

Soil Erosion, fertility and socio-economic role of enclosure land



Erosión del suelo, fertilidad y papel socioeconómico de las tierras excluidas

Asmare, Melkamu Terefe

Asmare, Melkamu Terefe *

melkamu1122@gmail.com

Ethiopian Environment and Forest Research Institute,
Etiopía

Journal of the Selva Andina Biosphere

Selva Andina Research Society, Bolivia

ISSN: 2308-3867

Periodicity: Bilingual

vol. 9, no. 2, 2021

directoreditorbiosphere@gmail.com

Received: 01 August 2021

Corrected: 01 September 2021

Accepted: 01 October 2021

Published: 01 November 2021

URL: <http://portal.amelica.org/ameli/journal/71/712918006/>

DOI: <https://doi.org/10.36610/j.jsab.2021.090200092>

Selva Andina Research Society



This work is licensed under Creative Commons Attribution-NonCommercial 4.0 International.

Abstract: Improper use of land could result in loss of biodiversity, soil fertility, and poverty to the people. Population growth, agricultural expansion, urbanization, the absence of alternative assets, and other biophysical factors aggravate forest land degradation. Previously, in most parts of the world different forest land reclamation approaches had been implemented. Many authors argue that the establishment of enclosure land use through providing equivalent benefit to participated local community sustainably reclamation degraded lands. Therefore, this review paper was aimed to assess the role of previously established enclosure land use for socio-economic as well as soil fertility improvement. Secondary data were used and summarized. Due to the conversion of communal grazing land to enclosure land soil fertility aspects were enhanced. The socioeconomic benefits of enclosure land to the local communities were shown inconsistency improvement across Agroecology. Therefore, further studies on how to sustainably, and equally share all benefits of enclosure land use to local communities should be studied for obtaining win-win results on the previously enclosure land uses.

Keywords: Culture, income, job opportunity, land reclamation, leadership skill, soil nutrient.

Resumen: El uso inadecuado de la tierra podría resultar en la pérdida de biodiversidad, fertilidad del suelo y pobreza para la gente. El crecimiento de la población, la expansión agrícola, la urbanización, la ausencia de activos alternativos y otros factores biofísicos agravan la degradación de las tierras forestales. Anteriormente, en la mayor parte del mundo se habían aplicado diferentes enfoques de recuperación de tierras forestales. Muchos autores argumentan que el establecimiento del uso de la tierra excluida al proporcionar un beneficio equivalente a la comunidad local participada en la recuperación sostenible de tierras degradadas. Por lo tanto, este documento de revisión tuvo como objetivo evaluar el papel del uso de la tierra de exclusión previamente establecido para la mejora socioeconómica y de la fertilidad del suelo. Se utilizaron y resumieron datos secundarios. Debido a la conversión de tierras de pastoreo comunales a tierras de exclusión, se mejoraron los aspectos de fertilidad del suelo. Los beneficios socioeconómicos de las tierras excluidas para las comunidades locales mostraron una mejora inconsistente en toda la agroecología. Por lo tanto, se deben estudiar más estudios

sobre cómo compartir de manera sostenible y equitativa todos los beneficios del uso de la tierra excluida a las comunidades locales para obtener resultados beneficiosos para todos en los usos de la tierra anteriormente excluidos.

Palabras clave: Cultura, ingresos, oportunidad laboral, recuperación de tierras, capacidad de liderazgo, nutrientes del suelo.

INTRODUCTION

For millions of people around the world, forests are the vital basis of life for national economic development as well as a carbon sink that will later contribute to climate protection. In all respects the peoples of the world are dependent on either wood or other forest products. Obtaining individuals who are free from addiction to forest products is equivalent to obtaining electrons for free. The viability of restoration choices can be affected by the differences in ecological and socio-economic conditions, political and authentic settings, and level of management¹. By excluding invasive species (negative factors in land restoration), land exclusion plays an important role in balancing the ecological and human foundations of life. Before establishing the exclusion, the surface/land should be scanned for pre-existing invasive alien species. Enrichment plantings should also be carried out after the introduced species have been checked for invasiveness. The establishment of restricted livestock areas or species protection support agricultural growth because they protect water catchment areas, stabilizes the local climate and the hydrological system. Community cooperation could be an essential ingredient for land restoration ventures to enhance the level of residential fulfilment and to progress its victory rate². Nevertheless, there are socioeconomic and demographic components, which decide the level of interest in such projects. The absence of advantage from the preserved zone, level of education, and sexual orientation are among the basic variables of community interest in land reclamation. Therefore, this review paper is aimed to create awareness through providing information and documenting files on the socio-economic and soil nutrient improvement role of previously established exclosure land uses.

