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Effects of woodfuel production on the environment and people in Adaklu Traditional Area, Ghana

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Abstract

Woodfuel serves as a major source of energy for cooking and micro industrial activities in Adaklu Traditional Area, Ghana. Increase in the demand for woodfuel coupled with the lack of alternative energy resources have contributed to an increase in cutting of trees to ensure adequate woodfuel supply. As a result of exploiting trees for woodfuel, ecological and health side effects of woodfuel production have emerged. To unearth these ecological and health effects, the following objectives were pursued: to determine the processes involved in woodfuel production; examine the extent to which anthropogenic activities of woodfuel production contribute to changes in the environment and analyse the effects of woodfuel production on the socio-economic life of people in the Adaklu Traditional Area. The method used to achieve the above objectives included the use of questionnaire surveys to collect primary data and the classification of remote sensing satellite images covering the study area in the years 1975, 1990 and 2000. The main ecological effect of woodfuel production on the environment in the Adaklu Traditional Area is deforestation as reflected in survey results and satellite image classifications. Other effects of woodfuel production are health problems and fairly longer distances covered in search of woodfuel.

Key words: Deforestation, environmental effects, woodfuel production, socio-economic effects.

Introduction

This article studies some effects of woodfuel production on the environment and its associated impact on the lives of people in the Adaklu Traditional Area, Ghana. The study covered 13 settlements focusing on woodfuel production processes; the extent to which woodfuel production has contributed to deforestation coupled with its associated environmental problems was examined. Furthermore, the demand and supply of woodfuel affecting the physical environment and the daily socio-economic life of the people were determined. Hypotheses for the study are: (1) human activities emanating from woodfuel production encourage the formation of forests; (2) given the pervasive nature of poverty in the Adaklu Traditional Area and the lack of technological resources, it may be argued that woodfuel production does not contribute to environmental degradation.

Even though woodfuel constitutes an important energy source in developing countries, its demand and supply patterns and effects on the socio-economic life of the people and the environment remains poorly understood [1]. In Ghana the value of wood used for energy production was US$ 200 million compared with US$ 150 million worth of wood used for timber exports in 1989 [2]. The most serious environmental problems facing Ghana are soil erosion and deforestation of which fuelwood extraction and charcoal burning makes up about 75% of Ghana's energy consumption. This no doubt constitutes a key component of deforestation [3]. Furthermore, studies in Ghana have revealed that in 1992 an annual charcoal consumption of 480,000 metric tons equally contributed to deforestation in the country [4]. Environmental effects attributable to woodfuel production in the Adaklu Traditional Area became a major problem between 1960 and 1970 when the Sissala people noted for commercial charcoal production migrated to the area for the purpose of charcoal production. For the purpose of this study, the term woodfuel as used in this article refers to both charcoal and fuelwood.

Methods

Study area: Adaklu is located approximately between latitude 6°30'N and 6°55'N and longitude 0°30'E and 0°12'E in the Ho Municipal District of the Volta Region (Fig. 1a-b). The Ho Municipal District covers a total land area of 2,660 sq. km. The population of the district is 235,331 [5]. The mean monthly temperature ranges between 32 and 22°C and the annual maximum and minimum temperature is between 37.8 and 16.5°C. Total annual rainfall ranges between 750 and 1,020 mm [6].

Sampling procedure: Thirteen settlements were purposively selected for data collection after a reconnaissance survey. The settlements were Golokofe, Wuve, Dome, Kedzi, Kpenyikor, Toglobo, Aboadi, Dabanu, Have, Kodzobi, Dzakpo, Vodze and Ando. These settlements are engaged in woodfuel production on commercial basis. Systematic sampling technique involving selecting every 5th household was used in Kodzobi, Have, Kedzi and Aboadi to select a sample of 15 people to answer the questionnaires on household basis. A household refers to the number of people living in a house or compound who eat from the same cooking pot. In Vodze, Dzapko and Toglobo every 3rd household was selected after selecting the first household at random to obtain a sample size of 15 people from each of these settlements. Simple random sampling was used in Ando, Wuve,

