ISSN 1068-3674, Russian Agricultural Sciences, 2022, Vol. 48, No. 3, pp. 219–226. © Allerton Press, Inc., 2022.

AGRICULTURAL SOIL SCIENCE AND AGROECOLOGY

Socio-Economic and Ecological Benefits of Forest Reserves in Tanzania, a Case of Nambinga Forest in Ulanga District

J. F. Ngwembe[a], G. S. Minja[b], A. J. Tegeje[c], and M. Y. Mkonda[c,*]

[a] *Department of Education, College of Natural and Applied Sciences, Sokoine University of Agriculture, Morogoro, 3038 Tanzania*

[b] *Department of Agriculture, Earth and Environmental Sciences, Mwenge Catholic University, Moshi, 1226 Tanzania*

[c] *Department of Geography and Environmental Studies, College of Natural and Applied Sciences, Sokoine University of Agriculture, Morogoro, 3038 Tanzania*

Received January 03, 2022; revised February 17, 2022; accepted March 22, 2022

Abstract—Forest reserves have numerous advantages ranging from economic to ecological in various areas of the globe. Recently, there have been increased anthropogenic activities in the forest reserves for subsistence, commercial and ecological purposes. These activities are mainly done around the forest reserves as livelihood options. The present paper aims at (i) assessing the perception of the local population living near the forest reserves on the values of forest, (ii) assessing the anthropogenic activities done in the forest, (iii) examining the temporal changes of the forest, and (iv) investigating the social, economic and ecological benefits of the forest resources. Although this paper applied mixed approaches in data collection; it mostly applied household survey, key informant interview, and snow bowling approaches. Quantitative data were mainly analyzed through SPSS version 22, while qualitative data were analyzed through theme content analysis. The results exhibit that; more that 70% of the respondents are aware of the actual and potential resources of the forest, while more than 50 are harnessing the resources (e.g. firewood, charcoal, and medicines). In addition, the forests have numerous economic and ecological benefits including increased income and infrastructure. However, deforestation and impacts of climate change are some of the major challenges affecting the forest reserves. The findings of this study would provide useful information about benefits of anthropogenic activities on the forest and these findings would be made available to development planners of various ministries of various countries including Tanzania.

Keywords: climate change, degradation, forest reserves, income, local community, Tanzania

DOI: 10.3103/S1068367422030089

1. INTRODUCTION

Forest reserves are portions of state lands where commercial harvesting of wood products is excluded in order to capture elements of biodiversity that can be missing from sustainably harvested sites (Burgess et al., 2007). However, IPCC (2014) revealed that humans have always interacted with natural ecosystems and have created artificial ecosystems to fit their needs. However, these interactions have made the life more difficult to biodiversity conservation worldwide since they have been widely reported to contribute more problems compared to natural. For example, road construction along forest area, which may involve one or more of these anthropogenic processes, is noted to increase landslide susceptibility close to roads both during and after construction (Devkota et al., 2013). Also emergence of invasive species and loss of ecosystem services have been observed in several disturbed forest ecosystems.

Anthropogenic activities result in the reduction and loss of tree population, the extinction of species; transformation and degradation of ecological communities include habitat loss, fragmentation, and degradation which are currently the most important threats (Eriksen et al., 2011). Intentional human activity is non-malicious, but that may have a negative impact on society through the triggering or catalyzing of other hazardous processes (Gill and Malamud, 2016). Although through those activities local communities can improve living standard, to understand the effects of population on the environment requires careful consideration of the full range of factors responsible for environmental deterioration, since the nature of this relationship is heavily determined by land use patterns and agricultural policies adopted by the government.

Nambiga forest reserve as other forest reserves in Tanzania has been used by local communities for many years and may provide ecosystem services and hold important gene reservoirs of value in medicine, agriculture and forestry (Thorlakson, 2011; Mkonda and He, 2017). Human activity has also, however,

changed the Earth's surface and immediate subsurface, sometimes catastrophically (Guthrie, 2015). However, in recent times the utilization has increased and commercial pit-sawing operations may have caused a change in the forest structure (Hull et al., 2009). For example illegal trapping activities were found in 11 separate locations distributed throughout the forest and the pitfall trapping presents the most serious threat because they can continue to kill animals up to several years after their construction. This implies succinctly to Nambiga Forest; it needs to be conserved for mutual benefit.

