Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.9, No.9, 2017

Integrated Watershed Management for Ecosystem Balance & Climate Change: Ethiopia

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Abstract
Increasing weather variability and climate change are contributing to land and natural/env'tal resource degradation by exposing soils to extreme conditions and straining the capacity of existing land management practices to maintain resource quality. Integrated concepts for managing natural resources in a sustainable and environmentally sound manner show encouraging impacts, if applied on a large scale and over a long period. Integrated Watershed management (IWM) implies the judicious use of natural resources such as land, water, biodiversity and overall ecosystem to obtain optimum production with minimum disturbance to the environment. IWM concepts play an important role for local communities to adapt to impacts of climate change. The scaling up of IWM practices means increasing soil fertility and land productivity at the end leads to balanced ecosystem. Protected soil ecosystems with its organisms are very important for soil organic matter decomposition and nutrient cycling under natural ecosystem. Thus soil fertility maintained and productivity increases. Policies and strategies can play a decisive role through IWM practices among which PASDEP is the most popular as it underlines awareness creation at individual land user and community level. Opportunities could be utilized for success of management practices such as recognition of the problems by the entire society, progressive new rural development policies, skilled man power, vast experience in IWM practices are notable.
Keywords: watershed management, environmental degradation, ecosystem balance, climate change

1. Introduction

Natural resources are increasingly becoming a limiting factor for meeting the food requirements of a growing world population. Integrated concepts for managing natural resources in a sustainable and environmentally sound manner show encouraging impacts, if applied on a large scale and over a long period (Forch, 2009).

Natural resources in Ethiopia are under extreme stress. Land degradation, including deforestation, soil erosion and biological soil degradation are rampant throughout the country. Because of its topographic nature, removal of the living land cover brings about soil degradation (Girma, 2000). Environmental degradation, high population growth in developing countries, and the need to enhance sustainable agricultural productivity are now interlocked issues that constitute a triple global challenge currently. These human equity and environmental issues can be tackled by improved integrated systems as a foundation for improving economic growth and environmental protection because it has the potential to increase the production of food, fuel wood, building materials, and fodder while arresting soil erosion and fertility decline.

As in URL (http://www.colorado.edu/;Kumar,2009): Integrated watershed management approach is the process of formulating and implementing a course of action involving natural and human resources in a watershed, taking into account the social, political, economic, and institutional factors operating within the watershed and the surrounding river basins and other relevant regions to achieve specific social objectives and is generally recognized as the most practical and efficient way to improve water quality and other environmental indicators while maintaining regional economic viability. The impacts of major watershed development programmes have been outlined in terms of biophysical impacts, environmental impacts, socio-economic impacts and overall economic impacts.

Convergence/union of various rural development programmes around the watershed could be ensured to promote holistic development of watersheds. For its continued success; the programme should be economically efficient, financially viable, technically feasible and socially acceptable while ensuring equity. Watershed management means putting in place systems that ensure land resources are preserved, conserved, and exploited sustainably now and for future generations. In more general saying, Watershed management is being seen as a major component for soil, water and vegetative cover conservation, rural community's living standards improvement and better environmental conditions (Endalkachew, 2007). From the 1990s until now, watershed management operations typically targeted resource use productivity, livelihood improvements, and poverty reduction objectives beyond resource conservation. In addition, it aimed to adopt integrated, participatory and demand-driven approaches at grassroots level. This approach is commonly known as a new generation of watershed management programs. The historical perspective of watershed management in Ethiopia was nearly the same to other developing countries (Gadisa, 2016).

In the face of climate change the global community, nations and local communities are undertaking action along two primary tracks: mitigation – the process of reducing greenhouse gas emissions and, thereby, associated climate change; and adaptation – the process of adjusting in response to, or in anticipation of, climate change.

The application of targeted conservation of natural buffer systems as a strategy for adapting to climate change offers several potential co-benefits: Biodiversity conservation, Poverty alleviation and enhanced sink capacity. A number of environmental management-based adaptation activities can also serve as climate change *mitigation* measures. Enhanced natural resource management is playing a growing role in helping communities at all decision-making levels address the sources of disaster (Arnold, 2003; IDNDR, 1994).

Climate change is not only an environmental problem but also poses a clear risk to development and international security. While climate change will affect all countries, it is developing countries and the poorest populations that will be hit earliest and hardest. The most vulnerable areas (sectors) to climate change include small-scale rain farming, pastoralists, coastal fishing & aquaculture communities, forest-based economy, the urban poor, coastal areas and floodplain settlements (Anonymous, 2009).

In sayings of Hurni, 1993; Ethiopia is an agricultural and the most environmentally trouble country in the shale region and it presents the worst example of soil erosion and land degradation problems in the world. **"**Today, the Ethiopian highlands have become, one of the largest areas of ecological degradation in Africa, if not in the world, cited in (Mulugeta, 1988). The major manifestations of Land degradation are severe soil degradation, loss of soil fertility, decline of biodiversity, reduction of productivity and also so many others. Much of the today's problems of soil degradation in Ethiopia are attributed to the past exploitive social and economic system which permitted very intensive use of the natural resources, to the limits of productivity (FAO, 1984).

Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rain fed agriculture which is very sensitive to climate variability and change, under-development of water resources, low health service coverage, high population growth rate, low economic development level, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc (NMA, 2007). Natural factors, socio-economic and institutional factors affect the process of degradation and influence decision on watershed management practices. However, there has been lack of guide for systematic study that identifies the forces that feed the interaction between degradation and conservation strategies of integrated watershed management.

The Concept of Integrated Watershed Management (IWM)

The watershed of a particular point on a stream is an area which contributes water to that point in the stream. Watersheds are separated from each other by water divides. IWM is a process of conservation, development and optimal utilization of the available natural resources in a watershed on a sustained basis and is an effective means for the conservation and development of land and water resources. It is a process with a multidisciplinary approach with people in the watershed as chief functionaries (decision makers and main actors) in the process. The aim of IWM is to achieve sustainable development of the communities living in the watershed on the basis of available natural resources in the watershed. Essentially, the aim of IWM is to improve productivity of available natural resources and the production capacity of the dependent population /the improvement of the livelihoods of local communities on a sustainable basis. This requires balancing their economic needs and expectations with environmental concerns so as to avert degradation of the natural resource base, in particular soil and water components (Winnege, 2005;Zoebisch *et al*,2005).Components include the conservation, development and optimal utilization of the natural resources within a watershed area i.e. soil and land management, water management, afforestation, pasture development; agricultural development, livestock management; rural energy management; enable people to build institutions for the management of the watershed with the mandate of decision making, knowledge sharing and executive powers to act according to the decisions made. The purpose of IWM can be achieved through the active involvement of people, the empowerment of people to take informed decisions and act accordingly and through ensuring people's ownership of the process by using local material and skills (Winnege, 2005).