DEVELOPMENT

Exclosure on soil erosion reduction and fertility improvement. In Ethiopia, inadequate agricultural practices such as cultivation on steep slopes, clearing of vegetation and overgrazing are the main factors leading to soil erosion and nutrient loss³⁻⁵. For instance, cultivation on the steep slopes in northern Ethiopia resulted in a loss of 35 tons of soil per hectare of land annually⁶. But today such a devastating loss of soil is being reduced by exclosures. For this reason, it was established as a form of land management with a spatial focus to improve environmental conditions and control soil erosion^{5,7}.

The role of exclosure on soil fertility is measured through considering the availability of essential nutrient (micro and macro nutrient) for plant growth. Nitrogen (N), Phosphorus (P), Potassium (K), Sulfer (S), Calcium (Ca), Magnesium (Mg), Iron (Fe), Zinc (Zn), Manganese (Mn), Cuppor (Cu), Borun (B), Molybdenum (Mo), and Chlorine (Cl) are among the essential nutrient for plant growth⁸. Mekuria et al⁹. and Conant et al.¹⁰ reported that variation in soil type, land-use history, land cover, climate, topography

AUTHOR NOTES

* Contact Address: Ethiopian Environment and Forest Research Institute, Jimma centre, P.O.BOX 1187, Ethiopia. Tel: +251 116 46 46 06. Terefe Asmare Melkamu E-mail address: melkamu1122@gmail.com

and vegetation cover creates difference in the content of soil organic carbon stock of a converted grazing lands (enclosure land). Due to such variability the contributions of enclosure for soil physical and chemical properties were studied in different way by different authors.

For instance, Abay et al.¹¹ reported that converting open grazing land into an enclosure improved most soil properties except soil pH, avP and EC. They reported that enclosure had a significantly ($p < 0.05$) higher SOC which shows an improvement of 46.5 or 61.3 % compared to grazing land. Besides, they said that, it increases CEC, TN and avK levels significantly ($p < 0.05$) by 16.8, 45.5 and 34 %, respectively.

Mekuria and Aynekulu¹² reported that the availability of N, P and CEC is varying with the age of enclosure and soil depth. They said that prevention of grass harvesting leads to raise the available soil P and N. Damene et al.¹³ also recently reported that management of degraded land by converting open grazing land to enclosure land with chomo grass sowing practice significantly enhances the total available N and SOC than open grazing lands (Table 1).

TABLE 1
Summary of Soil fertility role of Enclosure land use

Macro and micro nutrients	Its availability in the enclosure land relative to adjacent open grazing land	Suggested reason	Reference
TN	Insignificant change (but 0.45 times better than AOG land)	High SOC and legumes plant availability might enhance TN in the enclosure.	7,11
avP	Insignificant change (but 0.15 times higher than AOG land)		11
avK	increase(0.34 times better than AOG land)		11
SOC	Increase(>0.5 times of open grazing land)	High litter fall from tree/shrub	7,11,16
PH	No significant change is observed	Different temperature and rain fall varies SOM decomposition rate	1,11
CEC	Insignificant change(but 0.16 times higher than AOG land)	Different temperature and rain fall varies SOM decomposition rate	11
EC	Decrease (0.14 times lower than AOG land)	Might be due to high vegetation cover that optimize evaporation and infiltration	11

CEC= Cat ion exchange capacity, EC=electric conductivity, TN= total Nitrogen, avP=available phosphorus, avK= available Potassium, SOC=soil organic Carbon.

The presence of improved soil structure (high level of leaf litter and vegetation cover) in the enclosure land reduces the soil erosion better than open grazing land^{11,13}.

Study done in the upper Blue Nile basin of Ethiopia shown that the use of area enclosure with trenches is a best option for soil erosion and runoff reduction¹⁴. While for soil loss reduction issue alone, use of area enclosure is suitable land management practices¹⁴. The improvement in canopy and ground cover in area enclosure with increasing age of enclosure reduces sediment associated nutrient loss through lowering raindrops and soil erosion^{4,12,15}.

Socio-economic impact of enclosure land. In this review paper, the socio-economic role of enclosure land focus on family size, gender, income, occupations, culture, perception and attitude of the society, educational status of the society. The contribution of forests to total household income in the northern highlands and southern Ethiopia was 27 % and 34 %, respectively^{17,18}. Although such benefits are obtained, deforestation due to population pressures in Ethiopia is severe and has a long history, particularly in the central and northern highlands¹⁹.