Forests have been identified as one of the most important national assets (Kimaro et al., 2015, Thierfelder et al., 2012, Neufeldt et al., 2013). They supply ecosystem services and products to individuals, communities, and private sector and earn the government revenue tax. The rate at which natural forest resources are being harvested is unsustainable markedly in recent years. This is largely due to the increase in the local population, increasing poverty levels, ignorance, and poor policy enforcements, but through human activities. The pressure from many drivers to clear forests are expected to increase in future due to global urbanization, long-term population trends, growth in developing country, regional markets for key commodities and climate change adaptation factors (Kissinger, 2012).

The government of Tanzania gives the matter of environment very high priority in national planning in order to ensure that development is consistent with the enhancement of the environment for the well-being of the present and future generations (Salmi and Monela, 2000; Hong et al., 2018). There are some attempts made to study on a biodiversity and resources survey on Nambiga Forest reserve undertaken by Frontier-Tanzania, zoological trapping and vegetation surveys (Rossi et al., 2009). Therefore this study aimed to assess the socioeconomic and ecological benefits of anthropogenic activities in Nambiga forest as an ideal setting.

The findings of this study would provide useful information about benefits of anthropogenic activities on the forest recommend accordingly and findings would be made available to development planners such as the Ministry of Employment and Work and other development stakeholders. In addition these findings would be expected to assist policymakers in the effort to develop and implement the development scheme and also serve as a resource for research team developing new protocols.

2. THEORETICAL REVIEW

Theoretical framework is the structure that holds or support a theory of a research study. The theoretical framework introduces and describes the theory which explains why the research problem under study exists. Therefore, this study guided by one theory of environment which is Environment Kuznets Curve (1995) proposed by Kuznets who correlates between income and environment degradation, afterwards theory has been applied in Forestry sector known as EKC for degradation, hypothesizing the similar notion of EKC.

Theoretically the concept of the theory was discussed by Lopez (1994) states that as economic or income growth rising, degradation will be declined when the stock effects of forest resource on agricultural production are internalized .According to this concept, human activities on the forest are the functions of income or economic growth where in early stage of development level of income is low and deforestation is one probably one of negative consequences of development, then as income rising the rate of deforestation will decline.

Therefore increasing income would incentivize people to improve their forest resource and environment quality.

3. MATERIALS AND METHODS

3.1. Study Area

Nambiga Forest Reserve is located in Ulanga District, on the eastern side of the Kilombero Valley between the Udzungwa and Mahenge Mountains, Morogoro region, between 36°27′ E to 36°30′ E and 8°34′ S to 8°36′ S, it covers 1390 ha and has 16 km of boundary. The reserve is split by the Lupiro-Malinyi road and lies between the villages of *Iragua and Itete*, surrounded on three sides by miombo woodland and by farmland on the other side. It is a lowland forest about 335 to 365 m above sea level and rainfall is highly seasonal, ranging between 1000 to 2000 mm per year, with February to May the wettest period and temperatures range from 22°C in July to 28°C in November.

3.2. Study Population

The area surrounding Forest is characterized by two centers of population, *Madabadabba* and *Iragua*. *Madabadabba* is a settlement by the "*Sukuma*" tribe of about 320 households while *Iragua* is a newly established settlement with a population of about 480 households, and with about eleven new ones moving in this settlement each year. The areas between these two centers are characterized by dispersed settlements of various sizes and agriculture is a major of livelihoods within the surrounding villages and farms are only seen adjacent to the reserve on the northern roadside boundary although there are other human activities.

3.3. Sample Size

The sample size consisted of 80 households members, of which individual were selected randomly to avoid biasness (Humphrey and Kimberly, 2007). This sample is almost 10% of the total households i.e. 800 (*madabadabba* 480 and *Iragua* 320) while gender will highly be observed. Reasons for choosing this sample size were; the study would ensure meaningful results, there would be some adjustment on the expected deviation among individual results and due to economic budget.

3.4. Sampling Procedures

Simple random sampling was employed in selecting the households from the study population, whereas, every household had chance to be selected (Cramb et al., 2004). Literally, every respondent required to provide information as directive from the questions and close explanations by providing the realistic information.