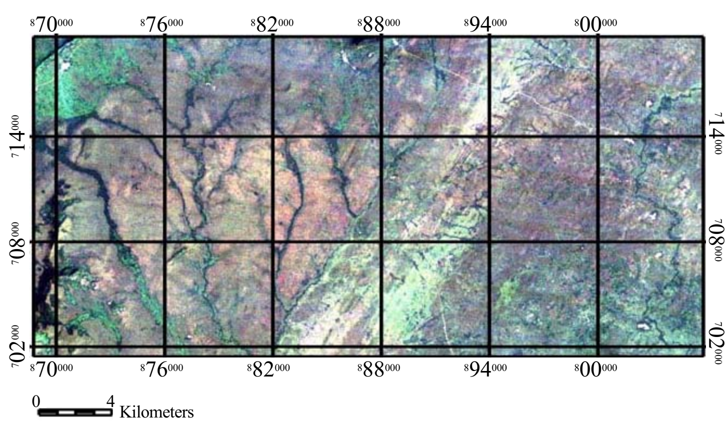
Source: http://www.nationsonline.org/oneworld/map/google_map_ghana.htm.

Figure 1a. Map of Africa showing location of test site in Ghana with arrow.

Dabanu, Golokofe and Dome to select the first 10 households at the entrance of each settlement and then the last five households located at the end of the settlement. In the case of Kpenyikor 10 people were selected in a random manner from 11 households. A total sample size of 190 respondents answered the questionnaires. The variation in the sampling method used for the respective settlements was influenced by the number of households and population at each settlement.

Data analysis: Descriptive statistics was applied to structure and analyse the data from the questionnaire. Furthermore, the statistical analysis was done using Microsoft excel. A chi-square test was carried out to test the hypotheses using the Statistical Package for the Social Sciences (SPSS) software.

Classification of ortho-rectified Landsat MSS 1975 (p207r56_2m19751228), Landsat TM 1990 (p193r56_4t19901225tif) and Landsat ETM+ 2000 (p193r56_7t20000204tif) images were done using the ENVI 4.3 software. Even though the Landsat MSS 1975 image has a lower resolution of 80 m compared to the 30 m resolution images for Landsat TM 1990 and Landsat ETM + 2000 images the lower resolution image was used because no high resolution images existed since 1975. The 4 band MSS images were loaded into the ENVI 4.3 software using the band combination of 3, 2 and 1 within the wavelengths of (red, NIR and SWIR) for all three images while the 7 band TM and ETM+ images were loaded using bands 3, 4 and 5 for image classification.



Source: USGS global visualisation viewer (http://glovis.usgs.gov/)

Figure 1b. Landsat TM 1990 image map showing test area.

Results

Charcoal production and fuelwood collection processes: Charcoal production involves cutting trees with diameters of over 30 cm using an axe. The cut down tree is chopped into pieces measuring about 2 m on average referred to as the chord. Chords of wood piles go through the process of pyrolysis, a process that breaks down the chemical structure of the wood to produce charcoal. Tree species used for the charcoal production are listed in Table 1.

It takes between four days up to two weeks for a heap or pile of wood to burn into charcoal. Big trees with numerous branches having diameters of 60 cm and more can produce about five 50 kg bags of charcoal compared to smaller trees of 10-20 cm that are capable of producing about two 50 kg bags of charcoal. Much of the charcoal production takes place in the dry season when farmers are not actively engaged in farming.

As far as fuelwood collection is concerned, most people gather more fuelwood for sale during the dry season than during the wet season. This is because during the dry season the bush is burnt hence any available dry wood is exposed for collection. In addition, fresh wood burnt by fire during the dry season soon becomes dry and available for collection as fuelwood either for sale or for domestic use. In present times, scarcity of fuelwood has compelled most people to cut down fresh trees, which are allowed to dry up for use as fuelwood. However, during the wet season the ground becomes muddy and wet hence making it difficult to walk around in the bush in search of fuelwood unlike the dry season.