To avoid such problems, the rehabilitation of degraded forests and woodlands by ecological and environmental viable (area enclosure and enclosure) land management practise is currently seen as a critical issues^{19,20}. In addition to its role in regulating ecosystem services, the enclosure has socio-economic benefits for the livelihood of the community^{18,21-25}. For example, the preservation of tree species in the vicinity of the church boundary is considered a heritage and offers spiritual benefits to society. Their role in demarcating the affected country and expressing the culture of a society is great as the facility requires less manpower^{26,27}.

The establishment of the exclusion had negative^{23,25} and positive^{4,28}, attitudes towards the local community. Accordingly, the positive attitude of the local community is crucial for the sustainability of the enclosure and future rehabilitation measures.

The economic role of enclosure can be direct or indirect. Its direct role for the local community is expressed through the provision of animal feed, bee fodder, fuel and other non-wood forest products^{17,21} (Table 2). A study conducted in Biyo-Kelala Area Enclosures, Ada`a District, Eastern Shewa Zone, Oromia Region, showed that income from enclosures was approximately 3.07 % of total annual household income²⁹. The indirect benefits of enclosure have also been achieved through improving land productivity and regulating environmental services³⁰. Studies done in the semi-arid lowlands of northern Ethiopia showed that converting communal grazing land into enclosure land over 30 years was achieved the US \$ 3.071 per hectare³⁰. The conversion of the aboveground carbon stock into the monetary value of a relatively older enclosure also creates a lot of economic benefit to a community and natural environment improvement. Conservation includes the preservation, maintenance, sustainable use, restoration and improvement of the natural environment. In this regard, Enclosure helps support the sustainable use of natural resources there by generating environmental, economic and social benefits for the rural communities³¹. This allows the local community to alleviate poverty by extending the vegetation cover on the degraded land.

TABLE 2
Summary of socio economic role of enclosure

Reviewed Socio economic parameters	Reference
Protect cultural heritage.	32
Shelter to several wild animal.	32
Act as esthetical value.	32
Spiritual significance.	32
Provision of fruit and medicine.	33
Provides fodder for livestock.	34
Improve hh (household) income.	17,34
Create Job opportunity to hh (wild fruit collection, fodder sell, bee keeping, mushroom collection, guard, grass cut and carry).	33
Improve the communal resource management skill of community.	35

hh=household

hh=household

CONCLUSION

Extensive dependence of rural household on the natural resource leads to resource degradation. Equitable resource distribution among end-users is important to sustainable forest land reclamation. Medicine, fuel wood, fruit, honey, aesthetic value, cultural value and spiritual uses were some of the socioeconomic uses of enclosure land to the rural households. Participation of local community on integrated soil erosion control practice in the enclosure land use enhances soil fertility when it is governed by local bylaws. Generally, the household who got benefit from land reclamation practice more motivated to protect other similar featured lands. In doing so, communities' attitude towards enclosure land use improves with improved ecological systems. Further studies of the use of enclosure land use on gender, education level and age group should be done and documented for end-users. In addition to this studies on the equal distribution of resource to the community should be done to reduce conflict among enclosure land user households and get benefits sustainably. Studies on enhancing the advantage of local communities, their preferred tree/shrub, grass and spice species that should be planted in the enclosure land uses is also needed.