3.5. Data Collection

Primary data from the field and secondary data from documentary review were involved. Although this paper applied mixed approaches in data collection; it mostly applied household survey (i.e. through questionnaire), key informant interview (i.e. structured interviews), and snow bowling approaches. Different types of data collection were used in order to triangulate information. For instance, documentary review involve the Ulanga and Malinyi Districts' reports, Tanzania forest conservation Group reports (NGO), The Global Forest Resources Assessments, Tanzania Forest service reports and Tanzania policy and Act documents.

Key informant interview was used to collect data from district officers and other staff. They were mostly asked a series of questions about the management of the Nambinga Forest and the allied ecosystems (Duru, 2015).

In addition, observation as a field data collection was important to the researchers in viewing the anthropogenic activities and comparing them with the socio-economic and ecological status of the population near forest. The approach served as a ground trothing strategy. At the end of each data collection day, there was a though checking of completeness of data and it involved the correction of some errors involved in the process.

3.6. Data Analyses

Quantitative data were analyzed through Statistical Package for Social Science (SPSS) version 22. In addition, qualitative data were analyzed through Theme Content Analysis.

Table 1. Age of respondents

Age	Frequency	Percent
15–29	40	50.0
30–49	38	47.5
Male	2	2.5
Total	80	100.0

Source: Field Survey Data (2021).

Table 2. Gender of the respondents

Gender	Frequency	Percent
Female	45	56.3
Male	35	43.8
Total	80	100.0

Source: Field Survey Data (2021).

4. RESULTS

4.1. Demographic Characteristics of the Respondents

Age of the respondents was considered to be important in assessing the social-economic and ecological benefits of anthropogenic activities using a case study of eighty selected household members in Ulanga district. The findings of the study show that, 40 (50%) of the interviewed members are aged 15–29 yr, 30 (47%) of interviewed members are aged 30–40 yr while 2 (2.5%) of interviewed members are aged 50 yr and above table 1 below illustrates.

On the gender of the respondents, the study managed to establish the fact that, the numbers of male members were little compared female members. Female members composed 45 (56.2%) while male members were 35 (43.8%). Female members are a little bit more engaged in many ordinary anthropogenic activities in the forest than males. Table 2 provides illustration based on the findings from the study area.

4.2. Time Spent by Respondents in the Area

The findings of the study reveal that: 61.2% living in the areas for more than five years, while 38.2% living in the areas for less than five years. From data obtained majority living in the areas for a longer time and they have been useful in providing right and accurate information based on the questions they have been asked, Table 3 provides information based on the findings from the study area.

4.3. Perception and Level of Awareness of Local People on Values of Forest

Table 4 illustrates the level of awareness of local communities on natural resources does the forest have, these perceptions are important because they influence the community's willingness to take part in

