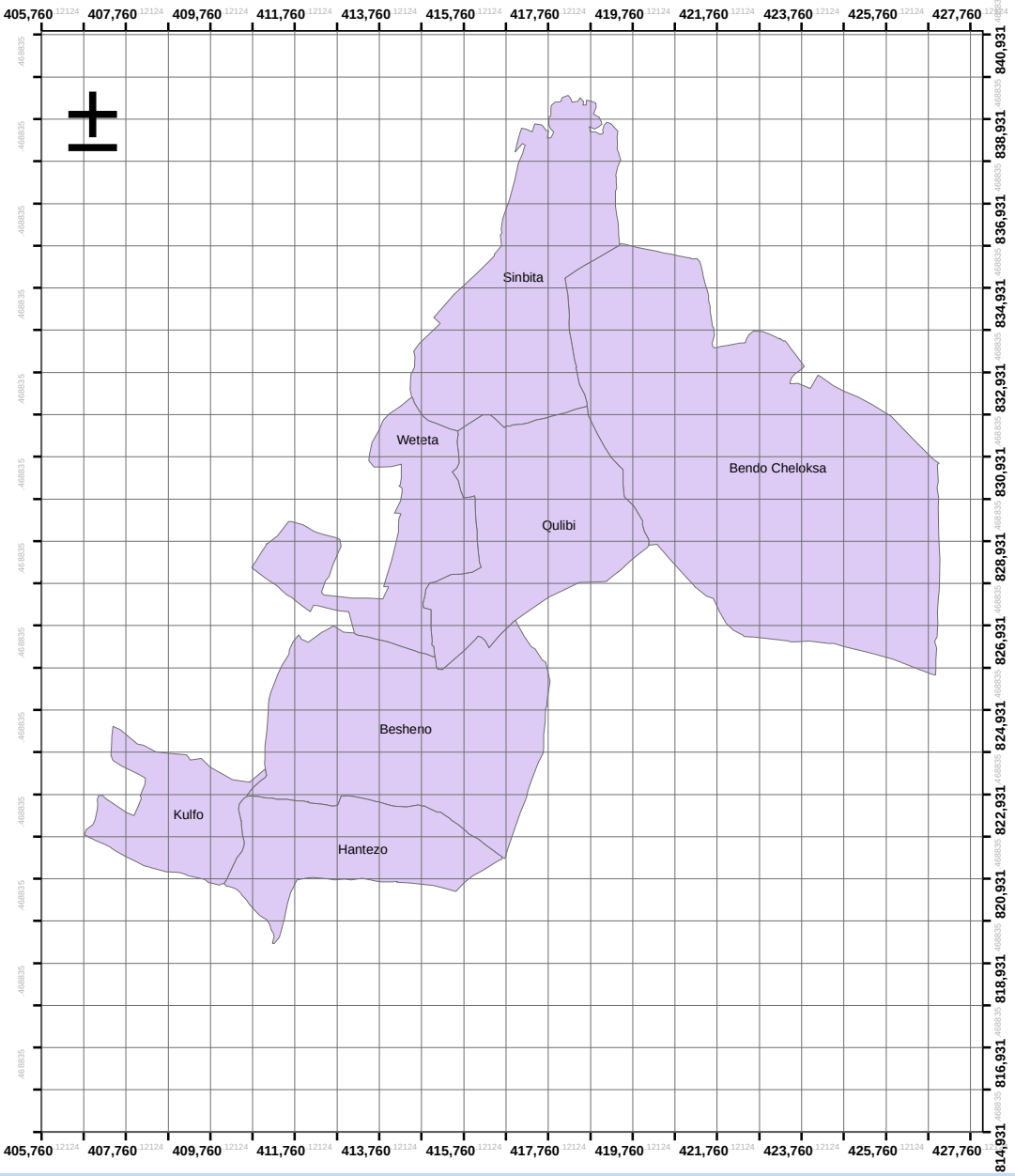
Landscape Management Plan For PIN Kebeles in Halaba Special Woreda

Kebeles: Sinbita, Weteta, Qulibi, Besheno, Kulfo, Hantezo and Bendo Cheloksa *Kebeles*



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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SUMMARY

This is a summary report on the biophysical and socio-economic analysis of seven *Kebeles* for landscape management plan (LSMP) development in Halaba Special Woreda. The LSMP is intended to improve smallholder livelihood through reduction of soil degradation and better management of natural resources. In order to minimize and if possible prevent natural resources particularly soil degradation, a system should be designed based on natural resources loss minimization as part of sustainable green development policy agendum of the current government. The purpose of the field assessment held from October 10/2016 to October 21, 2016 was to get first hand information about the biophysical, socioeconomic and watershed management practices employed in the Dijo and Bilate watershed of Sankura and Halaba Special Woredas. In this systematic field investigation, 7 *Kebeles* namely Kulfo, Hantezo, Besheno, Bendo Cheloksa, Sinbita, Qulubi, and Weteta *Kebeles* of Halaba Special Woreda were investigated. Serious soil degradation and flooding problems were observed in the study *Kebeles*. Gully intensity per *Kebele* is quite high indicating that the area is under huge influence of erosion. Deforestation, high population density, tillage erosion and bad management of soil and water conservation structures are among the major causes of erosion. Considering the current situation of the study area, the study assignment employed a range of tools to gather and analyze data from both primary and secondary sources. The data collection methods

include; document review and secondary data collection, focus group discussion, key informant interview, systematic field visit, transect walk, mind mapping , observation, and direct measurement.

1. INTRODUCTION

Soil degradation is one of the major problems confronting agriculture in Ethiopia. It is a major threat to the soil resource, soil fertility, land productivity, and, lastly to food and fibber production. Although the problem is as old as settled agriculture, its extent and impact on human welfare and global environment are more now than ever before. A continuation of high soil erosion will eventually lead to a loss in crop production even though fertilizers and other inputs often result in increased yield in the short term. These problems are referred to as on-site effects of erosion. Soil erosion also leads to environmental pollution. Further downstream, erosion leads to flooding, sedimentation of water reservoirs and poor water quality. A decrease in soil quality invariably leads to a decrease in water quality. These are off-site effects of erosion.

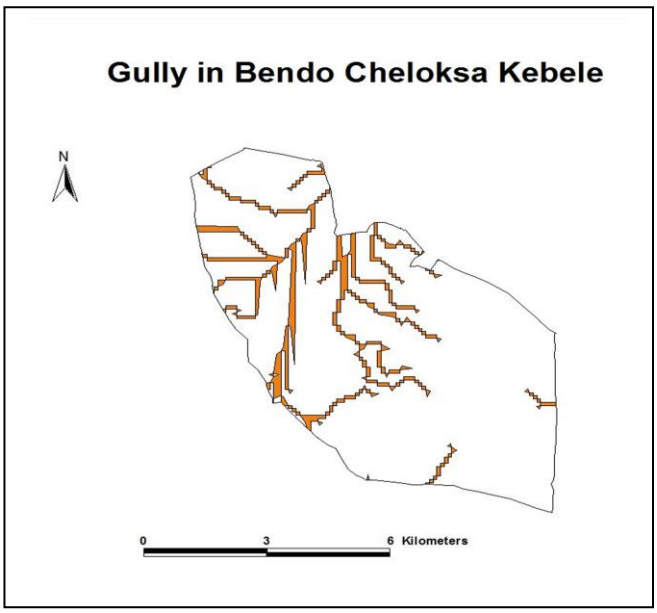
In Sankura Woreda and Halaba Special Woreda, extensive areas of agricultural lands are eroded every year and most of these lands (cultivated and grazing) are changed in to gullies. Gully erosion is geographically a widespread problem and is the worst stage of soil erosion (Figure 1).

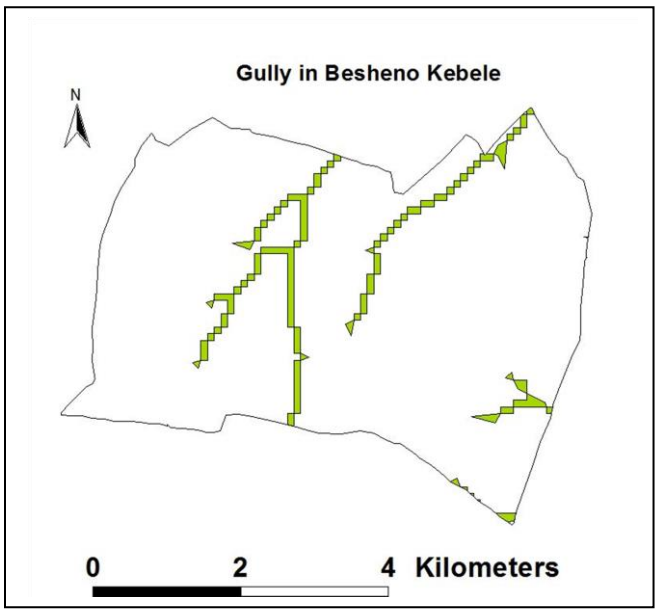
Figure 1.Frequently observed gully forms in all *Kebeles*

Gullies are particularly severe and widespread covering large tracts of areas. This form of soil erosion is more difficult and expensive to control than sheet and rill erosion. It is also more spectacular than the other forms of erosion. Contrary to sheet and rill erosion, the damage done to land by gully erosion in permanent and

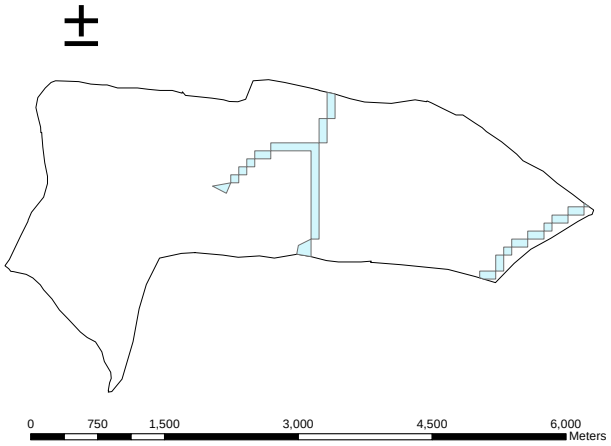
take long time to reverse it. Gully erosion is the main cause of depreciation in arable/non arable land sizes and land productivity/value by lowering the water table and depleting the available water reserves. Infrastructures particularly road networks in both Woredas are also undermined by rapidly advancing gully.

Equivalent to direct tillage erosion, in all *Kebeles*, poorly designed artificial waterways, poorly managed footpaths and cattle trafficking lines have been transformed to sever gully areas. Land degradation due to soil erosion, particularly gully erosion by water, is the main threat in the seven *Kebeles* of Halaba Special Woreda.

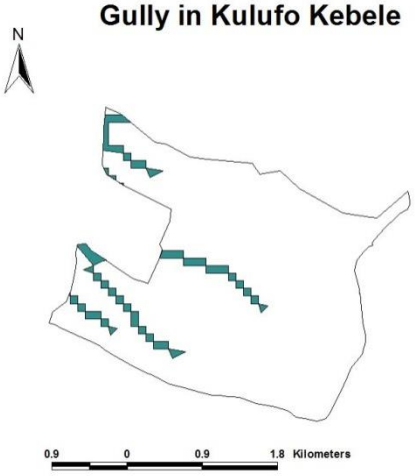




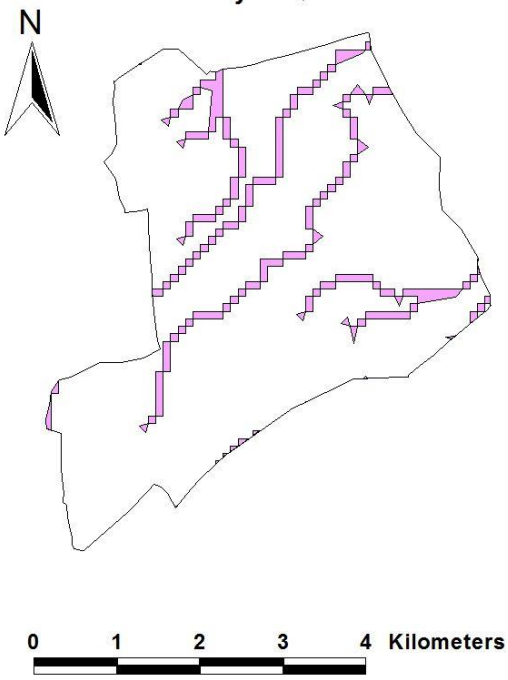
Gully in Hantezo



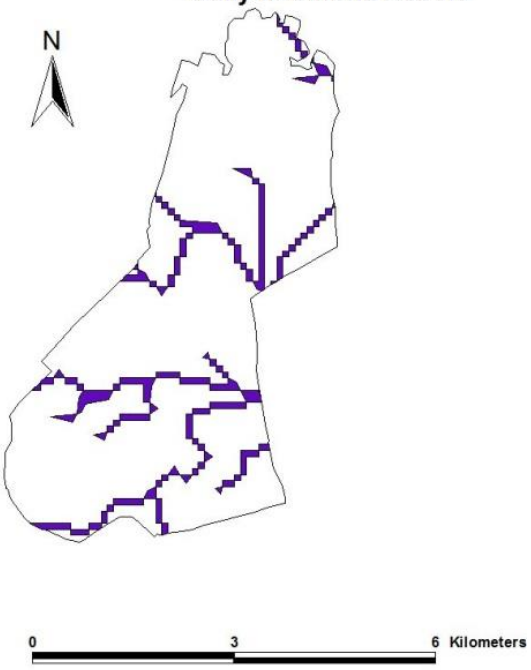
Gully in Kulufo Kebele



Gully in Qulibi Kebele



Gully in Sinbita Kebele



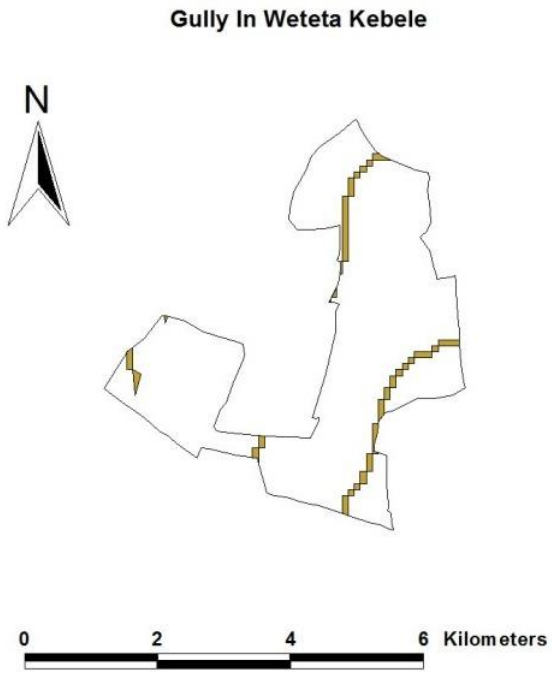


Figure 2. Intensity of major gullies in each *Kebeles*

This is manifested by the presence of a lot of gully affected area in all parts of project *Kebeles*. Fertile farming / cropping fields, grazing fields, foot slopes of degraded hillsides, foot trails and cattle trafficking lines have been significantly affected by gully erosion. Besides, side drains of tarmac and gravel roads, access and internal access roads, downstream areas from bridges, culverts and fords have also been seriously affected.

Obviously, watershed degradation results deterioration of the natural resources such as soils, water and vegetation, and in turn leads to decline of land productivity. Apart from decline of productivity, it also results adverse environmental impacts on lower-laying lands, water development schemes and command areas due to imposing sedimentation and flooding at the downstream outlet of watershed system. Siltation of water harvesting structures, flood

controlling structures, and agricultural fields are frequent observed at the downstream *Kebeles* of Weteta, Sinbita and Bendo Cheloksa *Kebeles*.

Traditional agricultural practices, deforestation, population pressure and expansion of cultivation into marginal lands, steep topography, seasonal abundant rainfall pattern and fragile nature of the soils largely facilitated the soil degradation process. High population of livestock coupled with existing free summer grazing system is the other aggravating factor for land degradation. These situations are observed evidently in all *Kebeles* surveyed.

2. OBJECTIVES AND SCOPE OF THE LMP

The general objective of this study is to investigate bio-physical, socio-economic, and institutional potentials and constraints of seven *Kebeles* in Halaba special woreda, develop a landscape management plan and put recommendations on conservation and rehabilitation of the natural resources to control soil erosion in these *Kebeles* and thereby to minimize sediment and flooding impacts on Sinbita, Bendo Cheloksa and Weteta community.

2.1. Specific objectives

The specific objectives of the current study are to:

- Assess bio-physical and socio-economic features of Kulfo, Hantezo, Besheno, Weteta, Sinbita, Bendo Cheloksa, and Quilibi *Kebeles* of Halaba Special Woreda,
- Assess and analyse the status of soil erosion and land degradation and flooding problems of these *Kebeles*

- Carryout land capability classification to identify the soil and water conservation(SWC) requirement classes to decide on required SWC measures
- Evaluate past and present experiences of the community on SWC activities
- Assess institutional capacity, and policy issue related to natural resources Management
- Undertake problem analysis and propose appropriate watershed management measures.

2.2. 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.

3. APPROACHES AND METHODOLOGY

3.1. 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 *Kebele*s with special care in maintaining the ***natural elements of their ecosystem and its surroundings.***

3.2. The Study Area

The seven *Kebele*s 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 *Kebele*s are about 5165 hectares of which nearly 5% is affected by gullies.

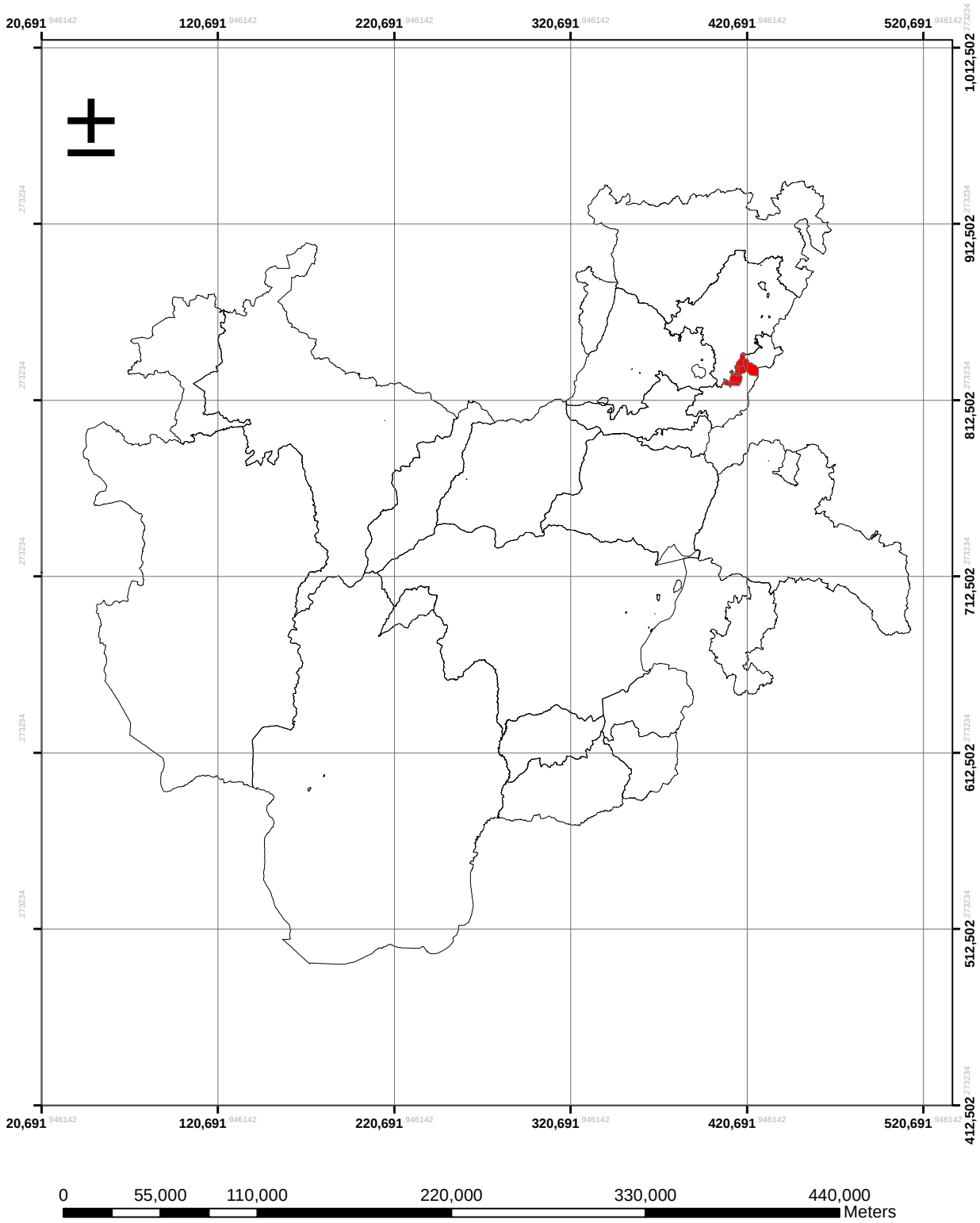


Figure 3. The study area in SNNPR State

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.

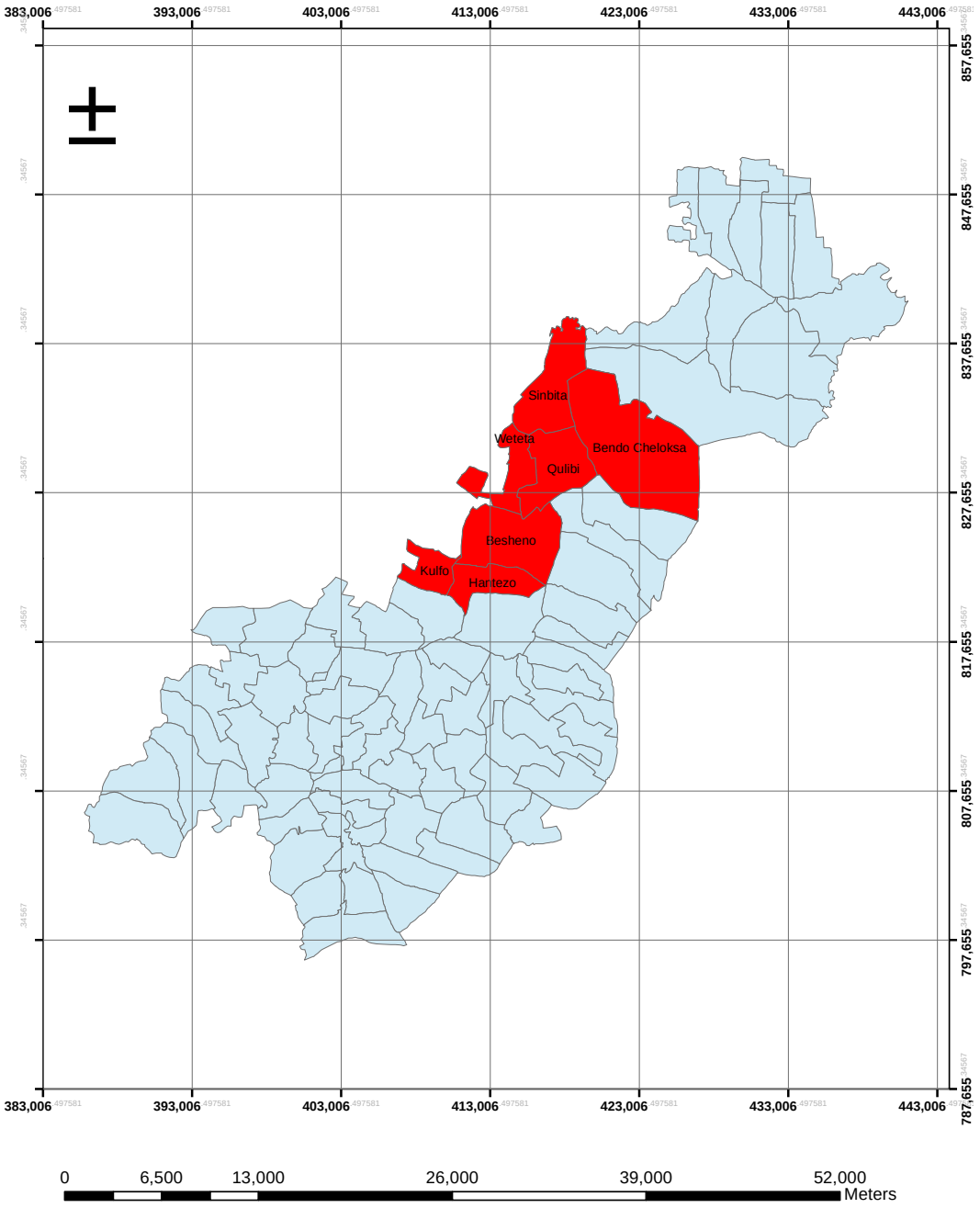


Figure 4. The study area inside Halaba Special Woreda

3.3. 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 has 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 *Kebele*s 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.

3.4. 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.

4. RESULTS- SOCIO-ECONOMIC AND BIOPHYSICAL SETUP

4.1. Major economic activities in the catchment

In both *Kebeles* the community led their life through diverse occupations. However, crop production and animal husbandry are the main stay of the community.

4.1.1. Agriculture

Agriculture is the major livelihood strategy for the rural communities. In the area the activity is carried out in its mixed form mainly farming and livestock rearing at small scale level.

Crop Production

The communities in the rural part of these *Kebeles* mainly depend on farming; cultivate crops that are rain fed for family consumption and if surplus for market in order to generate income for the household. The area is characterized by Maize-Pepper based farming system integrated with animal husbandry. The activity is carried out through traditional ways using animals and intensive family labor on fragmented plot of land. Major crops grown in the area includes maize, pepper, sorghum , Wheat, Chat, Coffee, Teff, Haricot Bean, and Home Gardening (Vegetables) also very common in low land areas of Besheno and Hantezo *Kebeles*.

According to community level focus group discussion with participants and with some key informants, in addition with soil degradation; the level of production of these crops is low because of limitation in application of modern agricultural technologies as recommended by professionals. In order to increase their product, only about 67.23% of respondents have been using inorganic fertilizer. Some of the respondents (11%) reported as they have been using organic

fertilizers to improve soil fertility. An average of 79.3% of the participants in all *Kebeles* used herbicides to control various diseases and pests from their crops.

The current trend showed that unless it is controlled by effective SWC activities, there is possibility of farmers loosing much of their arable land in short time.

Figure 5. Gully initiation after one season of rainfall, upstream of Bercho Kulfo *Kebele*

Agro-forestry is an important farming systems to reduce soil erosion from steep slopes and is one of the missing farming system (about two thirds of the fields visited during the transect walk lack this system) on arable lands in the majority of farmers resides in the *Kebeles* surveyed. This system should be introduced and scaled up in most agricultural fields where there is scant vegetation cover to reduce rate of soil erosion by rain water and wind during off seasons.

Source of Water for Crop Production

Rainfall; directly or through surface water harvesting structures are the only source of water for crop production in all *Kebeles* visited (rain (95.2%), ground/surface water (2.1%), water harvesting (2.7%). With appropriate drainage and water harvesting mechanisms, there is a huge potential of land suitable for agriculture in the flood plains of Sinbita and Bendo Cheloksa, where the slope is less than 4%.

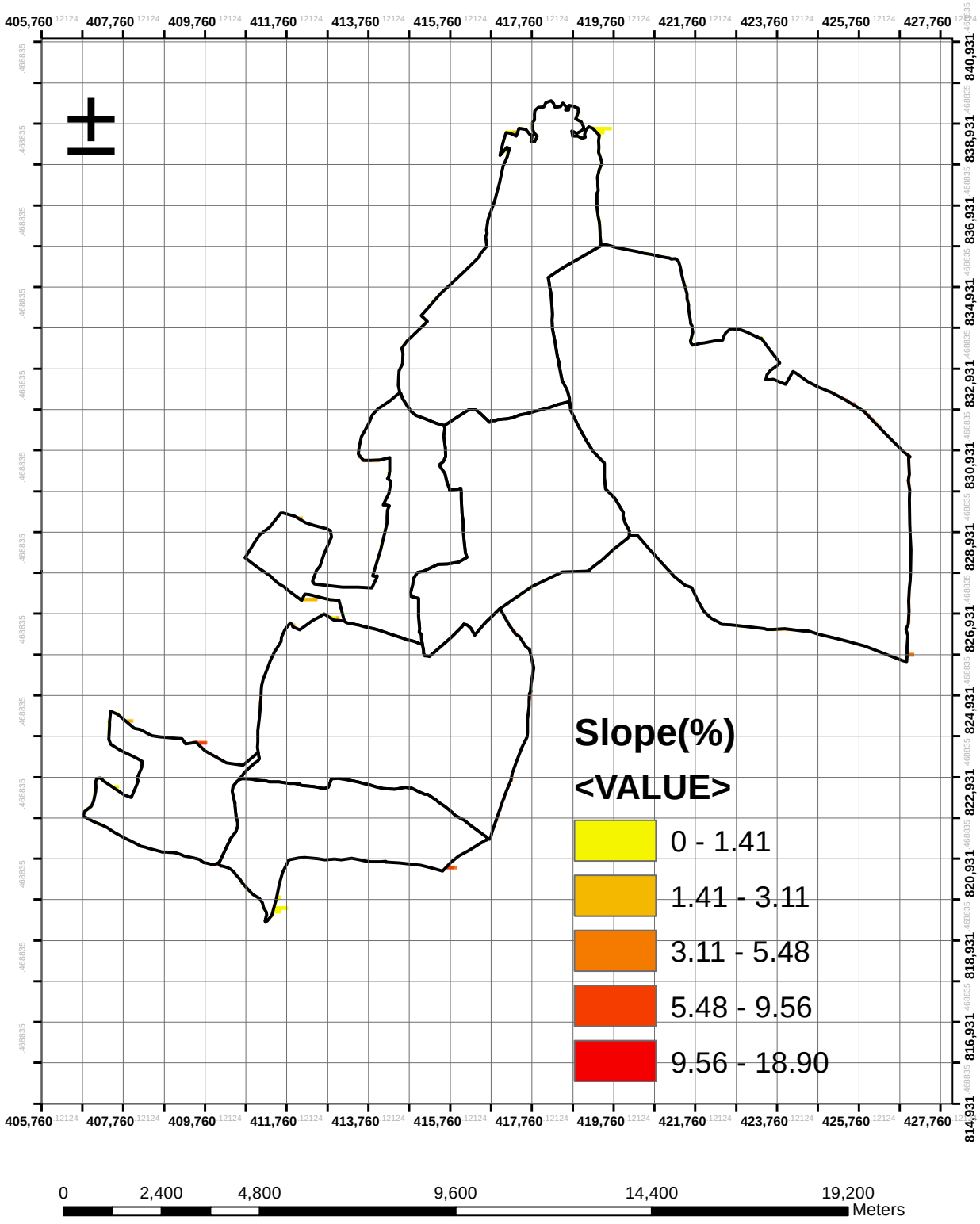


Figure 6. Slope distribution of each *Kebeles*

As shown above from the transect walk observation, rain-fed agriculture is the dominant mode of crop production in all *Kebeles* though there are some irrigation activities both from the surface and ground water. However, very few (2.7%) of the community members has been using water harvesting technologies mainly for livestock drinking which has potential role to reduce

4.1.2. Land Tenure and Land Security

Land is one of the most important production factors for agricultural activities. So access to and control overland has great implication on livelihood and environmental security of certain community. For rural households, in developing countries like Ethiopia land and labor account for the largest share of agricultural inputs. However, the quality and quantity of land available for households largely determine the amount of production obtained. In relation to land tenure, the transect walk exercise showed that majority (88%) respondents in the seven *Kebeles* have been cultivating their permanent plot and about 5.7% of them cultivating farm plots obtained through lease/rent in/ from other farmers. But 6.2% of the respondents do not identify the land tenure type of their plots. During community level group discussion the research team identified that people either with ample farm land or people with shortage of labor give their land for other farmers who has adequate labor through lease/contract/. In addition to that share cropping is another mechanism to access farm land in the *Kebeles*

When someone considers the issue of land tenure in Ethiopian context, farmers have the right to use their land indefinitely, but selling or mortgaging of land is forbidden by the constitution According to the constitution, land is the common property of Ethiopian Nation, Nationalities and Peoples (FDRE, 1995). But the responsibility of management of land and water resources is vested on public institutions at different levels starting from federal up to *Kebele* levels. With regard to the land tenure and management status of forests, communal lands

and water bodies in each of the *Kebeles* visited, there is clear gap. The situation is worst especially in relation to management of wetlands and swampy areas. According to KII and FGDs, as well as transect walk survey; it was observed that some marginal land which lacks private ownership have been used for water harvesting structures construction regardless of their suitability.

