



Underlying Anthropogenic Driving Factors of Forest Landscape Degradation in the Kilimanjaro World Heritage Site, Tanzania Using Survey-based Data

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ABSTRACT

This study aimed to investigate the underlying anthropogenic driving factors of forest landscape degradation in the Kilimanjaro World Heritage Sites (WHS), Tanzania using survey-based data. The essence is to support strategic policies for forest landscape protection and natural heritage sustainability. The research employed empirical data using mixed questionnaires of experts and residents to identify various indirect anthropogenic driving factors of forest degradation, analyze rural poverty and causal mechanisms as indirect anthropogenic drivers of forest degradation, and evaluate the level of awareness and community involvement in forest protection. ArcGIS was used to generate the Maps. About 140 sample sizes were utilized for this study. Using purposive and simple random techniques, about 46 and 100 mixed questionnaires were distributed to experts in forest guard and residents, respectively. Data were analyzed using quantitative and qualitative techniques. Findings showed that indirect factors of forest degradation include high tourism demand, poverty, culture and tradition of local communities, lack of forest protection and conservation education, and insufficient land availability. Also, findings showed that rural poverty as an indirect anthropogenic driving factor of forest degradation is attributed to unemployment in rural areas, inadequate land for agriculture, and insufficient productive forestry availability.

Additionally, this study revealed that residents are aware that the forest is under the government's protection, and most people in local communities are not involved in activities for forest protection. Therefore, the study suggests that the locals should be involved in the activities that promote forest protection for effective control and management. Alternative heating methods should also be explored to reduce much pressure on the available forest to improve the natural heritage sustainability of natural WHS found in Sub-Saharan Africa and other parts of the Global South.

INTRODUCTION

Protecting tropical forests from degradation through institutional instruments, including strategic policies and World Heritage Conventions (WHC), is a critical action to be implemented effectively due to the contributions of forests to improving environmental/natural heritage sustainability (Sandstrom et al. 2020, Sahide et al. 2020, Allan et al. 2017, URT 1998a, URT 1998b). In this context, sustainable natural heritage can be regarded as a condition that allows both present and future generations to use the resources of

the natural heritage (e.g., wildlife and eco-tourism) without degrading the healthy state of forest ecosystems

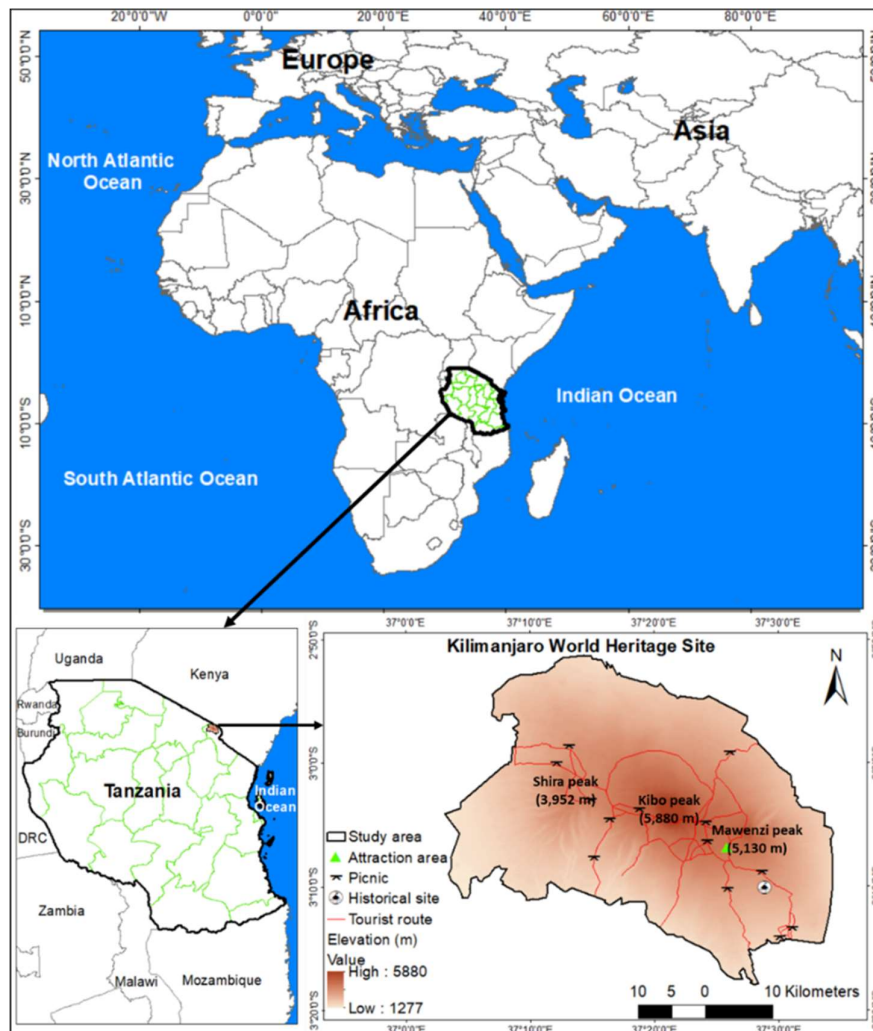
Implementing institutional instruments effectively for forest protection in the Kilimanjaro WHS, Tanzania in particular, and other natural WHS across the World in general, the causes of forest degradation are important to be identified and addressed. Forest degradation is associated with various causes that can be categorized into anthropogenic factors (for example, agriculture, charcoal production, settlement expansion, government policies) and

