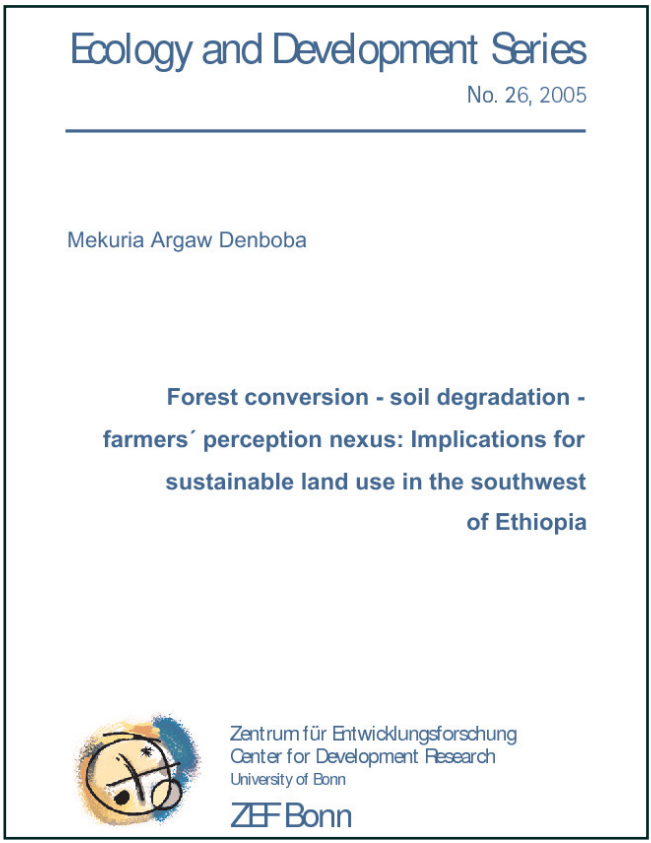
Forest coversion - soil degradation - farmers´ perception nexus: Implications for sustainable land use in the southwest of Ethiopia



1 GENERAL INTRODUCTION

1.1 Background and problem statement

"Our common future", published by the World Commission on Environment and Development (WCED, 1987), which is also known as the Brundtland Report, came up with a comprehensive analysis of the impacts of human activities on the environment and established the concept of sustainable development. Strategic pathways to improve the human well-being in the short term without threatening the local and global environment in the long term were put forward. As a follow up of the forwarded propositions, many developing countries have initiated soil and water conservation programs to combat land degradation and to counter its impacts on the sustainability of development endeavors. In many of the cases, results from the activities of such initiatives were not satisfactory and in some cases failed to achieve their targeted objectives for various reasons (Graaff, 1993). Land degradation has thus remained an unresolved issue of environmental problems in many developing countries and has put even short-term survival at stake.

Land degradation in developing countries, mainly in sub-Saharan Africa (SSA), is largely an outcome of the existing agricultural production system, which is a 'resource-poor' agriculture characterized by uncertain rainfall, low inherent land productivity, lack of capital, inadequate support services and poverty. This is not the case with the 'industrial' agriculture of the developed countries, which is capital and technology intensive, and the 'green revolution' agriculture of some developing countries, which is resource rich and sustained by plant breeding, inputs and irrigation technologies (WCED, 1987). The majority of the populations in the latter agricultural systems are supported by the non-agriculture sectors, while a greater share of the growing population in the developing countries (mainly in SSA) makes a living solely from agriculture. This high dependence in 'resource-poor' agriculture has resulted in high rates of deforestation and expansion of cultivation into fragile and marginal areas (Graaff, 1993).

The conversion of forest land into agricultural land is one way of increasing agricultural production and may itself not be a problem if the sustainability of agricultural land use is maintained, which is often not the case. In many of the cases,

however, deforestation on fragile soils and steep slopes leads to severe erosion and causes irreversible damage to soils. Forest conversion in such circumstances jeopardizes the important ecological role of forests in regulating hydrological regimes and maintaining biological diversity. Eventually, increasing rates of forest conversion, unsustainable agricultural land use and severe soil degradation create the *vicious circle* of the poverty-environment trap, which is the situation characterizing land degradation in the highlands of Ethiopia (Sonneveld and Keyzer, 2003).

