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Land Degradation in Ethiopia: Causes, Impacts and Rehabilitation Techniques

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Abstract
Land degradation is the common environmental problem in Ethiopia. It is one of the major causes of low and declining agricultural productivity and continuing food insecurity and rural poverty. In addition, land degradation directly affected the type of plant grown on the area, reduced availability of potable water, lessened volumes of surface water, depletion of aquifers and biodiversity loss. The major causes are rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. Topography, soil types and agro-ecological parameters are also additional factors affecting the land degradation processes in Ethiopia influenced by man. Throughout history, efforts to combat land degradation is focused on physical conservation structures. However, use of vegetative measures is very much limited.
Key words: land degradation, rehabilitation

1. Introduction

Land degradation is a major global issue for the 20th century and will remain high on the international agenda even for the 21st century (Working Group on Land Degradation and Desertification of the International Union of Soil Sciences 1999). Various sources suggest that 5 to 10 million hectares worldwide are being lost annually to severe degradation. If this trend continues, 1.4 to 2.8 percent of total agricultural, pasture, and forestland will have been lost by 2020 (Scherr and Yadav 1996).

Land degradation includes all process that diminishes the capacity of land resources to perform essential functions and services in ecosystems (Hurni *et al*. 2010) are caused by two interlocking complex systems: the natural ecosystem and the human social system. Interactions between the two systems determine the success or failure of resource management (Berry 2003). Principal processes of land degradation include erosion by water and wind, chemical degradation (comprising acidification, salinization, fertility depletion, and decrease in cation retention capacity), physical degradation (comprising crusting, compaction, hard-setting, etc.) and biological degradation (reduction in total and biomass carbon, and decline in land biodiversity) (WMO 2005). It is a continuous process and has become, however, an important concern affecting food security and the wealth of nations, and has an impact on the livelihood of almost every person on this earth (Bezuayehu *et al*. 2002).

Ethiopia is one of the most well endowed countries in Sub-Saharan Africa in terms of natural resources (Gete *et al*. 2006). However, natural resource degradation in Ethiopia has been going on for centuries (Hurni *et al*. 2010). Similarly, Berry (2003) also stated that loss of land resource productivity is an important problem in Ethiopia and that with continued population growth the problem is likely to be even more important in the future. The major causes of land degradation in Ethiopia are rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production (Girma 2001). Topography, soil types and agro-ecological parameters are also additional factors playing significant role in the degradation processes influenced by man (Paulos 2001). To combat land degradation, the Ethiopian government launched a massive soil conservation programme in the middle of 1970's (Hawando 1997). A slogan of environmental movement in 1980s and 1990s i.e. "think globally- act locally" face failures. Thus, a new slogan namely "think locally- act globally" have to be created (Hurni 2002). In addition, afforestation and conservation programs have been made in the last three decades (Badege 2001). However, success to date has been limited (Badege 2001; Paulos 2001). Thus, the purpose of this paper is to give an overview on the causes and impacts of land degradation in Ethiopia, and to present rehabilitative measures to restore degraded lands.

2. Land degradation: Causes, impacts and rehabilitation techniques

2.1 Causes of land degradation

Scholars identified different causes of land degradation. For example, according to Berry (2003), the cause of land degradation involves two interlocking complex systems: the natural ecosystem and the human social system. Interactions between the two systems determine the success or failure of resource management. While, WMO (2005) classified the causes of land degradation into biophysical factors such as unsuitable land use (land use for the purpose for which environmentally unsuited for sustainable use), socioeconomic factors such as poor land management practices, land tenure, marketing, institutional support, income and human health, and political factors such as lack of incentives and political instability. In parallel, Mulugeta (2004) argued that land

degradation is a biophysical process driven by socioeconomic and political causes in which subsistence agriculture, poverty and illiteracy are important causes of land and environmental degradation in Ethiopia. While, Gebreyesus and Kirubel (2009) reported that the heavy reliance of some 85 percent of Ethiopia's growing population on an exploitative kind of subsistence agriculture is a major reason behind the current state of land degradation. Similarly, studies conducted by Temesgen *et al*. (2014a, b) in Dera District, Ethiopia exemplified the increased of land degradation which mainly caused by the growing population of the area. Additional study by Fitsum *et al*. (1999) illustrated that there are multiple interacting forces which have caused and are causing land degradation in Ethiopia. These are the proximate and interacting or root causes. Thus, the above classification indicates that land degradation in Ethiopia is caused by the interaction of many forces (Figure 1 and 2).