natural factors, which include topographic elevation and slope, weather/climate (Yahya et al. 2020, Sedano et al. 2020, Shigaeva & Darr 2020). All factors, including anthropogenic factors, can further be categorized into factors used to define the causes of land and environmental dynamics. They include underlying factors that cause the proximate causes and proximate factors that constitute the direct causes, as well as spatial determinants used for geographical explanations of the proximate causes (Abiodun et al. 2017, Meyfroidt 2016).

Regarding the underlying anthropogenic driving factors, which is the focus of the current study, government policies are associated with forest degradation (Saraiva et al. 2020, Kogo & Kumara 2019). According to Khuc et al. (2018), if the population increases by 1%, per capita areas of forest degradation increase by 1.2% in the province of Vietnam.

Additionally, wood-fuel consumption is associated with forest degradation as reported by Sulaiman et al. (2017), that an increase in wood-fuel consumption leads to an increase in forest degradation in Sub-Saharan Africa. Furthermore, the highest and lowest deforestation occurs in the provinces with relatively high and low rates of poverty, respectively, in Vietnam (Khuc et al. 2018). As indirect anthropogenic factors that cause the proximate causes, underlying factors are critical to be neglected. Otherwise, the proximate causes may not be able to be put under control effectively by all institutional instruments for forest protection.

The paper, therefore, aims to use surveys of experts and residents to investigate the underlying anthropogenic driving factors of forest landscape degradation in the Kilimanjaro



Source: Enoguanbhor et al. 2022.

Fig. 1: Maps showing the location of the Kilimanjaro World Heritage Site.

World Heritage Site, Tanzania, using Survey-based Data. Specifically, the study seeks to:

1. Identify various indirect anthropogenic driving factors of forest degradation;
2. Analyze rural poverty and causal mechanisms as indirect anthropogenic drivers of forest degradation and;
3. Evaluate the level of awareness and community involvement in forest protection.

MATERIALS AND METHODS

Study Area

The researchers chose the Kilimanjaro WHS due to the forest degradation over the years (Rutten et al. 2015, Soini 2005) and the forest landscape, particularly the Montane forest, as one of the outstanding universal values of the natural heritage site (UNESCO 2021). The Kilimanjaro WHS (Kilimanjaro National Park) is located in northeast Tanzania and covers 1686.72 km² (Fig. 1). Kilimanjaro National Park was established in 1973 and initially comprised the whole mountain and moorland vegetation above the montane forest. It was inscribed as a natural WHS in 1987 under criteria vii, with the mountain as an outstanding universal value and one of the largest volcanoes in the world (UNESCO 2021, IUCN 2020). In 2005, the Kilimanjaro WHS was extended to include the montane forest (the natural or primary forests that serve as buffer zones and habitats for wildlife) due to human pressure resulting in forest degradation.

The topographic elevation of the mountain ranges from 1277 to 5880 m above sea level at Kibo Peak, which is relatively located at the center of the mountain, as shown in Fig. 1. Other peaks of the mountain include Shira Peak (3,952 m above sea level) and Mawenzi Peak (5,130 m above sea level), peaks located in the northwest and southeast of Kibo Peak, respectively (Fig. 1). As a WHS and a National Park, various strategic actions are taken, including Tanzania National Forest Policy, Tanzania Wildlife Policy, Tanzania National Environmental Policy, Tanzania Tourism Policy, Tanzania National Forest Policy of 1998, Tanzania National Environmental Policy of 1997, WHC of 1972, Wildlife Policy of Tanzania 1998, Tanzania National Park Regulations of 2003, and National Tourism Policy of 1999 (UNESCO 2021, URT 2002).

