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EVALUATION OF PHYSICAL SOIL AND WATER CONSERVATION STRUCTURES WITH RESPECT TO STANDARD PACKAGE IN ENEBSIE SARMIDIR DISTRICT: THE CASE OF GUANSA AND SHOLA WATERSHEDS, ETHIOPIA.

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ABSTRACT

Physical soil and water conservation structures are supplementary to biological soil water conservation in sustainable land management practices. This study examines qualities of physical soil and water conservation (SWC) measures for sustaining of use land in Enebsie Sarmidir *District*: The Case of Guansa and Shola Watersheds, Ethiopia. Guansa and Shola watersheds were purposively selected and data were measured in similar slope position in the two watersheds. Results showed that the existing bund length, vertical interval and horizontal interval 79%, 21.4% and 36% were in line with the recommended package in the Guansa watershed, respectively; while in Shola watershed 17% of bund length was close to the recommendation. Therefore, proper implementation of technological packages can make abiding conservation structures.

KEYWORDS: Guansa, Shola, structure, sustainable, SWC, watershed.

INTRODUCTION

Agriculture depends on soil and water which are vital natural resources for human survival. Since the soil and water resources are finite, their optimal management without adverse environmental consequences is necessary, if human survival is to be assured and development is to be sustained.[1] However, soil erosion by water is the major constraint for sustainability of economic development due to the fact that vast areas of fertile land became unproductive.[2] This contributes to food insecurity and constitutes a serious threat to sustainability of the existence of subsistence agriculture.[3, 4]

Soil and water conservation (SWC) is a key issue for improvement and conservation of the environment and to develop its agrarian economy in Ethiopia.[5] This is true because improvement of the agricultural sector can have huge impact on addressing issues of poverty and food security.[6] Therefore, to mitigate land degradation problems and to ensure the sustainability of land resources, different SWC activities are implemented repeatedly on the same plot of land every year. However, these structures partially or completely removed and did not curb the impact of soil erosion in a meaningful and sustainable manner.

Thus, it is vital to understand the underlying cause of the poor sustenance of constructed conservation structures depends on the structural qualities with respect to standard package. Therefore, this study was carried out to evaluate quality of constructed physical SWC measures for their sustainability in Enebsie Sarmidir District: A case study of Guansa and Shola Watersheds, Ethiopia.

MATERIALS AND METHODS

Description of the case watersheds

The study was conducted in Guansa and Shola watersheds, Enebsie Sarmidir *District* of the Amhara Region, Ethiopia. The *District* town (Mertule Mariam) is found 370 km Northeast direction from Addis Ababa and 180 km southeast from Bahir Dar (the Regional Capital City). The *District* is located at 10^0 52' North latitude and 38^0 17' East longitude and at an average altitude of 2650 m.a.s.l. The *District* is bounded with South Gondar Zone in the North, Enarj Enawuga *District* in the South, Goncha Siso Enesie *District* in the West and South Wollo Zone in the East. It has 35 administrative *Kebeles* (33 rural and 2 urban *Kebeles).*

Guansa watershed is found in the North direction at 4 km from the Mertule Maraim. The mean annual minimum and maximum temperature of the watershed ranges from 22.5 to 25 ^{O}C, and mean annual rainfall ranges between 941 and 1203mm. Its altitude range varied between 2650 -3410 m.a.s.l. The area has Weyna Dega (36.23%) and Dega (63.77%) agro-climatic zone [Agriculture *District*, 2013].

Shola watershed is located in Enebsie Sarmidir *District*. It is found at 3 km Northwest of Mertule Maraim. The mean annual minimum and maximum temperatures of the watershed area ranges from 22.5 to 25 ^{O}C, with mean annual rainfall ranges between 941and 1203mm. Its altitude range varied between 2523-2950 m.a.s.l. The area has to Weyna Dega (30.23%) and Dega (69.77%) agro-climatic zone [Agriculture *District*, 2013].

Improved SWC activities were introduced in the watersheds since the beginning of 1980s to reduce soil erosion. SWC structures like check dam, bund, waterway, and cutoff drain and were commonly practiced in both watersheds. However, hillside terrace and trench were only practiced in the Guansa watershed. In both watersheds, SWC activities have been implemented by Enebsie Sarmidir Agriculture *District*. However, the implementation process in the Guansa watershed has support from World Food Programme. World Food Programme supported farmers through "Food for Work" incentives for their labor contribution in SWC activities. "Food for Work" based soil conservation programs were aimed at promoting "improved" soil conservation practices.