Regarding certification of land, majority (78.7%) of respondents have certificate and the remaining 21.3% do not have certificate. The certificate insures use right for both husband and wife. Among those respondents who has land certificate, majority of them reported that the certification promoted their sense of ownership for their plot of land. According to FGDs participants in the seven *Kebeles*, farmers know their responsibilities when they exercise their use right. This implies the farmers are willing to invest their labor and time on the activities that are supposed to improve fertility of their plot of land.

4.1.3. Land Size and Soil Fertility

78% of the respondents have plot of farm land size bigger than 1.5 hectares; which is similar cause for major low land areas of Ethiopia. About 17% of the respondents have a range of 2-3 ha of farm land, whereas 6.6% of the respondents have bigger than 3 hectare of land size mainly found in Sinbita and Bendo Cheloksa *Kebeles*. These land resources are under increasing stress due to patterns of tillage erosion, land mismanagement and plowing/resizing of terraces. Deforestation of vegetation cover for fire wood and sell induced significant pressure on a limited patches of communal forests mainly in Kulfo and Bendo Cheloksa *Kebeles*.

Figure 7. Gang of women with their empty back donkeys cruising for deforestation in Bendo Cheloksa *Kebele*

The continuous cultivation of a farm without fallowing and without effective SWC technologies resulted with fertility reduction and exacerbation of soil erosion (figure below) on majority of the fields visited.

Figure 8. Teff and wheat fields without proper soil conservation structure, Hantezo and Besheno *Kebeles*

Due to moisture stress, majority of 88.3% of the participants of the FGD and KII are cultivating their plot of land one times per year. This was also justified with the help of the seasonal calendar of the individual *Kebeles*.

Table 1. Seasonal crop calendar of the seven *Kebeles (Maize, sorghum, millet, haricot bean, and wheat)*

		Sep				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				Jun				Jul				Aug			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Maize	Land Preparation																																															
	Sowing																																															
	Cultivation																																															
	Harvesting																																															
Sorghum	Land Preparation																																															
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	Harvesting																																															
Millet	Land Preparation																																															
	Sowing																																															
	Cultivation																																															
	Harvesting																																															
Haricot Bean	Land Preparation																																															
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	Harvesting																																															
Wheat	Land Preparation																																															
	Sowing																																															
	Cultivation																																															
	Harvesting																																															

Table 2. Seasonal crop calendar of the seven *Kebeles(Barley, Teff and Pepper*

		Sep				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				Jun				Jul				Aug			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Barley	Land Preparation																																															
	Sowing																																															
	Cultivation																																															
	Harvesting																																															
Teff	Land Preparation																																															
	Sowing																																															
	Cultivation																																															
	Harvesting																																															
Pepper	Land Preparation																																															
	Sowing																																															
	Cultivation																																															
	Harvesting																																															

In relation to this 38.1% of the respondents reported as the fertility of their farm land is reduced year after year. Soil erosion by water, and burning/foraging of crop residues, cultivating frequently a plot without fallowing, limited adoption of SWC technologies were some of the causes for fertility decline identified by FGD participants at *Kebele* level.

4.1.4. Perception regarding Causes of Soil Erosion and its Impact

Concerning their perception about adverse impact of soil erosion, 88.6% of the respondents perceive soil erosion as major cause for soil degradation in their respective *Kebeles* and majority of them also understand that improper soil and water management practice of their farm has been contributed for the present threat of their cultivated land. Tillage erosion is the dominant cause for erosion in the watershed followed by deforestation, erosion susceptibility of the soil, steepness of the slope, over cultivation and over/uncontrolled grazing respectively. These situations are in one or other related with high population pressure which leads to continuous cultivation without fallowing, cultivation of steep slopes and marginal lands, encroachment to forest reserves to expand farm plots. So, high population and limited awareness of the community can be termed as the proximate cause that leads to fragmentation of farm lands in the *Kebeles* and exerted high pressure over natural resource base. Therefore, strengthening awareness creation mechanisms through various strategies such as training, cultural institutions, local radios, is mandatory to balance population size with that of resource base. Thus, land is over utilized and eroded and its productive capability is diminished. The problems of population increase on the one hand and the limited availability of arable land coupled with severe soil depletion makes intensification of agricultural production while maintaining the resource base imperative.

During Group Discussion, Farmers cited soil erosion as their major problem that caused the declining crop productivity in the area. This in turn is caused by intensive cultivation of land without fallowing and removal of the vegetation cover of the land. In response to the problem of soil degradation, farmers practiced both traditional/local and introduced measures. However, the poor design of these structures was mentioned as a main reason for the failure of the structures in five *Kebeles*. Installing structures on flat lands, narrow spacing bunds induced difficulty in oxen plowing and the effect of structures in making part of the already degraded cultivable land out of cultivation were among the problems mentioned.

4.1.5. Animal Husbandry

Livestock is an important component of the farming system in the study area. A vast majority of the sample households included in this survey own animals of different kinds. 88.9% Cattle, 84% sheep and goats, 73% chicken are common domestic animals owned by households. Goat, sheep and chicken are sold and serve the purpose of immediate cash generation at times of cash shortage. The size of livestock owned indicates the wealth status of the household. Animal production is a deep rooted cultural practice for community in the surveyed *Kebeles*. The community exercise integrated form of agriculture by which animals are source of protein for the family and organic fertilizer for crop production, where as crop residues also used as feed for the animals.

Figure 9. A flock of cattle rushing towards water harvesting structure for watering, Bendo Cheloksa *Kebele*

Majority of the respondent rear local breed of cattle, goat and chicken which need due consideration in reducing free and over grazing during the off seasons in the watershed, which is one of the causes for soil erosion. In the transect walk exercise, it was observed that, on average three cattle were tied grazing around the home garden. However, the livestock population in these *Kebeles* is large for a various reasons. Traditionally, the number of animals, mainly cattle, determines farmer's social status in the form of wealth rank. This social value motivated farmers to keep as many cattle as possible. Furthermore, the increased human population has lead to an increase in animal population. This has resulted in overgrazing in the watershed. Regarding the feed source, 8.6% use crop residue, 11.5% uses grazing land and 0.2% uses developed/treated/ forage. Whereas 48% of the respondents use crop residue and free grazing on their pasture lands in the area. During the off seasons, scavenging of farm lands in and around the neighboring *Kebeles* are the traditional ways of animal husbandry.

4.2. Results-Physical setup of the seven Kebeles

4.2.1. Dijo Sub-Watershed and the Kebeles

The seven *Kebeles* in Halaba Special Woreda and the other seven *Kebeles* in Sankura Woreda of Silty Zone lies between 7⁰12'-7⁰36'N latitude and 38⁰06' – 38⁰30'E longitude. Majority of the *Kebeles* drain towards Dejo River during the rain event.

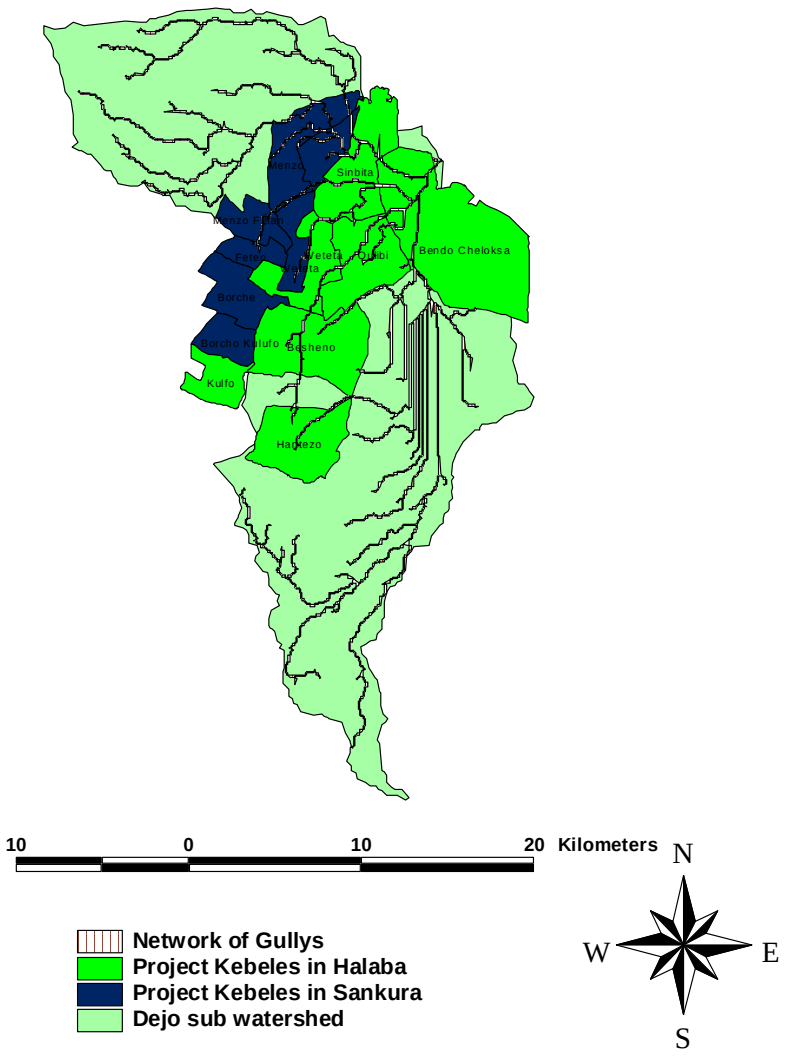


Figure 10. Seven *Kebeles* from Halaba and seven *Kebeles* from Sankura in Dijo sub-watershed

4.2.2. Soil

The soil of the area varies in texture over a wide range from sandy loam through loam in the upper 20 – 105 cm depth. The P^H is slightly acidic to neutral and none saline. Visual observation depicted that much of the communal lands are poor in their organic matter content. Figure 12 to 18 below presents the soil map of the area.

