

# Review on the Role of Integrated Watershed Management for Rehabilitation Degraded Land in Ethiopia

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## Abstract

The objective of this paper is to review the Role of Integrated Watershed Management for Rehabilitation Degraded Land in Ethiopia, Integrated Watershed Management (IWM) has been identified as a key for planning and management of natural resources in mountain ecosystems. It provides an ecologically sound economic base for the watersheds and its people. The livelihood of Ethiopia people living in the watershed cultivated watersheds is being threatened. Policies and strategies must urgently be developed to reverse present trends of land degradation. A recent impact assessment also showed the PSNP public works in Tigray region: reduced sediment in streams by 40-53% in areas closed to grazing and cultivation; increased woody biomass and forage production three to four-fold; increased water availability and quality; increased ground water recharge and improved downstream base flow of streams; lessened damage from seasonal floods; enhanced down-stream crop production through soil and water conservation interventions; increased stored carbon; increased biodiversity, and increased social cohesion by improving livelihoods. The main challenge facing watershed management is lack of sufficient capacity at all levels of government structures (federal, regional, district and Kebele) to implement the new and sustainable approaches, while the intervention needs of the watersheds. Agronomic measures include mulching and crop management, which use the effect of surface covers to reduce erosion by water and wind (Morgan, 2005). Some possible agronomic measures are strip cropping, mixed cropping, intercropping, fallowing, mulching, contour plugging, grazing management and agro-forestry. Agronomic conservation measures help in reducing the impact of rain drops through interception and thus increasing infiltration rates and thereby reducing surface runoff.

**Keywords:** land degradation, integrated watershed management, soil and water conservation

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## 1. INTRODUCTION

Agriculture is the main sector of the Ethiopian economy and contributes approximately 42% to the gross domestic product (GDP) and employs over 80% of the population (MoFED 2010; Diao 2010; ATA 2013). Despite its role, agricultural production is constrained by high climate variability where rainfall distribution is extremely uneven both spatially and temporally, and this has negative implications for the livelihoods of people (Georgis *et al.*, 2010). Drought frequently results in crop failure, while high rainfall intensities result in low infiltration and high runoff causing enhanced soil erosion and land degradation. Land degradation in the form of soil erosion and declining land fertility is a serious challenge to agricultural productivity and economic growth (Lemenih 2004).

Integrated Watershed Management (IWM) has been identified as a key for planning and management of natural resources in mountain ecosystems. It provides an ecologically sound economic base for the watersheds and its people. In any developmental activity, the watershed approach is more scientific because the inherent potential of soil, water and forest resources in a particular area is controlled by various factors such as physiography, geological base, soil characteristic, climate, present land use, socio-economic aspects etc. (Rawat 2007) A watershed may be defined as an area which contribute rainwater falling on it and allows the water to flow in one or more water courses with a single out let at the end. The Watershed approach is increasingly being employed in various resource management and development programs like soil and water conservation, environmental management, water resources management and development, forest, man and livestock resources management and development etc. (Sharma *et al.*, 2008).

The livelihood of Ethiopia people living in the watershed cultivated watersheds is being threatened. Policies and strategies must urgently be developed to reverse present trends of land degradation. To do so will require scientific planning and implementation that must be based on technical knowledge of watershed management practices and their effects on sustainability of the resources (Rawat, 2000). Integrated watershed management may become an alternative to reverse land degradation. According to the proceedings of the National Seminar on Watershed Management, Govt. of Ethiopia (2000) "Integrated watershed management is an integration of technologies within the material boundaries of drainage area for optimum use and development of land, water and forest resources to meet the basic minimum needs of the people in a sustained manner. Projectisation of the scattered programs of soil conservation, afforestation, water resources development and management, minor irrigation, animal husbandry and other rural development activities into well prepared micro watershed projects based on a study of climate, land, water and forest resources on the one hand and man and animal resources on the other offers hope for bringing about sustained natural resources development based on principles of ecology,

environment, economics, employment generation and energy conservation". As an integral part of sustainable development, resource management programs are taken up on watershed basis for successful implementation of agriculture, forest and other eco-restoration programs (Rawat & Haigh, 2008). Watershed management aims at optimizing the use of land, water, vegetation, man, animal and environment to prevent, soil erosion, moderate floods, improve water availability, increase food, fuel, fodder, fiber and timber production on a sustained basis (Bhardwaj and Dhyani, 2004). integrated watershed management approach (German *et al.*, 2007) to promote sustainable water and land resources management based on partnerships with the community. The participatory integrated watershed management approach emphasizes improving the productivity of water and land resources in an ecologically and institutionally sustainable way (Farrington *et al.*, 2009). Hence, Watershed management has become a central point of the rural development and poverty alleviation agenda. In general, integrated watershed management creates opportunities for reclaiming degraded land, improving soil fertility, water resources development, increasing agricultural production, off-farm activities, diversifying income sources and providing access to markets, where the benefits are realized at household and community level.(Tadese 2001).Therefore, the objective of this paper is prepared to review the role of integrated watershed management for rehabilitation of degraded land mainly through SWC practices in Ethiopia.

