

Assessment of Socio-Economic Characteristics and Drivers of Deforestation of Mandara Hills in Madagali Local Government Area of Adamawa State

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ABSTRACT: *There is sufficient proof that the entire world is fronting an ecological disaster because of huge deforestation. This study assessed the drivers of deforestation and the socio-economic characteristics of the respondents. Information was sourced by administering questionnaires to 200 respondents drawn from the support zone dwellers of Mandara hills in Madagali Local Government Area of Adamawa State, and alongside interviews scheduled using participatory rural appraisal technique. Data collected were analyzed using descriptive statistics and smith's saliency model. The later was used for ranking of benefits derived from the hills and the conservation measures proffered by the respondents. The following age classes 26-30 years with 30 respondents, 31-35 years (35), 36-40 years (32) and 41-45 years (30) had the majority of the respondents. On gender, the majority (84.50%) of the respondents were males. Percentage of respondents for civil servants (21.50%) and farming (27.50%). The mainstream of the respondents had formal education represented by primary (19.5%), secondary (24.50%) and tertiary (36.0%). Most of the respondents had income that ranged from ₦100,000.00 - ₦2,000,000.00. The major benefits derived from the hills included; human protection during wars and insurgency (32.50%) and farming (30.50%). Drivers of deforestation based on; bad, worse and worst effect rankings cumulatively showed agricultural expansion topping the list, followed by indiscriminate destruction of wildlife habitat. Conservation measures suggested in order of frequency of respondents included; reduced human settlement around the hills (34.50%) and implementation of natural forest regeneration and restoration (31.50%).*

KEYWORDS: deforestation, socio-economic, conservation, reforestation, forest

INTRODUCTION

Globally, deforestation is mainly caused by human activity and this pose a serious threat not only to human beings but the biodiversity in general and is mostly linked to the social and

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economic state of individuals. The social and economic state of man makes him a direct enemy of his environment as a result of the measures he adopts to ensure survival. However, the local man and those people in governance often overlooked this menace despite that deforestation constitutes one of the global emerging challenges facing the world and Nigeria is not an exception.

Nigeria as of 2020 has the highest deforestation rate of primary forest at 55.7% while it has an 11.1% annual deforestation rate of natural forest being the highest in the world (Azare *et al.*, 2020). According to the United Nations, UN (2023), Nigeria has the highest deforestation rate in the world with a projected value of 3.7% of its forest lost annually putting biodiversity and other resources of the environment in a state of peril. This happening shows doom for a developing country like Nigeria.

These two scholarly reports mean that Nigeria needs to step up to avoid the storm of deforestation. Presently, the northern part of Nigeria especially those within the Sahel zone (Borno, Yobe, Jigawa, Katsina and Sokoto) are experiencing local climate change fueled by deforestation activity coupled with the encroachment of Sahara Desert at the rate of 1.6 kilometers annually (Duala, 2024).

The question is 'why is Nigeria which is endowed with a vast expanse of forest land and known to be a good manager of the natural environment in the country now with the leading crises of deforestation in the 21st century? Perhaps the definition of deforestation connotes the clearing out of forest areas to accommodate new land for farming, infrastructural development, urbanization and provision of resources like timber, fuelwood and minerals among others (Anifowose and Ashiru, 2019; Ogundele and Adebisi, 2016; Tidán, 2013) could probably be the answer although it is subject to debate.

From the above definition, it is clear that deforestation simply disrupts the natural balance of ecosystems leading to enormous consequences on human existence like lack of access to clean water and air (Taylor and Parker, 2022; Ojo *et al.* 2018). This means that under the present circumstance the dwellers of Mandara Hills and beyond are facing the ecological crises by the reason of incessant deforestation that tends to be on the increase (Adebayo *et al.*, 2019). This has resulted in the inability of the residents to enjoy the basic services from the Mandara Hills as there are fast disappearing (Ijaduwa, 2021).

Adequate information on the socio-economic characteristics of the local dwellers and drivers of deforestation could be the main tools to be used by policy makers for the sustenance of Mandara Hills as earlier observed by Abdullahi *et al.* (2015). However, this study focused on the socio-economic characteristics, benefits derived from Mandara Hills and drivers of deforestation in the study area to provide the baseline information needed for the conservation of Mandara hills flora and fauna resources that will sustain the biodiversity.

MATERIALS AND METHODS

Study Area

The study was conducted in Madagali local government area of Adamawa state, Nigeria, which shares a boundary with Gwoza local government area of Borno State in the North, Askira Uba local government area of Borno State in the West, Michika local government area of Adamawa State in the South and Cameroon Republic in the East. The local government area lies on latitude $10^{\circ} 24^1$ N and longitude $13^{\circ} 48^1$ E with a population of 156, 230 (National Population Commission, NPC, 2011). Below (**Fig. 1**) a map of the Madagali local government area showing the study locations.