Data Collection and Analysis

We designed two sets of questionnaires to collect empirical data from experts and residents and the questionnaires comprise open-ended and closed-end (Babbie 2013, Secor 2010). While questionnaires were distributed to experts using

purposive sampling (Babbie 2010), residents' questionnaires were distributed using random sampling (Kothari 2004). The choice of the research respondents and purposive sampling techniques used in this study is because they are the key informants and are more knowledgeable about research interests. 3 researchers administered all questionnaires by hand from 21st February to 8 April 2022. Forestry experts, both males and females, were selected from different Government Departments and Agencies, including the Tanzania Forest Service (TFS), Kilimanjaro National Park (KINAPA), Sokoine University of Agriculture Training Forest (SUATF), and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The expert respondents are adults between the ages of 28 to 40 years with the lowest qualification of a B.sc degree in forestry and related fields. Most of the experts are researchers, and some are forest guards with working experience in various Government departments and Agencies, which include Tanzania Forest Service (TFS), Kilimanjaro National Park (KINAPA), Sokoine University of Agriculture Training Forest (SUATF), and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The total population of the study is 140. Out of 46 questionnaires that were distributed to experts, 26 were retrieved. 100 questionnaires were distributed to residents at Kitowo, Rua, Lyasongoro, and Kokirie settlements, and 66 were retrieved. ArcGIS was used to generate the location of the Kilimanjaro World Heritage Site, land cover transitions, and the degraded primary forest. The sampled respondents and the number of retrieved questionnaires are good enough for the analysis, considering no advanced statistical analysis was done.

Regarding the analysis, we summarized dataset characteristics for closed-ended questions using quantitative(descriptive) analysis by calculating the response

Table 1: Ranking methods for questionnaires' open-ended questions.

Questionnaire	Rank		
	Symbol	Number of times a variable is identified	Description
Experts	*	1-2	Very low
	**	3-4	Low
	***	5-6	Moderate
	****	7-8	High
	*****	9 and above	Very high
Residents	*	1-2	Very low
	**	3-4	Low
	***	5-6	Moderate
	****	7-8	High
	*****	9 and above	Very high

Table 2: Indirect human driving factors of forest landscape degradation in the Kilimanjaro WHS based on experts' surveys.

Driver variables	Ranking
1 High tourism demand	****
2 Poverty in local communities	****
3 Culture and tradition of local communities	**
4 Lack of forest protection and conservation education for local communities	**
5 Insufficient land availability in local communities	*
6 Population growth and pressure	*
7 High dependency	*
8 Lack of sources of energy other than charcoal	*
9 Unemployment	*
10 Environmental degradation in other regions	*
11 Lack of proper security mechanism	*
12 Lack of land use plans	*

Ranking: * = Very low; ** = Low; *** = Moderate; **** = High; and ***** = Very high

frequencies and using qualitative methods of coding, sorting, synthesizing, and ranking for open-ended questions (Bryman 2016, Maxwell 2013). The respondents were asked to identify the various anthropogenic driving factors of forest degradation. The factors were ranked "very low, Low, Moderate High, Very High. We ranked all identified variables based on how many times each respondent identified a variable, as described in Table 1.

RESULTS AND DISCUSSION

The results in Table 2 show the indirect human driving factors of forest landscape degradation in the Kilimanjaro WHS based on experts' surveys. The major factors include high tourism demand and poverty in local communities, with both factors ranked "High." Other factors affecting forest degradation are the culture and tradition of local communities and a lack of forest protection and conservation education for local communities, and both factors are ranked "Low." The factors that are ranked "Very low" include insufficient land availability in local communities, population growth, and pressure, high dependency, a lack of sources of energy other than charcoal, a lack of proper security mechanisms, and a lack of land use plans.

