Long-term grazing exclusion did not provide adequate soil carbon accumulation for carbon credits in pastoral areas of northern Kenya

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Research Brief

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Abstract

The development of carbon markets and credits under the Kyoto protocol emphasize the need for enhanced carbon storage in northern Kenyan rangelands for climate change mitigation and local livelihoods diversification. However, to qualify for carbon credits, carbon markets are requiring additional carbon storage beyond what is existing under normal-land use practices. Grazing exclusion is often thought to improve rangeland productivity and provide the extra carbon storage that warrants carbon credits. In this study we assessed soil carbon accumulation in semi-arid pastoral ecosystems of northern Kenya that have been under 82 years of grazing exclusion, and compared these findings with soil carbon storage in the adjacent areas of continuous grazing. We found yearly soil carbon accumulation at the rate 0.769 tonnes ha-1 in grazing exclusion areas, providing economic value of $16.65 and $9.59 based on voluntary and compliance carbon markets, respectively. Considering the uncertainty in the value of carbon credits, the transaction costs of setting up and monitoring a carbon credit program, and opportunity costs of long-term grazing exclusion, it is unlikely that the additional soil carbon storage is economically viable for carbon credits.

Rangeland carbon storage can mitigate climate change and diversify local livelihoods

The importance of pastoral rangelands in the mitigation of global climate change through carbon storage in soils and vegetation has been widely emphasized. Evidence is now emerging that a significant proportion of the carbon is stored in soils as opposed to vegetation. Soils store the largest amount of terrestrial carbon as plant residues and litters. Consequently, there is increasing need to link soil carbon storage in pastoral rangelands to local livelihoods through promotion of carbon-credits. This is because carbon credits will not only mitigate climate change through reduction of carbon dioxide emissions, but will also diversify local livelihood and reduce vulnerability associated with climate variability and change. However, under the Kyoto carbon trading platform, adoption of carbon sequestration practices should ensure reduction of carbon dioxide in addition to what is existing under the normal-land use practices.

Soil sample collection in the controlled grazing area with help of security guards. (Photo credit: Bulle Hallo Dabasso)

Implications of grazing on rangeland carbon storage

Grazing exclusion is a commonly recommended practice to improve rangeland productivity and provide extra carbon storage for carbon credits. However, both positive and negative implications on rangeland carbon storage have been reported. Grazing has been suggested to reduce rangeland productivity and changes plant species composition, therefore leading to less carbon sequestration in the rangelands. On the contrary to these negative impacts, grazing is thought to enhance litter decomposition, removing dead materials for enhanced photosynthesis and therefore providing additional carbon storage. These divergent opinions make it difficult to determine whether grazing exclusion actually provides carbon accumulation significant enough to warrant carbon credits. In this study we assessed soil carbon accumulation in semi-arid pastoral ecosystems of northern Kenya under 82 years of grazing exclusion and compared these findings with soil carbon storage in the adjacent areas of continuous grazing. We further evaluated the economic value of soil carbon difference between the two grazing management for carbon credits.

Soil sampling in the grazed and non-grazed areas of Marsabit for carbon analysis

Three locations of Marsabit Forest Reserve (MFR)[1] were purposively selected as areas of long-term grazing exclusions. At every location of MFR, adjacent communal grazing areas were identified as areas of continuous grazing[2]. A public road that ran around the edge of MFR formed the borderlines between the MFR and communal grazing areas. A transect walk of 2-kms from the road into the MFR were conducted with soil sampling done at every 100 m. Soil sampling was done using a soil-auger at the depth of 30 cm. Soil samples were collected in khaki paper bags and labelled based on name of study location, type of site (either MFR or communal grazing site), sampling point and date of collection. All the sampling points were marked with

Research assistant, Mr. Suleman Somo, carefully weighing the soil samples.(Photo credit: Bulle Hallo Dabasso)

Soil analysis in the research laboratory of University of Nairobi, College Agriculture and Veterinary Services. (Photo credit: Bulle Hallo Dabasso)

Geographical Positioning System coordinates to ensure proper collection at the same location in the next season of sampling. Another transect of the same length conducted from the road into the communal grazing site and soil sampling was done following the same sampling procedure. The process was repeated in the three study locations around the MFR covering a total of 240 soil samples. All soil samples were oven-dried at 800C for 48 hours and passed through 2mm-sieved after which their bulk densities were determined. An estimated 100g of sieved soils from every sample were measured for carbon content analysis.

Analysis for carbon was done using oxidization-reduction process in the soil laboratory of University of Nairobi. Means for soil carbon storage for both MFR and communal rangelands were analyzed and least square differences used to separate the means. Analysis of variances done to test for variation in soil carbon storage between MFR and communal grazing areas were conducted with significant differences accepted at 5%. Economic values for any variation of soil carbon storage between MNP sites and communal grazing sites were calculated based existing carbon markets.

Soil carbon accumulation under long-term grazing exclusion may not be economically feasible for carbon credits

Long-term exclusion of grazing provided extra soil carbon at a rate of 0.769 tonnes ha^{-1} per year. The additional soil carbon possibly resulted from accumulation of un-grazed plant residues and litters. Although this suggests the negative implications of continuous grazing in soil carbon accumulation, the economic viability of using long-term grazing exclusion for carbon credits is uncertain. The extra soil carbon accumulation under long-term grazing exclusion had the potential of sequestering 2.822 tonnes ha-1 of carbon dioxide equivalents, which has the economic value of $16.65 and $9.59 based on voluntary and compliance carbon markets, respectively[3]. Considering the uncertainty in the value of carbon credits, the transaction costs of setting up and monitoring a carbon credit program, and opportunity costs of long-term grazing exclusion, it is unlikely that the additional soil carbon storage is economically viable for carbon credits.

End notes

[1]Marsabit Forest Reserve was gazette in the 1932 as protected area and livestock grazing in the forest was prohibited since then (Witsenburg and Roba 2004).

[2]Pastoralists have traditional institutions that govern grazing management to uphold environmental conservation. The word "continuously grazing" is only used to differentiate it from grazing exclusion applied in this study.

[3]One tonne of carbon is equivalent to 3.67 of carbon dioxide equivalent (Tennigkeit and Wilkes 2008). Voluntary carbon markets average of $ 5.9 per tonne of carbon dioxide as carbon credits (Molly and Daphne 2013), while carbon credit in Clean Development Mechanism (CDM) is 3.4 $ per tonne of carbon dioxide equivalent (Galgani 2012).

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TIRI, Targeted Investment for Research Impact, identifies early-career researchers who are interested in tackling livestock production problems through innovative approaches and fresh perspectives. This small-grant program is open to early-career researchers (five or fewer years into research career) in any discipline, from student to professor, and from any organization that is engaged in applied research on livestock production in South Asia and East Africa — colleges and universities, government research centers or laboratories, or non-profit organizations.

Proposals are selected based on their potential to make livestock production systems more resilient to increasing climate variability and severity. At the end of one year, TIRI scholars are expected to demonstrate concrete outcomes and real potential for future impact. The 10 selected East Africa TIRI scholars and the 18 selected Nepal TIRI scholars are addressing research problems on various livestock and climate research themes.

Feed the Future Innovation Lab for Collaborative Research on Adapting Livestock Systems to Climate Change is dedicated to catalyzing and coordinating research that improves the livelihoods of livestock producers affected by climate change by reducing vulnerability and increasing adaptive capacity.

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