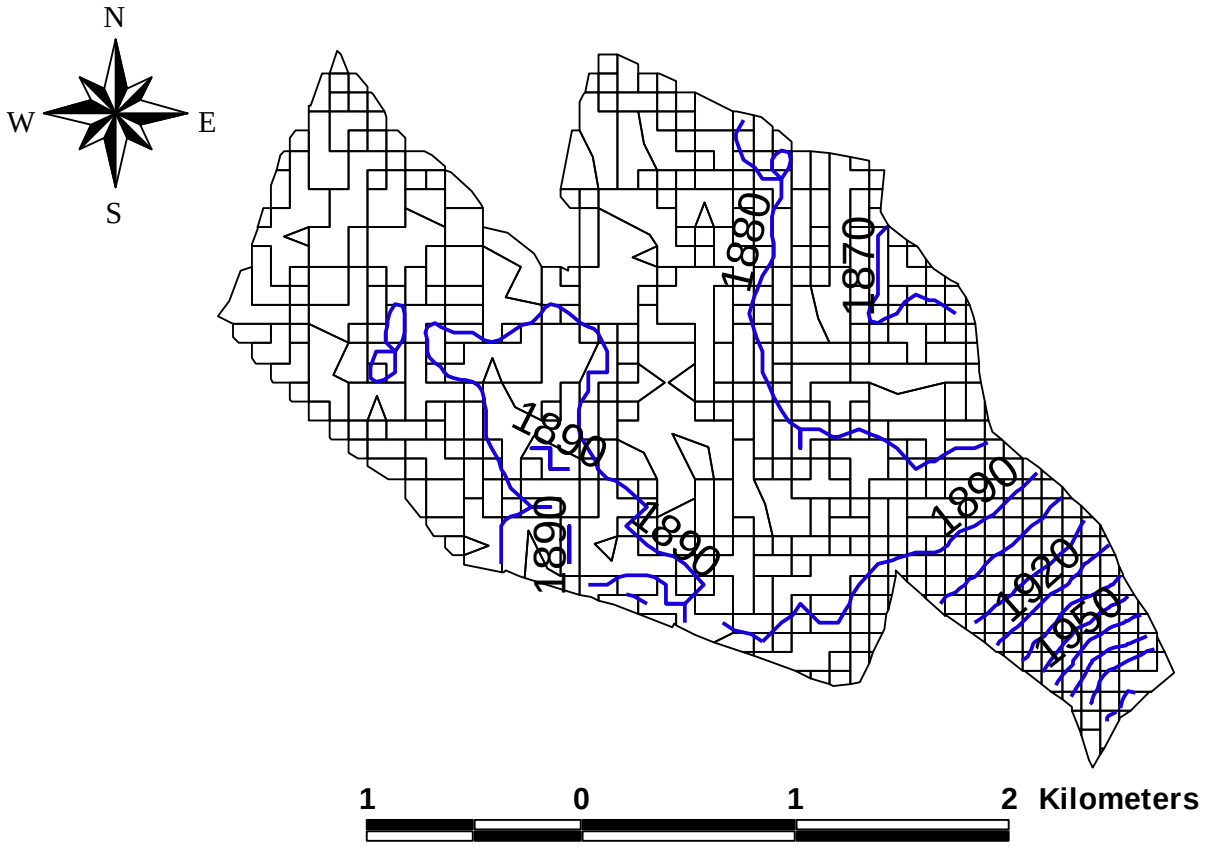


Figure 30. Contour map of Menzo Feten Kebele

5.Gully distribution

Majority of the gullies in the Kebele is originated from neighboring Kebeles. However, significant number of the same also initiated within the Kebele. About 6.15% (45 ha) of the Kebele is threatened by gully erosion.

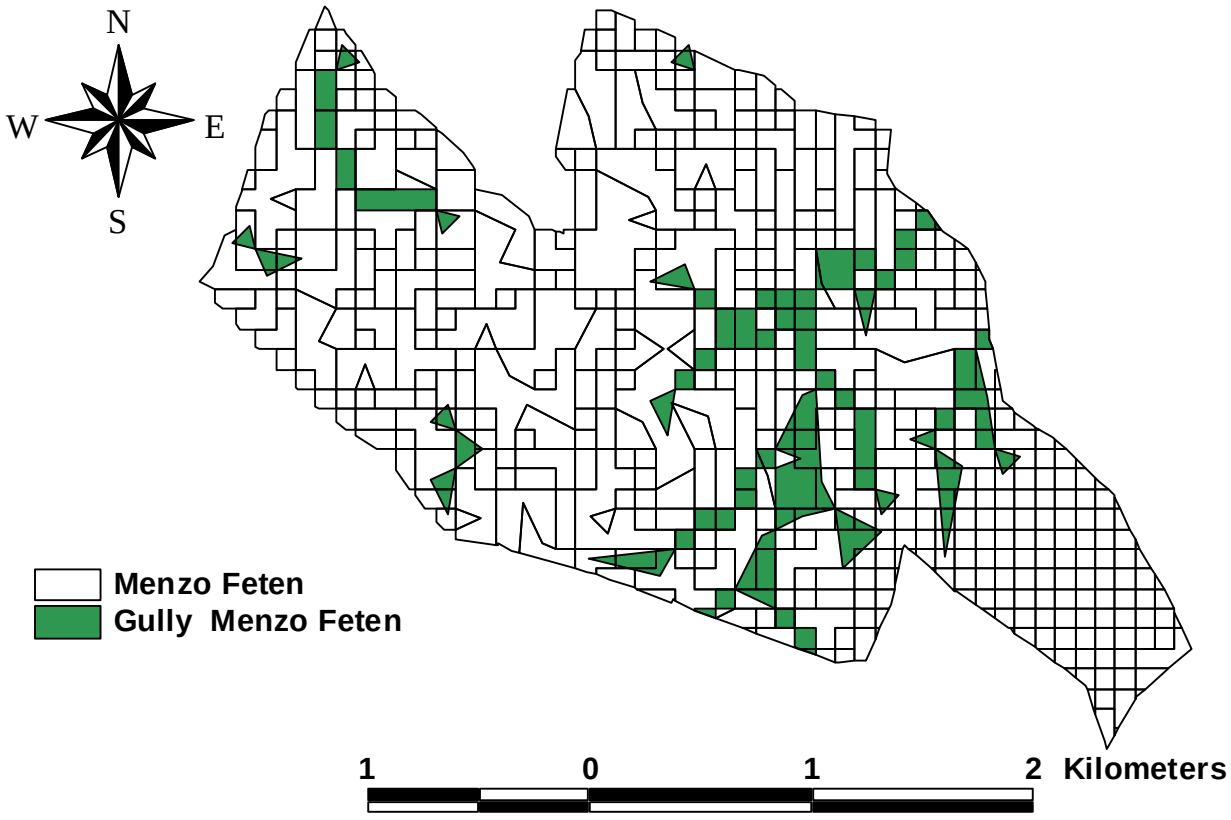


Figure 31. Gully map of Menzo Feten Kebele

Table 7. List of gullies that demand immediate action

Gully name	Average width (m)	Average depth (m)	Total length in the Kebele (km)	Location in Menzo Feten	Village
Tersho	5	4	4	East	Tersho
Abero	6	5	4	North West	Abero
Sulala	4	4	2.5	North West	Sulala
Abosere	3	3	1.5	South	Abosere
Kelbeto	4	3	1	Central	Kelbeto
Feten	3	2	1.5	North West	Feten
Tewabech	3	2	1.5	North West	Tewabech
Menzo	3	2	1	South West	Menzo

6.*Base Map of the Kebele*

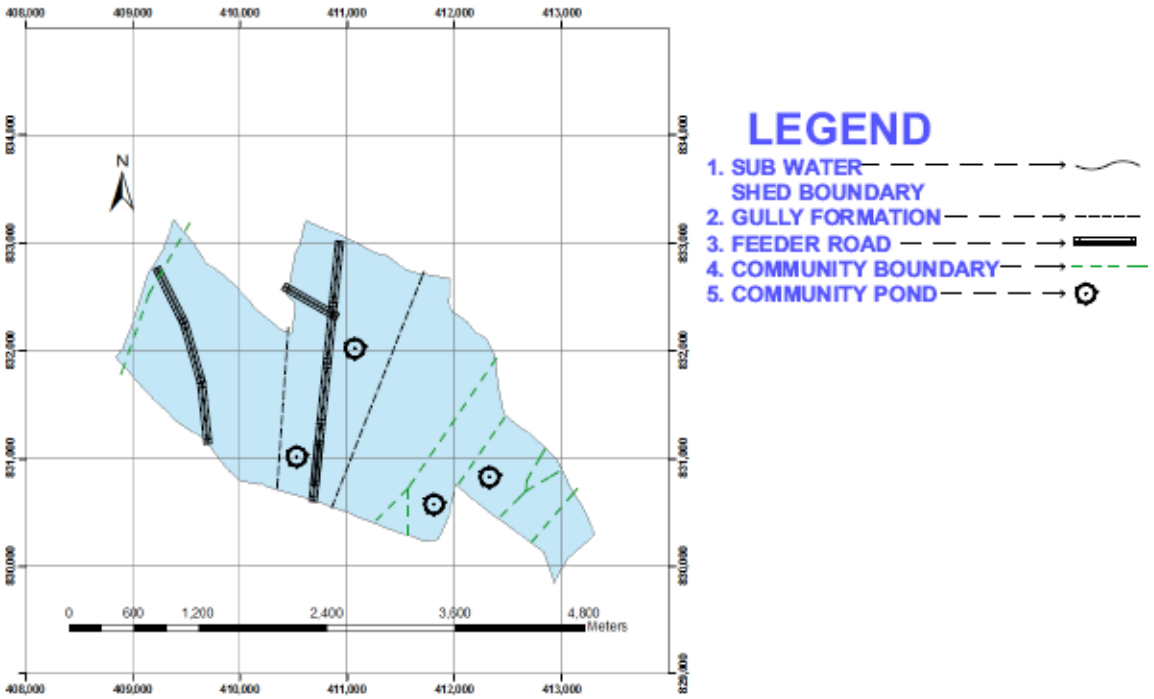


Figure 32. Base map of Menzo Feten Kebele

7.Development Map of the Kebele

Different interventions were suggested/recommended based on the level of soil degradation, slope, land use and farmers experience. The following list presents those interventions that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains

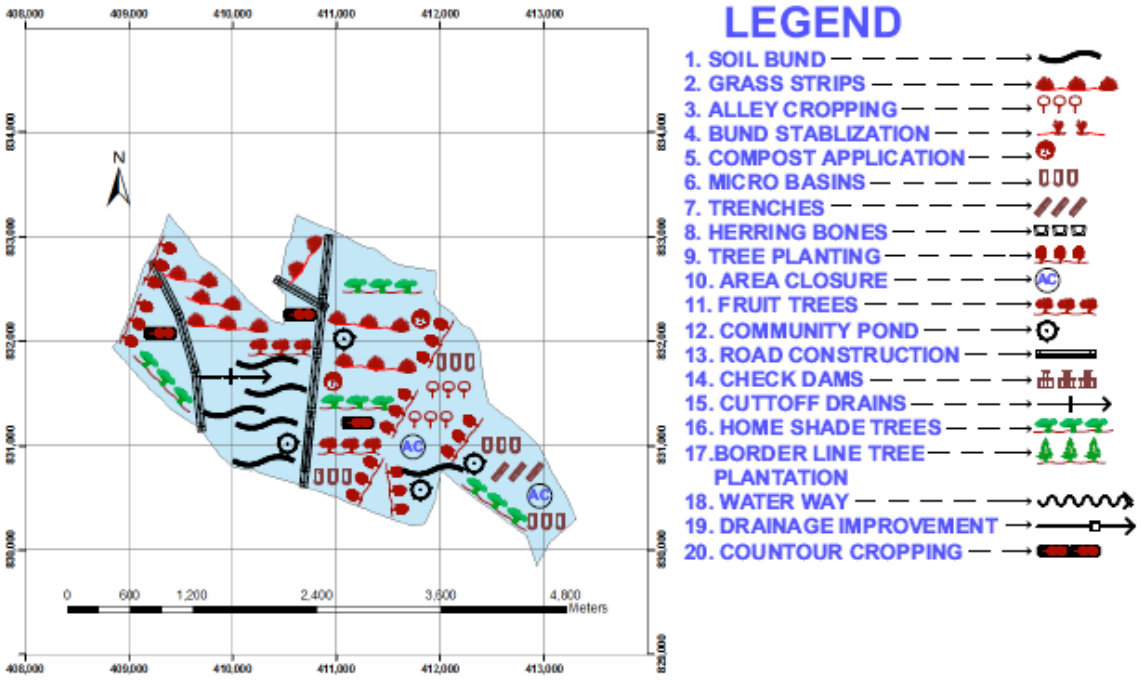


Figure 33. Development map of Menzo Feten Kebele

5.4. Feten Kebele

General

Feten Kebele is situated in Silti Zone of SNNP Regional State covering an area of 386 ha of which 5.3 hectares are highly degraded. Majority of the degraded areas are located on the Western side of the Kebele.

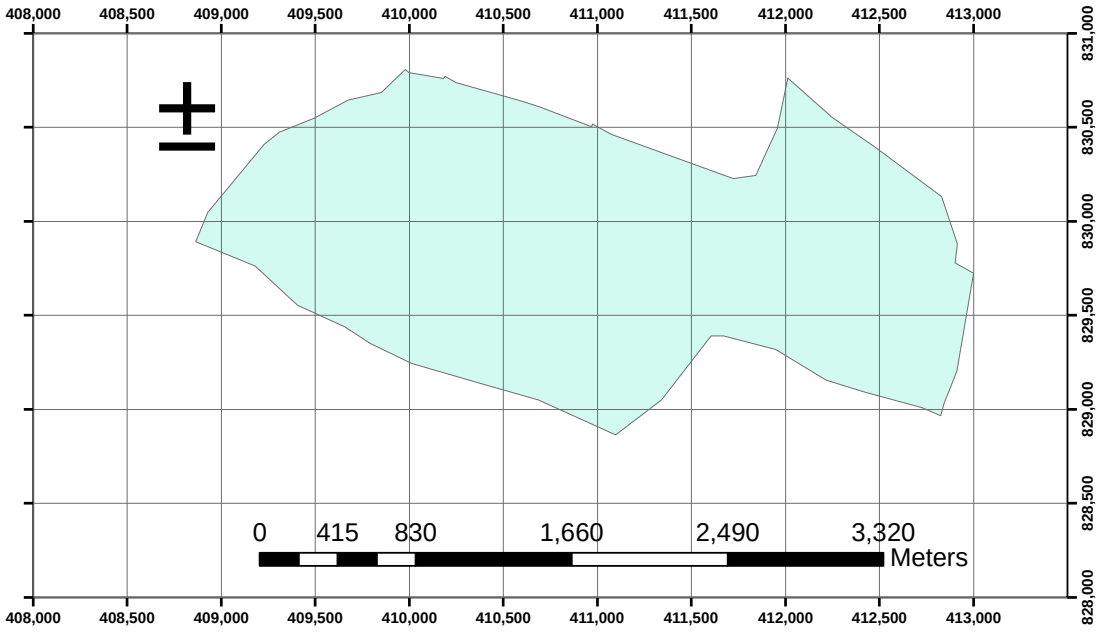


Figure 34. Political map of Feten Kebele

Geographically, the area is situated at an Easting between 409,000 m to 413,000 m and Northing of 825,000 to 831,000 m.

The Kebele is bordered on the East by Weteta and Halaba Special Woreda, on the West by Tachignaw Kemo, on the North by Menzo Feten Kebele and on the South by Bercho Keble. There are various community based organization in the Kebele such as "women support group", "Credit and saving institutions", *"Equb"* and *"Edir"* to help each other in terms

of social and economic issues. Two types of “Edir” namely “higher Edir” for the purpose of solving major social issues of the members and “Lower Edir” for the purpose of organizing funereal services is practiced in the Kebele.

Basic Infrastructure

1.Water supply

Water harvesting structures are the main supply source of water for cattle population in the Kebele. Domestic water supply mainly came from few water points in the Kebele and the surrounding Kebeles too.

2.Health

Inside the FTC compound, there is one veterinary medicine center. According to the Kebele health workers report the Kebele sanitation and hygiene coverage for the year 2016 was about 90% . However, the field observation indicated that the figure may not implicate the whole aspects of sanitation. The majority of the households have latrine for their family.

3.Education

There is elementary school at the center of the Kebele to give the service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 7 kms away from Alem Gebeya town.

Demographic overview

According to the information obtained from the Kebele administration office the total population of the Kebele for the year 2016 was about 2075 out of this the males are 1017 (49.01%) while the females are 1058(50.99%).

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

Similar to other agrarian community in the country, agriculture (farming as well as livestock rearing) is the main stay of the Kebele's population. Very few households depend on trade activity for their livelihood.

Biophysical Conditions

1.Soil

Majority of the farm lands have vitric andosols mainly composed of very fine textured sandy loam soil easily affected by both wind and water erosion. The minimum soil depth is 20 cm observed at the Eastern boundary of the Kebele with Weteta Kebele and a maximum of 70 cm at the boundary between Tachignaw Kemo Kebele of Sankura Woreda. Significant proportion of the top soil also covered with highly degraded luvic phaeozems mainly dominating the Eastern one third of the Keble.

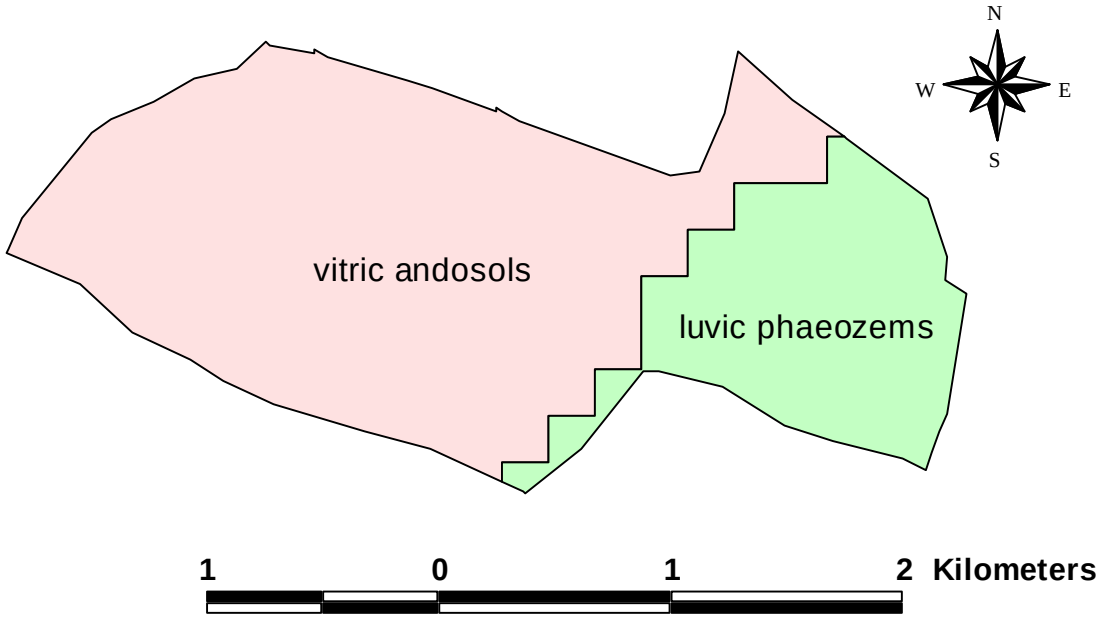
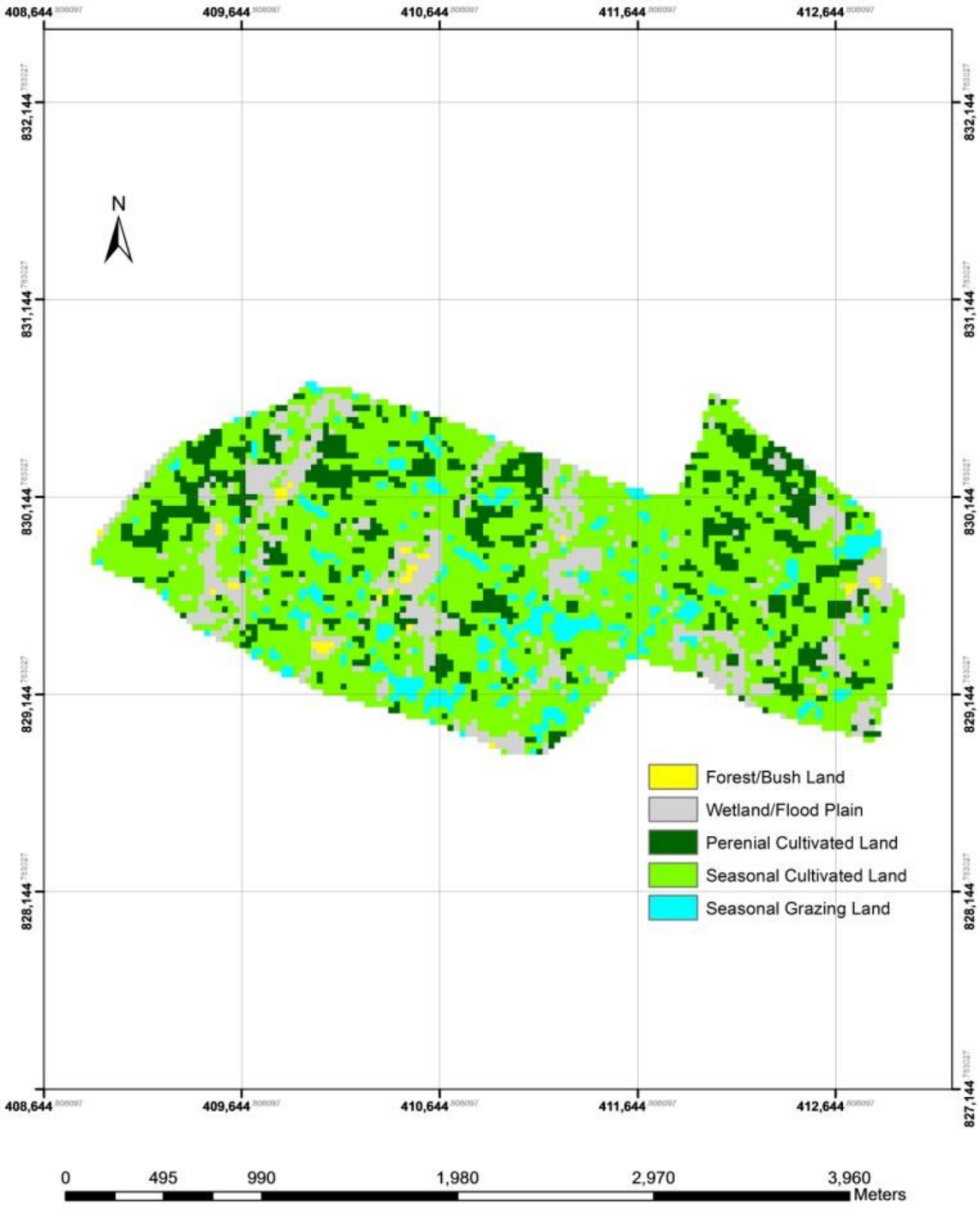


Figure 35. Soil map of Feten Kebele

2.*Land use/land cover and settlement*

Similar to other Kebeles, arable land is the dominant land use. Small patches of forest land is observed at the Eastern hills of the Kebele. Scattered trees and shrubs are found around the homesteads and cemeteries. Small patches of shrubs, trees, and grasses are also observed on farmlands. The vegetation in the area has been categorized under the semi-humid woodland dominated with narrow-leaved species. Grazing and forest land are frequently affected by over stocking and over grazing. Deforestation mainly for the purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.


408,644
409,644
410,644
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832,144
831,144
830,144
829,144
828,144
827,144
N
Forest/Bush Land
Wetland/Flood Plain
Perenial Cultivated Land
Seasonal Cultivated Land
Seasonal Grazing Land
0
495
990
1,980
2,970
3,960
Meters

Figure 36. Land use map of Feten Kebele

Table 8. Land use map of the kebele

Land use	**Area (ha)**
Arable Land	283
Grazing land	5.4
Forest	5.6
Degraded land	5.3
Infrastructures	86.7

3. *Slope*

The significant interactions between gully erosion on the one hand and slope, hydrological (i.e. infiltration, drainage) as well as other soil degradation processes (piping, mass wasting, tillage erosion and erosion by land leveling) has been observed in the Kebele either accelerating or hampering land degradation rates under different environmental conditions as well as for taking appropriate measures to control them. Directly or indirectly; slope contributes to the formation of gully in the study area and consequently facilitate its formation to a very large extent as it affect the current and speed of running water.

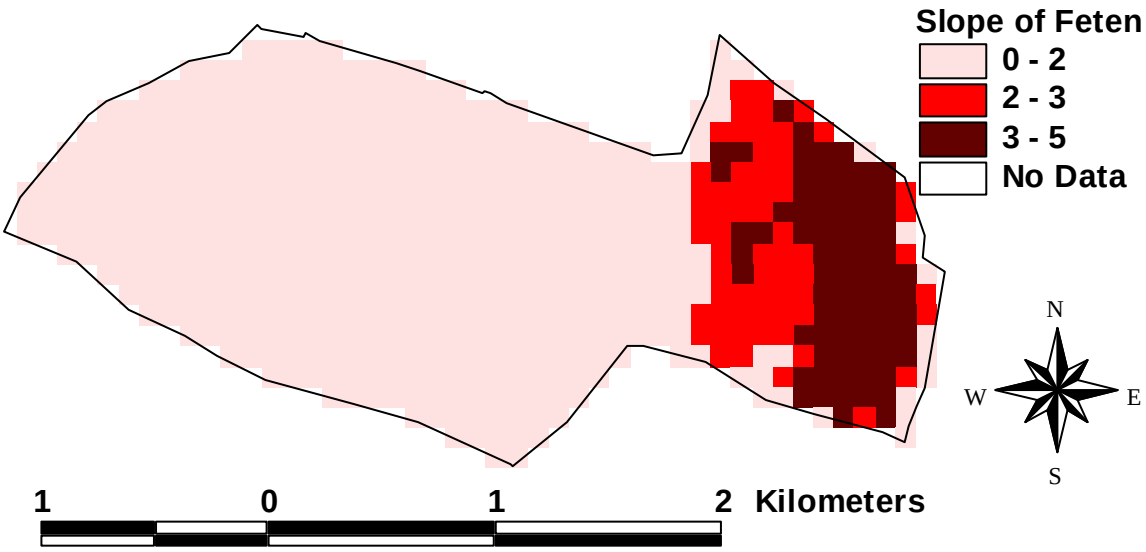


Figure 37. Slope of Feten Kebele

Erosion also occurred on the two-third gentle topography of the area because of poor infiltration and inadequate storage of surface water due to surface crusting of cultivated fields as well as enhanced tillage erosion. The maximum slope of the Kebele is 5%. However, due to poor land cover and wrong tillage practices, this gradient facilitated soil erosion and gully formations. The soil is very fragile and week to cope with the smallest errrosive runoff current coming during the rainy season.

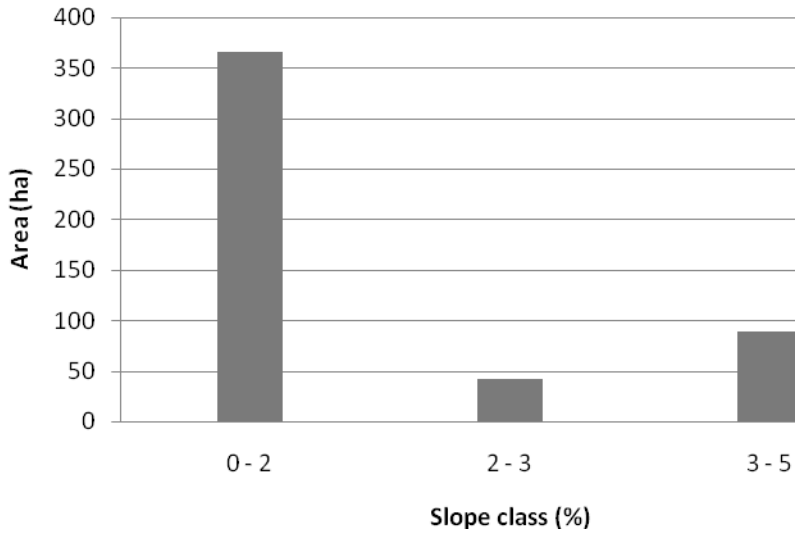


Figure 38. Slope distribution of Feten Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 1977 and 1881 meters above sea level. The flow is from South, South East and West to North direction. Together with the flood coming from the neighboring Kebeles part of the Kebele is the source of erosion and West and North West is a place of sedimentation. Eastern part of the Kebele, specifically, all locations downstream direction of the hill is affected by flooding and needs drainage structures. However, the western parts where hilly areas were dominant, tree planting and infiltration improving trenches are mandatory. On all farm lands particularly on the low lying areas minimum tillage practices are recommended.

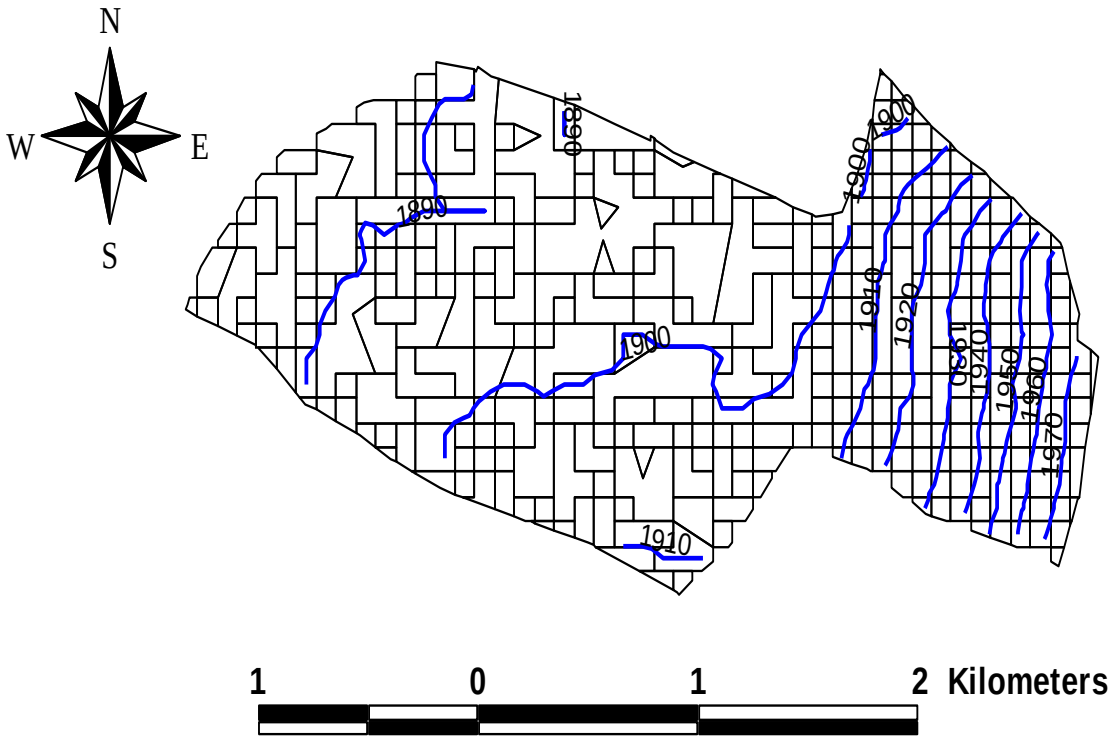


Figure 39. Contour map of Feten Kebele

5.Gully distribution

Most of the active and recently developed gully-systems in the Kebele have their origin below settlements or along footpaths, where topsoil is highly compacted and hence the infiltration rate reduced. Consequently, the construction of check dams in the above soil zones will only have a sustainable effect on gully erosion if, in addition, in the source areas corresponding measures are implemented. Majority of the gullies in the Kebele is originated from the surrounding Kebeles. About 9.8% (38 ha) of the Kebele is threatened by gully erosion.

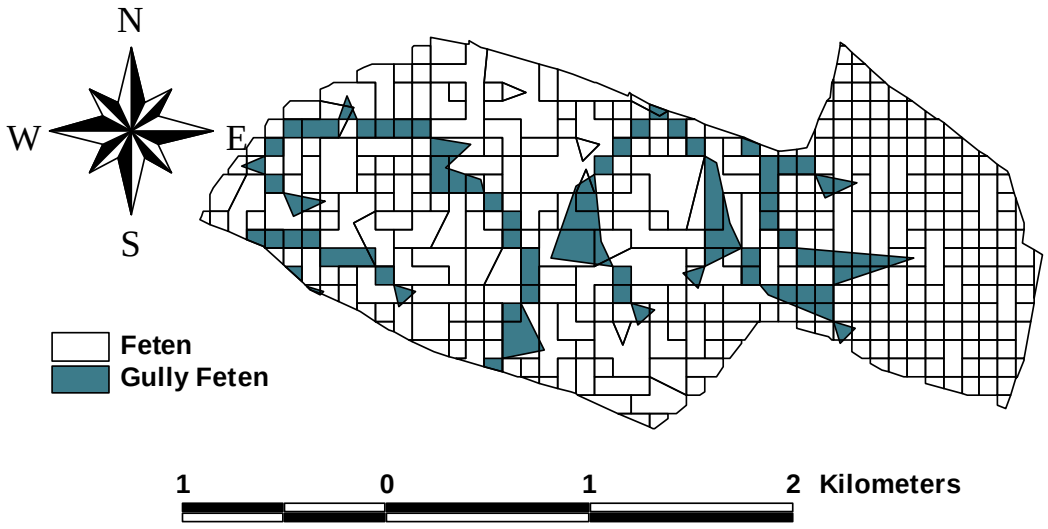


Figure 40. Gully map of Feten Kebele

Those gullies listed below demands immediate interventions to hamper their progressive development in the Kebele.

