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Effects of Vegetation Type and Species Composition on Carbon Stocks in semi-arid Ethiopian Savannahs

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M. Sc. Thesis

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Abstract

CO_2 is one of the most important GHGs in the atmosphere. Its concentration is steadily increasing, causing severe climate change effects. These changes are of enormous importance for the people living in the semi-arid savannahs of the Borana region in southern Ethiopia. Having negative impacts on the pastoral production systems that play an important role in this area, the dependency on traditional systems might be no longer sufficient to sustain food security. The establishment of a system of payment for environmental services (PES) could be a feasible opportunity for alternative income generation. PES systems are based on the process of carbon sequestration, i.e. storing the atmospheric carbon in the terrestrial biosphere. In this context, grasslands and savannah ecosystems are increasingly the focus of attention, as they hold a great potential, due to their large global extension.

The aim of this pilot study was to gain information on the current amount of carbon stored in the aboveground biomass and in the soil in this area, and to evaluate the impact of vegetation type and species composition on the belowground carbon stocks.

In a 10 km² study area 4 dominant vegetation types were characterized (grassland, bushland, tree savannah and bush-tree savannah). 20 30x30 m plots were installed, representing 5 plots per vegetation type. In every plot, soil samples were taken in 4 depths to determine SOM, SOC, pH and $CaCO_3$ content. The SOC concentration was measured using the Loss-on-ignition method. Soil bulk density was measured in 2 depths (0-10, 10-30) with 5 repetitions each in every plot. Species were identified for the analysis of species composition. Biomass of trees and bushes was estimated using allometric equations. Biomass of understorey vegetation was destructively measured. A one-way ANOVA and a cluster analysis were carried out for the statistical analysis. The vegetation type had a great influence on the accumulation of aboveground biomass and aboveground carbon stocks, being highest in tree savannahs (51.9 ± 16.1 t ha^{-1} and 25.9 ± 8.1 t C ha^{-1}), and lowest in grasslands (0.8 ± 0.4 t ha^{-1} and 0.4 ± 0.2 t C ha^{-1}). Soil organic carbon stocks were generally high in this area (326.4 ± 28.6 t C ha^{-1} to 394.9 ± 28.6 t C ha^{-1}) and showed no significant differences between the vegetation types. Species composition changed to more annuals and herbaceous species with increasing woody vegetation and cluster analysis showed that the distribution of vegetation types was partially dependent on the soil type. These results provide initial data to assess the carbon sequestration potential of the semi-arid savannahs of the Borana region in Ethiopia.

Key words: carbon stocks, aboveground biomass, vegetation type, species composition, semi-arid savannah