



Effects of human activities on Kahe I forest reserve in Moshi rural district, Kilimanjaro region, Tanzania

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ABSTRACT

The purpose of this paper was to examine the effects of human activities on Kahe 1 Forest Reserve located in Moshi Rural District, Kilimanjaro Region, Tanzania. Specifically aimed to (i) identify human activities performed in Kahe 1 Forest Reserve, ii) determine effects of human activities on the condition of Kahe 1 Forest Reserve, and iii) assess measures to address challenges facing Kahe 1 Forest Reserve. Data were collected using households survey, Focus Group Discussions, naturalistic observations and transect walk. A total of 75 head of households and forest officers answered the questionnaires. Results showed that human activities performed in the forest include illegal logging, cutting trees for firewood and charcoal making contribute to habitat loss, land degradation and deforestation. Suggested measures to address the challenges include prohibiting the unauthorized activities, regulating the activities and conduct monitoring using authorities like Tanzania Forest Services Agency and Village Environmental Committees. The study recommends involving communities in protecting forests and conduct periodic audits of the forest for strengthening the conservation and sustainable management of the forest. These results will contribute in laying down proper strategies to stop the ongoing encroachments and restore the degraded areas in Kahe 1 Forest Reserve.

Key Words: Deforestation- anthropogenic activities-land use-lumbering-protected forests.

INTRODUCTION

Since ancient times, human have utilized, conserved and managed forests worldwide (Fadhilia *et al.* 2016). Forests support human livelihoods in various ways (Rasmussen *et al.* 2017). Regardless of the types of the forest, protected or not protected, natural or planted forests, all these forests offer direct and indirect goods and services (Mhache 2012). Indirectly, forests regulate climate, sequester carbon, source of rivers and streams as well as attraction of rainfall which support wildlife and agricultural activities (Nwafor *et al.* 2012). Directly, forests provide fuelwood (firewood and charcoal), timber, medicinal herbs, fodder, food and habitat for wildlife (Haapanen and Mhache 2013, Kideghesho 2015, Gupta *et al.* 2021).

However, due to the lack of balance between forest use and regeneration, most forests around the world have experienced deforestation (Gwalema 2015). An estimated 420 million hectares of forest has been lost worldwide through deforestation since 1990 but the rate of forest loss has declined substantially (FAO 2020). In the five-year period from 2015-2020, the annual rate of deforestation was estimated at 10 million hectares, down from 12 million ha in 2010-2015 (FAO 2020). Deforestation since 2010 has emerged as a central problem in tropical forests in Africa, Asia



and in the world at large (FAO 2014, 2020). The future of African forests is uncertain due to rapid population growth and high rate of urbanization (Mhache 2012, Jacovelli 2014). Africa had the highest annual rate of net forest loss in 2010-2020, at 3.9 million ha, followed by South America, at 2.6 million ha (FAO 2020). Studies done by Gwalema (2015) and Madzivhandila (2023), confirmed that, majority of people in Sub-Saharan Africa depend on forests to sustain their livelihoods. Despite efforts to reduce deforestation through afforestation, reforestation, tree planting and agro-forestry practices, forests continue to be lost each year (Vogt *et al.* 2019, FAO 2020). Human activities such as industrial farming, subsistence farming, building materials consumptions, illegal logging or industrial logging intensify deforestation (Gwalema 2015).

Unauthorized logging further threatens public forests, as inadequate management and monitoring fail to ensure proper harvesting and conservation (de Lima 2018, FAO 2020). Major disruptions of forests destruct the role of forests in climate change and its influence in the hydrological process (Vilhar *et al.* 2022). Tanzania is facing a challenge of conserving its forests and woodlands since forests and woodlands play an important role in wildlife and human survivals. Forests and woodlands offer building materials, fodder, clean water, medicine and fuel wood. With all these benefits which people accrue from forests, any strategy of conserving them does not get support from the local population surrounding the forest resources because local people lacked alternative means to sustain their lives, hence in the efforts to meet the needs of urbanization and rapid population increase, forests are depleted or degraded (Gwalema 2015). Population increase has exerted pressure on forest resources in respective areas to the extent that the threat to the survival of forest resources are compromised (Lugazo 2017).

