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ANALYSIS OF FACTORS AFFECTING SUSTAINABLE COMMERCIAL FUELWOOD COLLECTION IN DAWADAWA AND KUNSU IN KINTAMPO NORTH DISTRICT OF GHANA

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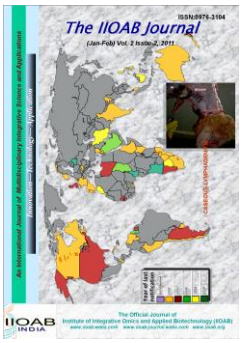
ABSTRACT



This paper examines factors affecting sustainable commercial fuelwood collection in the Kintampo North District of Ghana for the purposes of sustainable woodland management and fuelwood collection. Over dependence on fuelwood collection for livelihood by the rural people in Kintampo North District leads to over exploitation of the woodlands in the area. This situation is a source of concern to managements of woodland and traditional energy sub-sector in the country. Biophysical and socio-economic factors contribute to woodland management in diverse ways: by hindering the exploitation of woodland thereby facilitating sustainable fuelwood collection; and by promoting exploitation of woodland. Focus group discussion was employed to identify factors affecting fuelwood collection in Dawadawa and Kunsu communities of Kintampo North District. Pair-wise comparison was used to rank the factors. Participatory mapping was used to map fuelwood collection sites for relating the collection sites to biophysical factors. Large tracks of land have been exploited at Dawadawa compared to Kunsu, mainly due to the type of land tenure system. Land tenure and low producer price of fuelwood were ranked first in Dawadawa and Kunsu respectively among the factors affecting commercial fuelwood collection. Current collection sites are over 24km and 10km respectively from settlements in Dawadawa and Kunsu. The land tenure system practised in Kunsu promotes effective management system for sustainable fuelwood collection in the Kintampo North District of Ghana; which can be adopted in the other districts of Ghana.

Keywords: *Fuelwood; firewood; energy; woodlands; commercial fuelwood collectors*

[I] NTRODUCTION

Fuelwood (FW) plays an important role in the socio-economic lives of more than two billion people globally [1]. More than 1.8 billion m^3 of fuelwood is used globally and it constitutes about 7% of the world's total primary energy consumption with 76% of it being used in developing countries particularly in Africa [1, 2]. In developing countries such as Ghana, fuelwood is a major source of domestic energy. In the rural communities it is used for cooking, general heating and lighting; where as in the urban areas of developing countries where alternative energy exist, fuelwood still remains the main source of domestic energy [3–6]. Africa is rated the top highest fuelwood consumer in the world energy projections for the years 2010, 2020 and 2030 [7]. Africa's fuelwood consumption is expected to stand at 544.8 million m^3 and 46.1 million tons for firewood and charcoal respectively by 2030 [7]. Widespread use of fuelwood in the developing world and Africa in particular has been linked to woodland degradation, and poverty [8]. Fuelwood collection and use is on the increase in both the rural and urban areas with population growth and poverty as the most important contributory factors especially in Africa [9]. With the current 2.3% rate of global population growth [10], fuelwood use is expected to increase due to continuous dependence on it as the main household energy

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source. The current situation poses considerable challenge to the forests and woodland resources [11, 12].

This means that every effort must be made to ensure sustainable fuelwood collection by ensuring sustainable woodland management if the above targets must be met. The demand for fuelwood and its social consequences may worsen for the urban poor of developing countries particularly at this time that prices of petroleum products are on the increase. Fuelwood use is on the increase and concerted effort towards sustainable woodland management is crucial for sustainable fuelwood collection [13]. Notwithstanding the important role fuelwood plays globally and the growing interest in fuelwood use, its collection particularly for commercial purposes is widely criticised for its contribution to woodlands and forests degradation [4, 14, 15, 16, 7]. By their objective, commercial fuelwood collectors are those who harvest fuelwood for sale. By their nature they fell both live and dead trees preferably species with high calorific value. They also harvest both primary and secondary preferred tree species [17] depending on the kind of tools collectors use; chainsaw users prefer primary tree species which have high wood density and high market value while cutlass or axe users harvest secondary tree species because they are easy to cut though their wood densities are low. They also rent woodlands from the chiefs and landlords in countries such as Ghana. Poor woodland access triggers environmental degradation which in turn aggravates poverty and further worsens the situation of degradation [16]. The effects of fuelwood collection on woodlands and forest can be reduced through good management practices [18]. Understanding factors that affect fuelwood collection can improve management of woodlands in order to minimize the negative effects associated with commercial fuelwood collection and the consequences on human well-being.

Ghana depends heavily on fuelwood especially for her domestic energy needs. The pattern of fuelwood consumption in Ghana is not different from what is observed in other developing countries. Consumption is on the increase while the quantity and quality of woodlands are decreasing. Fuelwood constitutes about 70% of energy consumed in Ghana [11, 19]. Ghana is one of the countries with high per capita fuelwood demand in West Africa and among the top two in charcoal consumption, signifying the important role fuelwood plays in Ghana's socio-economic development [20, 21]. It is therefore not surprising when the Strategic National Energy Plan (SNEP) 2006-2020 projects a rise in fuelwood consumption from 14 million ton in 2000 to between 38 - 48 million ton by 2012, and 54 - 66 million ton by 2020 [11]. In Ghana, much of the fuelwood that is consumed in the urban centres of the country is produced in areas such as Kintampo North District (KND) within the transitional zone, which is ecologically fragile. Despite the ecological sensitive nature of these areas, commercial fuelwood collection is one of the main sources of income for the rural poor who defy conservation practices to make ends meet on daily basis. Besides, the transition zone is noted for the heavy presence of migrant population most of whom are engaged in fuelwood collection for commercial purposes. The migrants do not have ownership rights to the woodlands and thus rent woodlands from the chiefs and individual family heads. The ownership of planted trees on rented lands is not clearly defined in Ghana and does not encourage people to plant trees on rented lands to supplement fuelwood collection from natural woodlands [22]. Also, Land based economic activities have expanded leading to accelerated woodland conversion to farms and settlements. Thus woodlands are under severe pressure raising questions about their sustainability and future fuelwood supply.