## 2. LITERATURE REVIEW

### 2.1 History of Watershed Management

The origins of modern watershed management can be traced back to the 19<sup>th</sup> century. However, the approach first achieves prominence in developing countries in the 1970s in programs designed to protect downstream resources and infrastructure through improvements in upland natural resources management (Darghouth *et al.*, 2008). The concepts of watershed management has internationally gained significance following the United Nations conference on environmental and development in 1992 in Rio de Janeiro (also known as the earth summit) (Forch and schutt, 2004). In Ethiopia, planning the development of watersheds has started in the 1980's (Lakew *et al.*, 2005; Gete 2006; Tongul and Hobson, 2013). It was concentrated on selected large watershed located mainly in the highly degraded parts of the highlands of Ethiopia (Gete, 2006). The purpose was mostly for implementing natural resources conservation and development programs (Lakew *et al.*, 2005).

The major part of the initiative was supported by the world food programmer (WFP) through its food for work land rehabilitation project (Gete, 2006). The food for work rehabilitation project is designed to provide employment for chronically food insecure people who have "able bodied" labor (Tangul and Hobson, 2013). However, the unmanageable watersheds (too large to monitor and manage) with the top down planning methodology was less effective than had been hoped (Gete, 2006; Tongul and Hobson,2013) Similarly, Lakew *et al.*, (2005) stated that watershed development has been problematic when applied in a rigid and conventional manner this is true when applied without community participation and using only hydrological planning units, where a range of interventions remained limited and post rehabilitation management aspects were neglected. The Ethiopian government has for a long time recognized the serious implication of continuing soil erosion to mitigate environmental degradation and as a result large national programs were implemented in the 1970s and 1980s. However, the efforts of these initiatives were seen to be inadequate in managing the rapid rate of demographic growth within the country, widespread and increasing land degradation, and high risks of low rainfall and drought. Since 1980, the government has supported rural land degradation, these aimed to implement natural resources conservation and development programs in Ethiopia through watershed development (MoARD, 2005). Watershed projects in Ethiopia were very few in number. The institutional strengthening project was implemented by FAO, and was principally aimed at capacity building of ministry of natural resource's technicians and experts and development agents in the highlands regions of the country. The projects used the sub watershed as the planning units and sought the views of local technicians and numbers of the farming community to prepare of land use and capability plans for soil and water conservation. This approach was tested at the pilot stage through FAO technical assistance under MAO during 1988-1991(MoARD, 2005). This was the first step in the evolution of the participatory planning approach to watershed development. By late 1990, watershed development was considered the focal point for rural development and poverty alleviation. Several NGOs and bilateral organizations adopted watershed development in the last decade in their perspectives intervention areas with collaboration of government partners. For instance, the land rehabilitation project, with WFP Food for Work assistance aimed at addressing the problems of food insecurity through the construction of soil conservation structures, community forestry, and rural infrastructure works. Watershed in the country where the incidence of chronic food insecurity is most severe. GTZ-Integrated food security program south Gondar, with integrated watershed management approach assistance aimed at improving the nutritional food insecure households in south Gondar through natural resource management by biological and physical soil conservation measures, crops and rural infrastructure works (GTZ-IFSP,2002).The project succeeded with gully rehabilitation approach. At present a wide variety of donor and development agencies are promoting watershed development. In Ethiopia watershed management was merely considered as a practice of soil and water conservation .The success stories of early watershed projects were marked as the basis of major

watershed initiatives in Ethiopia .but only technological approaches were adopted from those early successful projects and the lessons related to institutional arrangement were neglected

The newly implemented projects neither involved nor took effort to organize people to solve the problem collectively. Where village level participation was attempted they typically involved one or two key persons like village leaders, These projects failed due to their centralized structure, rigid technology and lack of attention to institutional arrangements.(Gleick, 2000).