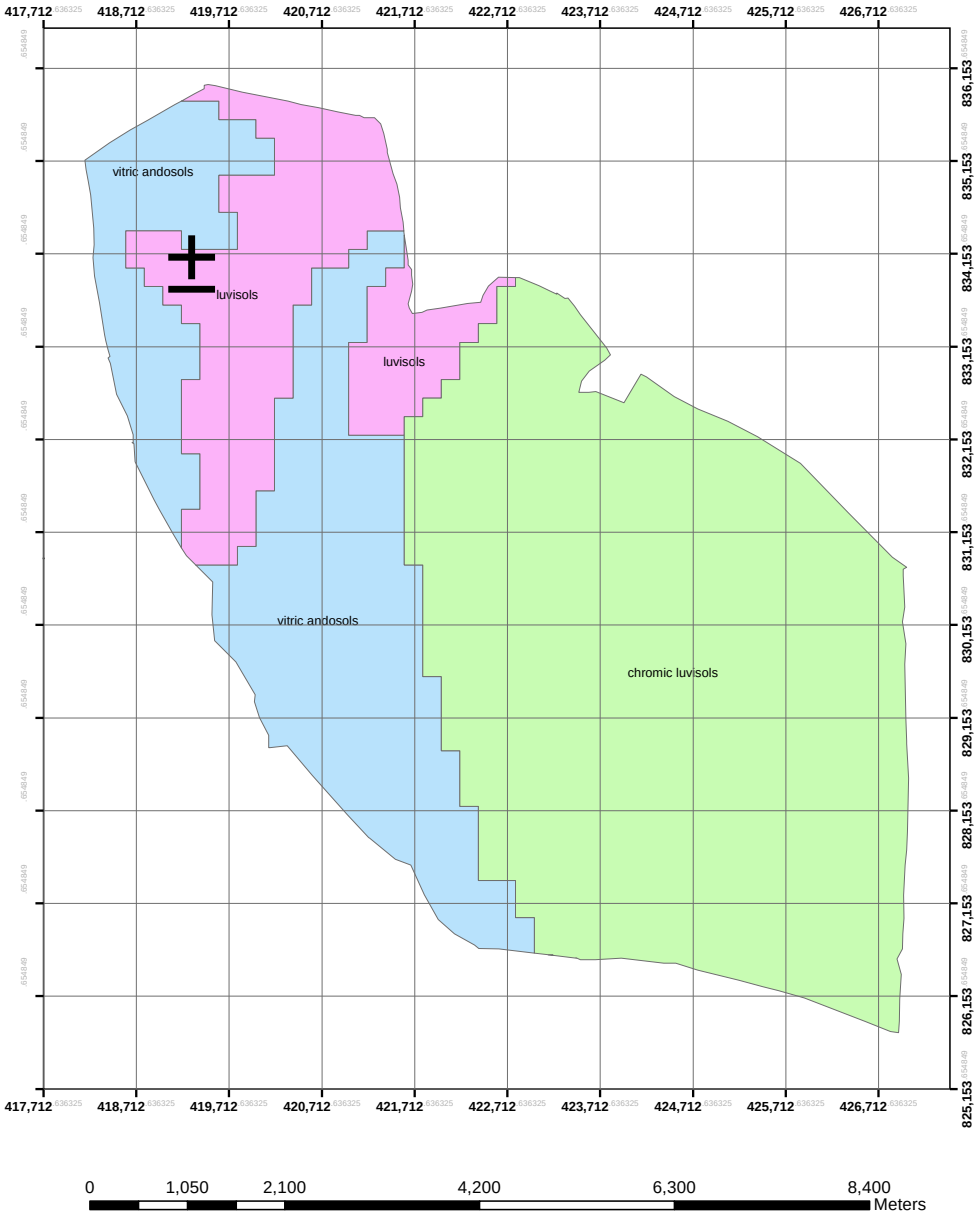


Figure 11.Soil Map of Bendo Cheloksa Kebele

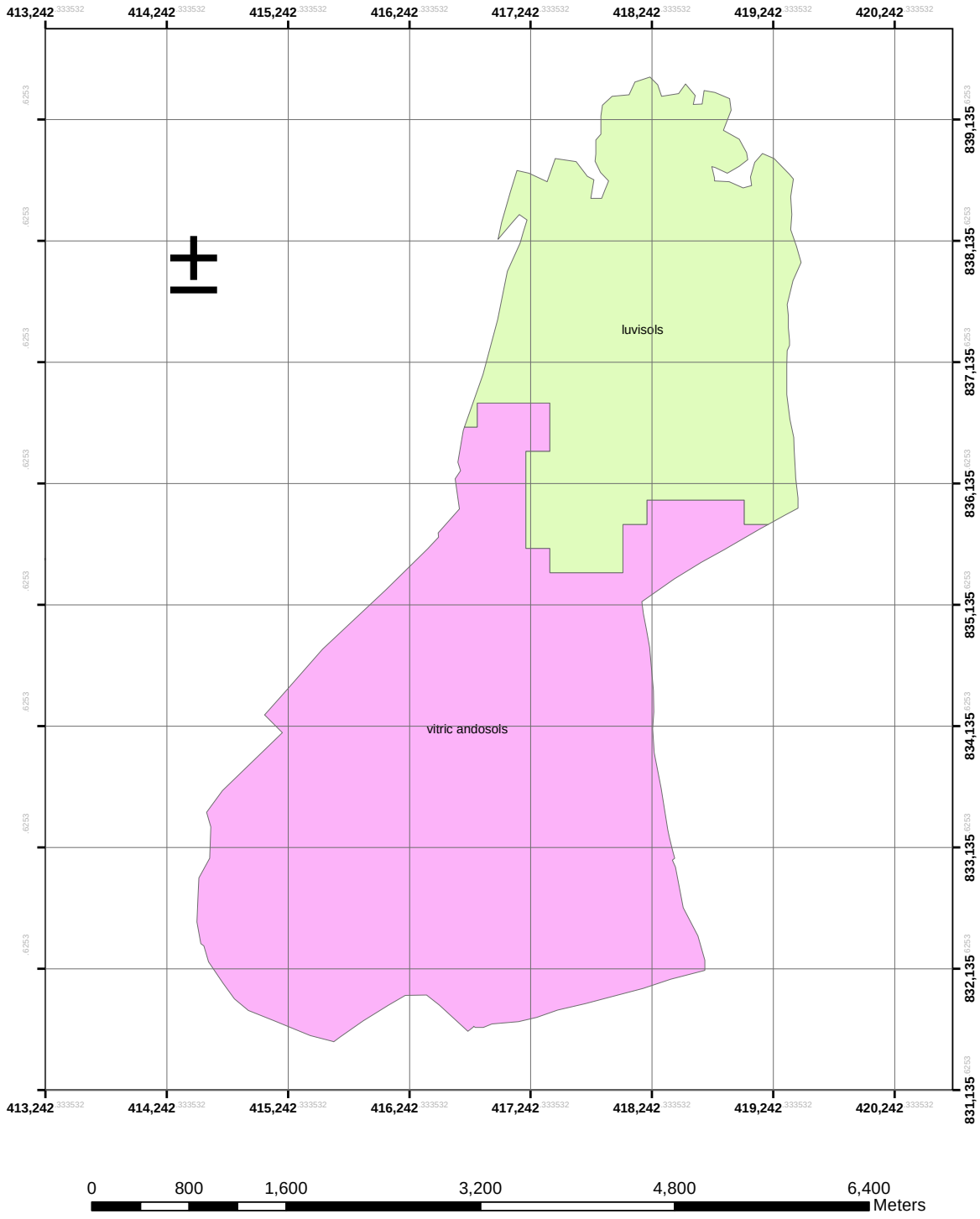


Figure 12. Soil Map of Sinbita Kebele

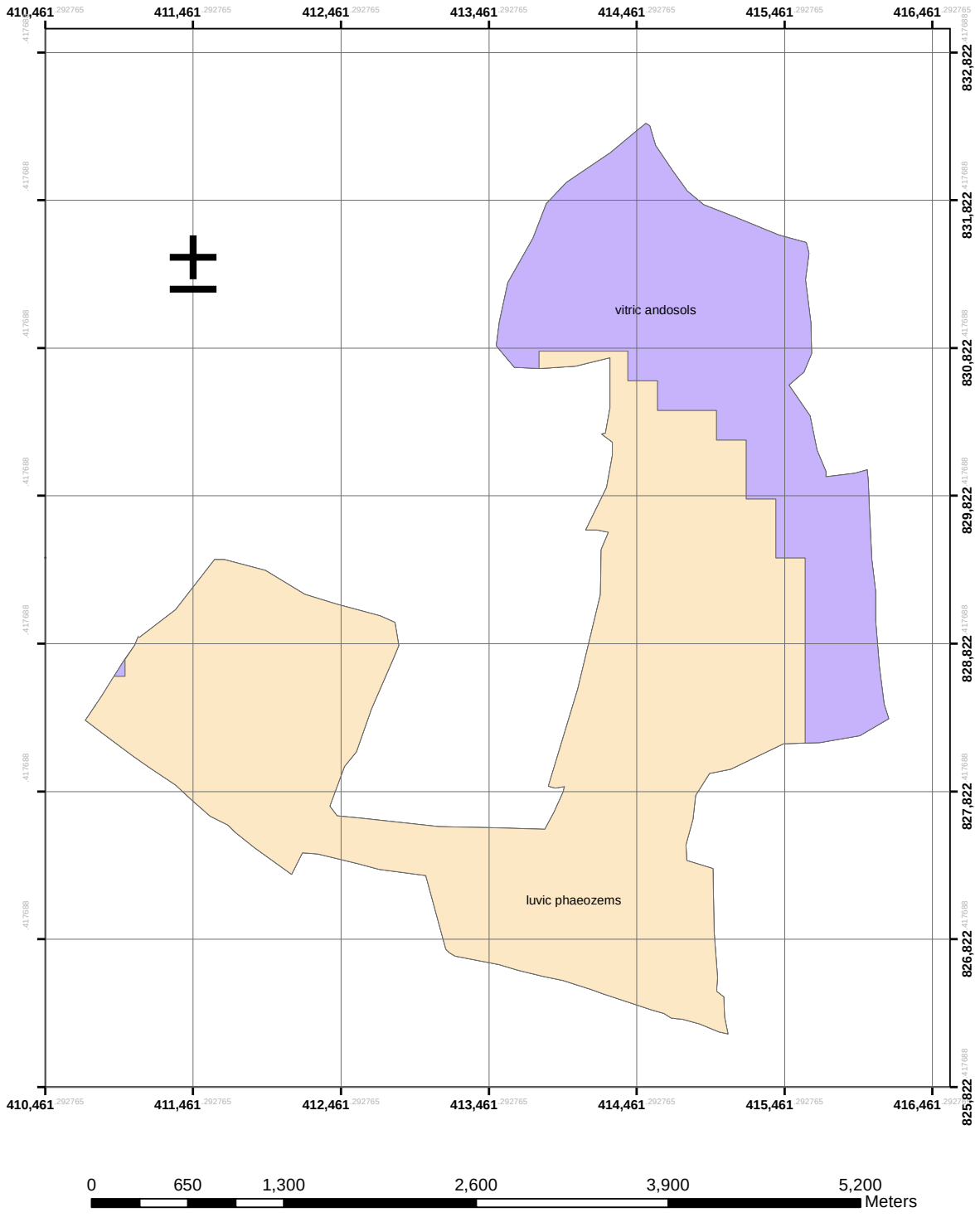


Figure 13. Soil Map of Weteta Kebele

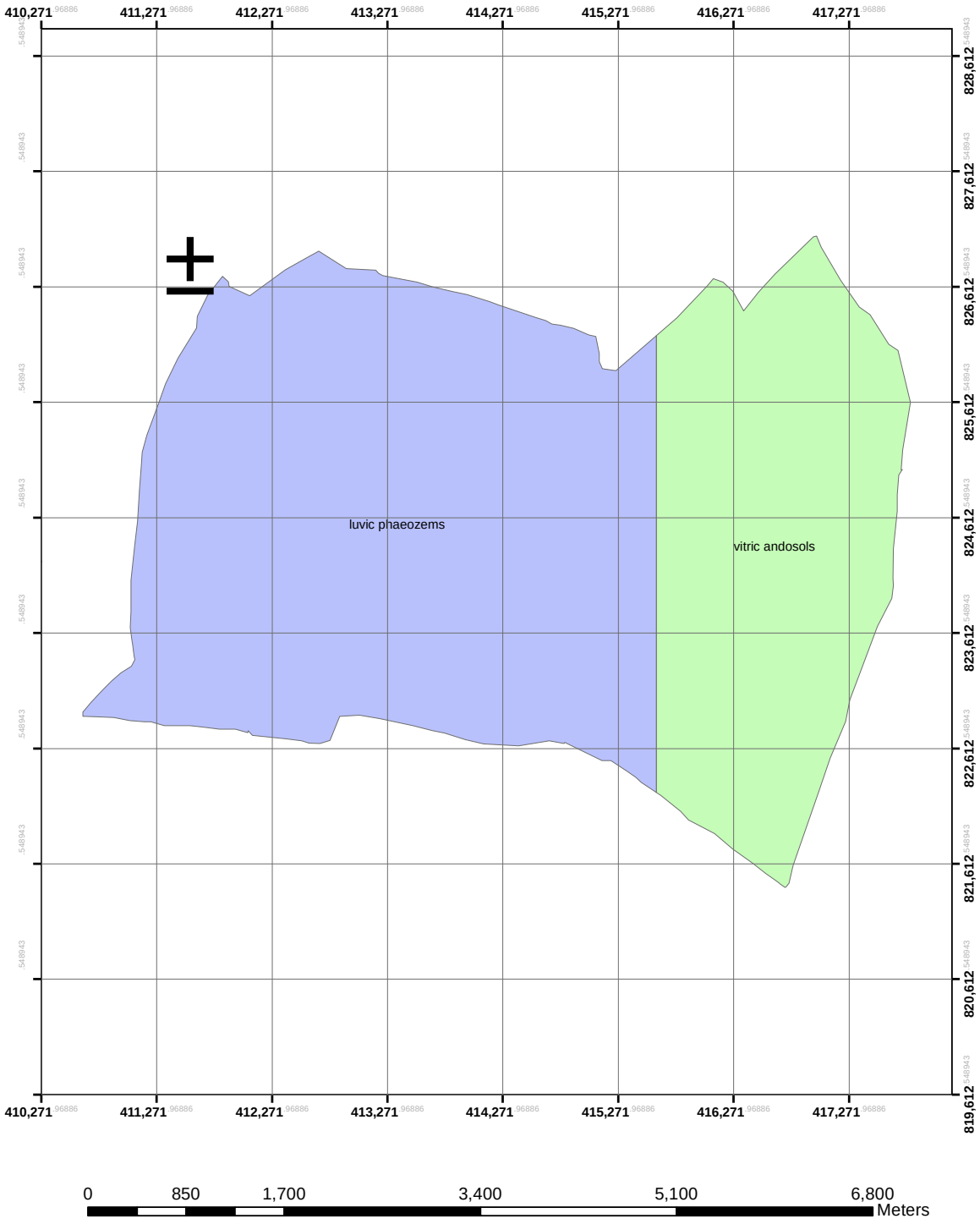


Figure 14. Soil Map of Besheno Kebele

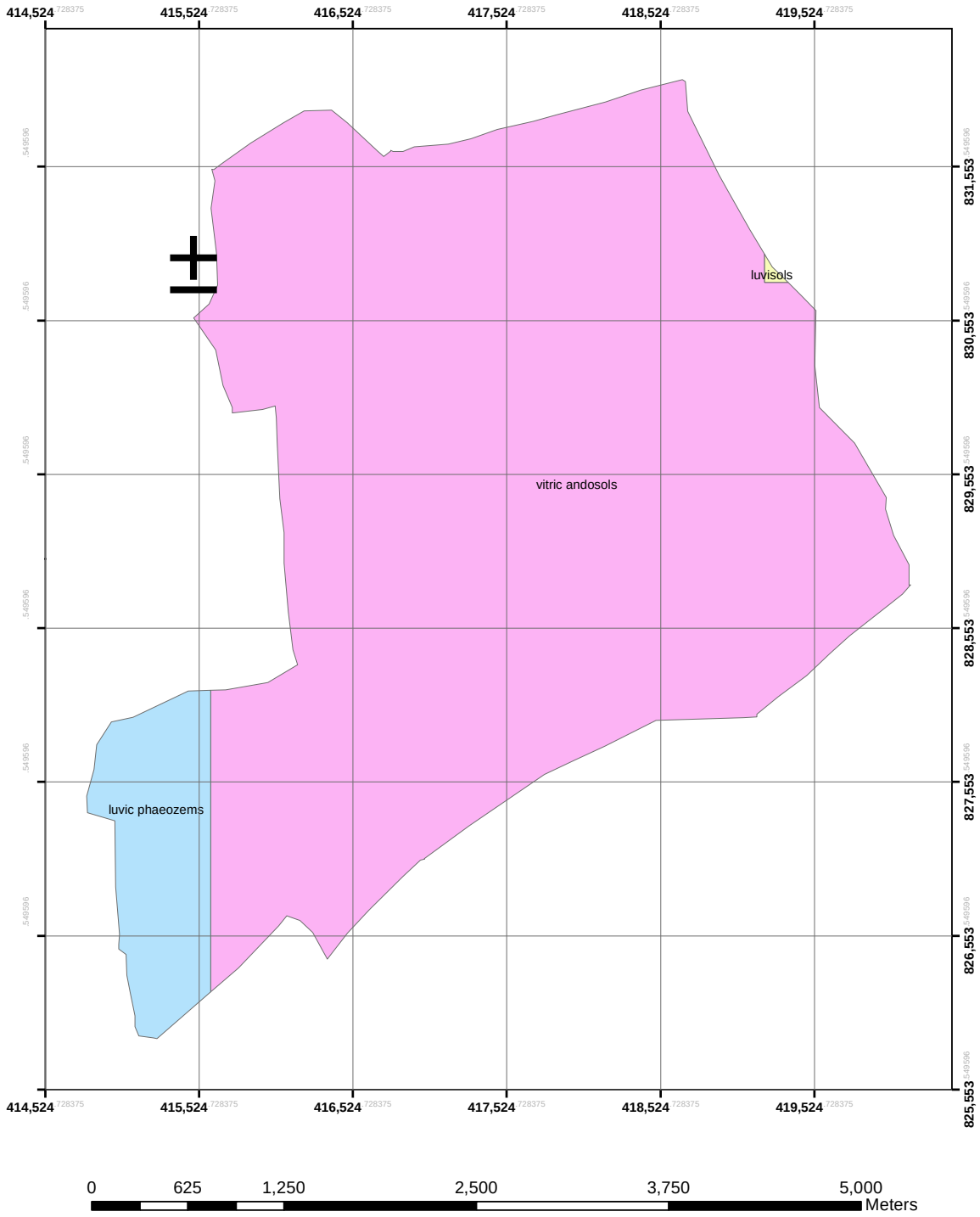


Figure 15. Soil Map of Qulubi Kebele

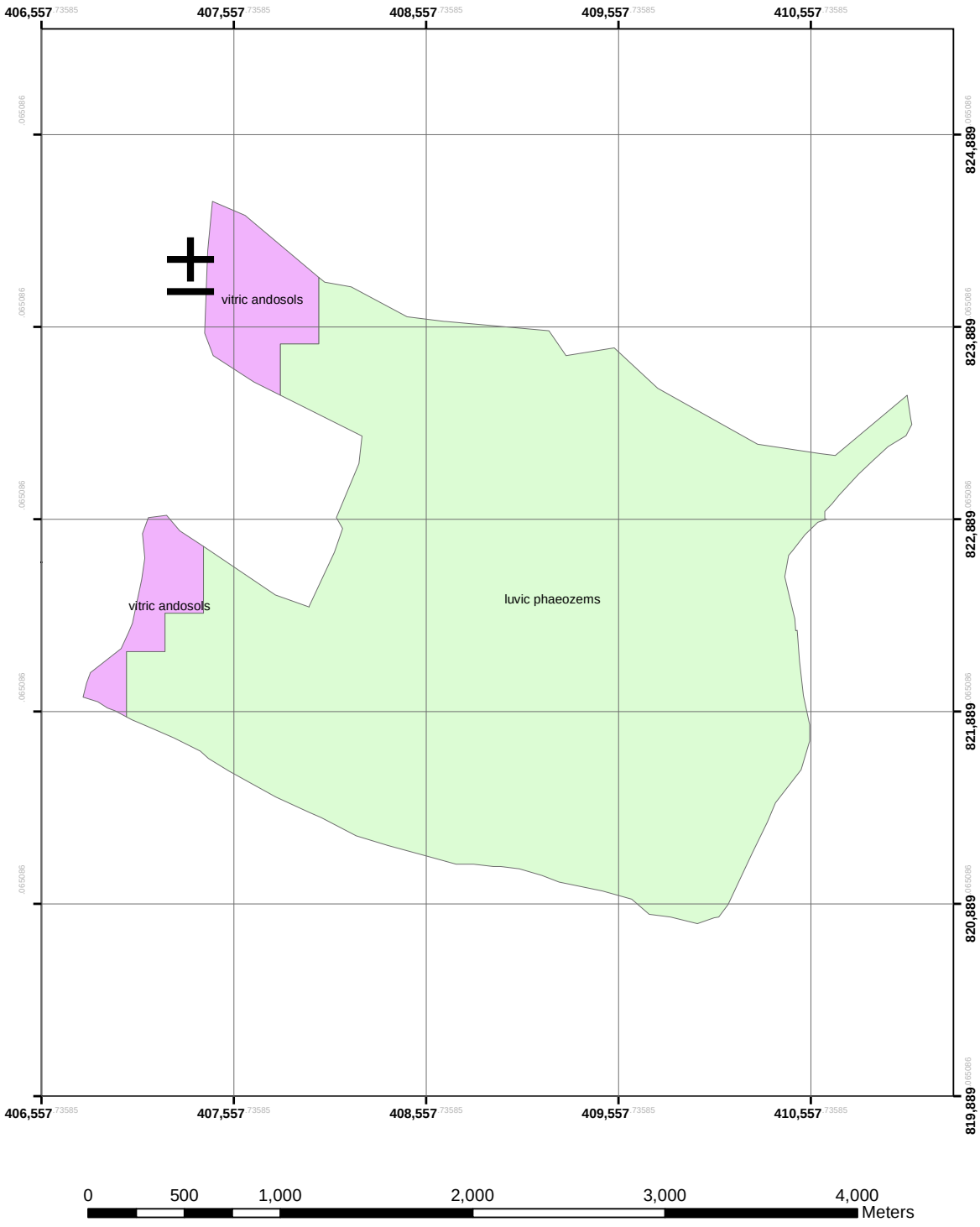


Figure 16. Soil Map of Kulufo Kebele

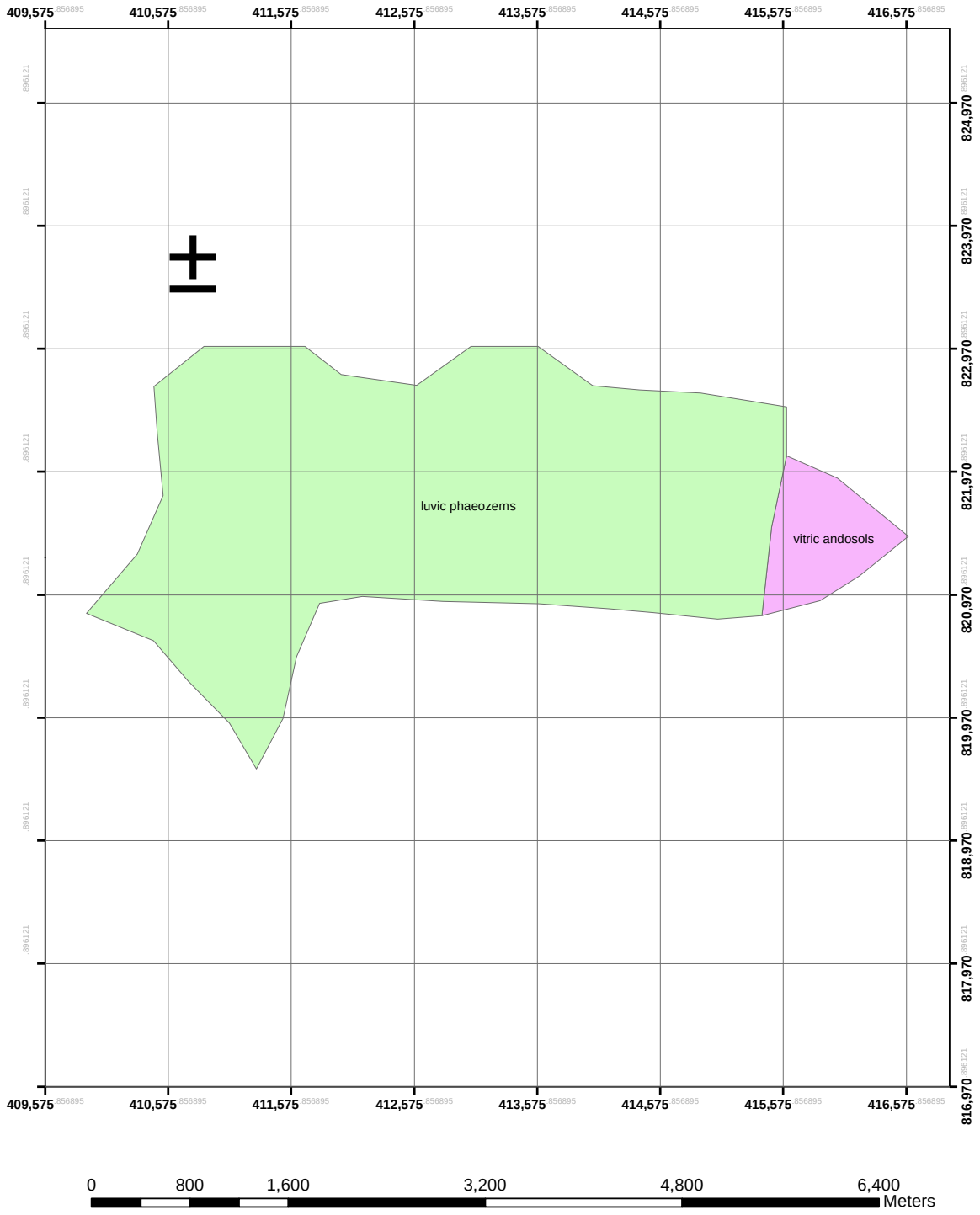


Figure 17.Soil Map of Hantezo Kebele

4.2.3. Rainfall

From 18 years of metrology data available for the area, the mean annual and effective rainfall is 970 and 811.7 mm respectively. This rainfall is inadequate to sustain crop basically because of the uneven distribution over the area and the higher consumptive use requirements (1378.9 mm per year). The minimum rainfall occurs in the months of October, November, December, and January and the maximum occurs during the months of April, May & August.

Table 3. Evapotranspiration and rainfall data for the study area

Month	ETo (mm/d)	Total Rainfall (mm/month)	Effective Rain (mm/month)
January	3.81	32.0	30.4
February	4.17	89.0	76.3
March	4.43	98.0	82.6
April	4.28	124.0	99.4
May	3.94	107.0	88.7
June	3.53	64.0	57.4
July	3.06	131.0	103.5
August	3.15	128.0	101.8
September	3.29	112.0	91.9
October	3.94	48.0	44.3
November	3.97	32.0	30.4
December	3.80	5.0	5.0
Total (mm/Year)	1378.89	970.0	811.7

4.2.4. Temperature

The mean monthly temperature varies between 18^{o}C and 20^{o}C occurring in the months of December and February respectively.

Table 4. Climate data for the study areas

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd. (Km/d)	SunShine (Hours)	Solar Rad. (MJ/m2/d)
January	27.6	10.8	66.0	78.0	8.5	20.4
February	28.1	12.1	62.0	78.0	8.6	21.8
March	27.7	12.3	67.0	78.0	9.0	23.3
April	27.0	12.9	70.0	78.0	8.4	22.5
May	26.9	12.0	84.0	78.0	7.9	21.0
June	25.3	12.3	82.0	95.0	6.6	18.6
July	23.5	12.8	83.0	52.0	5.2	16.7
August	23.8	12.6	83.0	35.0	5.3	17.3
September	25.1	12.5	84.0	69.0	5.1	17.2
October	26.6	10.5	82.0	69.0	8.5	21.8
November	27.1	9.2	69.0	86.0	9.3	21.8
December	27.8	7.9	66.0	86.0	8.8	20.4
Average	26.4	11.5	74.8	73.5	7.6	20.2

4.2.5. Relative humidity

The relative humidity of the area is relatively constant. The minimum relative humidity occurs from December to March & the maximum occurs from June to September. The mean annual relative humidity is about 75%., which is suitable for crop production in general.

4.2.6. Potential Evapotranspiration

The mean annual evapotranspiration is about 1379 mm. The mean monthly evapotranspiration is low during the months July, August, and September & high during the months of January, February, March and April (Co-SAERSAR, 2002).

4.2.7. Wind

The mean daily wind velocity varies between 35km/day to 95km/day. Higher values are observed between November and June.

4.2.8. Vegetation

The crops grown on the area are maize, sorghum, millet *(Eleusine coracana),* teff *(Eragrostis tef),* beans, pepper & wheat. Maize is dominant crop followed by pepper and perennials. Live stock production is the source of income and protein for the farmers. A substantial proportion of the total area is occupied by grazing and fodder production. The average private grazing land size in Bendo Cheloksa is twice as big as the size observed in another *Kebeles*. The next bigger private grazing land size is observed in Sinbita *Kebele*, indicating that the livestock population in the two *Kebeles* are bigger than the others. Therefore, forage cultivation such as a*lfa- alfa* and *Sesbania-sesban* in this two *Kebeles* can minimize overgrazing and its impact on soil degradation. Figure 19 to 25 below presents the vegetation cover of the area during the rainy season of 2015 (extracted from Landsat satellite image).

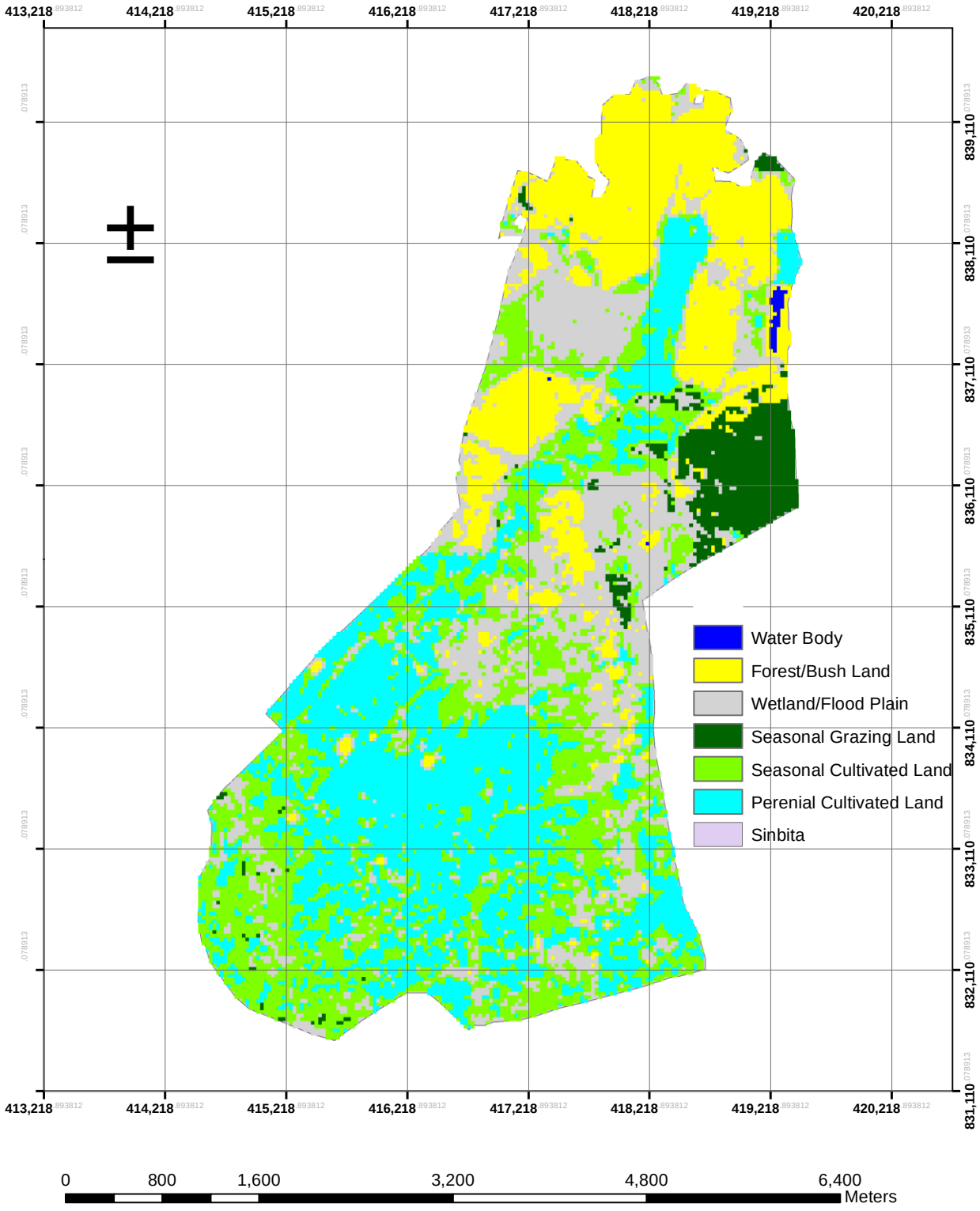


Figure 18. Vegetation cover of Sinbita Kebele.

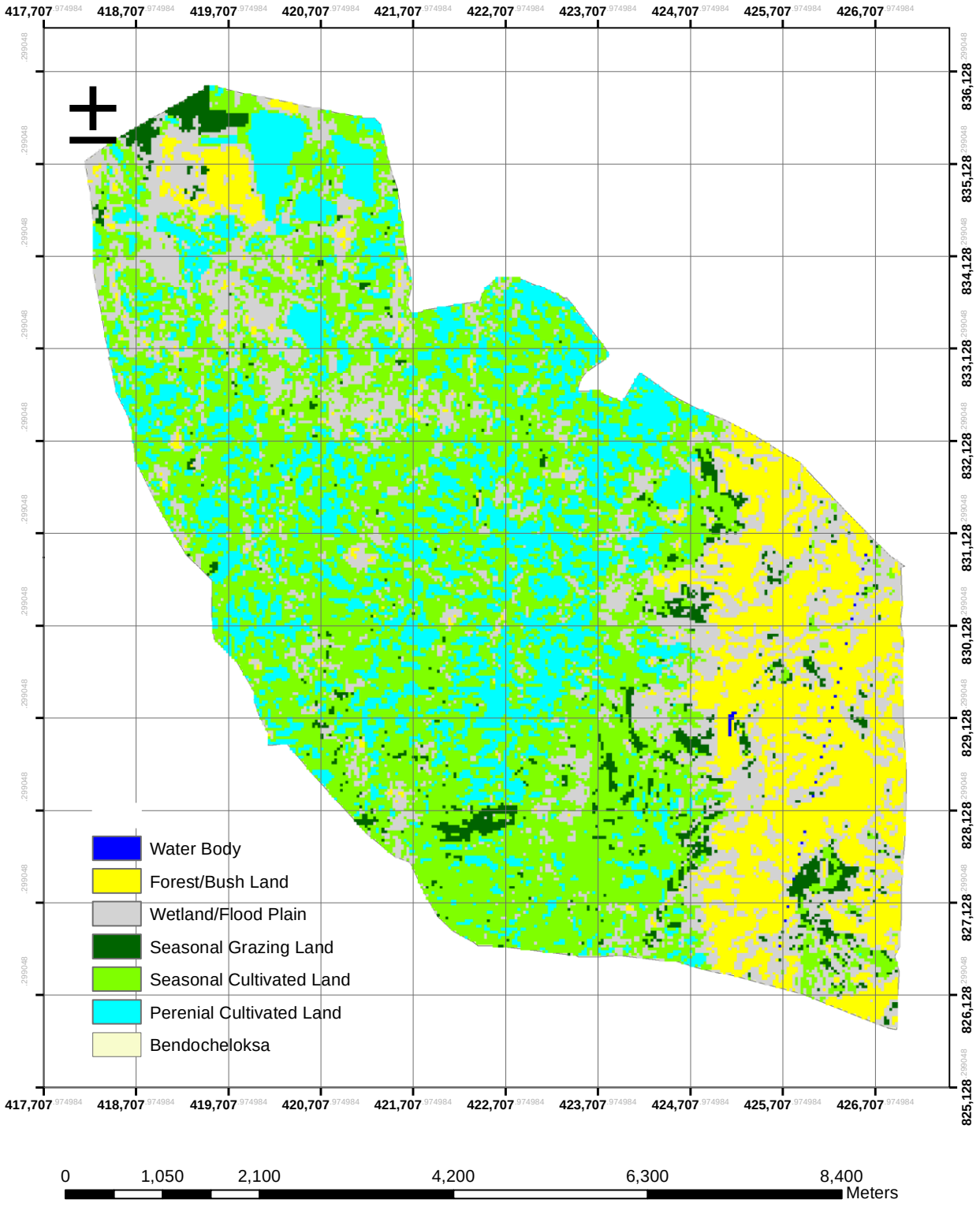


Figure 19. Vegetation cover of Bendo Cheloksa Kebele

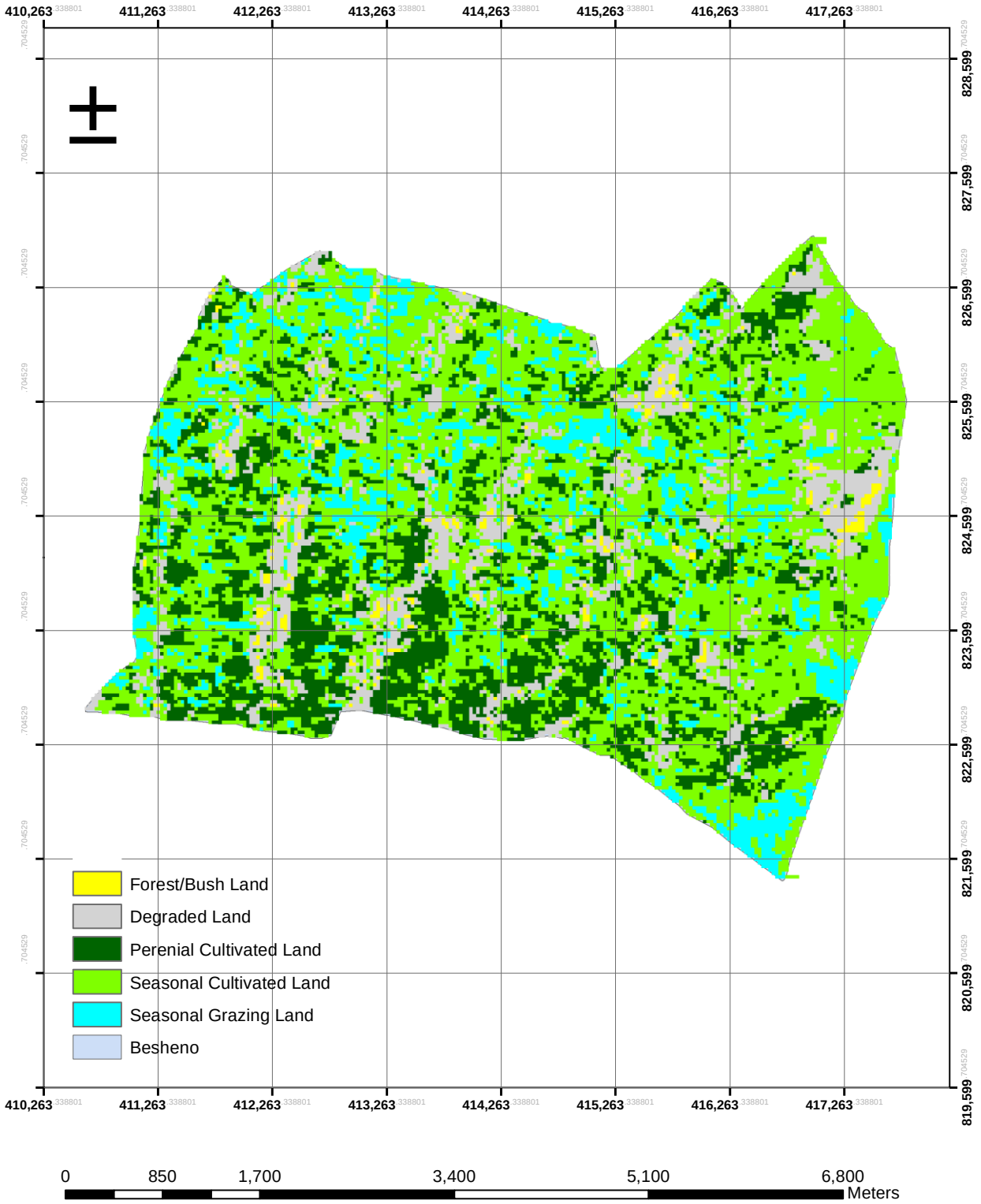


Figure 20. Vegetation cover of Besheno Kebele

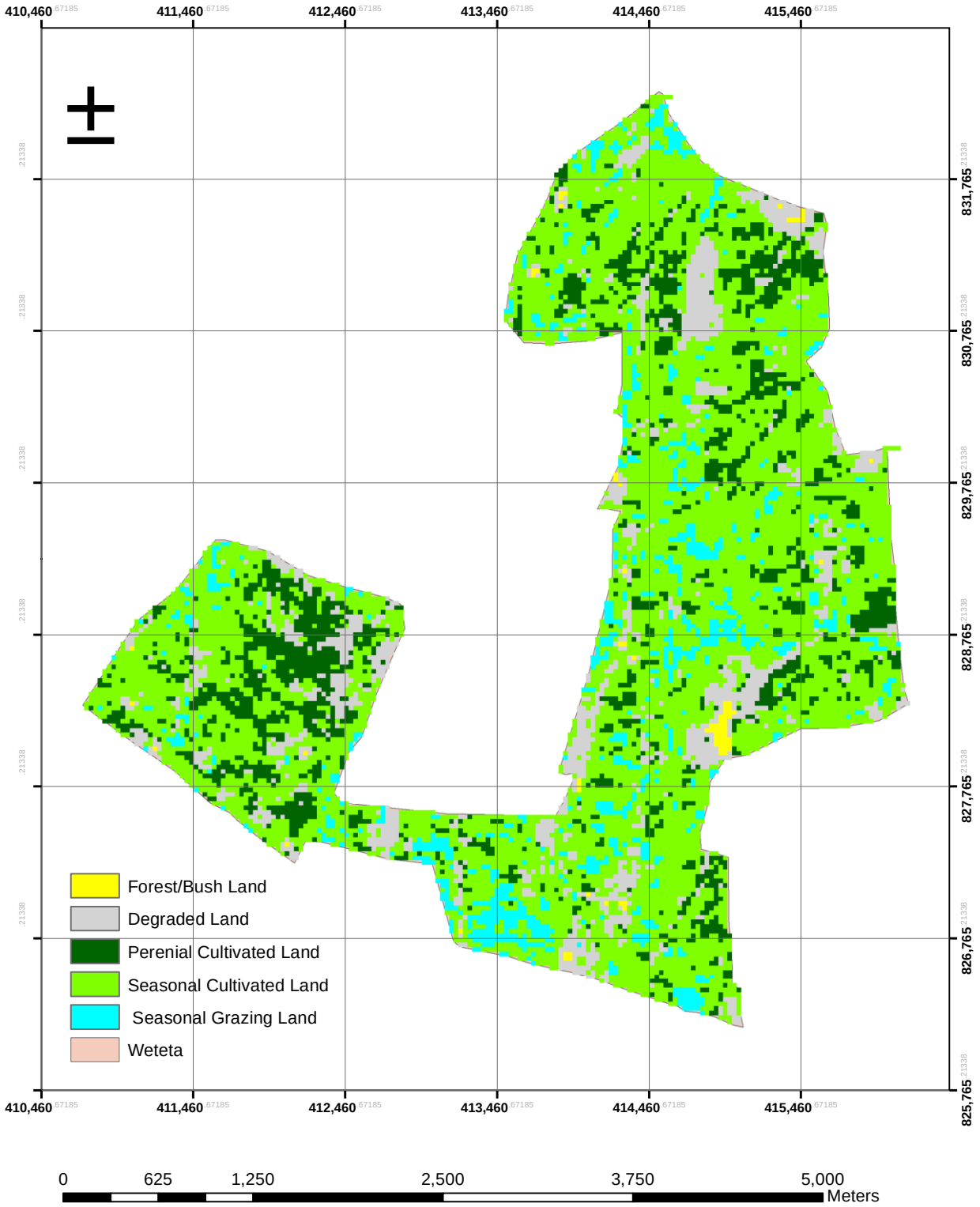


Figure 21. Vegetation cover of Weteta Kebele

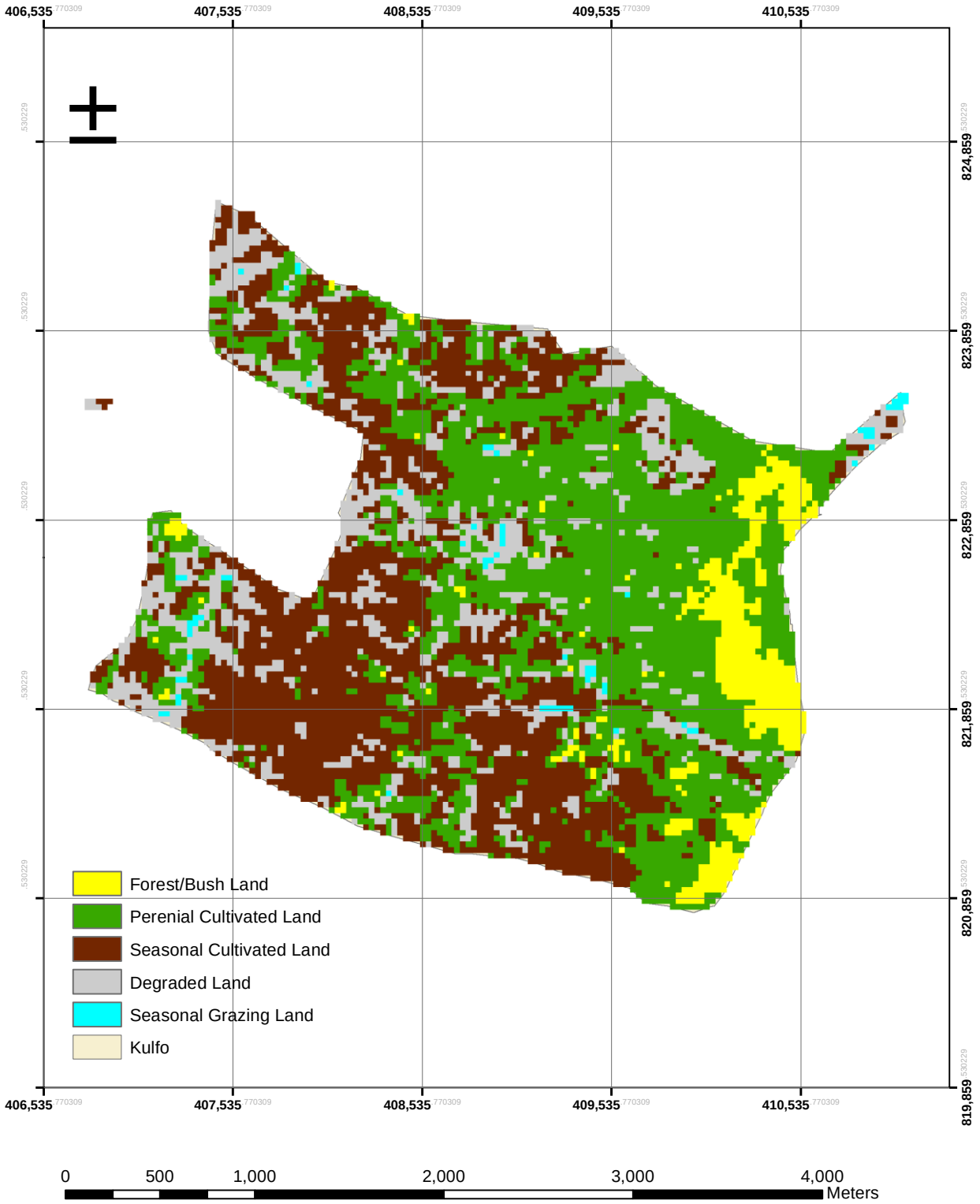


Figure 22. Vegetation cover of Kulfo Kebele

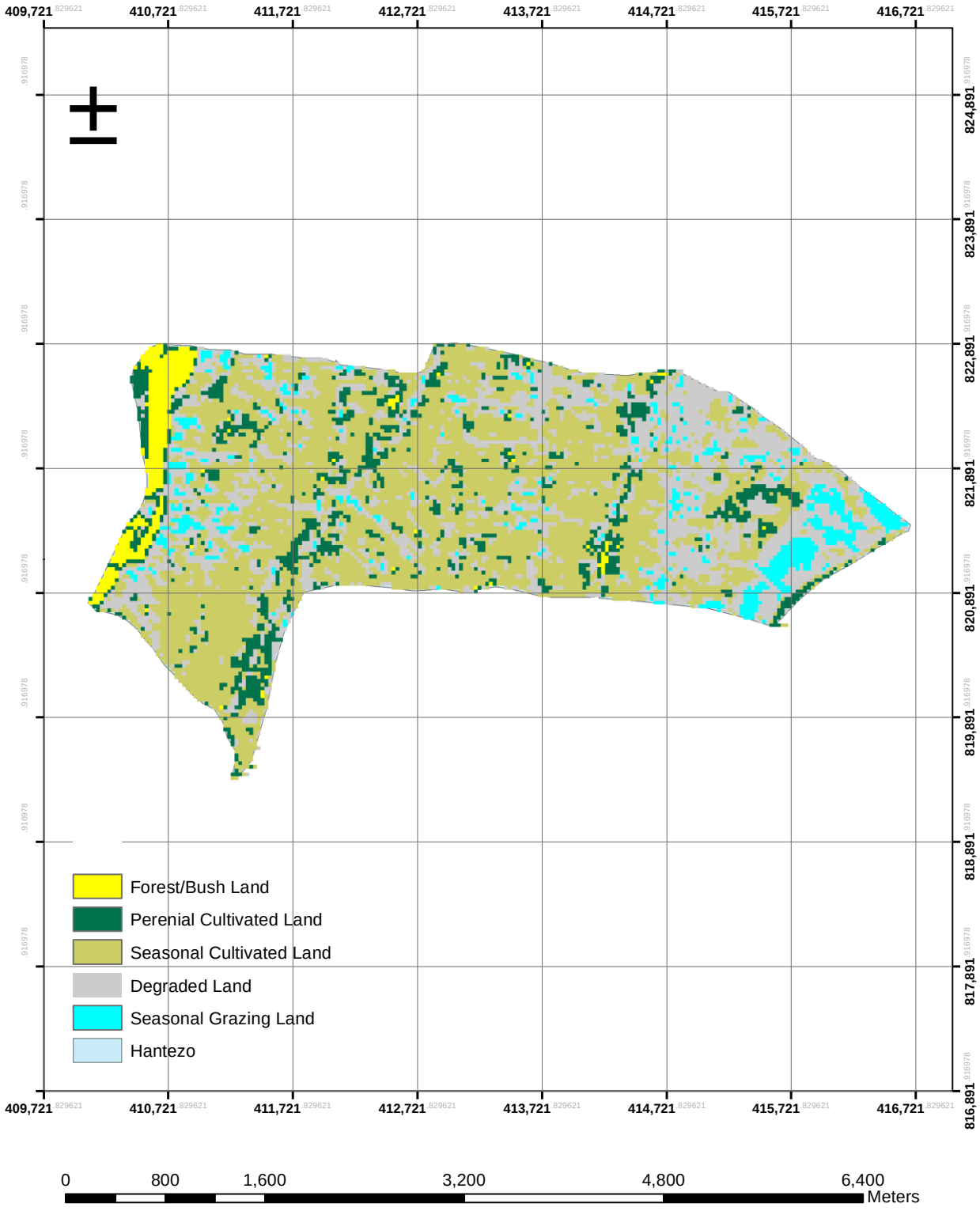


Figure 23. Vegetation cover of Hantezo Kebele

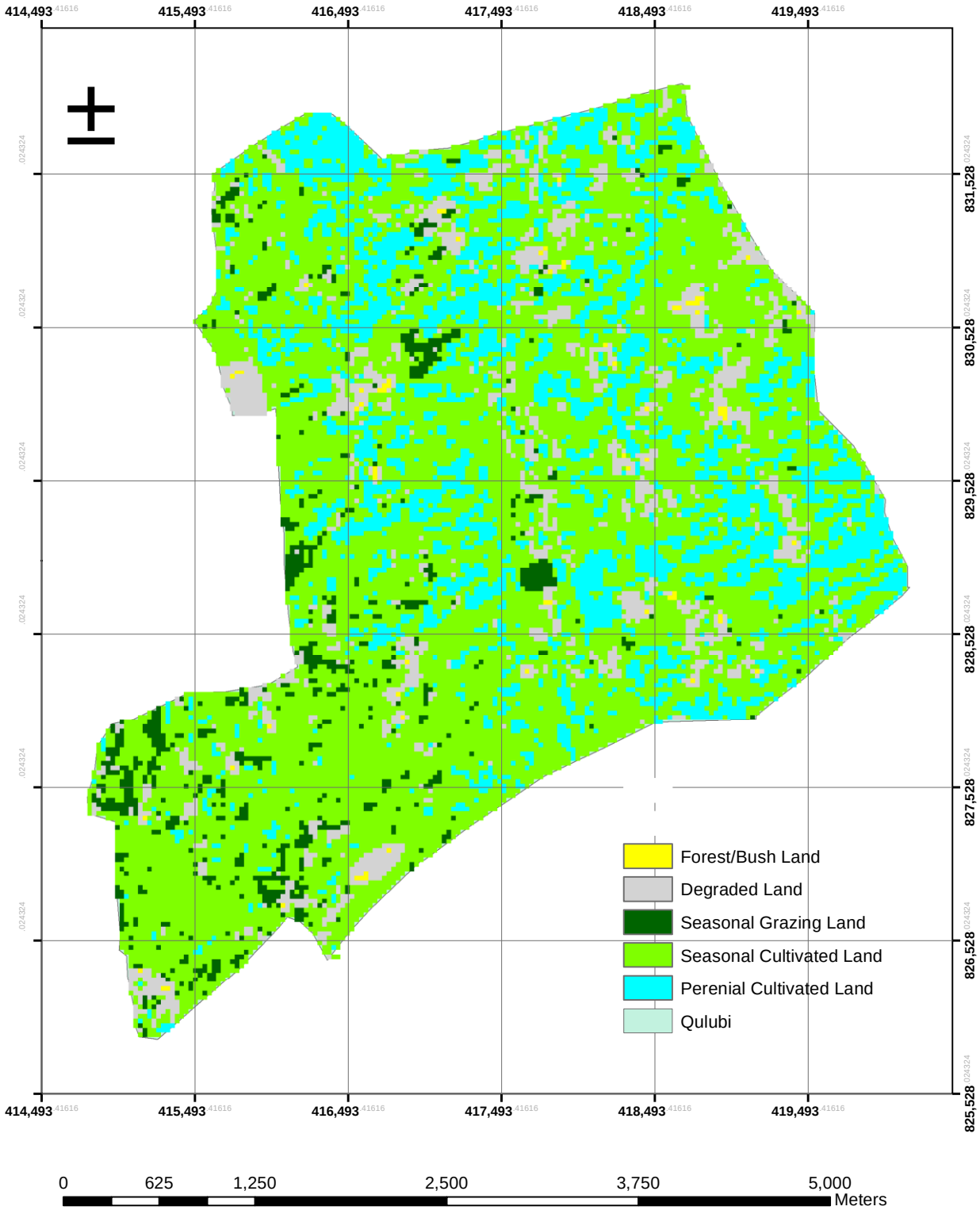


Figure 24. Vegetation cover of Qulubi Kebele

4.2.9. Agroecology

All the *Kebeles* are lying in the dry *Weyna-Dega* to *Dega* agro-ecology zone where their elevation ranges between 1790 to 2150 meters above sea level (masl).