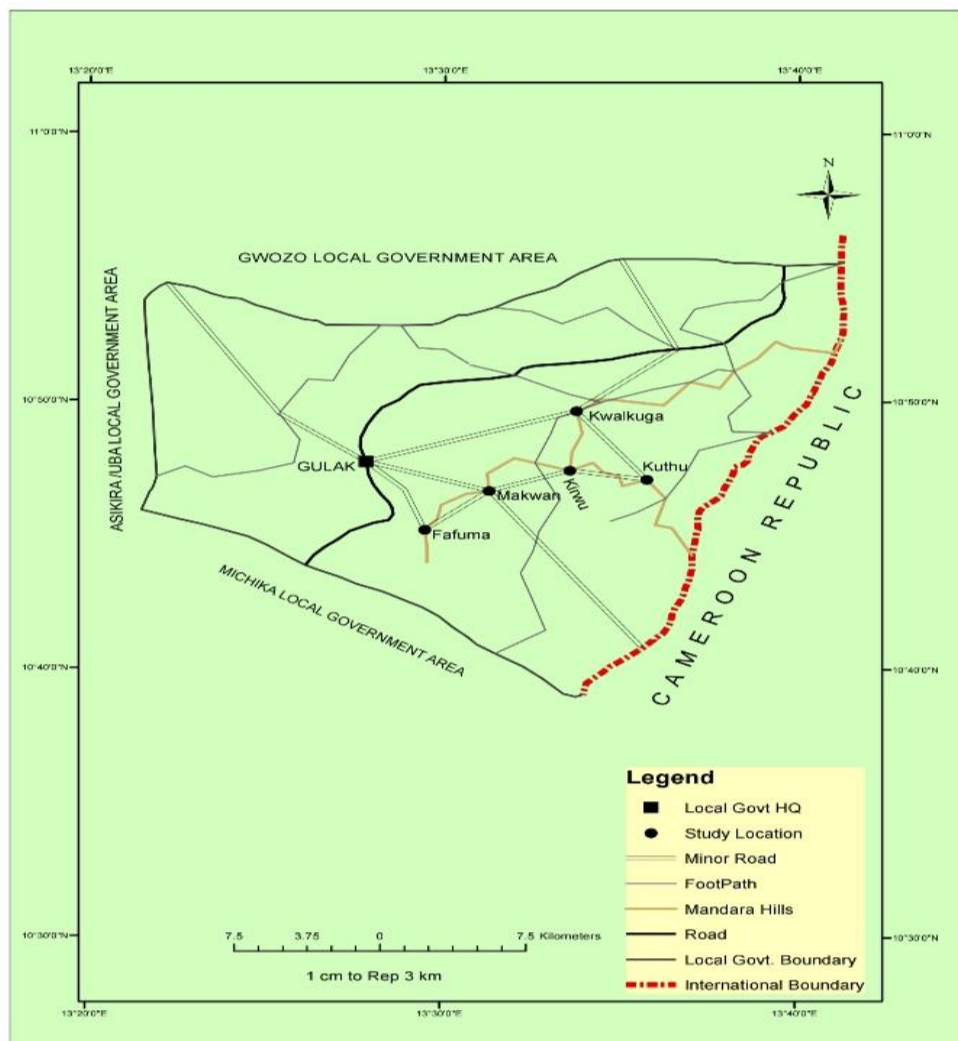


Fig. 1: Map of Madagali local government area of Adamawa state showing the study locations

Source: Environmental Survey, 2023

Data Collection

Information on the socio-economic characteristics, benefits of Mandara hills, awareness level of support zone dwellers of the hills and the drivers of deforestation were obtained using structured and semi-structured questionnaire based on the method of Taherdoost (2022). In line, interview schedule involving group discussions with the Mandara hill forest user groups, farmers, traders and other residents in the study area were held through participatory rural appraisal technique as adopted by Ruslin *et al.* (2022) and Wati *et al.* (2020) in their separate studies.

Sample Size and Sampling Technique

A total of 200 respondents of 26 years and above comprising of male and female within the study area were sampled based on the population of the support zone dwellers using simple random sampling technique as outlined by West (2016) coupled with proportional allocation technique. The age preference was to ensure that each of the respondents should have been aware of the activities taking place in the study area for a minimum of 10 years through passive or active participation.

The study area was stratified into 5 locations (Kirwu, Kuthu, Fafuma, Makwan and Kwalkuga) based on the administrative units and hill valleys. The number of questionnaire administered in each community was based on modified Kareem *et al.* (2015) method of proportional allocation technique where n_h was replaced by M and then N_h was replaced by h . The formula is stated as follows:

$$M = \frac{h \times n}{N}$$

Where M = number of questionnaire administered in each community.
 n = Total number of questionnaire administered.
 h = Estimated population of the people in each community.
 N = Total number of people in all the communities.

Below (Table1) the detail number of respondents drawn from each community on which questionnaire was administered.

Table 1: Details of Questionnaire Administered in each Community

Name of community	Estimated population of community (h)	No. of questionnaire administered in each community (M)	% of Respondents in each community
Kirwu	683	35	5.12
Kuthu	916	46	5.02
Fafuma	764	39	5.10
Makwan	738	37	5.01
Kwalkuga	856	43	5.02
Total	3,957 (N)	200 (n)	

In addition, interviews and group discussions with the community forest user groups, farmers and other residents in the study area were held through participatory rural appraisal technique as adopted by Wati *et al.* (2020). The discussion with the respondents aided in the

identification, judgment and rating of the effects of drivers of deforestation on Mandara hills. Furthermore, respondents suggested possible strategies that could help in the conservation and protection of the Mandara hills.