This study examined the status of Kahe 1 Forest Reserve located between Kahe and Chakindo villages, and the Pangani River Basin flats at 700m above the sea level in Moshi Rural District, Kilimanjaro Region. This forest is highly affected by the increasing demands of forests products including charcoal making, timber production, poles cutting for building and expanding dwellings in the expense of the forest. Urbanization process has stimulated demand of forest products such as charcoal, honey, medicinal herbs, timber, grazing land and demand of more land for agricultural use. These demands of forest products are causing severe deforestation on the forest (Kideghesho 2015). A similar view was recorded by FAO (2020) which indicated that, forest resources were fast disappearing in arid and semi-arid areas due to over utilization influenced by demand for forest products and grazing activities.

Studies conducted in different areas in Tanzania showed that, human activities such as grazing, logging and charcoal making results in the reduction and loss of trees population (Gwalema 2015). Another impact of human on forests includes the extinction of species, degradation of ecological communities including habitat loss, fragmentation and habitat degradation (Kideghesho 2015). Other impacts include transformation of ecological communities into other uses, over-exploitation, introduction of non-native species, and pollution of habitat and climate change (Muluneh 2021). However, if the carrying capacity of a forest is damaged due to clear-felling of trees, the area will not be able to support species that it has (Muluneh 2021). With the forementioned effects on forests, this study was conducted to explore the threats of human activities in Kahe 1 Forest Reserve. The main objective of this study was to assess the effects of human activities on Kahe 1 Forest Reserve. Specifically, this study aimed at (i) Identifying human activities performed in Kahe 1 Forest Reserve, (ii) examining the effects of human activities performed in Kahe 1 Forest



Reserve and (iii) determining measures to address the effects of human activities in Kahe 1 Forest Reserve.

MATERIALS AND METHODS

Study Area Description

This study was conducted in Kahe I Forest Reserve located in Moshi Rural District, Kilimanjaro region, Tanzania (Figure 1). The forest covers the total area of 886 hectares.

The forest is located at 3° 30' 0" South, 37° 26' 0" East and 20 km Southeast of Moshi Town (Bryce 1967). The reserve is located between Kahe and Chakindo village in Pangani River Basin (Bryce 1967). Kahe 1 Forest Reserve is surrounded by four villages of Mwangarika (North), Mawala (West), Oria (East) and Ngasini (South). It is covered by alluvial loam soil, grey soil and dry alkaline soil. The rainfall ranges between 500-700 mm a year and the temperature is 26°C max. in February with 21°C min. in July. Kahe 1 Forest Reserve is covered by ever-green forest due to the presence of underground water in central western parts of the reserve (Bryce 1967).

Woodlands are found on less well drained soil and deciduous forest in the Southeast of the forest. Large tree species found in Kahe 1 Forest Reserve include *Ficus sycomorus* (Figi), *Milicia excelsa* (African teak) and *Newtonia buchananii*. The smaller trees found in the forest include *Tabernaemontana ventricosa* (soccer ball fruit) and *Trichilia emetica* (Natal mahogany). Wild animal species found in Kahe 1 Forest Reserve include snakes, rabbits, lizards, tortoise, squirrels and rats. The main human activities include agricultural activities where people cultivate maize, beans, banana, yams and sweet potatoes.

Sampling design

This study used both purposive and simple random sampling techniques for sample selection. As part of simple random

sampling, heads of households were randomly selected. Homogenous purposive sampling techniques enabled the researcher to choose respondents based on the fact that, they have the desirable information on flora and fauna species found in the forest. Three community leaders and five forest officers were purposively selected from three wards and one district. The community leaders who are responsible to organize all issues of the community including rituals and prayer taking place in the Kahe 1 Forest were also involved in this study.