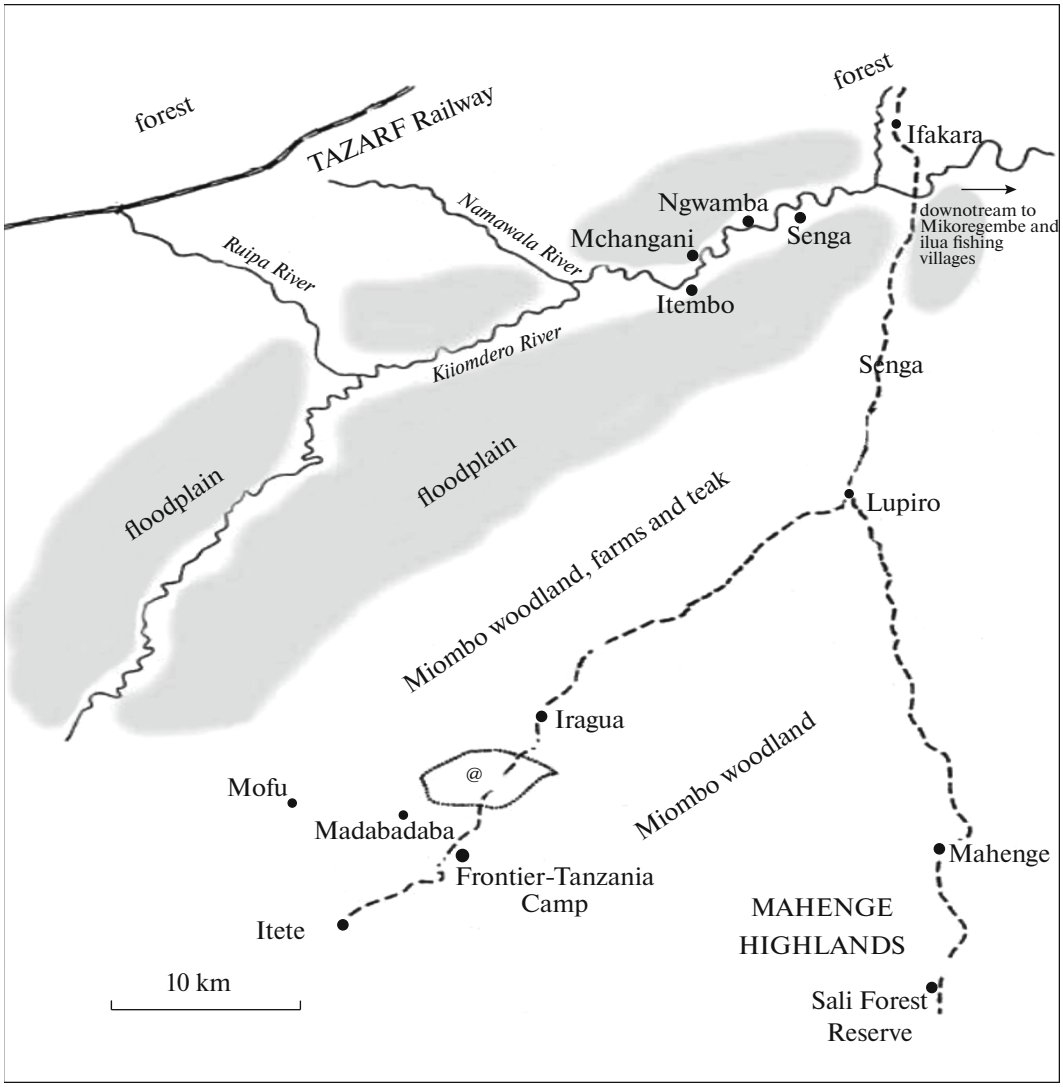

Fig. 1. A Map showing the location of Nambiga Forest Reserve in relation to the nearest towns and the main Lupiro-Itete road.

conservation of the forest. From the table, it can be seen that 77.5% of the respondent know some of resources, 16.2% know all and 6.3% know nothing about resources found in the forest. Based on the data obtained majority know some and depend very much on those resources and forest land for their livelihoods, thus they also suggests that more people in their village would like to be involved in harvesting forest resources and using forest land.

Table 3. Time Spent by Respondents in the Area

Time	Frequency	Percent
less than 5 years	31	38.8
5 years and more	49	61.3
Total	80	100.0

Source: Field Survey Data (2021).

4.4. Activities Taking Place in the Forest

The findings of the study reveal that, there are many anthropogenic activities taking place in neighboring villages around and in the forest as Table 5 illustrates below. Those activities are very crucial on their livelihood as result people satisfy their needs and wants through provision of services like shelter and fuel security to local communities and forest products are a vital part of our daily lives in more ways although these activities can involve forests directly or indirectly.

Apart from listed anthropogenic activities taking place in the forest, 82.5% agreed that there are other human activities taking place in the forest area which are timbering and hunting in which there is poaching of forest animals during night time. Even though, they play a vital role in increasing income of local communities as well as local government through taxes.

Table 4. Level of awareness of Respondents

	Frequency	Percent
I don't know	5	6.3
I know some	62	77.5
I know all	13	16.3
Total	80	100.0

Source: Field Survey Data (2021).

A district forest officer asserted that "Most people living around the forest entirely depend on the forest to get firewood and wood charcoal as source of energy". The District Agricultural and Livestock officer further commented that "The people around the forest reserve get water for domestic and small scale irrigation".

4.5. Changes as the Result of Anthropogenic Activities

Based on the results in Table 6 below and findings of the study indicate that forest resources decreased which is quite significant ecologically as it implies deforestation, loss of biodiversity as well as climate change in which 39.2% of the respondent considered deforestation as major disadvantage of anthropogenic activities in the forest, 28.8% pointed out loss of biodiversity as major effect while 32.0% pointed climate change as major effect as the result of anthropogenic activities in the forest. This directly means that the major forest change is human interference by overexploitation of resources as poor farmers use forest diversity as part of the risk management when crop harvest fail and people often turn to forest resources for supplementing food and income, the table below illustrates the findings.

