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Survey-based Analysis for Proximate Anthropogenic Driving Factors of Forest Landscape Degradation: The Case of Kilimanjaro World Heritage Site, Tanzania

Eveline Aggrey Enoguanbhor^{1*}, Dr. Evidence Chinedu Enoguanbhor, PhD², Iwebuke Edo¹ & Prof. Eike Albrecht, PhD¹

¹ Brandenburg University of Technology, Cottbus – Senftenberg, Platz der Deutsche Einheit 1, 03046 Cottbus, Germany.

² Humboldt University of Berlin, Rudower Chaussee 16, 12489, Berlin, Germany.

* Author for Correspondence ORCID ID: <https://orcid.org/0009-0000-6550-5315>; email: evelinemwambene@yahoo.com

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Institutional Instruments, WHC, Strategic Policies, Forest Degradation, Kilimanjaro WHS, Global South.

Protecting tropical forests from degradation is a critical challenge for implementing institutional instruments, including the World Heritage Convention (WHC) and strategic policies for forest protection in the Global South. Identifying and addressing proximate anthropogenic causes are important steps to support the effective implementation of institutional instruments. Our study, therefore, investigated the proximate anthropogenic driving factors of forest degradation in the Kilimanjaro World Heritage Sites (WHS) to support WHC and strategic policies for forest protection and natural heritage sustainability. We used surveys of experts and residents to generate data to identify direct anthropogenic driving factors and analyze forestry and agricultural activities, the level of tourism, and bush burning/wildfire activities as proximate anthropogenic driving factors of forest degradation. Our key findings showed that direct anthropogenic factors are mostly attributed to agricultural activities, beekeeping and honey harvesting, and charcoal production. Other factors include wildfire/bush burning, illegal logging, tourism activities, infrastructural developments, and the introduction of exotic plant species. Also, the findings showed that the level of forestry activities on the site is high, and most of the people have no access to productive (community) forests. Additionally, our findings showed that the levels of agricultural activities on the site and accessibility to agricultural lands are low and very low, respectively. Furthermore, our findings showed that the level of tourism activities on the site is high, and bush burning (wildfire) on the site is attributed to tourism activities and park rangers. The study findings are crucial to support decision-making processes on implementing the WHC and other strategic policies for forest protection and natural heritage sustainability in WHS across the Global South.

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INTRODUCTION

Forest degradation poses challenges to the implementation of institutional instruments (e.g., the World Heritage Convention - WHC and strategic policies) for forest protection and the situation hinders achieving the sustainability of forests as a natural heritage (Sahide et al., 2020; UNESCO, 2021; Lu et al., 2020; Allan et al., 2017; Sandström et al., 2020; CBD, 2020; URT, 1998a; URT, 1998b; Hua, 2007; URT, 1997). The sustainability of forests as a natural heritage in this context is a situation that allows current and future generations to utilize services (e.g., wildlife and eco-tourism) provided by the natural heritage and protection of forests from degradation through effective implementation of institutional instruments, including WHC and other strategic policies.

In Tanzania, the Kilimanjaro National Park, which was established in 1973, was inscribed as a natural World Heritage Site (WHS) in 1987 under criteria vii, where the mountain is classified as an outstanding universal value due to its uniqueness based on having one of the largest volcanoes in the world (UNESCO, 2021; IUCN, 2020). Additionally, the montane forest was classified as another outstanding universal value and integrity feature and was included in the site due to human pressure on forest degradation (UNESCO, 2021; IUCN, 2020). As a National Park and a WHS for tourism destinations, tourism pressure and

associated problems such as trampling of vegetation, soil erosion, and water pollution are among the problems threatening the site (IUCN, 2020). Other threats associated with the WHS include wildfires, illegal logging of forest trees, and climate change problems such as the melting of glaciers and the reduction of the snow cap (Enoguanbhor et al., 2023; IUCN, 2020).

To improve, attain, and maintain the sustainability of forests in WHS, including Kilimanjaro WHS through effective implementation of WHC and other strategic policies, various factors responsible for forest degradation must be identified and put under control (Enoguanbhor et al., 2022). These factors are grouped into anthropogenic and natural factors (Shigaeva & Darr, 2020; Yahya et al., 2020; Sedano et al., 2020; Zimbres et al., 2018; Tarazona & Miyasiro-Lopez, 2020; Viccaro et al., 2019; Sulaiman et al., 2017), that can as well be grouped into underlying and proximate factors (Meyfroidt, 2016; Adedire et al., 2016; Abiodun et al., 2017).