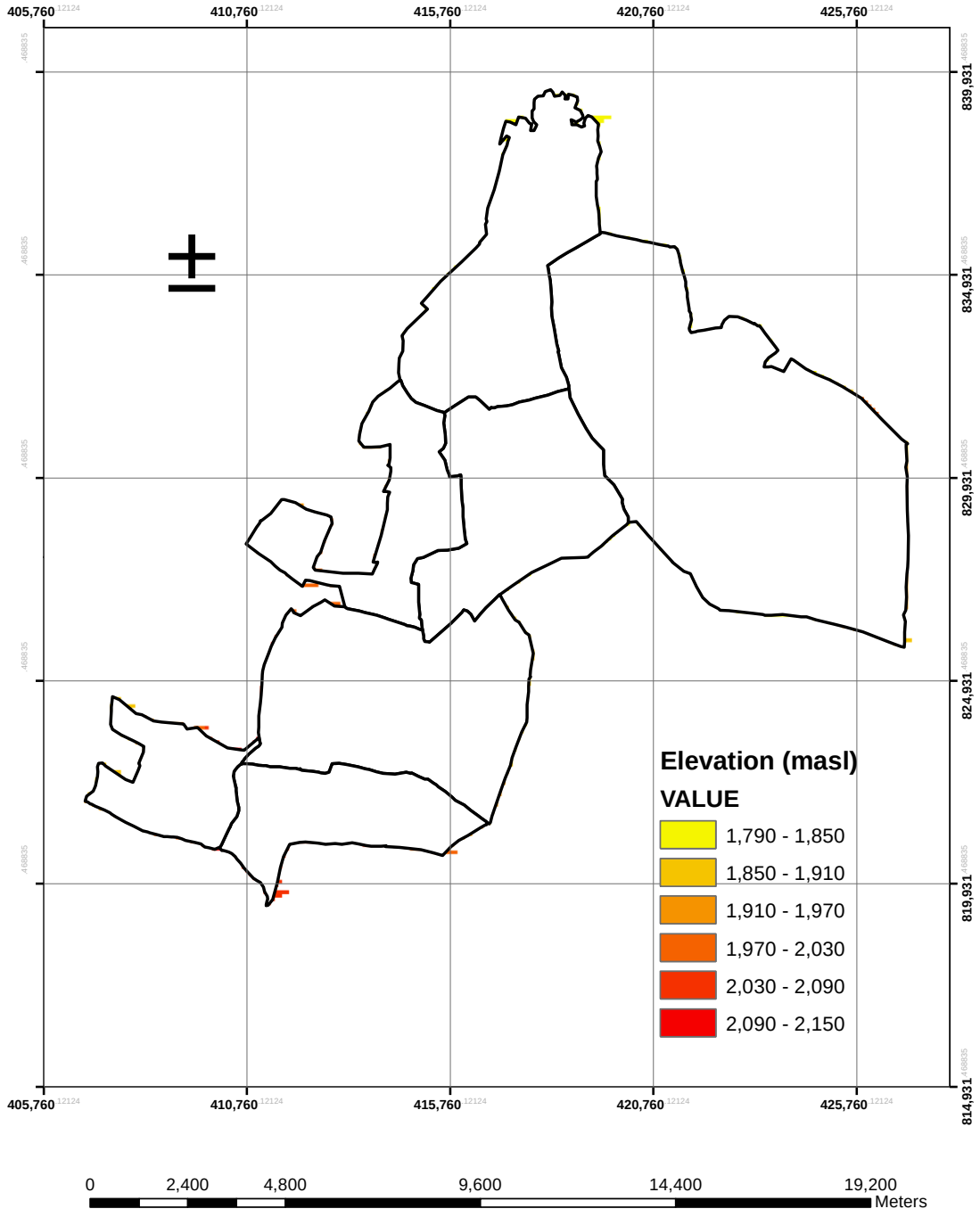


Figure 25. Elevation of each *Kebeles*

4.2.10. Soil erosion

The soil in the area is very susceptible to any form of erosion. Upstream of All *Kebeles* except Hantezo, the soil is highly degraded that demands an immediate attention through biological interventions mainly area closure and afforestaion. The existing indigenous trees based community afforestaion programs needs to be strengthened. In these areas, with small intervention, it is possible to regenerate the biomass and protect downstream areas. The table below summarized the average land sized that demanded strategic attention to hamper the current vast level of erosion with biophysical soil conservation structures.

Table 5. Area of each *Kebele*, degraded land and areas affected by flooding

Kebeles	**Area (ha)**	**Degraded Land that demand strategic intervention (ha)**	**Flood plain that demand drainage (ha)**
Besheno	2592	388.80	
Hantezo	1933.47	464.03	
Bando Cheloksa	5302.26	636.27	1219.52
Kulbi	1818.45	109.11	345.51
Kulfo	823.77	271.84	
Sinbita	2124.63	31.87	977.32
Weteta	1227.15	245.43	

Most agricultural lands are located at the middle reach of each *Kebeles*. These are the areas frequently affected by tillage erosion. In consultation with the community, all structural and non-structural interventions are recommended for these areas.

Figure 26. Typical tillage erosion at the middle reaches of Besheno *Kebele*

Downstream of all *Kebeles*, the soil is highly degraded and progressive development of the gully's are claiming more land in the respective *Kebeles*. Moisture stress during the dry season is one of the trends observed in these areas. Proper connection of artificial water ways and management of the natural water ways are some of the off farm interventions suggested on these spots together with on farm SWC structures. Accelerated gully development at downstream of Qulibi and Weteta *Kebeles* needs an immediate attention. About 6 hectares of land in Weteta and an equivalent amount on the other side of the boundary on Qulibi *Kebele* shall be intervened with biological interventions mainly area closure coupled with tree plantation and other structural measures to stabilize gullies.

4.2.11. Slope and Terrain

Majority of the topography is made from flat and moderate flat land formations. The gradient of the area ranges between zero to 18.9% indicating the vast area in Sinbita and Bendo Cheloksa affected by flooding and high lying areas in Besheno, Hantezo, Weteta, Qulubi and part of Bendo Cheloksa contributing the sediment load.

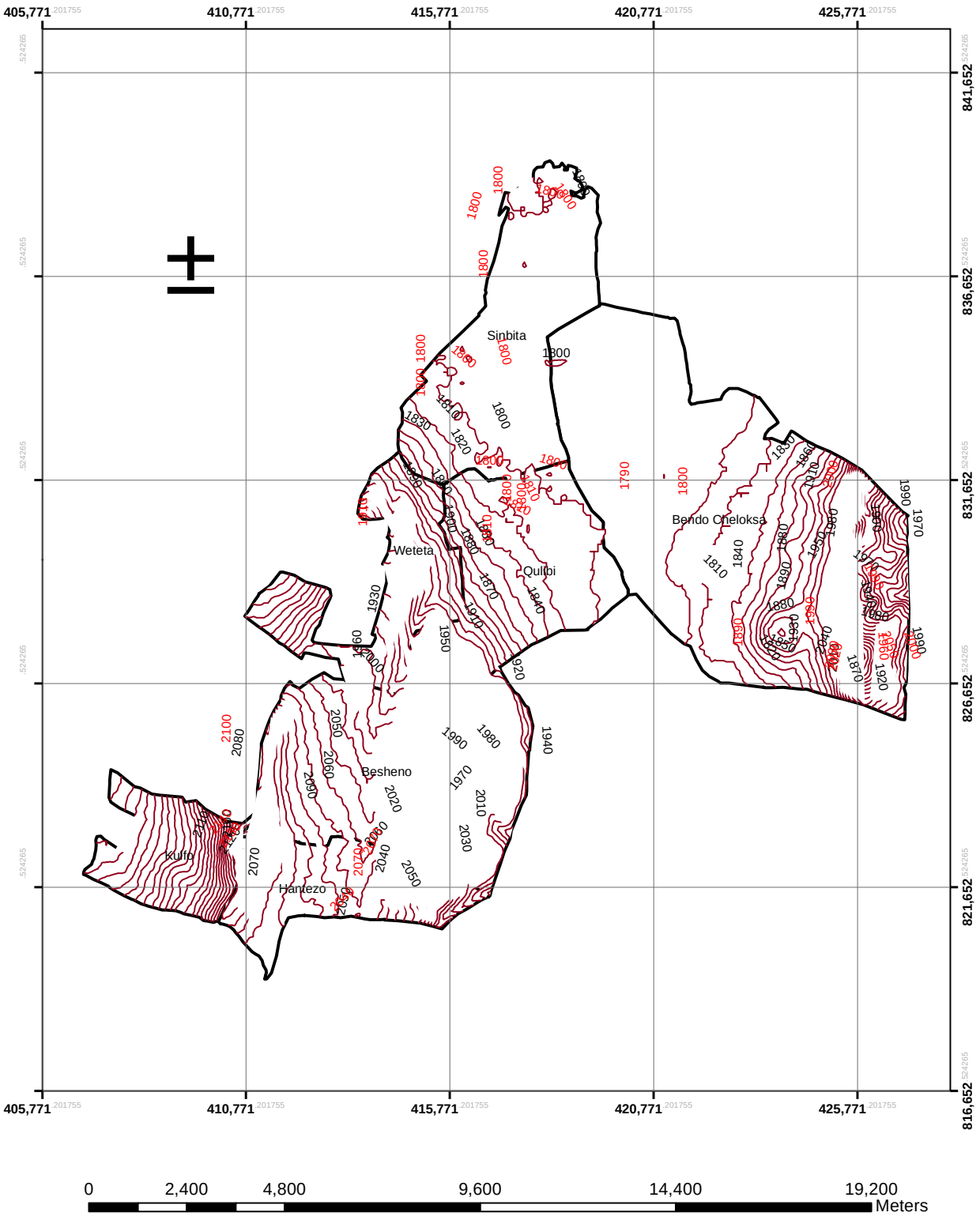


Figure 27. Topographic pattern of the seven *Kebeles*

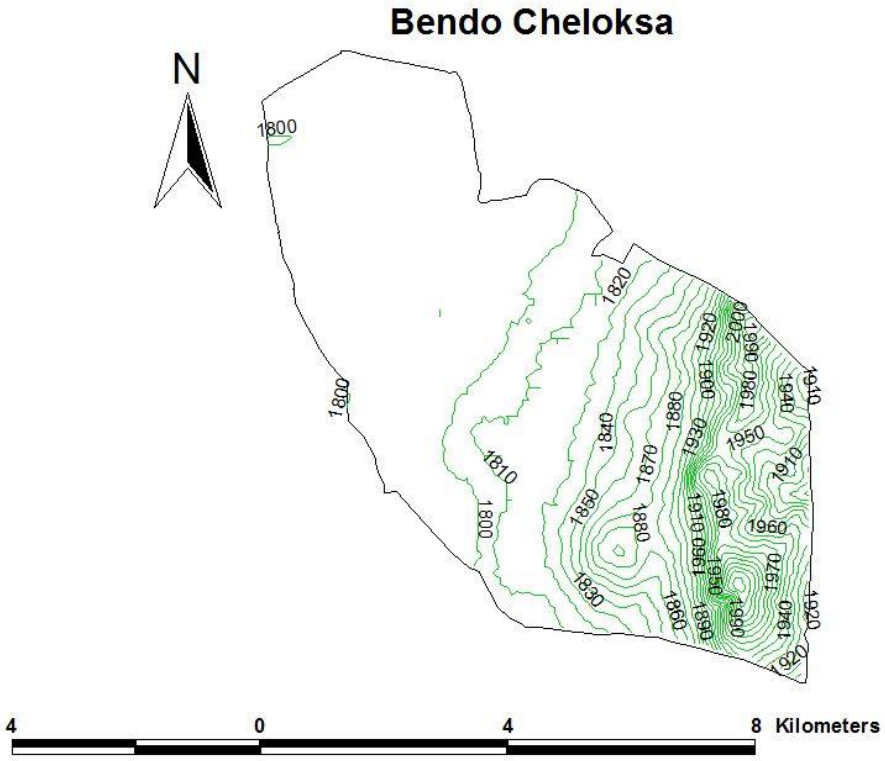


Figure 28.Contour map of Bendo Cheloksa *Kebele*

More than 40% of the terrain is flat in Bendo Cheloksa. Flood mitigation options mainly artificial water ways are requested by the community. Steep terrain, South East of the *Kebele* drains towards Abyata Lake without causing major problem in the North.

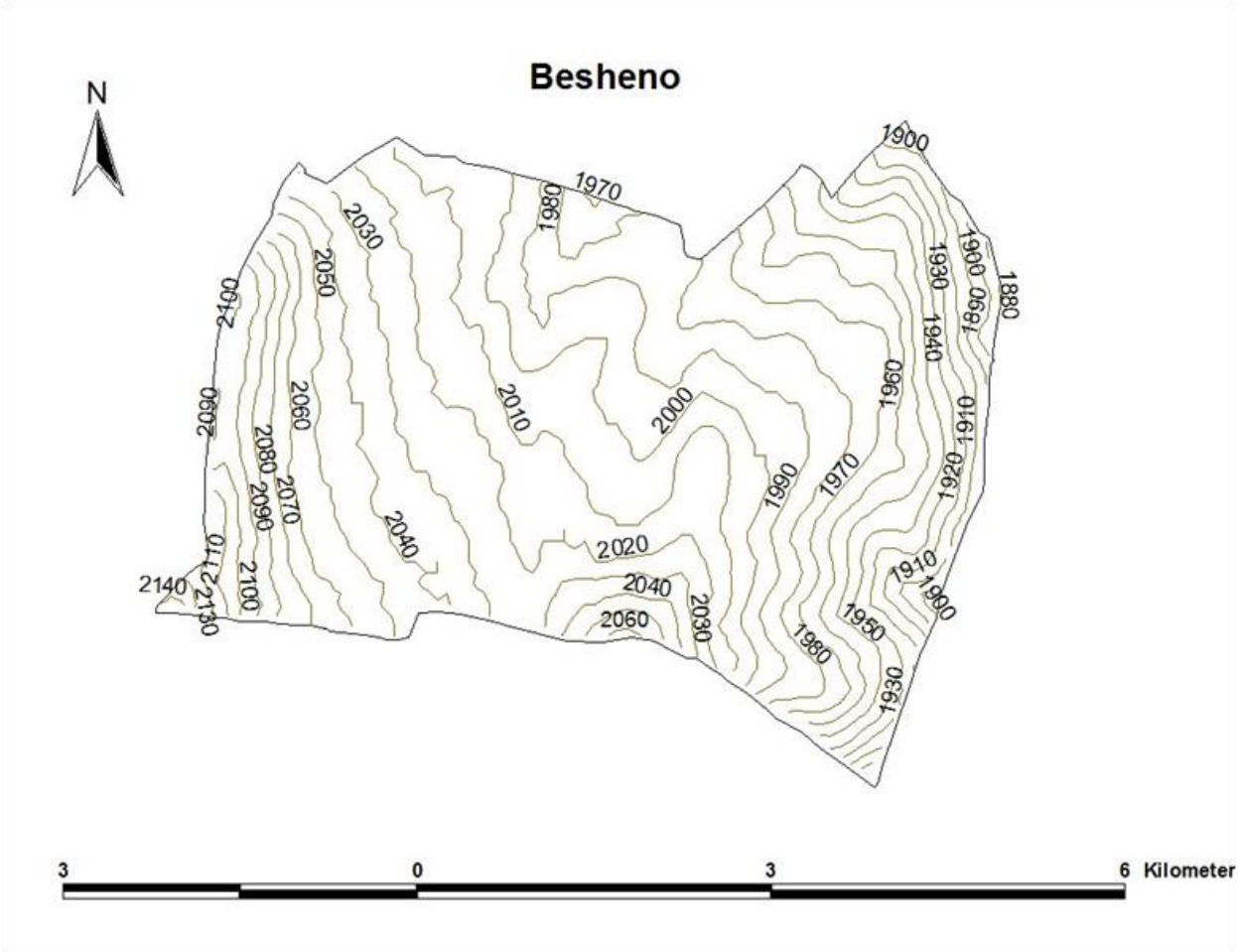


Figure 29. Contour map of Besheno *Kebele*

As the terrain depicted and justified during the transect walk that central part of Besheno *Kebele* is mainly used for crop production. Deep soil layer and sparse settlement made the area suitable for rainfed agriculture.

Indicators of gully erosion are frequent upstream of the *Kebele* where it bordered with Kulfo *Kebele*. Gully head stabilization structures are required before it is too late. Between the Besheno town and the *Kebele*'s border with Kulfo *Kebele*, the soil formation is deep and suitable for seasonal agriculture. However, tillage erosion that can easily be addressed through awareness creation is degrading the area. On the contrary, North of the *Kebele* until it bordered with Weteta *Kebele* is highly degraded that demand gully stabilization on both sides of the two *Kebeles*.

Figure 30. Degraded land in Besheno

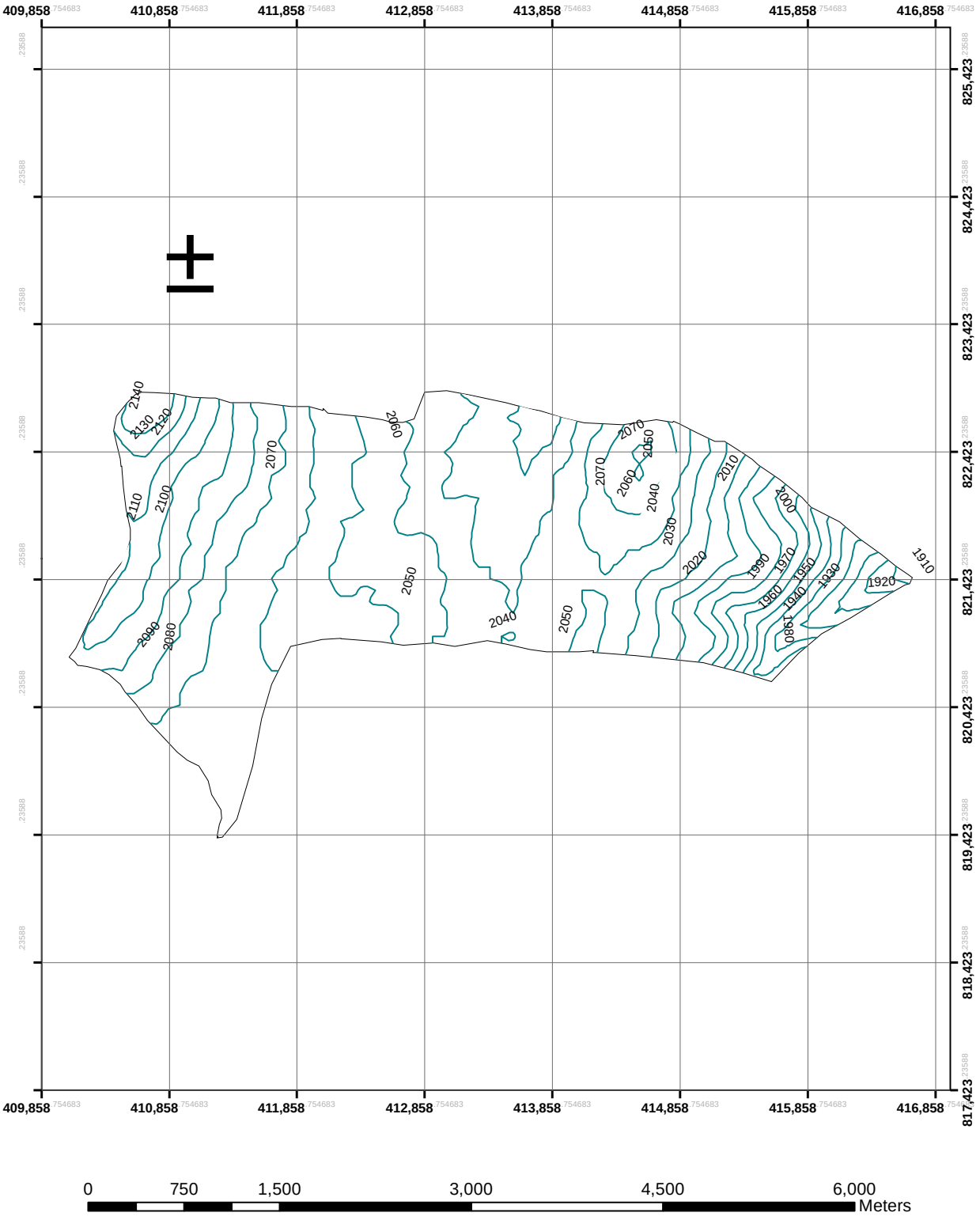


Figure 31. Contour map of Hantezo *Kebele*

As the terrain depicted and justified during the transect walk, central part of Hantezo *Kebele* is mainly used for crop production. Deep soil layer and sparse settlement made the area suitable for rainfed agriculture. Tillage erosion is frequent in the locality. The area below the farmers training center, North East of the *Kebele* where it bordered with Qulibi *Kebele* following the main road to the North and South direction, needs immediate attention that sustain the area closure practice and further facilitate indigenous tree plantation. Integrated watershed management approach shall be practiced among the two *Kebeles*.

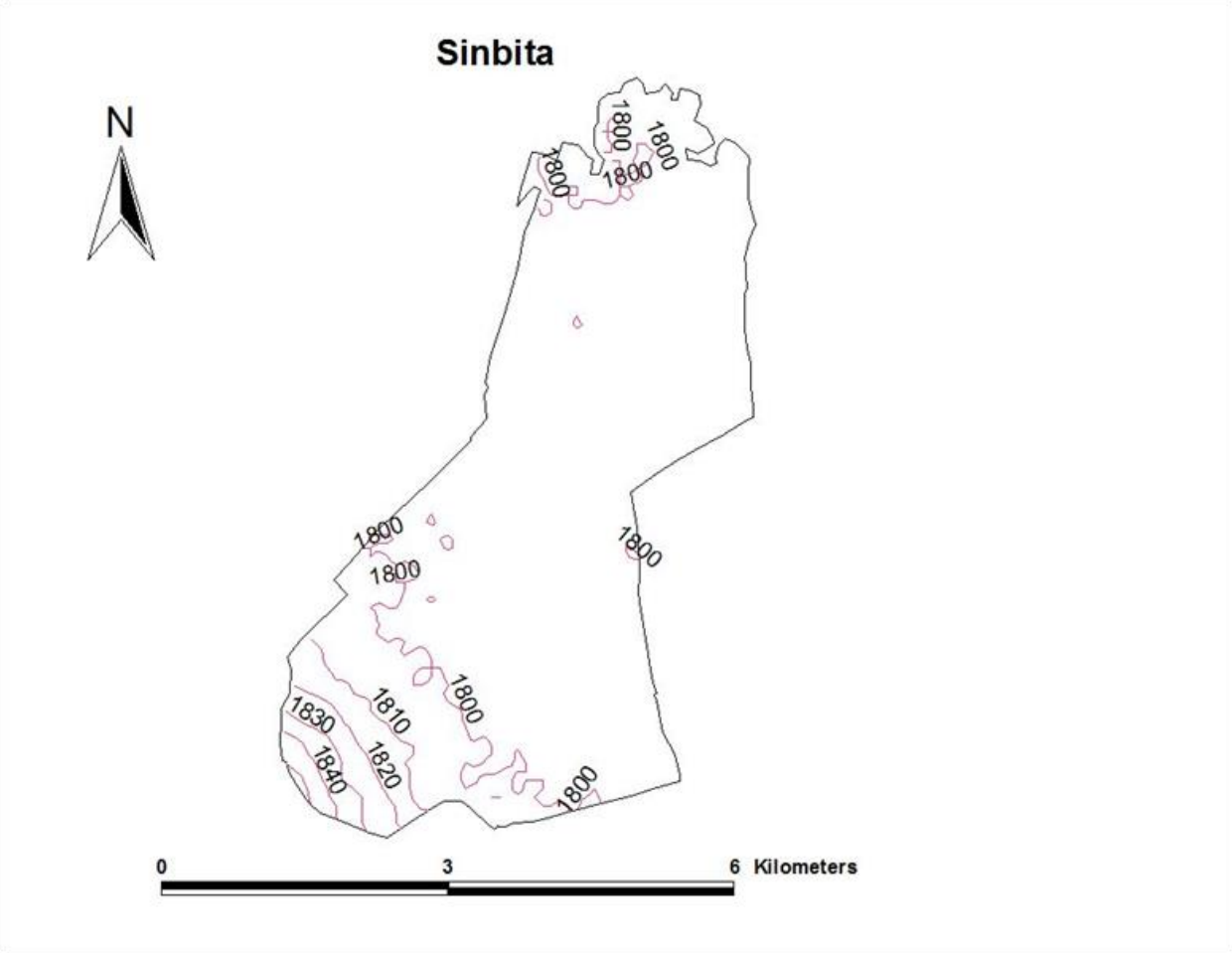


Figure 32. Contour map of Sinbita *Kebele*

Majority of terrain in Sinbita is flat. Flooding during the rainy season is frequent. Properly designed water ways to drain the flood or water harvesting structures

to contain the flood and use during the prolonged dry season is required in the area. The Kebel is a potential for recession farming and livestock rearing.

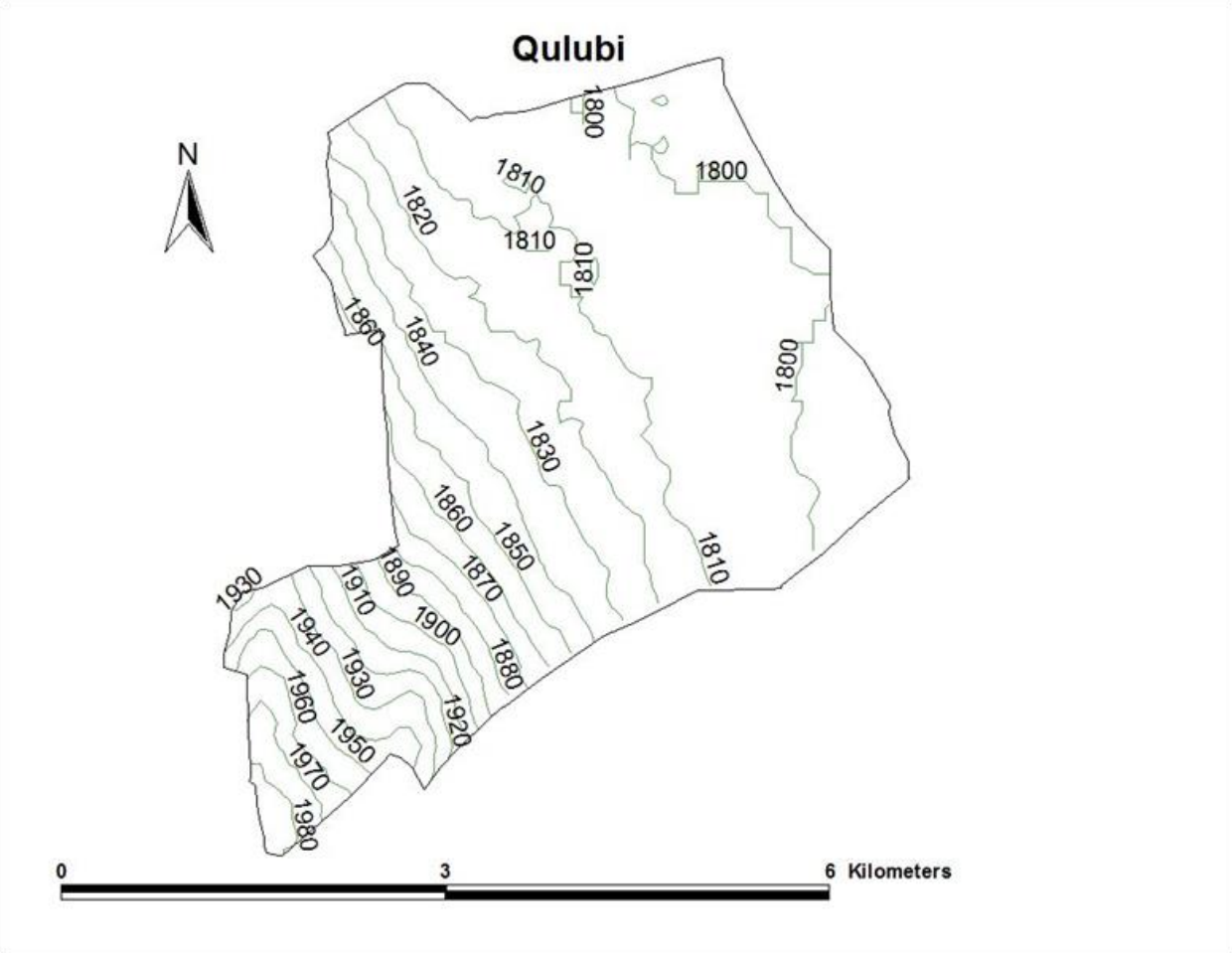


Figure 33. Contour map of Qulbi *Kebele*

South West of Qulibi *Kebele* where it bordered with Weteta and Besheno is highly degraded. As the narrow contour spacing shows, the terrain in this area is rough and frequented with gullies. Farmers are intruding in the area closure disturbing the land on the process of regeneration. Peculiar from other parts of the *Kebele*, the soil is very shallow and frequented by gullies.