Fig. 2a presents the results of rural poverty contributions to forest degradation in the Kilimanjaro WHS based on experts' surveys. 42.3% of the respondents attributed rural poverty to insufficient job availability in rural areas, and 30.8% attributed it to insufficient land availability for agriculture. 11.5% agreed to insufficient productive forestry availability, and 11.5% attributed it to other factors, including a lack of alternative sources of energy other than charcoal and firewood. The remaining 3.8% could not give their opinion. The results in Fig. 02b show different sources of income based on residents' surveys. While 71.2% of residents earn their incomes from agricultural activities, 22.7% earn from other sources, including small-scale businesses, porting, and construction/building. While 4.5% earn income from tourism

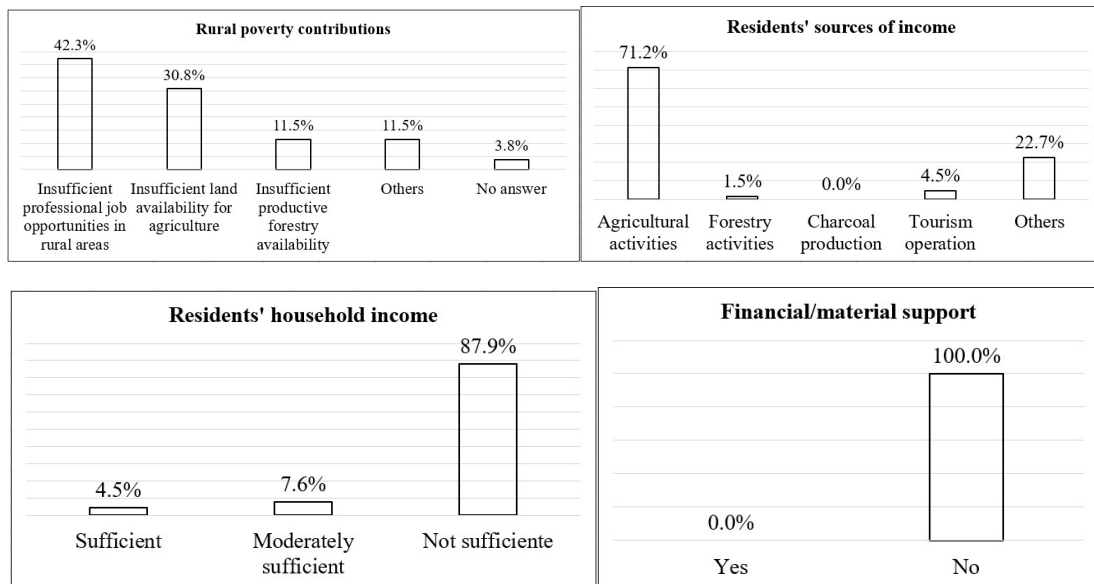


Fig. 2: (a) Rural poverty, (b) sources of income, (c) household income, and (d) financial/material supports as indirect contributions to forest degradation in the Kilimanjaro WHS based on experts' surveys.

operations, 1.5% from forestry activities, and no respondent earns income from charcoal production. Fig. 2c presents the results on the sufficiency of household income based on residents' surveys. 87.9% of the respondents agreed that their incomes are not sufficient for their households, and 7.6% and 4.5% opined that their household incomes are moderately sufficient and (fully) sufficient, respectively. The results in Fig. 2d show government financial/material support for local communities based on residents' surveys. All respondents opined that they receive no financial or/and material support from the government.

Fig. 3a and 3b present the results of awareness of forest protection by the government based on residents' surveys. While 87.9% of respondents are aware that the forest is under the government's protection, 12.1% of them are not aware. The results in Fig. 3b show local communities' involvement in forest protection of the Kilimanjaro WHS based on residents' surveys. While 87.7% of respondents opined that local communities are not involved in the activities for forest protection, 12.3% opined that local communities are being involved.

Our findings on indirect human driving factors of forest landscape degradation in the Kilimanjaro WHS based on experts' surveys (Table 2) show that the major factors include high tourism demand and poverty in local communities, the culture and tradition of local communities, a lack of of of forest protection and conservation education for local communities, insufficient land availability in local communities, population growth and pressure, high dependency, a lack of sources of energy other than charcoal, a lack of proper security mechanisms, and a lack of land use plans. The findings on high tourism demand and poverty in local communities and insufficient land availability in local communities indicate that the demand for tourism may continue to increase, which may affect forest protection if not managed properly, and poverty and insufficient land availability in local communities may force the people into

the forest for agricultural and illegal logging activities. The findings on population growth and pressure are similar to those of Khuc et al. (2018), who opined that if the population increases by 1%, per capita areas of forest degradation increase by 1.2% in the province of Vietnam. The findings on a lack of sources of energy other than charcoal support the findings from Sulaiman et al. (2017) that an increase in wood-fuel consumption leads to an increase in forest degradation in Sub-Saharan Africa. The finding on poverty in local communities is similar to the finding of Khuc et al. (2018), who reported the highest and lowest deforestation occurs in the provinces with relatively high and low rates of poverty, respectively, in Vietnam.