The proximate anthropogenic driving factors of forest degradation are factors that constitute the direct causes (Meyfroidt, 2016; Abiodun et al., 2017; Adedire et al., 2016). Examples of such factors include settlement expansion, charcoal production, and agricultural activities (Tarazona & Miyasiro-Lopez, 2020; Khuc et al., 2018; Yahya et al., 2020; Sedano et al., 2020; Shigaeva & Darr, 2020; Zimbres et al., 2018; Sulaiman et

al., 2017; Viccaro et al., 2019). According to Zimbres et al. (2018), road networks and urban areas are associated with forest degradation in the Amazon basin of Alta Floresta, Brazil. Agricultural expansion through the encroachment of crop cultivation into the forest contributes to forest degradation in the Aseko, Chole, Gololcha, Guna, and Merti Districts of Ethiopia (Yahya et al., 2020). According to Khuc et al. (2018), agricultural production negatively impacts forest degradation in Vietnam. Identifying and addressing proximate anthropogenic driving factors of forest degradation are useful steps to improve the implementation of WHC and strategic policies for forest protection.

This study aims to investigate the proximate anthropogenic driving factors of forest degradation in the Kilimanjaro WHS to support WHC and strategic policies for forest protection and natural heritage sustainability. The study's objectives are to:

- Identify direct anthropogenic driving factors of forest landscape degradation;
- Analyze the level of forestry and agricultural activities as direct anthropogenic driving factors of forest degradation and
- Analyze the level of tourism and bush burning/wildfire activities as direct anthropogenic driving factors of forest degradation.

MATERIALS AND METHODS

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

Source: Modified from Enoguanbhor (2021)

Questionnaires were used to collect data from experts and residents from 21 February to 8 April 2022 by the first Author. The questionnaires were designed to include open-ended and closed-ended questions (Babbie, 2013; Secor, 2010). We deployed purposive and probability sampling methods to distribute questionnaires to experts and residents, respectively (Babbie, 2010; Kothari, 2004). We defined the government departments and agencies to select experts for questionnaire distribution, and these included the United Nations Educational, Scientific and Cultural Organization (UNESCO), Tanzania Forest Service (TFS), Sokoine University of Agriculture Training Forest (SUATF), and Kilimanjaro National Park (KINAPA). While 46 questionnaires were distributed to experts, 26 questionnaires were retrieved. One hundred questionnaires were distributed to residents at Kokirie, Lyasongoro, Kitowo, and Rua settlements, and 66 questionnaires were retrieved.

We analyzed the data by integrating quantitative (descriptive) and qualitative analyses. We used descriptive analysis to summarize dataset characteristics for closed-ended questions of all questionnaires by calculating the response frequencies and used qualitative analysis, particularly coding, sorting, synthesizing (Bryman, 2016; Maxwell, 2013; Secor, 2010), and ranking (Enoguanbhor et al., 2021) for open-ended questions. We identified all variables and ranked them as described in *Table 1*.

RESULTS

Table 2 presents the results of the direct human driving factors of forest landscape degradation in the Kilimanjaro WHS based on experts’ surveys. The respondents attributed the factors ranked “Very high” to agricultural activities (farming and

animal rearing), beekeeping and honey harvesting, and charcoal production. Factors ranked “High” include wildfire/bush burning and illegal logging. Other factors ranked “Very low” include tourism activities, infrastructural developments, and the introduction of exotic plant species.

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

	Driver variables	Ranking
1	Agricultural activities (farming and animal rearing)	*****
2	Bees keeping and honey harvesting.	*****
3	Charcoal production	*****
4	Wildfire/bush burning	****
5	Illegal logging	****
6	Tourism activities	*
7	Infrastructural developments	*
8	Introduction of exotic plant species	*

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

The results in Figure 1a show the level of forestry activities in the Kilimanjaro WHS based on experts’ surveys. Most respondents opined that the level of forestry activities is high, followed by those who opined that the level is very high, low, and very low. The results in Figure 1b show the accessibility level to productive forests based on residents’ surveys. Most respondents agreed that the accessibility level to productive forests is very low, followed by those who agreed that it is low and high. Figure 1c shows the level of wood supply for charcoal production based on residents’ surveys. All respondents opined that the level of wood supply for charcoal production is low. The results in Figure 1d show the main sources of cooking/heating based on residents’ surveys, and most respondents indicated the use of firewood and charcoal, followed by those who indicated the use of gas, electricity, and other sources.