Sampling methods

For the purpose of evaluating qualities physical SWC activities, Guansa (better maintained) and Shola (poorly maintained) watersheds were selected purposively from Enebsie Sarmidir *District* and measured in similar slope position of each watershed. These two watersheds were selected to understand and compare the sustainability of physical SWC activities between Guansa and Shola watersheds under similar agro-ecology and socio-economic situations in two adjacent *Kebele*.

The evaluation undertaken in this study focused on the quality of technological characteristics (design and layout) of physical SWC activities in the watersheds. Along the transect line, the type of SWC structure in the area were identified. Layout and design characteristics of each structure were measured. The steepness of slope, soil depth, length of the structures, and spacing between the structures of design parameter were measured. Parameters of the structures (14 structures in Guansa watershed and 12 structures in Shola watershed) were measured. The existing physical SWC structures in the study area were compared and evaluated with the recommended packages of design and layout specification [7] indicated in Table 1. Finally, data were organized, summarized and analyzed using Microsoft excel.

Table 1. Bunds spacing expressed in vertical interval (VI) and horizontal interval (HI).

Slope in (%)	>75cm (soil depth)		50-75cm (soil depth)		25-50cm (soil depth)	
	VI (m)	HI (m)	VI (m)	HI (m)	VI (m)	HI (m)
3	1	33				
4	1	25				
5	1	20	0.7	15	0.5	10
6	1	17	0.7	12	0.6	10
7	1	14	0.8	12	0.7	10
8	1	12	0.8	10	0.7	9
9	1	11	0.9	10	0.8	9
10	1	10	0.9	9	0.8	8
11	1.1	10	1	9	0.9	8
12	1.1	9	1	8	0.9	8
13	1.2	9	1.1	8	1	8
14	1.2	8	1.1	8	1	7
15	1.2	8	1.1	7	1	7
16	1.3	8	1.1	7	1	6
17	1.3	8	1.2	7	1.1	6
18	1.3	7	1.2	7	1.1	6
19	1.3	7	1.2	6	1.1	6
20	1.4	7	1.2	6	1.1	6

Source: Soil and Water Conservation Team (2001)

RESULTS AND DISCUSSION

In Shola watershed 17% of the constructed soil bund length was in line with the recommended maximum and minimum length of soil bunds. However, in the Guansa watershed 79% of the lengths of bunds were well matched with the recommended length (Figure 1).

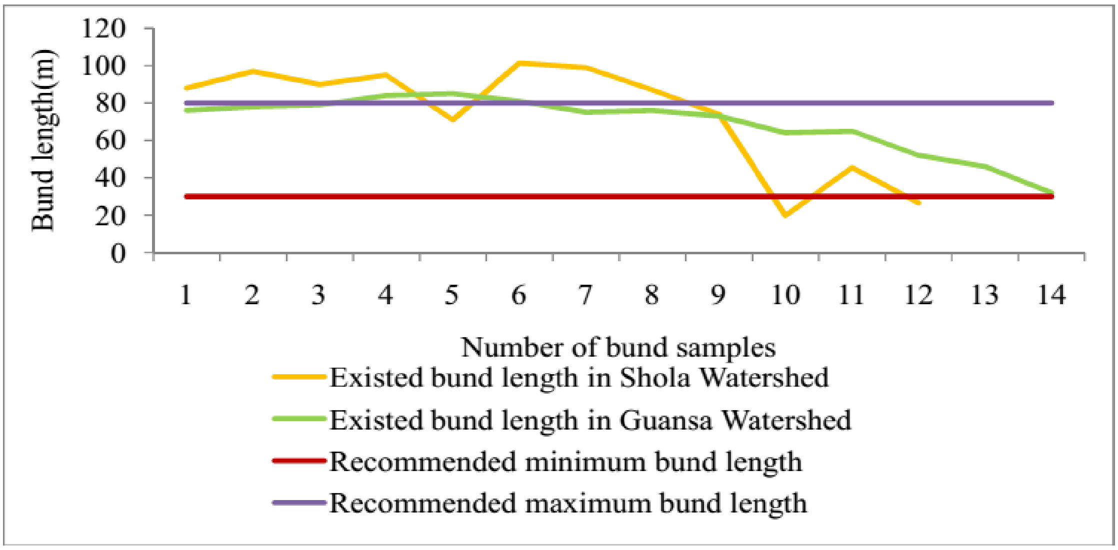

Figure 1: Existing bund length against the recommended ones

Regarding the horizontal distances between soil bunds, nearly 36% was close to the recommendation in Guansa watershed; while in Shola watershed it is far from the recommendation package (Figure 2). In terms of vertical intervals between bunds, about 21.4% was close to the recommendation in Guansa watershed; while in Shola watershed the figure is different from the recommendation package (Figure 3). The problem was mainly serious in the Shola watershed that most parameters for the existing SWC structures were not in line with the recommended ones.