Transportation, marketing and consumption of woodfuel: Transportation of charcoal and fuelwood from production points to nearby roads or market centres are often done by head loads. Women and children who carry pans and sacks full of charcoal and bundles of fuelwood on their head normally do not add any transportation cost to the woodfuel they convey to the market for sale. Charcoal and fuelwood from the nearby roads are conveyed by passenger vehicles to the market centres. In exceptional cases smaller households use fairly high amounts of fuelwood due to the waste of fuelwood coupled with small-scale industrial activities such as oil palm and gari processing carried out in homes for sale. The cost of transporting a bag of charcoal to the market is ¢500 (currency converter factor of Ghanaian Cedis to US$ is

Table 1. Selected wood species for charcoal production in Adaklu.

Local name	Scientific name
Hehe	*Anogeissus leiocarpus* (D.C. Guill)
Eyorkuti	*Vitellaria paradoxa* (C.F. Gaertn)
Exe	*Zanthoxylon zanthoxylvides* (Z. Walter)
Etoti	*Afzelia africana* (S.M. Kuntze)
Liliti	*Azadirachta indica* (A. Juss)
Atsiteti	*Milletia thonningii*

Source: Author's field survey, 2006. Scientific names are from Missouri Botanical Garden [7].

¢9,200 = US$ 1) while the selling price is ¢8,000.

Domestic consumption of fuelwood constitutes 99% of the people's energy source because it is available and cheaper than alternative energy sources such as liquefied petroleum gas and kerosene. Large households seem to have a higher tendency to consume more fuelwood compared to smaller households. As the household size increases to over 10 people about 180 kg of fuelwood is consumed on the average in a day, which is 34% of the study settlements wood energy consumption (Table 2). These figures suggest that as the household size increases there is the possibility of an increase in the number of kilograms of fuelwood consumed. The increase in fuelwood consumption may have a negative effect on the environment such as deforestation and soil erosion. For example, with small household sizes of between 1 and 3 people about 50 kg of fuelwood is consumed on the average in a day constituting only 5% of household energy consumption in the entire study area.

High fuelwood consumption by large households may also be attributed to the fact that fuelwood collection is at no financial cost to households. As a result, less effort is made to conserve energy. For example, after cooking a meal the firewood is left to keep burning till the next meal is cooked either in the afternoon (2 pm) or evening (6 pm). So long as women and children's labour is not paid for nor is fuelwood bought, it would continue to be considered as a cheap energy source that does not require any efficiency in its use.

Commercial consumption of fuelwood takes the form of small-scale industrial activities such as oil palm extraction, brewing of local gin (akpetesi) and the preparation of food by food vendors. The high cost of alternative energy sources such as electricity and liquified petroleum gas has made most commercial consumers of energy to depend on fuelwood.

Effects of woodfuel production: Human and environmental effects of woodfuel production have been identified in the Adaklu Traditional Area. Regarding the human effects, commercial charcoal production has created spatial variations in terms of distance from individual homes to charcoal production points. In Ando 33, 40 and 27% of respondents respectively walk 0.5, 2 and 3 km from their home to produce charcoal (Table 3). In Dzakpo, 40% of the respondents walk 2 km to the bush to burn charcoal ,while 53% of the respondents in Kpenyikor cover a distance of 3 km and more. On average, 26% of respondents cover a distance up to 0.5 km, 35% cover a distance up to 2 km and 39% of them cover an average distance of 3 km or more. Spatial variations in the location of suitable wood species may also determine how long charcoal producers walk to produce charcoal. Shorter distances covered to produce charcoal such as in Dzakpo are due to the consciousness on the part of the chief and people of Dzakpo to ensure that they plant trees as they cut them for woodfuel.