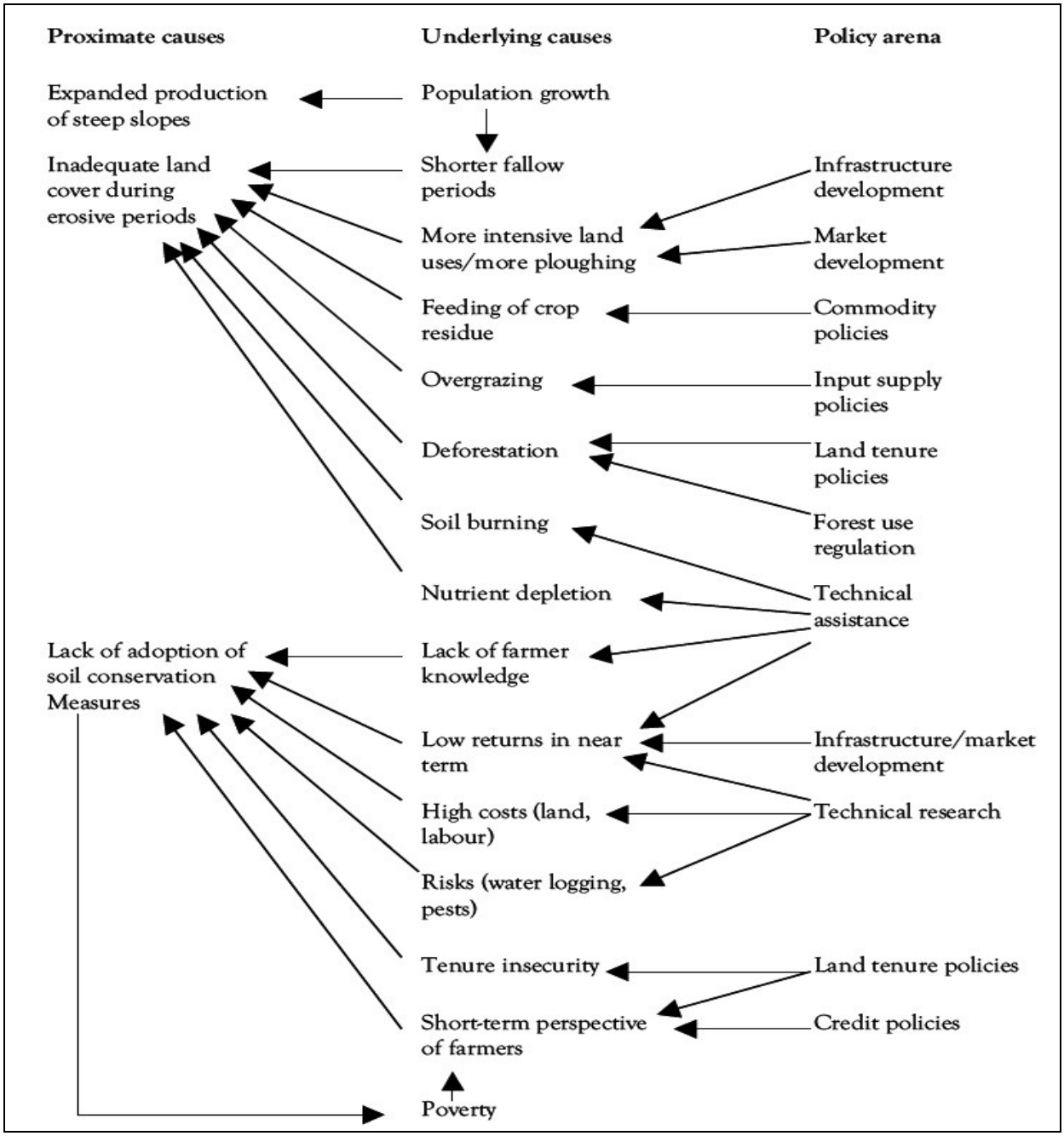

Figure 1: Causes of soil erosion (Fitsum *et al.* 1999)