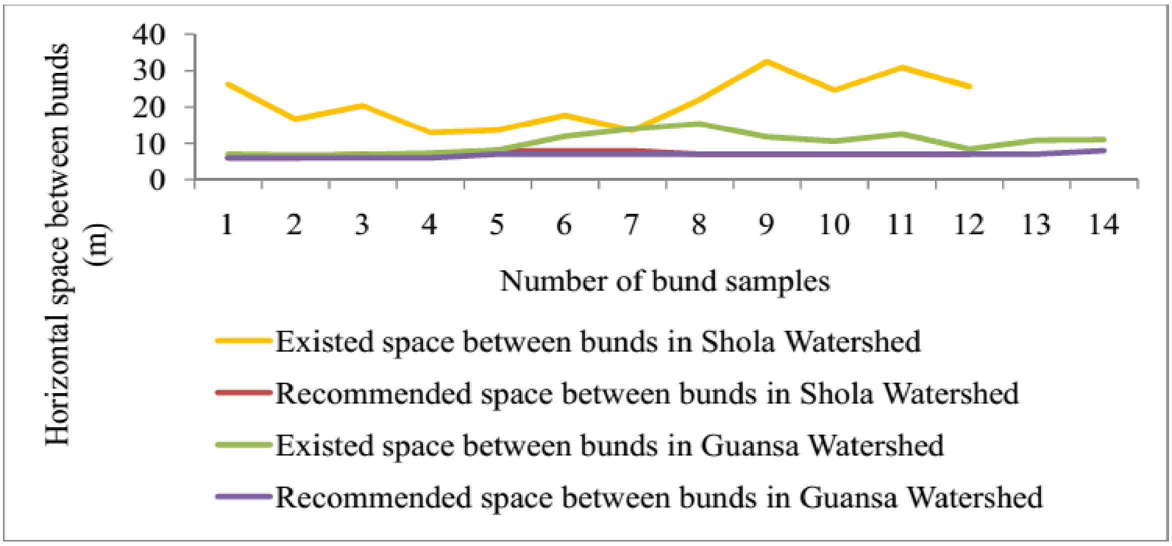

Figure 2: Existing horizontal space of bund against the recommended ones

Most of SWC structures implemented were not following proper survey based on standard to design the structures. Giving less attention to the orientation of the structures and slope of the land, improper placement of SWC treatments in spaces between the structures (Figure 4.) and wrong combination and application of design of structures (Figure 5) are the main design problems observed. Discussions with farmers showed that the main reason for the collapse of SWC structures was lack of knowledge and skill. This was not only for farmers but also for Development Agents. Most SWC structures were dismantled in the Shola watershed due to concentrated runoff overtopping the structures and improper tillage. This is in line with a study conducted by [8, 9] in the Koga watershed, Highlands of Ethiopia, where most farmers concluded that SWC technologies were poorly designed which was a major cause of gully erosion.[10] Also found that the absence or incorrect construction of supporting structures increased the volume of surface runoff on cropland in such a way that structures cannot cope, and thus shortens their life and makes erosion reduction difficult. Another study in Southern Ethiopia [11] indicated that not following proper survey and standard design, little or no consideration of socio-economic profile of the area, less attention to the orientation and slope of the land, improper placement of SWC treatments, wrong combination and application of design were found as the major implementation problems. Therefore, implementation of SWC measures based on the recommended packages can prolong the existence of the SWC structures. This results in increasing the sustainable land management by reducing soil loss from the farmland.