Data Analysis

The Data collected were analyzed using Smith's saliency model as adopted by Osoba *et. al.* (2019) and descriptive statistics (percentage). Smith's saliency model is calculated by dividing the frequency of respondents in agreement with a factor by all the respondents sampled. Mathematically given as:

$$S = \frac{IR}{TR}$$

Where S = Saliency value
 IR = Inverted rank (frequency of respondents in agreement with a factor)
 TR = Total rank (total frequency of respondents in sampled)

RESULTS AND DISCUSSION

Assessment of the Socio-Economic Characteristics of the Respondents Drawn from Support Zone Dwellers

The socio-economic characteristics examined include age, sex, occupation, educational qualification and annual income of the respondents. Other parameters assessed were awareness level of existence of Mandara hills, benefits derived from the hills, awareness and drivers of deforestation. In line, possible strategies for the conservation and protection of Mandara hills were suggested by the respondents.

Age Classes of Respondents

The age classes of respondents were assessed based on communities (locations) as presented in Table 2. The results in Kirwu revealed that the age class ranged from 2.86% in the class of 46-50 years to 28.57% in class range of 26-30 years. The result of Kuthu shows close range of sampled respondents that ranged from 4.35% to 13.04% of 66-70 years and that of 36-40 and 46-50 years respectively. No respondent was recorded within the age of 51-55 years. Similarly, in Fafuma the number of respondents in the age class of 31-35 years was the highest (9) representing 23.07% of the sampled population in the community.

In Makwan, the percentage age of respondents ranged from 8.11% for the age classes of 26-30, 46-50 and 66-70 years to 18.92% in the age classes of 36-40 and 51-55 years respectively. No respondent was recorded in the age class of 61-65 years. The result of Kwalkuga revealed that the number of respondents ranged from 4.65% in the age classes of 51-55 and 61-65 years to 20.93% in the age classes of 26-30 and 41-45 years respectively.

In Mandara hills, the pooled result arranged in order of frequency of respondents shows that majority of the respondents were recorded in the age classes of 31-35 years (35), 36-40 years

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(32), 26-30 years (30) and 41-45 years (30) representing 17.50%, 32.0%, and 15.0% respectively.

It could be deduced from Table 2 result that the high number of respondents recorded for the age ranges of 26-30, 31-35, 36-40 and 41-45 years represent the bulk active age segment of the community that makes use of Mandara hills. This finding agrees with Aiyeloya and Chima (2011) that members of this age bracket are the major users and destroyers of the forest ecosystems or natural habitat.

Table 2: Age Class of Respondents (%)

Age Classes (Years)	Frequency of Respondents					Total
	Kirwu	Kuthu	Fafuma	Makwan	Kwalkuga	
26 - 30	10 (28.57)	5(10.87)	3(7.69)	3(8.11)	9(20.93)	30 (15.0)
31 - 35	5(14.29)	11(23.91)	9(23.07)	4(10.81)	6(13.95)	35(17.50)
36 - 40	3(8.57)	6(13.04)	8(20.51)	7(18.92)	8(18.60)	32(16.0)
41 - 45	3(8.57)	5(10.87)	7(17.95)	6(16.22)	9(20.93)	30(15.0)
46 - 50	1(2.86)	6(13.04)	2(5.13)	3(8.11)	3(6.98)	15(7.50)
51 - 55	3(8.57)	-	4(10.26)	7(18.92)	2(4.65)	16(8.0)
56 - 60	4(11.43)	8(17.39)	2(5.13)	4(10.81)	1(2.33)	19(9.50)
61 - 65	3(8.57)	3(6.52)	3(7.69)	-	2(4.65)	11(5.50)
66 - 70	3(8.57)	2(4.35)	1(2.56)	3(8.11)	3(6.98)	12(6.0)
Mean	37	44	43	47	41	

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Sex of Respondents

Table 3 shows the number of respondents sampled from the support zone dwellers of Mandara hills based on sex or gender. The result revealed that a total of 169 respondents representing 84.50% were male while 15.50% (31) were female. On location basis, Kuthu had the highest number of male (40) and closely followed by Fafuma and Kwalkuga with 37 each. The number of male respondents drawn from Kirwu (25) was the least representing 71.43% of the respondents sampled from the community.

Result of female respondents showed highest in Kirwu (28.57%), followed by Makwan (18.92%) while the least was recorded for Fafuma (5.13%) representing 10, 7 and 2 respondents respectively.

Table 3: Sex of Respondents of Mandara Hills (%)

Location	Frequency of Respondents		Total
	Male	Female	
Kirwu	25(71.42)	10(28.57)	35
Kuthu	40(86.96)	6(13.04)	46
Fafuma	37(94.87)	2(5.13)	39
Makwan	30(81.08)	7(18.92)	37
Kwalkuga	37(86.04)	6(13.95)	43
Total	169(84.50)	31(15.50)	200

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Occupation of the Respondents

The result of Table 4 shows that the respondents were engaged in 7 different occupations cutting across civil servants, farming, trading, community security (vigilante), hunting, students and crafting/artisan. The general rating shows that the major occupation of the support zone dwellers of Mandara Hills was farming represented by 27.50%, followed by civil servants (21.50%) while the least was hunting with only 15 respondents representing 7.50% of the total sampled population.

