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Estimation of Carbon Sequestration Potential under Different Vegetation Types in the Borana Rangelands, Ethiopia

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Abstract

The Borana rangelands in southern Ethiopia used to be among the most productive pastoral areas in East Africa. However, over-utilisation and over-grazing have resulted in declining rangeland conditions and woody-species encroachment. Payment for environmental services (PES) based on carbon sequestration has been proposed as additional livelihood option to offer an incentive for an improved and sustainable management which in turn is expected to increase the carbon sink in such semi-arid ecosystems. Nevertheless, information on basic above- and below-ground biomass and carbon pool inventories providing reference data for common vegetation types of the Borana rangelands is missing.

Within four representative vegetation types (grassland (GL), tree savannah (TS), bush-tree savannah (BT) and bushland (BL)), we repeatedly determined above- and below-ground biomass (AGB, BGB) using destructive sampling methods and allometric equations (for woody biomass). Total mean AGB (herbaceous + woody biomass) was highest in TS (24.2 $\pm$ 7.6 t ha^{-1}) and lowest in GL (1.0 $\pm$ 0.4 t ha^{-1}). Regarding the sum of all herbaceous biomass fractions (green, standing dead, litter), AGB decreased from 1.94 t ha^{-1} (BL) to 1.02 t ha^{-1} (GL) in June 2012 (after the rain season) and from 2.83 t ha^{-1} (BL) to 0.30 t ha^{-1} (GL) in Oct. 2012 (after the dry season). In contrast, below-ground biomass (BGB) of the herbaceous layer ranged from 3.20 t ha^{-1} (BT) to 2.45 t ha^{-1} (GL) and did not show this pattern among vegetation types. Dynamic sampling indicates AGB minima before and maxima after the rainy season, but only for the vegetation types GL and BT, while BL and TS did not show a pronounced seasonal dynamic.

Our data provide a first multi-seasonal quantification of above- and below-ground biomass and carbon stock estimates for common vegetation types in the Borana rangelands. We hypothesise that differences in biomass and carbon pools of the herbaceous layer between vegetation types are mainly based on above-ground vegetation dynamics, while below-ground biomass allocation does not reflect the above-ground pools. Thus, a first step to building a database as reference for PES systems and sustainable rangeland management has been taken.

Keywords: Above- and below-ground biomass, Borana rangelands, carbon sequestration, Ethiopia, semi-arid savannah, vegetation types

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