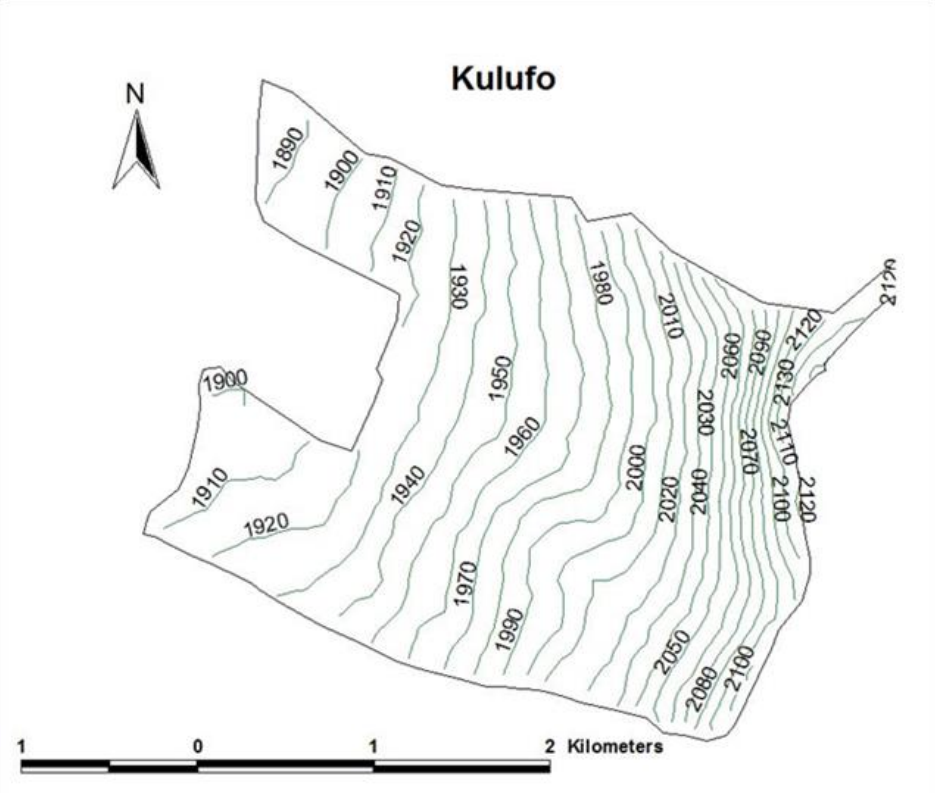


Figure 34. Contour map of Kulufo *Kebele*

Among all the *Kebeles* studied, Kulufo *Kebele* held the top position both in terms of erosion and water stress. Extreem North East boundary of the *Kebele* it bordered with Besheno *Kebele* is moderetelly fertile. The soil debth is about 50 cm but fragile in its formation. The black cotton soil show some organic matter content of the soil. About 100 m down to the South West direction away from this boundary, undisturbed area *closhure practice* preserved the ecology. Few meters down sparcelly populated accatia plantation failed to kerep the soil. At the boundary between agricultural land and the accatia planted area closhure, gullies are frequiented on average 50 to 80 meter distance South. Agricultural lands are shallow in depth and affected by gullies. Shortage of private and communal grazing lands are observed during the transect walk. Most social and technical infrastructures are affected by the gulley formations.

Short term strategies are required for gully stabilization and plantation inside area closhures.

Figure 35. Sparcelly populated, accatia forested, area closhure in Kulufo

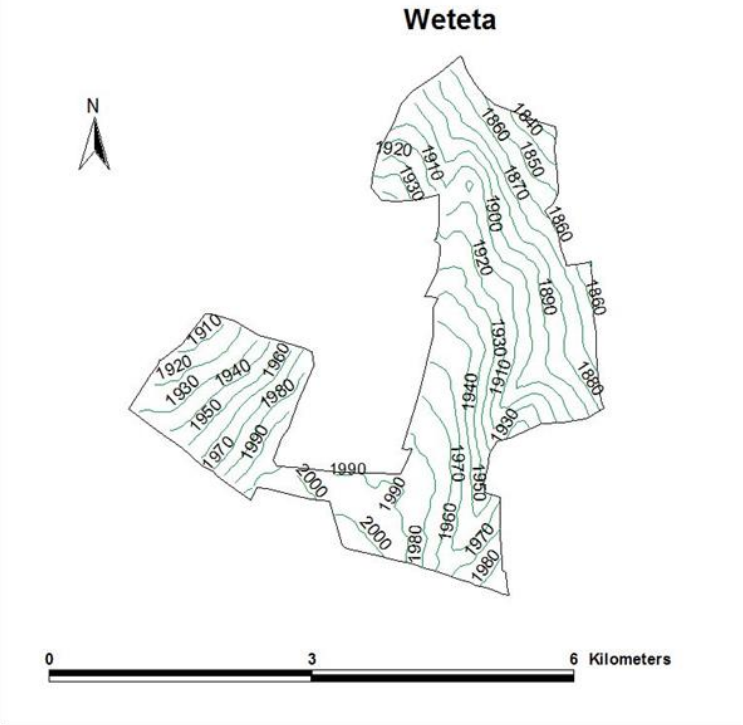


Figure 36. Contour map of Weteta *Kebele*

Generally the terrain is rough and affected by gullies. Short term gully stabilization interventions are required on these areas as coined similar to the aforementioned *Kebeles*; at the beginning of the rainy season there is a tremendous volume of erosion materials coming from Weteta *Kebele* that affects Sinbita *Kebele*. Tillage erosion is highly frequent in this *Kebele*. Shallow, light brown silt soil is dominant in the area. All the farm lands, where Weteta *Kebele* is bordered with Qulibi and Besheno *Kebeles* need immediate attentions.

4.3. Results: Suggested interventions and Development Plan

After thoroughly debated upon the problems of each *Kebele*, the following development plan was proposed in consensus with the community. The development maps and the proposed interventions are presented below.