Land degradation in Ethiopia stems from the historical development of agriculture and human settlement in the highland regions. Literature shows that the highlands are the oldest settled regions due to the favorable climatic conditions and fertile soils (Huffnagel, 1961). The physiographic abruptness influences the prevailing moisture-laden winds and provides considerable rainfalls to the highlands. The moderate temperature prevents the occurrence of tropical diseases. The volcanic parent material supplies a rich diversity of nutrients that make the soils suitable for crop production (Sonneveld and Keyzer, 2003). These positive factors have contributed to the high human and livestock population density there. As a result of increasing population density, agriculture has expanded at the expense of the natural vegetation (Melaku, 1992).

The natural high forests that used to cover about 40 % of the highlands have been converted to cultivated land and reduced to 2.7 % in less than a century (IUCN, 1990). One of the main reasons is that agriculture did not evolve into a better production system, but rather stagnated at the subsistence level for several centuries. The productivity of subsistence farming is very low and often causes extensification of cultivation into marginal areas with steep slopes. The massive removal of the vegetation exposed the soil to the highly erosive rainfall in the highlands and, at the same time, expansion of cultivation on the steep topography increased the risk of erosion and resulted in severe soil degradation (Fitsum *et al.*, 1999). Loss of the fertile top soil reduced production and the per capita income, which further impoverished the 'resource-poor' subsistence farmers.

The shortage of land, rapid growth of population and demand for increased food production intensified the pressure on the land and aggravated the process of land degradation (Sonneveld and Keyzer, 2003). Efforts to reverse the situation by

introducing soil and water conservation technologies did not yield concrete results (Dessalegn, 2001). Adoption of many of the technologies provided to farmers was minimal. Exclusion of farmers in the planning and implementation of conservation programs and their lack of awareness of the problems were main factors (Kebede *et al*., 1996; Dessalegn, 2001). Moreover, apart from several socioeconomic and technical factors, the extent of soil degradation in some areas has already passed the threshold level and restoration is no longer feasible (Constable and Belshaw, 1989). On the other hand, controlling severe soil erosion on steep slopes requires large amounts of capital and labor investment, both of which are critically scarce. Thus, unabated land degradation that shattered the seed-farming agro-ecological zones in the central and northern highlands contributed to the occurrence of recurrent droughts, which eventually led to out-migration of people from these highlands to the sparsely populated and less degraded southwestern highlands. At present, the southwestern highlands are the major destination areas of state-sponsored resettlements and sporadic migrations.

In contrast to the seed-farming central and northern highlands, the southwestern highlands have a different agro-ecology, which is characterized by perennial crop farming. Although 'resource-poor' and subsistent, agriculture is very intensive and specialized in the production of various root crops and perennial cash crops. The region is generally sparsely populated because of a relatively recent history of human settlement (Tafesse, 1996). The existing comparatively high forest cover and the relative ecological stability of the region may show that the impact of agriculture on the natural forest was moderate until recent times. In addition to the intensive nature of agriculture, the most important factor that has contributed to the survival of substantial amounts of intact natural high forests in the region is the economic importance of the forests in providing local livelihoods and in generating state revenue from the forest coffee.

With regard to the coffee-rich natural forests in the southwest region, the Kefa Zone is an area that contains more than 50 % of the remaining high forests in the country. These forests have a local, regional, national and international significance for their economic, ecological and high biodiversity values (Bech, 2002). For example, an international scientific journal recently published the discovery of a naturally decaffeinated coffee plant collected from these forests (Silvarolla *et al.*, 2004). At

present, there are growing interests from various concerned stakeholders to protect and conserve these forests.

However, the forests are threatened by agricultural expansion due to the increasing population pressure in the region as a result of migration and resettlements. Resettlers and migrants are predominantly from the seed-farming agro-ecological zones, and they are specialized cultivators of cereal crops. They have introduced a cereal crop-based farming system into the region. This is an extensive system that requires a relatively larger area than the traditional perennial crop-based farming system to sustain an average household. Besides, the resettlers have also introduced a number of new crops, e.g., pepper (*Capsicum annuum* L.) and finger millet (*Eleusine coracana* L.). The newly introduced system increased the diversity of crops in the existing traditional farming system and aggravated the conversion of natural forests into agricultural land (Alemneh, 1990). In recent times, the growing number of commercial coffee and tea plantations has also accelerated the conversion of forests. For example, in less than three years (1999 – 2001), about 110 km^2 of forests in the Kefa Zone have been converted to coffee and tea farms[1].