Table 9. List of gullies in Feten Kebele

Name of gullies	Width in meter	Depth in meter	Length in km	Direction from center of Kebele
Sultan Bushira	15	30	2	South East
Bediru G/sale	17	26	1	East
HeganoShikuri	17	27	1.5	North
Shikurala Mohamed	18	28	1	South
SinoroKedir	20	27	1.5	South
NasiroYassin	10	13	1	Center

6.Base Map of the Kebele

The community map below depicted the different land uses as the farmers perceived their environment. The degraded areas on their map is those areas which have higher gradient mentioned on the slope

distribution map generated above. Much of the homesteads are located at higher elevations near the boundary of the Kebele for flood protection.

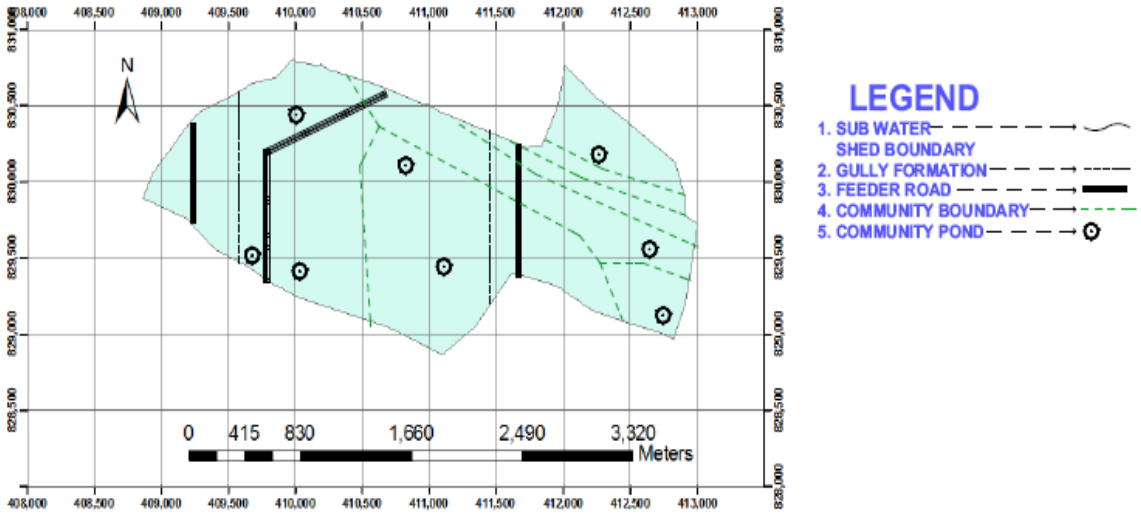


Figure 41. Base map of Feten Kebele

7.Development Map of the Kebele

Different interventions were suggested/recommended based on the level of soil degradation, slope, land use and farmers experience. The following list presents those interventions that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains

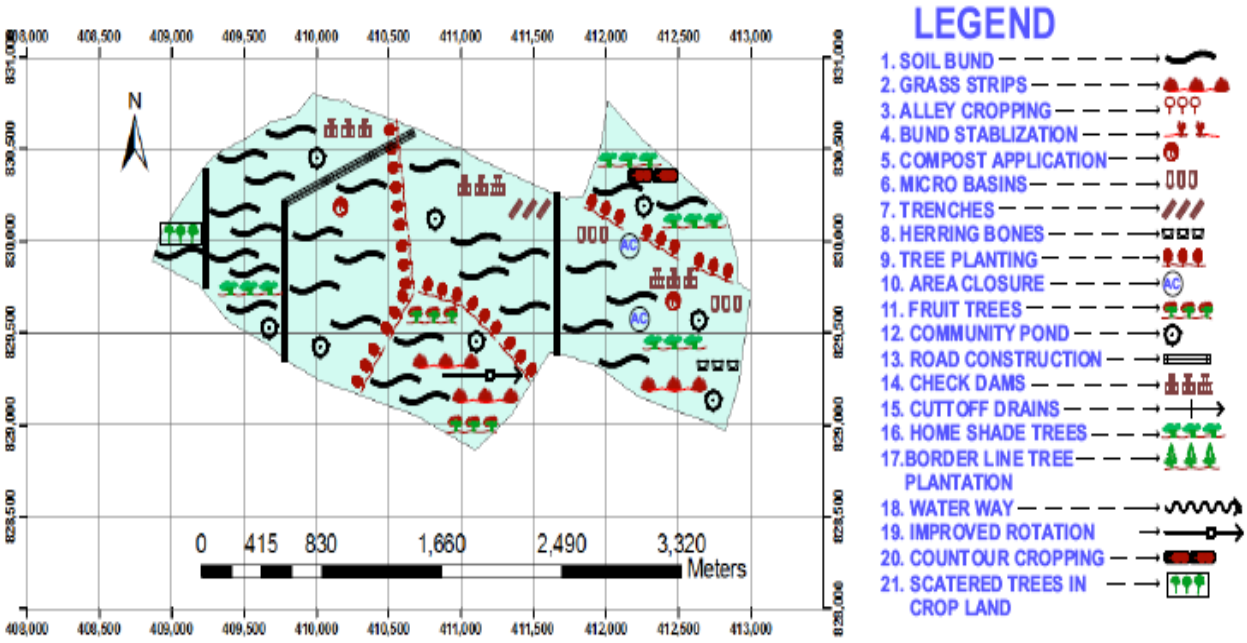


Figure 42. Development map of Feten Kebele

5.5. Weteta Kebele

General

Weteta Kebele is situated in Silti Zone of SNNP Regional State covering an area of 927 ha of which 11 hectares is highly degraded. For Land Management Planning purpose the Kebele prepared one degraded cluster having 412.5 ha of land for rehabilitation.

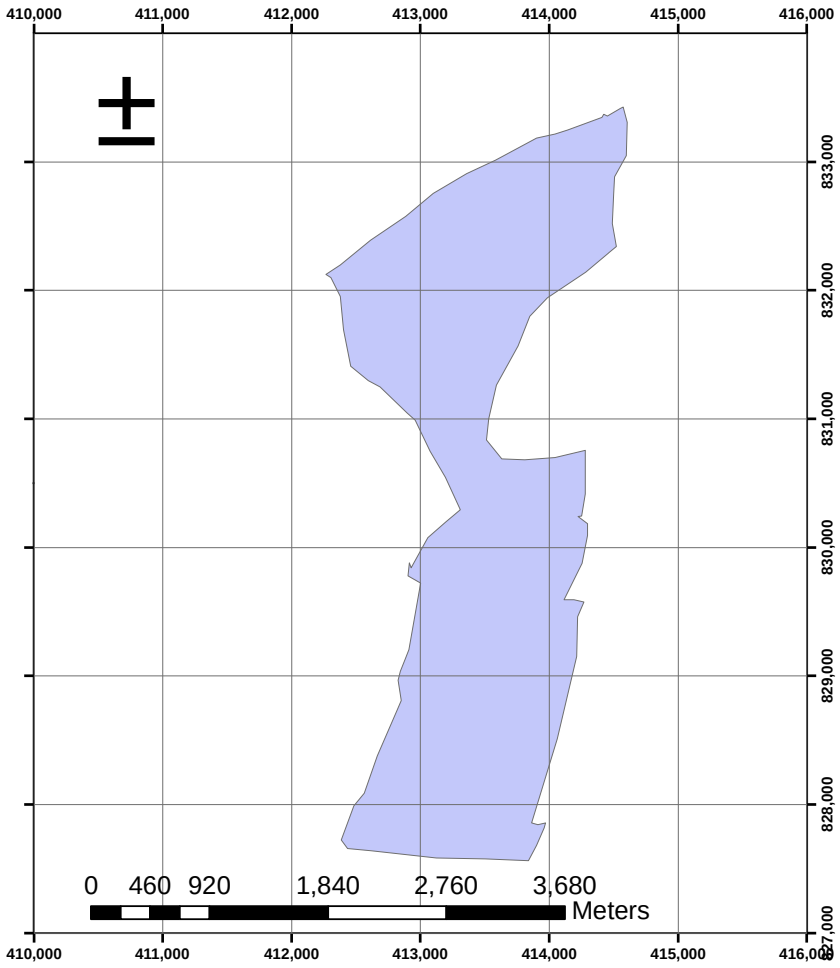


Figure 43. Political map of Weteta Kebele

Geographical location of the Kebele is between 827,000 and 834,000

Northing and 410,000 to 416,000 Easting.

The Kebele is bordered on the South and East by Halaba Special Woreda on the West by Feten and Menzo Feten Kebeles, and on the North by Menzo Kebele. Similar with other Kebeles, there are various community based organization in the Kebele such as "credit and saving institutions" , "women assocaions" *"Equb"* and *"Edir"* to support each other during social and economic difficulties. Two types of "Edir" namely "higher Edir" for the purpose of solving major social issues including farm input distribution of the members and "Lower Edir" for the purpose of organizing funereal services.

Basic Infrastructure

1.Water supply

Silt loaded Water harvesting structures are the main supply source of water for cattle population in the Kebele. There is no deep well for community water supply. Domestic water supply mainly came from few water points in the Kebele and the surrounding Kebeles too..

2.Health

Water born diseases are prominent in the area. One health center for humans and one veterinary medicine center is found in the Kebele. The majority of the households have pit latrine. Road side pit latrines are observed every 500 meters on average. However, they are without hand washing facilities that may be the source of different communicable diseases.

Figure 44. Hygiene information in Sankura Woreda

Those households who have no latrine at their backyard use open field defecation, that may be the main source for pollution of unprotected water source and main source for transmission of diseases.

3.Education

There is one first cycle (1-4) school at the center of the Kebele to give the service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 6 kms away from Alem Gebeya town.

Demographic overview

327 male headed and 47 women headed households are found in the Kebele. According to the information obtained from the Kebele administration office the total population of the Kebele for the year 2016 was about 2857 out of this the males are 1393 (48.76%) while the females are 1464(51.24%).

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

Agriculture (farming as well as livestock rearing) is the main stay of the Kebele's population. Very few households depend on trade activity for their livelihood. The table below summarizes the cattle population in the Kebele.

Table 10. Livestock population in the Kebele

Cattle type	**Number**
Cow	384
oxen	488
Heifer	185
Bull	130
Donkey	284
Horse and mule	86
Sheep	1660
Goat	1350

Biophysical Conditions

1.Soil

Fifty percent of the farm lands have vitric andosols composed of clay loam fine textured soil easily affected by both wind and water erosion.

The minimum soil depth is 33 cm and a maximum of 60 cm. Significant proportion of the top soil also covered with very fertile luvic phaeozems composed of sandy loam textured soil transported and deposited on the low lying areas of the Kebele.

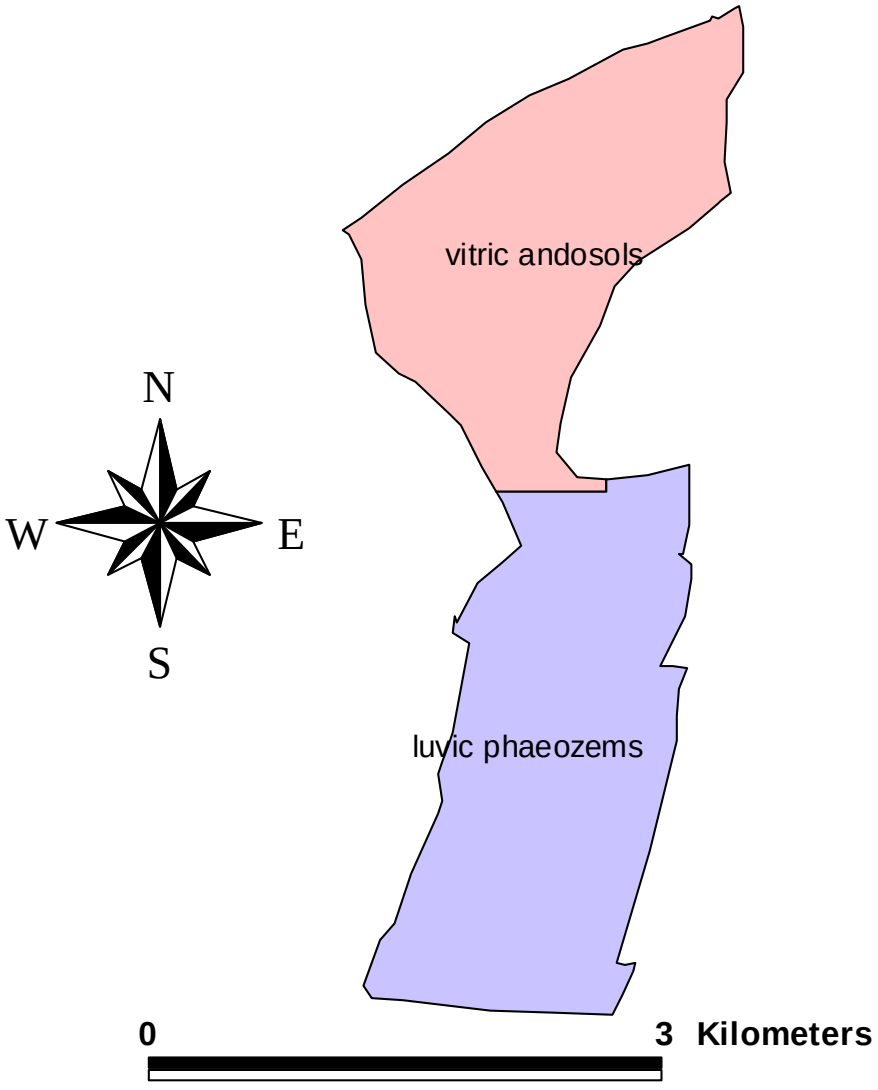


Figure 45. Soil map of Weteta Kebele

2.*Land use/land cover and settlement*

Arable land covered with seasonal and perennial crops are the dominant land use observed in the Kebele. Scattered trees and shrubs which are found around the homesteads and cemeteries played a significant role in maintaining the stability of the micro environment. *Acacia species* are dominant in the community forest lands. Farm lands are dominated by eucalyptus tree species. Similar to other Kebeles, on the hills, the vegetation is extremely threatened because of grazing. Deforestation mainly for the purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.

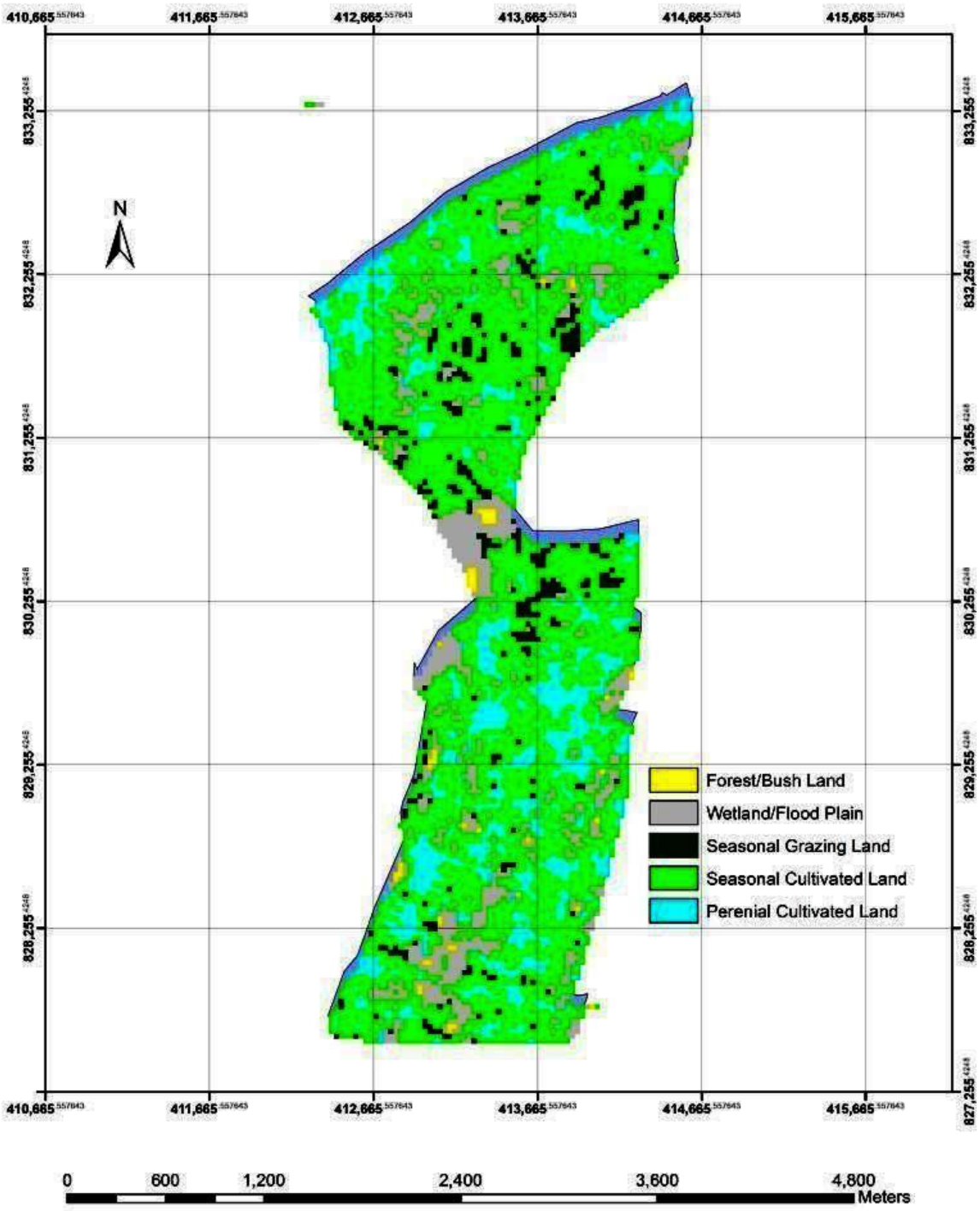


Figure 46. Land use map of Weteta Kebele

Table 11. Land use of Weteta Kebele

Land use	**Area (ha)**
Seasonal and Perennial crops	702.5
Grazing land	-
Forest	11
Degraded land	11
Infrastructures	214

3. *Slope*

Peculiar from other Kebeles observed, central part of the Kebele is dominated by high lying areas. Higher gradients are observed at the center of the Kebele dictating the flow to the North and to the South. The maximum slope of the Kebele is less than 10%. However, due to poor land cover and wrong tillage practices, this gradient facilitated soil erosion and gully formations within the Kebele. The soil is very fragile and week to cope with the smallest errrosive runoff current coming during the rainy season.

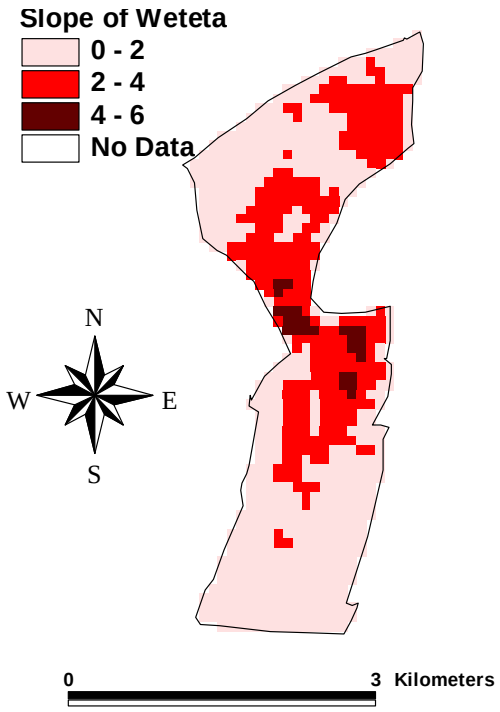


Figure 47. Slope of Weteta Kebele

Surface features which were represented above by drainage area, tillage practice, slope, drainage practice and drainage orientation have observed to produce concentrated runoff down slopes and initiate gullies in the Kebele.

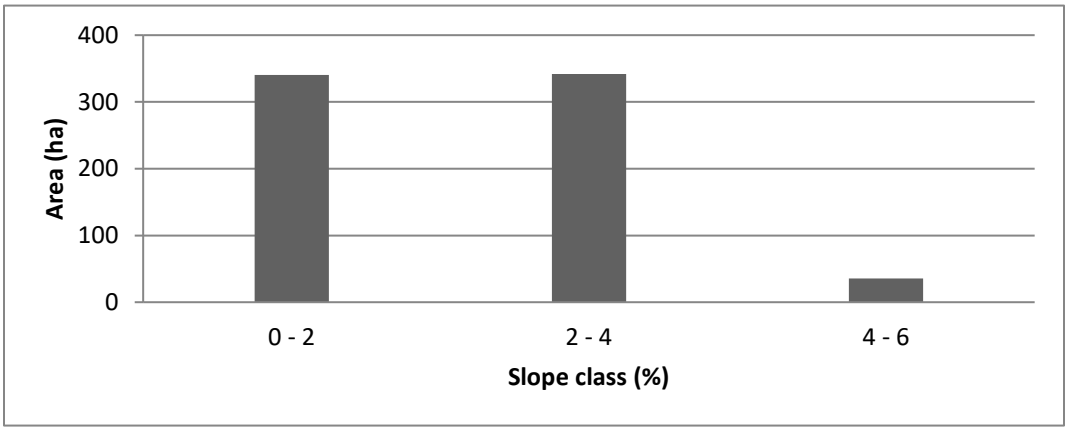


Figure 48. Slope distribution of Weteta Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 2001 and 1814 meters above sea level. The flow is from central part of the Kebele to the four directions.

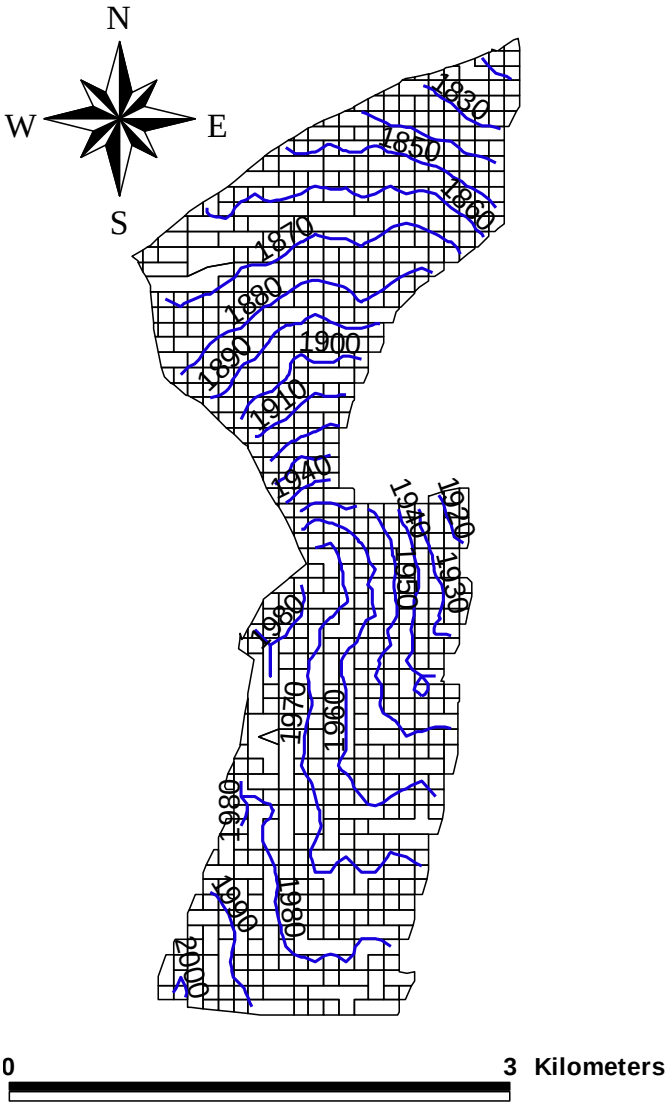


Figure 49. Contour map of Weteta Kebele

5.Gully distribution

Gully development in the Kebele was related to a land use/land cover change such as planting of eucalyptus trees, cultivation of new land, and by the degradation of the vegetation cover on steep slopes. Yet it is still not clear whether or not the gully formed in the area is resulted directly from land management practices (tillage, crop type) or from a change in the hydrology of the landscape due to land management (e.g., higher water tables, lower evapo-transpiration), or some combination of the two.

The gullies were expanding laterally in their middle parts due to gully wall collapse. Gully bank failure was exacerbate by the formation of cracks on fine clay loam vitric andosols as compared with luvic phaeozems. During the dry season, the clay soils develop cracks and crumple as water seepage separates them from the main ground during the wet season. About 4.5% (42 ha) of the Kebele is threatened by gully erosion.

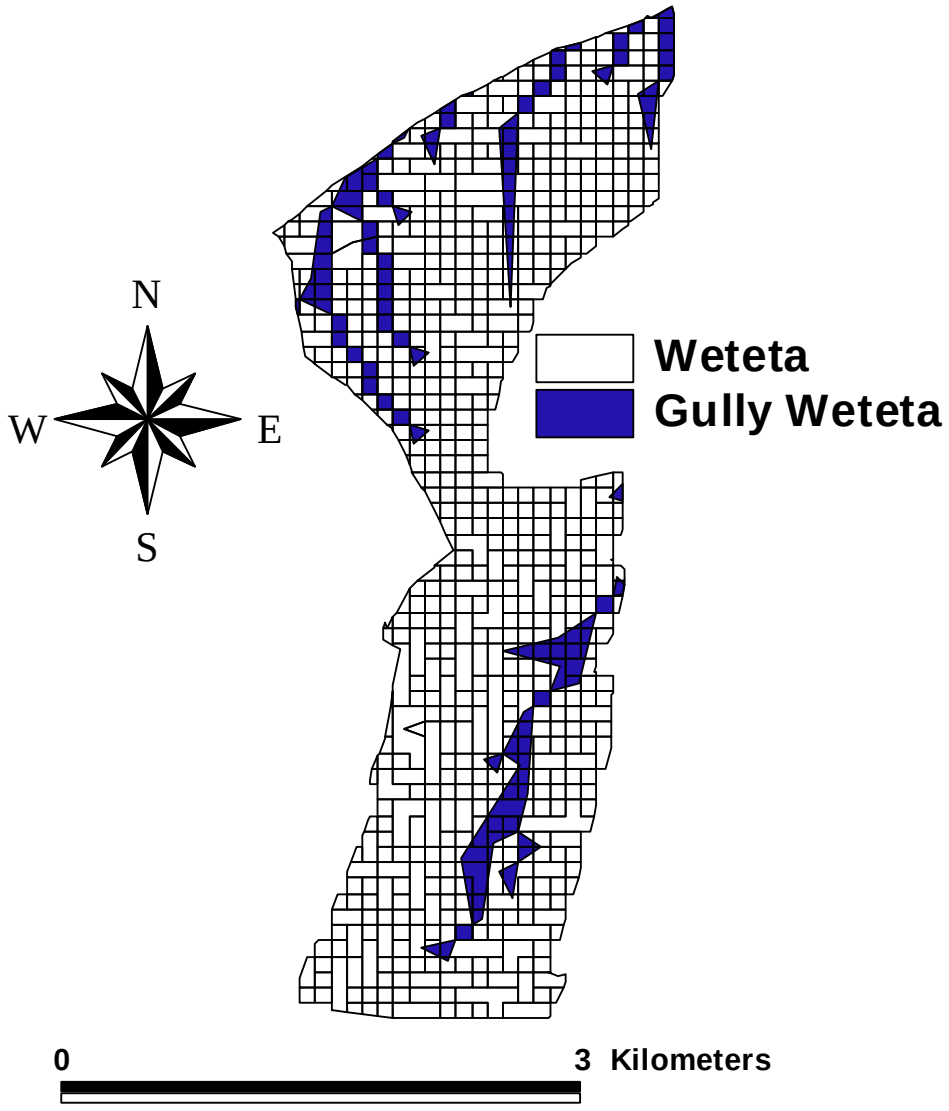


Figure 50. Gully distribution in Weteta Kebele

The list of gullies mentioned below demands urgent interventions to hinder their progressive development.

Table 12. List of gullies that demand immediate action

Gully name	Average width (m)	Average depth (m)	Total length in the Kebele (km)	Location in Weteta	Village
Sorge	6.5	6	1.5	North East	Sorge
Feten Abelcho 1	5	5	1.3	North East	Feten Abelcho
Feten Abelcho 2	6	7	0.75	North	Feten Abelcho
Aredo 1	6	5	1.25	North West	Aredo
Aredo 2	3	3.5	0.75	North West	Aredo
Aredo 3	3	2.5	2.5	South	Aredo

6.Base Map of the Kebele

The community map below depicted the different land uses as the farmers perceived their environment. The degraded areas on their map is those areas which have dominated by vitric andosols at a higher gradient mentioned on the slope distribution map generated above. All the boundaries where the Kebele bordered with other Kebeles are affected by gullies at different levels.

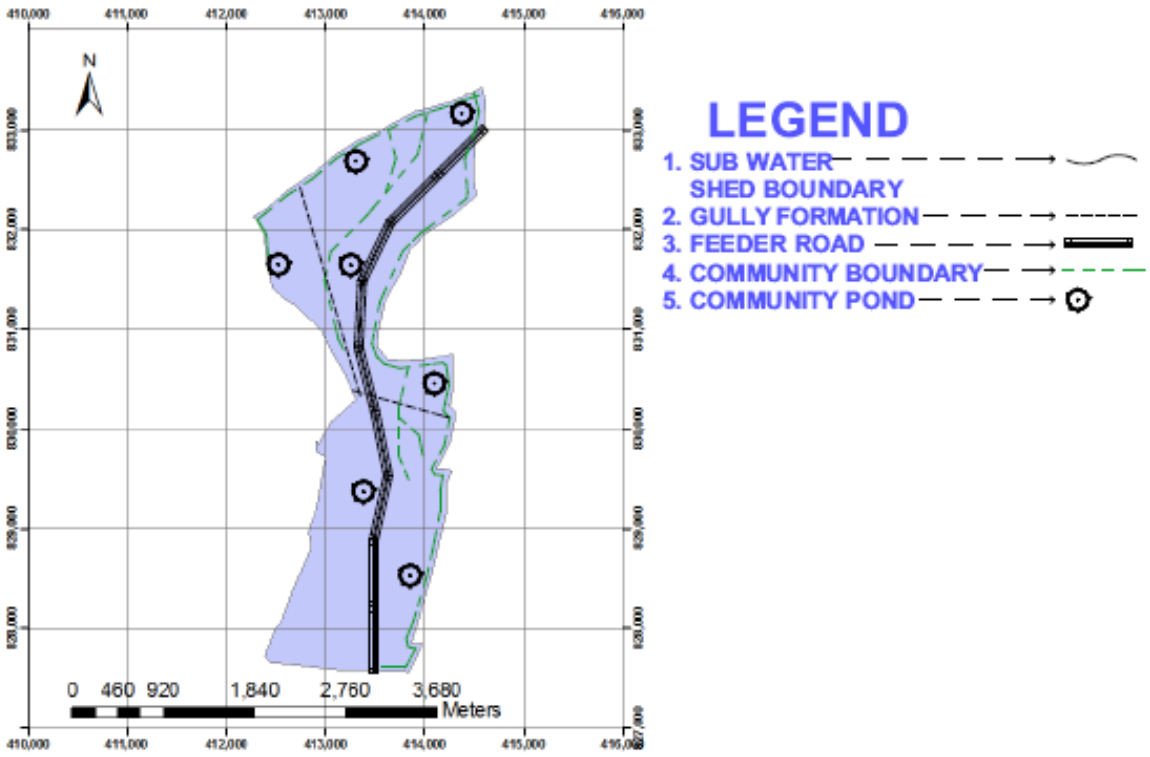


Figure 51. Base map of Weteta Kebele

7.Development Map of the Kebele

The following list presents those interventions suggested by a team of experts, development agents and farmers that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains

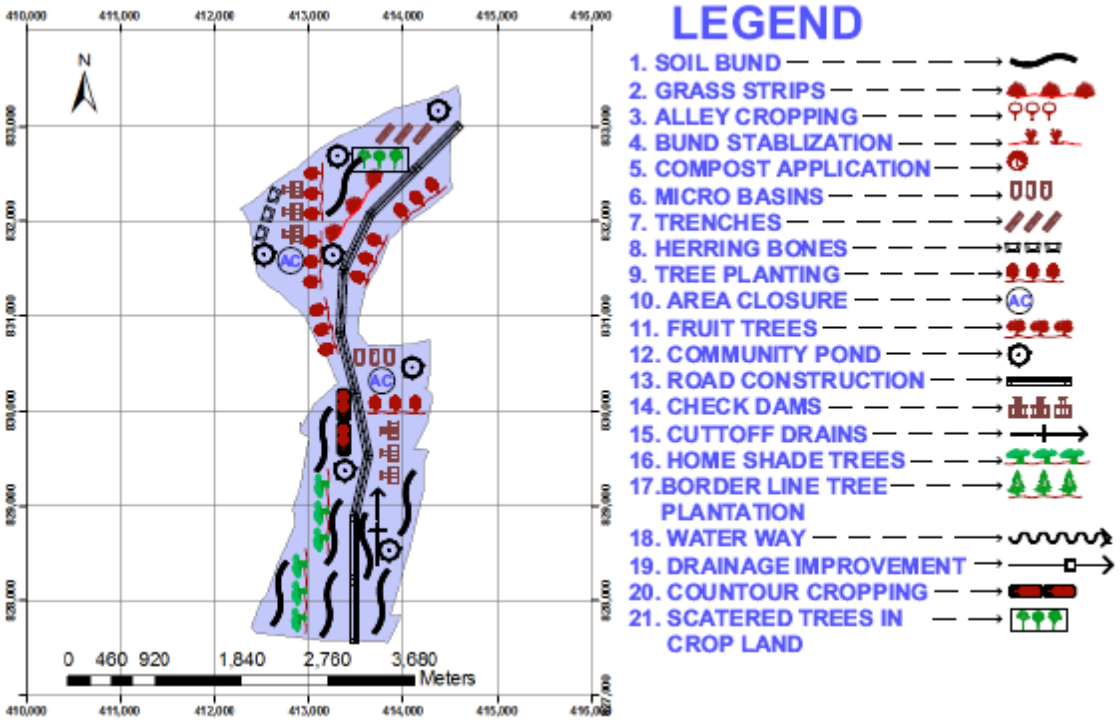


Figure 52. Development map of Weteta Kebele

5.6. Bercho Kebele

General

Situated in Silti Zone of SNNP Regional State, Bercho Kebele covers an area of 570 ha of which 24.6 hectares is highly degraded.