On location basis, farming topped the occupations in Kirwu with 37.14% representing 13 respondents out of the 35 sampled. In Kuthu, farming has the highest value of 39.13% of the respondents engaged in farming. The percentage of respondents in the seven occupations ranged from 4.35% (2) – 39.13% (18).

The situation with Fafuma and Kwalkuga seems to be different where civil servants topped the occupations with 25.64% and 25.58% of the respondents respectively. No respondents were recorded for community security in Fafuma. In Makwan, 27.03% were students representing 10 respondents of the sampled population.

This finding implies that students in rural communities mostly rely on farming as a source of income and similarly the present day civil servants. The population of this 2 occupations (students and civil servants) usually create a multiplier effect on the farming activity on and around the Mandara hills base and valleys. The cumulative effect directly means demand for more farmland thereby leading to deforestation. The farming activity alongside crafting, hunting and wood trading which directly depends on the flora and fauna resources of Mandara hills may be responsible for deforestation of the hills. This unveiling incidence affirms Akanwa and Ikegbunam's (2019) report that the pattern of utilization of resources of natural habitat by man determines the state of its exploitation.

Table 4: Occupation of Respondents of Mandara Hills (%)

Location	Frequency of Respondents					
	Kirwu	Kuthu	Fafuma	Makwan	Kwalkuga	Total
Civil Servants	6(17.14)	8(17.39)	10(25.64)	8(21.62)	11(25.58)	43(21.50)
Farming	13(37.14)	18(39.13)	9(23.08)	6(16.22)	9(20.93)	55(27.50)
Trading	3(8.57)	5(10.87)	7(17.95)	4(10.81)	1(2.33)	20(10.0)
Community Security (Vigilante)	3(8.57)	6(13.04)	-	6(16.22)	3(6.98)	18(9.0)
Hunting	2(5.71)	3(6.52)	4(10.26)	2(5.41)	4(9.30)	15(7.50)
Students	5(14.29)	2(4.35)	6(15.38)	10(27.03)	10(23.26)	33(16.50)
Artisan/Crafting	3(8.57)	4(8.70)	3(7.69)	1(2.70)	5(11.63)	16(8.0)
Total	35	46	39	37	43	200

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Educational Qualification of Respondents

The result of the investigation of educational qualification of support zone dwellers of

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Mandara Hills is presented below on location and pooled basis (Table 5). In Kirwu, 14.29% of the respondents had no formal education, 20.0% had primary and 25.71% had secondary education while 40.0% representing 14 respondents had tertiary education.

In Kuthu, the assessment showed 15.22% of the respondents had no formal education, 19.56% had primary education and 23.91% had secondary education while 41.30% had tertiary education. Similarly in Fafuma, 25.64% had no formal education, 12.82% had primary education, 30.77% had secondary and tertiary education respectively. In Makwan, the record showed that 21.62% of the respondents had no formal education, 16.22% had primary and 24.33% had secondary while 37.84% had tertiary education. The result of Kwalkuga showed 23.26% had no formal education, 27.91% had primary and 18.60% had secondary while 30.23% representing 13 respondents had tertiary education.

The pooled result of the study area shows that 36.0% of the sampled population were students representing 72 respondent who had tertiary education, 49(24.50%) had secondary, 40(20.0%) had no formal education while 39 respondents representing 19.50% had primary education. The result indicates that most of the respondents (no formal, primary and secondary education) are perceived to have low income even in government services while others may be under employed and this made them to depend on the resources of Mandara Hills especially the forest as an alternative source income.

Similarly, the desire of the respondents for more farmland and all other forces threatens the existence of Mandara hills as a natural habitat. This finding agrees with Curtis *et al.* (2018) that the desire for fatal land by farm families is probably the largest driver of deforestation in the world.

Table 5: Educational Qualification of Respondents of Mandara Hills (%)

Location	Frequency of Respondents					Total
	Kirwu	Kuthu	Fafuma	Makwan	Kwalkuga	
No formal education	5(14.29)	7(15.22)	10(25.64)	8(21.62)	10(23.26)	40(20.0)
Primary school	7(20.0)	9(19.57)	5(12.82)	6(16.22)	12(27.91)	39(19.50)
Secondary school	9(25.71)	11(23.91)	12(30.77)	9(24.33)	8(18.60)	49(24.50)
Tertiary	14(40.0)	19(41.30)	12(30.77)	14(37.84)	13(30.23)	72(36.0)
Total	35	46	39	37	43	

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Annual Income of Respondents

Investigation carried out to assess the annual income of respondents is presented below in Table 6. The result as presented in perceived order of higher income showed that in Kirwu, 8 respondents representing 22.86% had annual income between ₦501,000.00 - ₦1,000,000.00 were the highest, followed by ₦100,000.00 - ₦500,000.00 and ₦1,501,000.00 - ₦2,000,000.00 with 17.14% each while the least were respondents that had income between ₦3,001,000.00 - ₦3,500,000.00 and ₦3,501,000.00 - ₦4,000,000.00 with 5.71% each representing 2 respondents per income range.