***Base Map of Each Kebeles* : According to the Farmers Boundary**

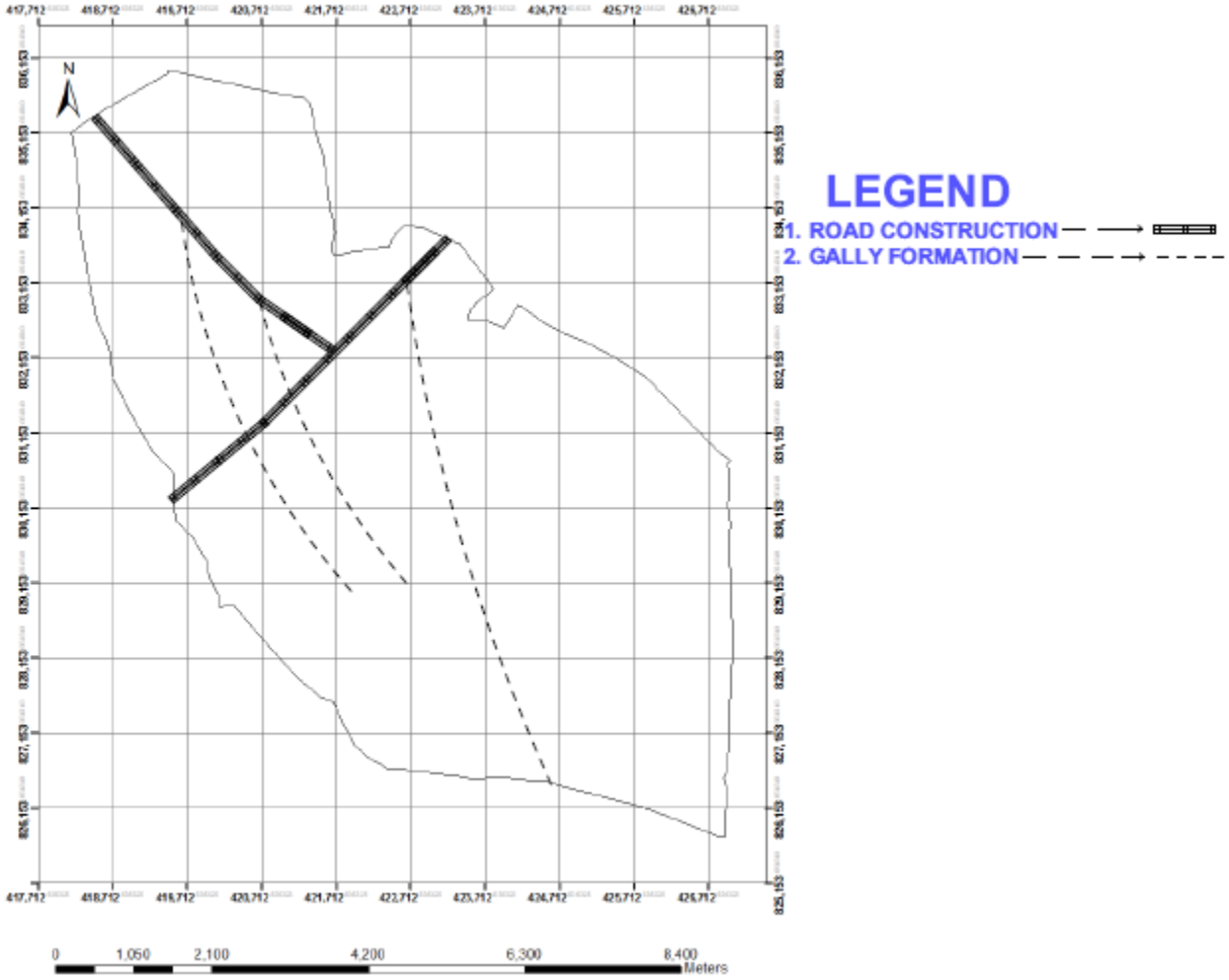


Figure 37. Base map of Bendo Cheloksa *Kebele*

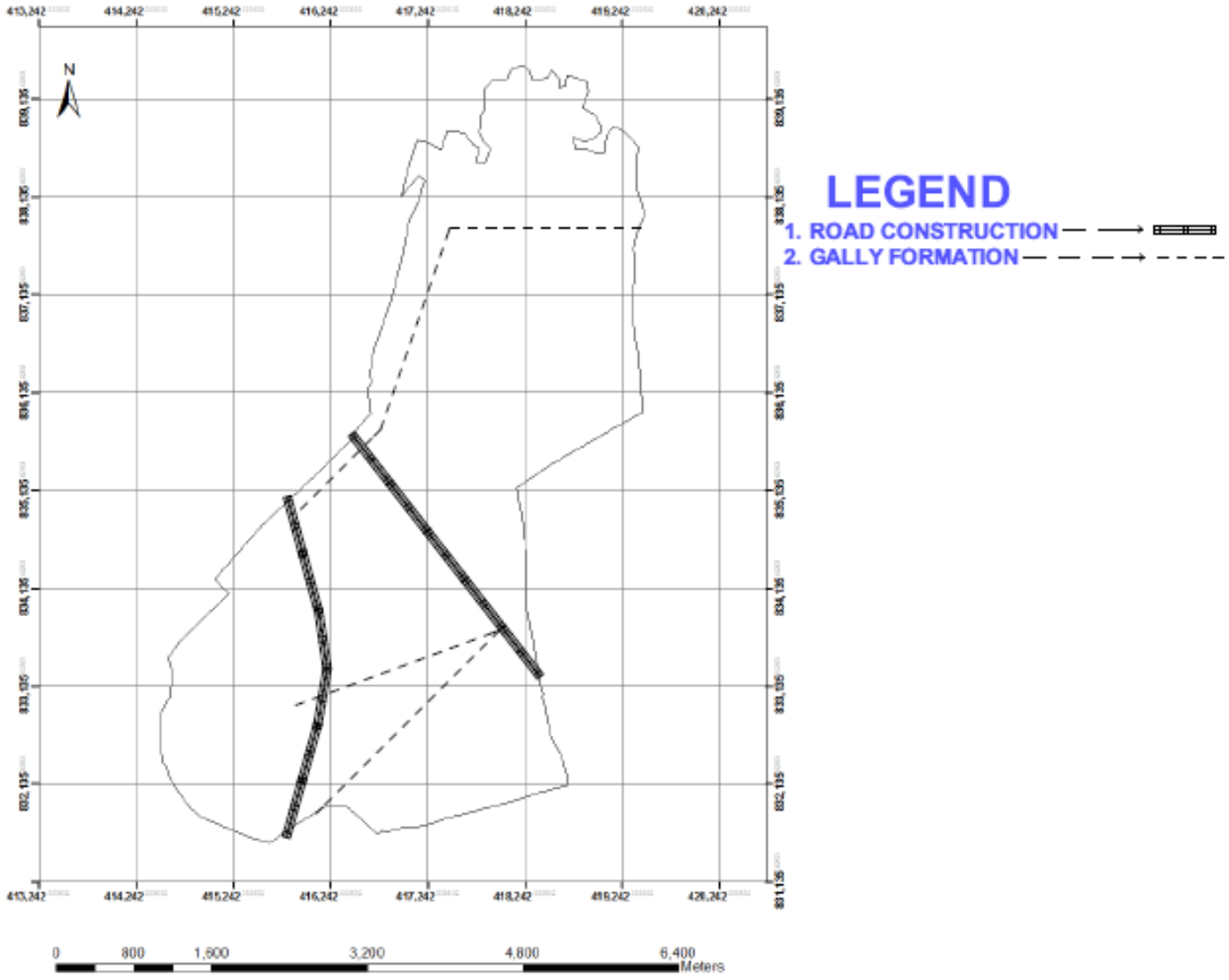


Figure 38. Base map of Sinbita *Kebele*

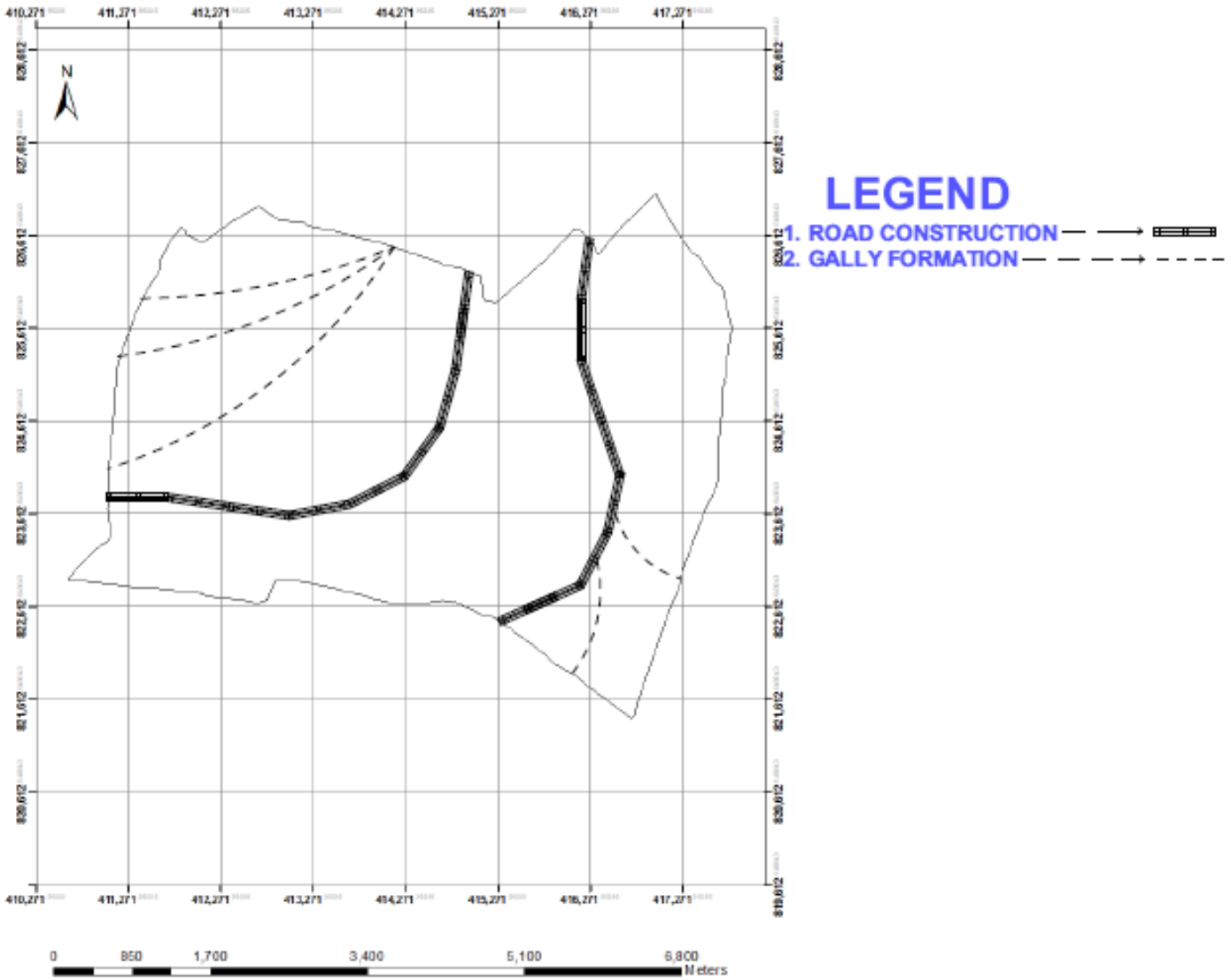


Figure 39. Base map of Besheno *Kebele*

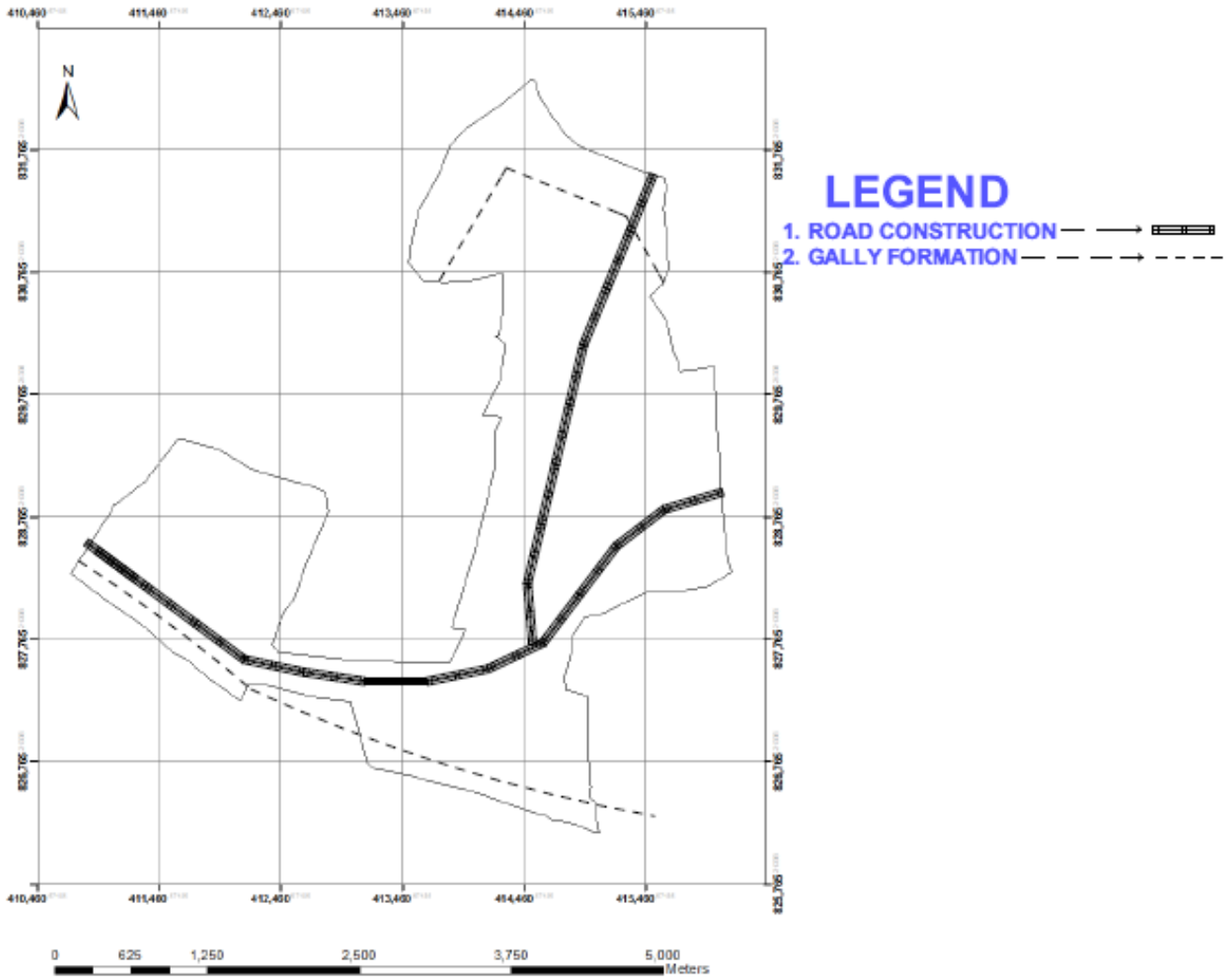


Figure 40. Base map of Weteta *Kebele*

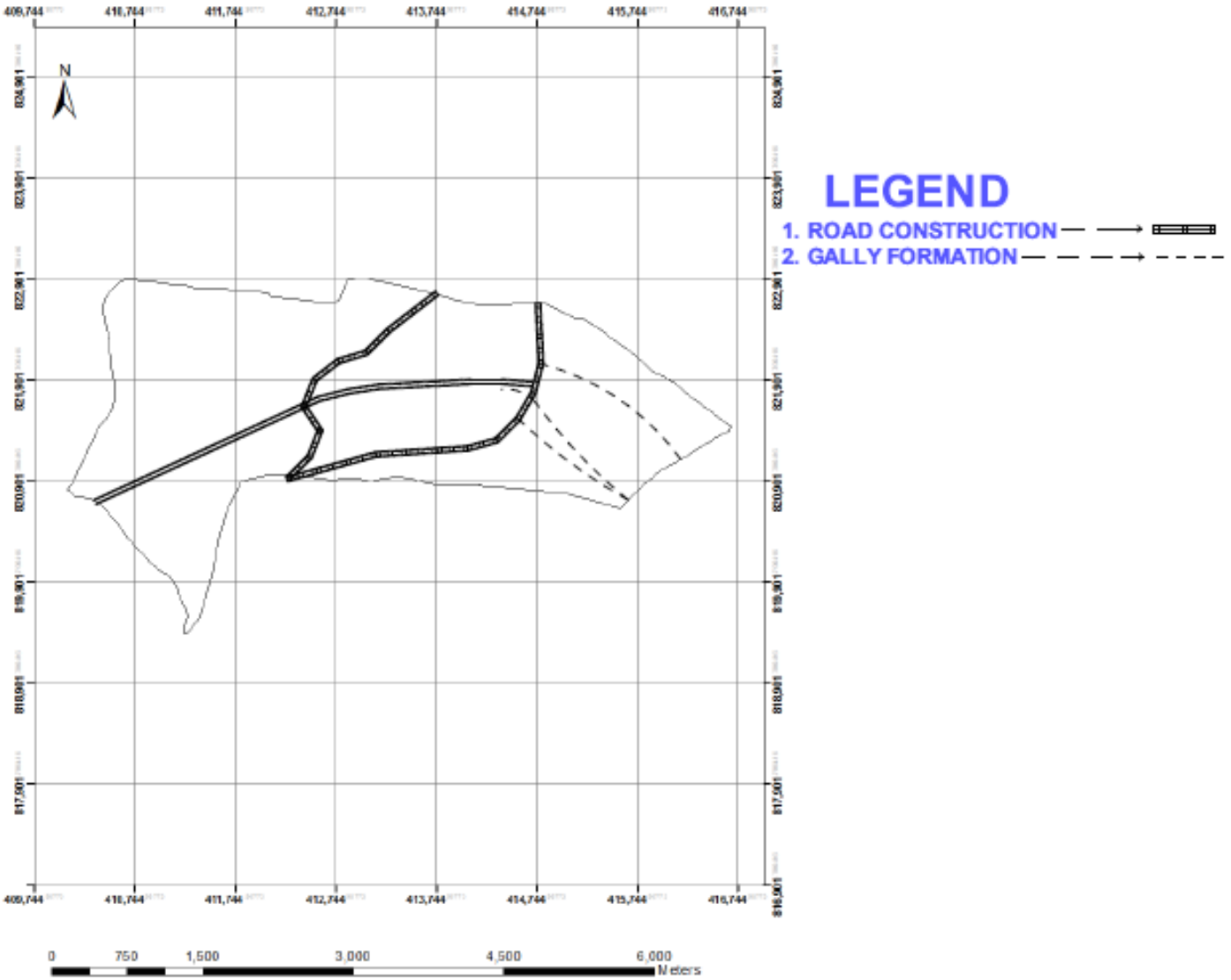


Figure 41. Base map of Hantezo *Kebele*

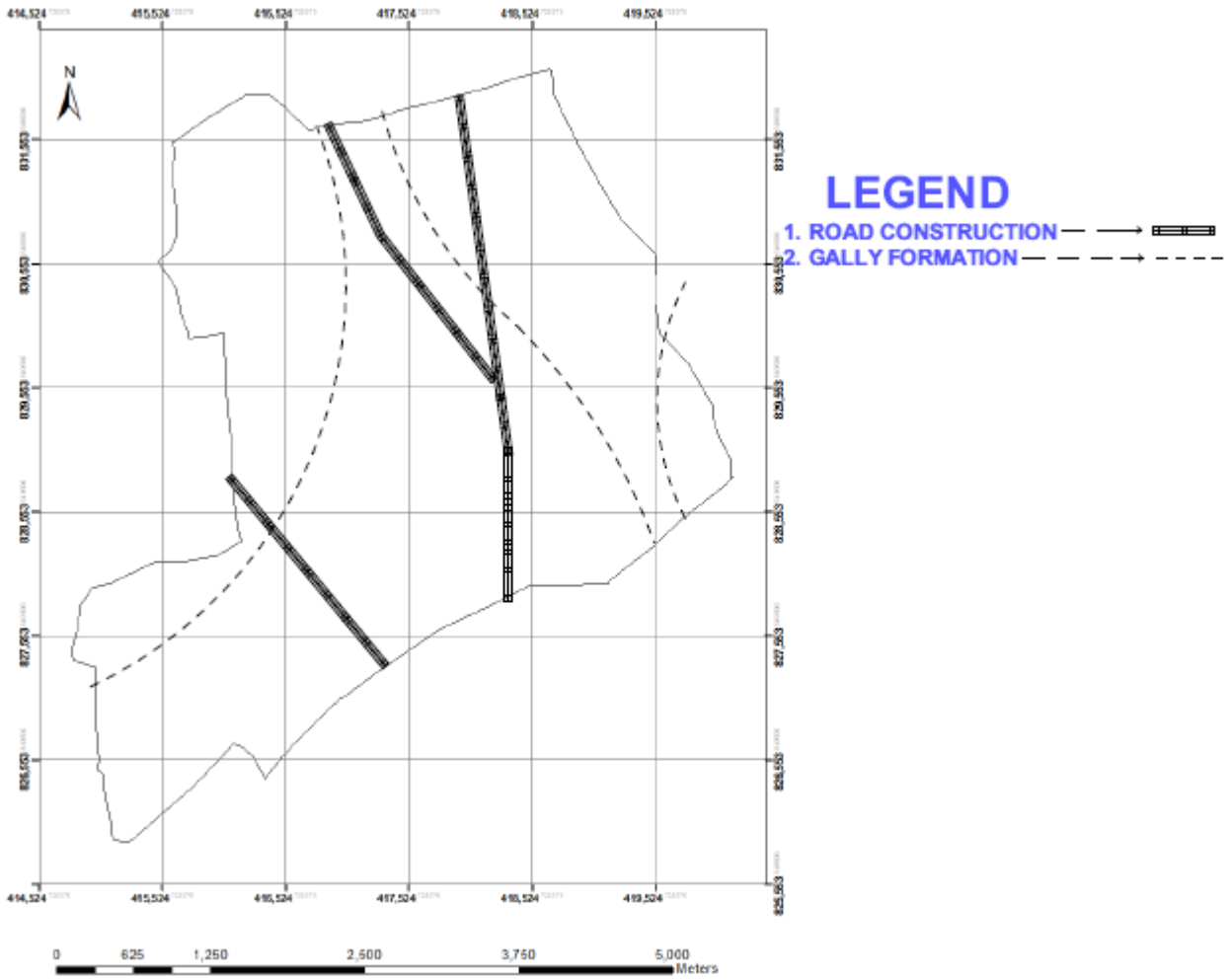


Figure 42. Base map of Qulibi *Kebele*

Suggested Development Map of Each Kebeles

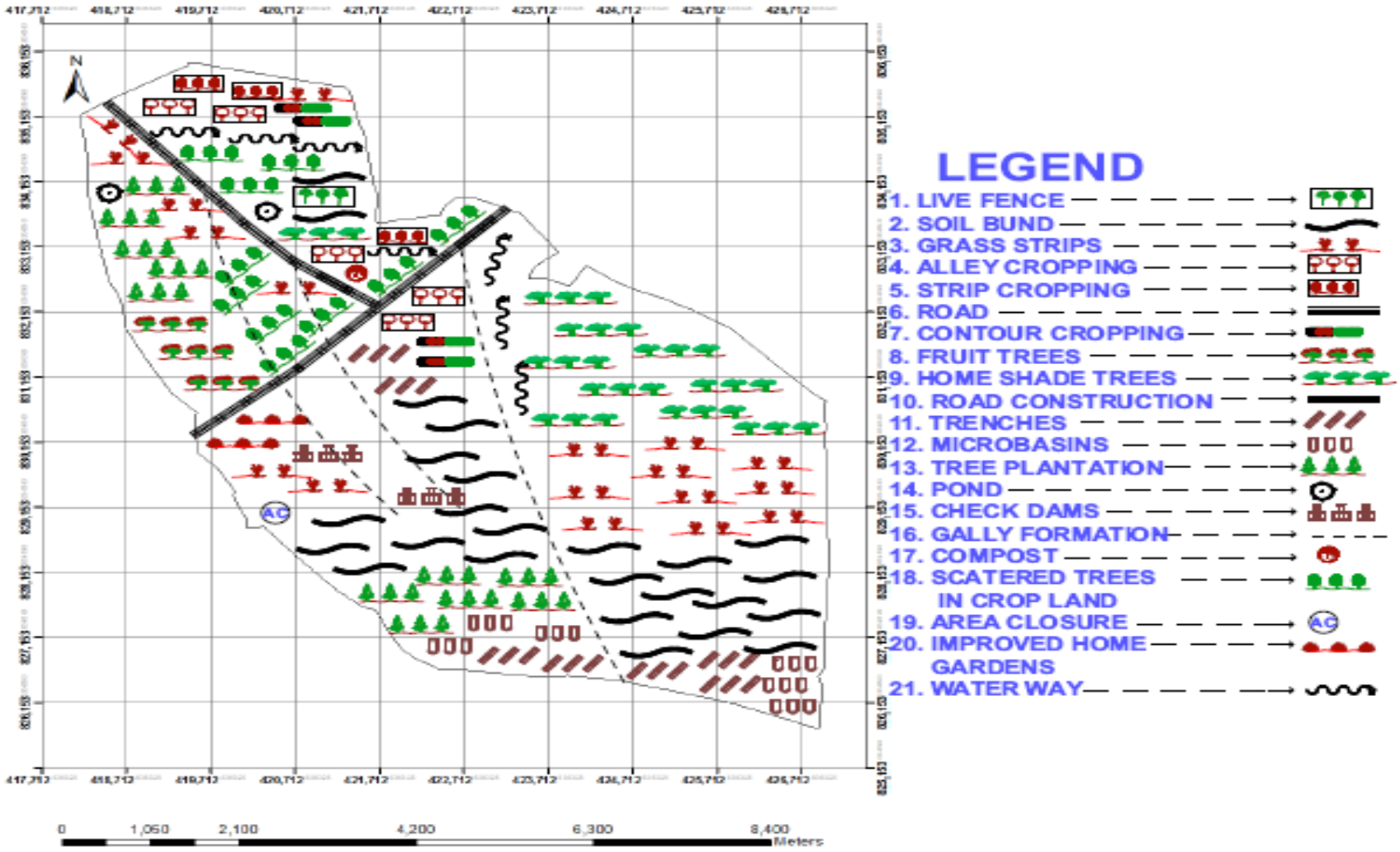


Figure 43. Suggested development map of Bendo Cheloksa *Kebele*

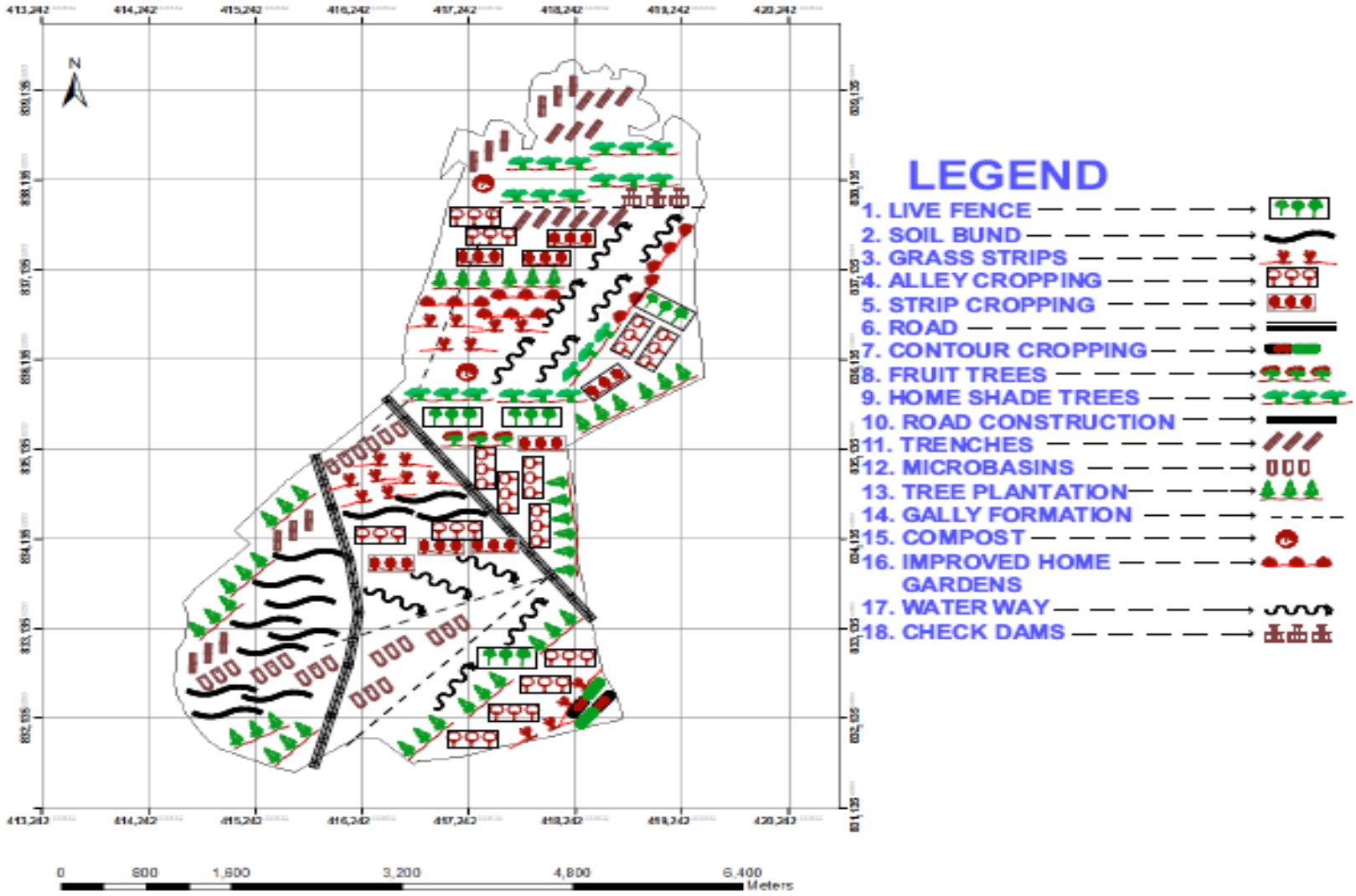


Figure 44. Suggested development map of Sinbita *Kebele*

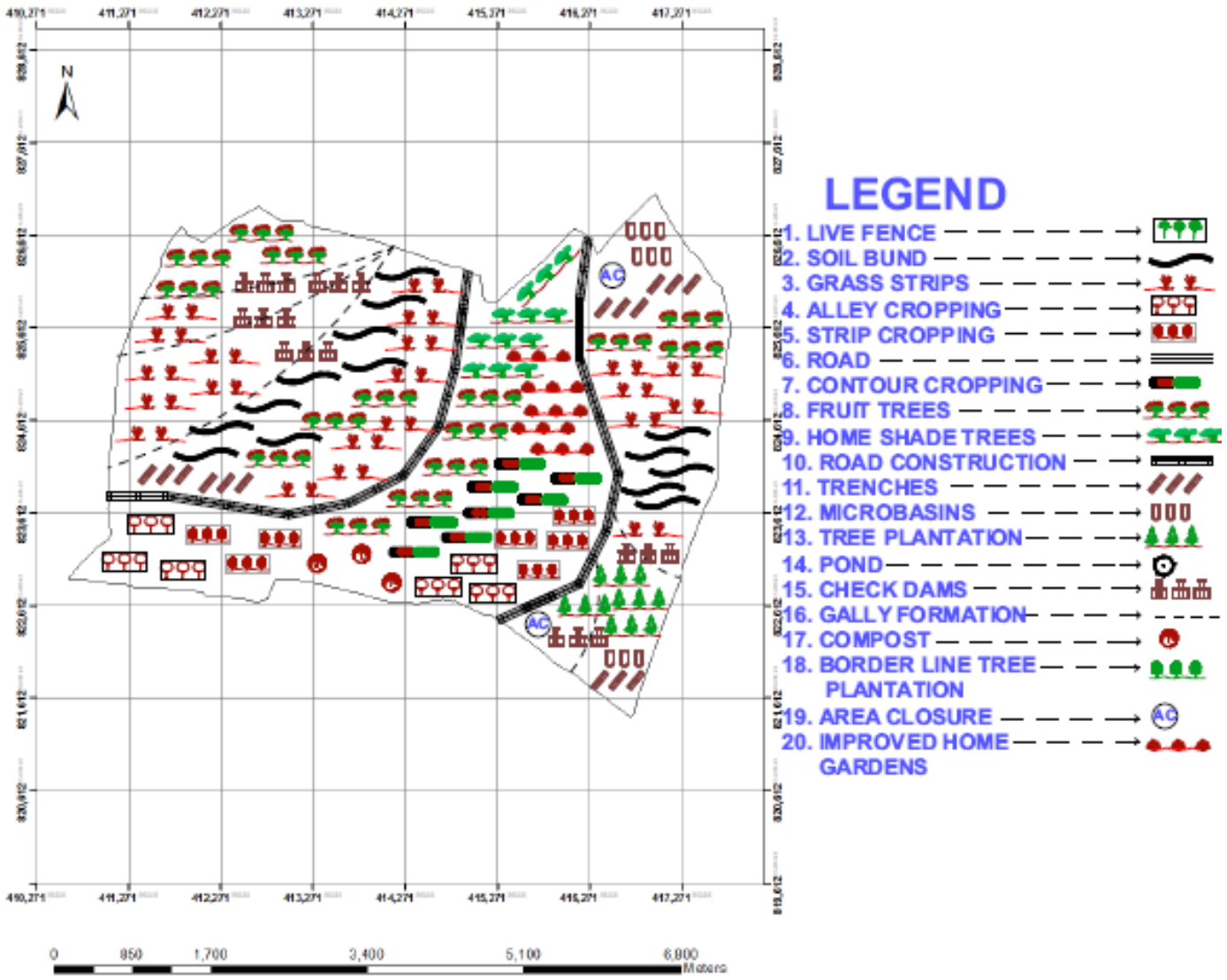


Figure 45. Suggested development map of Besheno *Kebele*

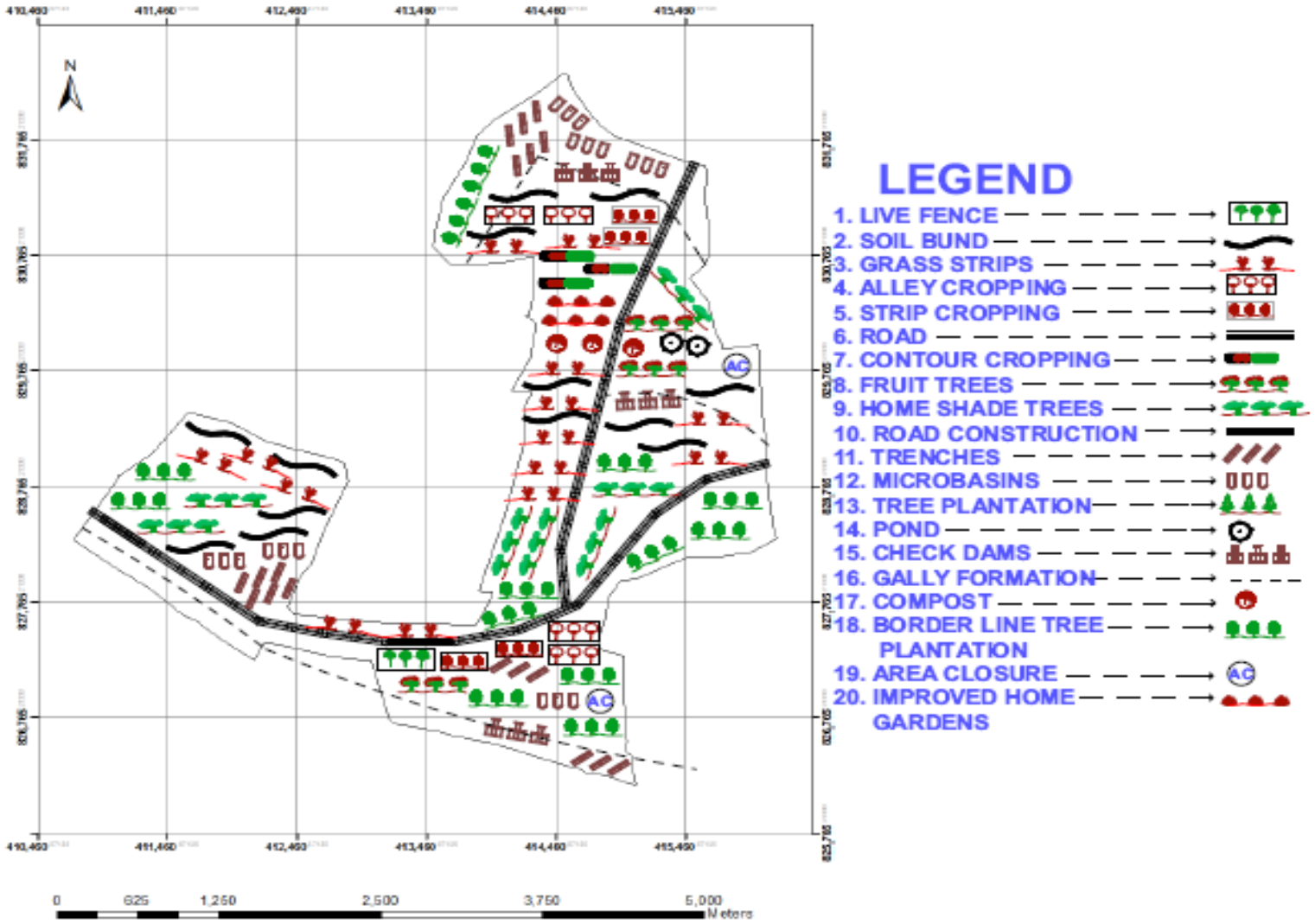


Figure 46. Suggested development map of Weteta *Kebele*

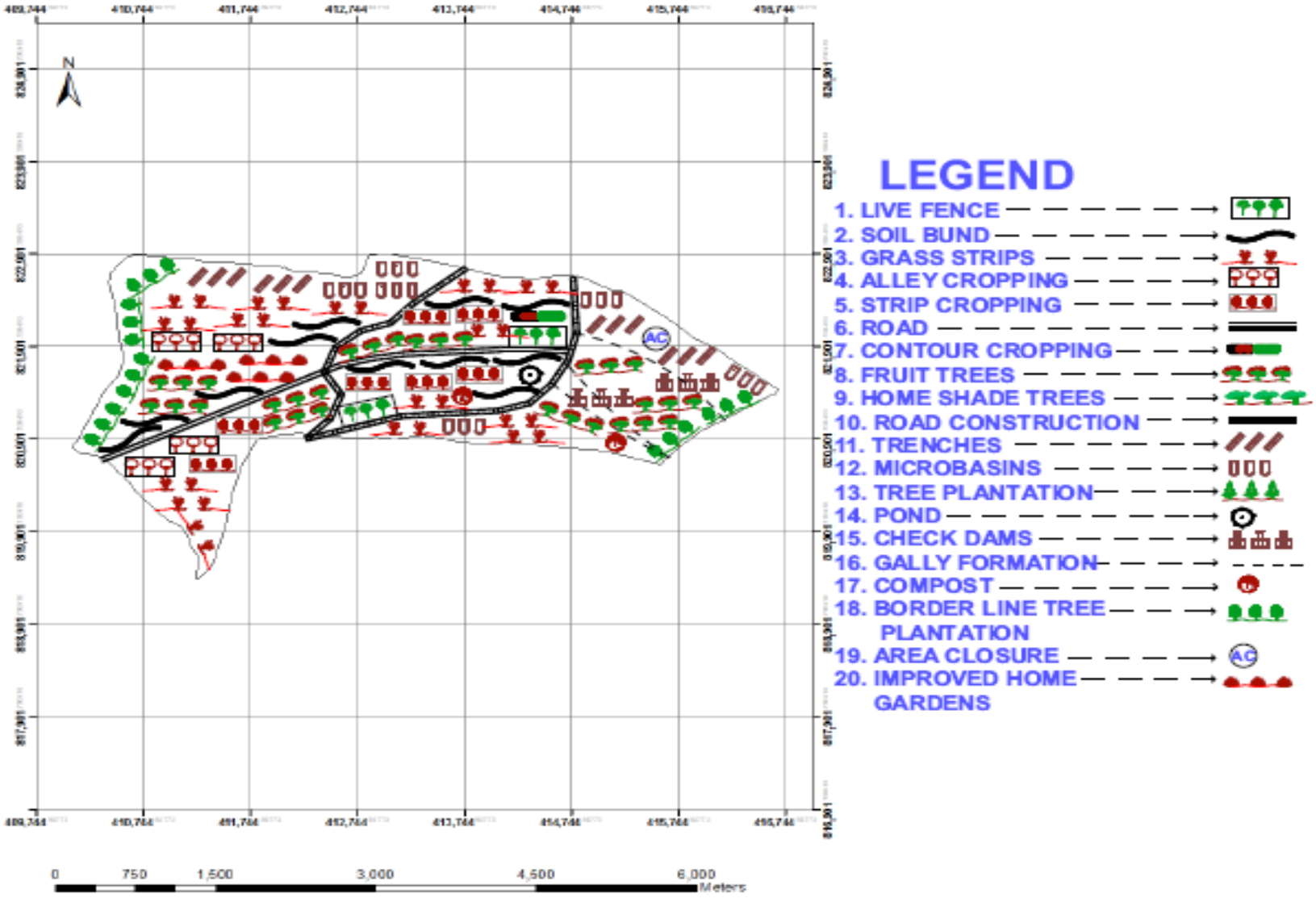


Figure 47. Suggested development map of Hantezo *Kebele*

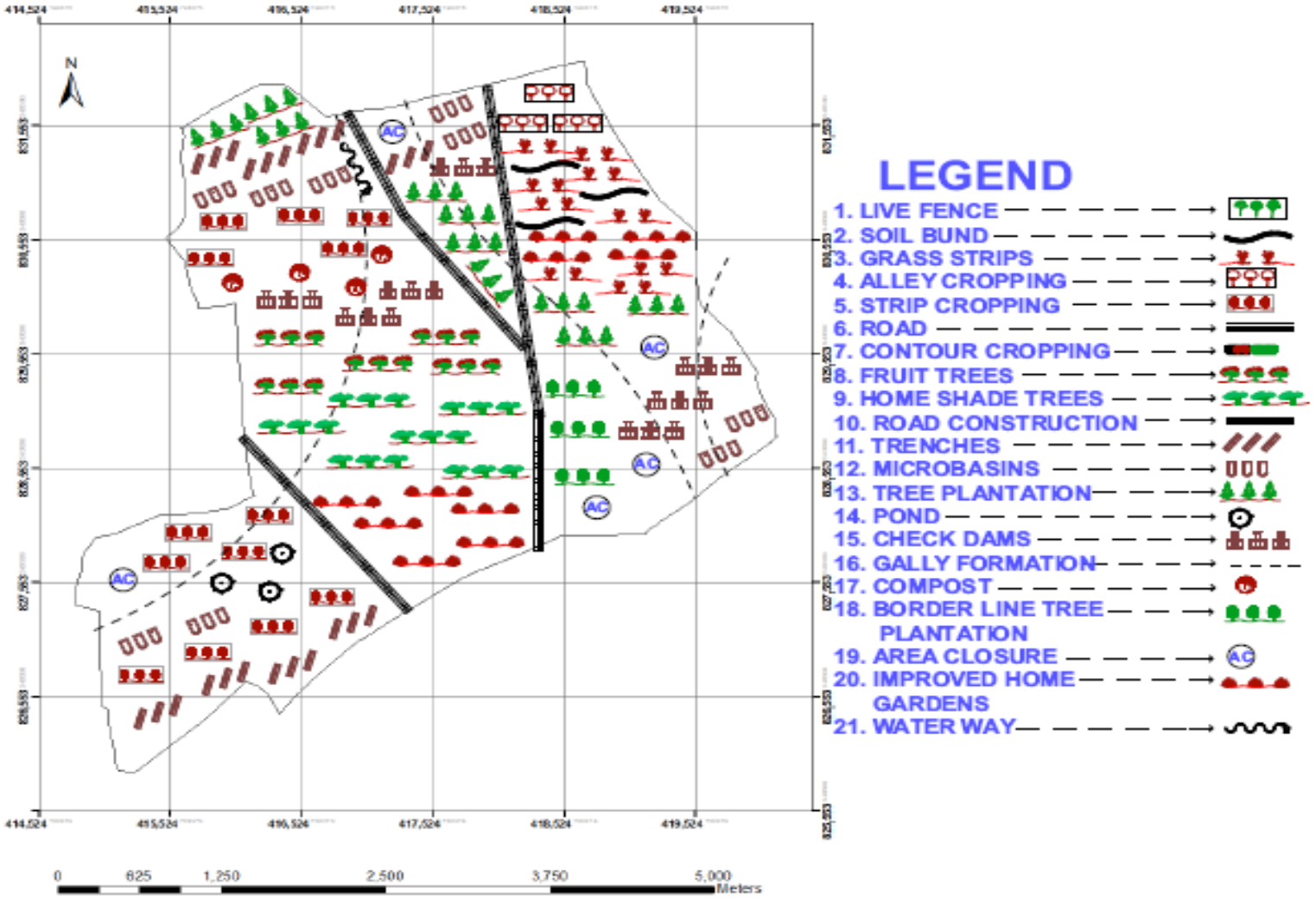


Figure 48. Suggested development map of Qulibi *Kebele*

4.4. Results: Suggested Interventions for Different Land Uses

Table 6. Suggested interventions for different landuse patterns

No	Kebele	Degraded Land	Gully	Farm Land	Forest Area
1	Kulufo	Trench	Check dam	Bund	Half moon terrace
		Micro basin	Soil/sand bag	Fanyajuu	Plantation pit
		Eyebrow basin		Bund Stabilization	Area closure
		Bund		Agroforestry	Direct sowing of grass seeds
		Cutoff drains	SS dam	Cutoff drains	
		Tree plantation	Gabion	Fallowing	Micro basin
		Area closure		Composting	Trench
				Controlled Grazing	
2	Weteta	Trench	Check dam	Bund	Half moon terrace
		Micro basin	Soil/sand bag	Fanyajuu	Plantation pit
		Cutoff drains		Bund Stabilization	Area closure
		Tree plantation		Agroforestry	Direct sowing of grass seeds
		Area closure	SS dam	Cutoff drains	
			Gabion	Fallowing	Micro basin
				Composting	
3	Sinbita	Trench	Cutoff drains	Bund	
		Micro basin	Check dam	Forage production	Plantation pit
		Forage production	Soil/sand bag	Agroforestry	Tree plantation
		Cutoff drains	SS dam	Cutoff drains	Direct sowing of grass seeds
		Tree plantation		Water ways	
		Area closure		Fallowing	Micro basin
				Composting	Trench
				Controlled Grazing	
4	Bendo Cheloksa	Trench	Check dam	Bund	Trench
		Micro basin	Soil/sand bag	Fanyajuu	Micro basin
		Forage production		Bund Stabilization	Area closure
		Plantation	SS dam	Agroforestry	Plantation pit
		Area closure		Cutoff drains	Tree plantation
		Cutoff drains		Fallowing	Direct sowing of grass seeds
		Tree plantation		Composting	
		Ponds		Controlled Grazing	Half moon terrace

Suggested interventions for different landuse patterns **(continued)**

No	Kebele	Degraded Land	Gully	Farm Land	Forest Area
5	Besheno	Trench	Check dam	Bund	Micro basin
		Micro basin	Soil/sand bag	Fanyajuu	Plantation pit
		Eyebrow basin		Forage production	Tree plantation
		Bund		Agroforestry	
		Cutoff drains		Cutoff drains	
		Tree plantation		Agroforestry	
		Area closure		Composting	
		Pond			
6	Kulubi	Micro basin	Check dam	Bund	
		Half moon terrace	Soil/sand bag	Fanyajuu	Plantation
		Trench	SS dam	Fallowing	Micro basin
		Tree plantation	Gabion	Agroforestry	Improved pits
		Improved pits		Check dams	
		Cutoff drains		Fallowing	
		Area closure		Composting	
7	Hantezo	Micro basin	Soil/sand bag	Bund	
		Trench	Check dam	Fanyajuu	Plantation pit
		Half moon terrace		Forage production	Tree plantation
		Plantation		Agroforestry	Direct sowing of grass seeds
		Improved pits		Fallowing	Micro basin
		Pond		Composting	Improved pits
				Controlled Grazing	

4.5. Results: SWC activity calendar-Halaba Special Woreda

Table 7. SWC activity calendar

	Sep				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				Jun				Jul				Aug			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Soil Bund																																															
Fanyajju																																															
Check dam (wood)																																															
Check dam (stone)																																															
Soil/sand bags																																															
Gabion																																															
Cutoff drains																																															
Water ways																																															
Stone bund																																															
Road construction																																															
Micro basin																																															
Half moon terrace																																															
Eyebrow basin																																															
Micro trench																																															
Trench																																															
SS dam																																															
Micro pond																																															
Pond																																															
Terrace repair																																															
Seedling production																																															
Plantation pit																																															
Road repair																																															
Plantation																																															

5. DESCRIPTION OF INTERVENTION

5.1. Physical soil and water conservation (SWC) measures:

Physical soil and water-conservation measures are those measures developed through soil cutting and earth moving to reshape the topography. They are mechanical barriers constructed across the direction of the flow of rainwater to retard or retain the runoff and thereby reduce the soil and water losses. The important principles to be kept in view while planning physical control measures are:

- Increasing the time of concentration of runoff thereby allowing more of it to be absorbed and held by the soil,
- Intercepting a long slope into several short ones so as to maintain less than a critical velocity for the runoff water,
- Protection against damage due to excessive runoff.
- Usually such measures are not complete on their own and require the addition of a vegetative cover before becoming fully effective and permanent.
- Selection and design of physical measures

While selecting and designing physical measures, the following factors should be taken into account.

- ❖ Climatic conditions, especially rainfall and the need to retain or discharge excess rainfall (runoff)

- Topography of the land, more specifically of slope steepness
- Conditions of the soil (erodibility, texture, drainage, depth, stoniness and risks of mass movement)
- The availability of an outlet or waterway for safety discharging runoff away from the land
- Farm size and the farming systems
- Availability of labour and cost
- Availability of construction materials
- Adequacy of existing agronomic or vegetative conservation measures.

Each measure with their suitability based on specific site conditions: mainly slope, soil depth, vegetation cover, cropping patterns and erosion levels including their design were presented as an annex (See annex 1).

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

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.

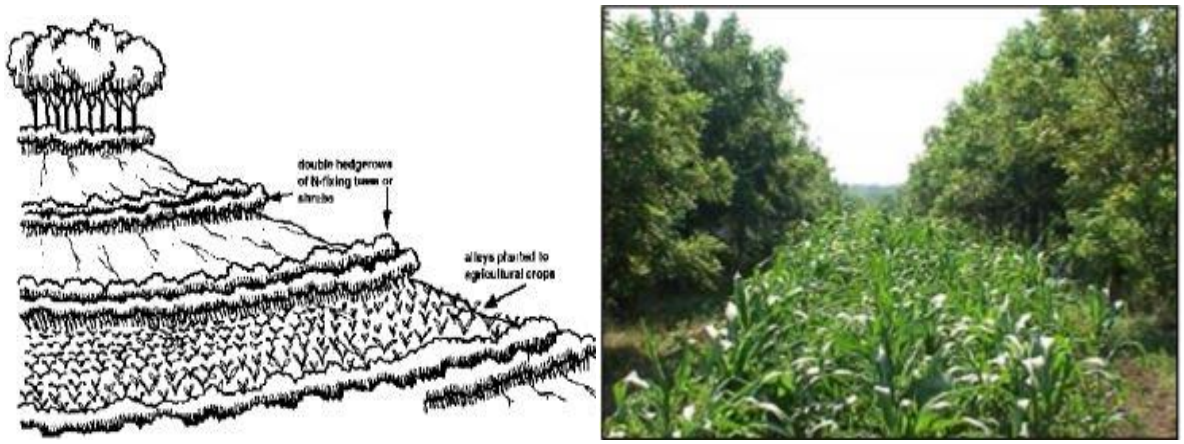


Figure 49. Alley cropping

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.

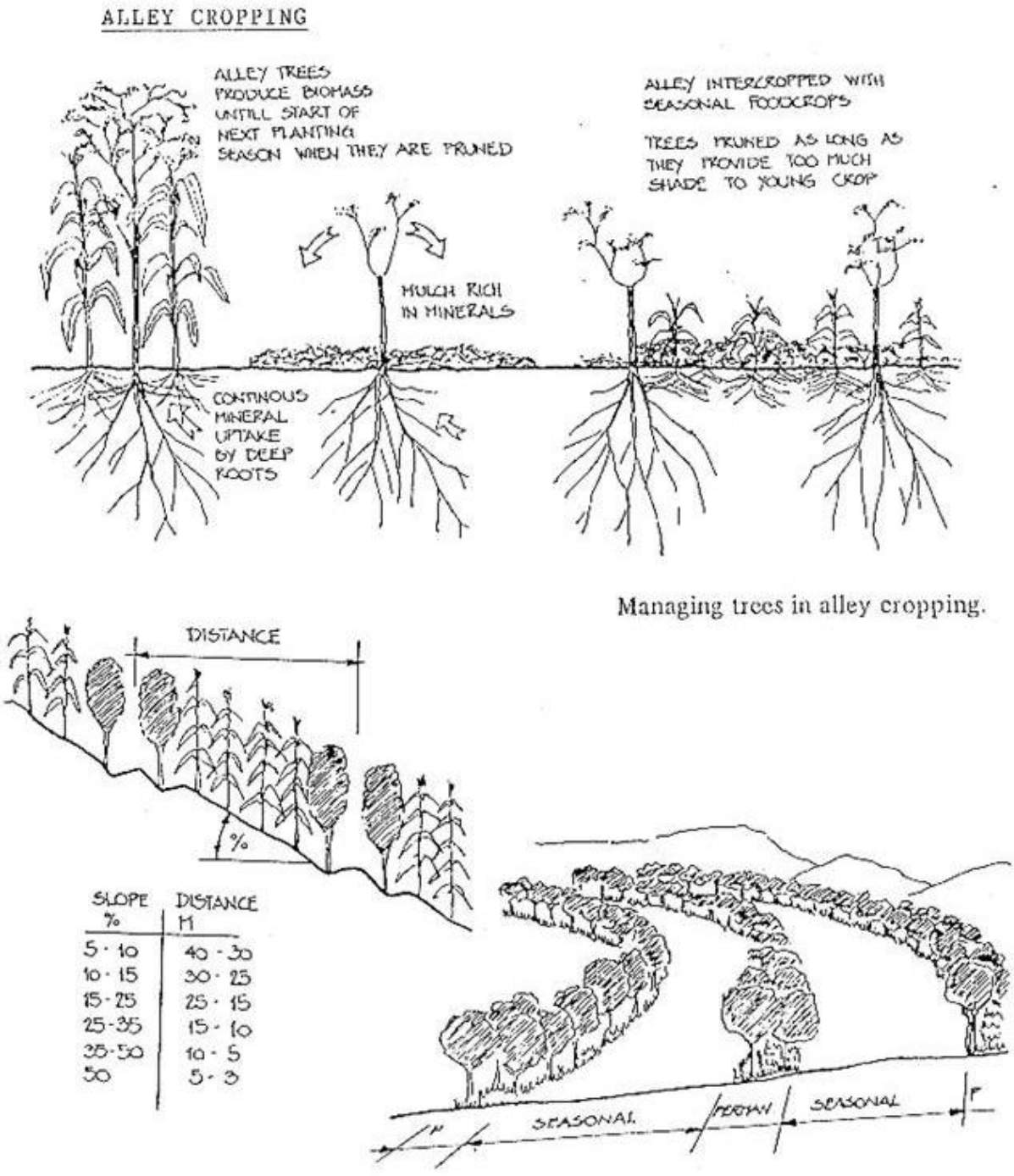


Figure 50. Alley cropping: Recommendations for lay out and spacing of permanent living terraces (or contour alleys). (Source: Zimmermann T. (1986): Agroforestry-a last hope for conservation in Haiti? Agroforestry systems 4, p.225-268.)

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.

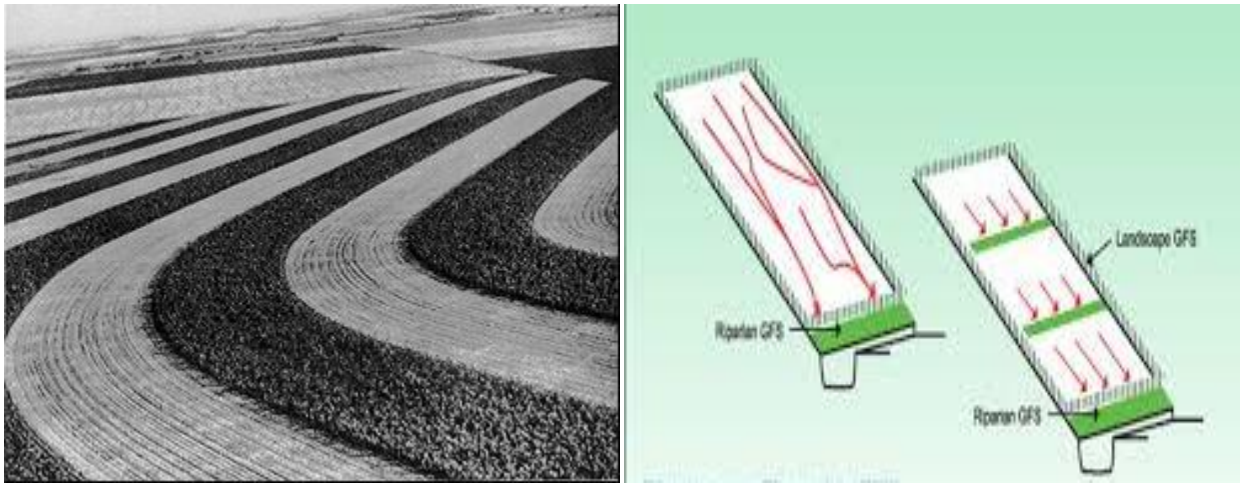


Figure 51. Grass Strips: schematics; and plot with and without grass strip

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.