4.6. Level of Dependence on Forest Land and Resources

Table 7 describes the assessment on level of dependence on forest land and forest resources over years. From table it can be noted that local population depend much on forest resources available to ensure good standard of living through satisfaction of their social and ecological needs, as 50% depend very much on forest resources compared to those who some sort depend on available resources, since local communities surrounding study area engaged more on anthropogenic activities.

4.7. Socio-Economic and Ecological Benefits of Anthropogenic Activities

The study results reveals that there are some socio-economic and ecological benefits of anthropogenic activities taking place in Nambiga forest as Table 8 indicated below. Since 45.5% of the total respondent pointed out economic growth as one of the benefits of human activities in the forest, 32% of the respondents pointed that there is development of infrastructure and 30.6% pointed that increase of per capital income as a benefit of anthropogenic activities in the Nambiga forest. Due to the presence of some minor tourism activities and timbering there increase in per capita income finally may lead to economic growth of local people and they will be able to mitigate hunger and malnutrition.

4.7. Suggested Solution to Ensure Better Utilization of Forest Resources

When requested to suggest solutions to reduce problems emanating from improper utilization of the forest resources available at the study area, 41.8% suggested provision of educational campaign on proper utilization of resources available, 46.4% suggested implementation of policies and laws concerning with proper management of available forest resources, while 11.8% suggested the use alternative energy sources such as biomass in order to reduce problems emanating from improper utilization of resources and conserve environment as whole. Table 9 provides information based on the findings from the study area.

5. DISCUSSION

Forest reserves have significant contribution to the livelihoods of the people. These significant ranges from ecological, economic and social perspectives (Henry et al., 2009; Hartemink et al., 2008). This study reveals that more than 60% of the people living

Table 5. Activities taking place in Nambinga Forest

	Activity	Frequency	Percent
(i)	Grazing livestock on pastures of forest	57	17.1
(ii)	Growing crops on the forestry farm land	52	15.6
(iii)	Collecting fuel and dry wood	76	22.8
(iv)	Collecting fruits, medicinal and aromatic herbs and plants	75	22.5
(v)	Beekeeping on the forest	73	21.9
Total		333	100.0

Source: Field Survey Data (2021).

Table 6. Changes as the result of anthropogenic activities

Change	Frequency	Percent
Deforestation	60	39.2
Loss of biodiversity	44	28.8
Climate change	49	32.0
Total	**153**	**100.0**

Source: Field Survey Data (2021).

Table 7. Level of dependence on Forest Resources

Dependence	Frequency	Percent
Very much	40	50.0
Sort of	36	45.0
Not at all	4	5.0
Total	80	100.0

Source: Field Survey Data (2021).

Table 8. Socio-economic and ecological benefits

Benefit	Frequency	Percent
Economic growth	61	45.5
Development of infrastructures	32	23.9
Increase of income	41	30.6
Total	134	100.0

Source: Field Survey Data (2021).

around Nambinga forest reserves have more than 5 yr in the area and thus, they have imperative role in the management of the forest (Table 3). It was further revealed that majority of them (>70% of the people were aware of the value of resources found in the forest reserve (Table 4). These data had justifiable reality as most of the respondents were adults (Table 1) and women (Table 2). These results were supported by the District Forest Officer who asserted that "Recently there has been increased awareness among the people on the value of forest resources and most people are willing to take part in the management of this ecosystem".

The study identified various activities taking place in the study area which are also serving as sources of income to local communities. Generally, the communities surrounding the study area are always getting food, energy, building materials, traditional medicines and water from the forest. Since the major theme of this paper was to explore the socio-economic and ecological significance of Nambinga Forest to the surrounding population, it was revealed that about all the respondents were involved in numerous livelihood activities such as grazing livestock on pastures of forest, growing crops on the forestry farm land, collecting fuel and dry wood, collecting fruits, medicinal and aromatic herbs and plants, and beekeeping (Table 5). The District Agricultural Officer supported these findings as he asserted that "Small scale farmers have been using the nearby land to cultivate for maize and cassava but also using the nearby grassland to feed their livestock". These findings are also supported by Duru (2015), Hong et al. (2018), and Timko (2018).

The communities enjoy several socio-economic and ecological aspects such as the increase of income, economic growth, and development of infrastructures as seen in Table 8. This finding was supported by the District Community Development Officer who asserted that "Through community based forest management organization; people have been enjoying the benefits of conserving the forest through funds from the funding agencies".