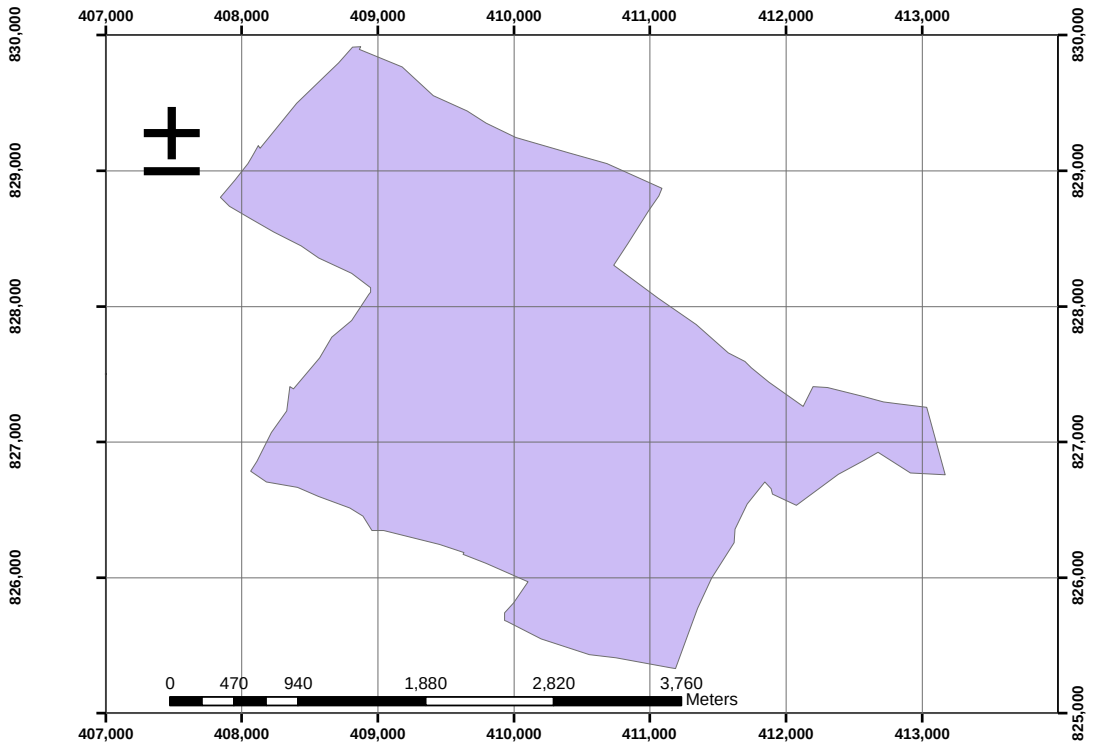


Figure 53. Political map of Bercho Kebele

The Geographical UTM Easting of the Kebele is between 413,100 m to 407,900 m and Northing of 825,200 m to 830,950 m.

The Kebele is bordered on the East by Halaba Special Woreda on the West by Kore and Tachignaw Kemo Kebeles, on the North by Feten Kebele and on the South by Bercho Kulufo Kebele. Similar to other Kebeles mentioned above there are various community based

organization in the Kebele including *"Equb"* ,*"Edir"* credit and saving organization for the purpose of social and economic challenges facing the members.

Basic Infrastructure

1.Water supply

There are 139 hand dug wells, one pond and 86 water harvesting troughs are found in the Kebele. These water supply schemes provide water for both livestock and human consumption purpose. The hand dug wells are mainly used for irrigation purposes. However improved water supply for domestic consumption is one of the major problems of the Kebele.

2.Health

One health center for humans and one veterinary medicine center is found in the Kebele. According to the Kebele health workers report the Kebele latrine coverage for the year 2016 was 95% this does not indicate the whole aspects of sanitation. The majority of the households have latrine for their family. Those households who have no latrine at their backyard use open field, bush and backyard that is the main source for pollution of unprotected water source and main source for transmission of diseases.

3.Education

There is one first cycle (1-4) school at the center of the Kebele to give the service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 10 kms away from Alem Gebeya town.

Demographic overview

The Kebele population for the year 2016 was about 5078 out of this the males are 2488 (49%) while the females are 2590 (51%). Specific to this Kebele, on average 9 people lives in one hectare of land as compared with 5 person per hectare in Feten Kebele, 4 person per hectare in Menzo Kebele, and 1 person per hectare in Worabe Sinbita Kebele showing the highest pressure on land as compared with all the others.

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

Agriculture (farming as well as livestock rearing) is the main stay of the Kebele's population. Very few households depend on trade activity for their livelihood.

Biophysical Conditions

1.Soil

Equal proportion of the Kebele farm lands have vitric andosols and vitric phaeozems, mainly composed of very fine textured sandy/sandy loam soil susceptible to erosion. Soil depth ranges between 35 and 55 cm.

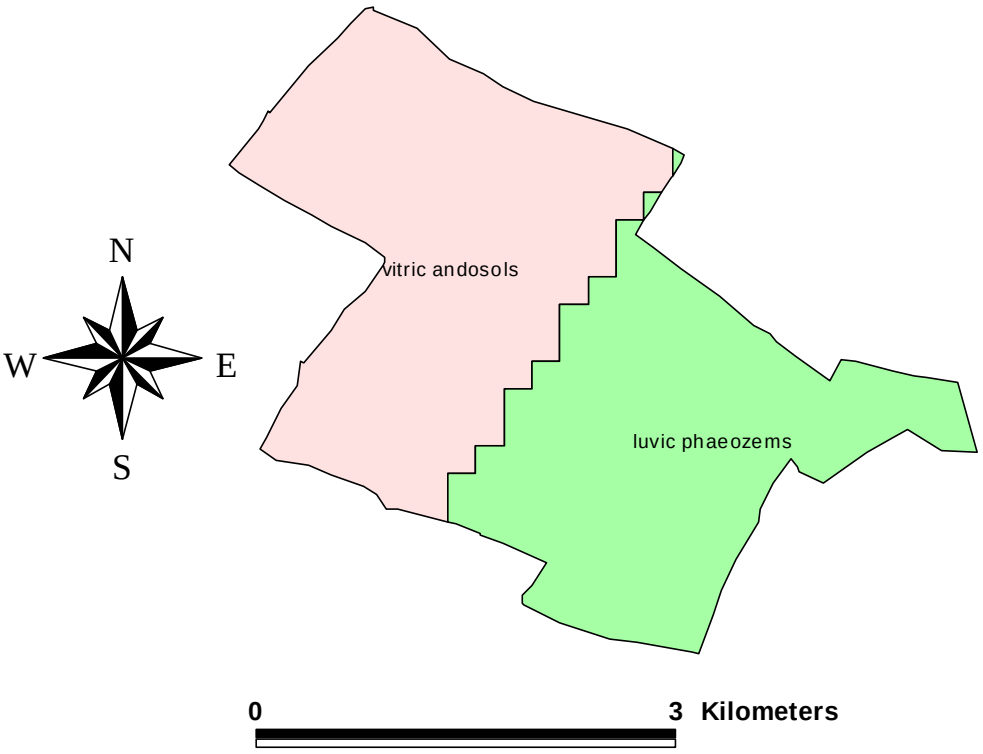


Figure 54. Soil map of Bercho Kebele

2.Land use/land cover and settlement

More than 65% of the area is used for agriculture. The forest cover of the target area is dominated by plantation of exotic species (dominantly

eucalyptus). Remnants of indigenous trees are found in a scattered manner, shrubs and grass are still seen on some part of the hill slope areas which has relatively good soil depth; and bare land with gravel outcrops also exists. The dominant exotic species are *Eucalyptus citriodora, Eucalyptus camalduneis and Jacarnda mimosifolia.*

The spatial and proportional distribution of the land use shows that mixed (residence and agriculture) use (65%) and land occupied by institutions (27.8%) are the dominant land uses on the Kebele. The third highest share is that part of the Kebele's degraded area with sloppy topography accounting for about 4.3 % of the total land area of the Kebele. Deforestation mainly for the purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.

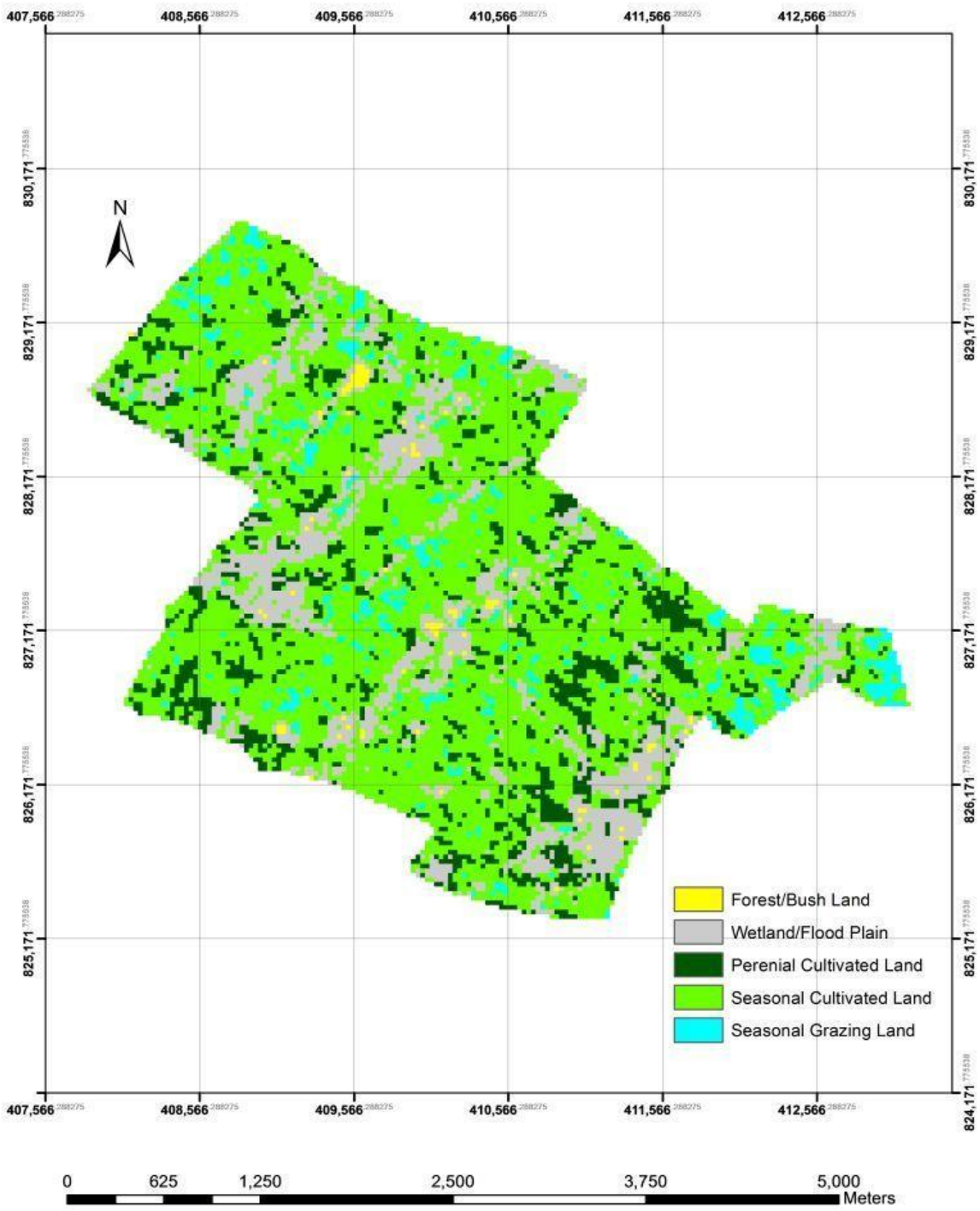


Figure 55. Land use map of Bercho Kebele

Land use	Area (ha)
Arable land	371.2
Grazing land	10.2
Forest	5.4
Degraded land	24.6
Infrastructures	158.2

3. Slope

As compared with all the other Kebeles, the Kebele is composed of high slope areas. The maximum slope of the Kebele is 8%. However, due to poor land cover and wrong tillage practices, this gradient facilitated soil erosion and gully formations. The soil is very fragile and week to cope with the smallest errrosive runoff current coming during the rainy season.

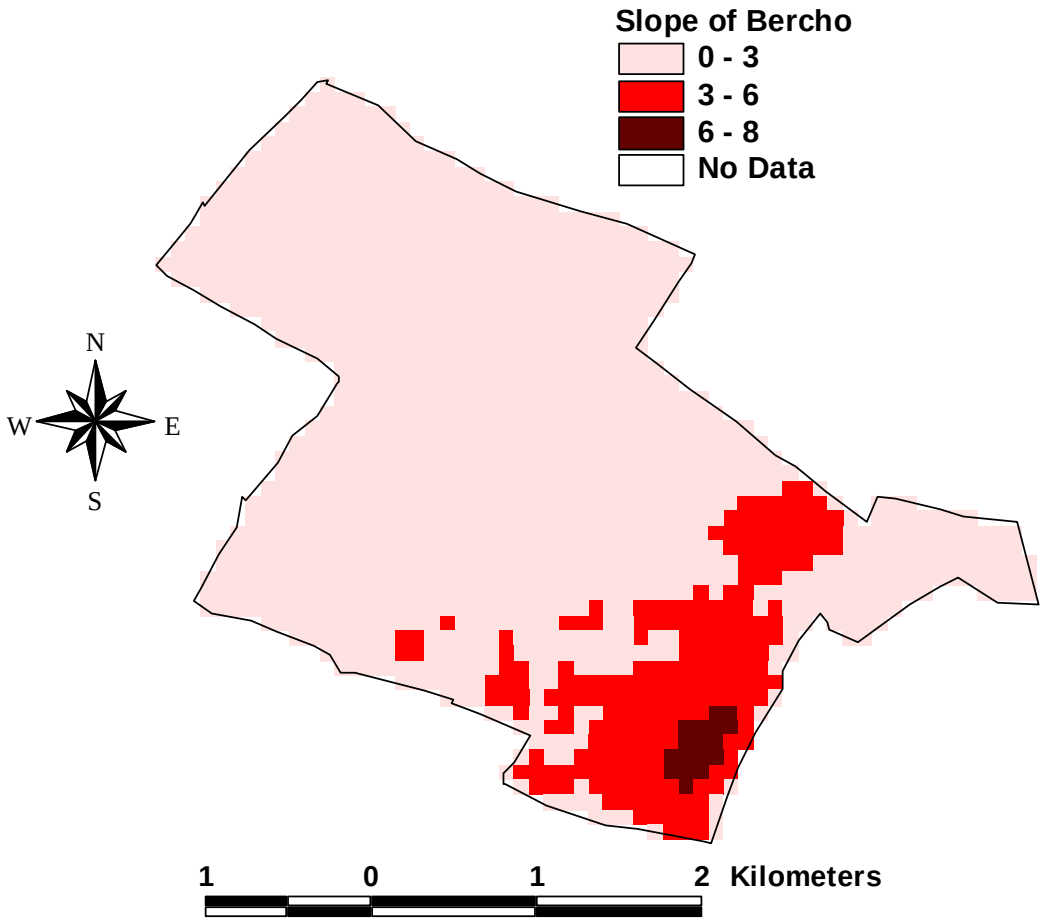


Figure 56. Slope of Bercho Kebele

The areas of higher slope South of the Kebele are proposed to be covered by forest which is helpful to erosion and land degradation. The total area of this land use is about 12 hectares and includes the already forest and bushes covered areas and areas to proposed to be afforested. The forestation process needs avoiding the species which are of weeds character and also exotic and planting the indigenous trees. The selection of the trees should be in consideration of the erosion protection and dense growths.

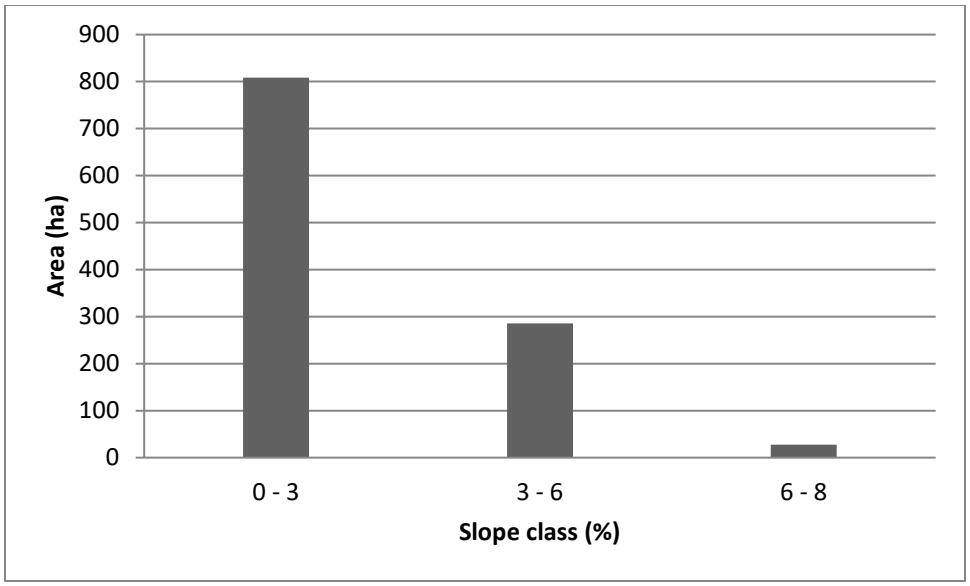


Figure 57. Slope distribution of Bercho Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 2100 and 1878 meters above sea level. The flow is from South East to North West direction towards Bilate River.

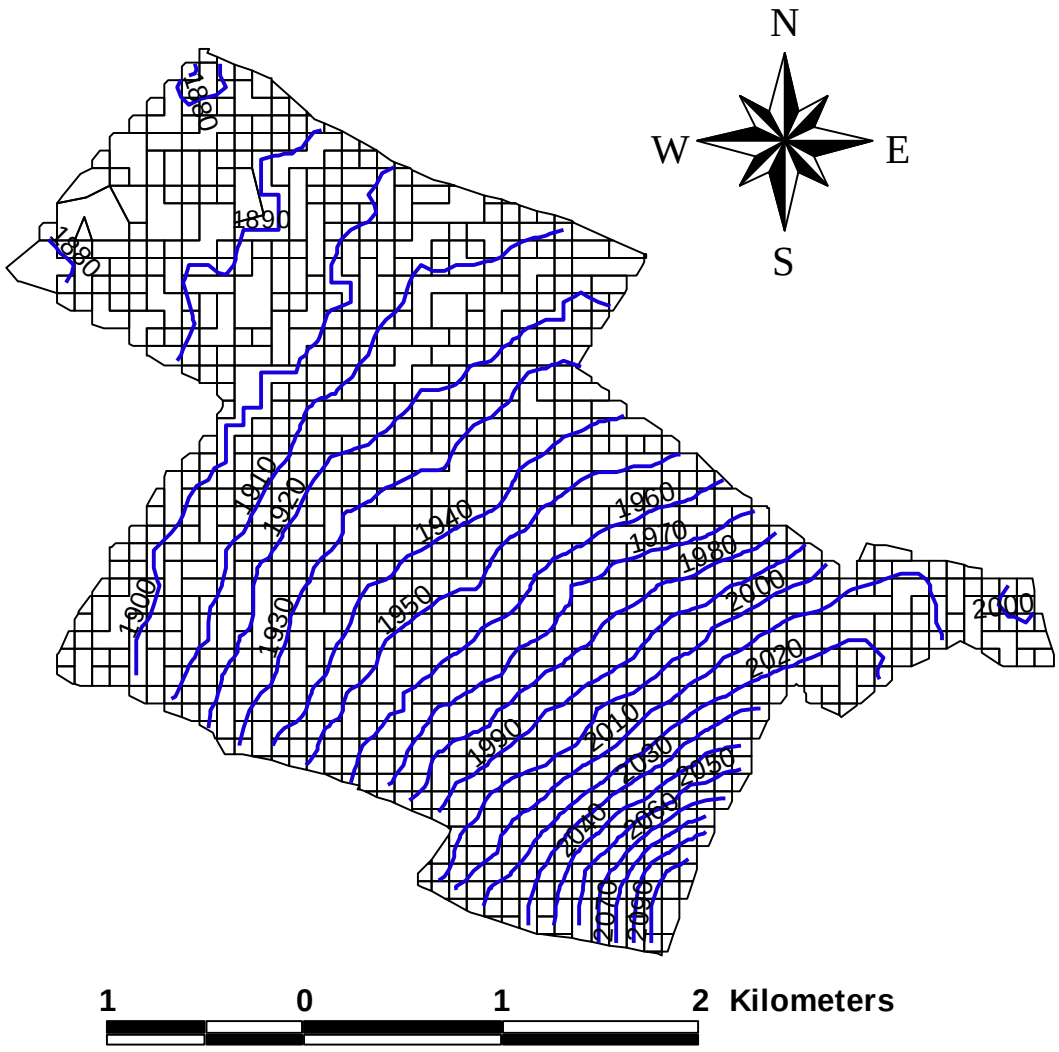


Figure 58. Contour map of Bercho Kebele

5.Gully distribution

Gully development in the area is initiated as a result of changes in conditions which influence the hydraulic characteristics of flow and the forces that resists erosive flows. The resulting concentration of flow is sufficient to sustain and increase erosion process. Subsequent head

ward erosion and widening of gully were continue until the gully is adjusted to a new set of equilibrium conditions and becomes relatively stable. Majority of the gullies were initiated within the Kebele. About 22.1% (126 ha) of the Kebele is threatened by gully erosion.

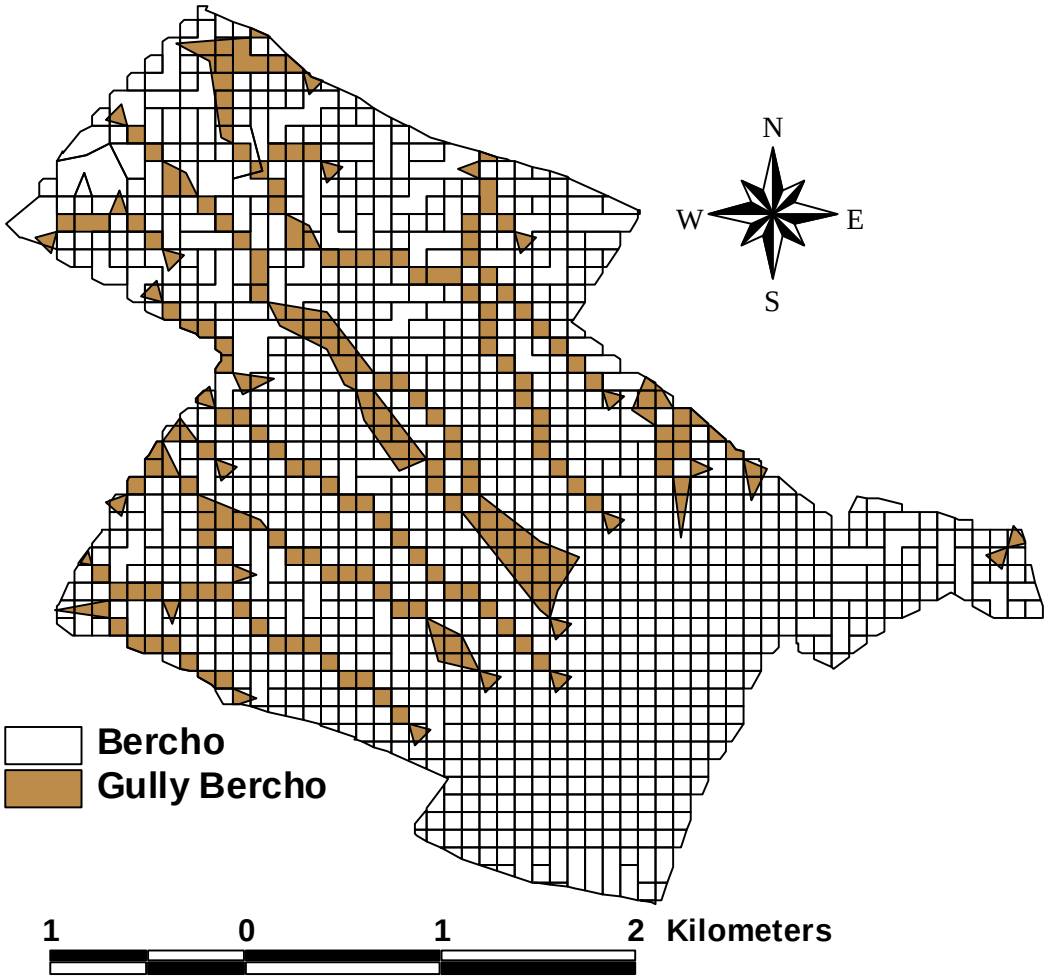


Figure 59. Gully map of Bercho Kebele

The gullies listed below needs immediate attention by the respective institutions before they took much cultivated land from the existing land use.

Table 13. List of gullies that demand immediate interventions in the Kebele

Gully name	Average width (m)	Average depth (m)	Total length in the Kebele (km)	Location in Bercho
Kedir Mohamed	25	20	3	South East
Bushira Hussen	20	15	2	South East
Kedamo Kiyar	17	13	1	South East
Sanga Kiyar	17	12	1.5	East
Suraji Shikure	16	10	1.5	East
Tofik Detamo	15	10	0.5	North East
Salima Jemal	13	10	1	North East
Kemal Jemal	14	9	1	North East
Gutago Lalanda	10	8	1	North East

6.Base Map of the Kebele

The community map below depicted the different land uses as the farmers perceived their environment. The degraded areas on their map is those areas which are located upstream of farm lands mainly caused by grazing and plowing of steep slopes without protection.

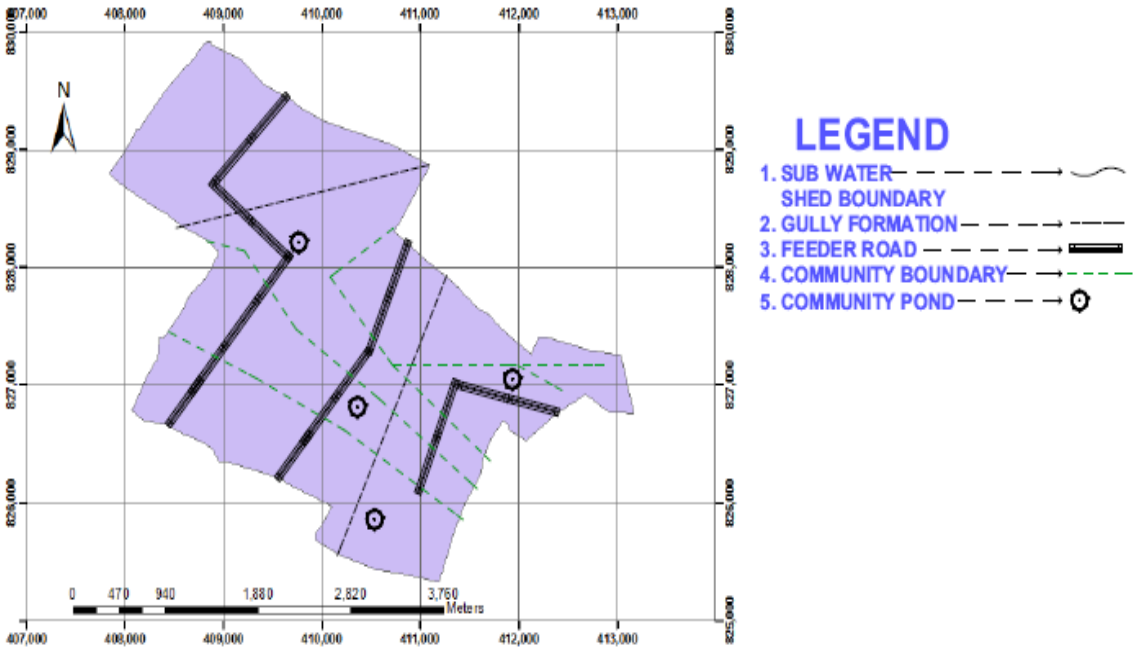


Figure 60. Base map of Bercho Kebele

7.Development Map of the Kebele

The following list presents those interventions suggested by a team of experts, development agents and farmers that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains
- Artificial water ways

Fertility management:

- Composting

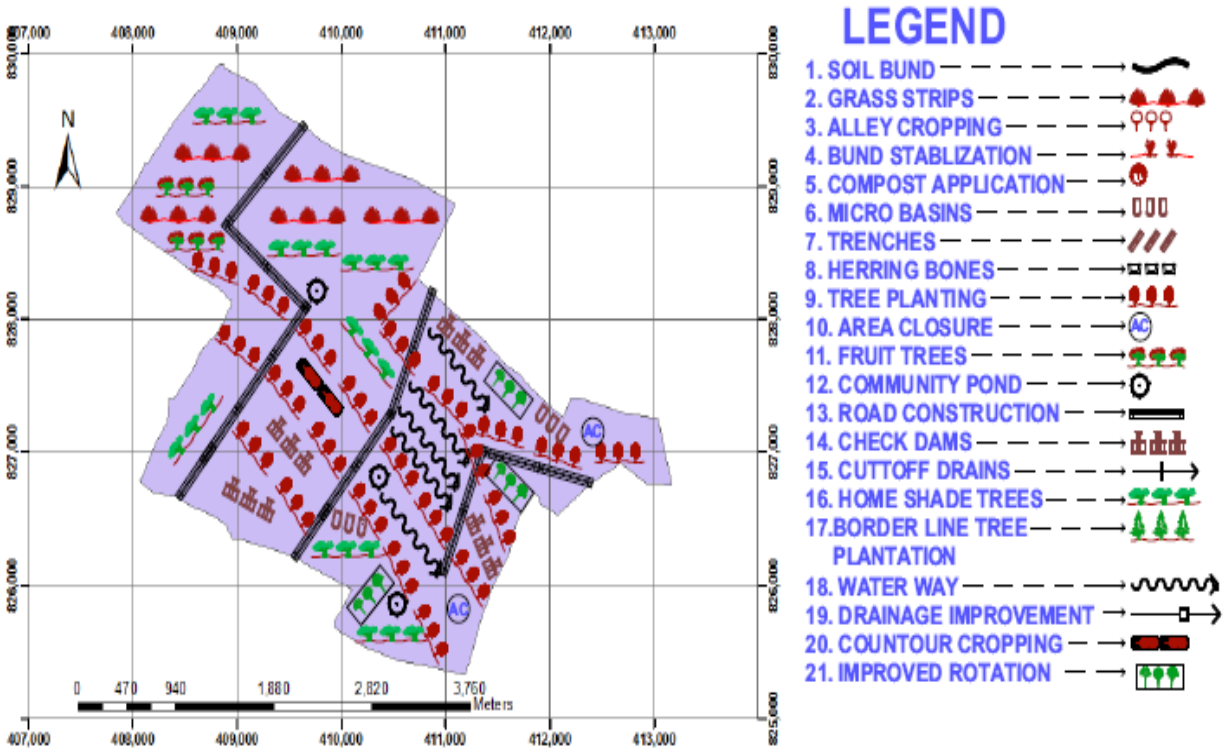


Figure 61. Development map of Bercho Kebele

5.7.Bercho Kulfo Kebele

General

Bercho Kulfo Kebele is situated in Silti Zone of SNNP Regional State covering an area of 568.84 ha of which 78.75 hectares is highly degraded. For Land Management Planning purpose the Kebele is structured by 4 development clusters of having about 143 ha, 144.4 ha, 127.4 ha, and 160 ha of land for each.