Data collection

Questionnaires were administered to 75 respondents who were randomly selected from 750 heads of households from four villages; Mwangarika, Mawala, Oria and Ngasini. The sample size from Mwangarika, Mawala, and Oria were 20 respondents each except Ngasini village where the sample was 15 respondents. The questionnaire was employed in order to collect information on demographic characteristics of the respondents, type of human activities performed in the forest, effects of human activities in the forest, and measures to address effects of human activities in the forest. Four focus group discussions (FGD) were held which comprises of five to seven members in total with equal representation from each village. Transect walk was also undertaken in the forest for the purposes of assessing the endemic species, size of the trees, presence of invasive species, presence of human activities in the forest like bare areas and burnt scars. These methods of data collection were used since they triangulate and check validity of the information collected through questionnaire survey (Kabir 2016). Other secondary data were obtained from various literature sources including published papers and unpublished documents and reports, books and internet webs (Google scholars and pubmed).

Data analysis



Data collected using questionnaires were cleaned, edited, coded and analysed using Statistical Package for Social Science (SPSS) Version 21 and Microsoft Excel Spreadsheets. Quantitative data were compiled, summarized and analyzed using descriptive statistics and cross tabulation technique after which tables showing relationship between variables and percentages were drawn. Data collected using observation and interviews were subjected to conceptual content analysis for generating of narratives.

RESULTS

Socio-demographic characteristics of the respondents

The results of the characteristics of the respondents involved in the survey are found in Table 1. Majority were females (56%), of the age between 41 – 50 years (30.7%), married (56%), and with secondary education (42.7%).