The results in Figure 2a show the level of agricultural activities in the Kilimanjaro WHS based on experts’ surveys. Most respondents agreed to a low level, followed by those who agreed to a high level, a very low level, and a very high level of agricultural activities in the Kilimanjaro WHS. Figure 2b presents the results on the accessibility level to acquire lands for agricultural activities based on residents’ surveys. Most respondents agreed to a very low level, followed by those who opined to a low level and a high level. No respondents agreed to a very high level.

Figure 3 presents the results on the level of tourism activities in the Kilimanjaro WHS based on experts’ surveys. Most respondents agreed that the level of tourism activities is high, followed by a low level, a very high level, and a very low level. 7.7% did not respond to the question.

Figure 1: (a) Level of forestry activities based on experts' surveys, (b) accessibility to productive forest based on residents' surveys, (c) level of wood supply for charcoal production based on residents' surveys, and (d) main sources of cooking/heating based

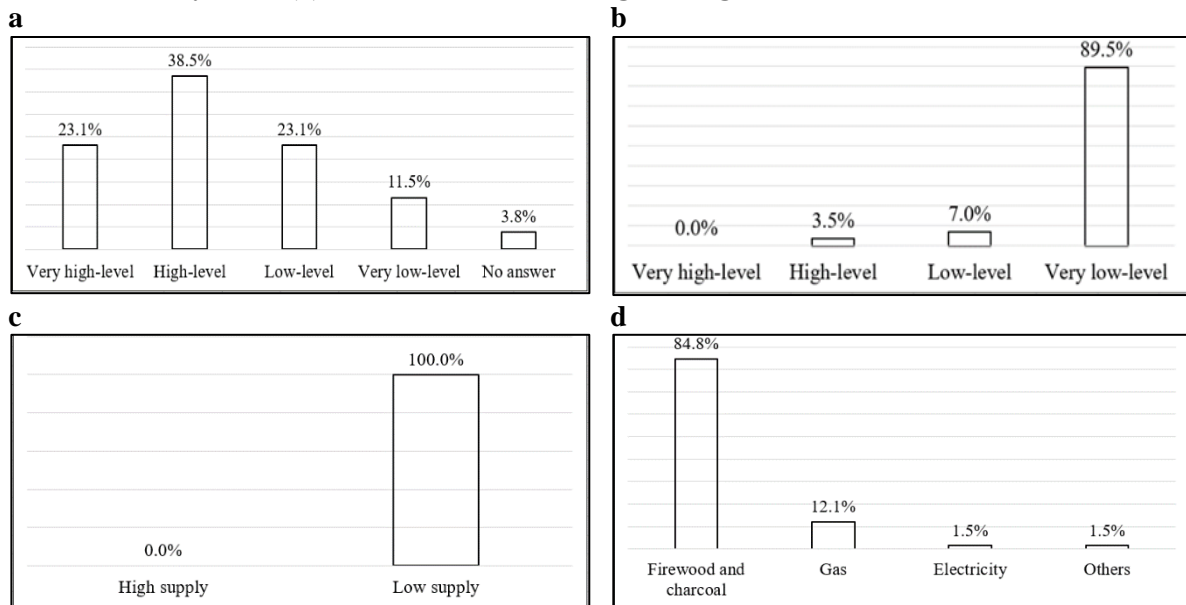


Figure 2: (a) Level of agricultural activities based on experts' surveys and (b) accessibility level to agricultural lands outside the Kilimanjaro WHS based on residents' surveys.

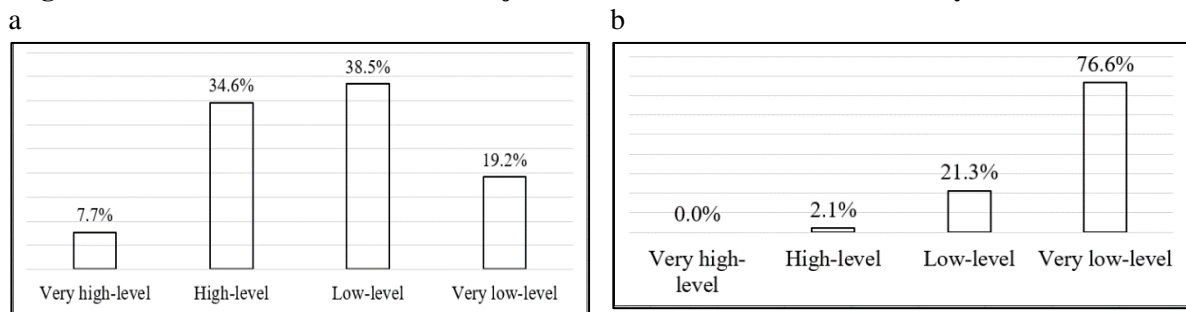


Figure 3: Level of tourism activities in the Kilimanjaro WHS based on experts' surveys.