As in (Kumar, 2009; http://www.colorado.edu/): The impacts of major watershed development programmes have been outlined in terms of biophysical impacts, environmental impacts, socio-economic impacts and overall economic impacts. The watershed development programmes involving the entire community and natural resources influence (i) productivity and production of crops, changes in land use and cropping pattern, adoption of modern technologies, increase in milk production, etc., (ii) attitude of the community towards project activities and their participation at different stages of the project, (iii) socio-economic conditions of the people such as income, employment, assets, health, education and energy use, (iv) impact on environment, (v) use of land, water, human and livestock resources, (vi) development of institutions for implementation of watershed development activities, and (vii) ensuring sustainability of improvements. It is thus clear that watershed development is a key to sustainable production of food, fodder, fuel wood and meaningfully addresses the social, economic and cultural status of the rural community.

WATERSHED ECOSYSTEMS

Watershed ecology is essential knowledge for watershed managers because watersheds have structural and functional characteristics that can influence how human and natural communities coexist within them. The gross structure of a watershed its headwaters area, side slopes, valley floor, and water body, as well as its soils, minerals, native plants and animals are, in one sense, raw material for all the human activities that may potentially occur there. The watershed's natural processes rainfall runoff, groundwater recharge, sediment transport, plant succession, and many others provide beneficial services when functioning properly, but may cause disasters when misunderstood and disrupted. It is crucial for people to understand watersheds and how they work before they make decisions or take actions that may affect important watershed structural or functional characteristics (*http://www.epa.gov/watertrain;* Calder, 1998; Hayward, 2005).).

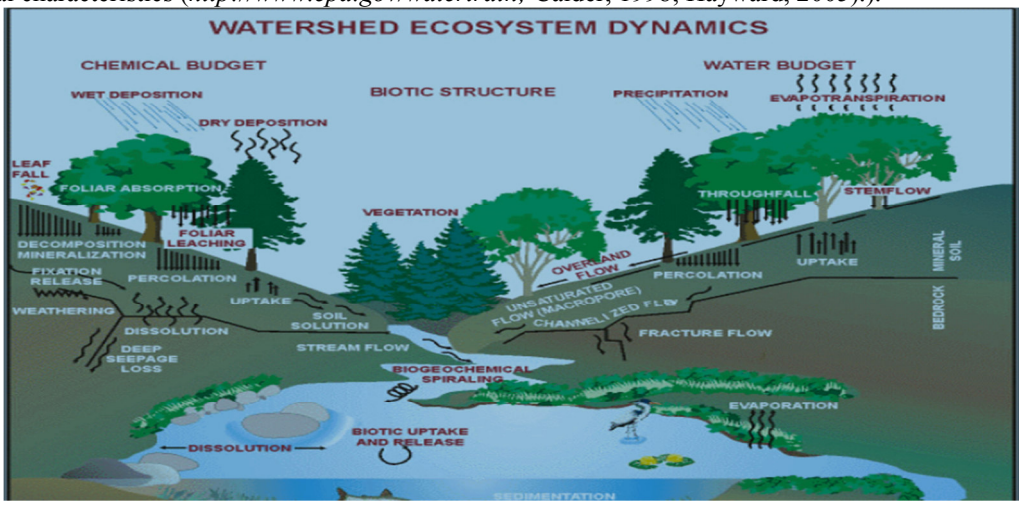

Figure. Watershed ecosystem dynamics (Johnson and Van Hook, 1989).

Dealing with the Environment through Watershed Management

According to World Bank (2008), Watersheds are complex systems where water, soil, geology, flora, fauna, and human land use practices interact. Hence, watershed degradation has environmental and socio-economic effects far beyond the more obvious onsite and downstream impacts. For the same reasons, watershed management interventions may bring local, regional, and global environmental benefits. However, watershed management programs have tended to neglect environmental impacts beyond immediate land and water impacts, although some projects did target broader environmental objectives, too.

An integrated approach to natural resource management at the watershed level would ideally address the complex system dynamics in watersheds, and would achieve global environmental benefits where feasible.

Environmental impacts both on-site and downstream could be understood.

Watersheds are complex systems where water, forests, wildlife, cultivation, and other human practices interact.

Forests, farming systems, water, human communities, and wildlife form part of highly complex interconnected systems in watersheds. Watersheds can also be repositories of global environmental benefits, such as biodiversity and carbon sequestration. Moreover, upper watersheds are linked, through water flows, to downstream land and coastal areas far from the steep terrains where water flows are generated.

Hence, watershed degradation has environmental and socio-economic effects far beyond the more obvious on-site (upstream) and downstream impact.

Because of the complex interactions within a watershed, degradation of land and water resources can have far-reaching and unwanted impacts on the environment beyond the impacts on soil and water resources and the related economic activities. These impacts on the broader environment may include, for example, declining biodiversity, dwindling environmental flows, or deterioration of a far-off marine environment. These environmental impacts may also have a direct or indirect cost for different sectors of the economy, including tourism (contaminated water, algae blooms, destruction of coral reefs near the coast, and ecotourism) and alternative sources of livelihood for upland communities (services generated by biodiversity). …and for the same reasons, watershed management interventions may bring local, regional, and global environmental benefits.

Watershed management programs may, for example, include conservation of existing natural areas, regeneration of native vegetation, and replanting indigenous species; creating ecological corridors for wildlife; establishing buffers for biodiversity; or choosing trees with a good carbon sequestration potential. These programs may bring local, regional, and global benefits. However, there may be tradeoffs. For example, planting trees may be a global good, but trees may change the local water balance (Calder, 1998; Hayward, 2005).

Soil Ecosystems and Erosion Mitigation efforts

A study by Forman and Godro (1986) based on soil ecosystems revealed that soil ecosystems include ants, termites, in many tropical soils. Besides these decomposers, the soil ecosystems include many more kinds of animals: predators, fungi, bacteria, protozoa, algae and others. Brady and Weil (2001) identified five key roles of soils: First; soil supports the growth of higher plants, mainly by providing a medium for plant roots and supplying nutrient elements that are essential to the entire plant. Properties of the soil to determine the nature of the vegetation present, and indirectly the number and types of animals (including) people, and vegetation can be supported. Second; soil properties are the principal factors controlling the fate of water in the hydrology systems, water loss, utilization, contamination and purification are all affected by the soil.

Third; the soil function nature's (natural recycling systems). Within the soil, waste products and dead bodies of plants, animals and people are made available for re-use by next generation of life.