Apart from social-economic and ecological benefits of anthropogenic activities, forest loss and degradation are major threat to Tanzania's wildlife resources and evergreen forest like Nambinga forest as the results of exploitation of forest resources increases and later on affect the composition, distribution and abundance of the flora and fauna.

Normally, these activities have caused forest degradation, loss of biodiversity and also this has intensified the impacts of climate change as seen in Table 6. This is due to over-dependence to the forest reserves (Table 7). Therefore, this calls for immediate solutions to limit the associated impacts because the level of dependency to the forest is very high. It is generally advised that there should be provisions of education to local people on the best use and management of forest resources, best implementation of environmental policies, and above all, there should be sustainable alternative of energy source (Mariki, 2016).

Table 9. Solutions for Better Utilization of Resources

	Solution	Frequency	Percent
(i)	Use of alternative energy sources	13	11.8
(ii)	Implementation of policies concerning with proper management	51	46.4
(iii)	Provision of education to local people	46	41.8
	Total	110	100.0

Source: Field Survey Data (2021).

Based on the findings; it is specifically recommended that: (i) Forest Department continue to support and implement effective policies and programs through further developing, testing and, as appropriate implementing innovative approaches and initiatives that are currently being developed such as policies, technologies and management that are decoupling the economy from environmental harm, (ii) Encourage land use planning and the use of forest for non-timber product extraction so that forest can be valued for its resources to both local communities and national at large, (iii) More patrols to discourage animal poaching and illegal timber extraction especially during night time and improving boundary marks so that the local people know which areas constitute the forest.