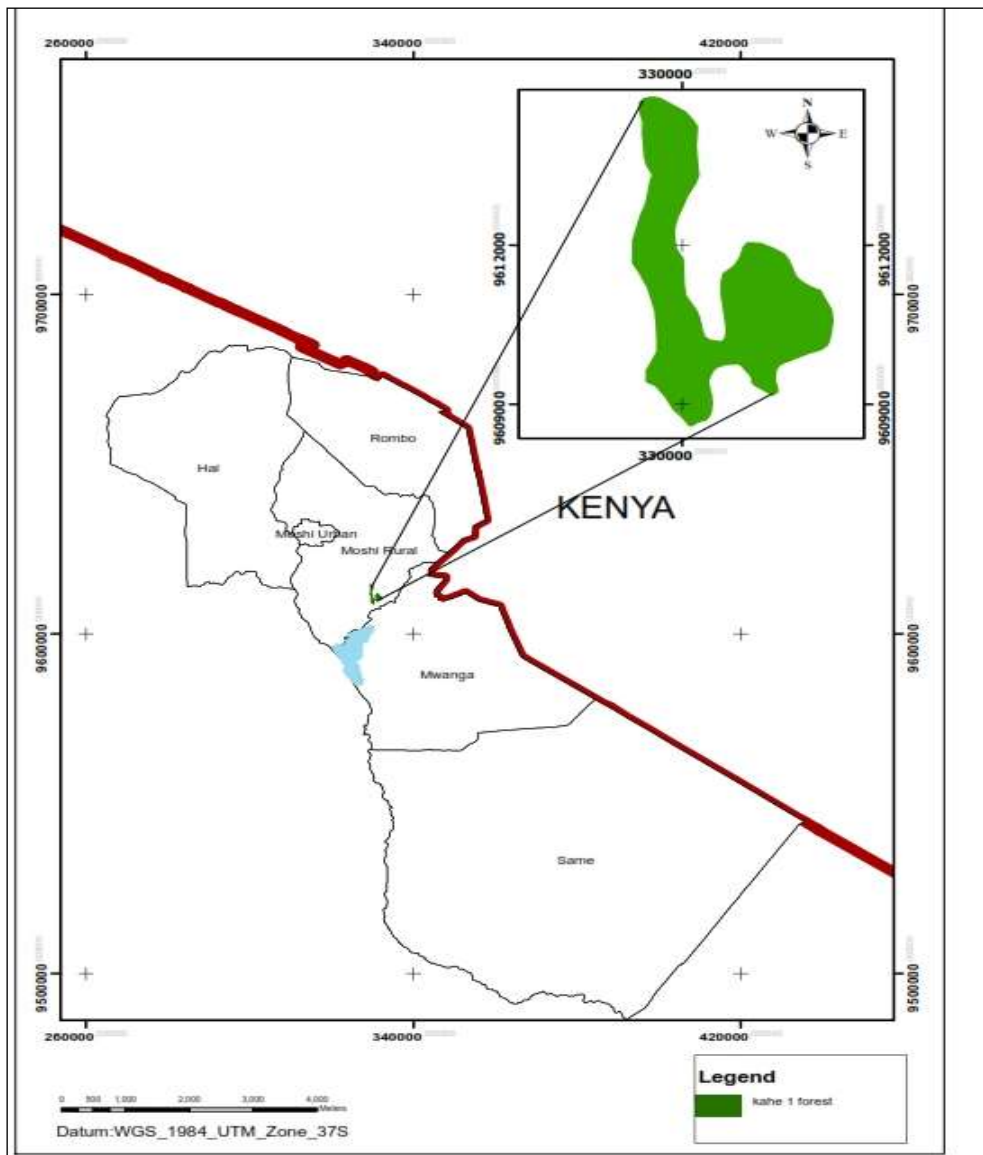


Figure 1. Map of Kilimanjaro region showing the location of Kahe 1 Forest Reserve in Moshi rural district, Tanzania



Table 1: Characteristics of the respondents involved in the survey found in four villages surrounding Kahe 1 Forest reserve in Moshi rural district, Tanzania

Characteristics	Frequencies	Percentages
Gender		
Male	33	44
Female	44	56
Age		
18-30	4	5.3
31-40	20	26.7
41-50	23	30.7
51-60	22	29.3
60+	6	8.0
Marital status		
Single	28	37.3
Married	42	56.0
Widowed	5	6.7
Education level		
Primary education	19	25.3
Secondary education	32	42.7
Diploma and certificate	17	22.7
Graduate	7	9.3
Occupations		
Farming	45	60.3
Agro-pastoralists	40	53.3
Petty business	10	13.3
Civil servants	7	9.3
Others	20	26.7

Source: Field survey, 2019

Females were many because males were not available at home during the interviews. Majority of the respondents (60%) were pure farmers followed by agro-pastoralists (53.3%) and others who engaged in non-farming activities including charcoal making, lumbering, tailoring, carpentry, mason etc.

Human activities performed in Kahe 1 Forest Reserve

Human activities performed in Kahe 1 Forest Reserve are presented in Table 2. Firewood collection was leading (76%) followed by farming (52%) and lumbering was the least (9.3%). Firewood collectors were not causing deforestation because they collected or fetched dead or dry wood in the forest. Firewood collectors, sometimes they fetched the remains or branches left after

taking other part of the trees for other uses like timber or building poles. Apart from collection of firewood from the forests; trees are also cut for charcoal and for timber making. Trees used for charcoal making included Mesquite (*Prosopis juliflora*) and Acacia species, while trees used for timber making include *Albizia* spp., *Ficus capensis*, *Tamarindus indica* and *Milicia excelsa*. Grazing of animals in the forest was another activity performed in the forest. Animals grazed in the forest included cows (*Bos taurus*), goats (*Capra aegagrus hircus*) and sheep (*Ovis aries*). These activities (farming, grazing, lumbering and charcoal making) provided people with building materials, income, food, meat, milk and energy source. However, charcoal and lumbering caused biodiversity loss,



deforestation and drying of water sources. Plate 1.
Examples of such activities are indicated on

Table 2: Human activities taking place in Kahe 1 Forest Reserve located in Moshi rural district, Tanzania

Activities	Frequencies (N=75)	Percentages
Firewood collection	57	76.0
Farming	39	52.0
Grazing	24	32.0
Charcoal making	31	41.3
Lumbering	7	9.3

Source: Field survey, 2019. Note: the percentages add to more than 100 due to multiple responses



a) Tree felling on the periphery of Kahe 1 Forest Reserve



b) Area cleared for charcoal making inside the Kahe 1 Forest Reserve

Plate 1: Examples of human activities taking place in Kahe 1 Forest reserve located in Moshi rural district, Tanzania. Source: Field survey, 2019