Despite the mounting pressure on the natural forest and the progressive development of the introduced farming system, the risk of soil degradation does not seem to have been given enough attention. Soil and water conservation has not been priority concern in the zone so far (Baah *et al.*, 2000). Literature shows that this type of intervention was concentrated in the already degraded areas of the highlands (Constable and Belshaw, 1989). Even though physical features of severe soil erosion (e.g., gullies and rills) are uncommon in the zone, there are indications that soil degradation is an emerging problem in other parts of the region. For instance, moderate to high degrees of soil erosion and chemical, physical and biological degradation of soil have been reported from environmentally similar areas in the Illubabor Zone of the southwest region (Alemneh, 1990; Solomon, 1994). Studies on these issues are lacking for the Kefa Zone.

Therefore, it is imperative that if the objectives of protecting and conserving the remaining high forests are to be met, the sustainability of the existing agricultural production systems has to be insured. This is fundamental not only for the conservation

[1] Data compiled from unpublished documents from the Kefa Zone Agriculture Development Department.

of the natural forests, but also for the proper functioning of the entire agro-ecosystem so that a sustained life support system can be maintained in the region. To do so, an objective analysis of the biophysical processes and assessment of the state of the resources (forest and soil in this case) is essential to provide indicators for soil conservation and sustainable land management planning and policy formulations. Therefore, addressing the following research questions is crucial: What is the trend of forest conversion and land use/land cover dynamics in the introduced and in the traditional farming systems? What are the underlying drivers? What are the impacts of forest conversion on the soil resource?

On the other hand, as mentioned above, the success of soil conservation activities and attaining sustainable land use depend on adoption of land management technologies and the land users' (farmers') awareness of the resource degradation problems. Evidence show that one of the often mentioned reasons for the failure of soil and water conservation campaigns are low adoption of technologies due to the lack of participation and motivation by farmers (Kebede *et al*., 1996). Apart from faulty approaches (e.g., top-down approach), the most important underlying factor for low adoption and low participation is the farmers' perception of resource degradation problems (Graaff, 1993; Biot *et al.*, 1995). In their day-to-day decision making on land use and management, the farmers' awareness of the degradation of their resources plays a significant role (Gray, 1999).

In some cases, farmers might be better aware of the condition of their land than is sometimes assumed by experts, but they may not be aware of the causes and consequences of the degradation processes. For instance, they may not realize that the soil erosion and nutrient declining processes are causes of declining yields (Fitsum *et al.,* 1999). In other cases, some farmers may not recognize the problem at all; others may not care for various reasons (Graaff, 1993). Farmers' awareness of resource degradation problems may be determined by a number of socioeconomic and biophysical factors (Cramb *et al*., 1999). For instance, low level of education has been reported as the reason for farmers' failure to recognize the process of soil erosion and an impediment to the implementation of soil conservation measures (Conacher, 1995). Thus, the perception of farmers is a prerequisite for technology adoption (Adesina and Baidu-Forson, 1995) as well as an important element to achieve sustainable land use.

Hence, to harness the biophysical findings, it is essential to examine the following research questions: How are the land users (farmers) percieving soil erosion and soil fertility problems? What socioeconomic and biophysical factors shape their awareness? What are their responses and coping mechanisms? What are the implications of the biophysical processes and the perception of farmers for sustainable land use in the study area? The formulated objectives are designed to address the research questions.

1.2 Objectives, hypotheses and significance of the study

The main objectives of the study are:

1. To evaluate and quantify the magnitude of forest conversion and the associated land use/land cover dynamics in the introduced and in the traditional farming systems, and to identify the underlying drivers;
2. To analyze and quantify the impact of forest conversion on soil erosion and soil fertility under the farming practices of the introduced and the traditional systems;
3. To assess the perception of farmers on soil erosion and soil fertility problems and their responses (coping mechanisms) as well as the socioeconomic and the biophysical factors that determine their perception.

