THE ECONOMICS OF LAND DEGRADATION

A Global Initiative for Sustainable Land Management

Case Study

Ethiopia Case Study

Soil Degradation and Sustainable Land Management in the Rainfed Agricultural Areas of Ethiopia: An Assessment of the Economic Implications

Ethiopia is known for its historic agriculture, but also for the associated, widespread, and on-going land degradation. The older agricultural areas of the northeast have long been particularly affected, but the highest soil erosion rates are currently being observed in the western parts of the highlands.
In order to reverse this trend, this case study provides a spatially explicit assessment of the extent of land degradation (soil erosion by water) and the costs and benefits of sustainable land management measures.

Introduction

The rainfed agricultural areas of Ethiopia (almost a synonym for the Ethiopian Highlands) are a paradigmatic example for doing an ELD Case Study. The highlands are favourable for rainfed agricultural activities, a main source of livelihood for about 87 per cent of Ethiopia's population (94 million in 2014) and around 75 per cent of the country's livestock. However, land degradation in this area is considered to be one of the severest cases worldwide.

Method

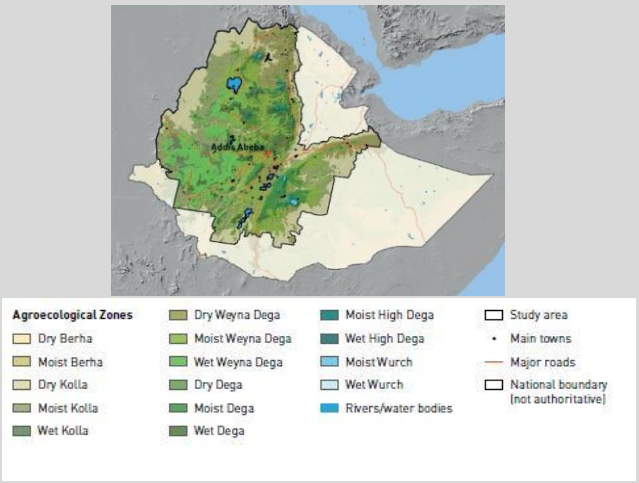
This case study provides a spatially explicit assessment of the extent of land degradation (soil erosion by water) and the costs and benefits of sustainable land management measures. As a basis for the final cost-benefit analysis, the study conducted a land cover mapping which was complemented by a conservation structure mapping. The unit of analysis is a pixel of 30 m by 30 m, in line with the resolution of the Landsat imagery used for assessing land cover. In total the study area covers more than 600 million pixels. Land cover was mapped using an approach that combined visual delimitation of units of analysis with expert knowledge and automated image classification. This approach made it possible to distinguish cultivated land (i.e., cropland, which in Ethiopia consists of land currently being ploughed or harvested, land with growing crops, land under mixed crop and trees system, and fallow land) from other land use or land cover classes. For the conservation structure mapping, the study devised on an approximate expert-based modelling approach incorporating various assumptions about the extent, quality and spatial distribution of such structures. Soil erosion and deposition values were estimated using pixel based landscape information and the Unit Stream Power Erosion Deposition (USPED) model, which works with the Universal Soil Loss Equation (USLE) parameters. The USPED model was adapted to Ethiopian conditions based on evidence from the Soil Conservation Research Programme, and calibrated and validated using data from former research stations. These adaptations made it possible to produce a pixel based soil erosion and sediment deposition model for the whole study area and even more importantly, to run different scenarios

Typical Ethiopian landscape with little soil and water conservation in Western Borena (Wello) [left]

Example of a cropland area with trees [right]

of investments in the cropland and show their effects after 30 years. Therefore, the study undertakes an estimation of future crop production for a 30 year time period by examining four different scenarios each modelling a different variation of conservation structure distribution and fertilizer application. The estimation algorithm was calibrated using information on productivity from reports of the Central Statistical Agency of Ethiopia.

Area Description



The study area comprises about 600.000 km² which is about 54 percent of Ethiopia's entire territory. 215.000 kn² have been identified as cropland.

Results

The initial land use mapping revealed that the study area comprises about 215.000 km² of currently cultivated cropland whereas governmental databases only indicate an area of approximately 123.000 km². Hence, much more land than believed is jeopardised by land degradation.

The present annual net soil erosion throughout the study area amounts to -940 million tonnes, or -18 tonnes/ha. Looking exclusively at cropland, the model produced an annual net erosion of –380 million tonnes (–20.2 tonnes/ha). This value could be reduced to –222 million tonnes (–11.8 tonnes/ha) if conservation structures were constructed on all sloping cropland. Currently just about 18 per cent of croplands dispose of conservation structures reducing soil loss through water- or wind erosion.

The results of the future crop production estimation analysis – assessing a discount rate of 12.5 per cent – show that by continuing "business as usual", crop production would decrease by more than 5 per cent in a 30 year time period. In contrast, by applying sustainbalbe land management practices on all sloping croplands (establishing conservation structure and fertilizer application), crop production would rise by 10 per cent. This economic benefit could be enhanced even further by planting fodder grass on all conservation structures, since growing fodder grass on the structures increases the productivity of conserved farmland due to the production on the otherwise unused area of the conservation structure. Moreover, the estimated economic benefits still are likely to be underestimated because the analysis did not include several ecosystem services which nonetheless would be strengthened by SLM practices too.

However, there are regional differences due to diverse slope and climatic conditions. Spatial differentiation is thus key in prioritizing development interventions and implementation. The ELD Ethiopia Case Study database provides an excellent source of data for such differentiation.

Recommendations

1. Two thirds of Ethiopian croplands urgently require conservation structures.
2. About 50 per cent of all required conservation structure investments need (external) financial support since implementation costs for local farmers are too high.
3. Investment priorities need to be spatially differentiated and be addressed appropriately and in a reasonable order

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