Fourth; soils provide habitats a myriad of living organisms, from small mammals and reptiles to tiny insects to microscopic cells of unimaginable numbers and diversity and finally Fifth; a human built ecosystems, soil play an important role as an engine erring medium, Brady(2000) concluded that, their findings report on soil ecosystem beyond natural processes to cultural significances of the soil as building material and provides the foundation for virtually every road, airport, and houses we build, concerning cares that are undertaken for sustainability of ecosystems. Ludi (2004) argued that economic development should be in such a way that as to meet the needs of the present generation without competing the ability of future generation.

Panda (2006) achieved the welfare of mankind depends on the wise use of our soil and water resources. Gupta (2005) found increasing land degradation contributes to temperature rise and become major cause for soil carbon loss and argued that the decrease in soil carbon content may result in slow organic matter recycling.

Watershed Management and the Challenge of Climate Change

As in World Bank (2008) Climate change is expected to bring both long-term structural changes to the water cycle and increased variability and unpredictability, and to have impacts on agricultural productivity. Greater frequency of high intensity rainfall, floods, landslides, and wildfires is also likely to increase the vulnerability of communities in many watersheds.

Although structural changes and increased variability and unpredictability resulting from climate change will have economic and social costs, an integrated set of management responses, within a broad integrated basin planning framework and including watershed management, can mitigate those costs. Watershed management can also help implement a risk management approach for disaster preparedness.

Recently, watershed management projects have begun to factor in climate change, and some "dedicated climate change adaptation projects" have been designed to deal with high-risk watersheds. Climate change risk analysis and adaptation options should now be factored in to all watershed management projects.

Expected Impacts of Climate Change on Watersheds

Climate Change is measurable increases in the average temperature of the Earth system. The earth is currently facing a period of rapid warming brought on by rising levels of heat-trapping gases, known as greenhouse gases, in the atmosphere. Greenhouse gases retain the radiant energy (heat) provided to earth by the sun in a process known as the greenhouse effect. The most significant Greenhouse Gases are Water Vapor, Carbon Dioxide, Methane, Nitrous Oxide, Ozone, and Fluorinated Compounds. These gases are emitted mainly from industries. The major impacts include temperature rises and heat waves, heavy rainfall and flooding, drought, strong winds and melting of polar ice, among the others (IPCC, 1995; Logan *et al*, 2007).

As in (Anonymous, 2009; NMA, 2007; IPCC, 2007): in order to prevent the expected effects, policymakers have thus largely focused on addressing climate change through mitigation. ***Mitigation*** refers to strategies to reduce the probability of climate change through sustainable practices that mitigate the increased occurrence, severity, and unpredictability of weather patterns resulting from climate change. The two major forms of climate change mitigation are:

1. Reduction of carbon emission through a range of technologies, regulations, or economic incentives, energy diversification to renewable sources and those that do not emit carbon.
2. Carbon sequestration through afforestation, avoided deforestation and degradation, as well as through sustainable land management practices, such as restoring degraded organic soils or using zero- or low till farming practices.

Carbon Sequestration to Mitigate Climate Change

Human activities, especially the burning of fossil fuels such as coal, oil, and gas, have caused a substantial increase in the concentration of carbon dioxide (CO2) in the atmosphere. This increase in atmospheric CO2 — from about 280 to more than 380 parts per million (ppm) over the last 250 years—is causing measurable global warming. Potential adverse impacts include sea-level rise; increased frequency and intensity of wildfires, floods,

droughts, and tropical storms; changes in the amount, timing, and distribution of rain, snow, and runoff; and disturbance of coastal marine and other ecosystems. Rising atmospheric CO2 is also increasing the absorption of CO2 by seawater, causing the ocean to become more acidic, with potentially disruptive effects on marine plankton and coral reefs. Technically and economically feasible strategies are needed to mitigate the consequences of increased atmospheric CO2.

The term ―carbon sequestration is used to describe both natural and deliberate processes by which CO2 is either removed from the atmosphere or diverted from emission sources and stored in the ocean, terrestrial environments (vegetation, soils, and sediments), and geologic formations. Before human-caused CO2 emissions began, the natural processes that make up the global.

―carbon cycle maintained a near balance between the uptake of CO2 and its release back to the atmosphere (IPCC, 2007; Logan *et al*, 2007; NMA, 2007).

Terrestrial sequestration (sometimes termed ―biological sequestration) is typically accomplished through forest and soil conservation practices that enhance the storage of carbon (such as restoring and establishing new forests, wetlands, and grasslands) or reduce CO2 emissions (such as reducing agricultural tillage and suppressing wildfires).

In addition to the impacts on agricultural productivity, climate change is expected to bring both long-term structural changes to the water cycle and increased variability and unpredictability. It would also increase the vulnerability of communities in many watersheds through higher-intensity rainfall and greater frequency of floods, landslides, and wildfires.

The impact of climate change on agricultural productivity is likely to stem not only from changes in water availability and quality, but also from temperature increases, which will cause ecosystems to shift over space and will hence change the suitability of crops to the different latitudes. It is expected that mid- to high-latitude countries could well benefit from the warming, while countries in the subtropical and tropical regions (low latitude) may experience deleterious impacts, and some marginal areas may go out of production (Mendelsohn *et al*, 2006).

In the uplands, runoff will increase and will exacerbate soil losses and land slips and slides. Increased downstream sedimentation is likely to result. Moreover, climate variability in the form of typhoons, floods, and droughts is expected to cause production losses. The rural poor are the most vulnerable, since they bear the brunt of natural disasters and declining local agricultural productivity. In addition, climate change is expected to bring an increase in stream flow in high latitudes and in Southeast Asia and a decrease in stream flow in central Asia, the area around the Mediterranean, and southern Africa. In other parts of the world, the direction of change is uncertain (IPCC, 2001).

Among scientists there is also “high confidence” that in many areas where snowfall is currently an important component of the water balance, peak stream flow will move from spring to winter and that water quality generally will be degraded by higher water temperatures. Flood magnitude and frequency are likely to increase in most regions, and low flows are likely to decrease in many regions.

Furthermore, as a consequence of changing rainfall patterns, floods, landslides, and wildfires are expected to increase. Drought years already bring an increase in fire outbreaks (McKenzie *et al*, 2004) and increased forest fires are likely to result in a change in vegetation structure—in unmanaged forested areas—that in turn exacerbates the fire risk (IPCC, 2001). Peter and Mayers (1992) found that the increase in the greenhouse gases in the atmosphere, thus is a major cause for increased temperature and earth’s surface warming (cited in Sigh *et al*, 2004).So, one can ask what is a linkage between erosion mitigation and Global climate change. It is most obvious that maintaining soil fertility with organic matter is one of the ultimate goals of SWC and at the same time mitigates erosion and balances the climate system.