## **2.2 The Contribution of Integrated Watershed Management for Reversing Land Degradation in Ethiopia**

Based on the assessment of AgWater Solutions researchers (AgWater Solutions, 2012) on six watersheds, two each in Tigray, Amhara and Oromia, various land rehabilitation and conservation measures are being employed in the watersheds (soil and water conservation structures, reforestation, gully treatment, area enclosures) along with water harvesting, rural water supply, and income diversification. Consequently, positive impacts were achieved. The immediate outcomes of integrated watershed management interventions in Tigray region include rehabilitation of natural resources, including recharge of the groundwater table; reforestation of uppercatchments; reduction in soil erosion and associated downstream siltation; and regeneration of plant resources. These outcomes in turn contribute to increased agricultural output, diversification of food and income sources, reduced migration and improved biodiversity. The resultant development impacts include increased food and nutrition security, improved status for women, reductions in poverty and an improved natural environment (Chisholm and Tassew, 2012). A recent impact assessment also showed the PSNP public works in Tigray region: reduced sediment in streams by 40-53% in areas closed to grazing and cultivation; increased woody biomass and forage production three to four-fold; increased water availability and quality; increased ground water recharge and improved downstream base flow of streams; lessened damage from seasonal floods; enhanced down-stream crop production through soil and water conservation interventions; increased stored carbon; increased biodiversity, and increased social cohesion by improving livelihoods(Tongul and Hobson, 2013). The above success of soil and water conservation measures for rehabilitating degraded land following watershed management approach in Ethiopia Studies indicated that the improvement in watershed management benefits to local households and farmers, the local community, and the society at large (Lakew et al., 2005)

## **2.3. Role of Soil and Water Conservation for Degraded Land Restoration**

Studies have indicated that biological and mechanical SWC measures can help to reduce soil loss and regenerate vegetation (Carla et al., 2003; Fu et al., 2003; Mekuria et al. Implications of soil and water conservation measures for land rehabilitation- a synthesis2007; Kalinina et al., 2009).SWC measures reduced both the in-situ and offsite impacts of degradation. Mechanical structures such as terraces, check dams, tranches and micro-basins modify terrain through changing slope length and angel, which in turn reduces runoff velocity, enhances water infiltration and traps sediments washed down the terrain (Vancampenhout et al., 2006; Nyssen et al., 2007). Sediment accumulated behind the terrace provides suitable conditions for plants/crops through conserving nutrients and water (Dercon et al., 2003; Gebremichael et al., 2005; Vancampenhout et al., 2006).

Biological SWC measures such as enclosure, homestead tree plantation, reforestation and enrichment tree plantation within enclosures help to restore vegetation cover and diversity (Asefa et al., 2003; Carla et al., 2003; Fu et al., 2003). With vegetation cover restoration, beside soil fertility improvement through regular organic matter addition, the soil surface can also be protected from raindrop splash and scoring effects of runoff water. This reduces soil particle detachment and transportation. The vegetation intercepts the rainwater, which enhances infiltration and reduces runoff. The infiltrated water percolates into the ground (aquifer), which in turn improves the hydrology. People down-slope witnessed that spring discharges considerably increased after the enclosure, and even in some cases dried springs recovered. Flood risks and sedimentation on fertile farmlands by stones and gravely material has been reduced. These lands are mainly situated along streams. Thus, the in-situ and offsite impacts of SWC interventions ultimately led to sustainable agricultural production and productivity In some areas, enclosures are divided among people who manage their land parcel and use grass through this system. The Kobo-Girana Valley Development Program (KFVDP) initiative can be cited as an example. They formed user groups and facilitated enclosures sharing among users, providing training on appropriate output use and management. As a result, the protected steep lands located above the farmlands showed reduced runoff, which had been damaging the cultivated lands.

Following the closure practice, improved and traditional irrigation has also been expanded. Agriculture offices and NGOs have helped farmers to improve the traditional irrigation. Therefore, the SWC practices played a considerable role in improving the irrigation water supply through better recharge. (Asefa et al., 2003).

## **2.4 Challenges of Watershed Management in the Highlands of Ethiopia**

Ethiopia faces a wide range of soil fertility issues that require approaches that go beyond the application of chemical fertilizers, the only practice applied at large scale to date. Core constraints include topsoil erosion (some

sources list Ethiopia among the most severely erosion-affected countries in the world, along with Lesotho and Haiti; erosion rates are estimated at 10 - 13 mm per annum on average); depleted macro and micro-nutrients, depletion of soil physical properties, and soil salinity (IFRI, 2010). The main challenge facing watershed management is lack of sufficient capacity at all levels of government structures (federal, regional, district and kebele) to implement the new and sustainable approaches, while the intervention needs of the watersheds (Tangul and Hobson, 2013). The other most important challenges of watershed management in Ethiopia are excessively steep slopes of the watershed and small land holding system. (Taha, 2002). Revealed that nearly two-thirds (63%) of the North Wollo Zone, Ethiopia comprises land too steep to cultivate sustainably. Large parts of this land also have very shallow soils and excessive drainage conditions. This land constraint is largely crop management independent. It is generally not amendable unless at great cost by means of physical structures (e.g. terraces) and even then only in places where the conditions allow the construction of the structures required. It could thus generally be considered a permanent limitation. The physical potential for small-scale rain fed crop production is seriously constrained in the larger part of the Ethiopian highlands (Taha, 2002). For instance, approximately 31% of the Ethiopia is classified as suitable for small-scale rain fed crop production. Out of this 31%, only 7% is considered moderately suitable and the remainder (24%) is classified as marginal. Highly suitable land does not occur in Ethiopia. The greatest threat to watershed management is the loss of habitat as humans develop land for agriculture, grazing livestock, draining wetlands and unwise use of pesticides. The most drastic damage has occurred in the natural high altitude forests where their biological resources once covered more than 35% of the total land area of the country but now only cover about 9%. The resulting deforestation and soil erosion have major implications on