Effects of human activities on Kahe 1 Forest Reserve

Activities conducted in Kahe 1 Forest Reserve have negative consequences on the forest. Results of human activities on forest condition in Kahe 1 Forest Reserve are indicated in Table 3. The effect of human activities on the forest increases as one move towards the center. Tree stumps and charcoal kiln was observed near the settlements, while the forest became denser further away from the settlement. Trees in the middle of the forest were undisturbed due to fears of the fierce animals like snakes and bees, and the presence of the people guarding the forest. Transect walks revealed many tree stumps, bare land areas and signs of erosion such as rills and gullies. Species diversity increased with distance from the settlements. Human impacts were more pronounced near settlements, where shrubs were more common, while the forest became denser toward the center. Most respondents (84%) identified deforestation as the main impact of human activity, while drying of water sources were the least mentioned (13.3%). Deforestation led to the disappearance of medicinal plants like *Cymbopogon citratus* (Lemongrass), *Aloe vera* (Cape aloes) and *Moringa oleifera*

(Drumstick tree), robbing the community valuable medicinal herbs. The presence of eucalyptus trees introduced in the Kahe 1 Forest Reserve show signs of dominating in the area and displacing indigenous plant species.

An old man interviewed in Mwangarika Village said that, “Different species like *Dalbergia melanoxylon* (African blackwood or Mpingo) and *Tamarindus indica* (Mkwaju) have disappeared due to illegal logging and charcoal making.” Similarly, Mgohamwende, a 58 years old resident of the same village emphasized that ‘*Soil erosion is pronounced in this village because of logging and clear-cutting of the forest. The presence of trees controls water flows and reduces soil erosion*’. Both statements highlight how deforestation has not only led to the loss of valuable tree species but also exacerbate runoff and soil erosion in deforested land.

Table 3: List of outcomes of human activities on Kahe 1 Forest Reserve located in Moshi rural district, Tanzania

Effects of human activities	Frequencies	Percentages
Deforestation	63	84.0
Land degradation	45	60.0
Soil erosion	31	41.3
Biodiversity loss	26	34.7
Introduction of invasive alien species	13	17.3
Drying of water sources	10	13.3

Source: Field survey (2019)

Measures to address the effects of human activities in Kahe 1 Forest Reserve

Different measures to address effects of human activities on Kahe 1 Forest Reserve were shared by the respondents during the

survey (Table 4). Environmental education was ranked higher (41.3%) while protection campaigns were ranked lowest (6.7%). Environmental education is crucial because it helps distinguish between harmful and beneficial practices. It equips people with



the knowledge necessary to protect and conserve the Kahe 1 Forest Reserve. Education acts as a glue, guiding individuals on what actions to take, when to take them, and why they are important. Other conservation efforts, such as choosing the appropriate types of trees to plant, also depend on proper education. Therefore, education plays a key role in this scenario.

Although different measures have been taken to conserve Kahe 1 Forest Reserve, it was revealed by the members of the focus group discussion that the forest is still in bad situation. One member remarked that, “*What we see today for Kahe 1 Forest Reserve is only 10% of what the forest used to be some 15 years ago*”. He further explained that “*Merciless extraction of the forest resources, grazing and charcoal making had deforested the forest to the alarming levels we see today*”. People interviewed had different reasons hindering the conservation of the forest as outlined in Table 5. Poor enforcement of laws and by-laws and poverty were ranked higher (32%) while lack of political will was the least (2.7%). Most people in rural areas depend on nature for their survival, forest been one of the natural resources. This situation becomes a challenge in protecting and conserving the forest. More than half of the total number of respondents could not tell

how forest can be conserved. It is obvious that, people do not know what to do in order to conserve and protect the forest. Lack of political-will was supported by 2.7% of the respondents. It was noted that, not all leaders are advocating environment issues, each leader has his/her focus. It was said by one member in the FGD that, “*Forest is there for us to use, not to be conserved*”. It is obvious that, some leaders provide contradicting arguments, some support forest conservation while others not.

During the interviews it was also learnt that the deviation of river Rau by the Japanese rice farm investors to their lower Moshi rice field project had contributed to the degradation of the forest because farmers around the forest reserve were deprived of the water for irrigation to their farm leading to poor harvests. Due to this situation farmers get less yield from their farms thus opt for invading the forest for resources to survive. Also, the water from the farmer’s rice farms around the forest reserve flows to the forest during over flooding making the small planted trees water logged and die as a result. This would not happen if the river Rau had not been deviated against its traditional course. If no serious measures are taken, the forest will disappear in the 10 years to come.

