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Impact of soil erosion associated factors on available feed resources for free-ranging cattle at three altitude regions: Measurements and perceptions

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ABSTRACT

The study was conducted to assess the status and trends of soil erosion and relate the perceptions of farmers on cattle productivity and botanical indicators to measured ecological conditions of rangelands in three altitude regions of southwest Ethiopia. A total of 342 farmers were interviewed. In addition, the ecological condition of rangelands was assessed. Severe soil erosion, ranked as the primary restriction to free-ranging livestock, occurred predominantly in the lower altitude region (LAR) ($P < 0.05$). More farmers in LAR witnessed an inadequacy of palatable plant biomass, grazable pasture as well as increased gully formation and expansion, which are strong indicators of soil erosion ($P < 0.001$). In addition to a decrease in grass cover and productivity of cattle, botanical composition, species richness and grazing capacity of herbaceous plants, less fodder trees and shrubs were observed ($P < 0.05$). There was a corresponding increase in the percentage of bare ground and soil erosion status along the degradation gradients ($P < 0.05$). The reported shift in botanical composition, and especially encroachment of invading plant species, can be attributed to soil erosion ($P < 0.001$). The results suggest that erosion is associated with reduced availability of feed resources and is related to altitude variation.

1. Introduction

Livestock production in Ethiopia is affected by numerous problems, of which land degradation features prominently (Gebremedhin et al., 2002; Tefera et al., 2002). Different scholars have defined land degradation in different ways depending on the purpose of their studies, but the most common definition within the context of agricultural production states that land degradation is a temporal or permanent lowering of the productive capacity of the land (FAO, 2001). This definition includes closely interrelated processes, such as physical deterioration (removal of top fine soil through erosion, surface crusting and sealing), chemical deterioration (i.e., loss of nutrients and humus by leaching, erosion), and biological deterioration (i.e., decrease in the population, activity and species diversity of soil fauna and flora) (Eyasu, 2002). All these forms of degradation lead to soil fertility depletion, loss of land productivity and declining per capita food production in sub Saharan Africa (Young, 1989). The problem is often better understood by farmers than policy makers, development planners and researchers of the countries in the Horn of Africa (Kassahun et al., 2008). Estimates vary considerably, but direct losses of productivity from land degradation through soil erosion are believed to be at least 3 percent of agriculture's gross domestic product (IGAD, 2004). Land degradation in southwest Ethiopia is mainly aggravated by depletion of soil fertility from grazable and cultivable land, agricultural productivity decline and clearing of natural vegetation (Abebayehu, 2010). Together with the type of grazing system, human population pressure and climate change are the most important driving forces affecting the environmental impact of mixed crop-livestock farming systems in the developing world (McIntire et al., 1992; Williams et al., 1995). Livestock production in Ethiopia is practiced under communal ownership of grazing land (ILRI, 1999) and is predominantly smallholder farming (Alemayehu, 2006). The cheapest ruminant livestock feed resource in Ethiopia (Alemayehu, 2006) and southwest Ethiopia remains natural pasture (Yisehak and Belay, 2011). Good grazing management practice and wise utilization of natural vegetation in free-ranging pastures are not encouraged to counter soil erosion, which

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therefore detrimentally affects overall animal productivity (EARO, 2003). Most communal grazing land has become severely degraded due to soil erosion (Belsky et al., 1993; Gebremedhin et al., 2002; Jahnke, 1982). The grazing land in this system is perceived as a common resource over which nobody has direct responsibility and whose utilization is open to all members of a community, and thus is typically under enormous threat (Alemayehu, 2006). Major impacts of degradation of rangeland resources identified by Jabbar et al. (2000), McCarthy et al. (2002), Haileselassie et al. (2005) and Mekuria et al. (2007) include reduction in total vegetation cover and palatable plant species, increase in undesirable and unpalatable plants, and depletion in soil quality and nutrients due to various forms of soil erosion.

It is widely accepted and supported by research on farming systems, that vegetation and soil type, mode of life and many more characteristics vary between altitudes (Ayana and Barrs, 2000; Alemayehu, 2005; Holechek et al., 2004; ILCA, 1990). The pattern of grazing-induced vegetation and soil changes in the major grazing lands (natural pastures) has not been documented in the Gilgel Gibe catchments of the Jimma zone southwest Ethiopia. Such information coupled with data on the affect of traditional grazing practices is essential in designing improved management strategies, efficient resource use and for formulating rations based on locally available feed resources. The aim of the present study was therefore to (i) assess the status and trends of soil erosion in freely grazed rangelands based on herbaceous, woody and soil layers, and (ii) examine and relate the perceptions of farmers of the impact of soil erosion on botanical, soil and cattle productivity to measured parameters in three different altitudes of the catchment.