The following sets of working hypotheses are formulated:

- The extensive cereal crop-based farming practices in the newly introduced system lead to higher rate of forest conversion and cause high rate of soil degradation than the intensive perennial crop-based farming practices in the traditional system;
- The perception of farmers of soil degradation problems is differentiated against their socioeconomic and biophysical background. Farmers with previous experience, i.e. the resettlers, being from degraded areas and having the experience, are more likely to be aware of the problem than the indigenous farmers in the traditional system;
- Appropriate awareness is a prerequisite for farmers' action. Thus, resettlers having the awareness are more likely to respond to the problem and to apply soil conservation measures than the indigenous farmers in the traditional system.

As the problems of land degradation have not been paid due attention in the Kefa Zone so far, this study will provide first-hand information on the impact of resettlement and expansion of agriculture on the forest resources and the state of soil degradation in the different farming systems. Since the study addresses the biophysical and the socioeconomic aspects of the problem, the results will be of crucial importance to formulate appropriate policies for resource conservation in the region. Development planners, resource managers and extension workers will benefit from the outputs. Moreover, the results will be of use to concerned stakeholders (e.g., development agencies), who try to initiate soil and water conservation as well as sustainable land use in the region. Overall, the study will provoke public awareness on the state of resource degradation in the region and instigate early protection measures.

1.3 Structure of the thesis

The thesis is organized into nine chapters. In Chapter 2, a review of the literature on theoretical perspectives, concepts, definitions and the state of land degradation in Ethiopia are elaborated. The the conditions of the study area and the methodological framework of the research are described in Chapter 3. In Chapter 4, land use/land cover change, the dynamics and state of forest conversion in the two farming systems are analyzed. The impacts of forest conversion on soil erosion and soil fertility are analyzed and discussed in Chapter 5 and Chapter 6, respectively.

In Chapter 7, the perception of farmers of soil erosion and soil fertility, their responses, the coping mechanisms, and the socioeconomic and biophysical determinants are analyzed and discussed. In Chapter 8, the interconnections (nexus) between the biophysical and the socioeconomic findings are discussed, and implications for soil and water conservation and sustainable land use are drawn. Chapter 9 concludes from the major findings of the research and provides relevant recommendations for further research.

2 LITERATURE REVIEW

2.1 Some theoretical perspectives

2.1.1 Agricultural change and land degradation

The complex relationship between human development and the environment is what causes land degradation, in which the use and management of the natural resources is a central issue. To date, there are no mega theories that coherently explain the relationship of resource management and land degradation. Land degradation is an interdisciplinary issue and thus other specialized theories and approaches are adapted in the explanation of resource management and degradation.

The two dominant agricultural change theories, which have been debated over the years and across disciplines, are the Malthusian and the Boserupian theory of agricultural change (Figure 2.1). Malthus (1817) argued that the power of population growth is indefinitely greater than the power of the land to produce subsistence for man. If unchecked, population continues to grow in a geometric ratio while subsistence (agricultural production) increases in an arithmetic (linear) ratio, yet population is dependent on agricultural production. As population density increases and land becomes scarce, the fallow period that farmers allow their land to rest decreases, and eventually farmers will expand production into marginal areas. When expansion is limited by the scarcity of the land resource, production extends through more intensive cultivation of existing fields. Such intensification (frequent cropping of a given land) decreases production and productivity, ending in food scarcity. Unless emigration or colonization of new land is possible, overpopulation leads to overexploitation and eventually to land/environmental degradation.

Critiques of the above mentioned treatise argue that the Malthusian perspective underestimates the capacity of human ingenuity and technology to overcome the constraints. Agricultural development, in this case, is viewed as a process of gradual change to better and better tools, whereby output per man-power in food production was increased and part of the population was made available for non-agriculture activities. This is the Boserupian perspective, which emphasizes more faith in technological development and states that shorter fallow will induce labor intensification and technological innovation, i.e., agricultural development is dependent

on population growth (Boserup, 1965). Boserup argues that extensive agriculture with low overall production is practiced when the density of population is low enough to allow it. When forced by rising population, production becomes more and more intensive, and adoption of technology increases. Better knowledge of land preservation and increased inputs improve yield, increase the value of land, and increase investment on land conservation and maintain productivity.

