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Carbon Stock Changes with Relation to Land Use Conversion in the Lowlands of Tigray, Ethiopia

WOLDE MEKURIA¹, EDZO VELDKAMP², MITIKU HAILE¹

¹Mekelle University, Land Resource Management and Environmental Protection Department, Ethiopia

²Georg-August-Universität Göttingen, Institute for Soil Science and Forest Nutrition (IBW), Germany

Abstract

Reduced emissions from deforestation and degradation are emerging as a strategy with big potential for mitigating climate impacts. This study analysed the effects of the conversion of free grazing lands to exclosures on ecosystem carbon sequestration in Tigray, Ethiopia. Replicated paired exclosures and adjacent free grazing lands were sampled. Three church forests were also sampled as a positive control. Soil carbon (C), carbon from woody and grass species as well as selected site and vegetation characteristics were determined. These were attained through standard procedures of soil analyses and destructive sampling of the identified sample plants. Significant ($p < 0.05$) differences in soil-C concentration and stock, and woody species carbon were found between exclosures and adjacent free grazing lands. The oldest exclosure (15-year-old) had significantly ($p < 0.05$) higher soil-C concentration and stock compared to the church forest. These differences were primarily attributed to the difference in amount and properties of input materials, inherent soil properties (% sand, silt, clay) and soil erosion. This was verified by the significant ($p < 0.01$) correlation between soil-C with the measured site and vegetation characteristics. The general trend in the ecosystem carbon stock increased in the order of: free grazing lands (40.4 Mg ha^{-1}) < five year-old exclosure (49.0 Mg ha^{-1}) < church forest (74.0 Mg ha^{-1}) < 10 year-old exclosure (86.1 Mg ha^{-1}) < 15 year-old exclosure (94.9 Mg ha^{-1}). Our results show that the conversion of free grazing lands to exclosures has a significant potential to increase carbon sequestration, even in strongly degraded free grazing lands, both through additional below and above-ground carbon storage. Expanding exclosures on degraded free grazing lands can thus contribute to mitigation of climate change, if the local people will be sufficiently compensated.

Keywords: Carbon stock, church forest, exclosures, free grazing lands, land use conversion