Review on Dynamics of Soil Erosion and Conservation Efforts in Ethiopia

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Author’s contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

This paper was aimed to review the spatial and temporal dynamics of soil erosion and conservation efforts being practiced in Ethiopia. In the country, there is highly fluctuating dynamics of soil erosion and its loss rate is large as per the stated international standards. Even if the efforts to conserve soil and water in the country are affected by different factors like agro ecology and the choice of conservation measures, it was practiced since 1970s. Apart from the government’s effort as well as the contribution of different non-governmental organizations in increasing the awareness and understanding towards the impacts of soil erosion, the land tenure system, the existence of poor technology, lack of finance, limited technical support and limited participation of the local community are some of the challenges in Ethiopia restricting the effectiveness of conservation efforts. In addition, the research activities done regarding soil and water conservation in the country are not following integrated and participatory approach. Thus, this makes the efforts regarding research and finding out the best approach for sustainable soil and water conservation practices inefficient. Therefore, promoting integrated and participatory approach as well as linking with income generating business like carbon trading through climate change mitigation is the best options for the expansion and sustainability of soil and water conservation measures in Ethiopia.

Keywords: Soil erosion; conservation efforts; Ethiopia.

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1. INTRODUCTION

Due to its adverse economic and ecological impacts, soil erosion is becoming the most critical environmental problems in developing countries like Ethiopia. It occurs due to several factors and these factors are worldwide and vary in their intensity and magnitude. In most cases they are natural in their origin, but the human interference triggers the erosive power of these factors. Land use/cover change and human activities aiming at different objectives are the primary cause of accelerated soil erosion [1].

The uncoordinated and uneven distribution in terms of space in researches conducted on the problem of soil erosion indicates the necessity of conducting a research in order to overcome the uncertainties related with estimating the total rate of soil loss from the country [2].

Different studies in Ethiopia reported that various soil and water conservation measures at various spatial scales have a positive impact on erosion control, soil moisture conservation, vegetation regeneration, soil build up, reduction of sediment and economic aspects [3-9]. Uncoordinated and fragmented researches have been done in Ethiopia regarding the dynamics, cause and impacts of soil Erosion. Additionally, very little studies are existing regarding the evaluations of the previous activities in soil and water conservation in Ethiopia.

According to [10] soil and water conservation practices have been applied for centuries, most likely first implemented during the Aksumite period in the Aksum area, Tigray Region, northern Ethiopia. Similarly, [11] reported that the traditional terraces in Konso area are best examples of a living cultural tradition stretching back 21 generations (more than 400 years). Indigenous soil and water conservation measures in Ethiopia are not considered by the experts of the discipline and policymakers [12,13].

2. SOIL EROSION RATES IN ETHIOPIA

According to the reports of different studies regarding the soil loss rates in different parts of Ethiopia, the soil loss rates caused by sheet and rill erosion shows greater spatial variation, with a mean soil loss 29.9 t ha\(^{-1}\) yr\(^{-1}\) where the highest rates were observed in Anjeni (110 t ha\(^{-1}\) yr\(^{-1}\)) and Chemoga (102 t ha\(^{-1}\) yr\(^{-1}\)) watersheds. [14,15] reported that in the northern highland areas and Central Rift valley of the country, slightly higher soil loss rates were recorded (38.7 t ha\(^{-1}\) yr\(^{-1}\) from rangelands and 7.2 t ha\(^{-1}\) yr\(^{-1}\) from croplands) due to the occurrence of extreme precipitation occurrences. Similarly, [16] estimated that 80% of the total annual soil loss in Ethiopia originates from croplands. [17] estimated annual gross soil loss of 1.5 x10\(^{6}\) t in Ethiopia. Similarly, [18] reported that the dynamics of soil loss shows spatial variation which is 0 t ha\(^{-1}\) yr\(^{-1}\) in the eastern and southeastern parts to more than 100 t ha\(^{-1}\) yr\(^{-1}\) in the northwestern highlands of Ethiopia.

A study conducted in the northwestern part of Ethiopia reported that there is high gully erosion rate of 530 t ha\(^{-1}\) yr\(^{-1}\), which is approximately 20 times larger than the sheet and rill erosion rates at the same study area [2,19]. A relatively similar gully erosion rate of 566 t ha\(^{-1}\) yr\(^{-1}\) was reported by [20] for the Damota watershed in eastern part of Ethiopia. But, lower gully erosion rate was reported in the northern part of Ethiopia by [21] which is 6.2 t ha\(^{-1}\) yr\(^{-1}\). Generally, most of the gully erosion studies conducted in the country are based on the interpretation of relatively low-resolution aerial photographs or in combination with satellite images and repeated photographs supplemented by data obtained from questionnaires [2]. Thus, as per the studies conducted by different researchers in different parts of the country, it is clearly shown that the inconsistency in estimation of soil loss at the country level.