The findings on rural poverty as an indirect anthropogenic driving factor of forest degradation in the Kilimanjaro WHS based on experts' surveys are attributed to insufficient job availability in rural areas, insufficient land availability for agriculture, insufficient productive forestry availability, and other factors, including a lack of alternative sources of energy other than charcoal and firewood (Fig. 2a). The insufficient professional jobs, land availability for agriculture, and productive forest as a community forest may force most people to exploit the protected forest for human sustenance. The results corroborate the findings of Isieke (2020), who bolstered that indiscriminate exploitation of wood for fuel-wood, unsustainable agricultural practices, mining, bush burning, and infrastructural development are among the drivers of forest degradation. Mores, Jeminiwa et al. (2020) noted that briquettes of charcoal, commercial and subsistence farming, overgrazing, fuel-wood extraction, and population increase contribute to forest degradation.

The findings on different sources of income based on residents' surveys (Fig. 2b) show that most people in local communities earn their incomes from agricultural activities. Their household incomes are not sufficient for their households (Fig. 2c). Also, the people do not receive any financial or/material support from the government (

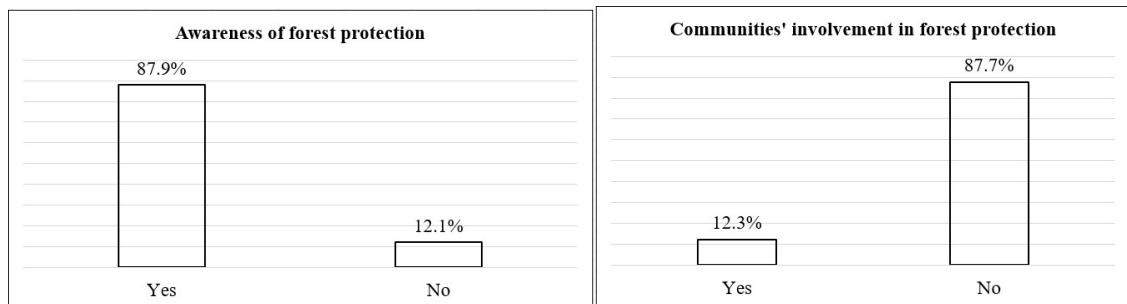


Fig. 3: (a) Awareness of forest protection and (b) local communities' involvement in forest protection based on residents' surveys.

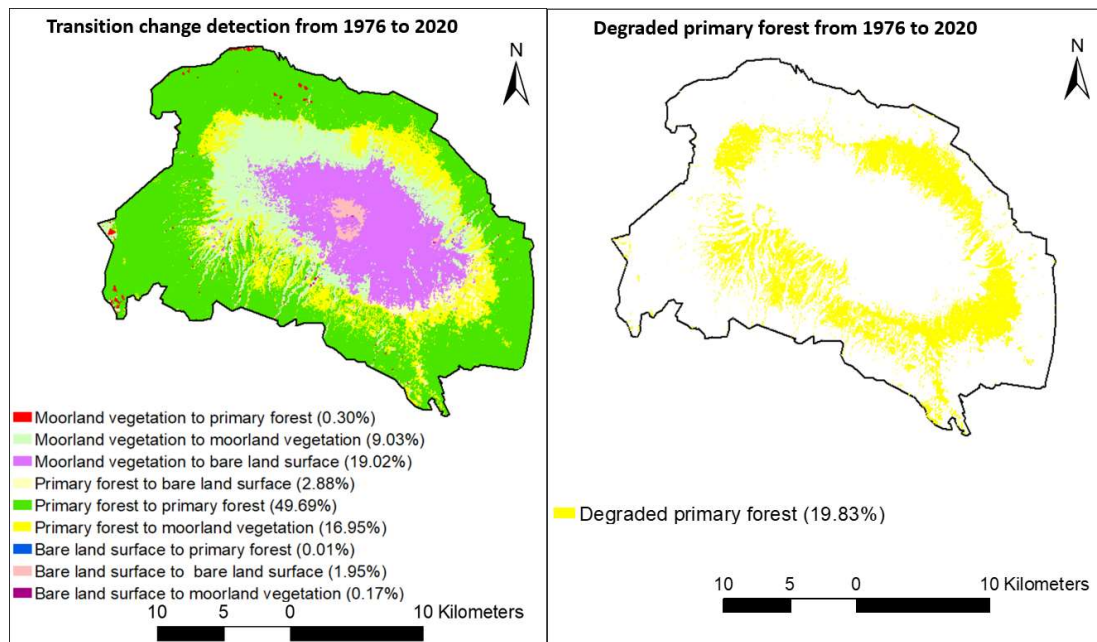
Fig. 2c). These indicate a high level of poverty that may lead to a high level of forest degradation (Khuc et al. 2018). Our finding on awareness of forest protection by the government based on residents' surveys (Fig. 3a) shows that residents are aware that the forest is under the government's protection, indicating possibilities for convincing the people about the necessity for forest protection through conservation education. The findings on local communities' involvement in forest protection of the Kilimanjaro WHS based on residents' surveys (Fig. 3b) show that most people in local communities are not involved in the activities for forest protection. This indicates that the people feel excluded from activities related to their natural heritage, forcing them to resist forest protection, which may lead to a violation.