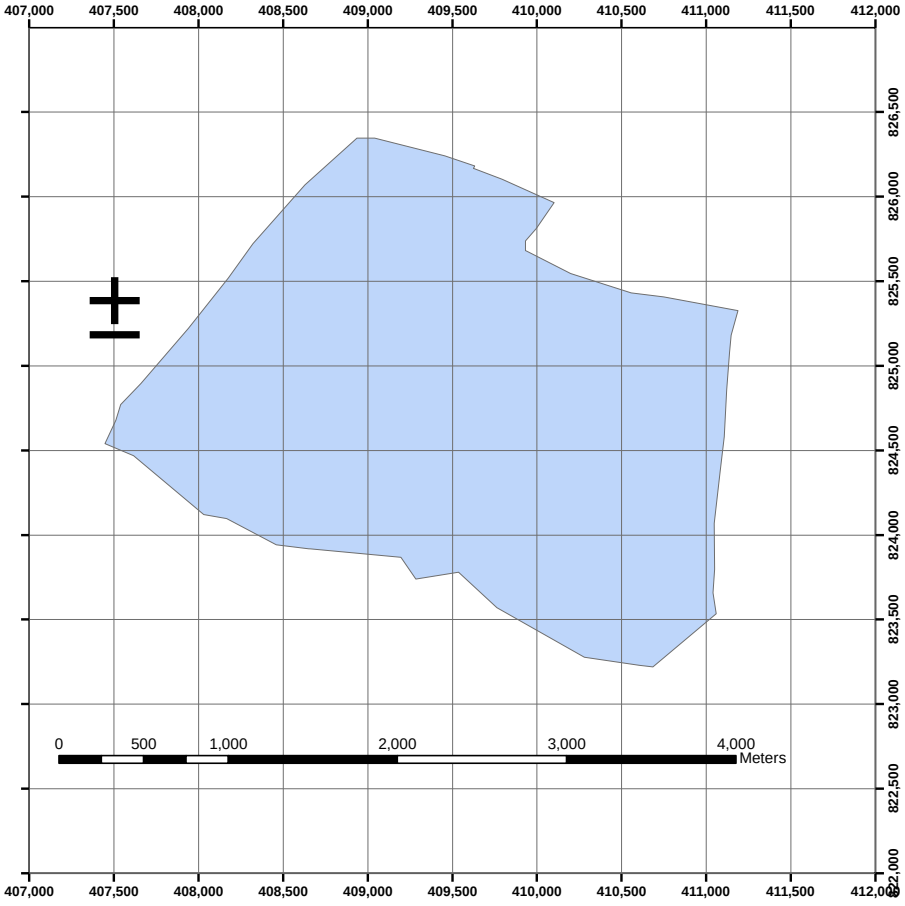


Figure 62. Political map of Bercho Kulufo Kebele

The Geographical UTM Easting of the Kebele is between 407,900 m to 411,200 m and Northing of 823,200 m to 826,400 m.

The Kebele is bordered on the East by Halaba Special Woreda on the West by Jata Kebele, on the North by Bercho Kebele and on the South by Halaba Special Woreda Kebele.

There are various community based organization in the Kebele such as "women support group", "Credit and saving institutions", *"Equb"* and *"Edir"* to help each other in terms of social and economic issues.

Basic Infrastructure

1.Water supply

Water points, ponds and water harvesting structures are used for domestic and livestock drinking purposes. However improved water supply for domestic consumption is one of the major problems of the Kebele.

2.Health

Livestock and human health problems are ranked among the first five major problems of the Kebele. One health center for humans and one veterinary medicine center is found in the Kebele. Coomunity led total sanitation The majority of the households have latrine for their family. Those households who have no latrine at their backyard use open field, bush and backyard that is the main source for pollution of unprotected water source and main source for transmission of diseases.

3.Education

There is one first cycle (1-4) school at the center of the Kebele to give the

service at the grass root community level.

4.Road

The Kebele is accessible by gravel road diverted from the main Asphalt road at Alem Gebeya town. The center of the Kebele is 13 kms away from Alem Gebeya town.

Demographic overview

According to the information obtained from the Kebele administration office the Kebele has 382 households (325 male headed and 57 female headed); the total population of the Kebele for the year 2016 was about 2007 out of this the males are 1004 (50.03%) while the females are 1003(49.97%).

Ethnic Group and Religion

Great majority of the Kebele population belong to Silti ethnic group. The language that is spoken by the group member is Siltigna. In fact according to obtained information from the Kebele administration office, most of the Kebele populations are familiar with Amharic language that is used as working language of the Regional State. The great majority of the Kebele population is Islam.

Economic-activity

Agriculture (farming as well as livestock rearing) is the main stay of the Kebele's population. Very few households depend on trade activity for their livelihood. The table below summarizes the cattle population in the Kebele.

Table 14. Livestock population in the Kebele

Cattle type	Number
Cow	395
oxen	268
Heifer	198
Bull	229
Donkey	385
Horse and mule	14
Sheep	412
Goat	425

Biophysical Conditions

1.Soil

Majority of the farm lands have luvic phaeozems mainly composed of very fine textured sandy loam soil easily affected by both wind and water erosion. The minimum soil depth is 3 cm observed at the Western boundary of the Kebele with Menzo Kebele and a maximum of 86 cm at the boundary between Halaba Special Woreda. Significant proportion of the top soil also covered with very fertile vitric andosols transported and deposited on the low lying areas of the Kebele where majority of irrigated agriculture is practiced.

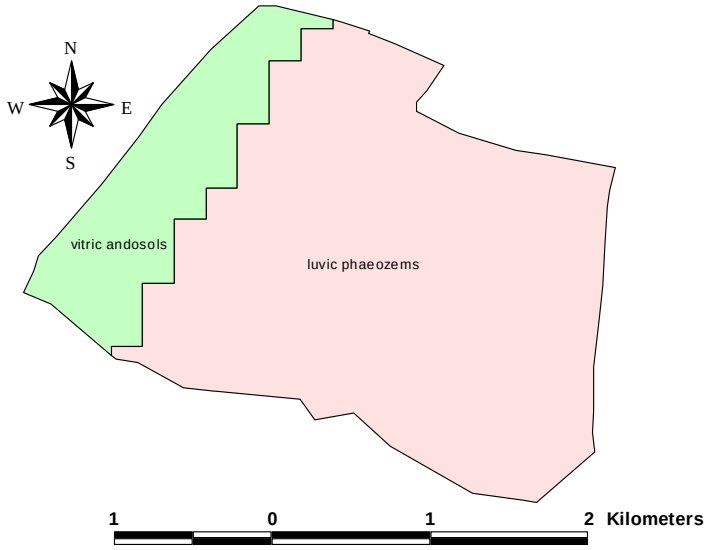


Figure 63. Soil map of Bercho Kulufo Kebele

2.*Land use/land cover and settlement*

The land cover in the Kebele is dominated by scattered trees and shrubs which are found around the homesteads. Small patches of shrubs, trees, and grasses are observed on farmlands. The vegetation in the area has been categorized under the semi-humid woodland with a mixture of broad and narrow-leaved species. *Accasia abyssinica*, eucalyptus tree,and *Accasia albida*, are the dominant tree types on off farm plots. On the hills, the vegetation is extremely threatened because of grazing and fuel wood extraction. Deforestation mainly for the purpose of fuel wood and the use of none efficient fuel stoves put significant pressure on the existing small patches of wood land in the Kebele.

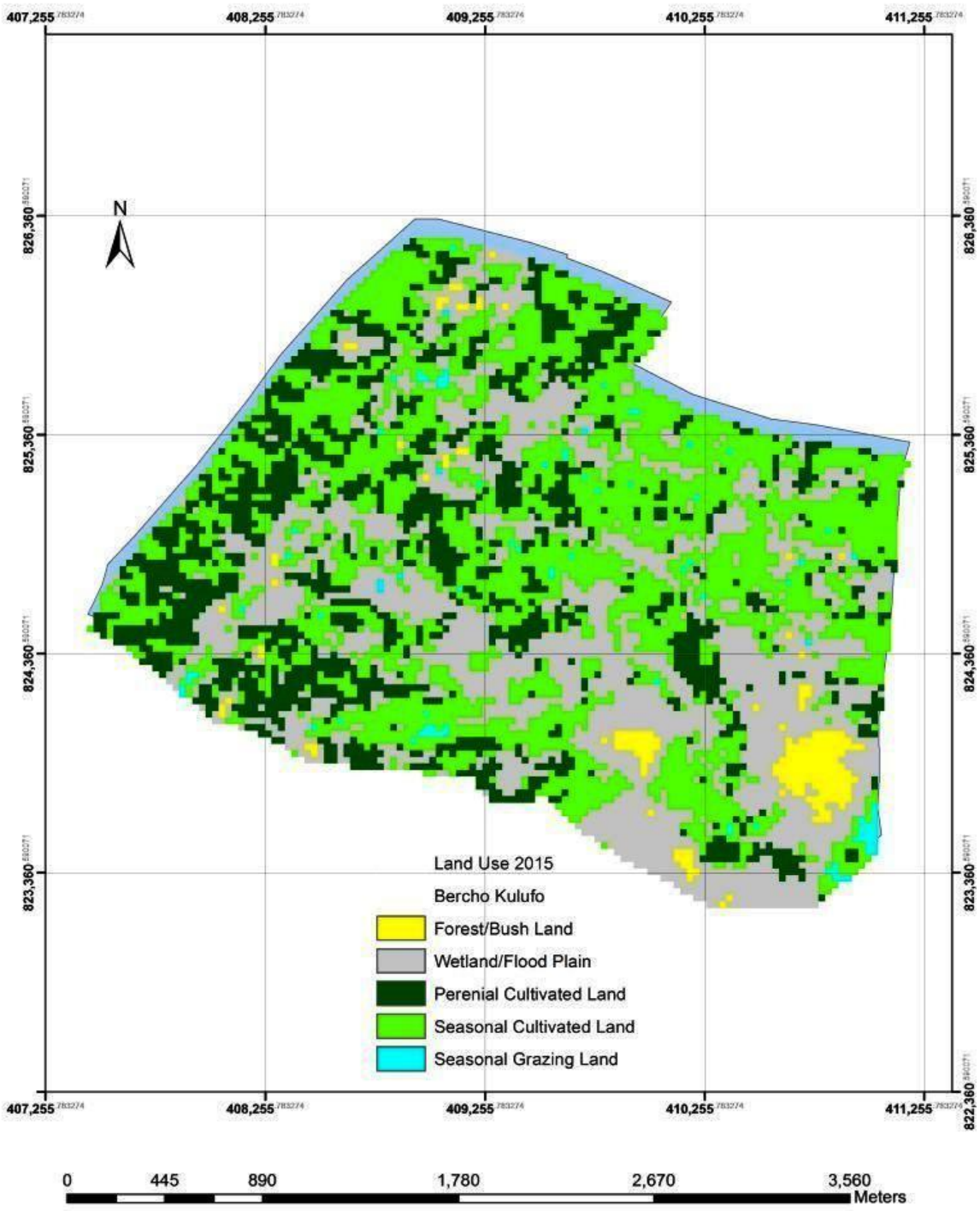


Figure 64. Land use map of Bercho Kulufo Kebele

Table 15. Land use of the Kebele

Land use	**Area (ha)**
Seasonal and perennials crops, grazing land	450.87
Forest	8.47
Degraded land	78.75
Infrastructures*	30.75

*cemeteries, roads, FTC, school, mosques

3. *Slope*

Directly or indirectly; slope contributes to the formation of gully in the study area and consequently facilitate its formation to a very large extent as it affect the current and speed of running water. Erosion may also occur even on gentle topography because of poor infiltration and inadequate storage of surface water due to surface crusting of cultivated fields. The maximum slope of the Kebele is less than 5%. However, due to poor land cover and wrong tillage practices, this gradient facilitated soil erosion and gully formations. The soil is very fragile and week to cope with the smallest errrosive runoff current coming during the rainy season.

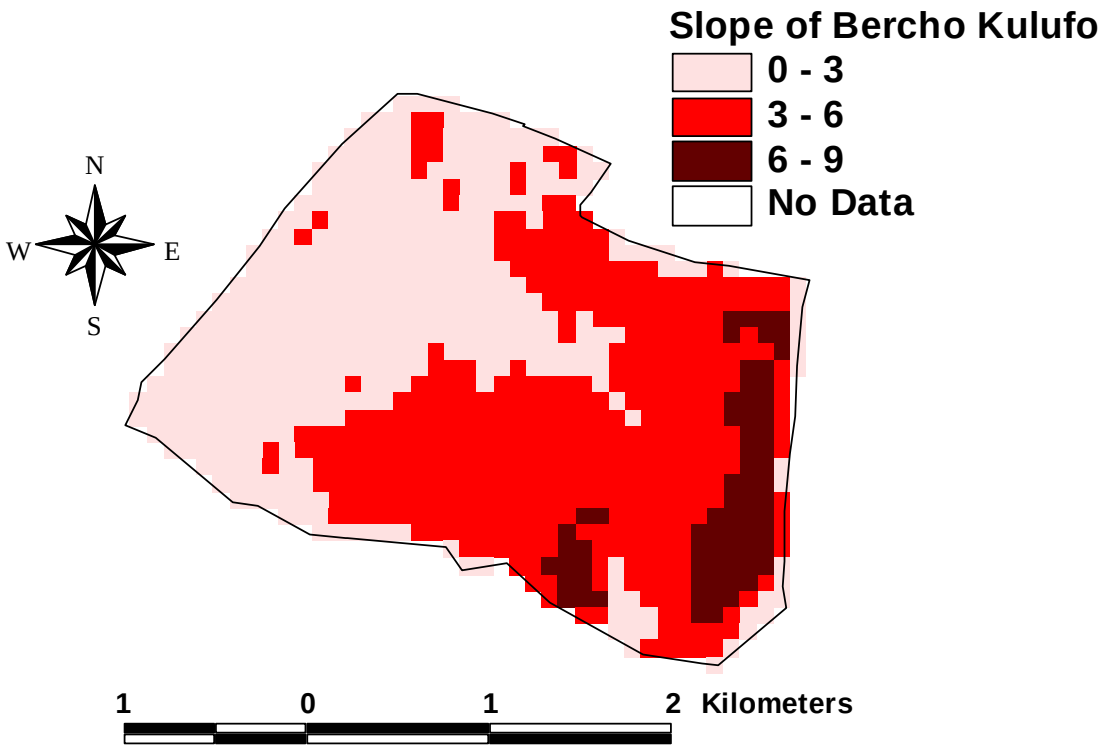


Figure 65. Slope in Bercho Kulufo Kebele

Runoff on low slopes flows slowly and quickly forms a water layer deep enough to act as surface mulch. Increasing slope length enhances soil loss as more runoff can accumulate on long slopes.

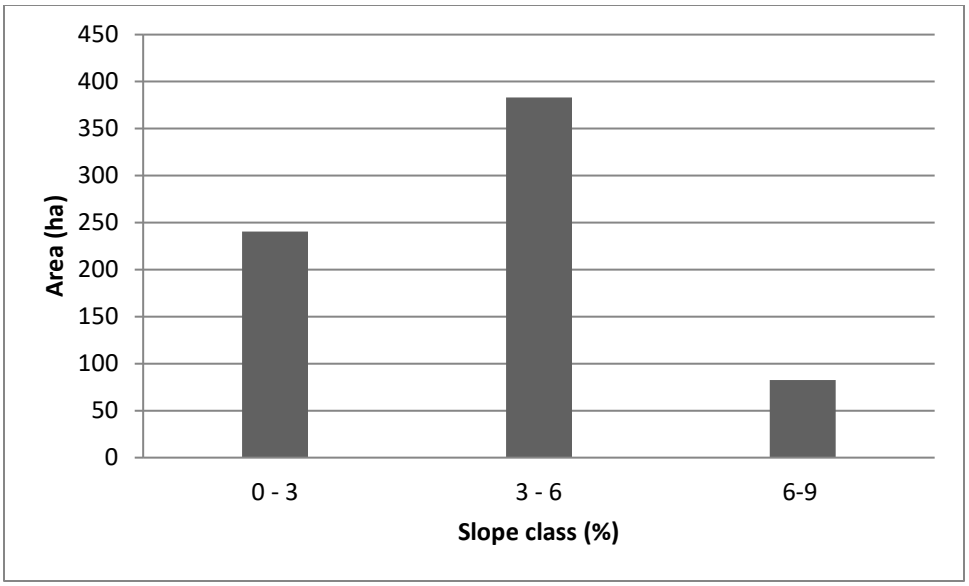


Figure 66. Slope distribution in Bercho Kulufo Kebele

4.Elevation and Contour

Maximum and minimum elevation of the Kebele is 1835 and 1795 meters above sea level. The flow is from South West to North East direction. Together with the flood coming from Menzo Kebele, South West part of the Kebele is the source of erosion and North East is a place of sedimentation. North East part of the Kebele, specifically, all locations downstream direction of the first cycle school is affected by flooding at least for five months every year.

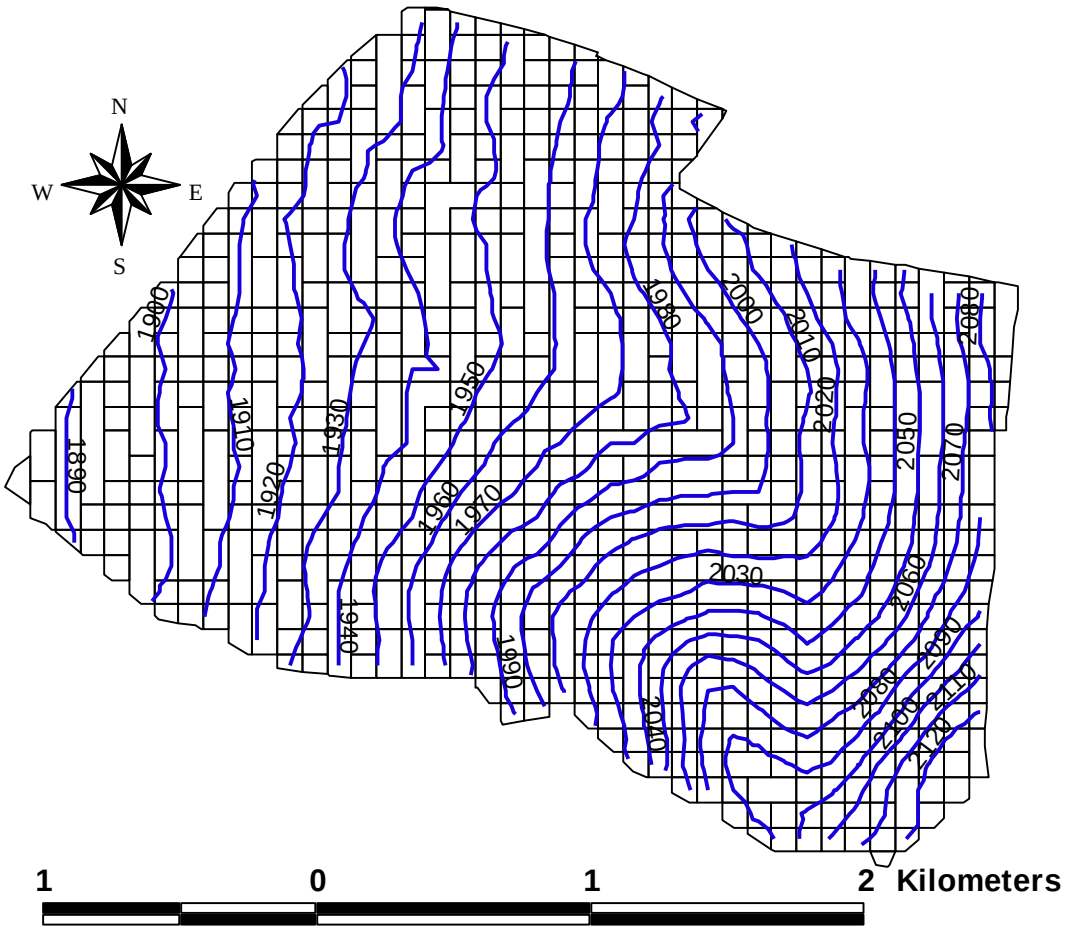


Figure 67. Contour map of Bercho Kulufo Kebele

5.Gully distribution

The Kebele drains towards Bilate River. Majority of the gullies in the Kebele is originated from the Kebele itself. About 8.8% (50 ha) of the Kebele is threatened by gully erosion.

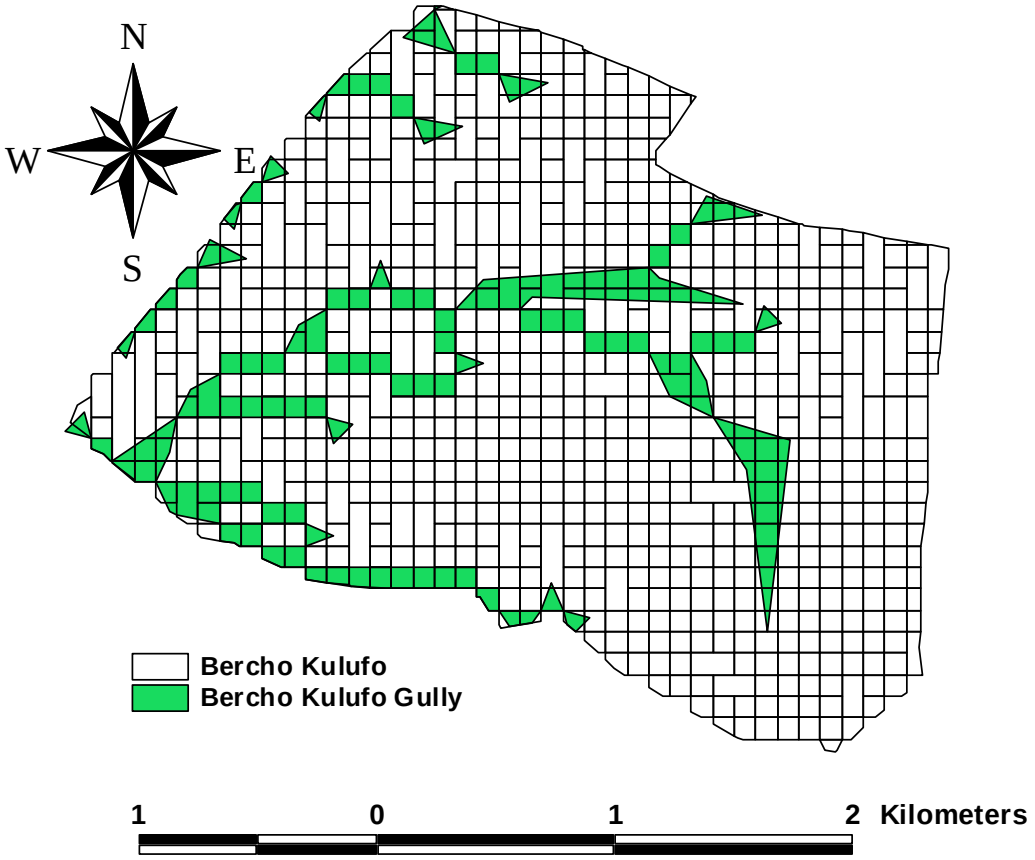


Figure 68. Gully map of Bercho Kulufo Kebele

Table 16. List of gullies that demand immediate action

Gully name	Average width (m)	Average depth (m)	Total length in the Kebele (km)	Location in Bercho Kulufo	Village
Lay Sabola	5	4	0.381	North East	Lay Sabola
Mehal Sabola	6	4	0.490	North West	Mehal Sabola
Eresha	5	5	0.450	South East	Eresha
Lay Dero	4	5	0.650	North	Lay Dero
Tach Dero	5	6	0.59	North West	Tach Dero
Tach Sabola	4	3.5	0.495	North West	Tach Sabola

6.Base Map of the Kebele

All foot trails were affected by gullies. The community map below depicted the different land uses as the farmers perceived their environment. The degraded areas on their map is those areas which are located upstream of farm lands mainly caused by grazing and plowing of steep slopes without protection.

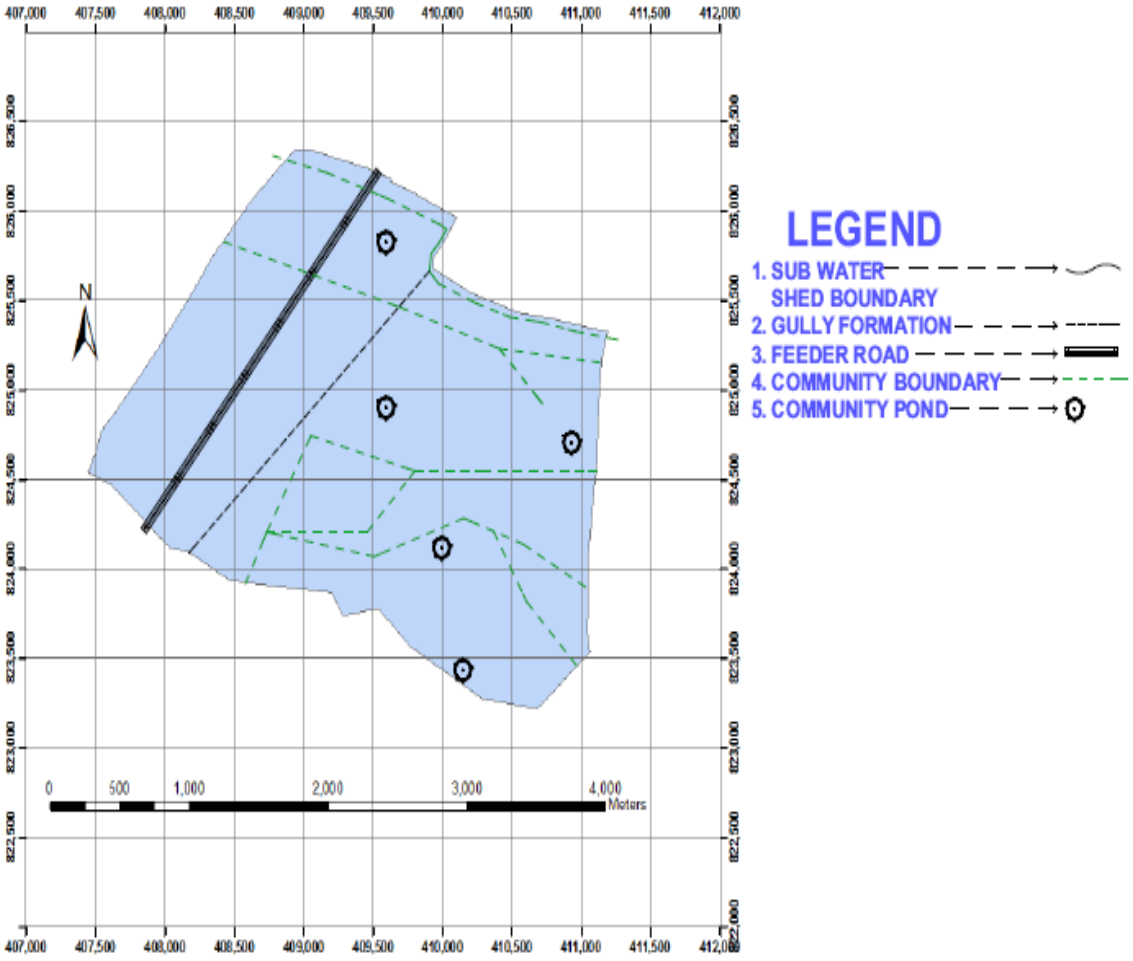


Figure 69. Base map of Bercho Kulufo Kebele

7. Development Map of the Kebele

The following list presents those interventions suggested by a team of experts, development agents and farmers that can mitigate the problem of soil erosion and storm water drainage in the Kebele.

Structural measures on different land uses include:

- Soil bunds, Bund stabilization, micro basins, trenches, herring bones,

Biological measures on different land uses include:

- Grass strip, Alley cropping, Tree planting, Area closure, contour cropping/farming, improved crop rotation

Gully stabilization measures on different land uses include:

- Area closure, check dams, grass/tree planting

Drainage measures on different land uses include:

- Cutoff drains
- Artificial water ways

Fertility management:

- Composting

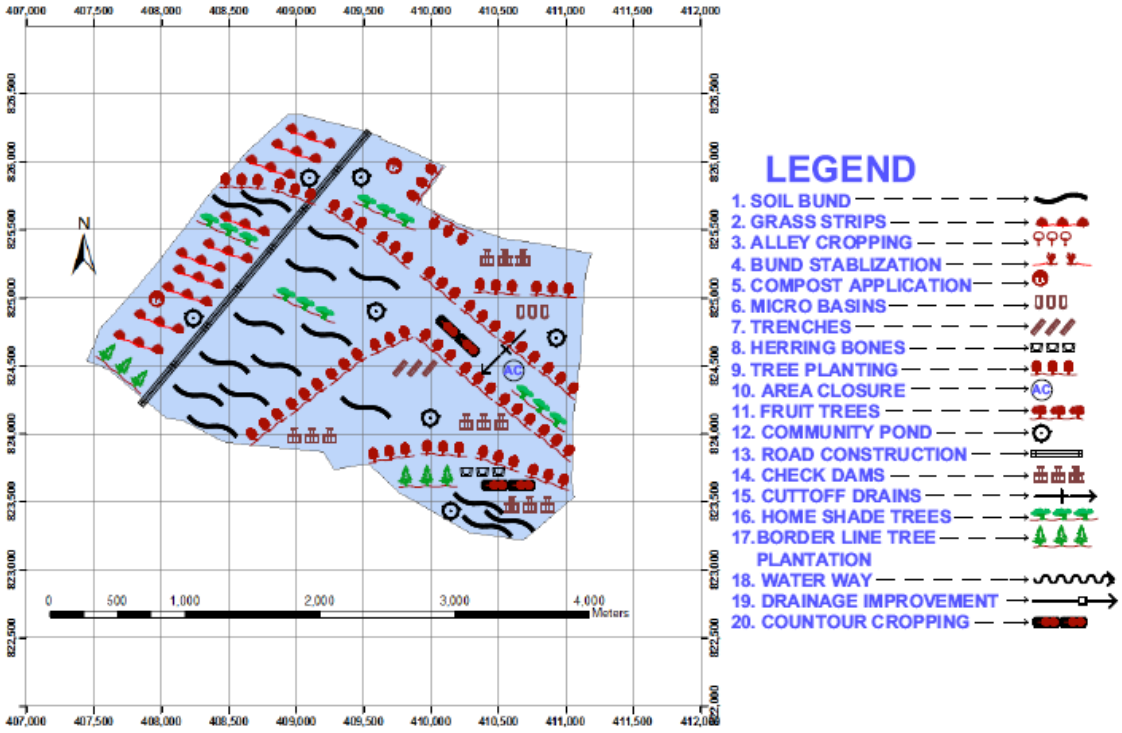


Figure 70. Development map of Bercho Kulufo Kebele

The implementation strategy and point of actions were presented in annex 4.

Refer the following annexure to get the whole overview of the land management plan:

Annex 1: Biophysical Soil and Water Conservation Measures Recommended for Halaba and Sankura

Annex 2: Water Harvesting and Runoff Management for Multiple Uses

Annex 3: Flood/Drainage Control and Management Measures Recommended For Halaba Special Woreda and Sankura Woreda

Annex 4: Possible Adaptation/Mitigation Options and Mitigation Strategies

Annex 5: Gully stabilization guidelines for Sankura and Halaba areas.

6. CONCLUSION

The severity of soil erosion in the seven Kebeles observed in Sankura Woreda of Silti Zone makes investment in soil conservation necessary for continued agricultural production. Various agronomic and physical soil conservation measures have, to some extent, been used traditionally by farmers in the area. Across the contour plowing and down-sloping waterways are most commonly observed all the farms visited. Farmers also construct check-dams and cut-off drains. In addition, farmers use various agronomic conservation practices, including contour plowing and vegetation strips. The traditional practices are efficient in controlling soil loss in some cases, but should be modified and developed further. One example is across-the-contour plowing and down-sloping waterways which does not control erosion sufficiently on steep slopes.

Terraces are most commonly constructed of soil since there is stone shortage in the area. Terraces and other soil and water conservation structures are constructed during the dry season when labour is available. Other soil and water conservation measures implemented through community mobilization and productive safety net programs include tree planting and check dam construction on communal lands. productive safety net programs are often regarded by the local people as a way to obtain food for survival. This leads to a lack of commitment and awareness by the farmers involved concerning soil conservation. In some cases, the negative effects of indifference may be devastating due to poor organization and incorrect construction of terraces.

Soil conservation activities shall be changed from a “technical-fix approach” to an approach where several aspects of land degradation and restoration are brought into focus. It is important that in the current

LMP development activity, farmers participation in the planning phases has to be repeated in the implementation phase too.

The impacts of soil conservation on soil fertility and crop yields have never been studied in Sankura Woreda. It is therefore not possible to quantify the benefits of soil conservation on food production. Research results from other parts of Ethiopia show that the construction of terraces and soil bunds leads to increased soil fertility and crop yields in the zone immediately above the bunds compared to the soil-loss-zone below bunds. Much of the down-slope fertility gain on sloping terraces is linked to a related loss in fertility up-slope. The building of terraces led to increased yields of wheat on four-year old terraces in Northern Ethiopia. Farmers also seem to be aware of the long-term effects of soil conservation measures on crop yields, but may not be in a position to act on their own to protect their soil.