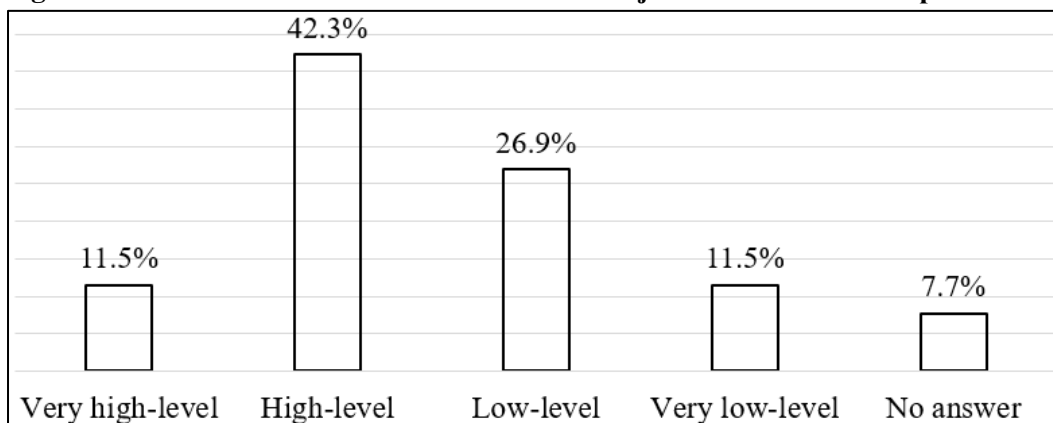


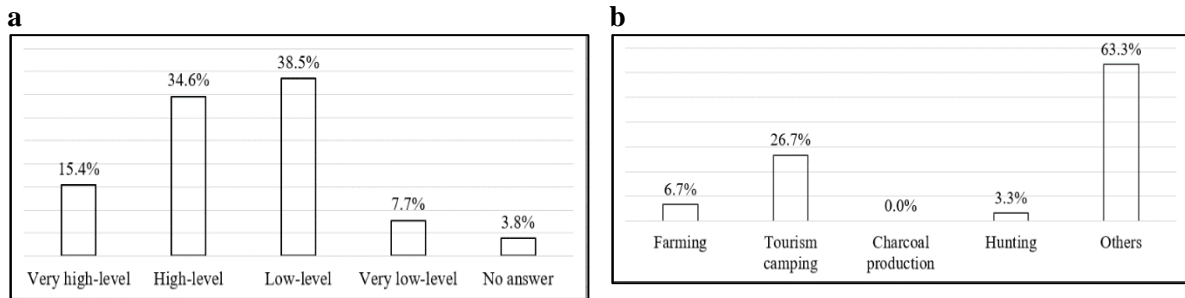
Figure 4a presents the results on the level of bush burning in the Kilimanjaro WHS based on experts' surveys. Most respondents showed that the level of bush burning is low, followed by those who indicated to be high-level, very high-level,

and very low-level. The results in Figure 4b show the sources of wildfire in the Kilimanjaro WHS based on residents' surveys, and most respondents attributed wildfire to other activities, including Park Rangers purposely setting the forest ablaze

to request funding to fight the fire (ranked “Very high”), honey harvesting (ranked “Moderate”), cigarette accidents (ranked “Low”), and waste burning (ranked “Very low”). Also, wildfire is

attributed to tourism, farming, and hunting, respectively. No respondent agreed to charcoal production as a source of wildfire.

Figure 4: (a) Level of bush burning based on experts’ surveys and (b) sources of wildfire in the Kilimanjaro WHS based on residents’ surveys.