Ethiopia's ability to become food secure. In addition to unsustainable land management practices, there are also a number of institutional constraints which are reducing the effectiveness of biodiversity and tropical forestry in Ethiopia. For example, there is poor coordination among various organizations (NGOs, non-government, and international organizations) involved in natural resources management. As we have observed in various field works of the review, the prevailing food insecurity, climate change, fragmented land holding, and upstream-downstream conflicts are the major constraint for sustainable watershed management implementation in Ethiopia. However, presently there are many opportunities for sustainable watershed management in the highlands of Ethiopia such as livelihood diversification (increased off-farm income generation activities), increased awareness of the local community and the commitment of the government to conserve the mountainous areas, upstream basins and watersheds to save the huge hydroelectric dams from siltation, extend the life time of reservoirs and to reduce the off-site effect of erosion. (Binyam and desale, 2014).

## **2.5 Type of Soil and Water Conservation Measures**

### **2.5.1 Agronomic soil and water conservation measures**

Agronomic measures include mulching and crop management, which use the effect of surface covers to reduce erosion by water and wind (Morgan, 2005). Some possible agronomic measures are strip cropping, mixed cropping, intercropping, fallowing, mulching, contour plugging, grazing management and agro-forestry. Agronomic conservation measures help in reducing the impact of rain drops through interception and thus increasing infiltration rates and thereby reducing surface runoff (Amsalu, 2007). These agronomic conservation measures can be applied together with physical soil conservation measure in Watershed. In some systems they may be more effective than structural measures (Heathcoat and Isobel, 2008). Furthermore, it is the cheapest way of soil and water conservation (Wolka *et al*, 2013). However, agronomic measures are often more difficult to implement compared with structural ones as they require a change in familiar practices (Heathcote and Isobel, 2008). Different types of material such as residues from the previous crop, brought-in mulch including grass, perennial shrubs, farmyard manure, compost, byproducts of agro-based industries, or inorganic materials and synthetic products can be used for mulching (Lal, 2004). It is effective against wind as well as water erosion. Some such plants as maize stalks, cotton stalks, tobacco stalks, potato tops etc. are used as mulch (a protective layer formed by the stubble, i.e., the basal parts of herbaceous plants, especially cereals attached to the soil after harvest). Crop residues also reduce the soil temperature by some degrees in the upper centimeters of the topsoil and provide better moisture conservation by reducing the intensity of radiation, wind velocity, and evaporation (Agele *et al.*, 2000).

### **2.5.2 Biological soil and water conservation measures**

Biological soil conservation measures are based on covering of land using vegetation and could be agronomic practice or forest cover (Amsalu, 2008). Biological Method primarily involves stimulation of plants growth (grasses, bushes or trees) over the denuded Measure area. Roots of these plants securely bind the soil while the crowns of bushes and trees offer impediments to the flow of air or water currents. Dead plants provide organic material to the soil which in turn improves soil structure and fertility. It is a natural protection by growing vegetation in a manner that reduces soil loss (Lal, 2005).

### **2.5.3 Physical soil and water conservation measures**

Physical soil conservation structures are the permanent features made of earth, stones or masonry. They are



designed to protect the soil from uncontrolled runoff or erosion, and to retain water where it is needed. In the watershed, steep land farming, physical structures such as rock barriers and contour bunds; waterways such as diversion ditches, terrace channels and grass waterways; and, stabilization structures or dams, windbreaks, and terraces such as diversion, retention and bench are often necessary (Morgan, 2008). The construction of physical structures is often labor intensive since steep slopes make construction difficult. Thus, both construction and maintenance require long-term collaborative effort by farmers, the local community and the government.

## CONCLUSION

Agricultural development in Ethiopia is hampered by land degradation; degradation in turn is treating the overall sustainability of production. Soil erosion is major cause of land degradation in Ethiopia. Generally, this review mentioned that land degradation problem in the area is complex and encompasses environmental, economic, socio-cultural ecological and political issues. There for, detail investigation should be under taken through integrated application of mechanical, biological and soil management practices have results in positive effect for rehabilitation of degraded lands since they reduced flood risks. Nutrient losses, sediment losses and increase grain yields. This review has showed the integrated watershed management practices are the only possible solution for rehabilitation of degraded land. Therefore, all integrated use of physical, biological and agronomic soil and water conservation measures through public investment with site suitability and their long-term agro ecological and economic consequences should be considered.

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