When recommending changes in farming practices, a new approach to the farmer is needed in many cases. Since reducing soil erosion is likely to be a less important objective for the farmer than securing immediate food needs, recommended changes should be shown to provide tangible results. Construction of mechanical conservation structures should be followed up by other activities like minimum/reduced tillage and other farm inputs, such as fertilizer, improved seeds, and other farming factors. If no additional improvement is offered, the promised yield increase from conservation measures is likely to be small.

REFERENCES:

Constable, M (1984). Resources for rural development in Ethiopia. EHRS, UTF/ETH/037/ET.

FAO, (1986). Strategy, approaches and systems in integrated watershed management. FAO conservation guide 14. Rome.

FAO. (1990). The conservation and rehabilitation of African lands; towards sustainable agriculture. FAO, Rome, 38 pp.

Gebre Egziabher, A. (1988). Socio-economic and ecological analysis of soil conservation in Ethiopia: Cases from Gununo Twin catchments. M.Sc. thesis, Agricultural University of Norway (NLH).

Greenland, D.J., G. Bowen, H. Eswaran, R. Rhoades, and C. Valentin. (1994). Soil, water, and nutrient management research - a new agenda. IBSRAM Position Paper, International Board for Soil Research and Management (IBSRAM), Bangkok, Thailand.

Hallsworth, E. G. (1987). Anatomy, physiology and psychology of erosion. Wiley, Chichester. 176 pp.

Hudson, N. (1992). Land husbandry. B T Batsford Limited, London. 192 pp.

Hurni, H. (1984b). Compilation of phase I progress reports (years 1981 to 1983). University of Berne, Switzerland.

Hurni, H. (1987). Erosion-productivity-conservation systems in Ethiopia, proceding of the IV international conference on soil conservation, Venezuela.

Kuru, A. (1986). Soil erosion and strategic state policy: The case of Ethiopia. Publications of the Department of Environmental Conservation at the University of Helsinki No. 7. Helsinki. 123 p.

Million, (2002).The status of natural forest priority areas in southwest Ethiopia, Addis Ababa.

Mitchell, A.J. (1986). Soil erosion and soil conservation. AGLS, FAO, Rome

Stocking, M. (1992). Land degradation and rehabilitation. Research in Africa 1980-1990:Retrospect and prospect. Dryland Networks Programme. Issues paperInternational Institute for Environment and Development (IIED) (34), 31.

Tilahun, Y. (1996). Impacts of conservation bunds on crop yields in Degua Tembien, northern Ethiopia. M.Sc. thesis, Agricultural University of Norway (NLH).

Vagen, T.G. (1996). Phosphorus status in soils from terraced and unterraced land on highly eroded slopes in Sankura Woreda, Ethiopia. M.Sc. thesis, Agricultural University of Norway.

Weigel, G. (1986a). The soils of the Gununo area, Sidamo Research Unit, Ethiopia. Research report 8, Soil Conservation Research Project, Addis Ababa.

Weigel, G. (1986b). The soils of the Maybar/Welo area, their potential and constraints for agricultural development. A case study on the Ethiopian highlands. Geographica Bernensia.

Annex 1

Biophysical Soil and Water Conservation Measures Recommended for Halaba and Sankura

1. Alley Cropping

Definition

Alley cropping is an agroforestry system in which food crops are grown in alleys between rows of hedges. The hedges follow the contour and consist of trees and shrubs such as *Leucaena* or Pigeon peas. Leguminous perennials are more suitable as they fix nitrogen. Hedges can also be placed on conservation structures.

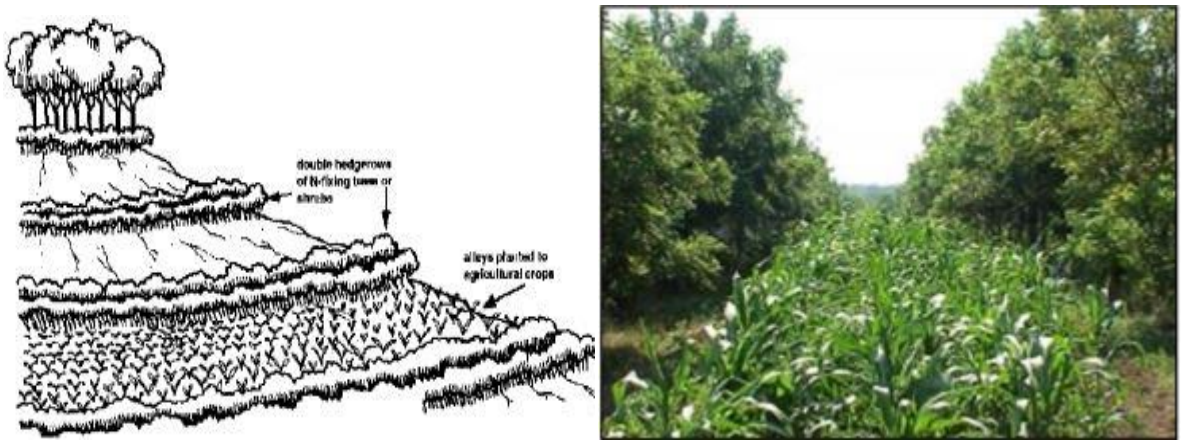


Figure 71. Alley cropping

Area of Applicability

1. Areas: All agricultural fields of Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo Kebeles of Sankura Woreda;

and Kulfo, Hantezo, Besheno, Bendo Cheloksa, Sinbita, Qulubi, Weteta Kebeles of Halaba Special Woreda.

2. Local Situation:
    a) Slope Range: All
    b) Soil Range: All, including shallow and degraded soils

Specifications

The following tree species are commonly used in agroforestry in Halaba and Sankura:

Acacia albida: This tree can be used on cultivated land to improve soil fertility and as fodder. Branches are cut short to minimize shadow when planted with *teff*.

Sesbania and Leucaena: These have been introduced and are used like *Acacia albida* on cultivated land. They may be cut short at the end of the dry season to keep shadow to a minimum especially with *teff*. With sorghum and maize, problems of light competition are less.

- Spacing between rows of hedges reffer the figure below. On hedgerows, trees and shrubs can be spaced 25-100cm apart.
- When cutting down, take care that shrub is cut above lowest split of branches, and not below, to support fast re-growth.
- Individual landholders on their land apply alley cropping, and the products are at their own use.
- Trees are planted in rows of pits along the contour spaced with up to a 5 meter vertical interval on steep slopes.

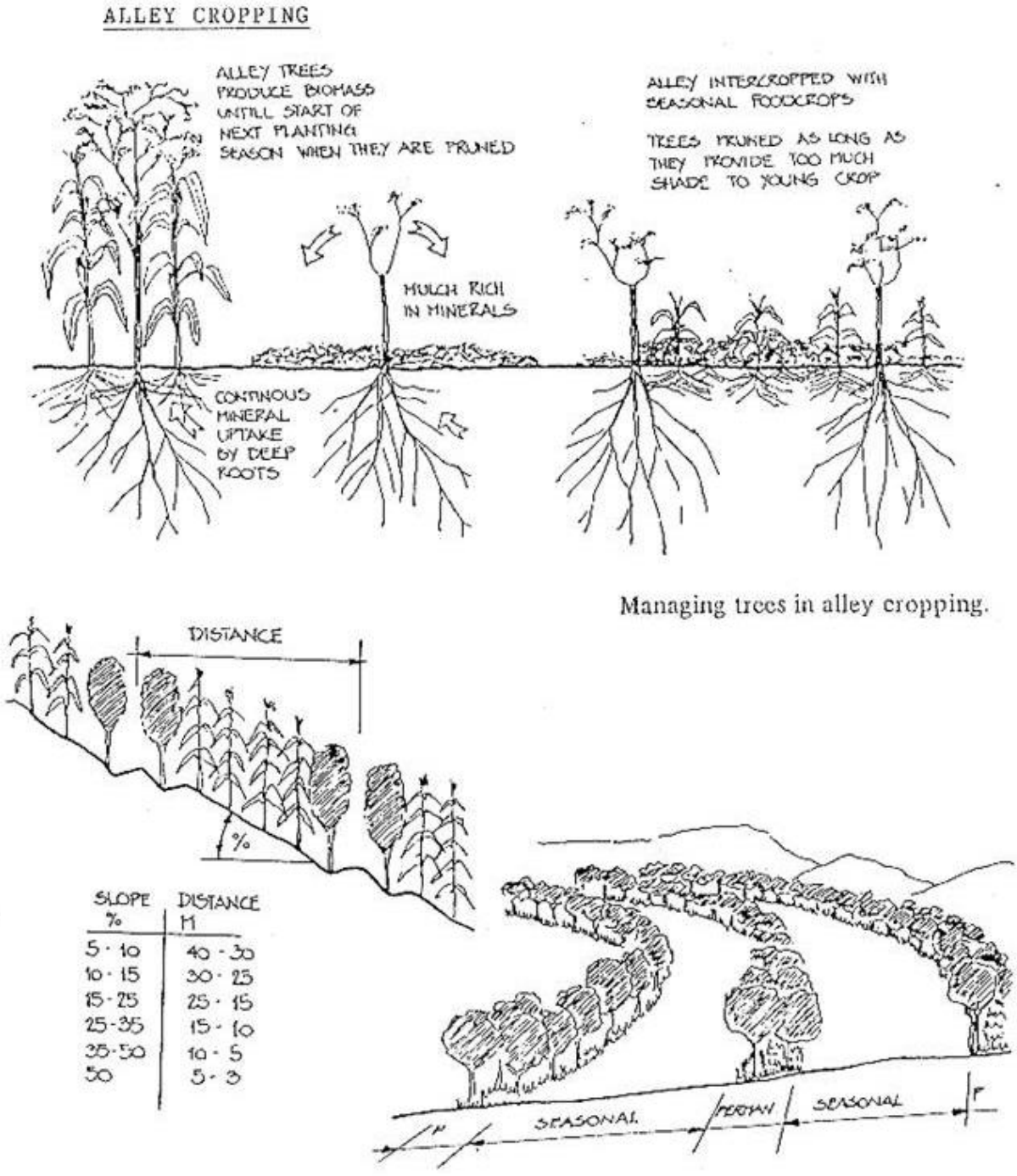
Effects

Trees and shrubs provide green manure or mulch for recycling nutrients to the soil. Pruning, applied during fallow, suppress weeds and create favorable conditions for

soil organisms. Soil erosion is reduced. Bunds on steeper slopes are stabilized. Nitrogen is fixed and made available to companion plants.

Combinations

Alley cropping can be used with physical measures applied on steep degraded slopes. Below steep slopes, cutoff drain is used to protect cultivated land. Cut and carry, tree planting and reforestation are used with alley cropping.



Managing trees in alley cropping.

Figure 72. Alley cropping: Recommendations for lay out and spacing of permanent living terraces (or contour alleys). (Source: Zimmermann

T. (1986): Agroforestry-a last hope for conservation in Haiti? Agroforestry systems 4, p.225-268.)

Other Material

Besides the trees mentioned, bushes and shrubs, which are traditionally known as fodder perennials, can also be used for alley cropping.

Management and Maintenance

Planting must be narrow in the hedge (every 1m). Weeding and pruning is needed. Grazing between rows of trees only with tied cattle, better even with cut and carry system in place. Crop production is shifting between trees, leaving strip fallow after cultivation for about five years. Use traditional knowledge about soil fertility improvement and tree management. Upbringing of trees needs careful supervision by the farmer who applies alley cropping on his land. Grazing should not degrade the grass cover. Crops are allowed only if soil fertility has improved. Crop rotation and relay cropping is recommended for further management of the soil fertility. Regular cutting of tree branches for mulch and fodder can improve soil fertility too.

2. Grass Strip

Definition

A grass strip is a ribbon-like band of grass laid out on cultivated land along the contours. Usually, grass strips are about 1 meter wide and spaced at 1m vertical intervals. They are mainly used to replace physical structures on soil with good infiltration (sandy, salty) on gentle slopes. Cattle must be excluded from this measure all year long to provide for sufficient length of the grasses to slow runoff and retain soil sediment.

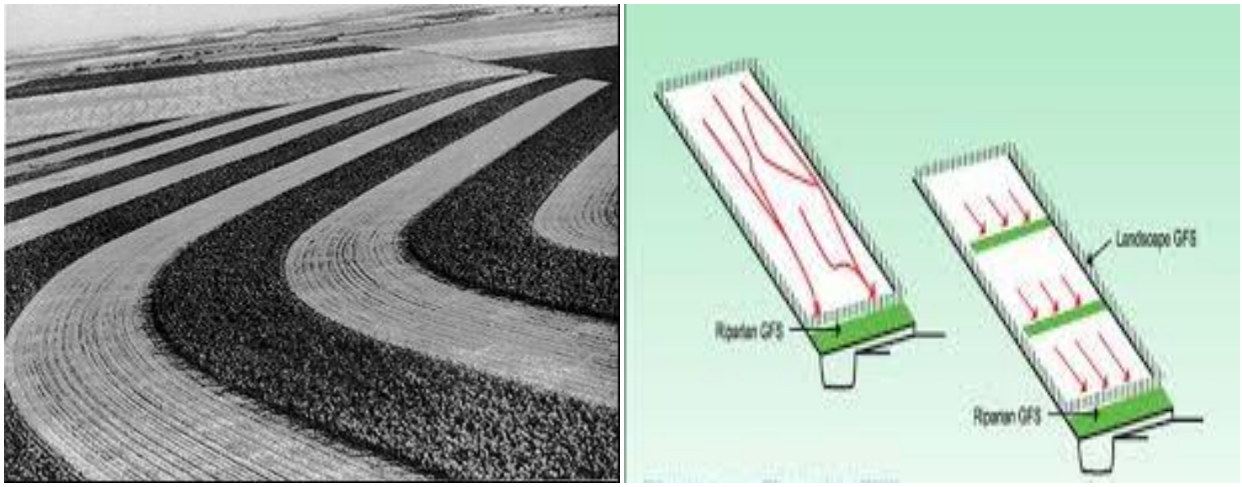


Figure 73. Grass Strips: schematics; and plot with and without grass strip

Area of Application

1. Areas: All agricultural fields of Worabe Sinbita, Bendo Cheloksa, Sinbita, Qulubi, and the two Wetetas.
2. Local Situation:

a) Slope Range:

Slopes of less than 15% gradients

b) Soil Range: All

Specifications

Grass strips are planted along the contour or along cutoff drain.

Spacing with 1 meter vertical interval means that on a 3% slope, grass strips will be 33m apart, and on a 15% slope, only 7m apart, still sufficient for ploughing between the strips.

Effects

Grass strips help to reduce runoff and to filter out sediments carried by runoff. They are especially suitable on soil with good infiltration and where the climate is not too dry for dense grass development. If grazing is totally prevented, the grass strips will effectively build up into terraces and provide good fodder for cattle, which can be used with CUT AND CARRY.

Combinations

Use CUT AND CARRY for grass management. Sometimes, CUTOFF DRAIN between grass strips is useful for safety reasons if heavy storms occur. REVEGETATION as for bunds can be applied to improve grass strips.

Materials

Local grass sods from well developed grassland for planting. Digging instruments, line level, stakes for marking strips. Grass seeds if available or collected nearby.

Management and Maintenance

Select grass carefully and consult farmers. Runner grass will disturb the crops. Introduced grass may be used, but generally the local spices known to the farmers will do. Grass strips can be improved to ALLEY CROPPING. Every farmer maintains the grass strips on his own land and he is allowed to CUT AND CARRY. Care must be taken that the strips are not narrowed with every ploughing. Width of one meter is the absolute minimum required for effectiveness.

3. Level Bund

Definition

A level bund is an embankment along the contour, made of soil and/or stones with a basin at its upper side. The bund reduces or stops the velocity of overland flow and consequently soil erosion. Level bunds are about 50-75 cm high and have a bottom width of 100-150 cm and a water retention basin on their upper side. Usually, tied ridges, placed in the basin about every 10m, help to prevent runoff of flow sideways and to concentrate and overflow at one point of the bund.

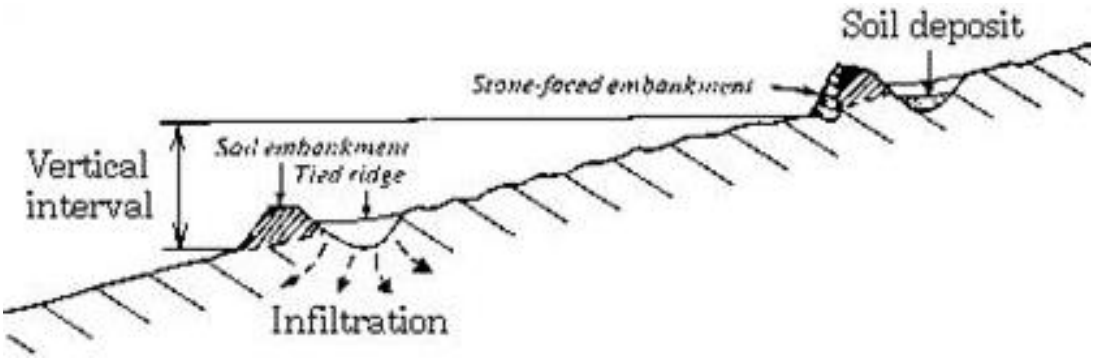


Figure 74. Level bund: terminologies

Area of Applicability

1. Areas: all dry Weinadega and All Kolla kebeles of Sankura and Alaba Woreda where there is seasonal moisture stresses.
2. Local Situation:
   a) Slope Range 3-50%
   b) Soil Range: All depths of more than 50cm, or according to farmer's consent

Specifications

The vertical interval between two bunds is 1 meter for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two and a half times the depth of the workable soil. About every 50m, a gap can be left open to allow ploughing oxen to cross and reach their land.

Effects

Level bunds are walls to retain all runoff between two bunds. Overflow should never occur, and runoff sideways will occur only due to inappropriate lining of the bunds. Soil, which is eroded between two bunds, is deposited in the basin behind the lower bund. Whenever the basin is full of sediments, the bund must be raised. A BENCH TERRACE will develop in the course of years.

Combination

CUTOFF DRAIN may be necessary in cases where not all runoff can be retained between the bunds; REVEGETATION is essential as is a combination with ALLEY CROPPING.

Materials

Line level, digging instruments, stone for stone-faced bunds, suitable local grass and legumes for REVEGETATION.

Management and Maintenance

REVEGETATION is recommended on all bunds, especially on soil bunds in moist areas. Grazing in cultivated land treated with bunds must be stopped throughout the year. CUT AND CARRY can be used as an alternative. The farmer must be present and agree to the design and lining out of bunds on his land. Otherwise, discuss alternatives. Every farmer is responsible for carrying out the maintenance

of bunds on his own land. Bunds must be maintained whenever they tend to break. Bunds have to be increased annually until BENCH TERRACE is developed.

4. Level Fanya Juu

Definition

A level Fanya juu ("Throw uphill" in Swahili language) is an embankment along the contour, made of soil and/or stones, with a basin at its lower side. The Fanya juu reduces or stops the velocity of overland flow and consequently soil erosion. In difference to the LEVEL BUND, the soil in a Fanya juu is moved upslope for construction. The water retention basin is thus at the lower side of the wall. Tied ridges about every 10-meter are used also here to prevent runoff to flow sideways.

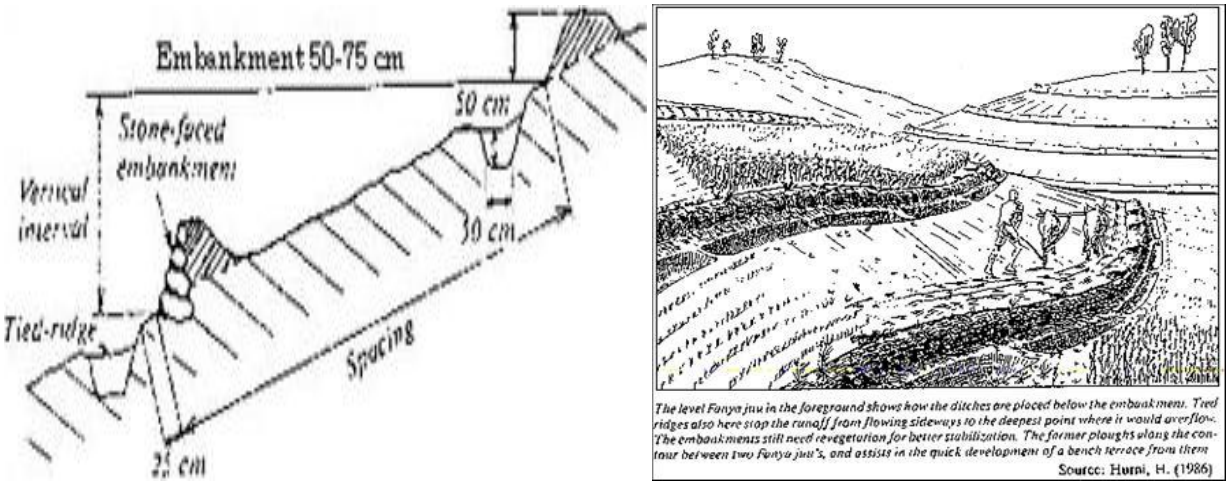


Figure 75. Design of Level Fanya juu, schematics and terminologies

Area of Applicability

1. Areas: all dry Weinadega kebeles of Sankura and Alaba Woreda where there is seasonal moisture stresses.
2. Local Situation:
    a) Slope Range: 3-50%

b) Soil Range:

All depths of more than 50cm, according to farmer's consent

Specifications

The vertical interval between two Fanya Juu is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two and a half times the depth of workable soil. The height of the Fanya juu is 50-75cm, and the ditch is about 50cm deep. The space between the ditch and the beam is at least 25cm. The width of the ditch depends on the soil fertility. On fertile subsoil, it may be very wide and crops can be planted in the ditch. About every 50m, a gap can be left open to allow ploughing oxen to cross and reach their land

Effects

Level Fanya juu are embankments to retain runoff between two bunds. Runoff is retarded behind them, and the overflow is collected in the ditch below the embankment. The tied ridges stop runoff in the ditch flowing sideways. Soil eroded between two Fanya juu's is deposited behind the lower one. Whenever the small basin behind and the ditch below the Fanya juju's are full of sediment, they must be raised with deposit material from the ditch. Like this, a BENCH TERRACE will develop in the course of a few years

Combination

CUTOFF DRAIN may be necessary in cases where not all runoff can be retained between the Fanya juu's. REVEGETATION is essential as is a combination with ALLEY CROPPING. Both can be used for better stabilization of the Fanya juu.

Materials

Line level, digging instruments, blocks of stone for stone-faced embankment and suitable local grass and legumes for REVEGETATION

Management and Maintenance

REVEGETATION is recommended on all Fanya juu's, especially on soil bunds in moist areas. Grazing must be stopped on cultivated land treated with bund throughout the year. CUT AND CARRY can be used as an alternative. The farmer must be present and agree to the design and lining out of the structures on his land. Every farmer is responsible for carrying out the maintenance of Fanya juu's on his own land. They must be maintained whenever they tend to break, especially in storms. Fanya juu's have to be increased annually until BENCH TERRACE is developed.

5. Graded Bund

Definition

A graded bund is defined like a LEVEL BUND, with the only difference that it is slightly graded sideways, with a gradient of up to 1%, towards a water way or river. Such a gradient is for surplus runoff to be drained if the retention of the bund is not sufficient. Tied ridges with top heights lower than the bund height server to retard such flow and to provide small basins for water storage.

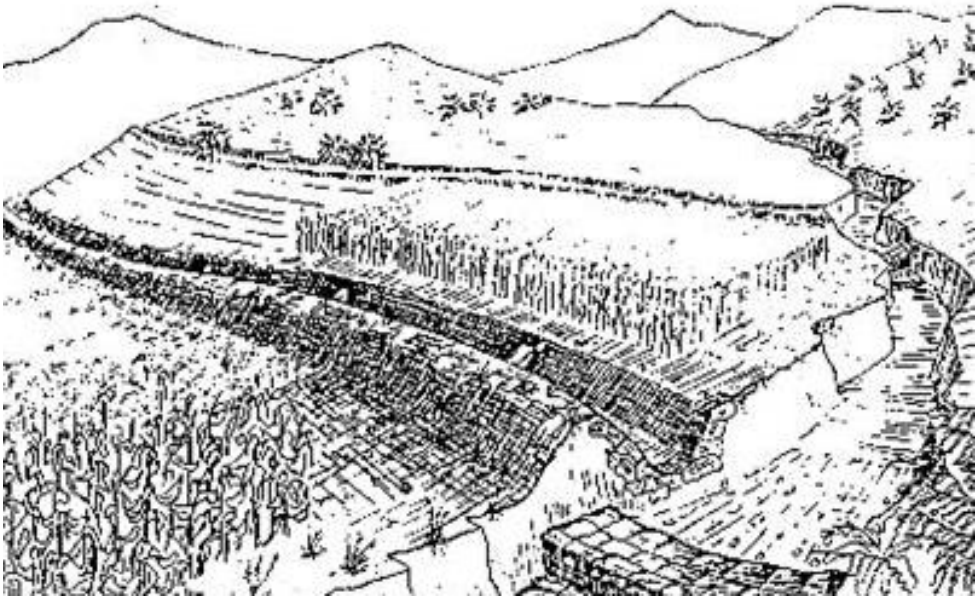


Figure 76. Graded bund

Area of Applicability

1. Area: All farm lands frequented by sheet erosion in all kebeles

2. Local Situation:

a) Slope Range:3-50%

b)Soil Range: All soil in wet, clay soil in moist agroclimatic zones

Specifications

The vertical interval between two bunds is 1 meter for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two and a half times the depth of rework able soil.

No gaps can be provided for ploughing oxen to cross (as for level bunds) because the graded bund saves as drainage line, which cannot be interrupted.

Whenever possible, use and improve traditional waterways in the area where you intend to apply graded bunds. Make the waterways one year before the graded structures to stabilize them before use.

If the bunds are long, the basins behind them have to be increased towards the waterway, because more and more runoff will have to pass during storms. The size of the ditch can be 25cm deep by 50cm wide at the beginning of the bund, but 50cm deep by 100cm wide after about 100-150m when the bund reaches the river.

Effects

Graded bunds retain normal amounts of runoff in their basins, but they can drain excess runoff of heavy storms, which would cause overflow and down slope destruction on level bunds. Most of the soil eroded between two bunds is deposited, while some will be drained sideways during heavy storms and lost from the land. However, graded bunds are more effective in wet areas as well as in moist areas with clay soils.

Combinations

WATERWAY must be developed one year before graded bunds are applied. This is needed for draining the excess runoff. REVEGETATION or ALLEY CROPPING must be used on the bunds for their stabilization. BENCH TERRACE develops from graded bunds with continuous increase over the years.

Material

Line level, digging instruments, blocks of stone for stone-faced bunds and suitable local grass and legumes for REVEGITATION.

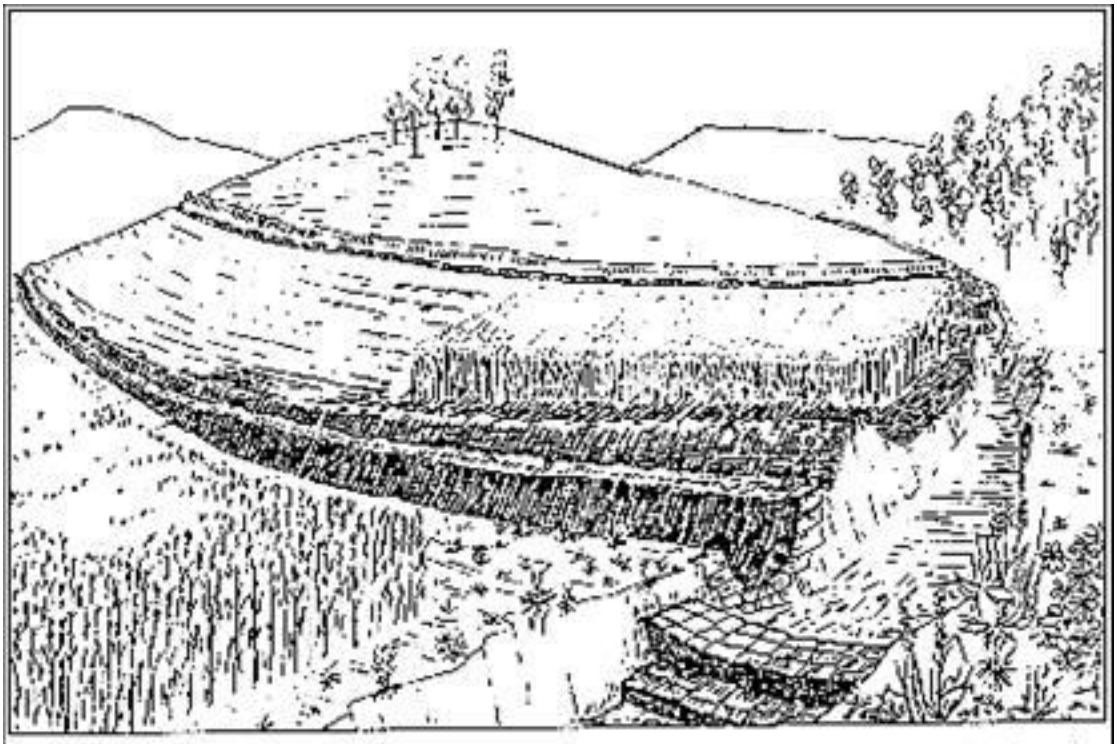
Management

REVEGETATION is needed especially on soil bunds in wet areas. Continuous repair during and after heavy storms is indispensable, especially in the first years after construction. The entry point to the WATERWAY has to be constructed carefully with dry masonry. Every farmer is responsible for carrying out continuous maintenance on the graded bunds of his land. Breakings have to be closed during and after storms. Bunds have to be increased annually until BENCH TERRACE is developed. Even thereafter, the drainage ditch going sideways to the next waterway or river must be maintained.

6. Graded Fanya Juu

Definition

A graded Fanya juu ("Throw uphill" in Swahili) is defined like a LEVEL FANYA JUU with the only difference that it is slightly graded sideways towards a waterway, with a gradient of up to 1%. This gradient is for surplus runoff to be drained if the retention of the Fanya juu is not sufficient. Tied ridges behind the embankment provide small basins for water storage and guide the water over the bund into the ditch below from where it is drained sideways.



The graded Fanya juu in this drawing just enters a natural drainage channel, where a checkdam has been constructed just below the inlet to prevent erosion. Also, the drainage ditch of the Fanya juu is reinforced with stone. Small tied ridges behind the embankment of the Fanya juu can be seen slightly. They help to prevent a sideways flow of water above the embankment. Instead, excess runoff will flow over the wall and enter the ditch. Revegetation is absolutely necessary on the wall to make it strong.

Figure 77. Graded Fanya juu

Area of applicability

1. Area: All farm lands that required excel runoff removal in all kebeles of Halaba and Sankura Woreda.
2. Local Situation:
    a) Slope Range: 3-50%, more on steeper slopes
    b) Soil Range: All deep soils in wet, deep clay soils in moist agroclimatic zones

Specifications

Caution is needed when applying graded Fanya juu's because they need careful design, supervision and maintenance, although conservation is effective. The vertical interval between two graded Fanya juu's is 1m for slope gradients of less than 15%. For steeper slopes, the vertical interval is two and a half times the depth of the workable soil. It is recommended to apply stone-faced bunds whenever possible to make them strong for overflow.

A typical cross-section shown for LEVEL FANYA JUU, also applicable for graded Fanya juu. No gaps can be provided for ploughing oxen to cross (as for level Fanya juu) because the graded Fanya juu serves as drainage line, which cannot be interrupted.

Whenever possible, use and improve traditional waterways in the area one year before you apply graded Fanya juu's. Discuss with farmers about the measures lined out before you implement them.

If the Fanya juu's are long, the ditches below them have to be increased towards the waterway because more and more runoff will have to pass during storms. The size of the ditch can be 50cm deep by 25cm wide at the beginning of the structure, but 75cm deep by 50cm wide after about 100-15-m when the graded Fanya juu reaches the waterway.

Effects

Graded Fanya juu's retain small amounts of runoff above their wall and they drain excess runoff of heavy storms through the ditch below which would cause overflow and down slope destruction on level (Fanya juu) structures. Some of the soil eroded between two Fanya juu's is deposited above the wall; some is deposited in the ditch, while the rest is drained sideways. Graded Fanya juu's are more difficult to manage, but support the development of BENCH TERRACE very well.

Combinations

WATERWAY is needed for draining the excess runoff. It must be developed one year before graded Fanya juu's are applied. REVEGETATION or ALLEY CROPPING is used on the Fanya juu's for their stabilization. BENCH TERRACE develops from graded Fanya juu's with the continuous increase of the wall.

Materials

Line level, digging instruments, blocks of stone for stone-faced embankments and as mentioned for combined measures (such as suitable local grass and legumes for REVEGETATION).

Management and Maintenance

REVEGETATION is recommended on all Fanya juu's including the stone-faced ones. Most important is a continuous repair during and after heavy storms. Otherwise, the ditch will be filled with sediment. The entry point to the WATERWAY has to be constructed with careful dry masonry. Every farmer is responsible for carrying out continuous maintenance on the graded Fanya juu's of his land. Breakings have to be closed during and after storms and the ditch emptied from sediment. Embankments have to be increased annually until BENCH TERRACE is developed. The drain sideways to the next waterway or river must be maintained.