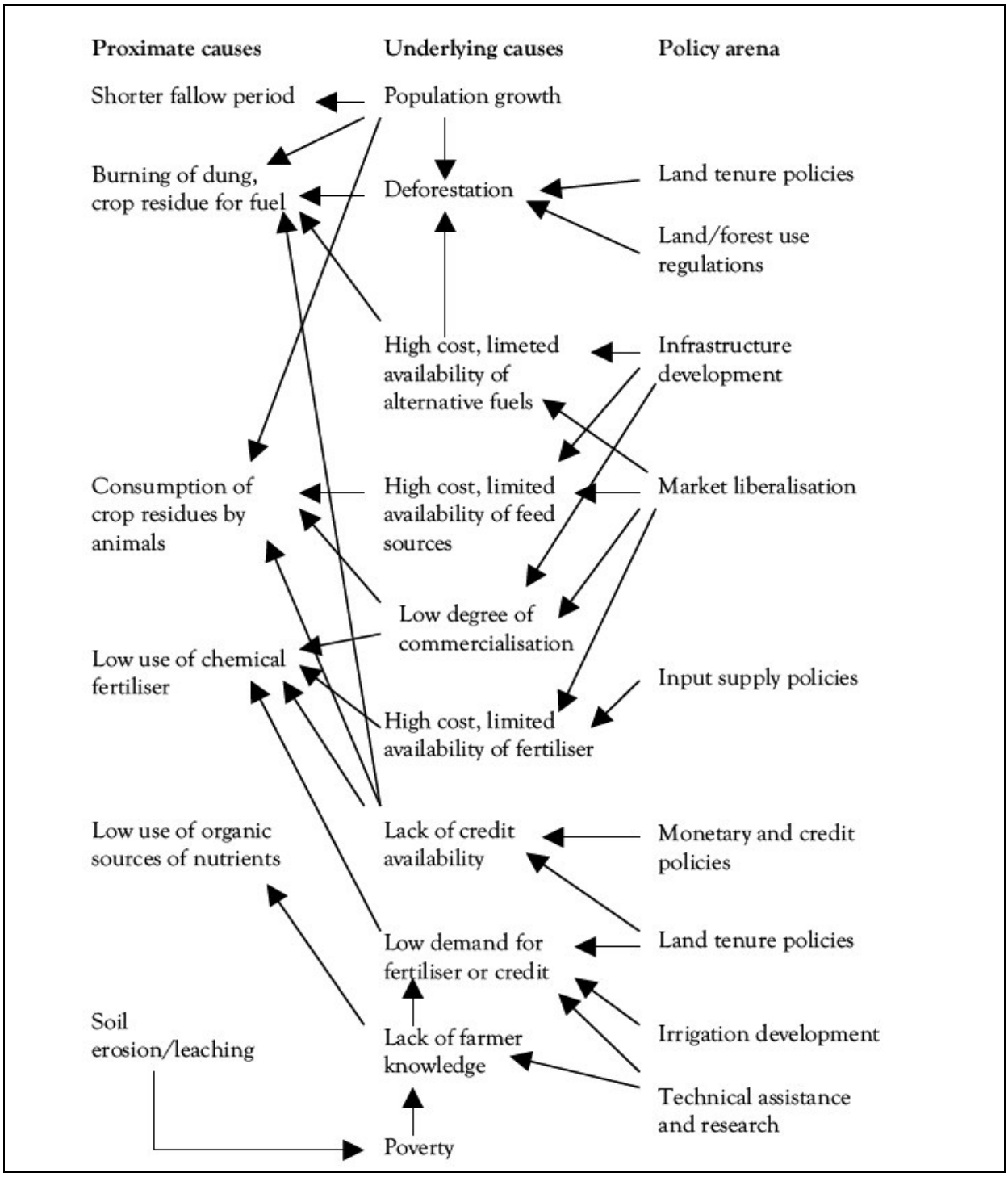

Figure 2: Causes of nutrient depletion (Fitsum *et al.* 1999)

2.2 Impact of land degradation

Land degradation manifests itself in many different ways: vegetation becomes increasingly scarce, water courses dry up, thorny weeds predominate in once rich pastures, footpaths grow into gullies, and soils become thin and stony. All of these manifestations have potentially severe impacts on the environment, for land users and for people who rely for their living on the products from a healthy landscape (Berry 2003).