The threat to sustainable woodland management and for that matter sustainable fuelwood collection poses a great challenge to the traditional sub-energy management in Ghana; particularly to meet the energy needs of the country between 2012 and 2020 as projected in the Strategic National Energy Plan [11]. It is therefore imperative to analyse the factors affecting sustainable fuelwood collection in the major commercial fuelwood producing areas at KND. This will contribute to solutions to sustainable commercial fuelwood collection while minimising its impacts on other natural resources. It is against the above views that the research was set out to analyse factors affecting fuelwood collection.

[II] MATERIALS AND METHODS

2.1. Study area

KND is one of the major producers of fuelwood within the transition zone of Ghana. Livelihood activities of majority of the people are natural resources based such as farming and commercial fuelwood collection [23]. The fuelwood collection is either the primary source of incomes or a supplement to the mainstream agriculture.

The district has many rivers and undulating topography **[Figure–1]** which influence the choice of fuelwood collection areas. KND is located between latitudes 8°45'N and 7°45'N and Longitudes 1°20'W and 2°1'W. The district has a surface area of about 5,108km². It shares boundaries with five other districts: West Gonja to the North, Bole to the West, East Gonja to the North-East, Kintampo South to the South, and Pru to the South-East. Some of these districts are also known for commercial fuelwood collection. The district is strategically located at the centre of Ghana and serves as a transit point for migrants from the northern part of the country [24]. The elevation of the terrain ranges between 60 -150m above mean sea level. The fuelwood collection is either the primary source of incomes or a supplement to the mainstream agriculture. The Tamale–Techiman–Kumasi trunk road passes through the district which facilitates the transportation of fuelwood to commercial markets in Accra, Kumasi and other urban centres thus creating a ready market for fuelwood. This has therefore made fuelwood collection a brisk business in KND.

KND falls under the interior wooded savannah. However, due to its transitional nature, the area does not totally exhibit typical savannah conditions. The savannah is heavily wooded, though most of the trees are not as tall and gigantic as those in the moist deciduous forest. It is believed that the transitional zone was once forested and that the savannah conditions currently prevailing have been as a result of man's

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activities such as agriculture, logging, bush fire [25] and fuelwood harvesting. KND experiences the interior Savannah type of climate as it is within the transitional zone of Ghana with the mean annual rainfall which is between 1,400mm-1,800mm