Table 4: Measures to address the effects of human activities on Kahe 1 Forest reserve located in Moshi rural district, Tanzania

Type of a measure	Frequencies (n=75)	Percentages
Environmental education	31	41.3
Tree planting	27	36.0
Afforestation and reforestation	26	34.7
Forest guard and patrols	21	28.0
Fines to people entering the forest illegally	19	25.3
Enforcement of laws, by-laws, policies and regulations	15	20.0
Imprisonment	11	14.7
Confiscation of properties people caught with	9	12.0
Protection campaign	5	6.7

Source: Field survey, 2019



Table 5: Factors hindering the conservation of Kahe 1 Forest Reserve located in Moshi rural district, Tanzania

S/no	List of factors	Frequencies	Percentages
1	Lack of finance	4	5.3
2	Lack of political will	2	2.7
3	Lack of interest of stakeholders	4	5.3
4	Lack of knowledge to the local community	17	22.7
5	Poor enforcement of by-laws and laws	24	32.0
6	Poverty	24	32.0
	Total	75	100.0

Source: Field survey, 2019

DISCUSSION

Human activities and its effects on Kahe 1 Forest Reserve

The results showed that anthropogenic activities significantly affected the quality of the forest, contributing to degradation through deforestation, land conversion, and unsustainable resource extraction. These human-induced activities have a more pronounced impact compared to natural factors, leading to a decline in biodiversity and forest health. Different studies have assessed effects of anthropogenic activities on the quality of forests in different parts of the world (Sale *et al.* 2011, FAO 2020, Dar *et al.* 2022). This study focused on the effects of wood collection, fire/ burning and timber making on Kahe 1 Forest Reserve. It was further revealed that, human activities were more intense near the forest edges than inside the forest. The same result was obtained by FAO (2020) that, more effect is found at the edge of the forest than the area far from the edge of the forest. Area proximity to the community was easy access to people for grazing, cutting wood for poles and charcoal making. The greatest impacts associated with charcoal making occurred mostly in the area adjacent to the kilns used to make charcoal and not in the forest where the harvesting of trees occurred.

Human activities have largely contributed to water shortage in different part of the world including the study area. It is obvious that,

forest is the main source of water (Ellison *et al.* 2012). In most places with heavy forest, water is flowing throughout the year, for example Congo forest offers a good source of water in Africa.

The study by Nchimbi (2021) found that lumbering is one of the major activities in tropical forests. Lumbering activities result in the removal of mature tree species that play a vital role in maintaining a cool climate under the canopy, essential for seedling germination. Trees affected include *Dalbergia melanoxylon* and *Tamarindus indica*. Lumbering also causes habitat destruction and a general decline in forest species abundance and diversity (Lawton *et al.* 1998, Mullah *et al.* 2014). Lumbering has greatest impact on biodiversity in tropical forests as it can lead to species extinction (Kleinschroth & Healy 2017). Severe damage to residual trees could be as high as 80% in some natural forests (Gogoi & Sahoo 2018). In this study, 60% of the residual trees were severely damaged; this result corresponds with the study of Gogoi & Sahoo (2018) that damage to residual tree population could be as high as 70% during selective timber harvesting in different countries.

According to Nzunda and Yusuph (2022) charcoal making and cutting of firewood and poles for sale have degraded Kahe 1 Forest Reserve. People were cutting big trees, slice them and burn them to make charcoal. Other trees were cut for firewood



and pole for construction of their house. Nzunda and Yusuph (2022) also observed that illegal logging contributed to forest degradation and loss of biodiversity in the forests. Without care, forest degradation and loss of biodiversity contribute to deterioration and depletion of natural resources resulting to loss of vegetation cover and species diversity.

Collection and gathering of firewood was obvious activity conducted in most forests including Kahe 1 Forest Reserve. The study done in western Bagamoyo by Haapanen and Mhache (2013) found that collection of firewood is mainly for household use, not for sale as charcoal. Activities taking place in Kahe 1 Forest Reserve was not different from other forests. Due to land shortages, people perceive forest land as fertile, and therefore, illegally clear the forest to grow crops. It was further revealed that, people with livestock graze them in the forests to address the shortage of fodder. Other pastoralists burn the forest with an intention of getting good pasture during the rain seasons.