CITED LITERATURE

1. Munie Shiferaw AM. Effect of plantation forests on soil chemical properties, soil temperature and regeneration of woody plants: a comparative analysis [thesis dissertation]. [Brno]: Mendel University in Brno; 2013 [cited 2020 Oct 18]. Available from: https://www.academia.edu/35550541/effect_of_plantation_forests_on_soil_chemical_properties_soil_temperature_and_regeneration_of_woody_plants_a_comparative_analysis
2. Fakere AA, Ayoola HA. Socioeconomic characteristics and community participation in infrastructure provision in Akure, Nigeria. *Cogent Soc Sci* 2018;4:1437013. DOI: <https://doi.org/10.1080/23311886.2018.1437013>
3. Lemenih M, Karlton E, Olsson M. Soil organic matter dynamics after deforestation along a farm field chronosequence in southern highlands of Ethiopia. *Agric Eco-syst Environ* 2005;109:9-19. DOI: <http://doi.org/10.1016/j.agee.2005.02.015>
4. Mekuria W, Veldkamp E, Haile M, Gebrehiwot K, Muys B, Nyssen J. Effectiveness of exclosures to control soil erosion and local community perception on soil erosion in Tigray, Ethiopia. *Afr J Agric Res* 2009;4(4):365-77.
5. Abebe T, Hunde Feyssa D, Kissi E. Area ex-closure as a strategy to restore soil fertility status in degraded land in Southern Ethiopia. *J Biol Chem Research* 2014;31(1):482-94.
6. Keyzer MA, Sonneveld BGJS. The effect of soil degradation on agricultural productivity in Ethiopia: a non-parametric regional analysis. In: Heerink N, van Keulen H, Kuiper M, editors. *Economic policy and sustainable land use*. Switzerland: Springer Nature; 2001. p. 269-92. DOI: https://doi.org/10.1007/978-3-642-57558-7_16
7. Yimer F, Alemu G, Abdelkadir A. Soil property variations in relation to exclosure and open grazing land use types in the Central Rift Valley area of Ethiopia. *Environ Syst Res* 2015;4:17. DOI: <https://doi.org/10.1186/s40068-015-0041-2>
8. Akenga P, Salim A, Onditi A, Amir Y, Waudo W. Determination of selected micro and macronutrients in sugarcane growing soils at Kakamega North District, Kenya. *J Appl Chem* 2014;7(7): 34-41. DOI: <https://doi.org/10.9790/5736-07713441>
9. Mekuria W, Langan S, Noble A, Johnston R. Soil restoration after seven years of exclosure management in northwestern Ethiopia. *Land Degrad Dev* 2017;28(4):1287-97. DOI: <https://doi.org/10.1002/ldr.2527>
10. Conant RT, Ogle SM, Paul EA, Paustian K. Measuring and monitoring soil organic carbon stocks in agricultural lands for climate mitigation. *Front Ecol Environ* 2011;9(3):169-73 DOI: <https://doi.org/10.1890/090153>
11. Abay K, Tewolde-Berhan S, Teka K. The effect of exclosures on restoration of soil properties in Ethiopian lowland conditions. *SN Appl Sci* 2020;2 :1771. DOI: <https://doi.org/10.1007/s42452-020-03538-9>
12. Mekuria W, Aynekulu E. Exclosure land management for restoration of the soils in degraded communal grazing lands in northern Ethiopia. *Land Degrad Dev* 2013;24(6):528-38. DOI: <https://doi.org/10.1002/ldr.1146>
13. Damene S, Bahir A, Villamor GB. The role of Chomo grass (*Brachiaria humidicola*) and exclosures in restoring soil organic matter, total nitrogen, and associated functions in degraded lands in Ethiopia. *Reg Environ Change* 2020;20:92. DOI: <https://doi.org/10.1007/s10113-020-01680-z>
14. Ebabu K, Tsunekawa A, Haregeweyn N, Adgo E, Meshesha DT, Aklog D, et al. Effects of land use and sustainable land management practices on runoff and soil loss in the Upper Blue Nile basin, Ethiopia. *Sci Total Environ* 2019;648:1462-75. DOI: <https://doi.org/10.1016/j.scitotenv.2018.08.273>
15. Tefera B, Sterk G. Land management, erosion problems and soil and water conservation in Fincha'a watershed, western Ethiopia. *Land Use Policy* 2010;27(4):1027-37. DOI: <https://doi.org/10.1016/j.landusepol.2010.01.005>
16. Okolo CC, Gebresamuel G, Zenebe A, Haile M, Eze PN. Accumulation of organic carbon in various soil aggregate sizes under different land use systems in a semi-arid environment. *Agric Ecosyst Environ* 2020;297:106924. DOI: <https://doi.org/10.1016/j.agee.2020.106924>
17. Mamo Bahiru K. Enclosure as a viable option for rehabilitation of degraded lands and biodiversity conservation: the case of Kallu Woreda, Southern Wello. [thesis masters]. [Etiopía]: Addis Ababa University; 2008 [cited 2020 Oct 18]. Available from: <http://213.55.95.56/handle/123456789/6185>