2.2.1 Socio-economic impact of land degradation

Land and water degradation threaten food security for many of the poorest and most food insecure living in Asia, Africa and Latin America. It also contributes to persistent poverty, and results in decreasing ecosystem resilience and provision of environmental services (Bossio *et al*. 2004). In addition, environmental decline due to land degradation adversely affects the health, well-being and livelihood opportunities of the individuals (Vivian *et al.*

1994; Scherr and Yadav 1996; Fitsum *et al.* 1999).

Due to the presence of land degradation, Africa as a whole has become a net food importer since the mid-1980s. However, the economic implications of land degradation are particularly severe in Sub-Saharan Africa because 65% of the population is rural and the main livelihood of about 90% of the population is agriculture (Project Development Facility 2007). The most serious problem of Ethiopia's land resources is soil erosion. Every year the country is losing billions of birr in the form of soil, nutrient, water and agro biodiversity losses (Paulos 2001). As a result, poverty and food insecurity are concentrated in rural areas (MoARD 2010). Estimates vary considerably but direct losses of productivity from land degradation in Ethiopia are minimally 3 percent of agriculture GDP (Berry 2003). Land degradation is one of the major causes of low and in many places declining agricultural productivity and continuing food insecurity and rural poverty in Ethiopia (IFPRI 2005). The Ethiopian highlands are affected by deforestation and degraded soils, which have eroded the resource base and aggravated the repeated food shortages caused by drought (Tilahun *et al*. 2001).

Land degradation reduced livestock productivity as a result of reduced grazing resources, loss of nutritious plants and grass species (Fitsum *et al.* 1999). Due to land degradation, increased runoff and reduced infiltration contributes to flooding problem (Desta *et al.* 2000; Bezuayehu *et al.* 2002). Deforestation and desertification adversely affect agricultural productivity, the health of humans as well as of livestock, and economic activities such as ecotourism (UNCCD 2004). Similarly, Shibru (2010) reported that the loss of soil productivity in Limo *Woreda* leads to reduced farm income and food insecurity, particularly among the rural poor and thus continuing or worsening poverty. Land degradation can contribute directly to poverty by reducing the availability of other valuable goods and services important to poor households (for example, fuel wood, construction materials, wild foods, and medicinal plants) and by increasing the demands on labor needed to forage for such goods.

2.2.2 Ecological impact of land degradation

Land degradation has multiple and complex impacts on the global environment through a range of direct and indirect processes affecting a wide array of ecosystem functions and services (GEF 2006). The principal environmental impacts of land degradation include a rapid loss of habitat and biodiversity, modifications of water flows, and sedimentation of reservoirs and coastal zones (Project Development Facility 2007). The resultant ecological impacts of land degradation in Ethiopia include loss in the chemical, physical and/or biological properties of soil which directly affects the type of plant that are grown on the area, reduced availability of potable water, lessened volumes of surface water, depletion of aquifers due to lack of recharge, and biodiversity loss (Berry 2003). Similarly, Mulugeta (2004) also described that land degradation is threatening biological resources and agricultural productivity.

Land degradation also interrupts the regulating and provisioning services of ecosystems, in particular nutrient cycling, the global carbon cycle and the hydrological cycle (GEF 2006). Generally, land degradation has a number of environmental impacts on regional and global level. First, degradation of forests and woodlands has impacts on global biodiversity. Second, changes in forest cover and wetlands are impacting the flow of major rivers. Third, large scale loss of forest cover changes the albedo and air circulation patterns and may affect global climate change. Fourth, soil erosion may cause excessive siltation in rivers and inland lakes, causing reduced water storage capacity in lakes, as well as eutrophication and water quality problems (Project Development Facility 2007).