In satisfying human needs with the forest products, human is causing destruction to the forest (deforestation). Deforestation is a major threat to many forests including Kahe 1 Forest Reserve. Deforestation is the conversion of forested areas to non-forest land use such as arable land, urban use, logged area or wasteland (FAO 2020). The study by Lindroos *et al.* (2017) confirmed that deforestation in natural forests causes severe damage to both trees and the underlying vegetation.

Measures to address effects of human activities in Kahe 1 Forest Reserve

No single measure which can solve the problem leading to forest degradation and deforestation. Promotion of improved wood fuel stoves and improved charcoal making kilns, electrification, and promotion of alternative sources of fuel can reduce effects of human activities on forest (Lusambo 2016). Since forest is also used as a source

of income; alternative source of income can reduce dependence on forests.

Another measure to address human impact on forests is to execute tree planting. Tree planting can improve and increase tree species in the forest. Tree planting (particularly for fuel purposes) should be carried out in conjunction with education and advice of the choice of species to grow for wood fuel uses. Tree species to be planted for energy uses (fuel wood) and other uses should be carefully selected to ensure that they are not toxic to other species (Lusambo 2016).

Regional and district forest officials should make available improved charcoal production technologies to all charcoal makers in their respective areas. This technology will enable charcoal makers to be more efficient (Rutta 2018). Application of improved charcoal production technologies is possible by putting in place by-laws requiring all charcoal to be produced using improved technologies. The existing forest management laws and by-laws should be strictly enforced (Lovett 2003). Environmental management committees from local communities surrounding the forest resources should be involved in all steps for sustainable forest management planning undertaken at regional/ district level.

The local communities are the immediate managers of the forest resources (Wily 1997). They should have both sense of ownership of forest resources and responsibility for its management. If the local communities are not dedicated towards management of their surrounding forest resources, deforestation and forest degradation will not end. Nielsen & Treue (2012) suggested that individuals caught engaging in forest destruction should face imprisonment or substantial fines. These fines should be high enough to effectively deter illegal harvesting of wildlife and forest resources in protected areas.



The four study villages; Mwangarika, Mawala, Oria and Ngasini in Moshi Rural District have by-laws which guide and regulate the use of environmental and forest resources. Individuals caught engaging in illegal activities within the forests face fines or imprisonment (Nielsen & Treue 2012). It is a mandatory that all wood fuel users use improved efficient stoves. Improved efficient stoves reduce effects of charcoal and firewood to village forests, as improved stoves use less charcoal and less firewood. Charcoal makers should be monitored by the village leaders and/ or environmental management committees to ensure that all charcoal makers use improved charcoal production technologies. This charcoal making technology will increase charcoal made and reduce waste. Above all, village leaders should educate villagers on effects of charcoal in the forest.

CONCLUSION AND RECOMMENDATIONS

The findings show that human activities performed in Kahe 1 Forest Reserve accelerated deforestation. There is a growing threat to the forest sustainability due to human activities performed. If the economic gains from Kahe 1 Forest Reserve are not substituted with other activities, the forest will disappear. Information from the focus group discussion indicated that Kahe 1 Forest Reserve has been depleted by human activities and preferred species for timber as well as charcoal production has disappeared. Timber harvesting and charcoal production by unscrupulous individuals have severely degraded the forest, leaving it bare and overgrown with shrubs. The small forest area left if not held with utmost care including instituting stringent measures to let or allow the forest to regenerate, the forest will disappear in a short period of time.

Considering the trends of deforestation in Tanzania this study recommends that, local governments should educate surrounding

communities on tree planting in order to address the problem of deforestation in Kahe 1 Forest Reserve. Local government should convene meetings with beneficiaries of Kahe 1 Forest Reserve on advantages of protecting the forest and disadvantages of continuing degrading the forest. Community education on forest management and conservation will make people aware of impacts of deforestation. Therefore, there is a need for serious enforcement of laws and by-laws for the protection of Kahe 1 Forest Reserve.

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