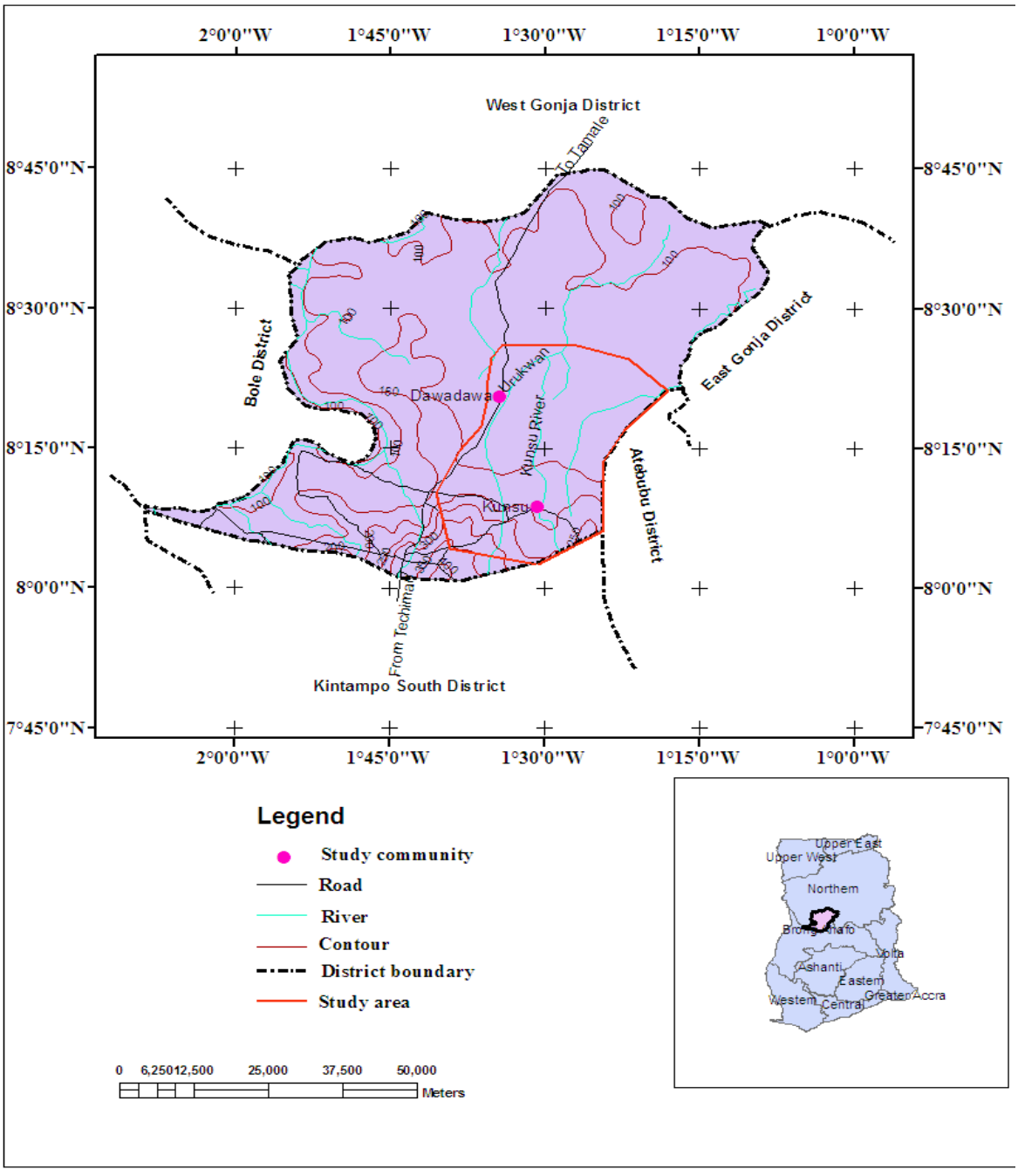

Fig: 1. Study Area

2.2. Materials and software

The Visible Near Infrared (VNIR) bands of Aster January 29th, 2007 image was used as the base map for the mapping of the fuelwood collection sites. Garmin 76S hand-held Global Positioning System (GPS) was used to pick sample locations of fuelwood collection sites in the field. A topographic map (1:50,000) was used as a guide during the reconnaissance survey and field visits. ERDAS Imagine 9.1 software was used to process the image; ArcGIS 9.2 software was used to overlay roads, rivers and contours with the image; and SPSS 15.0 software was used to process and analyse the socio-economic data. Microsoft Office Excel was also used to sort the GPS data for transformation into the Ghanaian local coordinate system.

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2.3. Sampling

Dawadawa and Kunsu are leading commercial fuelwood producing communities in the district [24] and were also purposively sampled because they were easily accessible by road at the time of the research. Each study community was stratified in order to have a representative sample. Major roads and paths were used as boundaries of the strata. Individual fuelwood collectors were purposively selected since commercial fuelwood collection was not carried out by everyone in the communities. The number of the respondents was determined by willingness of commercial fuelwood collectors to be interviewed because of the illegal nature of their activities and the time that was available for the research. In all, sixty commercial fuelwood collectors were interviewed in each community.

2.4. Focus group discussion and participatory mapping

A focus group of eight people was engaged in a discussion, centred on the identification of the major factors affecting commercial fuelwood collection in each community and mapping of the fuelwood collection sites. The fuelwood collection sites were mapped using participatory mapping whereby fuelwood collectors in each community identified and sketched areas where they collect wood. The mapping was done on geo-referenced Aster-2007 image overlaid with roads and boundaries of the study communities to improve the identification of the fuelwood collection sites. Participants mapped areas where preferred trees for fuelwood were completely harvested and areas that were being harvested at the time of the data collection. Participants referred to the distance from the settlements and rivers (Urukwan and Kunsu) to the collection areas. They also made reference to Tamale Techiman trunk road, Kintampo-Kunsu road, and neighbouring villages such as Attakura, and Kawumpe, Meawani and Adomano.

Two participants from the focus group were engaged in a field validation, which took the form of a mobile interview, through the fuelwood collection areas. The geographic locations of sample fuelwood collection sites were recorded using Garmin GPS 76S in order to validate the mapped areas.

2.6. Interviews and key informant discussions

Face-to-face interviews were conducted for fuelwood collectors in each community. Respondents were asked among other questions to rank the factors identified by the focus group discussions. Pair-wise ranking was used.

2.7. Data analysis

Weights were assigned to the ranks **[Table–1]** and used for statistical analysis in Statistical Package for Social Scientists (SPSS). The weights were assigned based on rank reversal. The most important factor by rank was assigned the highest weight while the least important factor was assigned the least weight. The mean weights, standard deviation, minimum and maximum weights of each factor were computed. The final ranking was done based on mean weight. The standard deviation, minimum and maximum weights served as explanatory variables. The greater the mean weight of a factor, the more it affects fuelwood collection. The factor with the greatest mean weight was ranked 1; meaning the most important factor affecting fuelwood collection and the factor with the least mean weight was ranked 6 meaning the least important factor affecting fuelwood collection

The fuelwood collection site map was scanned and geo-referenced in ArcMap. The boundaries of the collection sites were digitized on-screen. The boundaries together with the sample points were overlaid on the image.

Table: 1. Ranks and weights of factors affecting fuelwood collection

Rank	Weight Assigned
1	6
2	5
3	4
4	3
5	2
6	1

[III] RESULTS

3.1. Demographic characteristics of respondents

The major age group involved in commercial fuelwood collection in the communities is 30-39 years and constituted 50% and 43% of the respondents in Dawadawa and Kunsu respectively **[Figure–2]**. It is also evident from Fig. 2 that a number of respondents are of ages between 40 and 49 in both communities also engaged in commercial fuelwood collection. There were no collectors below 20 years.