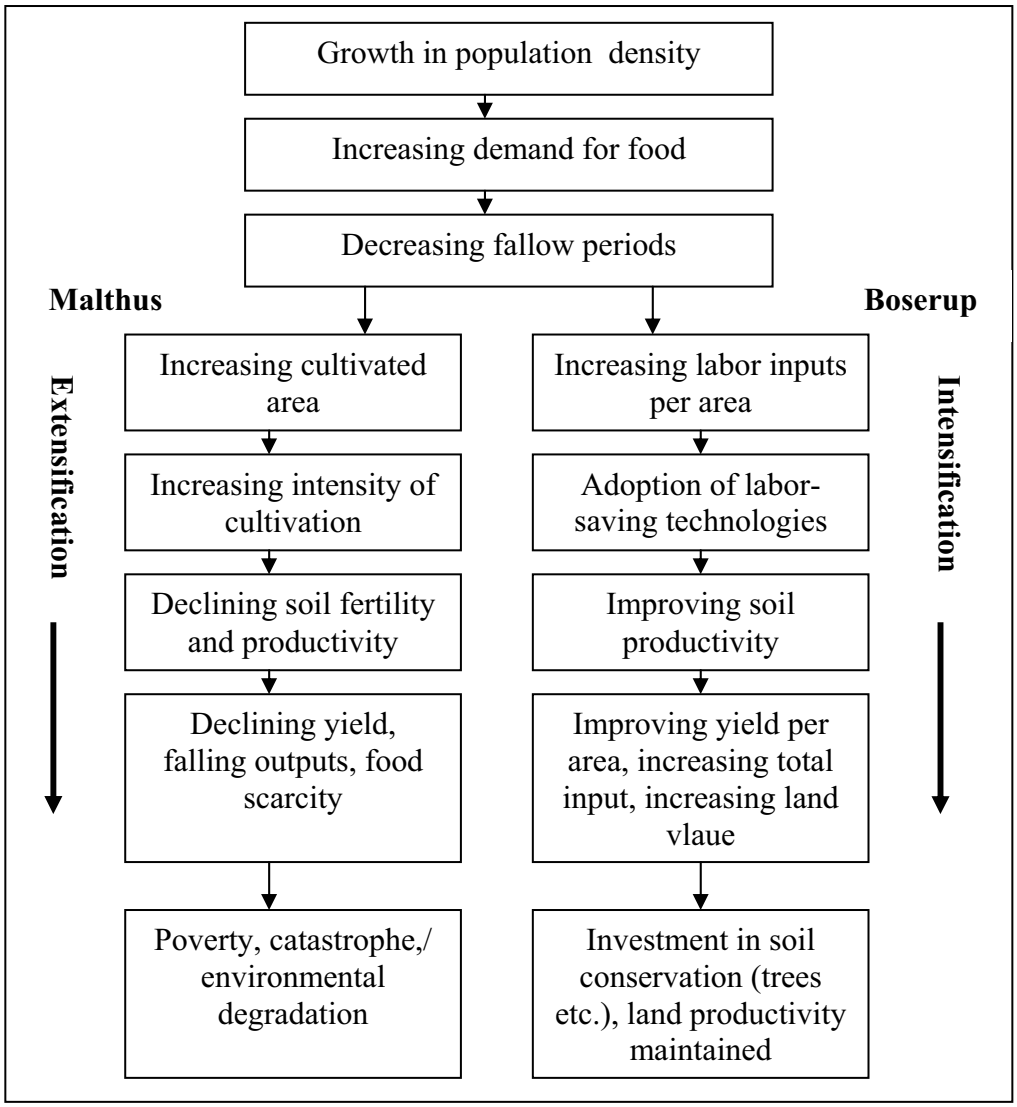


Figure 2.1: The Malthusian and Boserupian agriculture-population relationship

However, the Boserupian intensification requires the existence of ideal preconditions such as favorable environment, access to resources (access to capital, access to market, infrastructure), and supportive organizational structures (favorable