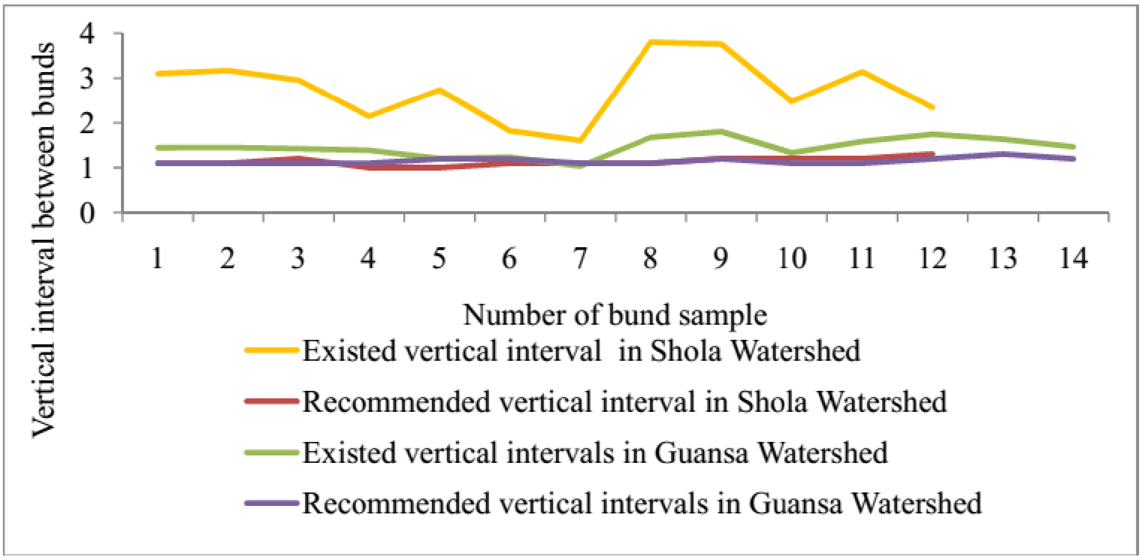

Figure 3: Existing vertical interval of bund against the recommended ones.

Figure 4: Improper bund channel design

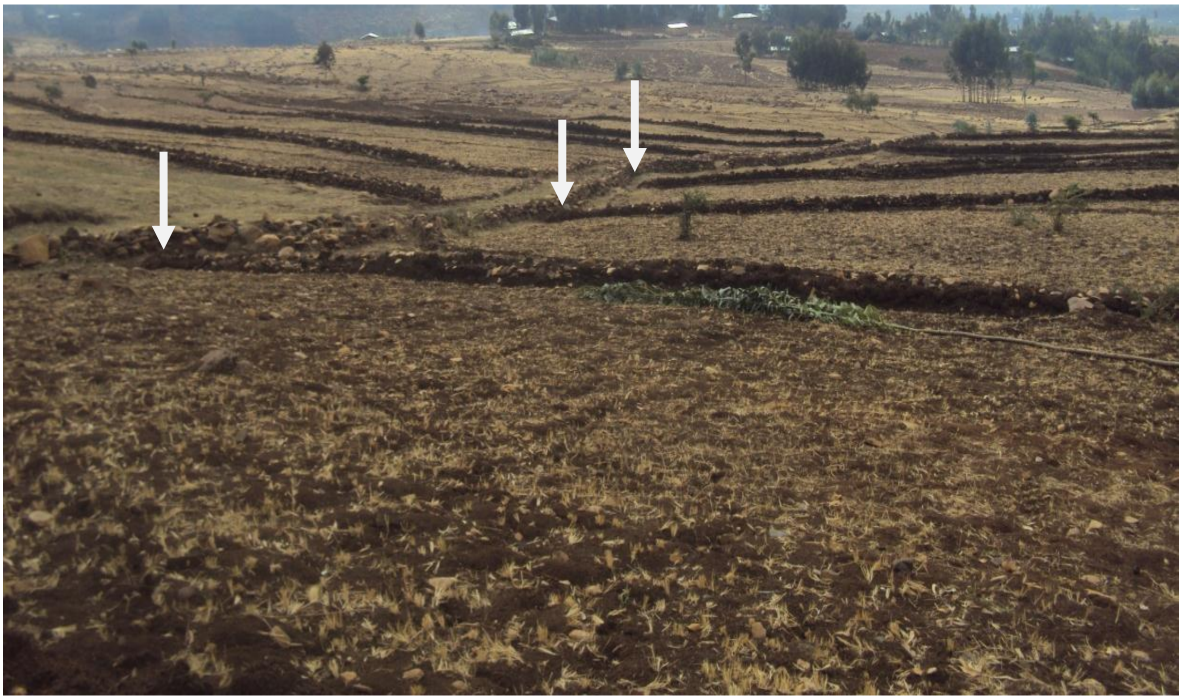

Figure 5: Bund outlet not connect with waterway

CONCLUSION

Most of SWC structures were not implemented following standard SWC structure designs. The design of bund length and spacing between the bunds (the horizontal distance and the vertical interval) were not in line with the recommended standards of SWC techniques in the Shola watershed than Guansa watershed. Properly designed and constructed SWC measures are not only prolonged the existence of SWC structures but also necessary to the successful of sustainable land management. Hence, the research encourages that structural SWC practices should be layout and designed based on the recommended standards of SWC package for the sustainability of land management. SWC specialists should be assigned in each *Kebele* to design SWC structures and to provide better training for farmers.

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