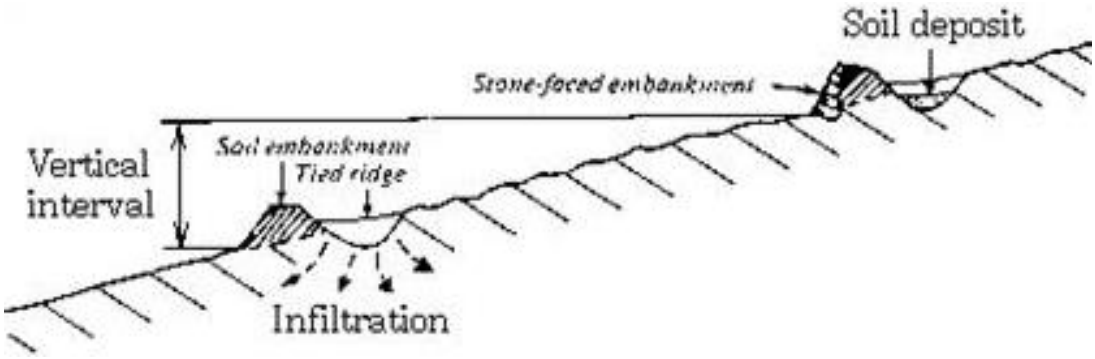


Figure 52. Level bund: terminologies

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.

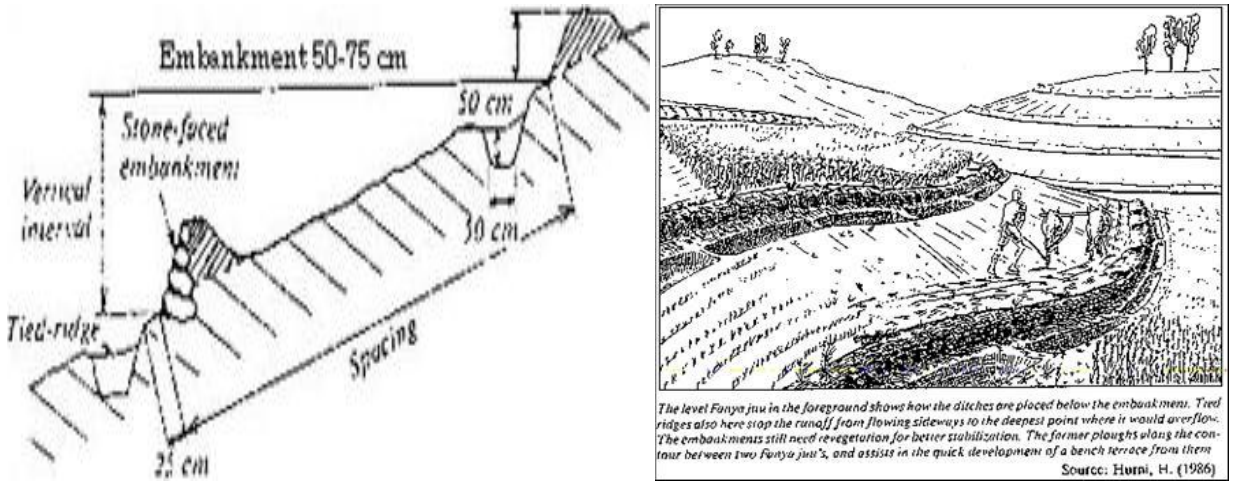


Figure 53. Design of Level Fanya juu, schematics and terminologies

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.

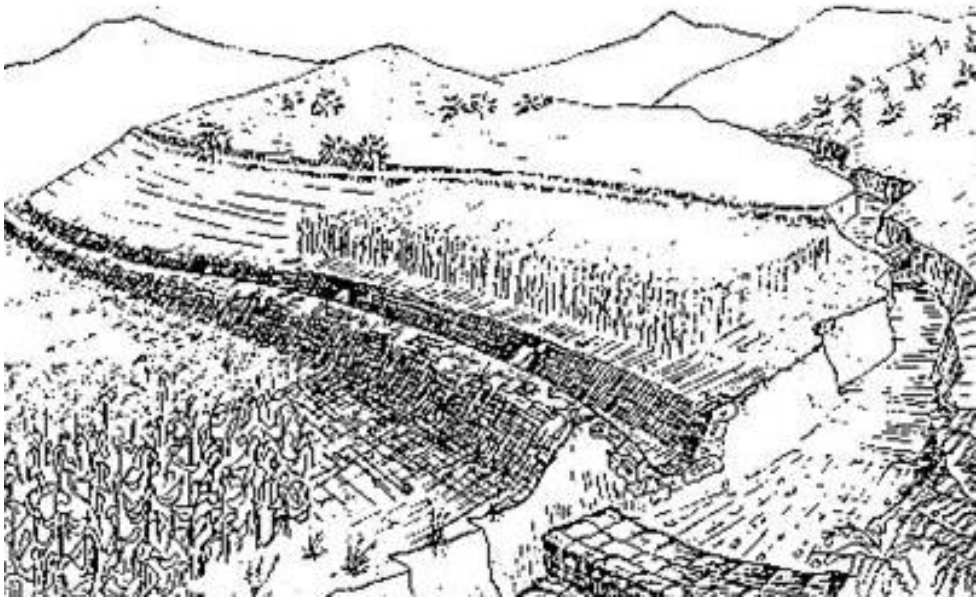


Figure 54. Graded bund

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.

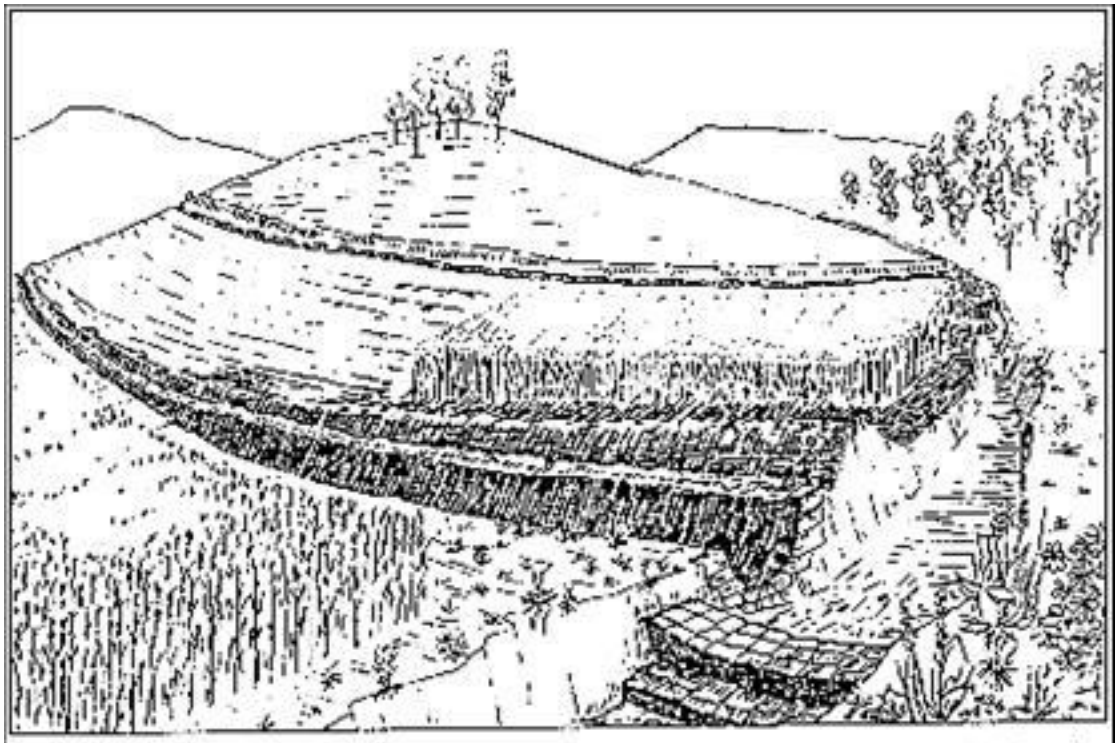
Management

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 55. 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.

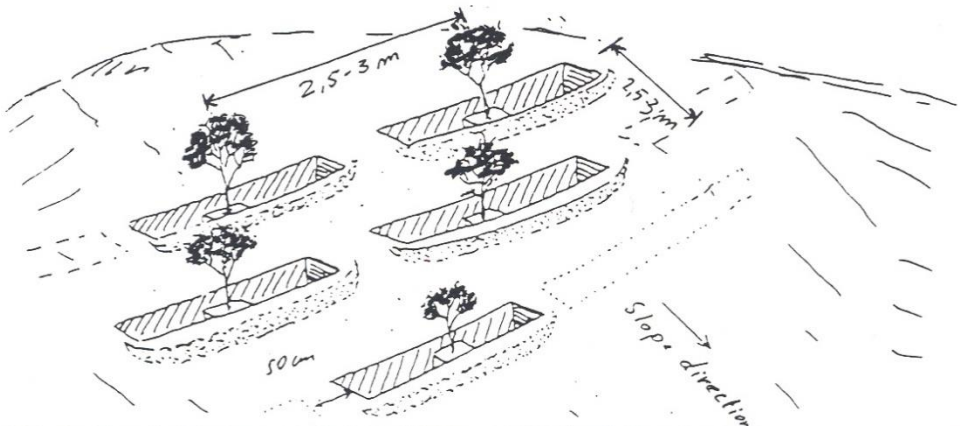


Figure 56. Water collection trenches

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).

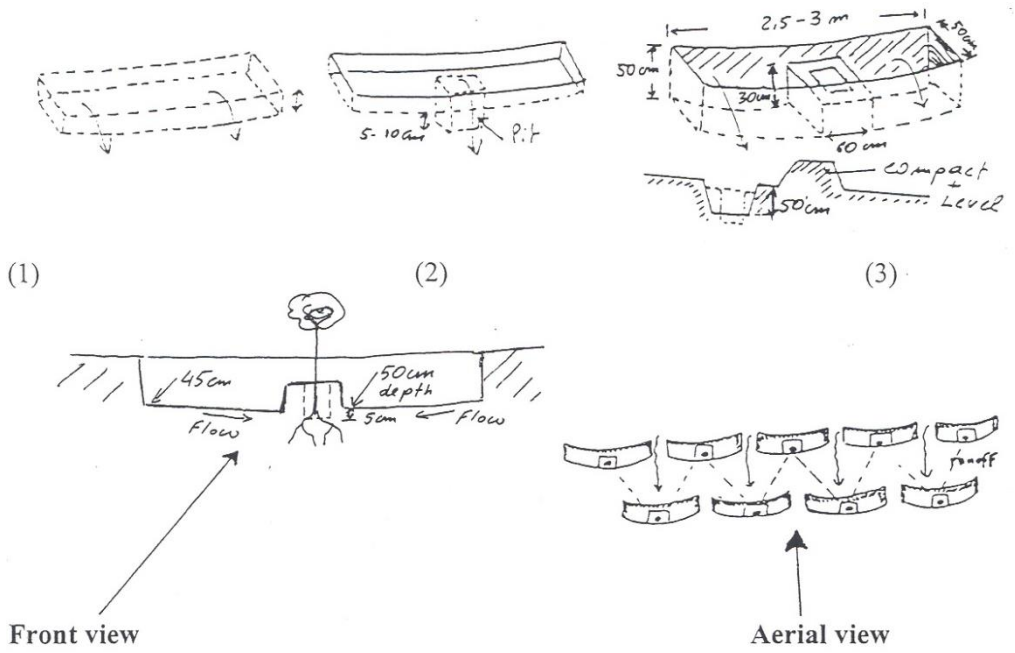


Figure 57. Design of water collection trenches

- 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.

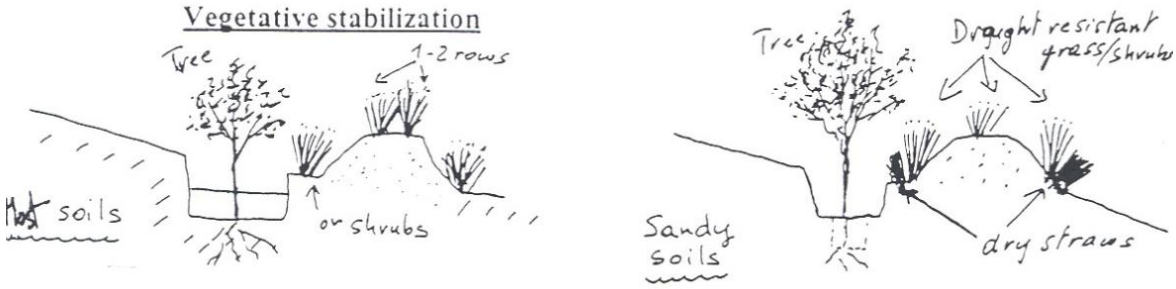


Figure 58. Vegetative stabilization of water collection trenches

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.

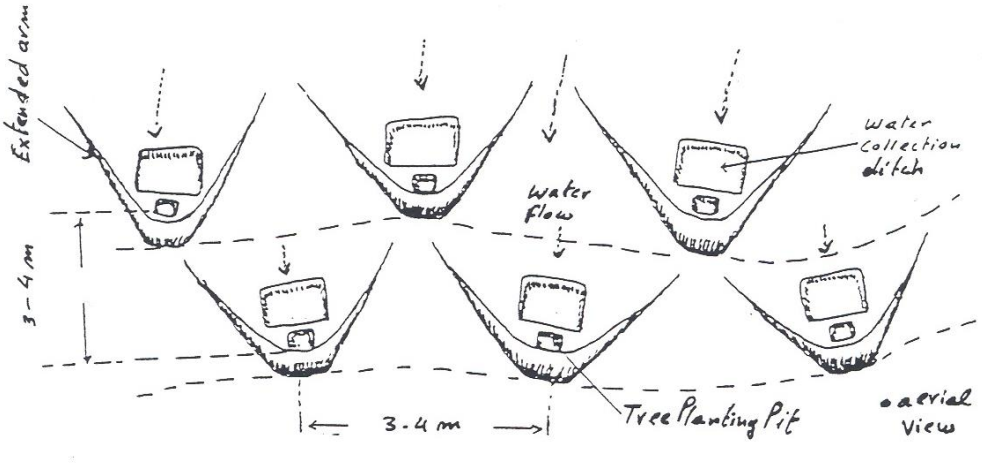


Figure 59. Layout of Herring bones

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.

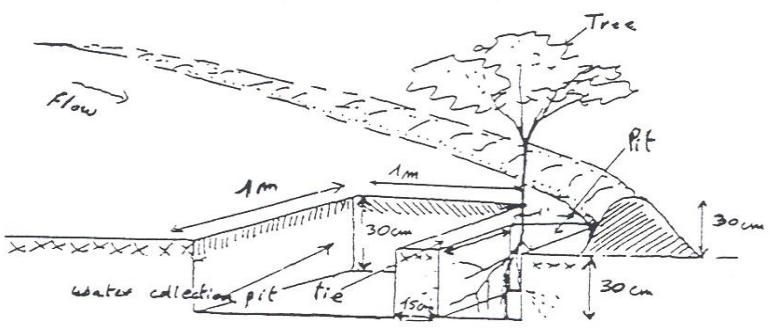


Figure 60. Design and dimensions of Herring bones

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).

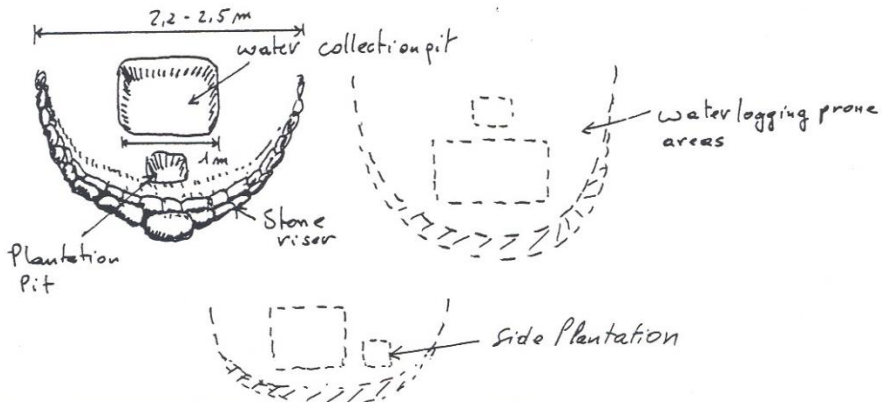


Figure 61. Layout of eyebrow basins

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

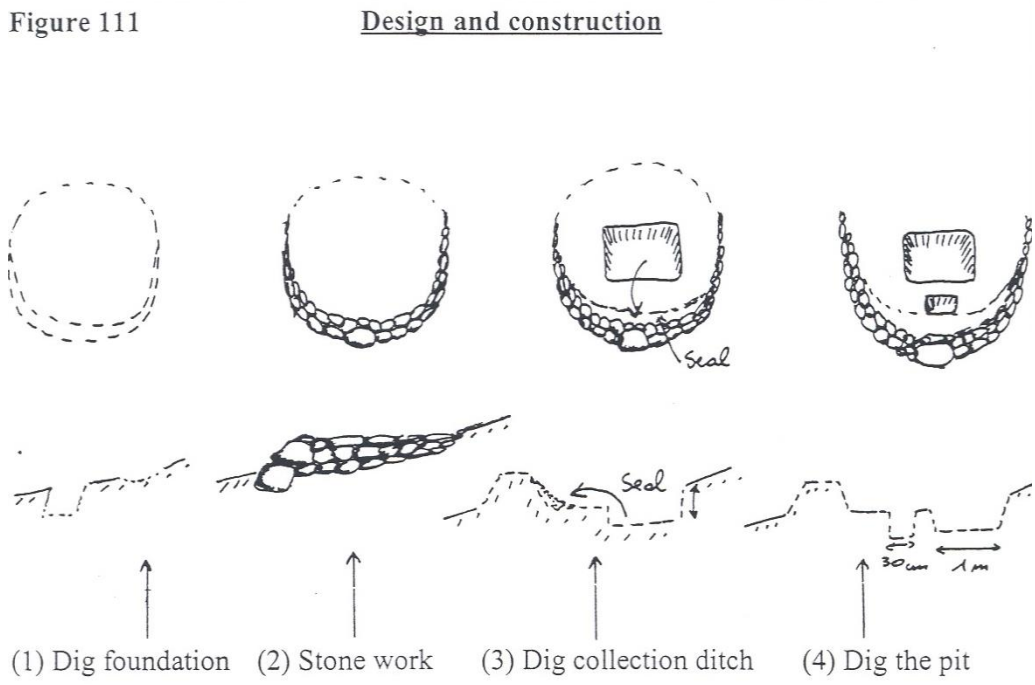


Figure 62. Construction steps of eyebrow basins

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.

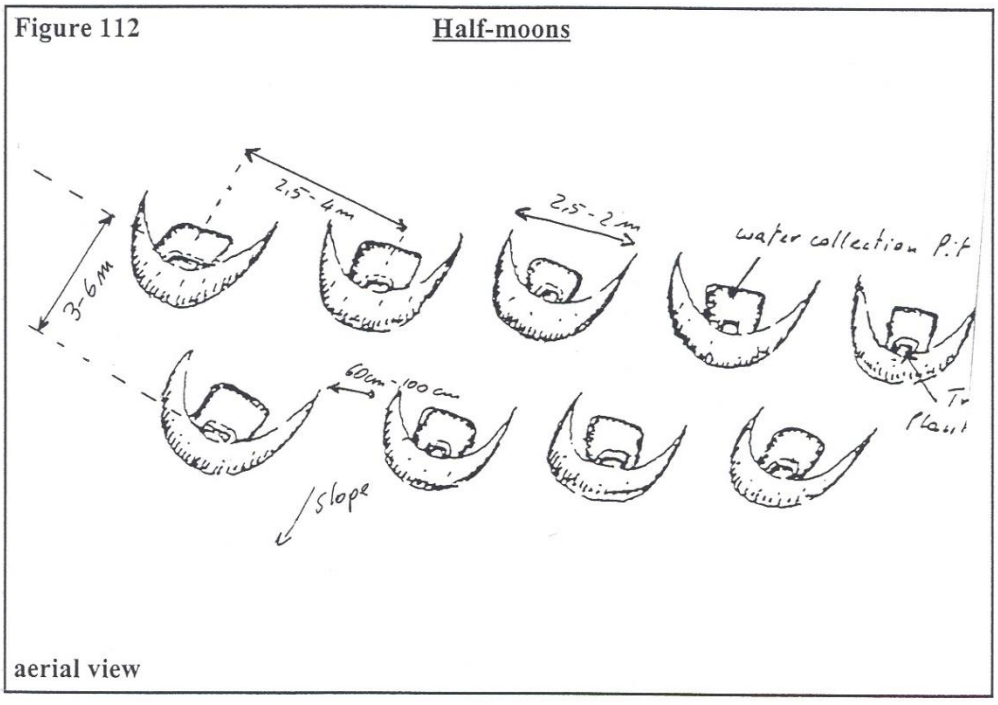


Figure 63. Layout of half-moons

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.

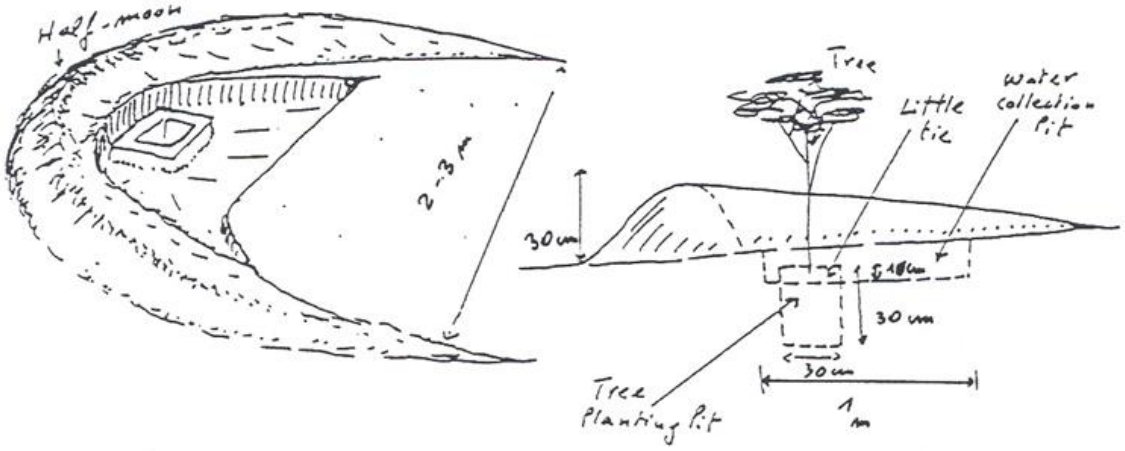


Figure 64. Design and construction of half-moon structure

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.

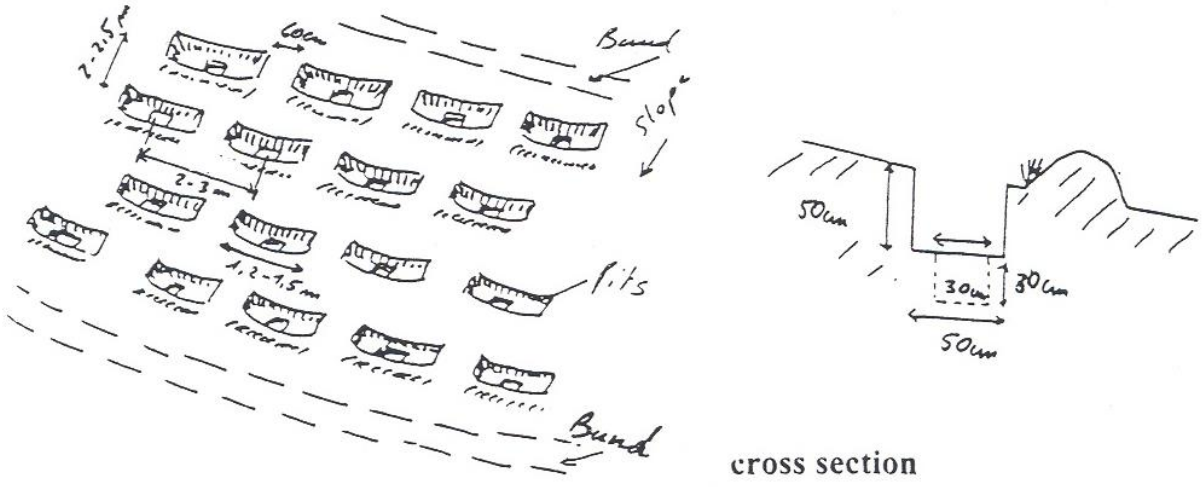


Figure 65. Improved pits along the contour

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.

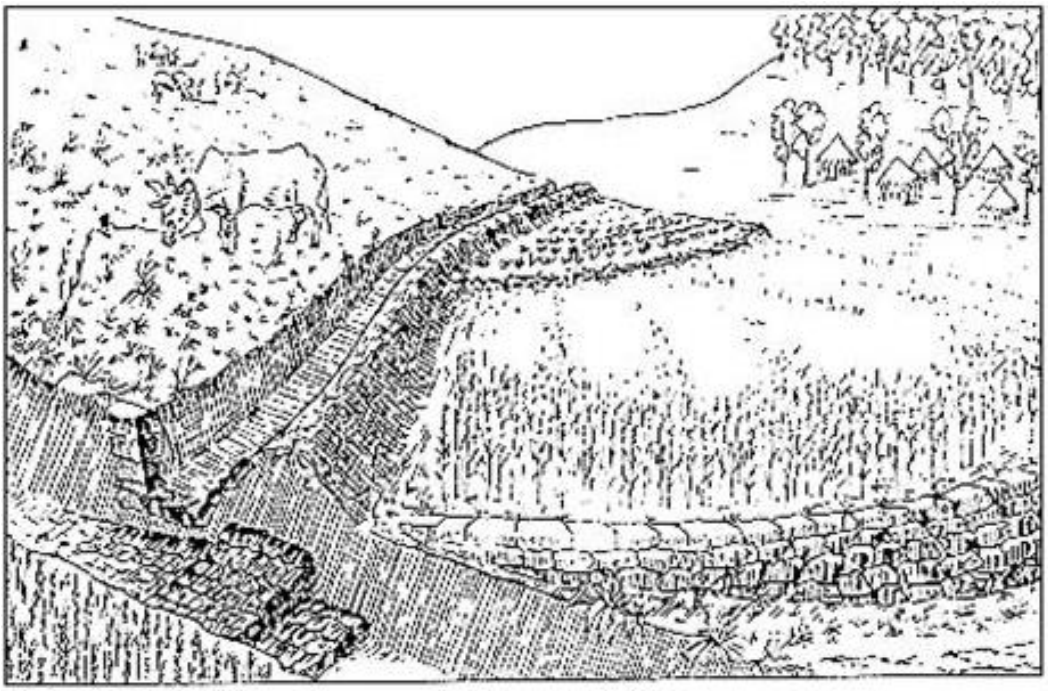
- The first reason is that whatever treatments you made to the land, runoff formation is inevitable.
- The second reason is that runoff formation/generation should be seen as an opportunity, a resource that can be harvested and used in a productive way.

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 66. 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 catchment (ha)	Depth of cutoff drain (cm)	Width of cutoff drain (cm)	Maximum 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.

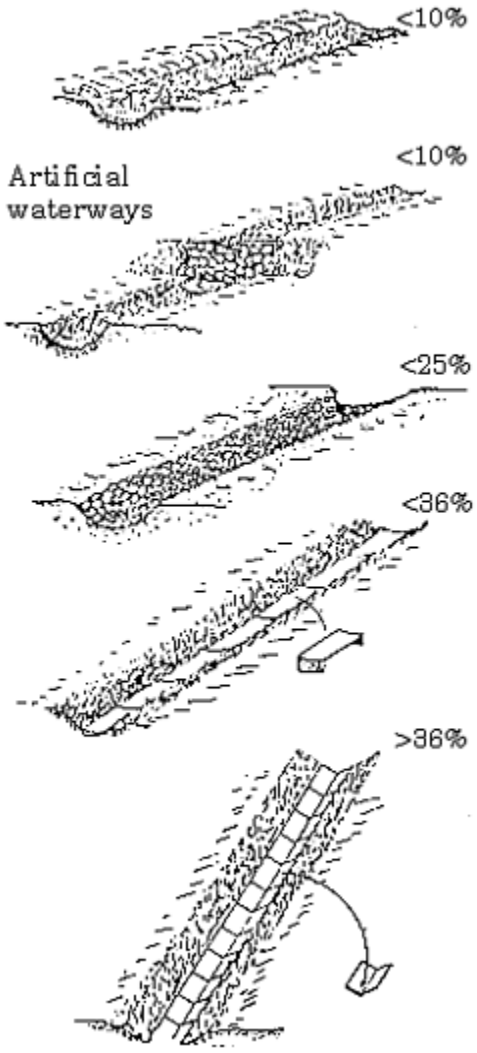


Figure 67. Water ways at different slopes and the required amendments in structure

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

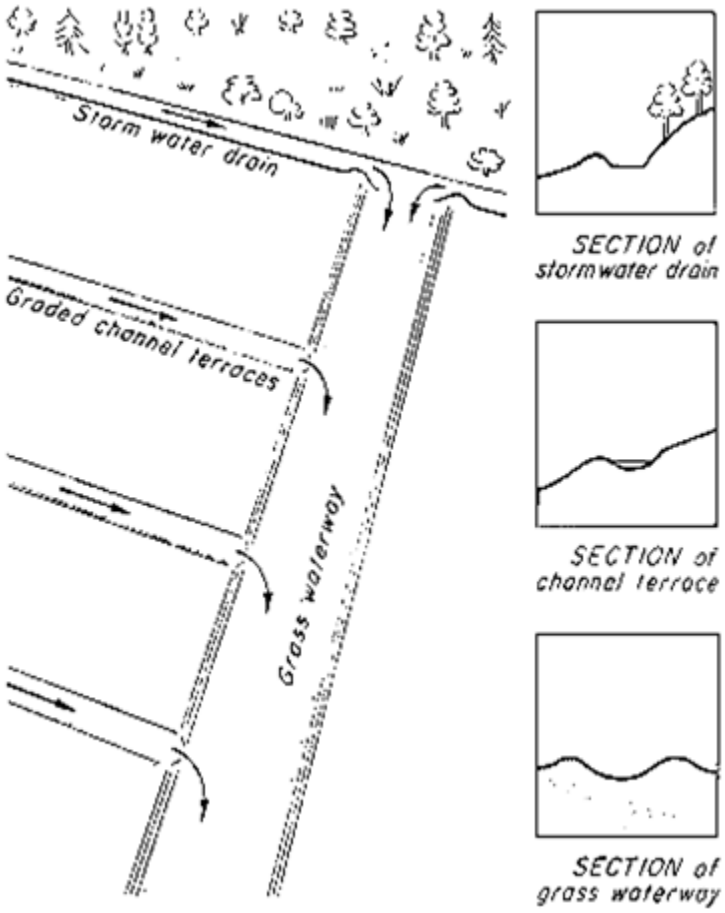


Figure 68. Grass water way and the input system sections

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.

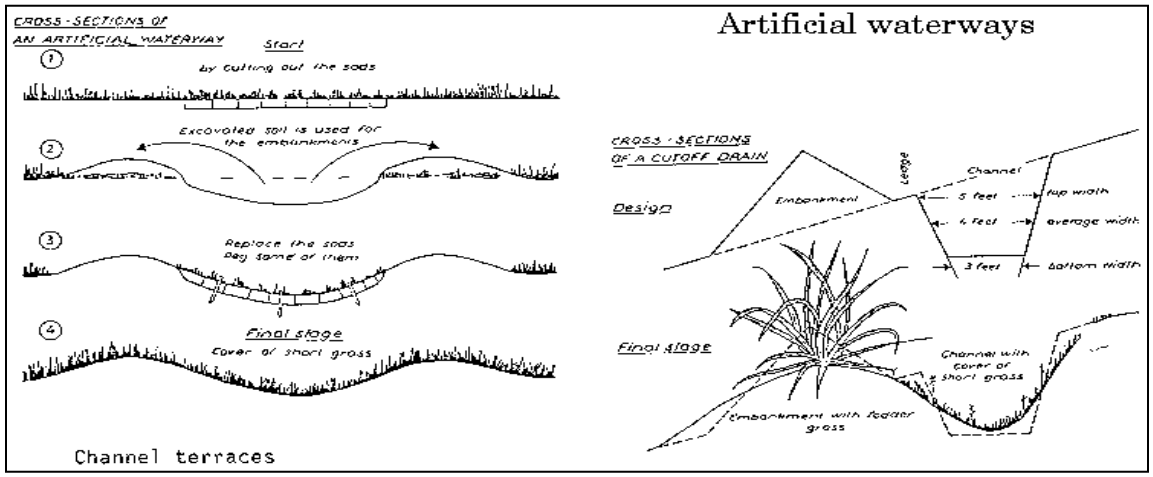


Figure 69. Cross-section of an artificial water way

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 Halaba Special 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 mitigation measures are included under the category of medium- and long-term mitigation options of the second and third part of this annexure. Suggested monitoring and follow-up activities, and adaptation measures 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.5. 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.5.1: Short-term mitigation measures.