The implication of the findings can be linked to indirect anthropogenic driving factors of forest degradation, particularly the culture and tradition of local communities and a lack of forest protection and conservation education for local communities. A similar study by Nura and Endris (2020) also confirmed that a lack of community awareness of sustainable use and management of forest resources (44.5%) and a lack of clear understanding of forest laws and regulations among the community (40.4%) contributed to forest deforestation in Jimma Zone, South Western Ethiopia.

From the cultural heritage point of view, the people may be feeling that accessibility and utilization of forest resources

are their fundamental human rights because it is their natural heritage from their ancestors, where their cultural activities (e.g., farming, rearing of animals, harvesting of trees and bees) are to be carried out for human sustenance. The lack of forest protection and conservation education for local communities is worsening the real-world situation because the people ought to be enlightened on the reasons why the forest should be protected for natural heritage sustainability. Despite the awareness of the people that the forest is under protection by the government, if forest protection and conservation education for local communities are not implemented, their culture and tradition would position the minds of the people to resist any form of restrictions from the forest. This may continue to hinder the implementation of the WHC and policies' effectiveness on forest protection and natural heritage sustainability. Additionally, an important implication of the findings can be linked to the living conditions of local communities that have not been able to improve through other institutional instruments for poverty alleviation programs. The main source of income for local communities is agriculture, and the accessibility to lands for agricultural expansion is very low. Their incomes are not sufficient for most people, and they do not receive financial or material support from the government.

Additionally, most people are not involved in the process of forest protection, and unemployment increases. Neglecting



Source: Enoguanbhor et al. (2022).

Fig. 4: Spatial patterns of (a) land cover transitions and (b) the degraded primary forest.

the people in such poor living conditions may continue to affect the effective implementation of the WHC and policies for forest protection and natural heritage sustainability. Thus, a large area of the montane/primary forest landscape has been degraded in the last four decades and has not been able to be regenerated, as shown in Fig. 4.

The information on underlying anthropogenic factors of forest degradation in the study area is essential to supporting the implementation of institutional instruments for forest protection and improving the sustainability of the Kilimanjaro WHS and other natural WHS found in the Global South. Thus, the study contributes to World Heritage Studies and management for natural heritage sustainability. This study is limited by time constraints due to the Tanzanian government bureaucracy while seeking official approval for the field research. Also, most experts were not available for questionnaires' distribution and retrieval. However, the 26 questionnaires retrieved from experts used for the current study can be said to be sufficient, considering no inferential statistics were performed in the current study.

Based on our findings and limitations of the study, we, therefore, recommend the following: First, the culture and tradition of local communities should be evaluated and considered other alternatives which include, through education, re-orient the minds of the people on the need to improve forest protection, attain and maintain forest, and natural heritage sustainability. Second, the living conditions of local communities should be improved through other institutional instruments, for example, poverty alleviation programs. This can be done by creating and improving different sources of income. Third, experts should always try to be available and respond to questionnaires. Finally, future research should apply the same or similar method to investigate the proximate anthropogenic factors of forest degradation.