WATERSHED MANAGEMENT PRACTICES

Watershed is not simply the hydrological unit but also socio-political-ecological entity which plays crucial role in determining food, social, and economical security and provides life support services to rural people (Wani *et al*., 2008).By late 1990; Watershed Development has increasingly been managed and developed for poverty alleviation and environmental conservation. In comparison to previous land rehabilitation initiatives strong emphasis was placed on household income - generating activities and innovative approaches towards conversion of degraded landscapes to productive lands (Tesfa &Tripathi, 2015). In 2005 Ethiopia began implementation of a more comprehensive approach to food security through the Productive Safety Net Programme (PSNP), in which more predictable food and cash transfers for chronically food insecure households were returned into labour on public works, particularly through Community Based Participatory Watershed Development. For instance, in 2014/15 (at the end of GTP one), area of land rehabilitated and area of land developed with community based watershed development program has been extended into 11.7million hectares and 12.16 million hectares respectively (FDRE, 2015). In addition to other projects, the current free labour massive social movements on watershed management activities might be the crucial example of natural resources management for sustainable

agriculture. Therefore, it is needed to examine the current practices, approaches, lessons learned and the challenges of watershed management in Ethiopia.

Physical soil and water conservation are methods which aimed to reduce the velocity of surface runoff and minimize soil erosion by shortening the length and minimizing the gradient of the slope. They also aimed to retain water when it is needed or safely dispose excess runoff. The structures mainly involve different types of bunds, terraces, check-dams, water diversion (cut-off drain, water ways) and harvesting structures (micro basins). These have been traditionally implemented over 400 years and some were introduced as modern technologies since four decades (Daniel, 2010). Biological soil and water conservation measures mainly involve tree planting in the form of afforestation or reforestation. Vegetation has a curative and protective value. Tree planting activities has a long history in Ethiopia. According to historical records, afforestation started in the early 1400s by the order of King Zera Yakob (1434-1468) but modern tree planting using introduced tree species (Australian Eucalyptus) was started when Emperor Menillik II (1889-1913) looked into solutions for alleviating shortage of firewood and construction wood in the capital, Addis Ababa (Amogne,2014). In 1995 Constitution and subsequent national economic policy and strategy was recognized natural resources management as a key prerequisite for sustainable development. For example: Article 92 mainly indicates about 'environmental issues'. Even though there is no specific provision concerning to increase forest covers in the constitution, some of the existing policies and laws (rural land, environmental, energy, investment, wildlife, etc) indirectly contributes forest cover increase in Ethiopia (Jonse *et al*, 2008).

In 2007, the council of ministers adopted a forest policy in the proclamation of No. 542/2007 which gives due attention to forest development and conservation considering its significance to the national economy, food security and sustainable development of the nation (FDRE, 2007). In this policy and strategy document, three policy statements have direct relationship with the increase of forest cover. These are: Private forest development and conservation; Development and dissemination of technologies; and Promotion of forest marketing development. A number of federal and regional offices are involved in projects and programs that are related to forestry. For example: Participatory Forest Management (PFM), Productive Safety Net Program (PSNP), Sustainable Land Management (SLM), and Managing Environmental Resources to Enable Transition to Sustainable Livelihoods (MERET) project, Agricultural Sector Support Program (ASSP), Agricultural Growth Program (AGP), Reducing emissions from deforestation and forest degradation (REDD) and etc. International and local NGO's also have been significantly participated in forest development, namely: GTZ, FARM Africa, SOS Sahel Ethiopia and the others. International agencies like WFP, FAO, SIDA, World Bank, African Development Bank are among the others having crucial involvements in this regard. Thus, the current government has not only taking care of remaining natural forests but it also initiated and encouraged people to plant multipurpose tree species. Moreover, it is identified Forestry as one the four main pillars of Climate Resilient Green Economy (CRGE) strategy of the country. This prioritized strategy was aimed to protect and re-establish forests for their economic and ecosystem services including carbon stocks (FDRE, 2011). An ecosystem approach was emerged early as a central strategy for the Integrated Natural Resources Management that promotes conservation and sustainable use through equitable sharing of benefits (Gadisa, 2016b). The Activities have been undertaken in a watershed context through afforestation, reforestation and forest management. In doing so, a wide range of biophysical, institutional, socioeconomic and household level factors had a critical influence on adoption of tree growing investment decisions. For example: land holding size, land tenure security, household size, productive labour force availability, education, income and credit access, age, level of perception on deforestation could be the determinants of tree-growing decisions by local land users (Akalu *et al*,2016), (Berhan *et al*,2016), (Alemu& Abebe,2011), (Zenebe *et al*,2010), (Woldeamlak,2007) and (Berhanu & Swinton ,2003). According to recent data, about 11.5 million hectares of Ethiopian land area is covered by forest in which plantation areas have been increased by 47.6% from 509,422 ha in 2000 into 972,000ha in 2015 (FAO,2015). Even though there were increased plantation area through massive watershed management program in the country, expansion of agricultural land, settlement programmes, extensive investments and other development activities are used within expenses of the remaining natural forest land (Bekele *et al*, 2015) and (Amogne,2014).

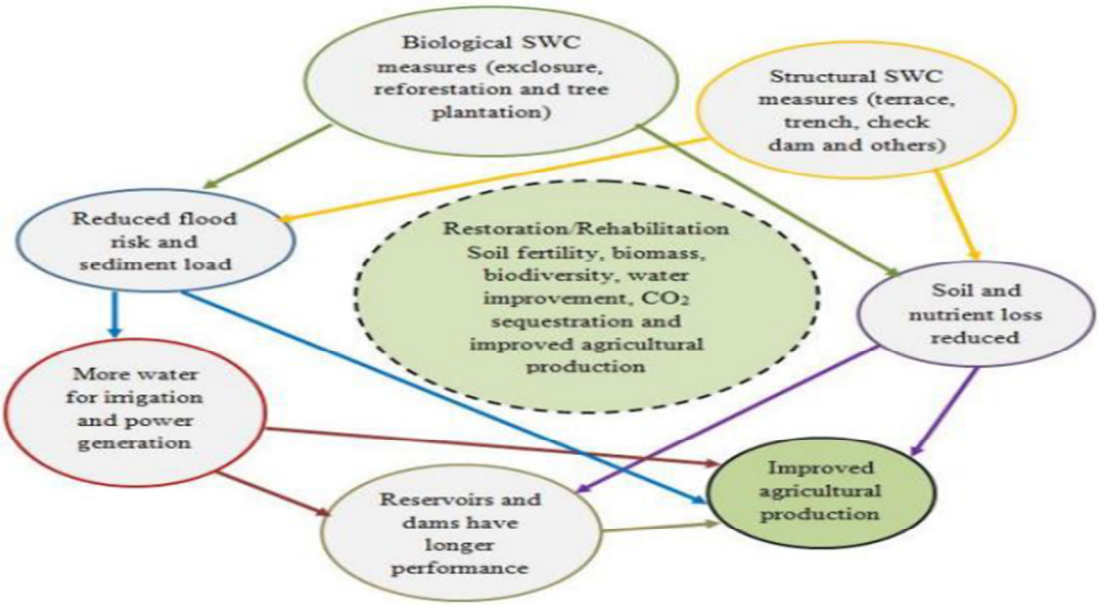

Figure 1: Conceptual framework demonstrating implication of SWC measures in degraded land rehabilitation (German *et al*, 2007)