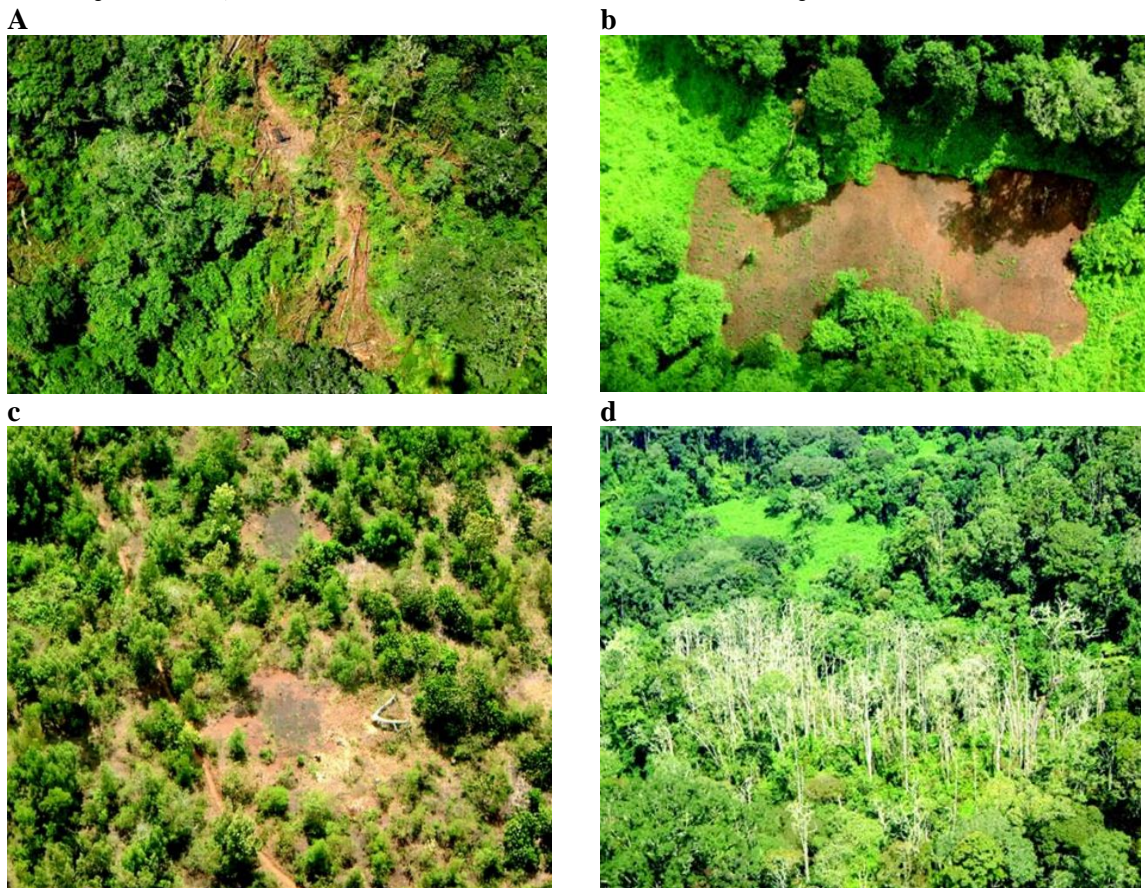


Others: Park Rangers *****, Honey harvesting ***, accidents through smoking cigarettes **, hunters *, waste burning *

et al., 2002). While *Plate 1(a)* shows the degradation in the southwest, *Plate 1(b)* shows a cultivated (Taro) field within the indigenous forest area. *Plate 1(c)* shows the charcoal kilns in the southeast, and *Plate 1(d)* shows the burnt forest in the southeast.

Plate 1 shows the aerial surveys of forest degradation in the Kilimanjaro WHS (Lambrechts

Plate 1: Aerial surveys of (a) forest degradation in the southwest Kilimanjaro WHS, (b) a cultivated (Taro) field within the indigenous forest area, (c) charcoal kilns in the southeast Kilimanjaro WHS, and (d) burnt forest in the southeast Kilimanjaro WHS.



Source: Lambrechts et al. (2002).

DISCUSSION

The study investigated proximate anthropogenic driving factors of forest degradation in the Kilimanjaro WHS to support WHC and strategic policies for forest protection and natural heritage sustainability.