The major source of income of commercial fuelwood collectors is fuelwood sale, 95% in Dawadawa and 92% in Kunsu **[Figure–3]**. Farming is a major source of income to 5% and 8% of the respondents in Dawadawa and Kunsu respectively, with fuelwood sale as a supplementary source. In Dawadawa, 70% of the respondents either had little or no formal education as compared to 80% in Kunsu. The rest of the respondents in both communities had either primary or Junior Secondary/Middle school education **[Figure–4]**.

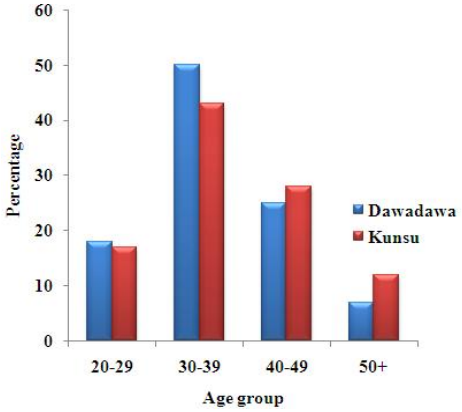

Fig: 2. Age distribution of FW collectors

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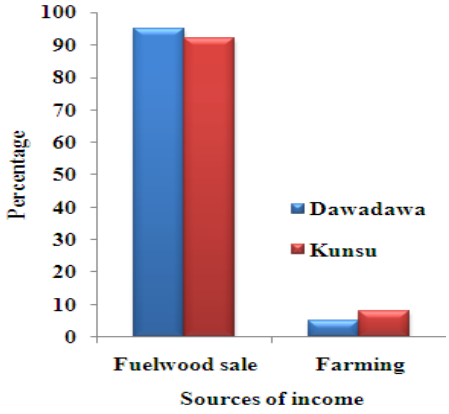

Fig: 3. Sources of income of FW collectors

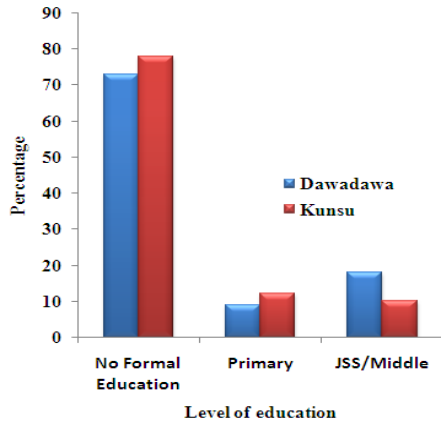

Fig: 4. Educational level FW collectors

3.2. Commercial fuelwood collection sites

Commercial fuelwood collection sites between the period 2000 and 2007 were studied **[Figure–5; Plate–1, Plate–2, Plate–3 & Plate–4]**. In the case of Dawadawa, collection site A was exhausted of harvestable preferred tree species **[Plate–1]**, site B **[Plate–2]** which is about 10km from the settlement still had few harvestable species and site C **[Plates–3 & 4]** which is about 20km **[Figure–6]** had a high density of harvestable preferred species. Site A and B **[Figure–5]** were dominated by *Afromosia spp*., *Nuclea latifolia*, *Ceiba pentandra*, *Adansonia digitata*, *Mitrogyna spp*., *Danialla olivery*, etc., which are not preferred species for commercial fuelwood **[Plates–1 and 2]**. Though, site A was exhausted of harvestable preferred species for commercial purposes, some domestic fuelwood collectors were found harvesting wood there **[Plate–1]**.

In Kunsu, respondents did not separate areas exhausted of harvestable preferred tree species from areas still dominated by harvestable preferred tree species since such areas do not exist in isolation as in the case of Dawadawa. Commercial fuelwood collectors collected fuelwood within 10km from the settlements **[Figure–6]**. Preferred tree species for commercial fuelwood collection in the study communities include *Lophira lanceolata*, *Pseudocedrela kotchyi*, *Albizia coriaria*, *Vitellaris paradoxa*, *Pterocarpus erinaceus*, *Anogeissus leiocarpus and Erthrophyleum guineensis.*

Plate: 1. **FW collection site– A**
Plate: 2. **FW collection site– B**
Plate: 3. **FW collection site–C**
Plate: 4. **FW collection site–C**