7. Area Closure

Definition

Area closure is one of the components of the biophysical conservation measures and it is recommended on forest and agricultural land types Worabe Sinbita (Southern parts where patches of acacia forest located), Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo Kebeles of Sankura Woreda; and Kulfo, Hantezo, Besheno, Bendo Cheloksa, Qulubi, and Weteta Kebeles of Halaba Special Woreda where soil erosion has becomes serious and the land has lost its productive potential. However, in all kebeles the eroded hillsides and fragile low lying areas are the prominent sites of area closure.

Area closure activity is recommended on highly degraded lands of the aforementioned kebeles for the main reason that:

- Those lands have been severely degraded due to soil erosion and it is unable to produce sufficient biomass,
- The chances of recovering this land by conservation measures are not encouraging,
- It is advisable that the area should be provided complete rest.

However, necessary supporting activities such as water harvesting (See annex 2) and enrichment planting etc are carried out in order to enhance the rate of recovery.

Various activities under area closure include:

- Closing off the entire area from the interference from human and livestock until it is completely conserved and ready to be reused…

- Necessary soil and water conservation work is carried out on these lands.
- Unwanted and uneconomical plant species are removed from the land
- Planting material of suitable species kept ready in advance of planting
- Suitable plant species are planted in between existing plant species
- Strip planting of forage species and spot planting of fodder, forest and other trees should be carried out during the early years
- Plants generating income should be planted on suitable sites
- To improve soil fertility some application of organic manure to planted species should be carried out.
- Management includes, weeding, removal of unwanted plants, pruning of trees, and safety from livestock
- Allow forage crops to produce seeds in the first year
- Biomass should be utilized by manually harvesting and feeding livestock under stall feeding system.
- Once the area has been well stabilized and conserved, it can be used for more intensive planting of suitable crops but with out encouraging soil erosion.

Benefits from Area Closure

- It is the simplest and most economical method of conserving degraded lands
- The hillsides which were previously closed have now become productive
- The community is producing a large amount of biomass
- The biomass generates substantial income for the community
- It has resulted in conservation of water in situ and runoff is reduced
- It has reduced flooding of lower areas,
- It has improved water table and revived springs

- Wild life has returned and environment is improved

Limiting factors

The rate and extent of success depends on many factors such as

- The severity of land degradation
- Rainfall
- Natural vegetation
- Effectiveness of soil conservation measures
- Effectiveness of enrichment planting
- Efficient management of area closure
- Interest of the community in this activity

Area closure activity has now been extended to farmlands and it is called farm closure. It has been observed that sustainable land management and improved production can not be achieved unless the free livestock movement is controlled. Intensive crop production is possible only when the land is safe from livestock through out the year. Only then natural resources can be intensively exploited for maximizing farm production.

Annex 2
Water Harvesting and Runoff Management for Multiple Uses

Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo Kebeles of Sankura Woreda; and Kulfo, Hantezo, Besheno, Bendo Cheloksa, Sinbita, Qulubi, Weteta Kebeles of Halaba Special Woreda are well known for their water stress. Water harvesting through the collection and concentration of runoff for productive purposes such as production of crops, fodder, pasture or trees production, livestock and domestic water supply is recommended. Particularly roof water harvesting with the construction of cisterns are not yet well utilized in all the kebeles visited. All the methods of concentrating, diverting, collecting, storing and utilizing and managing runoff for productive uses shall be used in each of the fourteen kebeles.

Most of the WHSC measures recommended here after would focus on *methods able to increase water availability to plants and thus on rainfall multiplier systems.* The selection of the measures should be tailored around the type of tree species to be planted and their water/soil requirements, the type of soils and topography, and land users' needs.

i. Design

Physical WHSC measures for reforestation/area closure purposes have a proper dimension to accommodate peak runoff discharges.

Biological support measures such as mulching of plantation pits and manuring are also described, providing a new set of possibilities for the enhancement of tree growth and productivity in many.

Agroforestry and soil management practices should be also be in place, paying attention to spatial arrangements, utilization of biomass and management techniques.

ii. Integration between land uses

As mentioned in several parts of the development map, tree plantation is integral part and often the precondition for the successful treatment and rehabilitation of cultivated and communal lands. This naturally happens because forest land is most of the time geographically confined on the upper reaches of watersheds, i.e. hillsides, mountains, ridges and plateaus. Therefore, most if the interventions aimed to improve cultivated lands should either be preceded by or be undertaken contemporaneously with forestry activities. A possible exception would be the diversion of excess runoff from the hillsides by the means of *cutoff drains* (See the next annexure).

However, the rehabilitation of degraded hillsides and poorly managed forest areas should be seen as an opportunity to protect the environment as well as to raise incomes and reduce the over-exploitation of already scarce natural resources.

iii. Integration between activities

Integration between physical and biological measures is essential for the successful growth of seedlings. In this respect, the involvement of agronomists and livestock specialists is likely to be important.

iv. Establishment/construction

- The construction should start from the top of the catchment and move downwards.
- In case of physical structures, the dimensions and construction standards should be outstanding and without gaps.
- Planting should be timely done and great care in transporting seedlings from the nursery to the plantation site should be ensured.
- Manuring and mulching of planting devices (pit, trench, etc.) should be ensured.

- Agroforestry measures should pay great attention to site preparation, layout, handling of seedlings, fertilization/manuring, management of trees, etc.

v. Management and maintenance

- Each plantation site would need a number of management operations such as weeding and mulching of grasses, pruning, pollarding and coppicing, etc.
- The maintenance of physical structures would include the repair of breakage, stabilization of embankments and de-siltation of collection trenches/pits if deposition is too high (intensive shower), gap filling and reinforcements with stones if necessary.

1. Water Collection Trenches

Definition

Trenches are large and deep pits constructed along the contours for the main purpose of collecting and storing rainfall water meant to ***support the growth of trees in moisture stress areas*** (water harvesting effect) and control erosion.

They ***are rainfall multiplier systems. The trench pits collect and store considerable amount of runoff water*** (0,75-1m^3) of water for max rainfall event). They ensure proper catchment's protection and rapid growth of trees. By their moisture conservation effect they accelerate the ***regeneration of natural and improved grass species*** and thus allow the area to supply additional animal feed.

Hillsides treated with trenches is a ***zero runoff system*** and ensures the ***protection of downstream cultivated areas*** and, if limited to only one part of the catchment's, control/reduce runoff into gullies and thus facilitate their rehabilitation (see SS dams and gully control measures). Part of the water captured by the trenches soaks into the soil and reaches the underground aquifer. Therefore, trenches ***contribute to recharge water tables*** and supply springs and wells with good quality water and for a longer period of time.

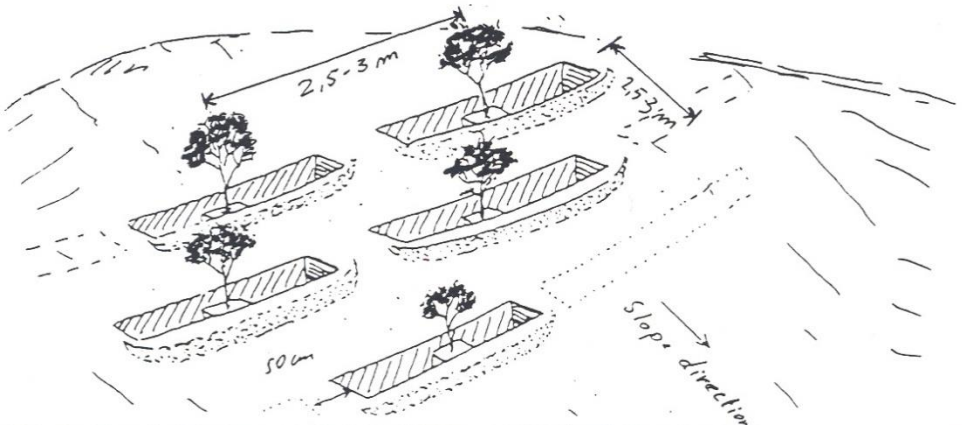


Figure 78. Water collection trenches

Technical Specifications

Site selection

- On hillsides where soil is not too rocky; on abandoned lands that you wish to restore for growing trees; on side of gullies not too steep; and on portions of forest land which should be enriched.
- Highly degraded areas coupled with area closure
- Around ***homesteads*** for fruit trees or other useful species**,** protecting downstream fields from erosion and contributing to the recharge of water tables.

Construction

- Start by digging the soil up to ***reaching 25cm depth x 50cm width x 2.5- to 3m length*** *(1)*. Then a ***30cm x 30cm x 30cm pit*** is dug in the middle of the trench (2).

- ***Bottom of pit should be 5-10 cm deeper than bottom of trench***. Side ditches may slope towards ties for maximum utilization of light showers (see the figure below).

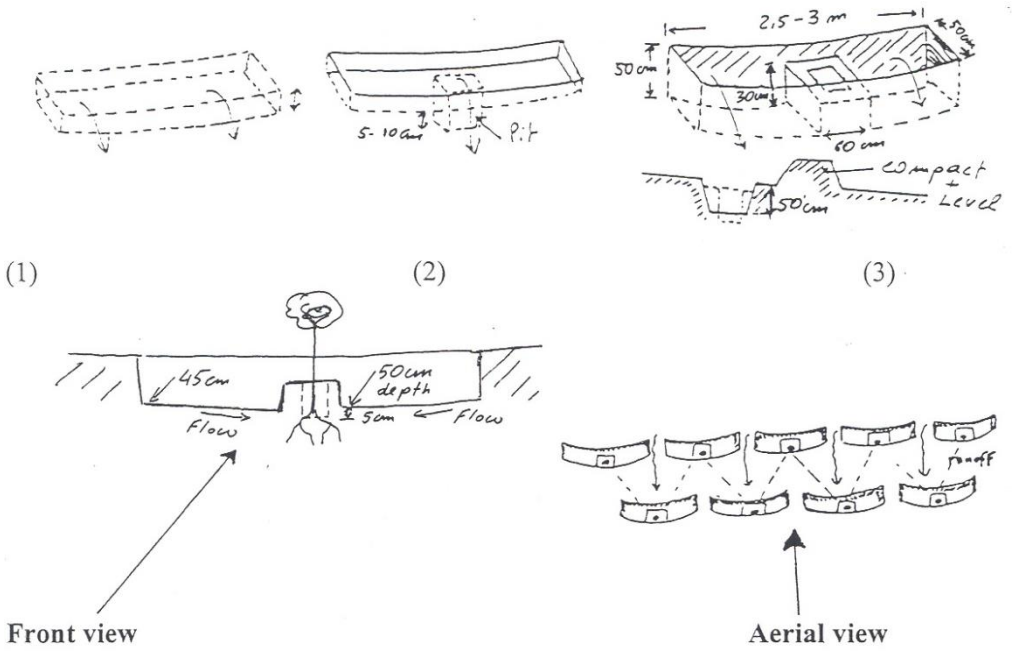


Figure 79. Design of water collection trenches

- Demarcate the tie around the pit (10-15cm from pit border on both sides) and proceed to deepen the collection ditch around the ties up to the required depth of 50cm (3). The piled soil of the embankment must be shaped level and well compacted.
- Trenches can be dug on hillsides having slopes between 5 to 50%, with hard, crusted, low fertility and compacted impoverished loamy clays, sandy loams and sand-clay-loams soils. Their design slightly changes depending on the type of soils.

Integration

It is mainly with stabilization and soil management measures.

- A reforested site treated with trenches should be regarded as a sylvipasture site or even as an agrosylvipasture site ***where food or forage crops can be grown on the trench embankment (see the figure below for stabilization of physical structures).*** Native palatable grass would benefit from the improved moisture conditions and grow well. In this case, seeds should be collected and used the following year to stabilize additional structures. Improved grass/legume pasture species should be also tested in different combinations.

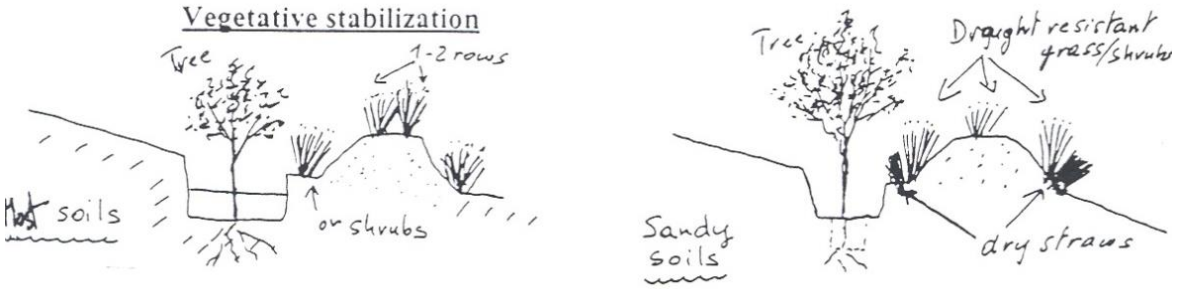


Figure 80. Vegetative stabilization of water collection trenches

Material

Planting materials, agriculture tools such as crow bars, pick axes, spades and shovels are required.

2. *Herring Bones*

Herring bones are small trapezoidal structures (called also A structures) constructed along the contours on gentle slopes. Their function is similar as of for trenches. They are ***suitable on gentler slopes and cheaper than trenches*** (less labour intensive). Advantages are otherwise the same.

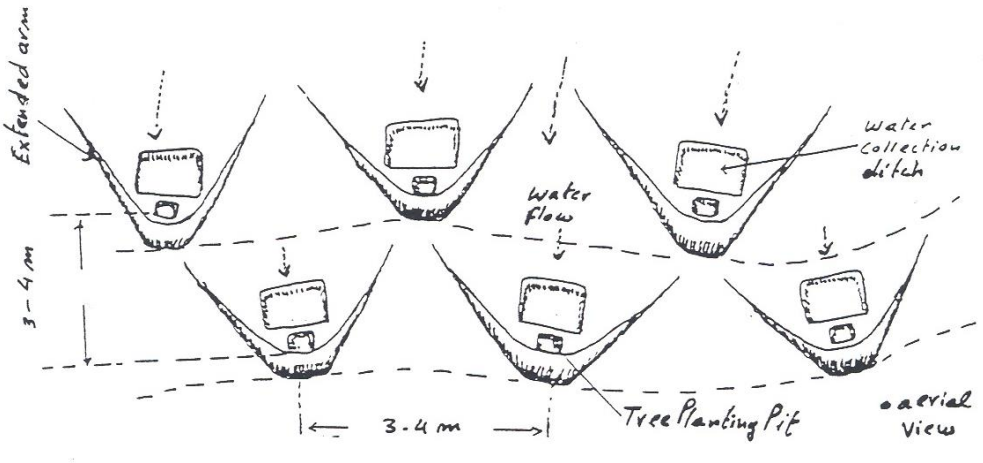


Figure 81. Layout of Herring bones

Technical Specifications

Site selection

- On degraded areas with slopes < than 5% and soils at least 50cm deep.
- On small plateaus having gentle slopes where soil is not too hard and rocky.

- On abandoned lands that you wish to restore for growing trees.
- On portions of forest land which should be enriched (gentle slopes).
- Around homesteads for valuable trees.

Layout and Construction

Layout

- Start from the upper part of the gentle sloping land.
- Distance between herring bones is 3-4m horizontally; the spacing between two outer tips or extended arms is laterally 30-50cm; the spacing between two herring bones vertically is 3-4m.

Construction

- They are constructed in a staggered position one from another (triangle).
- Construction starts by digging a ***30cm x 30cm x 30cm tree planting pit***.
- Then dig the water ***collection ditch 1m x 1 m x 30 cm deep*** and behind the pit (15cm tie). Keep some top soil aside for filling the plantation pit. Use the rest to construct the embankment (well shaped and compacted) and the water collection arms. The side arms should be well shaped and compacted.

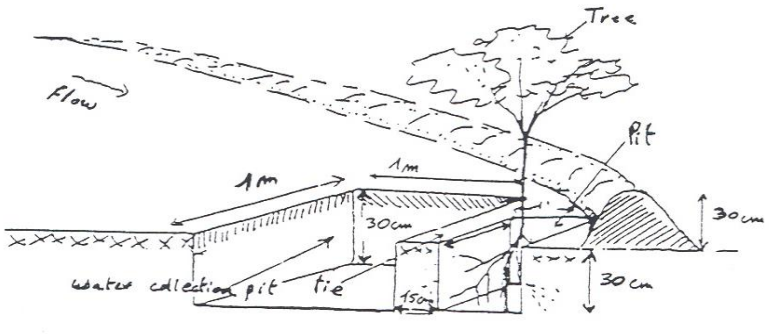


Figure 82. Design and dimensions of Herring bones

Material

Planting materials, agriculture tools such as crow bars, pick axes, spades and shovels are required.

3. *Eye-Brow Basin*

Definition

Eyebrow basins are semi-circular structures made out of stones constructed along the contours. They are suitable for the shallow and stony soils of the water stressed areas (water harvesting effect). This measure replaces microbasins in low rainfall areas (dry weyna dega and kolla).

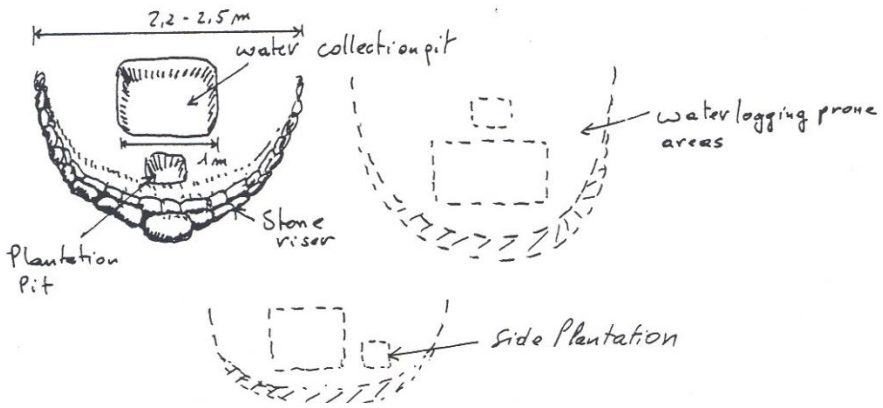


Figure 83. Layout of eyebrow basins

Site selection

- On hillsides where soil are shallow and rocky; on abandoned stony lands to restore for growing trees, on side of gullies not too steep and where stones

are available.

- On steep and stony portions of forest land which can be enriched. However, eyebrow basins can not be constructed on slopes > 60% and exceedingly rocky areas.

Layout and design

- Eyebrow basin has ***2.2-2.5 m diameter*** and a solid and well constructed stone riser (or stabilized by brushwood or life fence***): with 0.2 m depth foundation and height 0.4-0.6 m (based on slopes).***

Construction

- Construction starts by digging a ***foundation of about 20cm deep x 30cm wide*** at its lower point and decreasing uphill.
- Place ***large stones*** in the center of the foundation for maximum stability.
- Water collection area dug behind (or side of) plantation pit***: 1 m width x 1 m length x 20-25 cm depth (lower side***). Depth and size of water collection area may change based on available soil depth.
- Plantation ***pit 30cm x 30cm x 30cm***.

Figure 22: Design and construction

Figure 111 Design and construction

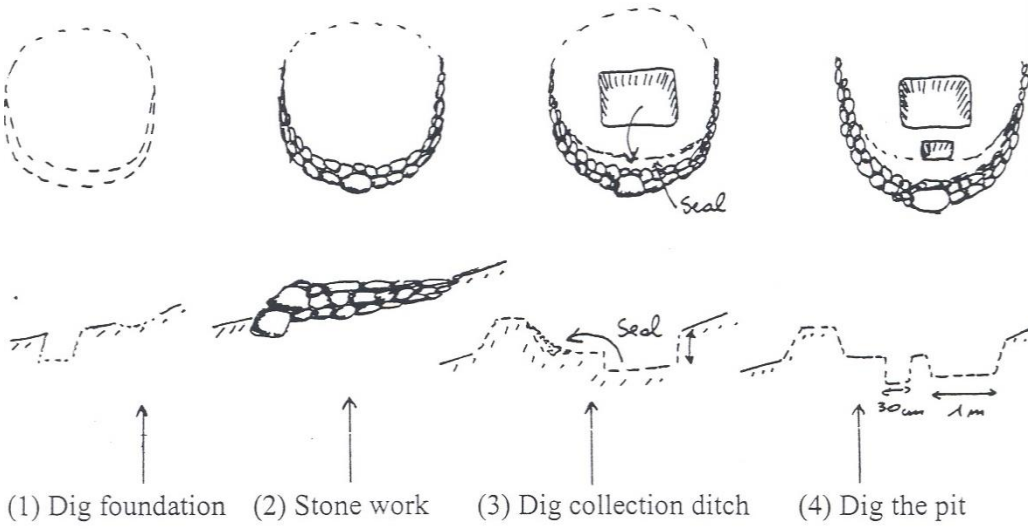


Figure 84. Construction steps of eyebrow basins

Material

Planting materials, agriculture tools such as crow bars, pick axes, spades and shovels are required. String, water level and A- Frame is required for layout.

4. Half-Moon Structure

Definition

Half-moons are ***semi-circular structures*** made out of soil constructed along the contours for the main purpose of collecting and storing rainfall water meant to support the growth of trees or crops (food or fodder). They are suitable for the gentle sloping and sandy areas of the 14 kebeles. Half moons (HM) can be constructed of different dimensions to accommodate various needs and conditions.

The HM described here applies for tree growth. Other sizes of HM structures, for instance for fodder crops follow a similar design as for soil bunds.Half-moons for trees growth are suitable on slopes up to 5% and sandy soils.

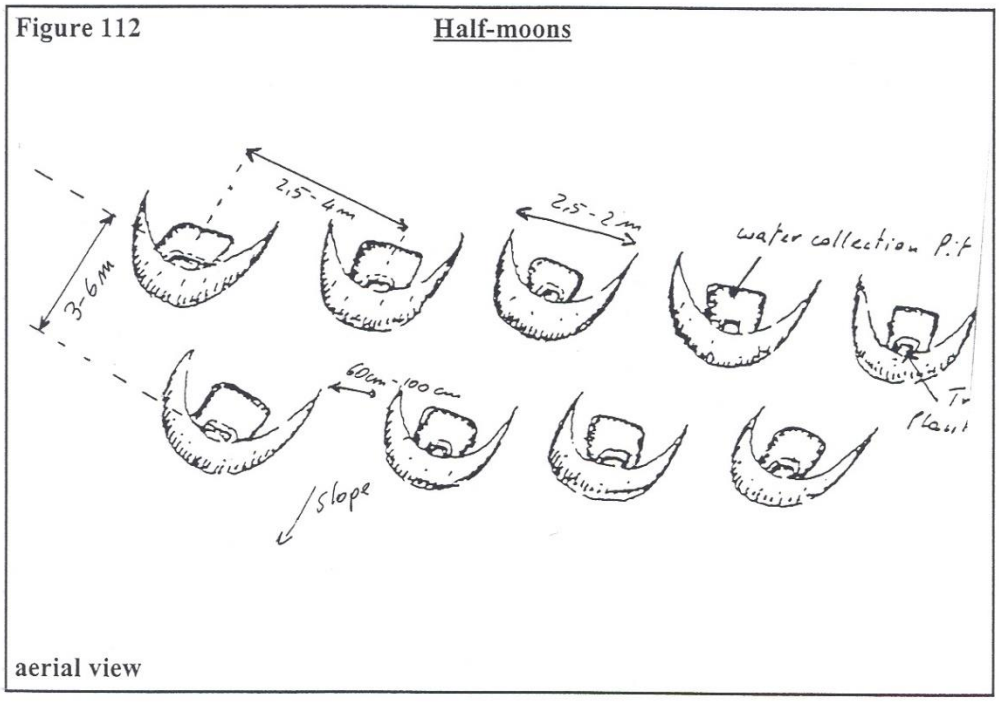


Figure 85. Layout of half-moons

Site selection

On degraded hillsides with slopes less than 5% and sandy soils; on small plateaus having gentle slopes and where soils are sandy; on abandoned lands (sandy areas) that you wish to restore for growing trees; and on bottom of gully sandy floors provided the gully sides are protected and treated.

Layout

The half-moon has a diameter of 2-2,5m. The lateral spacing between two half-moons is 50cm. The spacing between two consecutive half-moons is 3-6 m or more. They are constructed in a staggered position one from another (triangle).

Construction

- Construction start by digging a water collection ditch ***1mx1mx30cm deep.*** The excavated soil is piled and compacted 15cm from the border of the pit and given a half-moon shape**.**
- The embankment is supposed to be ***30-50cm high and have a base width of 60-90cm.***
- A ***30cm x 30cm x 30cm pit*** is then dug in the lower part of the water collection pit.

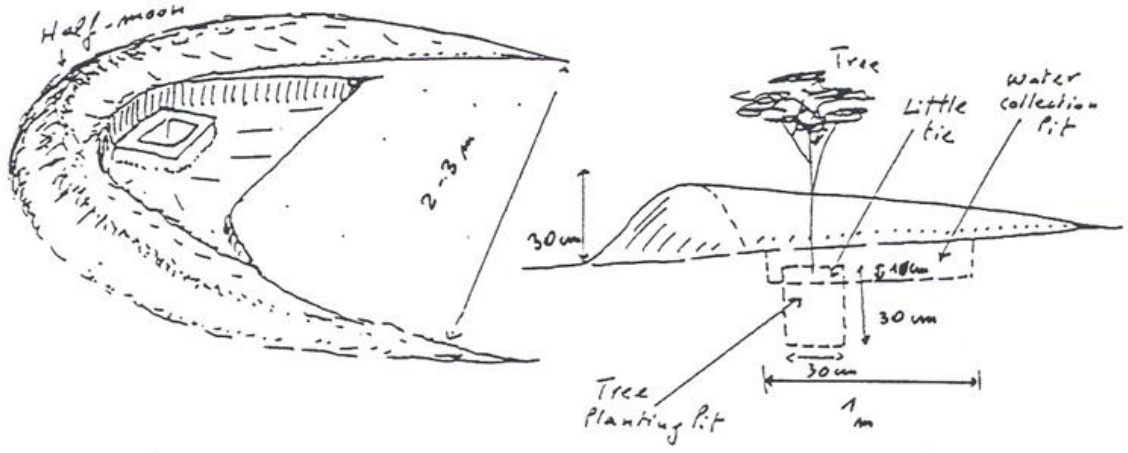


Figure 86. Design and construction of half-moon structure

Material

Planting materials, agriculture tools such as crow bars, pick axes, spades and shovels are required. String, water level and A- Frame is required for layout.

5. *Improved Pits*

Definition, scope and advantages

Improved pits are a ***variation of normal pits***; it is cheaper than trenches but less effective for water harvesting. In moisture deficit areas improved pits refer to larger excavations along the contour and staggered alternatively for maximum water harvesting. Though the water harvesting capacity of the pit is limited (0.25 – 0.35 m^3) this measure is suitable for dense plantations of species such as some Acacia sp., *Leucaena leucocephala, Sesbania sesban, Grevillea robusta*, and other species, particularly in better soils of water stressed conditions.

Site Selection

Pits should be dug in areas with ***slopes < 30% and soils with depth of at least 50 cm.*** On steeper slopes the small soil embankment may slide downwards and fill the next trench. Pits are made by a collection pit and a plantation pit dug in (1) front, (2) at its sides, (3) in the middle or (4) at the bottom of it.

Dimensions

The collection pit should have ***1.2-1.5m length, depth 50cm and width 50cm***. The ***plantation pit is 30cmx30cmx30cm, placed on a 50-60 cm tie***. The tie is positioned close to the top ground level (5-10 cm from ground level) if dug in front or at the side of the excavated ditch, or 20-25 cm from the top of the collection ditch in case of tie placed in the middle (same as for normal trenches), or directly at the bottom of the improved pit in case of very permeable soils (sandy). The pits should be staggered alternatively, distance apart should be 2m vertically and lateral spacing between pits 30-50 cm.

NOTE: Construction of soil or stone bunds between 10 or more lines of improved pits is recommended.

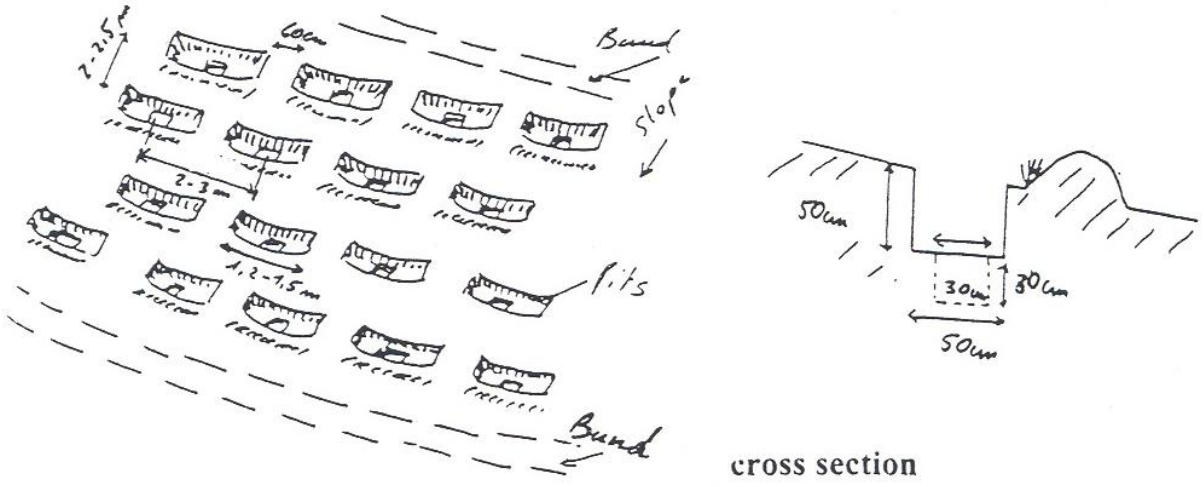


Figure 87. Improved pits along the contour

Material

Planting materials, agriculture tools such as crow bars, pick axes, spades and shovels are required. String, water level and A- Frame is required for layout.

Annex 3

Flood/Drainage Control and Management Measures Recommended For Halaba Special Woreda and Sankura Woreda

General

This refers to controlling the flood from causing damage to community assets such as farmland, buildings, roads, and others. Experiences around the two Woredas (Sankura Woreda and Halaba Special Woreda) implicated that flood from unprotected hilly areas causes damages to lower lying areas by depositing sediments on cropped land and causing temporary water logging problems, subsequently resulting in crop failure. Moreover, flood causes damage to roads by depositing sediments and boulders and result in failure of the roads.

Drainage refers to elimination of unwanted water from the land surface (flash floods). Surface drainage is needed particularly for Bendo Cheloksa, Sinbita and Worabe Sinbita kebeles where water accumulates on the land surface during rainy seasons and causes water logging or when the accumulated water interferes with other activities.

While planning to control flood in the above three kebeles, priority should be given to prevention of flood occurrence. Planning for prevention is simpler and cheaper than controlling flood in progress. Prevention minimizes or protects all possible chances of flood formation by treating every spot of runoff generating areas. This requires either holding the runoff right on the place of occurrence or allowing it to infiltrate into the soil (see annex 2), or safely eliminating it through diversion systems. In addition, it requires protection of any chance of runoff concentration

as much as possible. Practically, it is not always possible or advisable to protect runoff generation and concentration owing to the following two reasons.

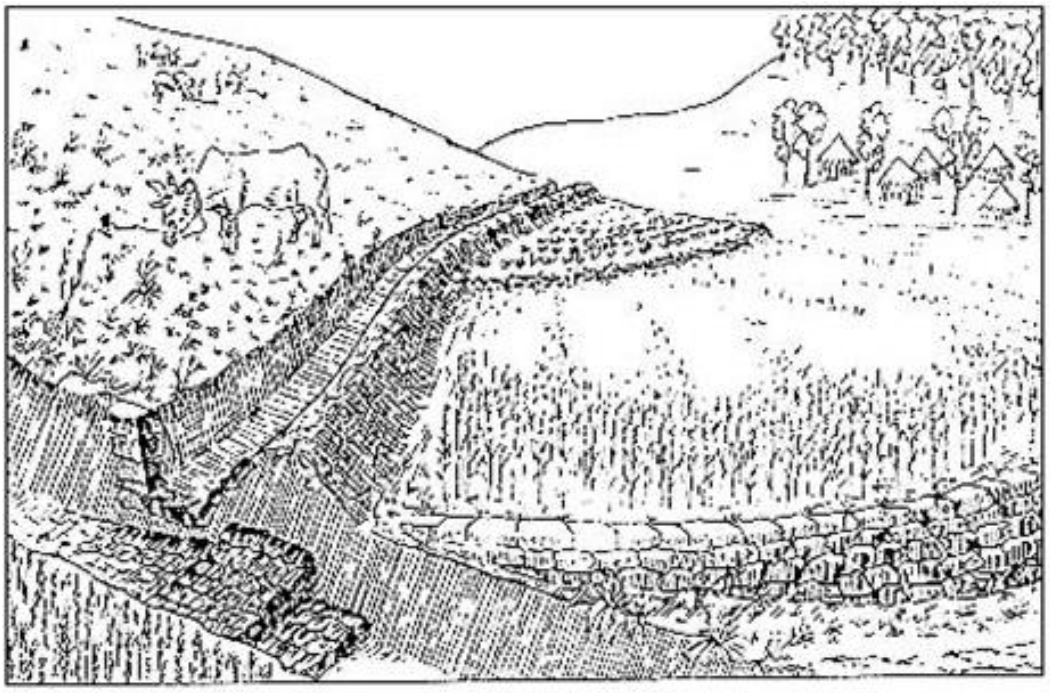
- The first reason is that whatever treatments you made to the land, runoff formation is inevitable.
- The second reason is that runoff formation/generation should be seen as an opportunity, a resource that can be harvested and used in a productive way.