Findings

The findings on direct human driving factors of forest landscape degradation in the Kilimanjaro WHS based on experts' surveys (Table 2) show that these factors are mostly attributed to agricultural activities (farming and animal rearing), beekeeping and honey harvesting, and charcoal production. Other factors include wildfire/bush burning, illegal logging, tourism activities, infrastructural developments, and the introduction of exotic plant species. The finding on agricultural activities supports those of Yahya et al. (2020), who opined that agricultural expansion through the encroachment of crop cultivation into the forest contributes to forest degradation in the Aseko, Chole, Gololcha, Guna, and Merti Districts of Ethiopia. Also, the finding is similar to Khuc et al. (2018), who reported agricultural production negatively impacts forest degradation in Vietnam. The findings on the level of agricultural activities in the Kilimanjaro WHS based on experts' surveys show low levels followed by high levels (Figure 2a). Plate 1b, which is an aerial photograph of a cultivated (Taro) field within the indigenous forest area, is evidence to support the findings that agricultural activities are going on in the protected area. The study shows that accessibility to agricultural lands in local communities is very low (Figure 2b). These findings indicate the pressure of agricultural activities (e.g., farming and animal rearing) within the protected forest areas of the site.

The findings on the level of forestry activities in the Kilimanjaro WHS based on experts' surveys (Figure 1a) show that the activities are high. Also, the majority of the people have no access to productive (community) forests for their sustenance (Figure 1b). Additionally, the supply

of wood for charcoal production is low (Figure 1c). Furthermore, most people rely on firewood and charcoal for cooking and heating (Figure 1d). These findings indicate that forest degradation may continue if such challenges are not put under control. The findings on the level of tourism activities in the Kilimanjaro WHS based on experts' surveys show a high level (Figure 3). The findings on the level of bush burning (wildfire) in the Kilimanjaro WHS based on experts' surveys show a low level, followed by a high level (Figure 4a). However, residents opined that the main source of wildfire is caused by park rangers requesting funds to fight the fire (Figure 4b). Also, tourism activities are other sources of wildfire (Figure 4b).

Implications of the findings

One implication of the findings can be deduced from integrated quantitative (descriptive) and qualitative methods, e.g., the use of mixed questionnaires (closed-ended, open-ended) of experts and residents to obtain new and similar findings, e.g., park rangers deliberately causing wildfire to request for the fund, and high-level tourism activities associated wildfire. Wildfire poses a challenge to the sustainability of the forest as a natural heritage. Also, wildfire destroys other wildlife, which may lead to their extinction. This integrated research method offers detailed insights into the real-world situation, which is based on experts' and residents' perceptions. Another implication of the findings can be linked to high forestry activities and firewood/charcoal as the main source of cooking. These situations show that forest degradation may continue, especially if such problems are not addressed. The detailed insights provided in our study are critical to support decision-makers in implementing WHC and strategic policies for forest protection and natural heritage sustainability in the Kilimanjaro WHS and other sites across the Global South.

Recommendations

All activities related to agriculture, beekeeping and honey harvesting, and charcoal production,

tourism should be controlled. Also, agricultural lands should be made available for local communities. Additionally, causes of wildfire/bush burning should be monitored closely and law enforcement should be applied to those involved. Furthermore, illegal logging activities should be prevented, but community forests should be provided for local communities. Finally, future research should integrate experts' perceptions with Geoinformation analysis or outcomes on geographical determinants of the proximate driving factors of forest degradation.

CONCLUSIONS

Our study investigated proximate anthropogenic driving factors of forest degradation in the Kilimanjaro WHS to support WHC and strategic policies for forest protection and natural heritage sustainability. Our findings showed that direct anthropogenic factors are mostly attributed to agricultural activities (farming and animal rearing), beekeeping and honey harvesting, and charcoal production. Other factors include wildfire/bush burning, illegal logging, tourism activities, infrastructural developments, and the introduction of exotic plant species. The findings on the level of forestry activities in the Kilimanjaro WHS showed that the activities are high. Also, the majority of the people have no access to productive (community) forests. Additionally, the supply of wood for charcoal production is low. Furthermore, the majority of people rely on firewood and charcoal for cooking and heating. The findings on the level of agricultural activities in the Kilimanjaro WHS showed low levels followed by high levels. The study shows that accessibility to agricultural lands in local communities is very low. The findings on the level of tourism activities in the Kilimanjaro WHS showed a high level. The findings on the level of bush burning (wildfire) in the Kilimanjaro WHS showed a low level followed by a high level. The main source of wildfire is attributed to Park Rangers, who wish to request funds to fight the fire and tourism activities.

Our study provided useful information on proximate anthropogenic driving factors of forest

landscape degradation to support the implementation of WHC and strategic policies for forest protection and natural heritage sustainability in the Kilimanjaro WHS and other sites across the Global South. Future research should integrate geospatial analysis and experts' perceptions on locational determinants of the proximate driving factors of forest degradation.

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