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In kuthu, the result seems to be similar to Kirwu were 28.26% (13) had income ranging between ₦501,000.00 - ₦1,000,000.00. This was closely followed by income range of ₦100,000.00 - ₦500,000.00 with 26.09% representing 12 respondents. The least sampled was 2.17% representing 1 respondent in the income range ₦3,001,000.00 - ₦3,500,000.00 while no respondent was recorded for the income range of ₦3,501,000.00 - ₦4,000,000.00.

The result in Fafuma shows close values of the respondents sampled across the income as the percentage values ranged from 5.13% - 23.08%. Investigation revealed that no respondent was recorded for income range of ₦3,501,000.00 - ₦4,000,000.00. In Makwan, 27.03% of the sampled population representing 10 respondents was the highest while the other income ranges had relatively close percentages except the income range of ₦2,501,000.00 - ₦3,000,000.00 and ₦3,501,000.00 - ₦4,000,000.00 with 8.12% representing 3 respondents. No respondents were recorded in income range of ₦3,001,000.00 - ₦3,500,000.00.

The result in Kwalkuga indicated a varied range of respondents sampled (4.65% - 27.91%). 12 respondents drawn from Kwalkuga representing 27.91% were within the income range of ₦100,000.00 - ₦500,000.00. This was followed by 10(23.26%) respondents within the income range of ₦1,001,000.00 - ₦1,500,000.00.

The pooled result shows that respondents within the income range of ₦100,000.00 - ₦500,000.00 with 23.0% was the highest followed by income range of ₦501,000.00 - ₦1,000,000.00 with 40 respondents representing 20.0% of the total population sampled. Respondents within the income range of ₦2,501,000.00 - ₦3,000,000.00, ₦3,001,000.00 - ₦3,500,000.00 and ₦3,501,000.00 - ₦4,000,000.00 represented by 6.0% (12), 5.0% (10), 3.50% (7) were relatively low.

This finding implies that the bulk of the respondents were of low income class and that the relatively low income status of the respondents might have contributed significantly to the deforestation of Mandara hills as they use the resources of the hills to complement their source of income. This may be the reason why Curtis *et al.* (2018) opined that the low income segment of the society living in rural areas is the major driver of deforestation.

Table 6: Annual Income of Respondents of Mandara Hills (%)

Annual Income	Frequency of Respondents					
	Kirwu	Kuthu	Fafuma	Makwan	Kwalkuga	Total
₦100,000.00 - ₦500,000.00	6(17.14)	12(26.09)	6(15.38)	10(27.03)	12(27.91)	46(23.0)
₦501,000.00 - ₦1,000,000.00	8(22.86)	13(28.26)	8(20.51)	6(16.22)	5(11.63)	40 (20.0)
₦1,001,000.00 - ₦1,500,000.00	4(11.43)	6(13.04)	5(12.82)	4(10.81)	10(23.26)	29(14.50)
₦1,501,000.00 - ₦2,000,000.00	6(17.14)	8(17.39)	9(23.08)	6(16.22)	4(9.30)	33(16.50)
₦2,001,000.00 - ₦2,500,000.00	3(8.57)	3(6.52)	5(12.82)	5(13.51)	7(16.28)	23(11.50)
₦2,501,000.00 - ₦3,000,000.00	4(11.43)	3(6.52)	2(5.13)	3(8.11)	-	12(6.0)
₦3,001,000.00 - ₦3,500,000.00	2(5.71)	1(2.17)	4(10.26)	-	3(6.98)	10(5.0)
₦3,501,000.00 - ₦4,000,000.00	2(5.71)	-	-	3(8.11)	2(4.65)	7(3.50)
Total	35	46	39	37	43	200

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Awareness of Existence of Mandara Hills

Information was sourced on the awareness of the existence of Mandara hills from the respondents and the responses are as shown in Table 7. Majority of the respondents representing 192 (96.0%) were aware of the existence of the Mandara hills while 8(4.0%) were not aware. The result on gender basis shows that 96.74% (178) of the males and 87.50% (14) of the females were aware of the hills. Similarly, 6 males (3.26%) and 2 females (12.50%) were not aware.

The low percentages recorded for not aware indicates that the local dwellers are full users of Mandara hills and therefore considered active participants in the over-use of forest resources. This observation upholds the opinion of Ahmed and Olaitan (2024) on the perception of rural women on the effects of deforestation.

Table 7: Awareness of Existence of Mandara Hills (% of Respondents)

Awareness of Existence of Mandara Hills	Frequency of Male	Respondents Female	Total
Aware	178(96.74)	14(87.50)	192(96.0)
Not Aware	6(3.26)	2(12.50)	8(4.0)
Total	184(92.0)	16(8.0)	200

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Benefits of Mandara Hills to the Support Zone Dwellers

The results of the investigation presented in Table 8 below revealed that 15 different services are gotten from Mandara hills. The benefits are presented in a perceived order of importance based on frequency of respondents in each location showed that the utilization of Mandara hill resources for fuelwood was highest in Kirwu, followed by the traditional festival site popularly called **Dukwa** (42.86%) and the least was its use for tourism with 11.43% representing only 4 respondents believing that such benefit exist.