CONCLUSION

The study used surveys of experts and residents to investigate underlying anthropogenic driving factors of forest degradation in the Kilimanjaro WHS to support strategic policies for forest landscape protection and natural heritage sustainability. Our findings showed that indirect anthropogenic driving factors of forest degradation include high tourism demand and poverty in local communities, the culture and tradition of local communities, a lack of forest protection and conservation education for local communities, and insufficient land availability in local communities. Other factors include population growth and pressure, high dependency, a lack of sources of energy other than charcoal, a lack of proper security mechanisms, and a lack of land use plans. The findings on rural poverty as an

indirect anthropogenic driving factor of forest degradation are attributed to insufficient job availability in rural areas, insufficient land availability for agriculture, insufficient productive forestry availability, and other factors, including a lack of alternative sources of energy other than charcoal and firewood. The findings on different sources of income based on residents' surveys showed that most people in local communities earn their incomes from agricultural activities, and their household incomes are not sufficient for their households. Also, the findings showed that the people do not receive any financial or/ material support from the government (Fig. 2c). The finding on awareness of forest protection showed that residents are aware that the forest is under the government's protection. The findings showed that most people in local communities are not involved in activities.

Therefore, the study suggests that the government, through the authority(s) in charge of a forest, should involve the locals in the activities that promote forest protection for effective control and management. Furthermore, alternative heating methods should be explored to reduce much pressure on the available forest. The findings from our study on underlying anthropogenic factors of forest degradation are crucial to supporting decision-making processes on the implementation of strategic policies and WHC for forest protection and improving natural heritage sustainability in the Global South.

REFERENCES

- Abiodun, O.E., Olaleye, J.B., Olusina, J.O. and Omogunloye, O.G. 2017. Principal component analysis of urban expansion drivers in greater Lagos, Nigeria. *Niger. J. Environ. Sci. Technol.*, 1: 156-168.
- Allan, J.R., Venter, O., Maxwell, S., Bertzky, B., Jones, K., Shi, Y. and Watson, J.E.M. 2017. Recent increases in human pressure and forest loss threaten many Natural World Heritage Sites. *Biol. Conserv.*, 206: 47-55.
- Babbie, E. 2010. *The Practice of Social Research*. Twelfth edition. Wadsworth, Belmont.
- Babbie, E. 2013. *The Practice of Social Research*. Thirteenth edition. Cengage Learning, Madrid, Wadsworth.
- Bryman, A. 2016. *Social Research Methods*. Fifth edition. Oxford University Press, New York, NY.
- Enoguanbhor, E.A., Enoguanbhor, E.C. and Albrecht, E. 2022. Spatial determinants of forest landscape degradation in the Kilimanjaro World Heritage Site, Tanzania. *Cent. Eur. J. Geogr. Sustain. Dev.*, 4(2): 5-23.
- Enoguanbhor, E.C., Chukwurah, G.C., Fotang, C. and Enoguanbhor, E.A. 2023. Integrating GIS and survey-based data to evaluate urban green infrastructural development in the context of urban planning implementation and challenges. *Int. J. Eng. Technol. Innov.*, 5: 111.
- Enoguanbhor, E.C., Gollnow, F., Walker, B.B., Nielsen, J.O. and Lakes, T. 2021. Key Challenges for Land Use Planning and its Environmental Assessments in the Abuja City-Region, Nigeria. *Land*, 10(5): 443.
- Enoguanbhor, E. 2021. *Urban Land Dynamics in the Abuja City-Region, Nigeria: Integrating GIS, Remotely Sensed, and Survey-Based Data to Support Land Use Planning*. Humboldt-Universität zu Berlin, Berlin.