Watershed Management, Ethiopian Case

In sayings of McCornick *et al* (2003): Ethiopia has varied landscapes, ranging from rugged highlands in the central part, to the wetland areas of Gambella and to the deserts of the Afar and the Ogaden area. Rainfall is highly variable across the country, from season to season, and from year to year. This variability subjects the country to frequent droughts and famines. Deforestation, population growth, overgrazing, and use of marginal lands have intensified erosion. Land degradation is serious in the highlands, contributing to low soil productivity and poor agricultural production. High erosion also causes downstream sedimentation, which can significantly decrease reservoir life.

The objective of watershed management is to improve the standard of living of the population living within the watersheds, decrease population pressure, and increase land productivity so that sustainable livelihoods and land use practices can be secured for the target populations. Without action, the challenges of food insecurity and famine, environmental degradation, and rapid population growth will intensify. Yet, through co-ordinate efforts of different stakeholders, production of food and energy, mitigation of droughts, arresting watershed degradation, reducing sedimentation, and improving the environment can be achieved. It is possible to capture these opportunities in a sustainable manner to benefit the people.

Any watershed management intervention for Ethiopia must address the root causes of land degradation, soil erosion, sedimentation and loss of soil fertility. Population pressure, fuel wood demand, lack of alternative sustainable livelihoods, and illiteracy are some of the root causes. In view of the multi-sectoral nature of the problems, a comprehensive and integrated approach is required. Treating the symptoms, as opposed to addressing the root causes, will lead to a downward spiral of degradation and poverty. The first benefit of appropriate watershed management is to reduce soil erosion and the subsequent siltation rate of reservoirs there by maximizing the benefits of irrigation and hydropower projects. The second important benefit will be an overall increase in land productivity, which will yield higher agricultural outputs and thus enhance food security and alleviate poverty.

There are several techniques of controlling degradation **(**1) Agronomic/Biological methods, which aim at controlling erosion/degradation by improving the vegetative cover of the soil;(2) Soil management techniques, which try to control erosion by improving the aggregation of the soil particles; and (3) Structural/Mechanical soil conservation methods, which control erosion by shortening the length and minimizing the gradient of the ground slope (Belay, 1992; Paulos, 2002). Effective and sustainable land management programs can be designed and implemented only if (1) the causes of land degradation are properly identified (2) the appropriate land management/conservation practices are selected (3) the farmers are effectively involved in the planning and implementation of the land management practices.

CHALLENGES OF WATERSHED MANAGEMENT IN THE COUNTRY

In the present past, there were different challenges, constraints as well as controversies that negatively affect the quality of interventions and scaling up of successful practices for sustainable watershed management in Ethiopia.

Some of the important constraints have been described as follows:

Inadequate community participation*:* the top-down and rigid planning approach was ignored local communities participation in which it mainly focused on technical and physical works alone without giving attention to the economic viability and social acceptability. Lack of awareness and lack of proper integration of introduced practices with indigenous knowledge was limited farmers' willingness to participate and less sense of responsibility over assets created. Due to the fact, during the political changes a large scale of forest areas; soil and water conservation structures were highly removed and destroyed by local communities in the country (Meshesha & Birhanu ,2015), (Simeneh ,2015) and (Waga *et al*,2007).

Policy, legislation and implementation constraints*:* Historically, Ethiopia has been designed a number of important policies and strategies though it was not an end by itself. They must be valued if and only if properly implemented. The poor implementation of policies and strategies remains a major constraint and they are hindering proper implementation of effective and sustainable practices for resource management in Ethiopia (Bekele *et al*, 2015), (Tesfa &Tripathi,2015) and (Amogne,2014). Weak linkages among various disciplines and concerned institutions: There was single medium focus and sector driven approach they could not be integrated and multi-sectoral approach. There was also poor coordination among researchers, extension centres and educational institutions that adversely affected the development and transfer of technologies from researchers to local experts and local communities, particularly the farmers. In addition, frequent restructuring of government institutions causes staff turnover, wastes institutional capacity and discontinuity of activities and initiatives. In this regard, MoARD and World Bank also suggested that these all undermines the proper implementation and up-scaling of successful sustainable environmental management practices in the country.

Lack of professional and technical standards*:* the technical interventions were not supported by dialogue/negotiation process. Construction of physical soil and water structures was considered as the only main solution to halt land degradation. Even the selection criteria and design parameters of SWC structures were not considered as per of required. Unfortunately, attention is mostly given to the number/quota of interventions but not their quality, standard, sustainability, and integration with other soil and land management practices (Adugnaw, 2014). Besides, there is an indication in which nonprofessionals have been assigned to initiate activities in natural resources management.

Other socio-economic and bio-physical challenges*:* There are many socio-economic and bio-physical constraints that hinder decisions to invest and sustain appropriate practices for overcoming land degradation in Ethiopia. Among the others poverty, population growth, land use change, land shortage, deforestation, climate change (drought and floods), and the others have often negatively affects the sustainability of watershed management practices in the country.

Relationship between poverty and soil degradation

The study by Madeley and Stolton (1992) indicated that a combination of rapid population growth and lack of sophisticated agricultural practices in the south causing a steadly escalating (back formation) spiral food shortage. Negassi *et al*, (2002) indicated the excessive exploitation of forest and soils caused fertility degradation, that is, physical, biological and chemical degradations of soil.

The Ethiopia Government National strategic plan for 15 years (2006-2009/10) studied by MoFED (2006) on PASDEP, accelerated and sustainable development to end poverty from this country reveals that natural resource conservation based development particularly involving soil and water conservation scaling out practices. The PASDEP implementation programs are broader, participatory, and has better mood for application.

And this is the actual relationship between the poverty and land and/or soil degradation. The aggravating internal, but the most severe influential factor is the occurrence of soil degradation at small holder's crop land due to lack of sufficient awareness concerning erosion hazards and the role of soil and water conservation practice. Provided that, the poverty scale at small holder farmer level is deep and wide.