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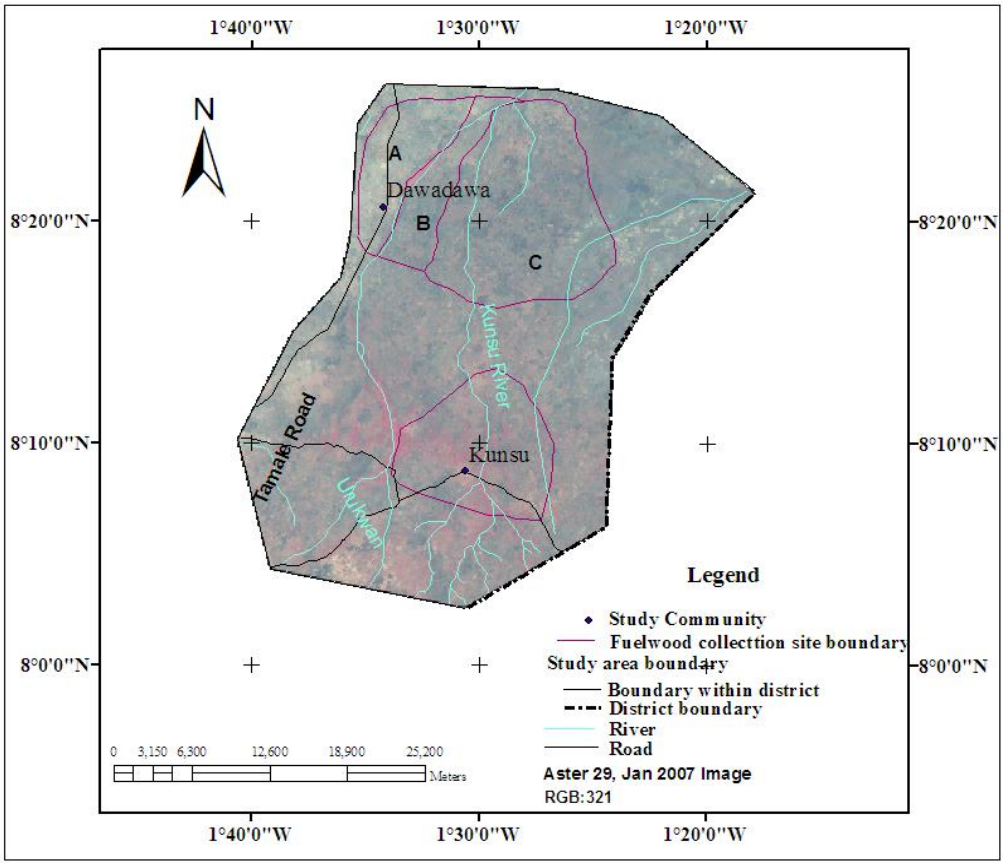

Fig: 5. Fuelwood collection site map

3.3. Factors affecting fuelwood collection

With the exception of poor roads, topography, slash and burn farming, and land tenure, the rest of the factors affecting commercial fuelwood collection are the same for the two communities **[Table–2]**. Land tenure and poor roads were not listed in Dawadawa as topography and slash and burn farming practice were not also listed in Kunsu.

Low producer price of fuelwood and poverty were ranked first and second respectively in Dawadawa **[Table–3]**. The mean weight of low producer price is marginally higher than that of poverty by 0.24 while the standard deviation is lower by 0.233. Bushfire is ranked least with a mean weight of 2.22 and standard deviation of 0.948. Slash and burn farming practices with the largest standard deviation of 1.203 is ranked fifth.

Table: 2. Factors affecting commercial fuelwood collection

Factor	Community	Effect of factor on fuelwood collection
Low producer price for fuelwood	Dawadawa and Kunsu	It leads to overexploitation of the woodlands.
Poverty	Dawadawa and Kunsu	It leads to over exploitation of woodlands.
Topography	Dawadawa	Increase cost of fuelwood collection during rainy season.
Rivers	Dawadawa and Kunsu	Reduce access to collection areas, increase cost of fuelwood collection during rainy season
Slash and burn farming	Dawadawa	Impediment to sustainable fuelwood collection as it destroys the woody vegetation.
Frequent bushfire	Dawadawa and Kunsu	Impediment to sustainable fuelwood collection, a disincentive to establishment of fuelwood plantations
Poor Roads	Kunsu	Inaccessibility to fuelwood markets.
Land tenure	Kunsu	Impediment in terms of access to wood resource and planting of trees on rented lands and management of trees.

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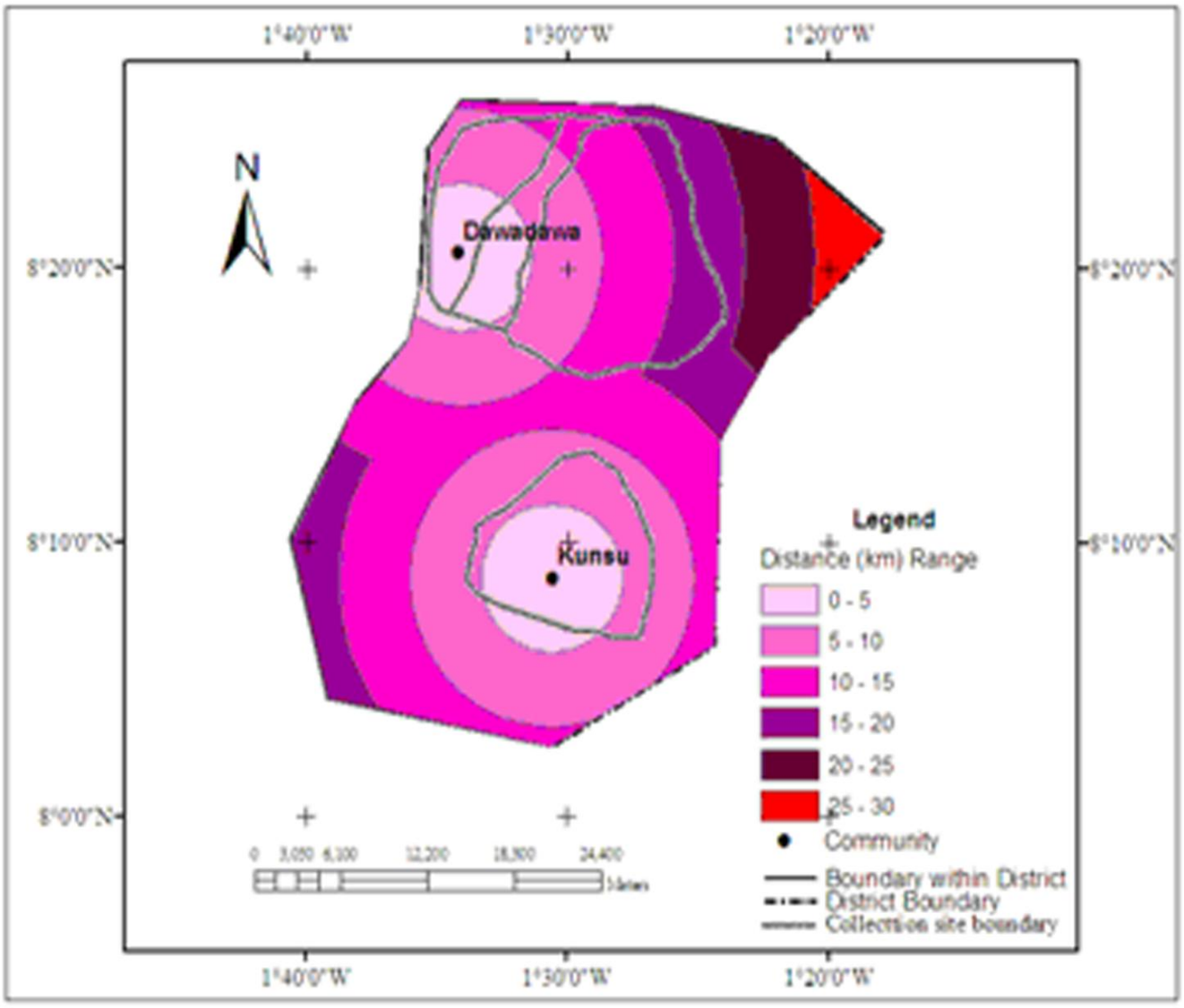