In Kuthu, the leading benefit was farming (43.48%), followed by source of stones and gravel for house construction (30.43%) while the least utilizable resources is a source of timber (10.87%). In Fafuma, farming (41.03%) topped the list, followed by fuelwood (38.46%) and the least is use for human settlement (10.26%). In Makwan, the responses showed the utilization of hills' resources in the following order of importance animal grazing (45.95%), farming (32.43%), wildlife conservation (29.73%) and human protection during wars and insurgency (27.03%) to list a few. In Kwalkuga, human protection during wars and insurgency (55.81%) surpassed all other benefits derived from Mandara hills as reported by the respondents, followed distantly by the source of stones and gravels for road and house construction opined by 12 respondents representing 27.91% of the sampled size in the location.

The pooled result of benefits derived from Mandara hills indicated that its use for human protection during wars and insurgency (32.50%) piloted the rest, followed by farming (30.50%), source of fuelwood (27.0%) and the least was erosion control (3.50%) as observed

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in order of significance. The ecological importance of this research indicates that human protection during wars and insurgency (32.50%), farming (30.50%), source of fuelwood (27.0%) and hunting of bushmeat (25.0%) are the major benefits obtained from Mandara hills that helps in deforestation.

The Smith's saliency value of 0.3250, 0.3050, 0.2700, and 0.2500 are high indications that these benefits could lure people to over exploit the Mandara hills. The immediate 4 activities above if kept in check will bring the problem of deforestation under control. The check will without doubt bring back the glory of Mandara Hills in terms of the natural endowment with resources such as wildlife and woody plants species of the area. This opinion agrees with Mba (2018) and Awe *et al.* (2012) in separate studies that stressed the need to address the major contributors to deforestation regardless of the importance of the benefits, if conservation is the target. The findings of this investigation has also kept us aware that the local residents of the study area had enjoy tremendous help from Mandara hills by its role of human protection during wars and insurgency that topped the list as the study area had been under incessant attack by Boko Haram insurgents for the past 15 years (2009 - 2014).

Table 8: Benefits Derived by Support zone Dwellers from Mandara Hills (% of Respondents)

Benefits	Frequency of Respondents					Total	Saliency value
	Kirwu	Kuthu	Fafuma	Makwan	Kwalkuga		
Human protection during wars and insurgency	7(20.0)	11(23.91)	13(33.33)	10(27.03)	24(55.81)	65(32.50)	0.3250
Farming	8(22.86)	20(43.48)	16(41.03)	12(32.43)	5(11.63)	61(30.50)	0.3050
Source of fuelwood	17(48.57)	9(19.57)	15(38.46)	7(18.92)	6(13.95)	54(27.0)	0.2700
Hunting of bushmeat	12(34.28)	8(17.39)	11(28.21)	9(24.32)	10(23.26)	50(25.0)	0.2500
Source of stones and gravels for road and house construction	6(17.14)	14(30.43)	5(12.82)	9(24.32)	12(27.91)	46(23.0)	0.2300
Wildlife conservation	7(20.0)	6(13.04)	12(26.09)	11(29.73)	9(20.93)	45(22.50)	0.2250
Provision of edible fruits, leaves etc.	9(25.71)	7(15.22)	14(35.90)	-	11(25.58)	41(20.5)	0.2050
Production of local crafting materials and thatching grass	10(28.57)	7(15.22)	9(23.08)	7(18.92)	6(13.95)	39(19.50)	0.1950
Animal grazing	6(17.14)	11(23.91)	5(12.82)	17(45.95)	-	39(19.50)	0.1950
Source of livelihood for the local dwellers	8(22.86)	8(17.39)	7(17.95)	10(27.03)	4(9.30)	37(18.50)	0.1850
Traditional festival site	15(42.86)	-	13(33.33)	5(13.51)	3(6.98)	36(18.0)	0.1800
Source of timber	7(20.0)	5(10.87)	8(20.51)	2(5.41)	11(25.58)	33(16.50)	0.1650
Use for settlement	11(31.43)	7(15.22)	4(10.26)	6(16.22)	4(9.30)	32(16.0)	0.1600
Use for tourism	4(11.43)	6(13.04)	7(17.95)	4(10.81)	5(11.63)	26(13.0)	0.1300
Rain inducement	6(17.14)	-	-	5(13.51)	8(18.60)	19(9.5)	0.0950
Helps control erosion	-	3(6.52)	-	1(2.70)	3(6.98)	7(3.50)	0.0350

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Awareness of Deforestation of Mandara Hills

The result of the assessment of the awareness of deforestation by the support zone dwellers is presented in Table 9. On location bases, the result of Kirwu indicated that 94.29% representing 33 respondents were aware of the deforestation while 5.71% were not aware.

The results of Kuthu, Fafuma, Makwan and Kwalkuga have the following percentages that are aware of deforestation 91.30%, 82.05%, 94.59% and 86.05% respectively. Similarly, the percentages of respondents not aware shows Kirwu (5.71%), Kuthu (8.70%), Fafuma (17.95%), Makwan (5.41%) and Kwalkuga (13.95%).