18. Babulo B, Muys B, Nega F, Tollens E, Nyssen J, Deckers J, et al. The economic contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia. *For Policy Econ* 2009;11(2): 109-17. DOI: <https://doi.org/10.1016/j.forpol.2008.10.007>
19. Lemenih M, Kassa H. Re-greening Ethiopia: history, challenges and lessons. *Forests* 2014;5:1896-909. DOI: <https://doi.org/10.3390/f5081896>
20. Mengistu T. The role of enclosures in the recovery of woody vegetation in degraded hillsides of Biyo and tiya, central and northern Ethiopia [thesis masters]. Sweden: Ethiopian MSc in Forestry Programme thesis; 2005.
21. Muys B, Gebrehiwot K, Aerts R, Haile M, Deckers J. Perspectives for the rehabilitation of dryland forests in Ethiopia. *J Dry-lands* 2006;1(2):217-20.
22. Tilahun M, Olschewski R, Kleinn C, Kindeya G. Economic analysis of closing degraded *Bosewellia papyrifera* dry forest from human intervention-a study from Tigray, Northern Ethiopia. *For Policy Econ* 2007;9(8):996-1005. DOI: <https://doi.org/10.1016/j.forpol.2006.09.004>
23. Tekalign M. The role of area exclosures for biodiversity conservation and its contribution to local livelihoods: The case of Biyo-Kelala area exclosures in Ada'a Wereda [thesis masters]. [Addis Abeba]: Addis Ababa University; 2010 [cited 2020 Oct 18]. Available from: <http://thesisbank.jhia.ac.ke/4115/>
24. Veldkamp E, Mekuria W, Tilahun M, Olschewski R. Economic valuation of land restoration: the case of exclosures established on communal grazing lands in Tigray, Ethiopia. *Land Degrad Dev* 2011;22:334-44. DOI: <https://doi.org/10.1002/ldr.1001>
25. Mulugeta G, Achene M. Socio-Economic challenges of area exclosure practices: A case of Gonder Zuria Woreda, Amhara Region, Ethiopia. *J Nat Sci Res* 2015;5(13):123-32.
26. Dudley N, Higgins-Zogib L, Mansourian S. The links between protected areas, faiths, and sacred natural sites. *Conserv Biol* 2009;23(3):568-77. DOI: <https://doi.org/10.1111/j.1523-1739.2009.01201.x>
27. Birhane E. Actual and potential contributions of enclosures to enhance biodiversity in drylands of eastern Tigray, with particular emphasis on woody plants [thesis masters]. [Sweden]: Swedish University of Agricultural Sciences; 2002.
28. Heitschmidt RK, Vermeire LT, Grings EE. Is rangeland agriculture sustainable?. *J Anim Sci* 2004;82(E Suppl): E138-46. DOI: https://doi.org/10.2527/2004.8213_supplE138x
29. Manaye A. Contribution of exclosures for restoration of woody species diversity and regulating ecosystem services in Ethiopia. Environment and Forest Research Center: Mekele, Ethiopia. *J Nat Sci Res* 2017;7(13):28-35.
30. Mekuria W. Conversion of communal grazing lands into exclosures restored soil properties in the semi-arid lowlands of Northern Ethiopia. *Arid Land Res Mang* 2013;27(2):153-66. DOI: <https://doi.org/10.1080/15324982.2012.721858>
31. Gebregziabher D, Soltani A. Exclosures in people's minds: perceptions and attitudes in the Tigray region, Ethiopia. *For Policy Econ* 2019;101:1-14. DOI: <https://doi.org/10.1016/j.forpol.2019.01.012>
32. Amin A, Zaehring JG, Schwilch G, Koné I. People, protected areas and ecosystem services: a qualitative and quantitative analysis of local people's perception and preferences in Côte d'Ivoire. *Nat Resour Forum* 2015;39(2):97-109. DOI: <https://doi.org/10.1111/1477-8947.12069>
33. Gebregziabher D, Soltani A, Hofstad O. Equity in the distribution of values of outputs from exclosures in Tigray, Ethiopia. *J Arid Environ* 2017;146:75-85. DOI: <https://doi.org/10.1016/j.jaridenv.2017.07.003>
34. Soltani A, Angelsen A, Eid T. Poverty, forest dependence and forest degradation links: evidence from Zagros, Iran. *Environ Dev Econ* 2014;19(5):607-30. DOI: <https://doi.org/10.1017/S1355770X13000648>
35. Ostrom E. Self-governance and forest resources. Occasional Paper [Internet]. 1999 [cited 2020 Oct 10];20:2-15. Available from: https://www.cifor.org/publications/pdf_files/OccPapers/OP-20.pdf

NOTES

Funding source: The Author ensured that this study didn't get any financial support from any funding agencies.

Conflicts of interest:No potential conflict of interest was reported by the author.

Acknowledgements:The author thanks the reviewers, board of editors for their constructive comments and suggestions.

Ethical considerations:The author declared that this manuscript is not submitted for possible publication to other journal publishers. In addition to this, I confirmed that this result is free of research misconduct.

Editor's Note:*Journal of the Selva Andina Biosphere (JSAB)* remains neutral with respect to jurisdictional claims published on maps and institutional affiliations.

ID of article:110/JSAB/2021

ALTERNATIVE LINK

http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S2308-38592021000200092&lng=es&nrm=iso (html)