Though the efforts carried out by government showed should be appreciated, the MoFED (2006) issued PASDEP from its infancy age up to now accomplished too many successful achievements except the remaining task is by far greater than the previous accomplishments.

If the ongoing efforts more scaled out concerning soil and water conservation and associated natural resource conservation, conservation based agriculture and in anyone sector according to the PASDEP poverty will be eradicated out from Ethiopia.

Moreover, PASDEP has been involved to scale out soil and water conservation practices at small holders farm level in order to tackle the land degradation and improve productivity. As well different types of farm forestry, agro forestry, wood lot, area closure are some of the PASDEP activities which can generate household income and gradually eradicate poverty.

PASDEP, also at an initiation level to build participatory watershed management and by this it is at its infant to young stage. Particularly the initiation by PASDEP to create household sustainable income generation source is the part that should receive appreciation for its promising efforts and inputs for poverty reduction.

Training is, main poverty alleviation method that capacitating household in sustainable income generation. PASDEP initiation should receive appreciation by this and ought to scaled up the present duties. Because, poverty is a root cause for deforestation; if not the only case. Hence, deforestation paves the way for land and/or soil degradation. It is this land degradation and/or soil loss that depresses the farming society, particularly small holder peasant. When the land lost growing stock (asset) due to deforestation the fertile soil lost due to erosion and hence production cost over whelms yield's price, it is obvious poverty entered to farmer's house.

The role of organizational capacity building to strengthen SWC and land management

Melaku (2009) showed that organizational strength is a tool for implementing newly issued strategies; Mearn and Leach (1988) found that indigenous technical knowledge reflects the diversity of local agro ecological conditions and the importance of this for livelihood strategy geared to manage risks and is important for specific local landscape and livelihood. They further understood that there is limits to local indigenous knowledge and underlined that local indigenous knowledge's is also rarely distributed evenly. Thus why local organization capacity building is necessitated.

Another study by Anderson and Ingran (1993) found that interactive approach used to gain insight in soil, water and land use practices achieved successes. The argumentation of the above authors is to fill the gaps of indigenous technical knowledge by positively intervening the local organization. Warren (1988) reported that the participation and empowering rural communities make the people progressive and self-reliance and concluded natural resource management that does not have a direct impact on income is seldom considered, special remarks that placed is priority for marginalized up land areas, and environmental awareness and natural resource management skills can be improved only if a certain level of organizational capacity is reached and primary needs (income, water supply, education, communication services) are first satisfied to a reasonable extent.

In Ethiopia according to PASDEP, MoFED (2006) local communities especially rural communities are provided with at least 3 Development Agents; i.e one each from natural resource, agronomy and animal husbandry. These skilled technical personals provide extension services for farmers and offer training at FTC (Farmers Training Center) pertaining the benefits of soil and water conservation practically at field in addition to class lesson.

The Ethiopian local institutions are by far more received credit in FDRE in comparison with the past. And by now they are in the position of exercising the cultural and/or traditional values and norms amongst which natural resource conservation and fair utilization is a one. Though, just as Mearns and Leach (1998) stated the local (cultural) organization and their indigenous knowledge is uneven and yet limitations are not fully avoided. Therefore, routine capacity building and follow up is important for sustainable soil and water conservation practices.

OPPORTUNITIES

According to Gadisa (2016) Ethiopia has also the opportunities helping to improve watershed management interventions and to scaling up successful practices. These opportunities can be the followings:

- Existence of good policies and strategies (environmental and land tenure policy)
- Good start and experiences in community based watershed management
- Better institutional setup and research systems
- Integration of concerned organizations
- Availability of indigenous knowledge and scientific technologies
- Existence of donor support and development partners

Therefore, in addition to implementing these ambitious climate resilient green economy strategies through watershed management practices, it must be capitalizing these opportunities in the country (Tesfa &Tripathi, 2015) and (Adugnaw, 2014).

The opportunities that Ethiopia possesses for the realization of national food independency strategy are too immense. Amongst which the recognition of the problem by the entire society is considerable. For example, the Government of Ethiopia issued different types of relevant strategies, and implementation program, MoFED, PASDEP (2006) Chapter 7.1.8 is a good witness for the recognition of the problem. Because if there were no problems it is not necessary to plan for solution.

The foundation of new rural development policy foundation was laid by Transitional Government of Ethiopia (TGE) since 1991. Melaku (2009) reported that the transitional government of Ethiopia: Promoted economic growth policy through a market based economy; Encourage private sectors to invest in the economy; Government provides selected services for and through decentralized administrative systems; and Agricultural and natural resources management (improvement).

Special strategies such as food security strategy (FSS), PRS (Poverty Reduction Strategy), and ADLI at large Melaku (2009). Amongst the best strategies and attached policies of ADLI the followings are presented: Developing and promoting use of improved agricultural technologies, such as improved seeds, fertilizers and pesticides through agricultural research, extension services, input supply and credit schemes; Expanding small

scale irrigation schemes in drought prone areas; Development of livestock resources ;Conservation of natural resources ;Implementation of an enabling land policy; Expansion of marketing services; Enabling private investors to play their proper role; Expanding economic social infrastructures that support development ;and concerning farming activities, ensuring that all activities are centered on farmers decisions.

Also, the Ethiopian food security strategy (FSS) which was issued in 1996 focused on the environmental rehabilitation according ILRI official report and as Melaku concludes the acknowledgement that in food security is a long term undertaking.

The study by Melaku (2009) on natural resources law and policies in Ethiopia ascertained that even the earliest monarchical rulers of the country had placed emphasis for natural resources conservation and environmental protection. The Melaku's study revealed that the earliest traveler such as Nonnus, since 4th C A.D at the region of Axumite Kingdom saw multitudes of elephants pasturing without any human attach: under the royal law of wildlife protection the natural resource protection, conservation and attempts to conduct proper utilization was chrono sequential tasks of the Ethiopian state and government leaders and further exemplified his findings: King David (1365 – 1395) and King Yacob (1597-1603) assigned forest guards for Wof-Washa forest protection. The experience of Ethiopia is not only restricted by these efforts only but also stone faced terraces (And anjet, Hullet anjet) at Northern part of Ethiopia and the Konso people and other southern and any part of the country's stone faced terraces ruminants are good evidences for that Ethiopia has deep experience in soil and water conservation. Also, the country well adopted scientific methodological path of modern soil and water resources conservation (Example: Tigray highlands).