Fig: 6. Distance map showing distace from settlement to FW collection site

Table: 3. Statistics of factors identified in Dawadawa

Factors	Weights			Std. Dev	Rank
	Min	Max	Mean		
Low producer price of fuelwood	4	6	5.68	0.539	1
Poverty	4	6	5.44	0.772	2
Topography	3	6	4.51	0.917	3
Rivers	2	6	4.05	0.818	4
Slash and burn farming	2	6	4.00	1.203	5
Bushfire	1	4	2.22	0.948	6

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Land tenure was ranked as the most important factor affecting commercial fuelwood collection with the highest mean weight of 5.75 and a standard deviation of 0.439 in Kunsu **[Table–4]**.

Bushfire was ranked the least factor with a mean weight of 1.42 and standard deviation of 0.675.

Table: 4. Statistics of factors identified in Kunsu

Factors	Weights			Std. Dev	Rank
	Min	Max	Mean		
Land tenure	5	6	5.75	0.439	1
Poverty	4	6	5.54	0.625	2
Low producer price of fuelwood	3	6	4.51	0.917	3
Roads	2	6	3.27	0.827	4
Rivers	1	4	2.17	0.699	5
Bushfire	1	3	1.42	0.675	6

[IV] DISCUSSION

4.1. Commercial fuelwood collection sites

Fuelwood is collected from woodlands in Dawadawa which are as far as 20 km from settlements. Collections sites in Dawadawa extend over large tracks of woodlands with current collection sites concentrated in the eastern part where preferred species are still abundant. Twenty (20) kilometre from settlement to collection sites in Dawadawa is considered a long distance [26]. It is a source of concern not only to the collectors but also management of the traditional energy sub-sector in Ghana since long distance from settlements to collection sites is a yardstick for fuelwood scarcity [26, 27]. Also some fuelwood collection sites are less than 10 km to the district boundary of Attebubu District which has the possibility of initiating conflict as collectors get closer to the district boundary.

4.2. Factors affecting fuelwood collection

Bush fire, and slash and burn farming practices were ranked low though these factors are noted for their devastating effects on woodlands in the study area. It is attributable to the fact that some fuelwood collectors were also farmers and did not agree that slash and burn farming destroys woodlands. This assertion is affirmed by the fact that, slash and burn farming has the highest standard deviation of 1.203 signifying a divided opinion in the ranking. Slash and burn farming was not identified in Kunsu though the practice goes on there and is because wood resource is abundant in Kunsu such that commercial fuelwood collectors do not realise its effects on sustainable fuelwood collection.

4.2.1. Land tenure system

Land tenure system was ranked first with the least standard deviation of 0.439 signifying agreement in the opinions of the respondents that land tenure system is really the most dominant factor affecting commercial fuelwood collection in Kunsu. Contrary to what was expected, it was not listed among the factors affecting commercial fuelwood collection in Dawadawa. This is ascribed to the perspective from which fuelwood collectors view land tenure in relation to woodland use and the land tenure system practised in each community. In terms of access to woodland, land tenure poses little difficulty to commercial fuelwood collectors once they are willing to pay for the woodland. In terms of sustainable fuelwood collection, it poses serious difficulties because land tenure system in Dawadawa does not ensure sustainable tree harvesting, such as enforcement of restrictions on sizes of trees to be harvested. The danger of such tenure system is that it leads to overexploitation of woodlands for commercial fuelwood collection as in Dawadawa. In Dawadawa, woodland is entrusted to the chief and he enjoys direct monetary benefits from renting the woodlands to commercial fuelwood collectors. Access to woodland is more or less open to them once they agree to pay the required tribute to the chief as rent. Thus it is expected that the chief takes responsibility of ensuring sustainability of the woodland such as restrictions on the type and size of trees to harvest [28]. Unfortunately, commercial fuelwood collectors do not have any motivation for sustainable harvesting because they rent the woodlands and this attitude begs enforcement of restriction on sizes of trees harvested for commercial fuelwood [29]. Land tenure system makes access to woodlands easy for commercial fuelwood collectors in Dawadawa and this explains why land tenure was not mentioned as a factor affecting commercial fuelwood collection. In Kunsu, woodland is entrusted to households who enjoy direct monetary benefits from renting woodlands to commercial fuelwood collectors. It is easy to enforce restrictions on access to woodlands because many people have interest to protect woodlands since they enjoy direct benefits from woodlands. Commercial fuelwood collectors are restricted to the number and size of tree species to harvest. These restrictions make access to woodland difficult for the migrant landless commercial fuelwood collectors and accounts for the ranking of land tenure system as the most important factor in Kunsu.