Description of the mitigation measures	**Location of Implementation**	**Implementation Indicators**	**Responsibility**[1]
Voluntary adoption of the LMP and preparation of water conservation, efficiency and productivity plans and implementation work at cluster level	Watershed development clusters in all kebeles	Number of sub kebele level/cluster level conservation plans	Halaba Special Woreda Administration[2] (HWA) With Kebele Adminstration (KA)
Experience sharing visit to places that have best practices on SWC like existing Halaba special Woreda NRM sites, Hawassa Zuria Woreda NRM sites	All watershed management clusters in the seven kebeles	Number of sub kebele watershed management cluster organizers that have participated	HWA-KA
Assess and plan joint SWC interventions focusing on solving very urgent problems of flooding	Sinbita, Weteta, Bendo Cheloksa and low laying areas in all kebeles	Hectares of conservation land adopted/selected from the LMP for flood protection	HWA-KA
Establishes new area closure sites mainly in all Kebeles on hilly, sloppy areas as described on the LMP	Kulufo and all highly degraded areas in all Kebeles described in the LMP	Hectares of land established from each sub kebele level watershed clusters	HWA- KA
Planning for distribution of energy saving stoves like 'gonze', 'mirt', 'obama' to the communities in the kebele for affordable cost.	All kebeles	Energy saving stoves access plan document	HWA-KA
Develop "Sinbita, Kulufo, and Bendo Cheloksa" Forset rehabilitation and management plan that includes demarcation of buffer zone area.	Northern part Sinbita ,Southern and Northern tip of Bendo Cheloksa and Northern part of Kulufo kebeles	Forest Rehabilitation plan document prepared	HWA-Sinbita,Kulufo and Bendo Cheloksa Kebele Administration

[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 Halaba Special Woreda Natural Resources and Agriculture Development Office.*

Awareness creation/raising programs to the community about the importance of NRM	All kebeles	Number of campaigns conducted and number of people that have participated	KA-Halaba Special Woreda (HW) NRD and EPO
Implementing farm land rehabilitation and terracing activities	All farm lands critically affected by erosion as indicated in the development plan of each kebele	Hectares of land rehabilitated with soil conservation activities	KA-HW - NRDEPO[3]
Implementation of biological soil and water conservation practices on degraded lands	All kebeles	Hectares of land rehabilitated with soil conservation activities	HWA-NRDEPO
Minimize the current use of crop residues for cattle feeding and burning, encourage on farm mulching	All kebeles	Number of farmers participated on on-farm crop management practices	HWA - NRDEPO
Close highly degraded areas from human and animal contact	All kebeles	Hectare of area closed lands	HWA - NRDEPO
Extension services for soil fertility management	All kebeles	Number of farmers participated on soil fertility management practices	HWA - NRDEPO
Extension services for minimum tillage/zero tillage and reduced tillage activities	All kebeles	Number of farmers participated on minimum tillage practices	HWA - Fish and Animal Resources office(HW-FARO)and HWA - NRDEPO
Extension services for irrigation agronomy and pump operation and maintenance	Sinbita and Bendo Cheloksa Kebele	Number of farmers participated on irrigation agronomy extension services	HWA - NRDEPO
Restrict free grazing of cattle on agricultural lands	All kebeles	Number of farmers participated on none free grazing forage management practices	HW-FARO
Create appropriate market for the irrigators to get decent income from their products	Sinbita and Bendo Cheloksa	Revenue increased due to intervention	Halaba Special Woreda Agricultural Office (HW-AO)
Extension service for ccentralizing individual activities of irrigators and develop appropriate cropping patterns	Sinbita and Bendo Cheloksa	New licensing protocol developed Number of licences given	KA - NRDEPO

[3] Natural Resources Development and Environmental Protection Office

Community education programs to create/raise awareness of water resource management	Flood plain irrigation farms around Sinbita and Bendo Cheloksa	Number of irrigation water users association created	HWA - NRDEPO
Plan and implement efficient irrigation systems		efficient water use and irrigation plan	HWA - NRDEPO
Extension services to improve irrigation, water management and agriculture practices		Number of training sessions given for irrigation water users	HWA - NRDEPO
Introduce appropriate water use practices and control the use of chemicals in irrigation fields		Number of agricultural input management training sessions given for irrigation water users	HWA - NRDEPO
Appropriate land use planning for irrigation		Number of irrigated land use plan for Sinbita and Bendo Cheloksa Kebeles	HWA - NRDEPO

V.6. Medium-term interventions

Table V.6.1:Medium-term mitigation measures

Description of the mitigation measure	Implementation Place	Implementation indicators	Responsibility
Rehabilitate vegetation cover of the kebele through appropriate soil and water conservation interventions such as gully treatment, area closure, terracing.	All kebeles	Number of rehabilitated sub watersheds	HWA-KA
Implement joint SWC interventions focusing on solving very urgent problems of flooding	Sinbita, Weteta, and Bendo Cheloksa Kebeles	Hectares of rehabilitated land	HWA
Credit/loan facilities for engagement in environmentally friendly agricultural practices like agro-forestry, rehabilitation of degraded lands through bee keeping and animal fattening	All kebeles	Number of farmers participating in such practices	HWA
Distribution of energy saving stoves like 'gonze', 'mirt', 'obama' for the communities in the kebele for affordable price	All kebeles	Number of fuel saving stoves distributed	HWA
Promotion of suitable energy recovery from biomass production like biogas	All kebeles	Number of biogas device established	HWA
Integrated plot level soil and crop management practices	All kebeles	Number of farmers engaged in such practices	HWA
Use of indigenous vegetation to rehabilitate gullies	All Kebeles	Hectare of land covered with *indigenous vegetation/* grass	HWA
Conduct sustainable soil conservation in the upstream area, Control erosion from agricultural landscapes	All kebeles	Hectare of land covered with conservation activities	HWA
Control the flow of floods in flood affected plot of lands focusing on Sinbita,Weteta and Bendo Cheloksa Kebeles	All kebeles	Length of fords/waterways used to control the flow	Halaba Special Woreda NRDEPO

Use of vegetation interventions to trap sediments from erosion	All kebeles	Hectare of land covered with *sediment trap vegetations*	HWA
Curbing potential organic matter losses from agricultural fields	All kebeles	Hectar of land using crop residue management practices	HWA
Due implementation of degraded lands demarcation and subsequent planting of suitable herbaceous and woody vegetation inside non rehabilitated area closure lands	All kebeles	Hectare of new forest land with new plantations	HWA
Use of forest vegetation to trap sediments and nutrients in storm water	All kebeles	Length of waterways and cut-off drains rehabilitated with forest/grass vegetation	Halaba Special Woreda NRDEPO
Financial support to urge vulnerable households switch from wood collection and selling business to environmentally friendly activities like bee keeping and animal fattening	All kebeles	Amount of loan distributed (Number of poors supported)	HWA
Training on value addition of their farm produces for improving household incomes	All kebeles	Number of training provided/number of trainees qualified on value addition	Halaba Special Woreda Agricultural office

V.7. Long term interventions

Table V.7.1: Long-term mitigation measures

Description of the mitigation measure	Place	Implementation indicators	Responsibility
Establish strong natural resources monitoring mechanism	All kebeles	Established Quality Monitoring Program	HW- EPA
Monitor the area closure activities and sustain its implementations through selling of harvested resources from area closed lands	All kebeles	Hectares of sustainable area closure sites	HW- NRDEP office
Strong monitoring and follow up of the application of organic matter in agricultural fields, traditional tillage practices and free grazing of animals	All agricultural fields around in each kebeles	Established Monitoring Program	HW- EPA
Establish strong extension services that promote zero/minimum or reduced tillage	All kebeles	Number of farmers participated in zero/minimum or reduced tillage practices	HW NRDEP office, HW Agricultural Bureau

V.8. 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 Halaba Special 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.8.1: 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	Responsibility
	Time	Location		
Establishment of early warning system	S	All Kebeles	Established early warning system	HW-EPA
Mapping the areas likely to suffer from risks posed by climate change	S	All Kebeles	Areal maps depicting vulnerable communities to risks caused by climate change	HW-EPA
Awareness creation on climate change	S	All Kebeles	Observed behavioural changes	HW-EPA
Monitor the hazards of drought	L	All Kebeles	Established monitoring scheme	HW-EPA
Research on effective adaptation programs	M	All Kebeles	Number of Research conducted	Werabe University
Implement adaptation policies and measures	M	All Kebeles	Adopted policy measures	Halaba Special Woreda Administration
Implementation of sustainable water management measures	M	All Kebeles	Number of kebeles where sustainable water management measures implemented	Halaba Special Woreda Administration
Integrated water resource management actions	S	All Kebeles	Number of users that have adopted integrated water resources management actions	Halaba Special Woreda Administration
Raising resources and seeking technologies for the implementation of adaptation measures	M	All Kebeles	Finances/materials secured for adaptation	Halaba Special Woreda Administration
Create linkages with practitioners engaged in drought monitoring, forecasting and management operations	S	All Kebeles	Number of linkages created	Halaba Special Woreda Administration

V.9. Possible Ecosystem Objectives and Components of Interventions

V.9.1. Reduction of the current soil erosion and sedimentation rate

Period	Annual soil erosion	Comments
2016	0.75-1.58 cm increasing at a rate of 2 mm/year	Current observation
2019	0.5 -1.1mm	Reduction by 1/3
2024	0.25 - 0.5 cm	Reduction 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.

V.9.2. Reduction of the impact of flooding on agricultural lands

Period	Flooding impact	Comment
2016	Base year	Half of the kebele is flooded for three months annually
2019	Reduction by 33%	Mainly with the use of artificial water ways
2024	Reduction by 75%	Mainly 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 *indigenous vegetation/* 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.10. Implementation Strategies

V.10.1. Introduction

In section V.9., 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.10.2. 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	Less than 30 %	Soil conservation and water Harvesting	Sub article 4
2	31 % to 60 %	Annual crops through making bench terraces.	Sub article 5
3	Bigger than 60%	Shall not be used for farming and free grazing; they shall be used for development of trees, perennial plants and forage production	Sub article 6
4	land where soil and water conservation works have been undertaken	System of free grazing shall be prohibited cut and carry feeding shall be introduced	Sub 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.10.3. Implementation Strategies

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

I. 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).

Box 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.

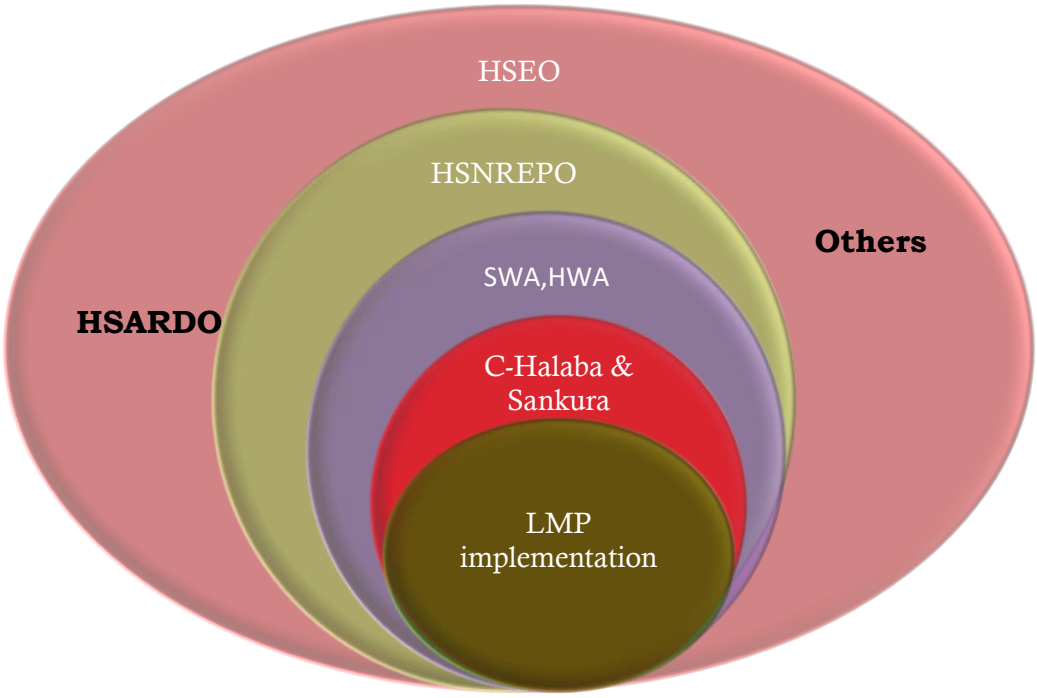


Fig. 8.1: Collaborating institutions and communities

(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)

II. 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.

III. 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

IV. 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. 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. Halaba Special 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 70. 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 71. 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 72. 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 73. 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.

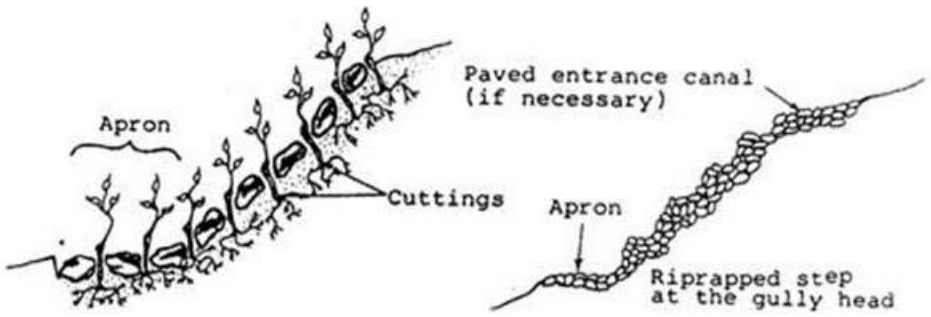


Figure 74. Stabilization of a gully head by riprap (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975)

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.

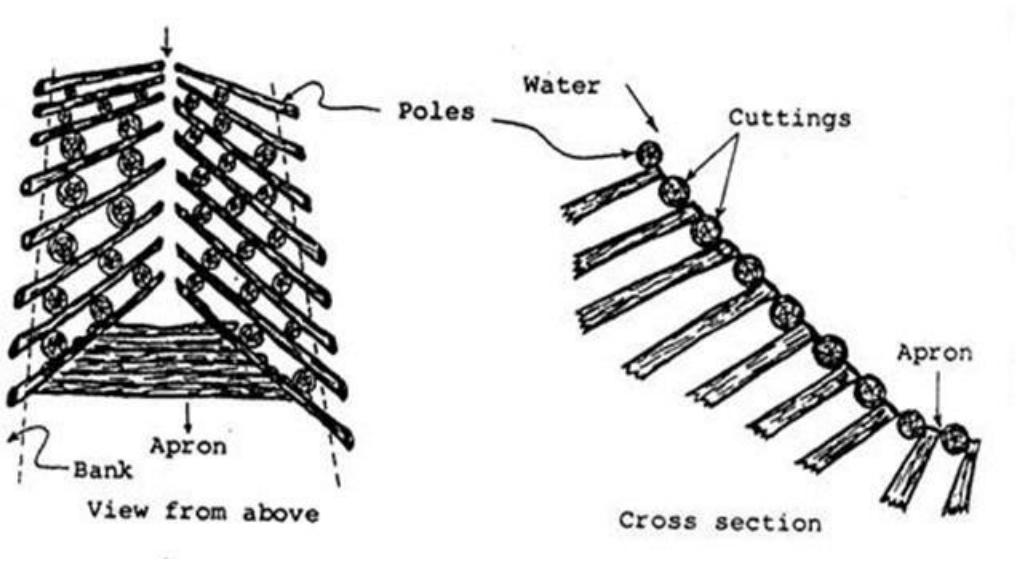


Figure 75.Gully head stabilisation by a pole structure (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975)

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.

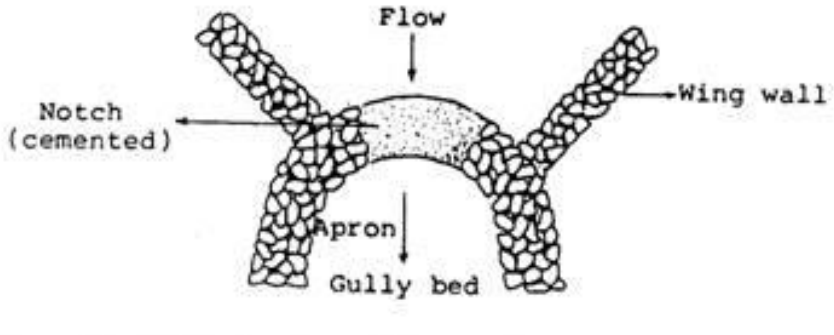


Figure 76.Gully head stabilisation by a solid structure with wing walls (view from above) (Source: Manual of Reforestation and Erosion Control, Agpaoa et al.,1975) .

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 77. 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).

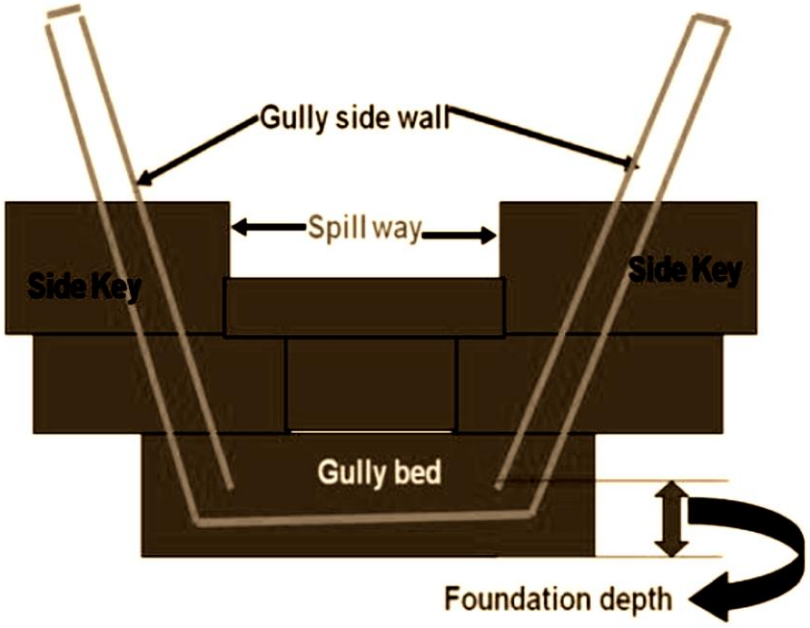


Figure 78. Schematics of gabion and Stone checkdams

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.

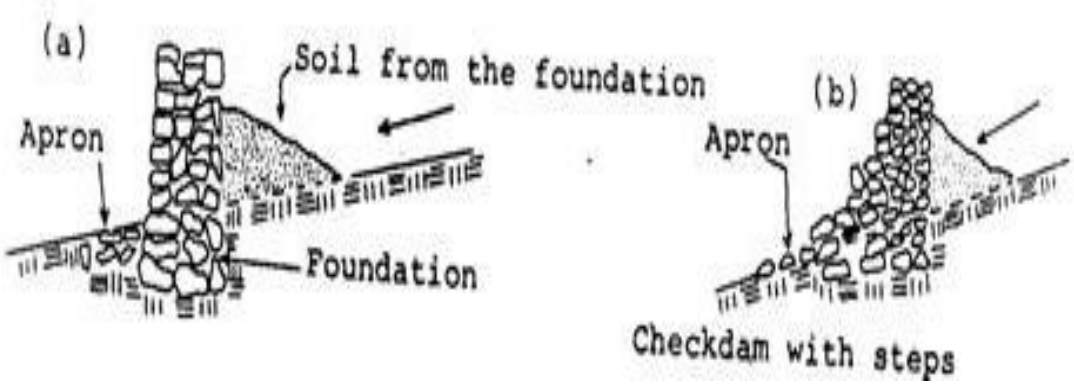


Figure 79. Dry stone checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

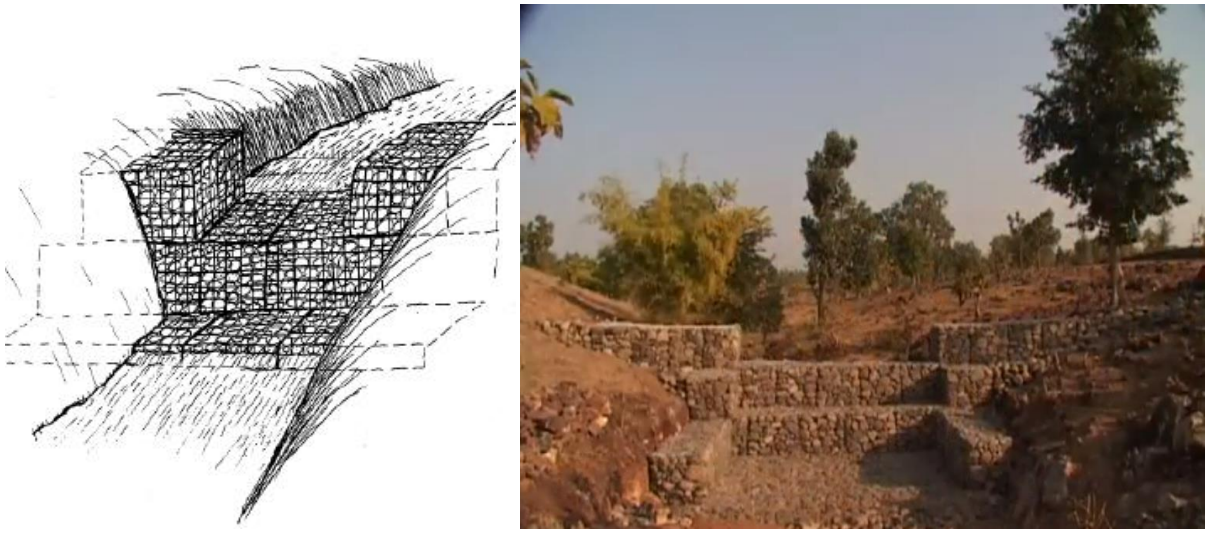


Figure 80. Gabion box checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

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 81.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.

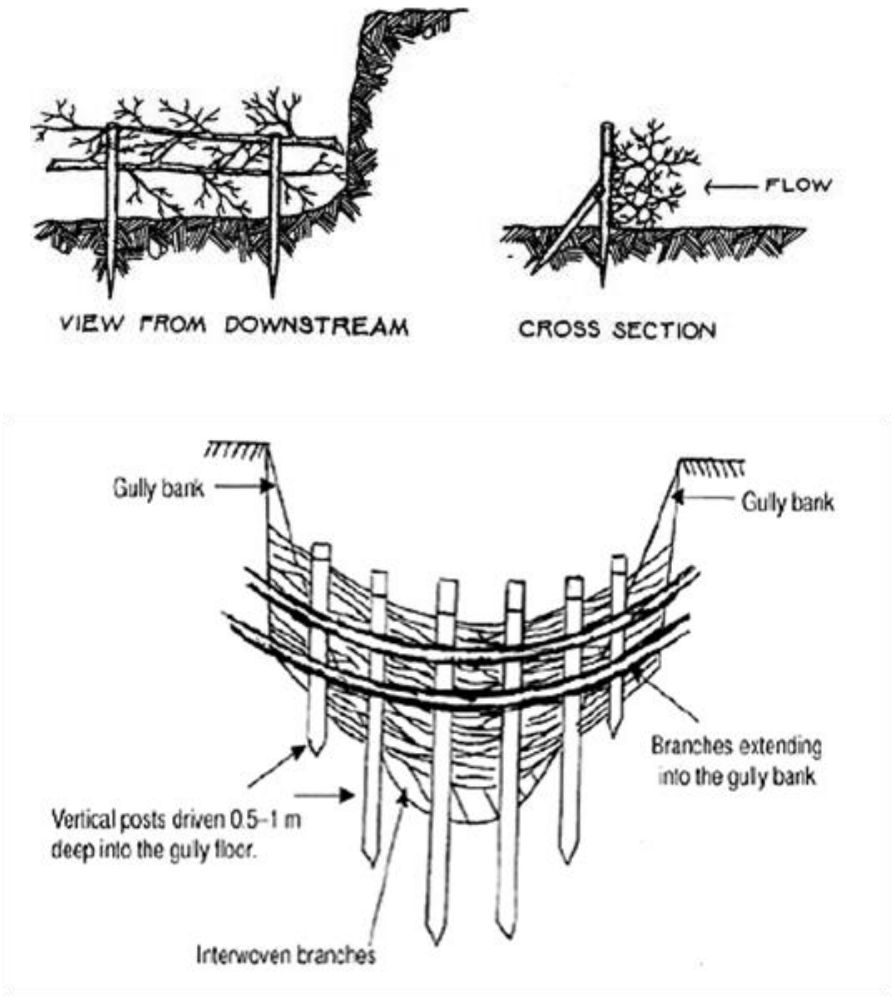


Figure 82. Brushwood checkdams (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.*, 1975)

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.

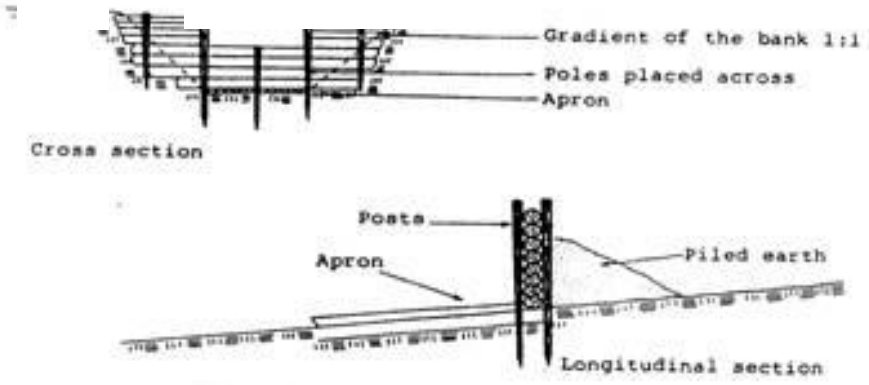


Figure 83. Pole or log checkdam (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,*1975)

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 84. 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.

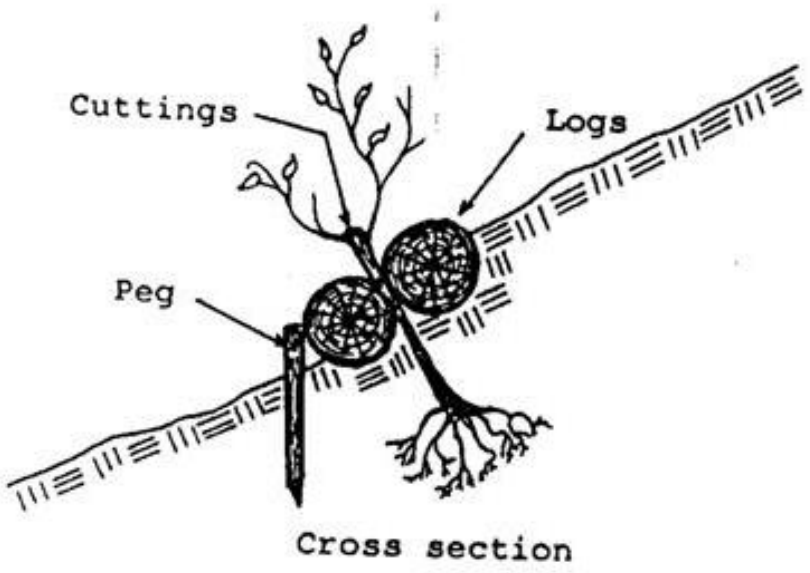


Figure 85. Ground tie with sprouting brushwood (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,* 1975)

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.

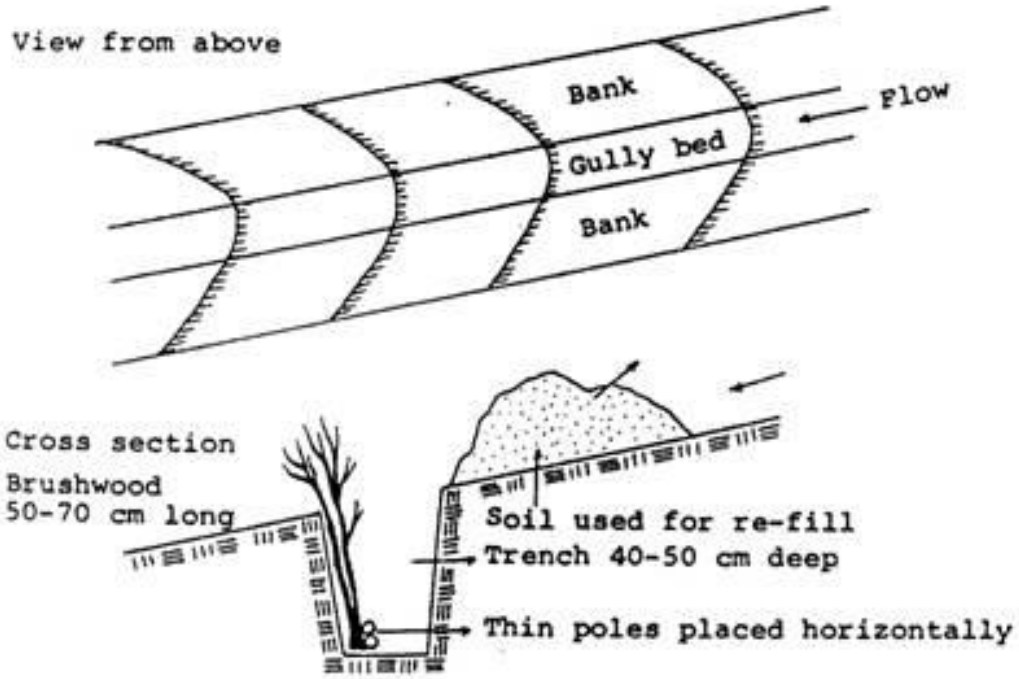


Figure 86. Construction of "brush combs" (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.*,1975)

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.

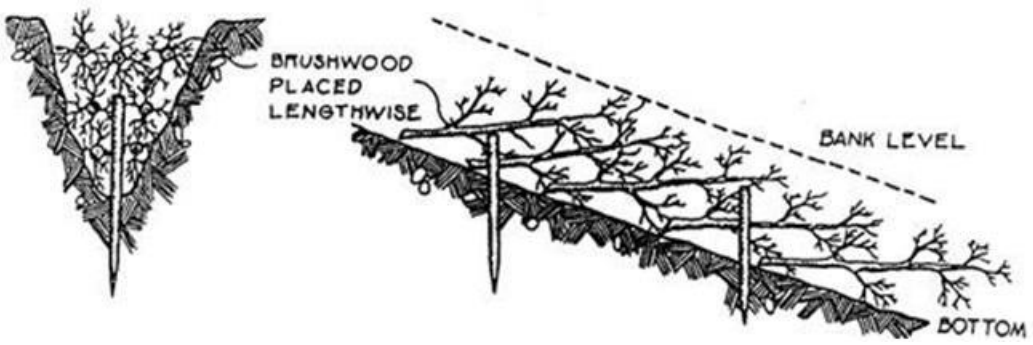


Figure 87. Plugging of small gullies (Source: Manual of Reforestation and Erosion Control, Agpaoa *et al.,*1975).

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

A publication of German Agency for Technical Cooperation (GTZ). 1975.