The most impressive wealth that Ethiopia on these days possessed is that the skilled man power starting from junior expertise level up to natural resource and/or forestry scientists together with plenty of labour. In fact, the bundle of problems which will be solved by the integrated efforts of the Ethiopians disregarding anything should be appreciable.

SUMMARY

An integrated approach to natural resource management at the watershed level would ideally address the complex system dynamics in watersheds, and achieve global environmental benefits where feasible. There are multiple interacting factors which have been caused land degradation in Ethiopia. Land use change, extensive deforestation, overgrazing, inappropriate land use, infrastructural expansions, burning of dung and crop residues are among the proximate causes; whereas ever rapid population growth, poverty, land tenure insecurity and climate change are among the main indirect causes. The natural phenomena of the country also highly exposed to land degradation because it has rugged mountains, deep gorges and incised river valleys, rolling plains, a wide range of temperature and rainfall events. On the other hand, highly concentrated mode of life on the highland areas and rain-fed agricultural dependency has made the country highly susceptible to land degradation and subsequent problems. Thus, watershed management was aimed to address the root causes of the problem. The Ethiopian farming societies are rural dwellers and the paper advices an individual household to stand by for scaling up IWM practices. Any interventions aimed to implement in a watershed should be in an integrated, flexible, multi-sectoral and multi-disciplinary approach; both scientific and indigenous knowledge should be equally paid attention; strengthening awareness creation, capacity building, real community participation and equitable benefit sharing are also requiring attention. In general, the effectiveness of watershed management practices must be evaluated in terms of environmental soundness, economic viability and social acceptability. Then, the success and sustainability of national food independency strategies will be realized.

References

Adugnaw B., 2014. Environmental Degradation and Management in Ethiopian Highlands: Review of Lessons Learned. International Journal of Environmental Protection and Policy, Vol. 2, No. 1, 2014, pp. 24-34. DOI:10.11648/j.ijepp.20140201.14.

Alemu Mekonnen and Abebe Damte, 2011. Private Trees as Household Assets and Determinants of Tree-Growing Behaviour in Rural Ethiopia: Environment for Development,Discussion Paper Series. EfD DP 11-14.

Akalu Teshome, Graaff J. and Menale Kassie, 2016. Household-Level Determinants of Soil and Water Conservation Adoption Phases: Evidence from North-Western Ethiopian Highlands: Environmental Management; 57: 620–636. DOI 10.1007/s00267-015 0635-5.

Amogne A., 2014. Forest resource management systems in Ethiopia: Historical perspective. International Journal of Biodiversity and Conservation, Vol. 6 (2), 121-131.

Anderson J.M., and Ingram J.S., 1993. Tropical Soil Biology and Fertility. A Hand Book of methods. Second Edition. A. B. International.

Anonymous, 2009. Climate Change- A Burning issue for Ethiopia. Green forum Conference Proceedings No.2.

Arnold, 2003. Adaptation to climate change in the developing world. Progress in Development Studies 33(2003)

pp.179–195. Adaptation to climate change: setting the agenda for development policy and research'. Symposium hosted by the Tyndall Centre for Climate Change Research and International Institute for Environment and Development, Royal Society, London, 25 Oct/2001.

Bekele M., Gebre Y., Mohammed Z., Zewdie S., Tebikew Y.,Brockhaus M. and Kassa H.,2015. The context of REDD+ in Ethiopia: Drivers, agents and institutions, Occasional Paper 127. Bogor, Indonesia: CIFOR.

Belay T., 1992. Farmers' Perception of Erosion Hazards and Attitude towards Soil Conservation in Gununo, Wolaita. *Ethiopian Journal of Development Research,* 14(2), 32 *P.*

Berhan Gessesse, Woldeamlak Bewket, and Bräuning A., 2016. Determinants of farmers' tree-planting investment decisions as a degraded landscape management strategy in the central highlands of Ethiopia: Solid Earth, 7, 639–650, 2016.

Berhanu Gebremedhin and Swinton S. M., 2003. Investment in soil conservation in northern Ethiopia: the role of land tenure security and public programs. Agricultural Economics 29 (2003) 69–84.

Brady N., 2000. The Nature and properties of soils. Prentice Hall, Upper Saddle River. New Jersey.

Brady N. and Weil R., 2001. The Nature and Properties of soils. Thirteen Edition. Prentice Hall. New Jersey.

Calder, I. R., 1998. Water-Resource and Land-Use Issues. SWIM Paper 3. Colombo, Sri Lanka:International Water Management Institute (IWMI).

Daniel Danano, 2010. Sustainable Land Management Technologies and Approaches in Ethiopia: The Federal Democratic Republic of Ethiopia Ministry of Agriculture and Rural Development; EthiOCAT 2010, Addis Abeba, Ethiopia.

Endalkachew Kissi, 2007.Teaching Manual on Soil and Water Conservation (unpublished), Jimma Univerisity; Jimma, Ethiopia.

FAO, 1984. Ethiopia,Land Use Production Regions and Farming Systems Inventory, Rome, Italy.

FAO,2015. Global Forest Resources Assessment 2015: Country report, Ethiopia.

FDRE, 2007. Federal Democratic Republic of Ethiopia: Federal Negarit Gazeta, A proclamation to provide for the development conservation and utilization forests: Proclamation No. 542/2007. 13th year, no. 56, September 2007. Addis Ababa, Ethiopia.

FDRE, 2011. Federal Democratic Republic of Ethiopia: Ethiopia's Climate-Resilient Green Economy strategy. Addis Ababa, Ethiopia September 2011.

FDRE, 2015. Federal Democratic Republic of Ethiopia: The Second Growth and Transformation Plan (GTP II) (2015/16-2019/20) (Draft). National Planning Commission, September 2015, Addis Ababa, Ethiopia.

Forman R., and Godran M., 1986. Landscape Ecology. John Wiley and Sons. Canada.

Förch G., 2009. IWM; A successful tool for adaptation to climate change.Siegen, Germany. http://www.rural21.com/uploads/media/rural_eng_22-25_03.pdf.

Gadisa Chimdesa,2016. Historical Perspectives and Present Scenarios of Watershed Management in Ethiopia. *International Journal of Natural Resource Ecology and Management.* Vol. 1, No. 3, 2016, pp. 115-127. doi: 10.11648/j.ijnrem.20160103.17

Gadisa Chimdesa (2016b). Ecosystem Approach for Sustainable Natural Resources Management: Journal of Resources Development and Management. A Review Article; Vol.19, 2016.

German L., Hussein Mansoor, Getachew Alemu, Waga Mazengia, T. Amede and A. Stroud,2007. Participatory integrated watershed management: Evolution of concepts and methods in an ecoregional program of the eastern African highlands. Agricultural Systems 94 (2007) 189–204.