6. CONCLUSIONS

This study exhibits that Nambinga Forest determines the major livelihoods of the surrounding communities. These communities acquire socio-economic and ecological advantages from this forest, and some of these include food from agriculture, energy from wood, water from the catchment, and medicines from plants and roots. Despite of these benefits, these activities have caused degradations and loss of biodiversity in the area. Therefore, it is considerably recommended that despite of these benefits, there should be proper management of the forest.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. Burgess, T.M., Butynski, N., Cordeiro, J., et al., The biological importance of the Eastern Arc Mountains of Tanzania and Kenya, *Biol. Conserv.*, 2007, vol. 134, no. 2, pp. 209–231.
2. Cramb, R.A., Purcell, T., and Ho, T.C.S., Participatory assessment of rural livelihoods in the Central Highlands of Vietnam, *Agric Syst.,* 2004, vol. 81, pp. 255–272.
3. Devkota, K., Regmi, D., Pourghasemi, H., Yoshida, K., and Pradhan, B., Landslide susceptibility mapping using certainty factor, index of entropy and logistic regression models in GIS and their comparison at Mugling–Narayanghat road section in Nepal Himalaya, *Nat. Hazards*, 2013, vol. 65, no. 1, pp. 135–165.
4. Duru, M., How to implement biodiversity-based agriculture to enhance ecosystem services, *Agron. Sustain. Dev.*, 2015, vol. 35, pp. 1259–1281. https://doi.org/10.1007/s13593-015-0306-1
5. Eriksen, S., Aldunce, R., Bahinipati, C.S., Martins, R.D., Molefe, J.I., Nhemachena, C., O''Brien, K., Olorunfemi, F., Park, J., Sygna, L., and Ulsrud, K., When not every response to climate change is a good one: Identifying principles for sustainable adaptation, *Clim. Dev.,* 2011, vol. 3, no. 1, pp. 7–20.
6. Gill, J. and Malamud B., Hazard interactions and interaction networks (cascades) within multi-hazard methodologies Earth Rev., *Geophysics,* 2016, vol. 52, no. 4, pp. 680–722.
7. Guthrie, G., The catastrophic nature of humans, *Nat. Geosci.,* 2015, vol. 8, no. 6, pp. 421–422. https://doi.org/10.1038/ngeo2455
8. Hartemink, A.E., Veldkamp, T., and Bai, Z., Land cover change and soil fertility decline in tropical regions, *Turk. J. Agric. For.*, 2008, vol. 32, pp. 195–213.
9. Henry, M., Tittonell, P., Manlay, R., Bernoux, M., Albrech, A., and Vanlauwe, B., Biodiversity, carbon stocks and sequestration potential in aboveground biomass in smallholder farming systems of western Kenya, *Agric. Ecosyst. Environ.,* 2009, vol. 129, nos. 1–3, pp. 238–252.
10. Hong, Z., Mkonda, M.Y., and He, X.H., Conservation agriculture for environmental sustainability in a semiarid agro-ecological zone under climate change scenarios, *Sustainability,* 2018, vol. 10, no. 5, art. ID 1430. https://doi.org/10.3390/su10051430
11. Hull, J., Burgess, N.D, Lovett, J., Mbilinyi, J., and Gererch, R.E., Conservation of Deforestation across an elevational gradient in the Eastern Arc Mountain, Tanzania, *Biol. Conserv.,* 2009, vol. 142, no. 11, pp. 2510–2521.
12. Humphrey, W.K. and Kimberly, E.M., Participatory resource mapping for adaptive collaborative management at Mt. Kasigau., Kenya, *Landscape Urban Plann.,* 2007, vol. 82, no. 3, pp. 145–158.
13. *IPCC, 2014a: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Global and Sectoral Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Chang*e, Field, C.B., Barros, V.R., Estrada, R.C., Genova, B., Girma, E.S., Kissel, A.N., Levy, S., MacCracken, P.R., Mastrandrea, and White., L.L., Eds., Cambridge: Cambridge University Press, 2014, part A.
14. Kimaro, A., Mpanda, M., Rioux, J., Aynekulu, E., Shaba, S., Thiong'o, M., Mutuo, P., Abwanda, S., Shepherd, K., Neufeldt, H., and Rosenstock, T., Is conservation agriculture 'climate-smart' for maize farmers in the highlands of Tanzania?, *Nutr Cycl. Agroecosyst.*, 2015, https://doi.org/10.1007/s10705-015-9711-8
15. Kissinger, G., Herold, M., and de Sy, V., *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers*, Lexeme Consulting, 2012.
16. Kuznets, S., Economic growth and income inequality, *Am. Econ. Rev.,* 1995, vol. 45, no. 1, pp. 1–28.
17. Lopez, R., The Environment as a Factor of Production: the Effects of Economic growth and Trade Liberalization, *J. Environ. Econ. Manage.*, 1994, vol. 27, pp. 163–184.
18. Mariki, S., Social impacts of protected areas on gender in West Kilimanjaro, Tanzania, *Open J. Soc. Sci.*, 2016, vol. 4, pp. 220–235.
19. Mkonda, M.Y. and He, X.H., The potentials of agroforestry systems in East Africa: a case of the eastern arc mountains of Tanzania, *Int. J. Plant Soil Sci.*, 2017, vol. 14, no. 3, pp. 1–11. https://doi.org/10.9734/IJPSS/2017/31299

20. Neufeldt, H., Jahn, M., Campbell, B.M., Beddington, J.R., DeClerck, F., de Pinto, A., Gulledge, J., Hellin, J., Herrero, M., and Jarvis, A., Beyond climate smart agriculture: toward safe operating spaces for global food systems, *Agric. Food Secur.*, 2013, vol. 2, art. ID 12.

21. Rossi, J., Govaerts, A., De Vos, B., Verbist, B., Vervoort, A., Poesen, J., Muys, B., and Deckers, J., Spatial Structures of Soil Organic Carbon in Tropical Forests—A case study of Southeastern Tanzania, *Catena,* 2009, vol. 77, pp. 19–27.

22. Salmi, D. and Monela, G., *Study on Forest Financing. Ministry of Lands Natural Resources and Tourism, Forestry and Beekeeping Division. Formulation of National Forest Programme in Tanzania*, Univ. Dar es Salaam, 2000.

23. Thierfelder, C., Cheesman, S., and Rusinamhodzi, L.A., Comparative analysis of conservation agriculture systems: Benefits and challenges of rotations and intercropping in Zimbabwe, *Field Crops Res.*, 2012, vol. 137, pp. 237–250.

24. Thorlakson, T., Reducing subsistence farmers` vulnerability to climate change: the potential contributions of agroforestry in western Kenya, Occasional Paper Nairobi, World Agroforestry Centre, 2011, no. 16, p. 76.

25. Timko, J.A, Policy nexus approach to forests and the SDGs: tradeoffs and synergies, *Curr. Opin. Environ. Sustainability*, 2018, vol. 34, pp. 7–12.