2.3 Mechanisms to prevent land degradation and restore degraded lands

Land degradation can be prevented through different mechanisms depending up on the nature and form of degradation. Most types of soil degradation can be prevented or reversed by adding nutrients to nutrient depleted soil, rebuilding topsoil through soil amendments, reestablishing vegetation, or buffering soil acidity (Scherr and Yadav 1996). However, some aspects of land degradation are less easily reversed than others. For example, terrain deformation by gully erosion, or total topsoil loss from erosion, or the wiping out of native soil fauna is more irreversible than a negative nutrient balance, or surface sealing and crusting (Coxhead and ygard 2008). In parallel, Scherr and Yadav (1996) illustrated that some types of land degradation are, for all practical purposes, irreversible. Examples are severe gulling and advanced salinization. Displacement of soil material (erosion) is also irreversible, although its long-term effects on productive capacity depend on the depth and quality of soil remaining.

According to Coxhead and ygard (2008), the main environmental principles for reducing land degradation are to maximize vegetation cover to prevent erosion, replace nutrients removed, and to put in place structures (terraces, bunds, vegetation strips) so as to reduce the speed and volumes of water flow over the soil. From this perspective, tree crops, perennial crops, intercropping and reduced-tillage systems are preferred. Similarly, UNCCD (2004) revealed that forests and tree cover combat land degradation and desertification by stabilizing soils, reducing water and wind erosion and maintaining nutrient cycling in soils. Therefore, sustainable use of goods and services from forest ecosystems and the development of agro forestry systems can contribute to poverty reduction, making the rural poor less vulnerable to the impacts of land degradation.

Broadly speaking, land degradation can be controlled, reduced or even reverted if the land is used wisely, if all

functions of the land are taken into account, and if long-term interests of all segments of human kinds replace short-term vested interests of privileged group globally, naturally and locally (Getachew 2005). Scherr and Yadav (1996) also pointed out that rehabilitating degraded landscapes depend on the costs relative to the value of output or environmental benefits expected. Throughout history, efforts to combat land degradation in Ethiopia is focused on physical conservation structures (Woldeamlak 2003). Similarly, Temesgen *et al*. (2014c) reported that farmers in Dera Woreda, Ethiopia heavily depend on physical soil conservation structures. However, using of vegetative measures is very much limited. However, it is agreed that, land degradation should be treated according to the type of land degradation (Table 1).

Table 1: Component of degradation, type of degradation and ways of improving degraded land (Scherr and Yadav 1996)

Component	Degradation	Improvement
Physical soil management	Crusting Compaction Sealing Water erosion Wind erosion Devegetation Over tillage	Soil conservation barriers Terracing Revegetation of denuded lands Tree protection Soil decomposition Breaking up of pans Cover crops Wind breaks Soil deposition Improved tillage methods
Soil water management	Impeded drainage Water logging Reduced water holding capacity Reduced infiltration Salinazation	Irrigation Water harvesting Field drainage Draining of water logging areas Filter strips
Soil nutrient and organic matter management	Alkalinization Acidification Nutrient leaching Removal of organic matter Burning of vegetative residues Nutrient depletion	Fertilization Composting Green manuring Animal manuring Flushing of saline alkaline soils Liming acid soils
Soil biology management	Over application of agrichemicals Industrial contamination	Introduction of biotic organisms Nitrogen fixing micro organisms
Vegetation management	Decline in vegetative cover Decline in biodiversity Decline in species composition Decline in availability of valued species	Increased vegetation cover Increased species diversity Improved species composition Improved availability of valued species

4. Conclusion

Being a common problem in Ethiopia, land degradation puts disastrous impact on the socio-cultural environment and ecological setting of the country. The major causes include rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. In addition, topography, soil types and agro-ecological parameters are contributing factors in the degradation processes influenced by man. To control land degradation, conservation measures throughout history are mainly focused on physical conservation structures which have less contribution for the addition of nutrients removed and to control soil erosion as compared to vegetation measures. However, as can be indicated in main text, land degradation can be prevented through different mechanisms depending on the nature and form of degradation.

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