Therefore, different alternatives of productive use of flood and different dimensions of how well the flood is exploited should be considered while planning flood-control schemes. The first priority should be given to what opportunities and limitations exist where water harvesting is of paramount importance. Flood-control schemes should be integrated with water harvesting schemes. Excess of what can be held should be safely eliminated. This annexure is critically focusing on storm water control and management in rural areas. More specifically, it gives an advice for the preparation and implementation of cutoff drains and waterways for storm water management from farm land in and Kulfo, Hantezo, Besheno, Bendo Cheloksa, Sinbita, Qulubi, Weteta Kebeles of Halaba Special Woreda; and Worabe Sinbita, Menzo, Menzo Feten, Feten, Weteta, Bercho, and Bercho Kulfo Kebeles of Sankura Woreda.

1. *Cutoff Drains*

Definitions

A cutoff drain is a channel used to collect runoff from the land above and to divert it safely to a waterway or river, thus protecting the land below from excessive erosion. They usually protect cultivated land from upslope forest land or grassland. It is dug across a slope to intercept surface runoff and carry it safely to an outlet. They also used to protect compounds and roads from uncontrolled runoff, and to divert water from gully heads.



This cutoff drain protects the terraced cultivated land to the right from excessive runoff from the grassland to the left and above, where controlled grazing is used with tied cattle. At the point where the cutoff drain enters the waterway, stone protection is needed and a checkdam has been made in the waterway just below the entry point as shown. Cutoff drains have to be covered with vegetation much more than on the recently constructed embankment shown here. Source: Hurni, H. (1986)

Figure 88. Cutoff drain protecting cultivated land

Location

- Slope range: 3-50%
- Soil range: All.

Construction

Assuming a70mm/hr storm intensity, a poorly grassed cutoff drain, a hilly pasture above the drain, clay loam soil, and a freeboard of 20cm in the drain, the dimensions of the cutoff drain, given for different sizes of the catchment above the drain are presented in the following table.

Size of atchment (ha)	**epth of cutoff drain (cm)**	**Vidth of cutoff drain (cm)**	**ximum gradient**
1	35	50	4.0
2	45	70	2.5
4	55	100	1.5
8	70	140	1.0
16	85	200	0.5
32	115	280	0.4
64	155	400	0.2

The gradient of the cutoff drain should not exceed the maximum gradient given. However, in some cases, it will be necessary to follow a natural line instead of a technical one. If the maximum gradient is exceeded, take care of erosion in the drain, or apply CHECKDAM.

- The gradient of the cutoff drain is lined out with the line level.
- Bigger cutoff drains have to be done in consultation with farmers

Effects

Cutoff drains protect down slope land from upslope runoff and erosion. On very long slopes, repeat cutoff drains several times. Cutoff drains have to be maintained annually or after heavy storms if necessary.

Materials

Agriculture tools such as crow bars pick axes, spades and shovels are required. String and water level are required for layout.

2. *Water ways*

Definition

A waterway is a natural or artificial drainage channel along the steepest slope or in the valley used to accommodate runoff. It is drainage structure that can dispose excess runoff from cutoff drains and graded terraces to the natural watercourse.

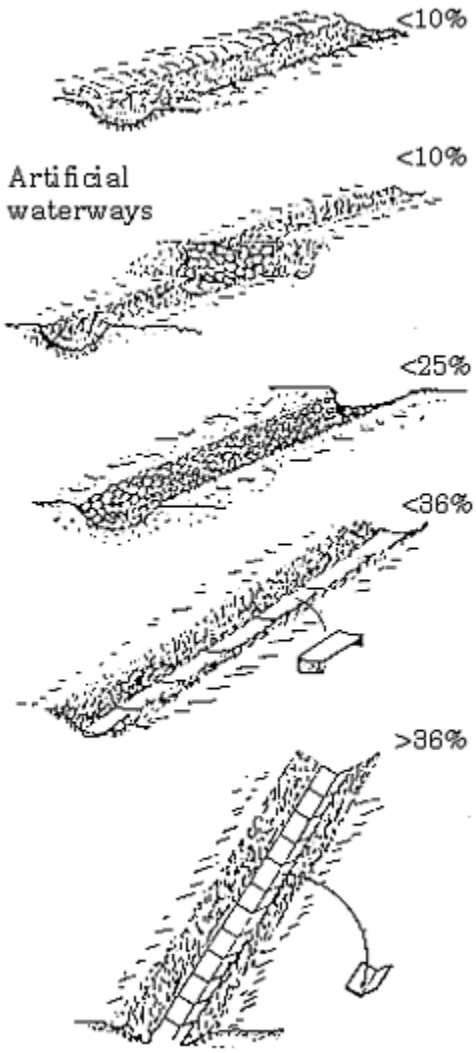


Figure 89. Water ways at different slopes and the required amendments in

structure

Artificial waterways as discussed here need to be grassed or stone paved. Traditional waterways need improvement according to the technical standards given.

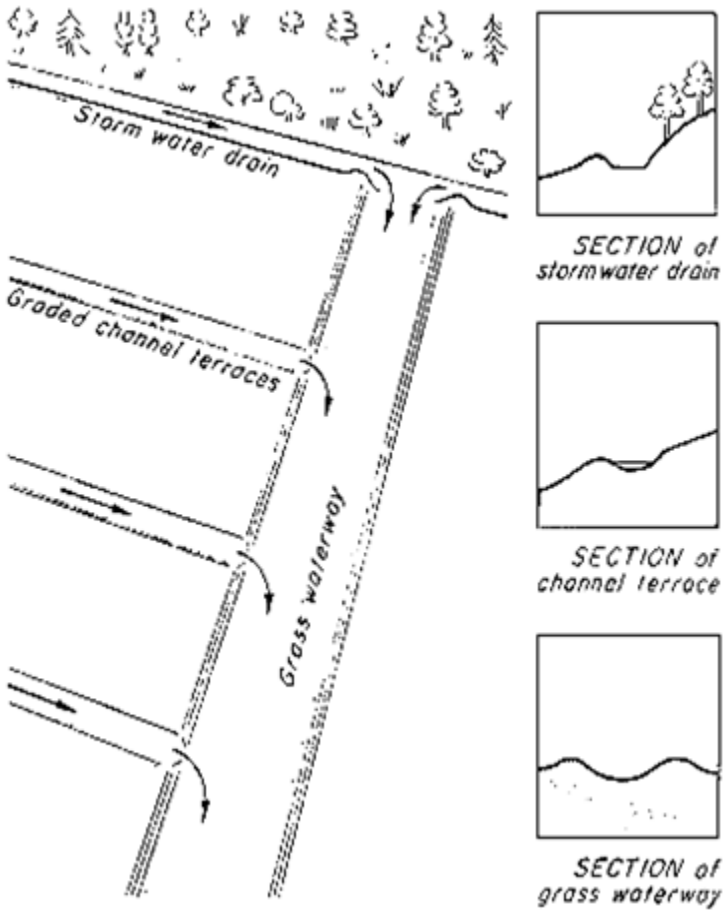


Figure 90. Grass water way and the input system sections

Location

- Slope range: 3-50%
- Soil range: All, but take care on deeply weathered subsoils.

Construction

- On cultivated land with graded structures, waterways must be placed every 250 m to avoid graded ditches to be too long.
- Waterways must always be constructed and grass developed on them, one year before graded structures are applied on the land.
- If there is enough land, cross-sections of waterways should be gentle as shown.

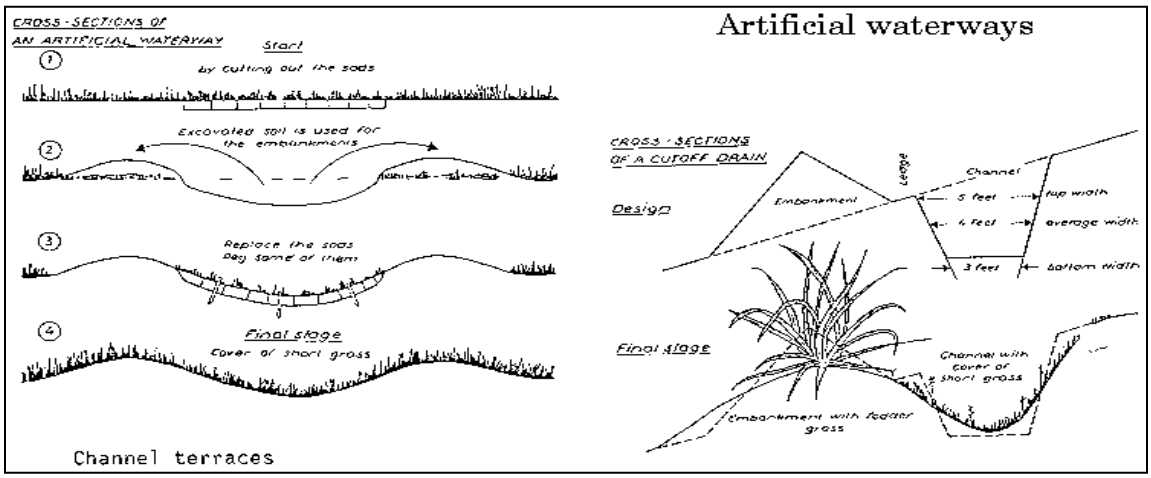


Figure 91. Cross-section of an artificial water way

Management and Maintenance

Waterways should not create a gully and not endanger land below them through overflow. Continuous management and repair of breakages, disruptions of the stone pavement and excessive scouring is needed.

Materials

Agriculture tools such as crow bars pick axes, spades and shovels are required. String and water level are required for layout.

Annex 4: Possible Adaptation/Mitigation Options and Mitigation Strategies

V.1. Introduction

Good practice in mitigation requires a relevant technical understanding of the impacts and the measures that work in local circumstances. Only those mitigation options that satisfy the four considerations listed hereunder are included in the mitigation options. The criteria are:

- practicality (technical feasibility);
- cost-effectiveness;
- availability of substantial evidences that prove the mitigations recommended are viable;
- alignment of the intervention with policy and regulatory framework priorities, and
- Acceptability by Implementing Agencies (community/potential participants).

The current section portrays the approach that is believed to best mitigate the important problems of land degradation in Sankura Woreda. The purpose of this annex is to sort out mitigation measures based on their feasibility and classify them based on their time of implementation.

The first section summarises all biophysical mitigation measures categorised under initial phase which only demand short spans of time for execution. This category also includes those activities which demand immediate execution - otherwise likely to induce irreversible damage to the ecosystem. Few non-infrastructures and most infrastructure demanding biophysical biophysical mitigation measures are included under the category of medium- and long-term mitigation options of

the second and third part of this annexture. Suggested monitoring and follow-up activities, adaptation measures and expected ecosystem standards are presented in the last two parts.

V.2. Short term mitigation options

Those activities which have an impact on activities listed under short term interventions are sorted out here. Because of their sensitivity, these activities shall be executed within three years.

V.3. Medium term mitigation options

For the most part, structural interventions and those interventions that demand careful planning before their implementation are included under this category.

V.4. Long term mitigation options

Monitoring and follow-up activities which are not included in the short and medium term activities are included here. These activities listed here shall be executed after all interventions under the previous phases are completed.

V.1.1.Short term interventions

This section focuses on short-term interventions in the landscape planning and it has been summarized in the table below.

Table V.1: Short-term mitigation measures.

iption of the mitigation measures	ion of plementation	mentation Indicators	nsibility[1]
ary adoption of the LMP and preparation of water conservation, ciency and productivity plans and implementation work at ster level	atershed development clusters in all kebeles	r of sub kebele level/cluster el conservation plans	a Woreda ministration[2] (SWA) Kebele Adminstration A)
ence sharing visit to places that have best practices on SWC like laba special Woreda NRM sites, Hawassa Zuria Woreda NRM es	ll watershed management clusters in the seven kebeles	r of sub kebele watershed nagement cluster organizers t have participated	A
and plan joint SWC interventions focusing on solving very gent problems of flooding	erabe Sinbita, Menzo and low laying areas in all kebeles	tares of conservation land adopted/selected from the LMP for flood protection	A
shes new area closure sites mainly in all Kebeles on hilly, sloppy eas as described on the LMP	ercho, Bercho Kulufo and all highly degraded areas in all Kebeles described in the LMP	es of land established from ch sub kebele level watershed sters	KA

[1]*Responsibility stands for that institution expected to organize the interventions. It doesn't necessarily mean the intervention is done by the institution alone*

[2] *all cross cutting issues like interventions done by coordinating neighboring rural administrations; are given as a responsibility of Sankura Woreda Natural Resources and Agriculture Development Office.*

ıg for distribution of energy saving stoves like 'gonze', 'mirt', ama' to the communities in the kebele for affordable cost.	ll kebeles	saving stoves access plan cument	A
p "Alemayehu forest" rehabilitation and management plan that ludes demarcation of buffer zone area.	rthern part Werabe ıbita and Menzo beles	Rehabilitation plan document pared	Vorabe Sinbita and nzo Kebele ministration
ıess creation/raising programs to the community about the portance of NRM	kebeles	r of campaigns conducted and mber of people that have rticipated	ıkura Woreda (SW) NRD d EPO
ıenting farm land rehabilitation and terracing activities	farm lands critically ected by erosion as licated in the velopment plan of each bele	es of land rehabilitated with l conservation activities	- NRDEPO
ıentation of biological soil and water conservation practices on graded lands	beles	es of land rehabilitated with l conservation activities	RDEPO
ze the current use of crop residues for cattle feeding and rning, encourage on farm mulching	beles	r of farmers participated on -farm crop management ıctices	NRDEPO
ıighly degraded areas from human and animal contact	beles	e of area closed lands	NRDEPO
ion services for soil fertility management	beles	r of farmers participated on l fertility management ıctices	NRDEPO
ion services for minimum tillage/zero tillage and reduced tillage ivities	beles	r of farmers participated on nimum tillage practices	RO and SWA - NRDEPO

ion services for irrigation agronomy and pump operation and intenance	Sinbita Kebele	r of farmers participated on gation agronomy extension vices	NRDEPO
t free grazing of cattle on agricultural lands	beles	r of farmers participated on ne free grazing forage nagement practices	- Fish and Animal sources office(SW-FARO)
appropriate market for the irrigators to get decent income from ir products	Sinbita and Menzo	ıe increased due to ervention	ra Woreda Agricultural ice (SW-AO)
ion service for ccentralizing individual activities of irrigators and velop appropriate cropping patterns	Sinbita and Menzo	ensing protocol developed r of licences given	RDEPO
unity education programs to create/raise awareness of water ource management	od plain irrigation farms around Werabe Sinbita and Menzo	r of irrigation water users sociation created	NRDEPO
ıd implement efficient irrigation systems		t water use and irrigation plan	NRDEPO
ion services to improve irrigation, water management and iculture practices		r of training sessions given for gation water users	NRDEPO
ıce appropriate water use practices and control the use of emicals in irrigation fields		r of agricultural input nagement training sessions en for irrigation water users	NRDEPO
riate land use planning for irrigation		r of irrigated land use plan for ferent agro ecologies	NRDEPO

V.1.2.Medium-term interventions

Table V.2:Medium-term mitigation measures

Description of the mitigation measure	Implementation Place	ementation indicators	esponsibility
litate vegetation cover of the kebele through appropriate soil and ter conservation interventions such as gully treatment, area sure, terracing.	kebeles	ıber of rehabilitated sub watersheds	A
ıent joint SWC interventions focusing on solving very urgent oblems of flooding	abe Sinbita and Menzo Kebeles	tares of rehabilitated land	
'loan facilities for eengagement in environmentally friendly ticultural practices like agro-forestry, rehabilitation of degraded ıds through bee keeping and animal fattening	kebeles	ıber of farmers participating in such practices	
ution of energy saving stoves like 'gonze', 'mirt', 'obama' for the nmunities in the kebele for affordable price	kebeles	ıber of fuel saving stoves distributed	
tion of suitable energy recovery from biomass production like gas	kebeles	ıber of biogas device established	
ted plot level soil and crop management practices		ıber of farmers engaged in	

	:ebeles	such practices	
indigenous vegetation to rehabilitate gullies	Kebeles	:are of land covered with *vetiver* grass	
ct sustainable soil conservation in the upstream area, Control sion from agricultural landscapes	:ebeles	:are of land covered with conservation activities	
l the flow of floods in flood affected plot of lands focusing on :rabe Sinbita and Menzo Kebeles	:ebeles	gth of fords/waterways used to control the flow	ra Woreda NRDEPO
vegetation interventions to trap sediments from erosion	:ebeles	:are of land covered with *sediment trap vegetations*	
g potential organic matter losses from agricultural fields	:ebeles	:ar of land using crop residue management practices	
nplementation of degraded lands demarcation and subsequent nting of suitable herbaceous and woody vegetation inside non abilitated area closure lands	:ebeles	tare of new forest land with new plantations	
forest vegetation to trap sediments and nutrients in storm water	:ebeles	gth of waterways and cut-off drains rehabilitated with forest vegetation	ra Woreda NRDEPO
ial support to urge vulnerable households switch from wood lection and selling business to environmentally friendly activities e bee keeping and animal fattening	eles	unt of loan distributed (Number of poors supported)	

ıg on value addition of their farm produces for improving usehold incomes	eles	ıber of training provided/number of trainees qualified on value addition	ra Woreda ricultural office

V.1.3.Long term interventions

Table V.3:: Long-term mitigation measures

Description of the mitigation measure	Place	Implementation indicators	esponsibility
ish strong natural resources monitoring echanism	beles	tablished Quality Monitoring Program	EPA
or the area closure activities and sustain its plementations through selling of harvested sources from area closed lands	beles	ctares of sustainable area closure sites	- NRDEP office
g monitoring and follow up of the application of ganic matter in agricultural fields, traditional tillage actices and free grazing of animals	agricultural fields around in each kebeles	tablished Monitoring Program	- EPA
ish strong extension services that promote ro/minimum or reduced tillage	kebeles	mber of farmers participated in zero/minimum or reduced tillage practices	NRDEP office, SW Agricultural Bureau

V.5. Adaptation measures for climate change impacts

Problems related to climate change will occur at any time in the kebeles. In order to respond for the climate change impacts, an adaptation program should be established. Early warning system, at each of the rural administrations, should be created and strengthened to act in response to disasters. All mitigation measures presented above may not sustain and can easily be wiped-out in few weeks if problems related to climate change like drought and famine occurred. Commonly protected areas of natural resources like closed areas, community forests, protected parks, and other sensitive resources like Water harvesting structures itself would be the ultimate refuge of the community affected by the impacts of climate change. Accordingly, establishment of early warning system is of paramount importance. Such activities should be undertaken by the Woreda Administration. Educational institutions, the Sankura Woreda NRDEP Office, etc. should be responsible for creating awareness on climate change and mainstream it into development and service activities so as to develop the requisite institutional capacity at all administrative levels.

Table V.4: **Adaptation measures for climate change impacts. In the implementation time S, M, and L stand for Short, Medium, and Long-term execution durations, respectively.**

Description of Adaptation measures	Implementation		Implementation indicators	esponsibility
	me	Location		
shment of early warning system	S	All Kebeles	ablished early warning system	A
ng the areas likely to suffer from risks posed by climate ange	S	eles	haps depicting vulnerable communities risks caused by climate change	V-EPA
ness creation on climate change	S	eles	ed behavioural changes	V-EPA
r the hazards of drought	L	eles	shed monitoring scheme	V-EPA
ch on effective adaptation programs	M	eles	r of Research conducted	erabe University
ent adaptation policies and measures	M	eles	d policy measures	nkura Woreda Administration
entation of sustainable water management measures	M	eles	r of kebeles where sustainable water nagement measures implemented	nkura Woreda Administration
ted water resource management actions	S	eles	r of users that have adopted integrated ter resources management actions	nkura Woreda Administration

g resources and seeking technologies for the plementation of adaptation measures	M	eles	es/materials secured for adaptation	nkura Woreda Administration
linkages with practitioners engaged in drought monitoring, ecasting and management operations	S	eles	r of linkages created	nkura Woreda Administration

V.6. Possible Ecosystem Objectives and Components of Interventions

7.6.1 Reduction of the current soil erosion and sedimentation rate

riod	nual soil erosion	mments
2016	75-1.58 cm increasing at a rate of 2 mm/year	rrent observation
2019	5 -1.1mm	duction by 1/3
2024	25 - 0.5 cm	duction by 1/2

Component 1- Kebele Afforestation: by increasing forest cover through tree plantation and preventing soil erosion, as well as conservation of existing natural forests.

Component 2- Land use Management: increasing gully rehabilitation, through soil and water conservation, and improved agricultural production, improved irrigation water management.

7.6.2 Reduction of the impact of flooding on agricultural lands

riod	oding impact	mment
016	se year	lf of the kebele is flooded for three months annually
019	duction by 33%	ainly with the use of artificial water ways
024	duction by 75%	ainly heavy metals

Component 3-Flood management: through the use of on-site water management, off-site artificial or natural waterways, buffer zone demarcation by the kebele administration, increased use of *vetiver* grass interventions in the buffer zone/forest, putting environmental regulations and laws on agricultural land management into action, applying integrated agricultural waste management in the households to mitigate problems aftermath of flooding.

Component 4-Irrigation: establishment of better irrigated agriculture extension services to better utilized aquifer stored flood water to compensate lost production during the flood seasons etc.

V.7. Implementation Strategies

V.7.1.Introduction

In section V.6., four important components for interventions that can facilitate the realization of the landscape management plan was presented. In this section implementation strategies for the mitigation measures discussed in the previous part are presented. Hence, the purpose of the section is three fold:

- To investigate the existing enabling environment (mainly legal framework) with respect to the different problems of the kebeles;
- To indicate the different mitigation strategies of the problems in the kebeles, and
- To sort out the available institutional setups to execute the different interventions suggested.

V.7.2.Enabling Conditions

While considering mitigation options, it is necessary to take into account of what enabling conditions there are for actions that are intended to be taken. Various policies and guidelines are available in Ethiopia which can serve as legal grounds towards sustainable management of land resources in general. Mainly the Federal Environmental Protection Authority (FEPA) which was established in response to the requirements of the Constitution (Proclamation No 9/1995) has the mandate and responsibility to *". . . ensure that all matters pertaining to the country's social and economic development activities are carried out in a manner that will protect the welfare of human beings as well as sustainably protect, develop and utilize the resource bases on which they* depend *for survival*" (Federal Negarit Gazeta of the Federal

Democratic Republic of Ethiopia - Proclamation No 9/1995). In addition to the EPA, the Investment Authority has been given responsibilities towards protecting the environment. These are captured in the Federal Negarit Gazeta - Proclamation No 37/1996) which states that ". . . *the intended investment activity would not be convening the operational laws of the country and that; in particular, it complies with conditions stipulated in environmental protection laws. . .* "

Among many environmental problems, land degradation and flooding have been identified as major problem of these kebeles. Corresponding to these problems, there are several relevant and overlapping policy instruments and mitigation guidelines (mainly by EPA) as well as sector organizations that are directed towards managing them. Some of these policy and strategy instruments include:

- Ethiopian Energy Policy,
- Rural Development Policy and Strategy,
- Proclamation on Rural Land Administration and Use,
- National Population Policy, Forestry Research Strategic Plan,
- Forestry action Program,
- Forest Conservation, Development and Utilization Proclamation,
- Conservation Strategy of Ethiopia,
- Productive Safety Net Program, and

These response instruments provide legal framework for sustainable management of natural resources.

The Ethiopian Energy Policy encourages energy mix, and in the long-term, a replacement of the traditional biomass based sources of fuel by modern technologies. Parallel to this, the policy promotes country-wide

re-forestation programs to supplement traditional fuels. The rural development policy and strategy justifies the voluntary resettlement programs (from area closed land to non degraded land) – which can also be viewed as a response to high population density. Forestry Research Strategic Plan, Forestry Action Program, Forest Conservation, Development and Utilization Proclamation, and Conservation Strategy of Ethiopia all provide legal framework for sustainable management of forest resources.

Environmental Pollution Control Proclamation No.300/2002 aims to ensure the right of citizens to a healthy environment and to impose obligations to protect the environment of the country. The proclamation is based on the principle that each citizen has the right to have a healthy environment, as well as the obligation to protect the environment of the country. The proclamation addresses the management of hazardous waste, municipal waste, the establishment of environmental quality standards for air, water and soil, and monitoring of pollution. In general, the Proclamation provides a basis for the relevant environmental standards applicable to Ethiopia to be developed, while sanctioning violation of these standards as criminally punishable offences. Furthermore, it empowers the Federal Environmental Protection Authority and/or the Regional Environmental Authority to assign environmental inspectors with the duties and responsibilities of controlling environmental pollution. In order to ensure implementation of environmental standards and related requirements, inspectors from EPA or the relevant regional environmental agency are empowered by the Proclamation to enter, without prior notice or court order, the premises within which any environmental inspection needs to be carried out. Such

extensive powers originate from Ethiopia's serious concern and commitment to protecting the environment from pollution.

The Public Health Proclamation of the Federal Republic of Ethiopia (200/2000) comprehensively addresses aspects of public health, including among others, water quality control, waste handling and disposal, availability of toilet facilities, and the health permit and registration of different operations. The Proclamation prohibits the disposal of wastes into the environment that can affect human health.

The Federal Democratic Republic of Ethiopia Rural Land Administration and Land Use Proclamation (Proclamation No.456/2005) emphasizes the importance of sustainably conserving and developing natural resources and passing over to the coming generation through the development and implementation of a sustainable rural land use planning. It allows the management of rural lands as presented below.

Table 8.1: Rural land use suggested by Proclamation No.456/2005

Group	Slope	Management of rural land	Article 13
1	ss than 30 %	il conservation and water rvesting	b article 4
2	% to 60 %	nual crops through making bench terraces.	b article 5
3	gger than 60%	all not be used for farming and free grazing; they shall be used for development of trees, perennial plants and forage production	b article 6
4	nd where soil and water conservation works have been undertaken	stem of free grazing shall be prohibited cut and carry feeding shall be introduced	b article 7

Article 13 sub article 7 of the same proclamation states that a rural land of any slope which is highly degraded shall be closed from human and animal interference fore given period of time to let it recover, and shall be put to use when ascertained that it has recovered. Unless the degradation is caused by the negligence of the farmers, semi pastoralists and pastoralists, the users shall be given compensation or other alternatives for the interim period. About forest management; article 13 sub article 10 of the proclamation affirms that biodiversity in rural forest shall be conserved and utilized as necessary, in accordance with a suitable land use strategy.

Adaptation to Climate Change Program is an EPA drafted program for the adaptation of climate change that is going to escalate every year. The formulation and implementation of climate change adaptation program is thought to be one of Ethiopia's endurance mechanisms against climate change. The program considers that climate change will affect the whole area of the country. Consequently, its solution also covers the whole area of the country. When implemented, the whole population, especially the farmers are expected to participate at all level of its lifecycle. With the participation of the population, the program forecasts that Ethiopia will become carbon neutral by 2025. The program forecasts that: the growing of extremes in the weather will challenge all physical structures built by humans, water availability for both humans and animals will increasingly fluctuate; and land degradation will be exacerbated. Hence about twenty different types of adaptation measures like funneling of organic wastes back to rural areas as manure or compost for agricultural soil conditioning and the like are suggested.

V.7.3.Implementation Strategies

Community mobilization is the ultimate goal of the implementation strategy. The following strategies shall be used in the realization of the LMP.

V.7.3.1. Establish and Strengthen Collaboration

1. Initiation and institutionalization of collaborative sub-catchment level negotiations with Halaba and Sankura *Woreda*s by NEPO
2. Develop sub-kebele approach for execution of soil and water conservation activities (see Box below).
3. Collaborative work has to be done between major stakeholders [like Natural Resources Development and Environmental Protection Office (NREPO), Kebele Administrations, Halaba special *Woreda* and Sankura Woreda Agricultural Development Office (AOs), Woreda Education Office and other institutions] for effective knowledge transfer and to manage the resources properly for suitable socio-economic activities.
4. Horizontal and vertical coordination between institutions to avoid conflict of interest among various stakeholders and encourage harmonization.
5. Ensure people's participation and create sense of ownership- without which all policies, especially environmental policies, will not be effective.
6. Establish strategic alliance that ventures to solicit fund and/or create opportunities that would ultimately be made available for landscape management activities (including reduction of the number of people engaged in illegally activities).

ox 1. Sub-watershed approach for IWM

- Classify the sub-watershed in to micro-watersheds,
- Select a community willing to participate in IWM and has interest on the micro-watershed,
- Prepare community based micro-watershed plan,

(**Attention:** the community has to involve at all stages of the activities from planning to implementation. Participation of women in watershed development planning, implementation and management is the key to ensure that they equally benefit from the various actions.)

- Organize a consultative meeting with the community at micro-watershed level and prioritize problems.
- Together with the community, select an area that needs quick preventive activities based on the sensitivities of the problem.
- Start with community knowledge to select specific measures that will be taken up by the specific watershed for sustainable conservation.
- Substantiate and endorse their locally selected option with existing mechanical soil and water conservation structure to harvest water and to reduce the soil erosion with locally available materials.
- Reach an agreement with the community to employ cut-and-carry system to feed their cattle around their farm.
- Design and launch the implementation program with influential agriculturalists, environmentalists, other stakeholders and community elders from the specified micro watershed.
- Provide sustainable professional support specifically at Kebele level by using Development Agents in all spectrums of the interventions.

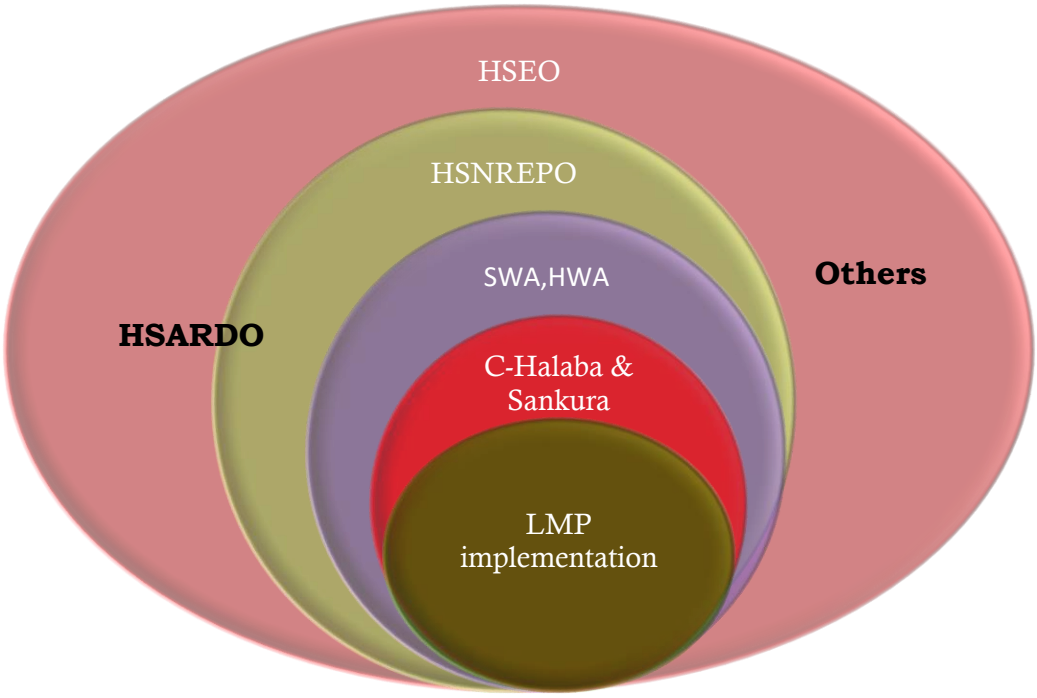


Fig. 8.1: Collaborating institutions and communities

(HSEO – Halaba and Sankura Woreda Education Office; HSNREPO-Halaba and Sankura Woreda Natural Resources Development and Environmental Protection Offices,HSARDO-Halaba and Sankura Woreda Agriculture and Rural Development Office; SWA -Sankura Woreda Administration, HWA –Halaba Special Woreda Administration. ; C-Halaba and Sankura - Communities in Halaba special Woreda and Sankura woreda; Others includes Regional Bureaus, GO's. NGOs)

V.7.3.2. Employ Model (Best Practice) selection

The following should be included in the list of practices while selecting types of models as exemplar:

i. Best practices of rehabilitation of degraded lands while improving livelihood of the community by Mendel in Hawassa Zuria Woreda,

ii. Best practices of awareness creation and supply of fruit seedlings to community members by JECCDO around Hawassa ,

iii. Best practices of supplying multi-purpose tree seedlings for the community to be planted in degraded lands by SOS Sahel,

iv. Best practices of rehabilitation from *Mekibassa Koreke* mountain range by Halaba special *Woreda* and its collaborators can be taken as good examples and should be effectively scaled up at other areas and by other organizations to solve the problem at hand through collaborative efforts.