In Mandara hills, 89.50% are aware of deforestation representing 179 respondents while 10.50% (21 respondents) are not aware. This result reveals high percentage of awareness, and this may be in connection with their active involvement in this unfriendly ecological act that is detrimental to the protection of the Mandara hills for its sustainable conservation. According to Kissinger *et al.* (2014) the level of awareness of an ecological area by users or support zone dwellers is proportional to the pressure that could be exerted on the resources of such area.

Table 9: Awareness of Deforestation of Mandara Hills (% of Respondents)

Awareness of Deforestation of Mandara Hills	Frequency of Respondents					Total
	Kirwu	Kuthu	Fafuma	Makwan	Kwalkuga	
Aware	33(94.29)	42(91.30)	32(82.05)	35(94.59)	37(86.05)	179(89.50)
Not Aware	2(5.71)	4(8.70)	7(17.95)	2(5.41)	6(13.95)	21(10.50)

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Drivers of Deforestation of Mandara Hills

Information on the ranking of drivers of deforestation in Mandara hills is presented below in Table 10. Multiple responses were observed and recorded from the respondents' indications. The percentage of those that reported worst effect ranged from 1.0% for lack of political and economic stability - 13.50% for agricultural expansion because of improved farming practices.

For worse, the percentage of respondents also ranged from 1.0% for erosion and proximity of the hills to local residents each – 10.0% for agricultural expansion. Similarly, for bad effect the percentages ranged from 1.50% for lack of political and economic stability – 17.50% recorded for continuous bush burning to ease hunting of wild animals.

The 13 listed drivers below (Table 10) are the activities threatening the survival and conservation of Mandara hills. The cumulative percentages of the top 5 ranked drivers or threats based on bad, worse and worst effects as ranked in a perceived order of endangerment are indiscriminate destruction of wildlife habitat (31.50%), Continuous bush burning to ease hunting of wild animals (31.0%), agricultural expansion because of improved farming practices (29.0%), lack of access to the available farm land because of Boko Haram

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insurgency (28.50%) and unsustainable demand for wood by human communities and industries (22.5%).

The listing of agricultural expansion as one of the 5 top leading drivers of deforestation in this investigation agrees with Osoba *et al.* (2019) findings that clearing of forest land for agriculture or farming purpose is the most serious driver of deforestation and therefore threatens the existence of natural habitat such as forest land.

Table 10: Drivers of Deforestation of Mandara Hills (% of Respondents)

Drivers of Deforestation	No Effect	Fair Effect	Frequency of Bad Effect	Worse Effect	Worst effect	No Idea
Agricultural expansion because of improved farming practices	10(5.0)	15(7.50)	11(5.50)	20(10.0)	27(13.50)	117(58.50)
Indiscriminate destruction of wildlife habitat	5(2.50)	14(7.0)	30(15.0)	18(9.0)	15(7.50)	118(59.0)
Unprecedented logging and demand for fuelwood by local dwellers	10(5.0)	21(10.50)	18(9.0)	11(5.50)	15(7.50)	125(62.50)
Continuous bush burning to ease hunting of wild animals	5(2.50)	8(4.0)	35(17.50)	10(5.0)	17(8.50)	125(62.50)
Illegal grazing due to continuous infiltration of domestic livestock into Manadra Hills for safety	13(6.50)	22(11.0)	17(8.50)	14(7.0)	9(4.50)	125(62.50)
Poor implementation of conservation laws by the enforcement agencies	6(3.0)	22(11.0)	21(10.5)	12(6.0)	13(6.50)	126(63.0)
Lack of access to the available farmland because of Boko Haram Insurgency	8(4.0)	7(3.50)	16(8.0)	11(5.50)	30(15.0)	128(64.0)
Increased human settlement around the Mandara Hills	12(6.0)	23(11.50)	14(7.0)	11(5.50)	8(4.0)	132(66.0)
Unsustainable demand for wood by human communities and industries	7(3.5)	14(7.0)	19(9.50)	19(9.50)	7(3.50)	134(67.0)
Over-exploitation of forest resources (fruits, leaves, seeds etc. for food) by local communities	9(4.50)	18(9.0)	18(9.0)	7(3.50)	12(6.0)	136(68.0)
Lack of political and	2(1.0)	12(6.0)	3(1.50)	4(2.0)	2(1.0)	177(88.5)

economic stability						
Proximity of the hills to local/support zone dwellers	4(2.0)	5(2.50)	7(3.50)	2(1.0)	4(2.0)	178(89.0)
Erosion	1(0.5)	3(1.50)	6(3.0)	2(1.0)	3(1.50)	185(92.5)

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

Suggested Conservation/Protection Measures for Mandara Hills

Presented in Table 11 below is the suggested conservation measures that could be used for the sustenance of Mandara hills. The result of multiple responses by the respondents based on pooled result indicates that reduced human settlement around the hills with 34.50% of the respondents, implementation of natural forest regeneration and restoration (31.50%), reforestation of Mandara hills (29.50%), provision of alternative source of fuel through establishment of woodland (25.50%) and effective security management (23.0%) are believed to be the top measures that could be adequate for the conservation and protection of Mandara hills.