Girma Kelboro, 2000. A Participatory Approach to Agroforestry in Watershed Management, MSc thesis, case study at Yannasie, SNNPR, Ethiopia, Wagenin, the Netherlands

Gupta P., 2005. Methods in Environmental Analysis. Agricultural and Technological University of Maharama Pratap. Agrobiots, India.

Hayward, B., 2005. From the Mountain to the Tap: How Land Use and Water Management Can Work for the Rural Poor. London: DFID.

Http://www.colorado.edu/research/cires/banff/pubpapers/128/).Internet document available at 13/01/2010 *Http://www.epa.gov/watertrain*): EPA's *Watershed Academy Web*

Hurni, H., 1993. Land Degradation, Famines & Resource Scenarios in Ethiopia. In: Pimental, D. (Ed). World Soil Erosion and Conservation. Cambridge: Cambridge University Press.

IDNDR, 1994. Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation, 1994. http://hoshi.cic.sfu.ca/~idndr/yokohama/yokohama.html:

IPCC, 1995. Climate Change 1995, Synthesis Report. Cambridge University Press, Cambridge

IPCC,2001. "Climate Change 2001: Synthesis Report. Intergovernmental Panel on Climate Change Third Assessment Report." Geneva: IPCC.Available at http://www.ipcc.ch/ipccreports/assessments-reports.htm.

IPCC, 2007. Climate Change 2007.Synthesis Report. Cambridge University Press. Cambridge.

Johnson and Van Hook, 1989. Analysis of biogeochemical cycling processes in Walker Branch Watershed. Springer-Verlag, New York.

Jonse B., Sisay N., and Alemu M., (editors), 2008. Policies to increase Forest cover in Ethiopia. Proceedings of a Policy Workshop held at Global Hotel, Addis Ababa, Ethiopia from 18-19 September 2007.

Kumar, S., 2009.Impacts of Watershed Development Programmes: Experiences and Evidences from Tamil Nadu.URL: http://mpra.ub.uni-muenchen.de/18653/1/MPRA_paper_18653.pdf.

Logan J, Venezia J & Larsen K., 2007. Opportunities & Challenges for Carbon Capture & Sequestration. WRI, USA.

Ludi. E., 2004. Economic Anlaysis of soil conservation: case studies from the highlands Amhara Region, Ethiopia. University of Beme. Switzerland.

Madely J., and Stalton S., eds., 1992. Land Reform and sustainable Agriculture. Inter Mediate Technology Publication in association with foundation for Development and Peace. © Stiftung. Entwick lung and Frie de (SEF) Bonn 1992.

Mendelsohn, R., A. Dinar, and L. Williams., 2006. "The Distributional Impact of Climate Change on Rich and Poor Countries." *Environment and Development Economics* 11(2006):1–20.

McCornick P.G., Kamara A.B. and Girma Tadesse. (eds)., 2003. Integrated water and land management research and capacity building priorities for Ethiopia.Proceedings of a

McKenzie, D., Z. Gedalof, D. L. Peterson, and P. Mote. 2004. "Climatic Change, Wildfire, and Conservation." *Conservation Biology* 18(4):890–902.

Mearns and Leach, 1998. Beyond the wood Fuel crisis. People, Land and Tress in Africa. Earth scan publications. Ltd. London.

Melaku Bekele, 2003. Property Rights. Institutional Exigency and the Role of Government. University of Agricultural Sciences. Uppsala, Sweden.

Melaku Bekele, 2009. Natural Resource Law and Policy. Wondo Genet College of forestry & Natural Resource.

Meshesha Y. B. and Birhanu B. S.,2015. Assessment of the Effectiveness of Watershed Management Intervention in Chena Woreda, Kaffa Zone, Southwestern Ethiopia: Journal of Water Resource and Protection, 7, 1257-1269.

MoFED, 2006. PASDEP, plan for accelerated sustainable development to end poverty. Addis Ababa, Ethiopia.

Mulugeta, T**.,** 1988**.** Soil Conservation Experiments on Cultivated Lands in the May bar Area South Wollo Region, Ethiopia. University of Berne, in association with the United Nations University, Switzerland.

Negassi A., Bein E., Gebru K., and Tengnas Bo., 2002. Soil and water conservation Mannual for Eritrea.

NMA, 2007. Climate Change Adaptation Program of action (NAPA).Abebe Tadege(eds.),AA, Ethiopia

Panda S., 2006. Soil management and organic farming. Agro bio. India.

Paulos, A., 2002. Determinants of Farmers' Willingness to Participate in Soil Conservation Practices in the Highlands of Bale: The case of Dinsho farming system area. Alemaya University, Page 14 Ethiopia.

Simeneh Demissie ,2015. Perception of Farmers toward Physical Soil and Water Conservation Structures in Wyebla Watershed, Northwest Ethiopia: Academic Journal of Plant Sciences 7 (3): 34-40, 2015. DOI:10.5829/idosi.ajps.2015.7.3.12822.

Tesfa Worku and Tripathi S. K.,2015. Watershed Management in Highlands of Ethiopia: A Review. Open Access Library Journal, 2: e1481.

Waga Mazengia, Deribe Gamiyo, Tilahun Amede, Matta Daka and Jermias M.,2007. Challenges of Collective Action in Soil and Water Conservation: The Case of Gununo Watershed, Southern Ethiopia: African Crop Science Conference Proceedings Vol. 8. pp. 1541-1545.

Wani SP, Sreedevi TK, Reddy TSV, Venkateswarlu B and Prasad CS. 2008. Community watersheds for improved livelihoods through consortium approach in drought prone rain-fed areas. Journal of Hydrological Research and Development. 23:55-77.

Warren P., 1988. Developing participatory and Integrated watershed management. Participatory upland conservation and development (PVCD). Italy.

Winnegge, R., 2005. Participatory Approach in Integrated Watershed Management.URL: *http://www.uni-siegen.de/fb10/fwu/ww/publikationen/volume0305/pdf/winnegge.pdf.*

Woldeamlak Bewket, 2007. Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: Acceptance and adoption by farmers: Land Use Policy 24 (2007) 404–416

World Bank, 2008. Watershed Management Approaches, Policies, and Operations: Lessons for Scaling Up. Washington, DC

Zenebe Gebreegziabher, Alemu Mekonnen, Menale Kassie,and Köhlin G.,2010. Household Tree Planting in Tigrai,Northern Ethiopia: Tree Species, Purposes, and Determinants:Environment for Development, Discussion Paper Series. EfD DP 10-01.

Zoebisch M, Marcho K, Hein S,Mowla R.,2005. Integrated Watershed Management - Studies and Experiences in Asia.URL: http://www.forestrynepal.org/publications/reports/4136.