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The land tenure system practised in Kunsu ensures sustainability of woodlands whereas that of Dawadawa does not. It is therefore clear that land tenure is an important factor through which people gain access to land and natural resources. Though it poses some level of difficulties in accessing wood resource in Kunsu and elsewhere [30], it ensures sustainable harvesting of wood.

4.2.2. Poverty

Most of the fuelwood collectors are poor and find it difficult to make ends meet on daily basis. The urban wholesalers capitalise on it and offer low producer-price for fuelwood. The poverty situation of the collectors makes it difficult for them to reject such undeserving prices offered by the urban wholesalers. The implication is that fuelwood collectors continue to work for hand-to-mouth and are not encouraged to establish private fuelwood plantations. Consequently fuelwood collectors continuously depend on the natural woodland and greatly contributing to the degradation of woodland as demonstrated in Dawadawa.

4.2.3. Low producer price of fuelwood

The ranking of low producer-price of fuelwood first and third in Dawadawa and Kunsu respectively shows the low economic benefits derived from commercial fuelwood collection. It indicates that fuelwood collection is not yielding the expected economic benefit. This has a negative implication on the sustainability of the woodlands in terms of protecting the woodlands against annual bush fires.

In Dawadawa for instance, for renting a chainsaw per operation, the fuelwood collector pays US$35.00, one-third of this amount is meant for fuel to operate the chainsaw, another one-third for maintenance of the chainsaw and the rest is meant for the labour of the chainsaw operator. The activities covered by the US$35.00 constitute a set of fuelwood harvesting operation. One harvesting operation yields an average of 100 bags of fuelwood depending on the type of three species and the expertise of the fuelwood collector. For every ten bags of fuelwood produced, one bag (US$3.00) is given to the chief as rent for the woodland. Therefore, for one harvesting operation (100 bags of fuelwood), the total rent is US$30.00 To transport a bag of fuelwood from the collection point to the sale point, it costs on the average US$1.00 depending on the topography of the terrain, the season of the year and the distance between the collection and the sale points. The total cost of transport per a harvesting operation becomes US$100.00. The time and energy spent by the fuelwood collector is estimated to worth US$ 1.00 for every bag of fuelwood produced. For the 100 bags of fuelwood produced per operation, the total time and energy spent is worth US$ 100.00. This brings the total cost of production to US$265.00 (US$35.00 + US$30.00 + US$100.00 + US$100.00) for one harvesting operation. If a bag of fuelwood is sold for US$3.00, then the total revenue generated for harvesting operation amounts to US$ 300.00 resulting in a profit of US$35.00 for a harvesting operation. This means that the producer profit per bag is US$0.35. A similar analysis applies to Kunsu. These expenses make producer-price of US$3.00 in Dawadawa and US$2.00 in Kunsu for a 46 kg bag of fuelwood worthless. These prices are far below the average prices of $8.00, $9.00 and $10.00 for the same quantity of fuelwood in the urban markets in Tamale, Kumasi, and Accra respectively. Evidence from field observation shows that the low producer price is due to lack of policy to regulate the prices of fuelwood nationwide; partly because fuelwood collectors in the study area do not have any recognised group to press home their needs. The fact that commercial fuelwood collectors do not have recognised groups has negative implications on the enforcement of conservation regulations because it is more difficult to monitor an individual than a group.

4.2.4. Topography and poor roads

Among the biophysical factors, topography was ranked the most important factor for commercial fuelwood collection in Dawadawa because of the flat nature of the terrain (0 – 2% slope). Topography was not mentioned in Kunsu because there were alternative collection sites in times of floods. Flooding affects fuelwood collection since it denies fuelwood collector's access to collection sites.

The quality, density and length of roads to market centres are critical to the profitability of commercial fuelwood collection. The roads facilitate fuelwood transportation to market centres in the urban areas. It is ranked fourth among the factors affecting fuelwood collection in Kunsu. This is due to the deplorable state of the main Kunsu-Kintampo road which limits access to the nearest urban centre (Kintampo). The effect of the poor state of the road is translated into low producer-price for fuelwood in Kunsu; since it becomes difficult for vehicles to convey fuelwood from Kunsu to Kintampo for onward transportation to Kumasi and Accra. Poor roads were not identified in Dawadawa because the community is linked to the market centres by the Tamale–Techiman highway which facilitates the transportation of fuelwood.