2. Materials and methods

2.1. The study area

The survey was carried out in five selected districts (*woredas*) of the Jimma administrative zone, Ethiopia, located in the Gilgel Gibe dam catchment (Fig. 1), 260 km away from Addis Ababa. The Gilgel Gibe dam (JU, 2006) lies in the centre of the study area situated at 7°47′19.17″–7°49′02.50″ °N and 37°13′08.54″–37°20′06.31″ °E, and the altitude ranges from 1600 to 1700 m above sea level (masl). The dam has a catchment area of 4200 Sq Km (PHE, 2010). The catchment is characterized by crop-livestock mixed farming system where rangeland is major feed resources for livestock (Yisehak et al., 2009). Rangelands cover about 10% of the total land surface of the catchment. Livestock husbandry plays an important role in sustaining the livelihood of the resource poor farmers. The study districts are characterized by its population density has been estimated at 30–85 people per km^2. Cattle are the populous animal among herbivores livestock species in the districts followed by goats and sheep. Climate change is prevalent and rangelands in the region tend to support short or scrubby vegetation that usually are dominated by herbaceous plant species. The climate of the area (GOR, 2006) is characterized by short and main rain seasons occurring from mid February to May and June to September, respectively. Cattle production is mainly carried out by traditional smallholders on freely grazed communal rangelands throughout the year. Nitosols are the most abundant soil type, covering about 90% of the study area (GOR, 2006), which are dark reddish brown in color and slightly acidic. The area has slightly undulated to plain terrain features.

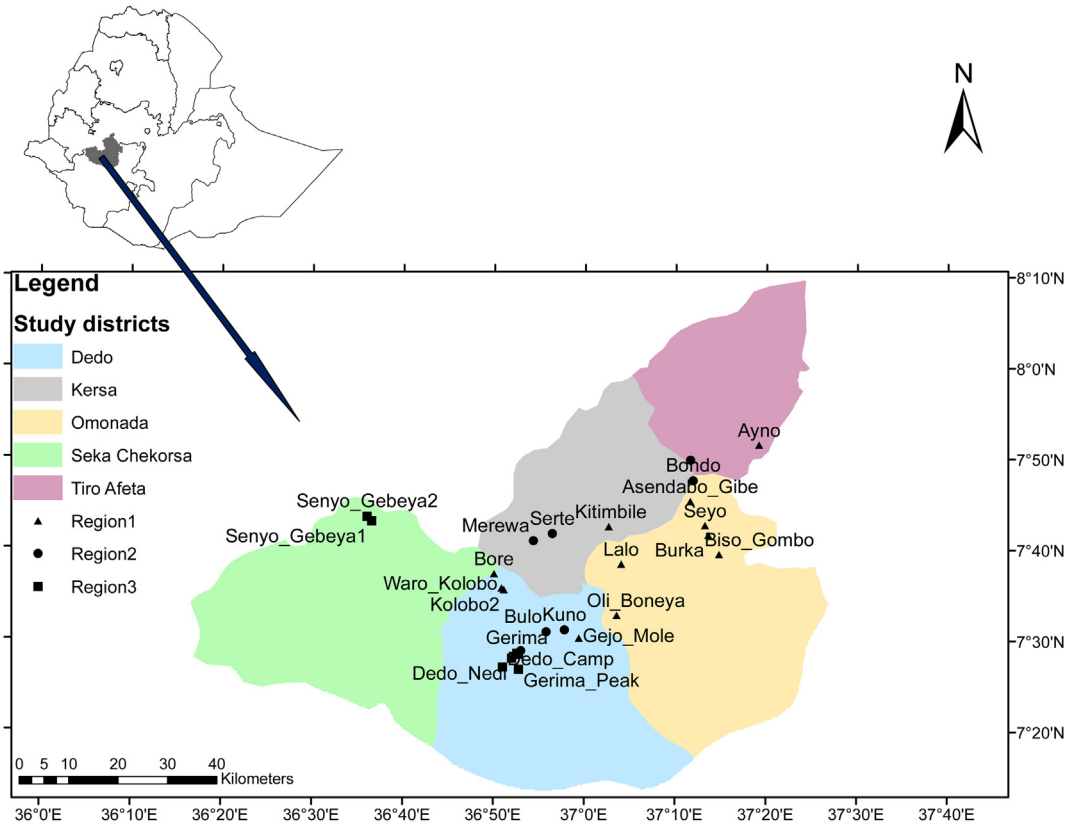

Fig. 1. The study districts of Gilgel Gibe catchment.