V.7.3.3. Awareness Creation

i. Creating awareness of the community through training, conferences, local media, social organizations like *"Eder",* religious and community leaders, etc. to change the perception of the society towards their activity and their impacts over the environment.

ii. Regular awareness creation program and campaigns at the grass root level about NRM, using *"Eder",*, churches, mosques and schools etc. Such activities will change the mindset of residents and help them to perceive land as a non renewable resource rather than something which is limitless.

iii. Educate the community about the concepts of Integrated Agricultural waste Management – IAWM, priority should be given to waste segregation at the point of generation followed by conversion of "waste into resource" such as energy recovery, composting and recycling.

iv. Participatory adult education for the community

v. Strengthening functionality of Farmers Training Centers – FTC

vi. Strengthening environmental clubs and mainstream environmental education in schools

vii. Utilization of local media (e.g., 100.9 FM, Community Radio, etc.) in disseminating information

V.7.3.4.Enforcement of Environmental Laws and Regulations

i. While a balance of activities including education and preventive actions are important, enforcement of laws/regulation is to compel the behavioral changes required to obtain compliance;
ii. Plan and enforce strict environmental limits;
iii. Regulatory activity and law enforcement of natural resource protection departments and responsible bodies at all levels should be strengthened;
iv. Political commitment of various implementing institutions towards implementing environmental provisions, rules and regulations should be improved);

V.7.3.5. Extended Support to/from Institutions

i. NRDEP office and Agricultural development offices should:
   - Introduce improved fruit seedlings, necessary skills and market linkage to engaged the community in agro forestry activities that do not harm the surrounding ecosystem;
   - Provide technical support for the implementation of SWC activities;
ii. Sankura/Halaba Woreda Administration should be encouraged to place NRM as their priority in their development agenda;
iii. Encourage agricultural waste composting practices using different incentive mechanisms;
iv. Sankura/Halaba Woreda Administration should be supported to place the rule of law on rural land management ;

v. Sankura Woreda Health Department needs to be encouraged to include agricultural waste management as one of the priority areas for the rural health extension program;

vi. Strengthening the capacity of existing small scale enterprises that are involved in environmentally friendly business in the kebele by providing training and through arrangement of experience sharing programs;

vii. Provision of land and financial support to small scale enterprises that are involved in environmentally friendly business to improve their capacity and help them to implement their activities in a larger scale and sustainable ways.

ANNEX 5

GULLY STABILIZATION GUIDELINES FOR SANKURA AND HALABA AREAS

Wherever possible, gully control in each of the fourteen *kebeles* should be achieved by vegetative methods or by using a combination of vegetation and cheap, simple structures, i.e. porous checks can slow water down and cause silt to deposit; weirs constructed of masonry or concrete can also be used. Other examples which can be used are gabions, wire bolsters, netting dams, brushwood dams and log dams. Their purpose is to provide protection just long enough to give the vegetation time to start growing. The permanent masonry or concrete structures have two main aims: a regulating function for flash floods; and to act as a quick-acting silt and sand trap.

In all the observed *kebeles*, gullies are originated from concentrations of flowing water on the soil surface either there is a change in land use/land cover, due to neglected rills and furrows in farm lands or places where there is intensive tillage erosion. On other land uses, they started from livestock trails in overgrazed pastures, faulty drainage from roads, wrongly designed artificial water ways and traditional plough made drainage lines done by farmers.

Figure 92. Traditional plough made drainage lines progressively developing to gully (*Sankura Woreda, Bercho Kulfo Kebele*)

Most gullies observed are not older than 25 years old while their formation is hastened by heavy rainfall, when large quantities of runoff attain a high velocity and increased erosive power on a very shallow fragile soil.

The following phases are distinguished for gully erosion control in Bercho Kulufo, Bercho, the central part of Weteta and southern part of Menzo Feten kebeles from Sankura Woreda; and Kulfo, Hantezo, Bendo Cheloksa, and Weteta Kebeles of Halaba Special Woreda:

- Improvement of the catchments area of the gully to reduce and regulate the quantity of runoff;
- Stabilisation of the gully head to prevent the gully from ”eating backward”;
- Safe conduct of water through the gully, if it is part of the natural drainage system;
- Reclamation of the gully area, where it is not part of the natural drainage system.

1. IMPROVEMENT OF THE CATCHMENT AREA

In denuded watershed like, Qulubi, Weteta, the northern part of Bercho Kulufo, *Kulufo and Werabe Sinbita kebele* with its accelerated runoff, re-establishment of the vegetative cover would be the appropriate measure to take.

Figure 93. Poorly managed area closed land at the border between Weteta and Qulubi Kebele where most gullies were populated

The area must be planted with shrubs and trees to improve the soil condition, increase infiltration and reduce surface runoff. In serious cases, the absorbing capacity of the catchment can be increased by “contour bunding”.

Contour bunding is the construction of low earth dams along the contour, behind which the water can gradually infiltrate into the soil. It is designed more for pastures and agricultural land, but may also be useful for this purpose too.

2. STABILISATION OF THE GULLY HEAD

If the gully does not belong to the natural drainage system and stabilisation is attempted by planting only, the runoff entering the gully head has to be intercepted by a diversion canal.

Figure 94. Progressive gully head following cattle trails in agricultural land of Weteta kebele of Sankura Woreda

This canal is dug above the gully head at a distance of once or twice the depth of the gully. It should have a trapezoidal cross section and must be designed wide enough to conduct maximum rainfall. Precautions must be taken that not a new gully develops from the diversion canal, which should be checked after every rainfall event.

Figure 95. Canal dug above the gully head to stop its progressive development in Weteta kebele of Sankura Woreda

Where the gullies are part of the natural drainage system, sometimes only temporary diversion canals are dug. In this case the gully head is stabilised in a way that the gully cannot enlarge by waterfall erosion (see Fig.5) anymore when water enters.

To stop the gully from eating back, the gradient of the gully head is first reduced to smaller slope. The surface of the gully head is then stabilised by any of the following methods:

- A brush cover well anchored to the ground is the most recommendable vegetative method.

- Sodding may be possible in grassland, where sods are available. The sods must be “nailed” to the surface.
- Riprap interplanted with cuttings is also a very recommendable method to stabilise a gully head. The layout of the riprap should be concave to concentrate the water in the middle. An apron at the bottom is essential to prevent scouring.

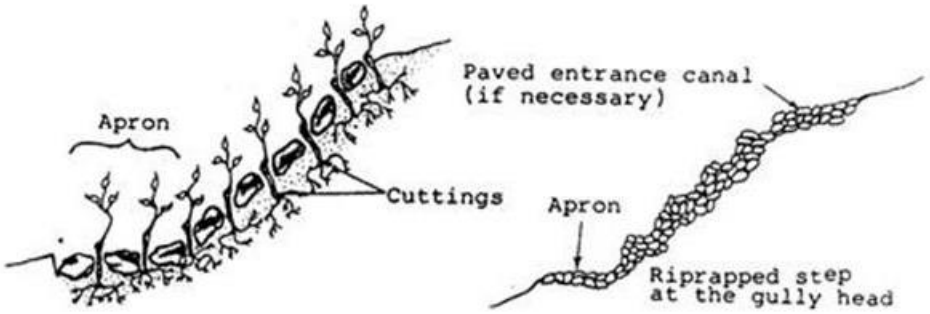


Figure 96. Stabilization of a gully head by riprap (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975)

Pole structure: In the absence of stones also a pole structure can be employed for the gully head. It should be laid out in V—shape to concentrate the water in the centre. An apron must be constructed below and a canal above at the intake.

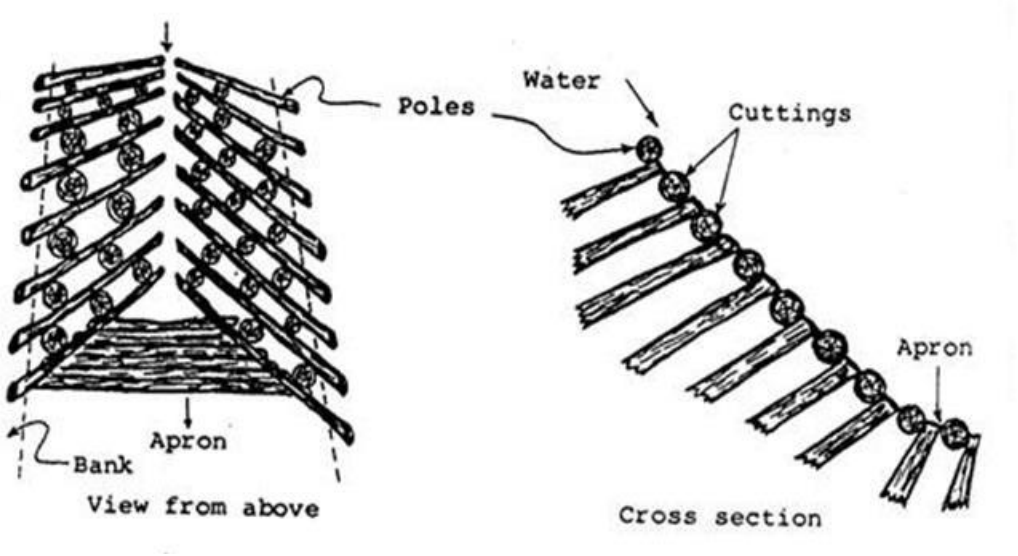


Figure 97.Gully head stabilisation by a pole structure (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975)

Solid structures for gully head stabilisation can be made of riprap, gabions, masonry or concrete. The construction can be in the form of an arch as shown in Figure 7. If it is necessary to concentrate the runoff above the gully head, there should be wing walls of earth or riprap. The flow is conducted through a spill way or notch and falls down to the bottom of the gully bed, which is protected by an apron.

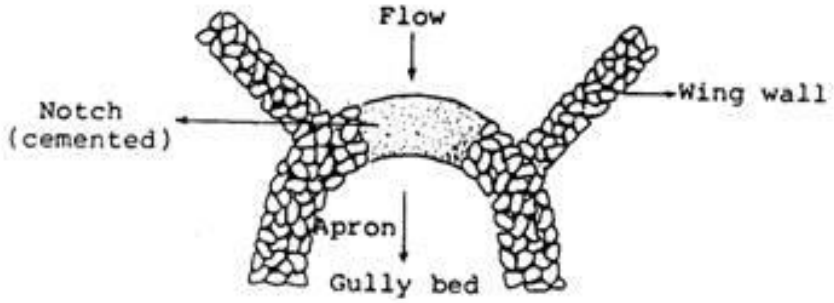


Figure 98.Gully head stabilisation by a solid structure with wing walls (view from above) (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975).

3. STABILISATION OF GULLIES BELONGING TO THE NATURAL DRAINAGE SYSTEM

After improvement of the catchment and stabilisation of the gully head, the gully bed has to be treated to prevent further deepening and widening. This is achieved mainly by various types of checkdams and ground ties.

The purpose of a checkdam is to reduce the gradient and break the velocity of the flow. Through checkdams the water is conducted safely from a higher to a lower point without causing erosion at the gully bed. The waterpools behind the dams promote the percolation of water into the soil. Checkdams still serve their purpose even when they are completely silted up by reducing the gradient inside the gully.

For gullies which are part of the natural drainage system as observed in the majority of off farm gullies in Bercho Kulufo, Bercho, the two

Wetetas, Menzo Feten, Kulfo, Hantezo, and Bendo Cheloksa only checkdams with a long life span are suitable. They should be constructed in places where the bed is narrow and the banks are firm. Curves or sites within or just below gully junctions must be avoided.

Checkdam Design

In an ideal case, checkdams should be spaced in such a way that the bottom of the upper checkdam is level with the top of the next lower one. In a steep gully this is difficult to achieve because too many checkdams would be required. If the section between two successive checkdams cannot be made level, the gradient should at least not exceed 5 percent.

Figure 99. Spacing of checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975)

The height of the dams influences their spacing. There is the alternative of constructing a few high or many low dams on a certain gradient. High checkdams have to resist a greater pressure than low ones and, therefore, are more liable to damages. While concrete or masonry dams can be built at any height, dry stone or brushwood dams should be low. Under normal conditions, the height of a checkdam should not exceed 1 meter.

Checkdams must be well anchored in the ground and particularly in the banks to prevent underscoring and scouring between the dam and the banks. The flow is directed through a waterway or notch in the centre of the dam. Below the dam, where the water hits the gully bed, a protective apron must be constructed. For additional strength the checkdam is filled up to the notch with soil on the upstream side.

The following types of checkdams are recommended in gully affected *kebeles*:

I. Stone checkdams: recommended for Bercho Kulufo and Kulufo kebeles

Stone checkdams constructed either as a dry stone wall (Figure 10) or a gabion box (Figure 11) are mainly recommended for big gully stabilization in *Bercho Kulufo and Kulufo kebeles* due to less biomass coverage, high intensity of gullies and immediate danger of gully in these kebeles. During construction, the gradient of the gully banks is reduced to about 45° or 1:1. Then a foundation 30 to 50 cm deep extending well into the banks is dug (Figure 9).

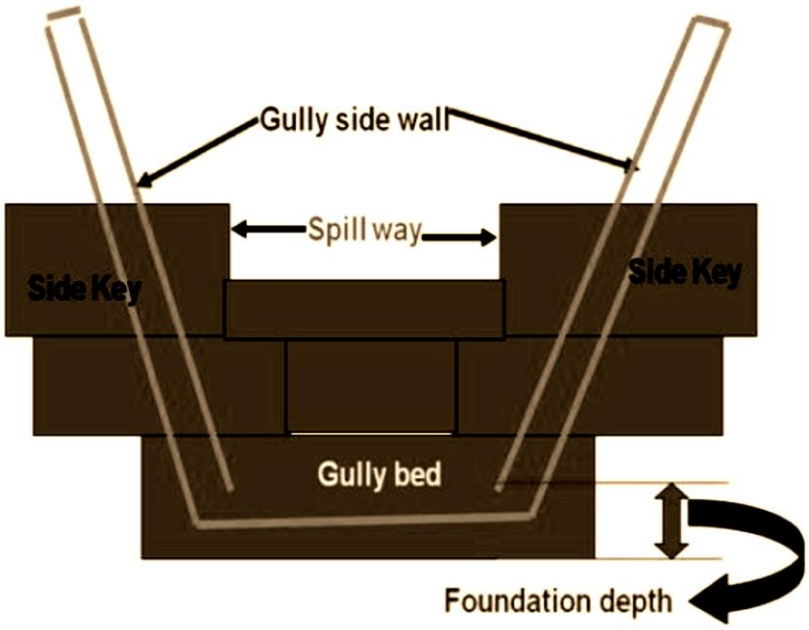


Figure 100. Schematics of gabion and Stone checkdams

The soil is piled upstream to be used later for the re-fill. The largest stones are placed in the bottom layers. The joints in successive layers are broken according to the usual rules of riprap.

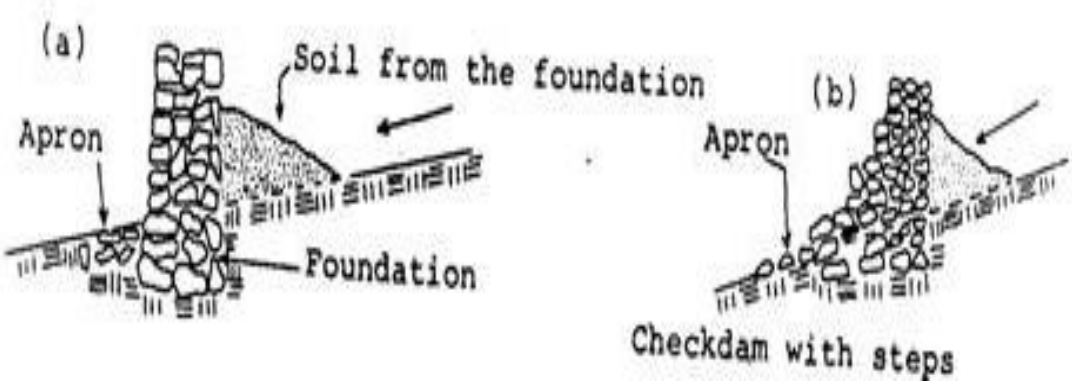


Figure 101. Dry stone checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

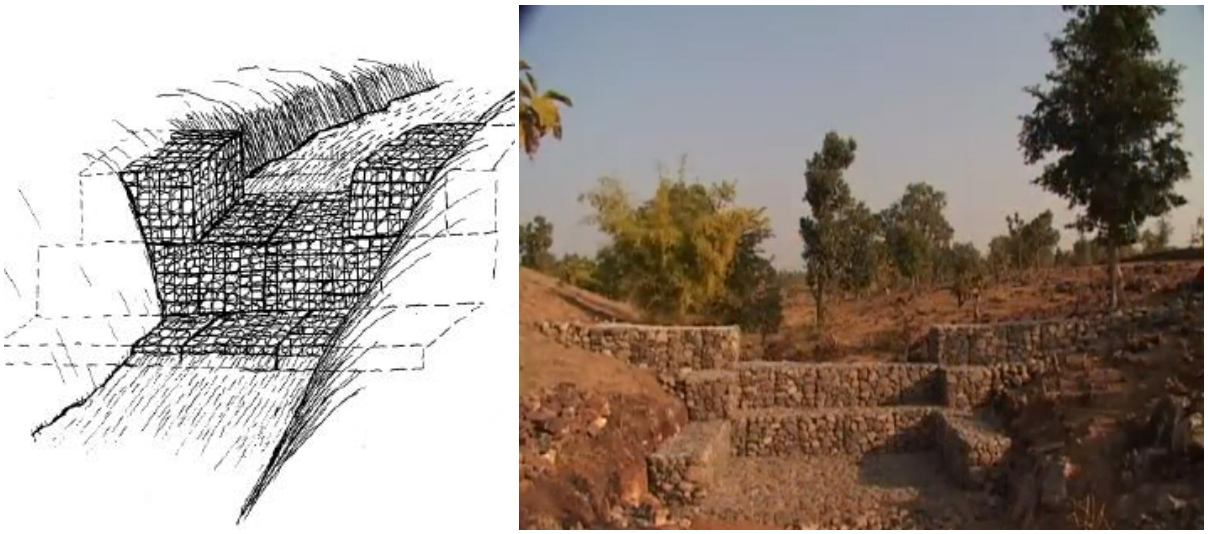


Figure 102. Gabion box checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

Larger checkdams can be constructed with steps in front (Figure 10, b). In every layer of stones a step of 15 to 20 cm is left on the down-stream side, so that the width is reduced from base to top. The advantage is saving of stones and that the flow is gradually conducted down to the apron.

For large dams two wing walls with appropriate foundations are often constructed at the upper side to force the flow into the water-spill or notch and prevent it from damaging the banks. The wing walls should form an

angle of about 300 with the banks. For small checkdams wing walls are not required.

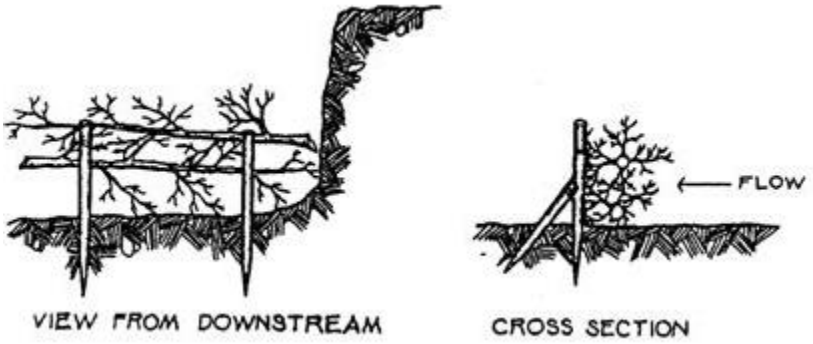
In the centre of the ” crown ” a notch of concave shape is to be spared, which must be wide enough to cope with peak runoff. Generally a length of half the span of the dam and a depth of 20 to 30 cm are considered appropriate. For the notch, large flat stones/well packed gabion are reserved that cannot be washed away.

When large quantities of run-off are expected, it is advisable to use some concrete for the notch and the crown of the dam, or to cover everything with a wire netting in the case of Stone checkdams. Below the dam an apron has to be constructed with stones. On the upstream side the dam has to get an earth fill for greater strength. Finally, the structure is supplemented by planting seedlings and cuttings of suitable species with a dense and wide spread root system like elephant grass, vetivar grass, or dual purpose creepers like “*Engecha* “(Figure 12) along the banks.

Figure 103.Dual purpose creeper grass locally called "*Engecha"* in Halaba Woreda potentially useful for plantation on checkdams

II. Brushwood checkdams: recommended for all kebeles where stone is unavailable

They are only temporary and recommended for most gullies located in agricultural fields and road sides. At first, a foundation extending well into the banks is dug. The brushwood, sprouting or non-sprouting, is placed between two rows of pegs driven-in 40 cm apart across the gully bed. The distance between the rows should be 0.80 to 1.0 meter for gullies up to 5 meters in width. The brushwood is packed firmly and the two rows of pegs are tied together by wire. On top a notch of about half the span of the dam is spared.



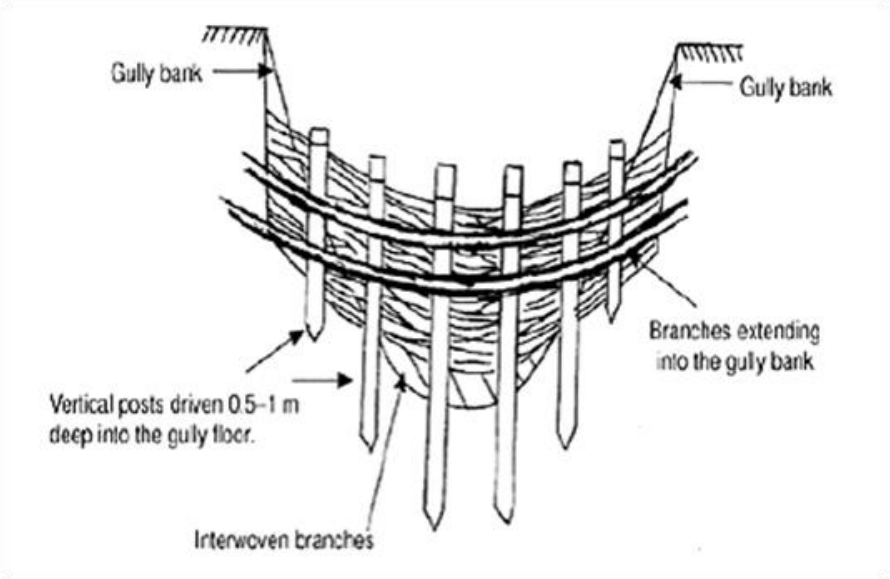


Figure 104. Brushwood checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

On the lower side of the dam, branch wood is placed lengthwise to provide an apron preventing scouring by overflow. It is very important that these temporary structures are supplemented by cuttings and seedlings similar to stone checkdams stabilization, which can take over when the brushwood has decayed.

III. Pole checkdams: recommended for low lying kebeles where pole from eucalyptus tree is available

In Sankura Woreda (Worabe Sinbita, Sinbita, Weteta, Menzo Feten kebeles) and Halaba Special Woreda (Hantezo, Bendo Cheloksa, Weteta kebeles) where

sand and stone materials are scarce, eucalyptus pole checkdams are recommended.

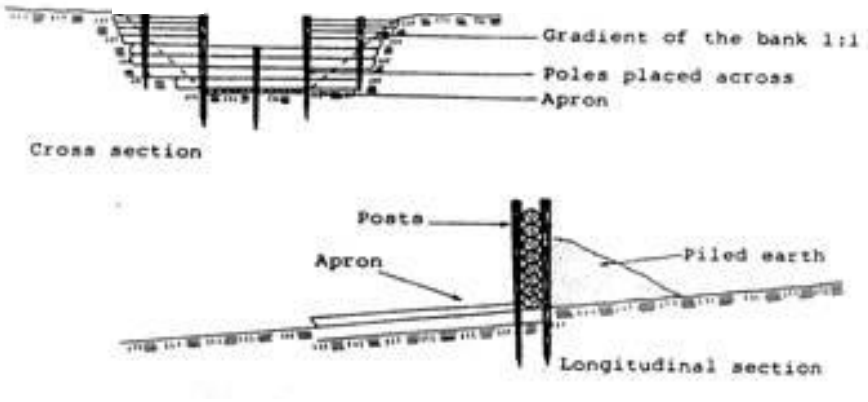


Figure 105. Pole or log checkdam (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.*,1975)

Some of the poles have to be erected as uprights at intervals of about 60 centimetres to keep the horizontal poles in place. The central posts are taken down to notch level, while the others reach the height of the checkdam. Below the checkdam some poles are placed lengthwise to form the apron. The horizontal logs are nailed or tied to the uprights by galvanised wire. A structure of this type may last for a few years. It is hoped, that after its decay the vegetation will finally control the expansion of the gully.

IV. Sand/soil bag checkdams: recommended for all kebeles where either of the above materials are unavailable

Where it is justified checkdams can also be constructed of sand or soil bags as shown below (Figure 15). These materials allow much higher structures than the ones described in II and III. Their construction principles are similar with the previous techniques.

Figure 106. Sand/soil bag checkdams for gully stabilization in Amhara Region

The sections between the checkdams can be stabilised by" ground ties" (Figure 16), which consist of cuttings of sprouting plants planted between two logs placed across the gully bed. The sprouts will effectively reduce the velocity of the flow.

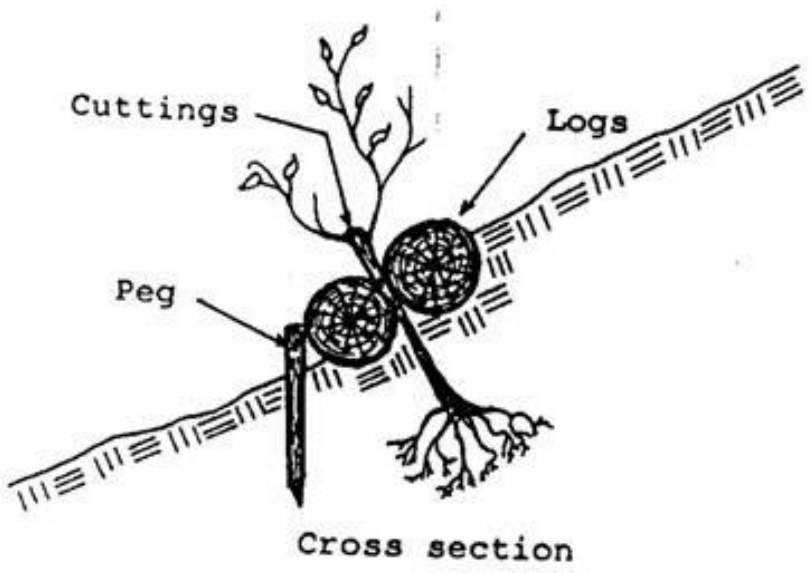


Figure 107. Ground tie with sprouting brushwood (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

The logs serve as miniature checkdams, reducing the gradient of the gully bed (Figure 16). They must be well anchored in the banks. For the cuttings, a bushy species like sisal species should be chosen. Wherever possible, the gradient of the gully banks must be reduced to about 1:1 and planted with suitable species. If the gully banks are left with a steep gradient, they cannot be colonised naturally by invading vegetation. As the moisture conditions along and inside the gullies are quite favourable, these may be good sites for planting fruit trees and other valuable species.

4. RECLAMATION OF GULLIES NOT BELONGING TO THE NATURAL DRAINAGE SYSTEM

Kulufo, Bercho Kulufo, Bercho, Weteta, Qulubi, Southern part of Hantezo, Southern part of Menzo Feten are full of totally degraded land where gullies make up for a large part of the area without actually being needed in the natural drainage system. The objective of reclaiming these gullies is to utilise their area again. With small interventions, shallow gullies on farm lands may be gradually filled up by sediments. Larger gullies have to be stabilised, so that their size will not increase. The general procedure can be:

- Digging of a diversion canal, if the conditions permit;
- Stabilisation of the gully head:
- Reducing the gradient of the banks to 45°, so that they can be planted or colonised by pioneer vegetation. It is also possible to stabilise the banks by cordons and brush covers interpolated with cuttings and seedlings:
- Where necessary, construction of checkdams, which can generally be more of the temporary type:
- Protection of the gully bed and measures to increase salutation

The methods used here are slightly different from the measures taken for gullies of the natural drainage system, because generally less water can be expected in these non-draining gullies. Typical measures recommended for the reclamation of non-draining gullies include brush combs and plugging of gullies.

Brush combs: Recommended for shallow gullies in the farm lands of Kulufo, Bercho Kulufo, Bercho, Weteta, Qulubi, Southern part of Hantezo, Southern part of Menzo Feten kebeles

Their function is to reduce the velocity of the flow and “comb out” the sediments, so that the gully is gradually silting up.

In contrast to bench layers the brushwood is placed more vertical. At first trenches, which should follow the contour, is dug 40 to 60 cm deep across the gully bed and the banks. Seen from above the layout will be more or less u-shaped (Figure 16). The brushwood, which must be of a sprouting species, is placed upright and tightly together on the down-stream side of the trench. For greater stability some thin poles are placed horizontally along the butt ends of the brushwood. Afterwards the trench is refilled and tamped.

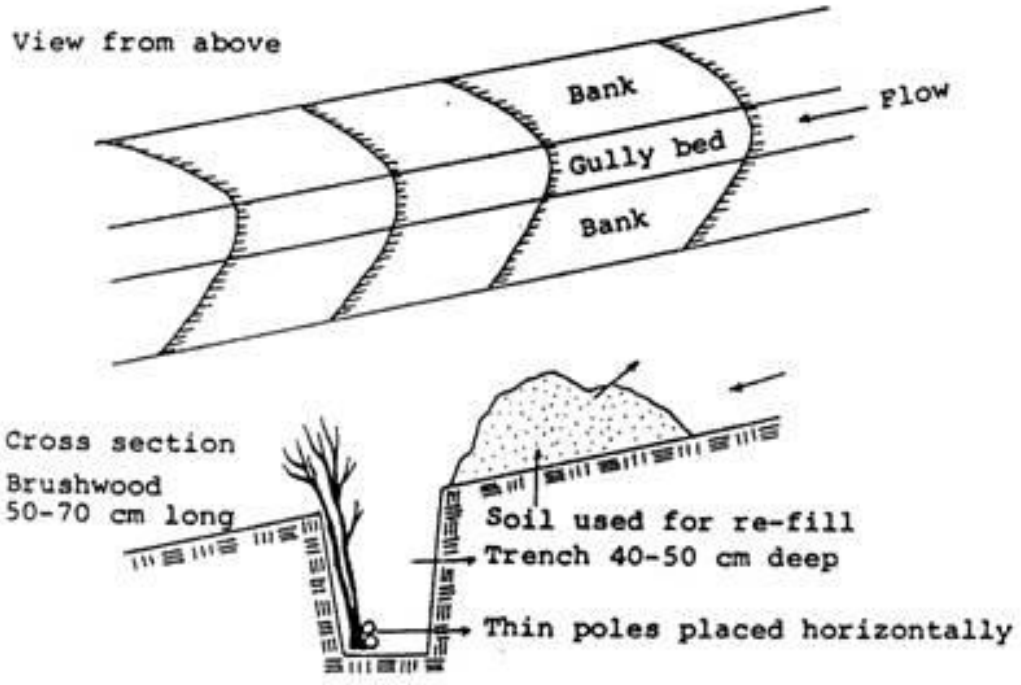


Figure 108. Construction of “brush combs” (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,*1975)

Plugging of gullies: Recommended for shallow gullies in the farm lands

Smaller gullies of less than one meter in depth can often be stabilised by plugging them with brushwood. It is laid out lengthwise in the gully, and an anchorage is generally not required, except in steep gullies. The brushwood must be bushy and need not be of a sprouting species. The velocity of the flow will be reduced and the gully gets filled up with sediments.

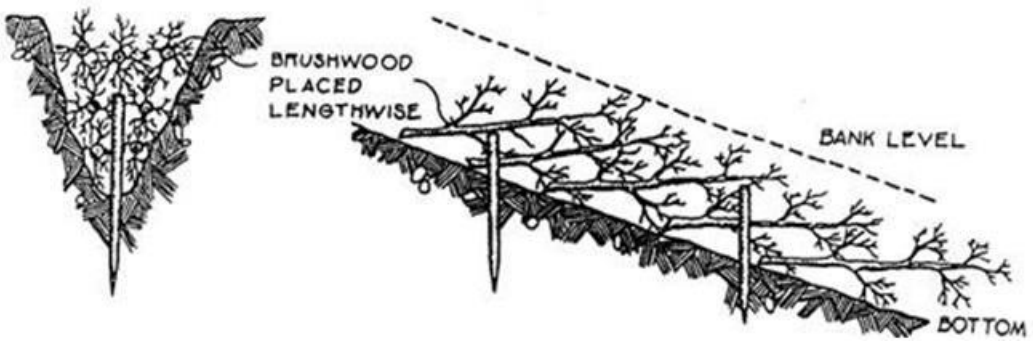


Figure 109. Plugging of small gullies (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,*1975).

There is no custome made design that suits every locations in the study area. These recommendations with proper site specific design shall be integrated with other soil and water conservation interventions suggested for each land use in in the main land management plan.

All the black and white pictures are excerpt from:

Manual of Reforestation and Erosion Control

A. Agpaoa, D. Endangan, S. Festin, J. Gumayagay, TH. Hoenninger, G. Seeber, K. Unkel and H. J. Weidelt.