[V] CONCLUSION

Fuelwood collection is a major source of livelihood for commercial fuelwood collectors at KND. Land tenure can be an incentive or a disincentive in woodland management for fuelwood collection.Woodlands in Dawadawa are under severe pressure to support livelihoods of commercial fuelwood collectors since the land tenure system does not ensure sustainable harvesting of wood. Woodlands are managed sustainably in Kunsu compared to Dawadawa due to effective tenure system that is practised in Kunsu. The land tenure system and low producer price of fuelwood are major disincentives to the establishment of private plantations to supplement diminishing natural woodlands in the study area.

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FINANCIAL DISCLOSURE

Finances so far are borne by authors and subsequent expenses will still be borne by authors.

REFERENCES

[1] FAO. [2005] State of the world's forests. United Nations Food and Agriculture Organization (FAO), Rome, Italy.
[2] Trossero MA. [2002] Wood energy: The way ahead. *Unasylva* 53 (3): 3–9.
[3] Madubansi M, Shackleton CM. [2007] Changes in fuelwood use and selection following electrification in the Bushbuckridge lowveld, South Africa. *Journal of Environment and Management* 83: 416–426.
[4] Naughton-Treves L, Kammen DM, Chapman C. [2007] Burning biodiversity: Woody biomass use by commercial and subsistence groups in western Uganda's forests. *Biological Conservation* 134: 232–241.
[5] Brouwer R, Falcao MP. [2004] Wood fuel consumption in Maputo, Mozambique. *Biomass and Bioenergy* 27: 233–245.
[6] Nagothu US. [2000] Woodfuel and fodder extraction and deforestation: mainstream views in India discussed on the basis of data from semi-arid region of Rajasthan. *Geoforum* 32: 319–332.
[7] Arnold M. & Persson R. [2003] Reassessing fuelwood situation in developing countries. *International Forestry review*, 5: 379–383
[8] Chambwera M, Folmer H. [2007] Fuel switching in Harare: An almost ideal demand system approach. *Energy Policy* 35: 2538–2548
[9] Ffolliott PF, Brooks KN, Gregersen HM, Lundgen AL. [1995] Dryland Forestry: Planting and Management. New York: John Wiley & Sons.
[10] UN. [2007] Africa and the Millennium Development Goals. UN Department of Public Information.
[11] Energy Commission of Ghana. [2006] Strategic National Energy Plan 2006–2020, Annex IV: Woodfuels and Renewables. Jadal Print, Accra.
[12] Mahapatra AK, Mitchell CP. [1999] Biofuel consumption, deforestation, and farm level tree growing in rural India. *Biomass and Bioenergy* 17: 291–303.
[13] Lefevre T, Todoc JL, Timilsina GR. [1997] The role of wood energy in Asia. Centre for Energy-Environment Research and Development, Asian Institute of Technology Bangkok, Thailand.
[14] Ouedraogo B. [2006] Household energy preferences for cooking in urban Ouagadougou,Burkina Faso. *Energy Policy* 34: 3787–3795.
[15] Chambwera M. [2004] Economic analysis of urban fuelwood demand: the case of Zimbabwe. PhD thesis, Wageningen University, The Netherlands.
[16] Wunder S. [2000] The Economics of deforestation: The example of Ecuador. Macmillan Press Ltd.
[17] Coomes OT, Burt GJ. [2001] Peasant charcoal production in the Peruvian Amazon: rainforest use and economic reliance. *Forest Ecology and Management* 140: 39–50.
[18] Abbot JIO, Mace R. [1999] Managing Protected Woodlands: Fuelwood Collection and Law Enforcement in Lake Malawi National Park. *Conservation Biology* 13 (2): 418–421.
[19] Songsore J. [2003] Regional development in Ghana: The theory and reality. Woeli Publishing Services, Accra New Town FAO 2001;
[20] FAO. [2001] Forest resources assessment 2000. FAO, Rome.
[21] Yevich R, Logan JA. [2003].An Assessment of Biofuel use and Burning of Agricultural Waste in the Developing World. *Global Biogeochemical Cycles* 17(4): 1095. doi:10.1029/2002GB001952.
[22] UN Energy. [2006] Assessing policy options for increasing the use of renewable energy for sustainable development: modelling energy scenarios for Ghana. New York, NY, USA.
[23] Amanor KS. [2003] Natural and Cultural Assets and Participatory Forest Management in West Africa (*International Conference on Natural Assets, Paper 8, Philippines*).
[24] MLRDE [2006] Ministry of Local Govt., Rural Development and Environment, Maks Publications and Media. (http://www.ghanadistricts.com/districts/?news&r=10&_=37)
[25] Pabi O. [2007] Understanding land use/cover change process for land and environmental resources use management policy in Ghana. *GeoJournal* 68: 369–383.
[26] Miah D, Ahmed R, & Uddin MB. [2003] Biomass fuel use by the rural households in Chittagong region, Banglades. *Biomass and Bioenergy* 24: 277– 283.
[27] Bembridge TJ, Tarlton JE. [1990] Woodfuel in Ciskei: A Headload Study. *South African Forestry Journal* 154: 88–98.
[28] Barrow E, Clarke J, Grundy I, Jones K, Tessema Y. [2002] Analysis of stakeholder power and responsibilities in community involvement in forestry management in Eastern and Southern Africa. IUCN, Eastern Africa
[29] DFID. [2005] Survey of perceptions among key decision-makers of environmental issues in the transitional zone of Ghana. Annex G of the Final Technical Report of project R8258.
[30] McCrary JK. Walsh B. [2005] Hammett, *A.L. Forest Ecology and Management* 205: 299 – 309.

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