- Enoguanbhor, E., Gollnow, F., Walker, B., Nielsen, J. and Lakes, T. 2022. Simulating urban land expansion in the context of land use planning in the Abuja City-Region, Nigeria. *GeoJournal*, 87: 1479-1497.
- Isieke U. 2020. The Unpopular factors were driving forest, land degradation, and climate change in Nigeria.
- IUCN. 2020. Kilimanjaro National Park - 2020 conservation outlook assessment. <https://worldheritageoutlook.iucn.org/explore-sites/wdpaid/17761>
- Jeminiwa, O.R., Jeminiwa, M.S., Taiwo, D.M., Dauda, M. and Iolaoti-laaro, S.O. 2020. Assessment of forest degradation indices in Mokwa forest reserve, Niger State, Nigeria. *J. Appl. Sci. Environ. Manage.*, 24(8): 1351-1356. DOI: 10.4314/jasem.v24i8.7.
- Khuc, Q.V., Tran, B.Q., Meyfroidt, P. and Paschke, M.W. 2018. Drivers of deforestation and forest degradation in Vietnam: An exploratory analysis at the national level. *Forest Policy Econ.*, 90: 128-141.
- Kogo, B.K. and Kumara, L. 2019. Forest cover dynamics and underlying driving forces affecting ecosystem services in western Kenya. *Remote Sens. Appl. Soc. Environ.*, 14: 75-83.
- Kothari, C.R. 2004. *Research Methodology: Methods & Techniques*. Second edition. New Age Int. (P) Ltd., Publishers, New Delhi.
- Lu, S., Sun, H., Zhou, Y., Qin, F. and Guan, X. 2020. Examining the impact of forestry policy on poor and non-poor farmers' income and production input in collective forest areas in China. *J. Clean. Prod.*, 276: 123784.
- Maxwell, J.A. 2013. *Qualitative Research Design: An Interactive Approach*. Third edition. SAGE Publications, Inc., NJ.
- Meyfroidt, P. 2016. Approaches and terminology for causal analysis in land systems science. *J. Land Use Sci.*, 11(5): 501-522.
- Nura, K.T. and Endris, F.S. 2020. Assessment of levels of community awareness to effects of forest degradation and their environmental management practices in Jimma Zone, South Western Ethiopia. *Int. J. Multicult. Multi-religion. Underst.*, 7(2): 212-228. <https://doi.org/10.18415/ijmmu.v7i2.1501>
- Rutten, G., Ensslin, A., Hemp, A. and Fischer, M. 2015. Forest structure and composition of previously selectively logged and non-logged montane forests at Mt. Kilimanjaro. *Forest Ecol. Manage.*, 337: 61-66.
- Sahide, M.A., Fisher, M.R., Erbaugh, J.T., Intarini, D., Dharmiasih, W., Makmur, M., Faturachmat, F., Verheijena, B. and Maryudi A. 2020. The boom of social forestry policy and the bust of social forests in Indonesia: Developing and applying an access-exclusion framework to assess policy outcomes. *Forest Policy Econ.*, 120: 102290.
- Sandström, C., Kanyama, A.C., Rätty, R., Sonnek, K.M., Nordström, E.M., Mossing, A. and Nordin A. 2020. Policy goals and instruments for achieving a desirable future forest: Experiences from backcasting with stakeholders in Sweden. *Forest Policy Econ.*, 111: 102051.
- Saraiva, M.B., Ferreira, M.D., Cunha, D.A., Daniel, L.P., Homma, A.K. and Pires, G.F. 2020. Forest regeneration in the Brazilian Amazon: Public policies and economic conditions. *J. Clean. Prod.*, 269: 122424.
- Secor, A.J. 2010. Social surveys, interviews, and focus groups. In B. Gomez, and J.P. Jones III (eds), *Research Methods in Geography: A Critical Introduction*. Blackwell Publishing Ltd, West Sussex, pp. 194-205.
- Sedano, F., Lisboa, S., Duncanson, L., Ribeiro, N., Siteo, A., Sahajpal, R., Hurtt, G. and Tucker, C. 2020. Monitoring intra and inter-annual dynamics of forest degradation from charcoal production in Southern Africa with Sentinel-2-2 imagery. *Int. J. Appl. Earth Obs. Geoinform.*, 92: 102184.
- Shigaeva, J. and Darr, D. 2020. On the socio-economic importance of natural and planted walnut (*Juglans regia* L.) forests in the Silk Road countries: A systematic review. *Forest Policy Econ.*, 118: 102233.
- Soini, E. 2005. Land use change patterns and livelihood dynamics on the slopes of Mt. Kilimanjaro, Tanzania. *Agric. Syst.*, 85: 306-323.
- Sulaiman, C., Abdul-Rahim, A.S., Mohd-Shahwahid, H.O. and Chin, L. 2017. Wood fuel consumption, institutional quality, and forest degradation in sub-Saharan Africa: Evidence from a dynamic panel framework. *Ecol. Indic.*, 74: 414-419.
- UNESCO 2021. Convention concerning the protection of the world's cultural and natural heritage. <https://whc.unesco.org/en/conventiontext>
- URT. 1998. National Forest Policy. Dar Es Salaam: Ministry of Natural Resources and Tourism.
- URT 2002. The Forest Act. Dar Es Salaam: URT.
- URT 1998. The wildlife policy of Tanzania. Dar Es Salaam: Ministry of Natural Resources and Tourism.
- Yahya, N., Bekele, T., Gardi, O. and Blaser, J. 2020. Forest cover dynamics and its drivers of the Arba Gugu forest in the Eastern highlands of Ethiopia during 1986-2015. *Remote Sens. Appl. Soc. Environ.*, 20: 100378.