3. SOIL AND WATER CONSERVATION EFFORTS IN ETHIOPIA

Different efforts have been done to conserve soil and water in Ethiopia, mainly starting from the 1980s. Bunds constructed with soil combined with trenches mainly in agricultural lands, which are constructed by the local community mobilization; such soil bunds integrated with fodder trees mainly Sesbania were implemented starting from the stated date [22]. Food for work, Managing environmental resources to enable transition to more sustainable livelihoods, the national sustainable land management project, productive safety net programs and community mobilization through free labor days are the initiatives in Ethiopia concerning soil and water conservation.

Soil and water conservation efforts to manage the degraded lands in Tigray has shown advantages in terms of soil structure, infiltration
capacity, crop yield, biomass production, groundwater recharge, and prevention of flood hazard [23]. Studies on land use and land cover change over the past few decades document a trend towards the increased removal of remnant vegetation, but the trend has slowed and even reversed in some areas of northern Ethiopia because of the government’s set-aside policy [24]. In other studies, [5] found a significant increase in woody vegetation and soil and water conservation structures in areas with higher population densities, especially during the last two decades. Some researchers stated that Soil and water conservation efforts do not lead to the desired effects, or are even counterproductive [25,26].

The effectiveness of soil and water conservation measures is, however, influenced by the moisture regime and by the age of the structures. [27] reported that soil bunds, stone bunds, and grass strips are more effective under low rainfall regimes, whereas grass waterways are more suited to use under high rainfall regimes. [28] indicated that soil and water conservation efforts in the Ethiopian highlands will work to a more limited extent in humid areas compared with the semi-arid areas. [9] studied the evolution of the effectiveness of stone bunds and trenches for the reduction of runoff and soil loss in the semi-arid Ethiopian highlands and concluded that these measures are only fully effective in the first year of their construction.

Herweg and Ludi [29] have undertaken a study to assess the effectiveness of different soil and water conservation practices such as soil and stone bunds, double ditches, terraces particularly fanyaju and grass strips in different areas with varying agro ecologies and indicated that the measures did not bring a net increase in crop yield and biomass production. Similarly, [30] stated that fanyaju terraces cannot be characterized as a win measure to reduce soil erosion because of the lower net value of crop income for plots with fanyaju terraces as compared with those without them. By contrast, another case study from the Anjeni site by [7] reported that soil and water conservation measures have long term advantageous to smallholder farmers.

A study by [31] in Northern Ethiopia, Tigray regarding the impacts of stone bunds on crop yields and farm profitability revealed that practicing stone bunds yielded a 50% rate of return. But, in the other study conducted the same area of the region stated that the cost of building stone bunds is nearly the same as the value of the induced crop yield increase, despite an average increase in grain yield of 53% [24].

4. FACTORS AFFECTING ADOPTION OF SOIL AND WATER CONSERVATION PRACTICES IN ETHIOPIA

The major factors affecting adoption of soil and water conservation measures in Ethiopia include availability of little capital, lack of or limited incentives and benefits, land tenure policy, availability of technology and lack or poor technical support from the experts. Since the implementation of soil and water conservation measures is labor intensive, availability of labor becomes the major challenge as reported in different studies [32,3,33,34]. Even if the economic condition of the farmers is not a such secures paying for soil and water conservation measures [8,35,36,34,2], they have willingness to contribute a substantial amount of free labor as a gesture of their support for conservation programs [35]. Another factor which makes farmers senseless to adopt and implement soil and water conservation practices in their farmlands is the land tenure insecurity arising from the government’s ownership of land [3,33].

Several studies undertaken in Ethiopia, noted the application of inappropriate technology relative to local conditions as a reason for the low adoption rate or the un sustained use of soil and water conservation measures [8,37,38,3,39]. Additionally, lack of technologies that provide quick response to subsistence constrained farmers also seems to deter investments in land resources [36]. In order to improve the sustainability of soil and water conservation measures as well as their efficient utilization, biophysical as well as financial or economic interventions shall to be considered [34,36,38].

Poor technical support from local experts working closely with the community and other development officers is another factor that negatively affecting farmers’ cooperation in soil and water conservation practices [32,34,40] argued that extension services for natural resources management have been marginalized. Moreover, the attention given to indigenous soil and water conservation practices is no as such conducive, which is usually underestimated and deemphasized in the design of land management practices in the country [12].
5. CONCLUSION

Soil erosion is a dynamic and a serious problem in Ethiopia, showing and increasing and varying trend both temporally and spatially. Most of the conservation efforts in the country in different areas are for the sake of drought protection in the regions experiencing climate change in the form of drought. Moreover, the extent and areal coverage of available soil and water conservation measures remain unknown. In addition, the research activities done regarding soil and water conservation in the country are not following integrated and participatory approach. Thus, this makes the efforts regarding research and finding out the best approach for sustainable soil and water conservation practices inefficient. Promoting integrated and participatory approach as well as linking with income generating business like carbon trading through climate change mitigation is the best options for the expansion and sustainability of soil and water conservation measures in Ethiopia.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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