The respondents opined that majority of the listed conservation measures (Table 11) emerged as a result of insecurity situation in the area caused by Boko Haram insurgency. This ugly scenario has forced people to migrate and settle at the base and valleys of hills in order to take refuge from the incessant attack by the insurgents. According to the respondents the Mandara hills have given them tremendous protection and defense against the insurgents over the years. This result submits that the low responses shown for other conservation measures interprets that they will have minor role in conservation of Mandara hills even put in place.

On location basis, no respondent was recorded in Kirwu, for avoidance of farming on the hills and fighting corruption. Similarly in Fafuma, no respondent was recorded for conversion of Mandara hills into forest and game reserves and fighting corruption. In Kwalkuga, no respondent was recorded for environmental education through enlightenment campaign.

This means that the respondents of those areas had no idea on these measures as ways to ameliorate deforestation activity on the hills. Some of the conservation measures listed in Table 11 are similar to that of Ojo *et al.* (2018) on the study conducted in Borgu local government area of Niger state, Nigeria. This study observed that the first 5 conservation measures with high saliency value (0.3450, 0.3150, 0.2950, 0.2550 and 0.2300) seems to be promising in any conservation plan that could be drawn for the study area.

Table 11: **Suggested Conservation/Protection Measures for Mandara Hills**
(% of Respondents)

Suggested Conservation/Protection Measures	Kirwu	Kuthu	Frequency of Fafuma	Respondents Makwan	Kwalkugu	Total	Saliency Value
Reduced human settlement around the hills	15(7.50)	12(6.0)	13(6.50)	11(5.50)	18(9.0)	69(34.50)	0.3450
Implementation of natural forest regeneration and restoration	10(5.0)	17(8.50)	16(8.0)	9(4.50)	11(5.50)	63(31.50)	0.3150
Reforestation of Mandara hills	19(9.5)	14(7.0)	6(3.0)	3(1.50)	17(8.50)	59(29.50)	0.2950
Provision of alternative source of fuel through establishment of woodland	9(4.50)	8(4.0)	13(6.50)	10(5.0)	11(5.50)	51(25.50)	0.2550
Effective security management	12(6.0)	8(4.0)	9(4.50)	13(6.50)	4(2.0)	46(23.0)	0.2300
Environmental education through enlightenment campaign	15(7.50)	11(5.50)	5(2.50)	3(1.50)	-	34(17.0)	0.1700
Provision of social amenities to divert people's attention from the hills' resources	6(3.0)	8(4.0)	5(2.50)	7(3.50)	4(2.0)	30(15.0)	0.1500
Encouragement of tree planting campaign	4(2.0)	3(1.50)	6(3.0)	6(3.0)	8(4.0)	27(13.50)	0.1350
Full implementation of conservation laws	8(4.0)	6(3.0)	3(1.50)	3(1.50)	7(3.50)	27(13.50)	0.1350
Controlled grazing	5(2.50)	7(3.50)	2(1.0)	6(3.0)	5(2.50)	25(12.50)	0.1250
Avoid bush burning	6(3.0)	4(2.0)	7(3.50)	3(1.50)	4(2.0)	24(12.0)	0.1200
Conversion of Mandara hills into forest and game reserves	7(3.50)	10(5.0)	-	2(1.0)	5(2.50)	24(12.0)	0.1200
Avoidance of farming on the hills	-	6(3.0)	4(2.0)	9(4.50)	3(1.50)	22(11.0)	0.1100
Reduced exploitation of Mandara hills for stones and gravels	6(3.0)	4(2.0)	1(0.5)	3(1.50)	7(3.50)	21(10.50)	0.1050
Use of traditional council	2(1.0)	2(1.0)	6(3.0)	4(2.0)	3(1.50)	17(8.50)	0.0850
Use of buffer zones where partial human activities can take place	5(2.50)	2(1.0)	3(1.50)	2(1.0)	2(1.0)	14(7.0)	0.0700
Fighting corruption	-	2(1.0)	-	6(3.0)	1(0.5)	9(4.50)	0.0450
Avoid festivity on the hills	2(1.0)	1(0.5)	2(1.0)	1(0.5)	1(0.5)	7(3.50)	0.0350

Source: Field Survey, 2023

*Figures in parenthesis are in percentages (%)

CONCLUSION

The investigation showed that the majority of the respondents were aware of existence of Mandara Hills and the deforestation activity happening on and around the hills. The study also revealed that they were many drivers of deforestation and similar benefits derived from Mandara hills. In line, the socio-economic indices of the support zone dwellers as they appear presently are not favorable to the conservation of biological resources of the hills.

Considering the high number of literate segment of the respondents as representatives of the support zone dwellers, the conservation of Mandara Hills is possible. What is required is a high level of conservation education for every stratum of the population as well as implementation of the suggested conservation measures above since baseline information on the socio-economic characteristics of the support zone dwellers have been provided.

It is expected that these information will be useful for designing of a conservation plan for Mandara hills.

Recommendations

This study recommends that:

- (i) The problems of socio-economic characteristics of the support zone dwellers need to be addressed as one of the measures for conservation of the Mandara hills
- (ii) Government need to consider improvement of the security situation of the study area paramount
- (iii) Promotion of sustainable agricultural practices to reduce pressure on the forest resources

The authors declare that there is no conflict of interest

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