Beside the longer distances covered to produce charcoal, charcoal producers in the various settlements interviewed face various health problems ranging from eye pains to hernia. Fifty three percent of respondents experience eye pains in Wuve, and 33% suffer from upper respiratory track infections such as cough and chest pains in Dabanu. A further 13% of the respondents complained of dizziness in Vodze, while 48% waist pain complaints were reported in Kodzobi. On the average, fever is the most common health problem (29%), followed by eye pains (24%) and upper respiratory track infections (16%). The cause of fever is attributed to the intense sunshine under which charcoal burners work. It is characteristic to most of the people not to seek medical attention when sick with fever. Instead, they resort to boiling herbs to drink without a thorough diagnosis of the cause of the health problem. Smoke generated from fuelwood when cooking causes eye pains, headache and dizziness. This is particularly the case during the raining season when fuelwood gets wet coupled with high atmospheric humidity. These conditions make smooth burning of fire difficult. As a result, much effort is put into fanning the fire. Blowing air into the fire by mouth exerts much energy such that the thick smoke generated during the process enters the human eyes and causes the person involved to become temporally blind. At the same time eye itches are experienced. Eye pain is, therefore, a common disease in most of the settlements.

The cutting of trees for woodfuel production has created environmental problems. For instance, the maximum number of trees cut to produce charcoal in a month by a respondent is about 10 trees. Given this figure, if an individual charcoal producer should produce charcoal every month of a year then about 120 trees are cut by each of the 190 respondents. The implication of each respondent cutting 120 trees is that there is the possibility of woodfuel scarcity in the near future due to deforestation. This is especially of serious concern when trees are not replanted at the same rate. Deforestation in Adaklu has been confirmed by evidence obtained from satellite image classifications (see Figs 2

Table 3. Average distance covered by population (in %) to produce charcoal in Adaklu.

Settlement	Distance covered up to 0.5 km (%)	Distance covered up to 2 km (%)	Distance covered 3 km and more (%)
Ando	33	40	27
Kodzobi	13	27	60
Vodze	20	13	67
Have	33	33	34
Dzakpo	33	40	27
Wuve	20	53	27
Kedzi	27	53	20
Kpenyikor	20	27	53
Toglobo	20	60	20
Aboadi	27	28	45
Dabanu	27	27	46
Golokofe	40	13	47
Dome	20	40	40
Average	26	35	39

Source: Author's field survey, 2006.

Table 2. Household size and fuelwood consumption in a day.

Size of household (number of people)	Percentage consumption (%)	Fuelwood consumed per day (kg)
1 – 3	5	50
4 – 6	15	100
7 – 10	46	140
Over 10	34	180
Total	100	470

Source: Author's field survey, 2006.

to 4). Deforestation of the forest cover may adversely influence the rainfall pattern of the study area since the amount of rainfall attracted to the area due to the presence of trees is likely to decrease and this may adversely affect agriculture considered the prime economic activity of the area.

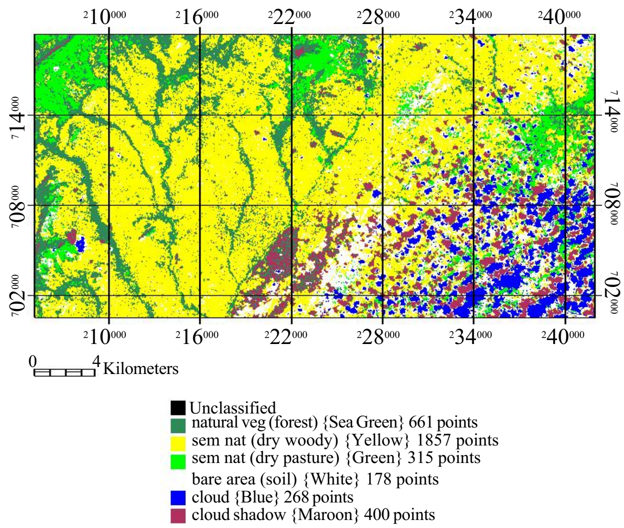


Figure 2. Land cover map of Adaklu Traditional Area 1975.

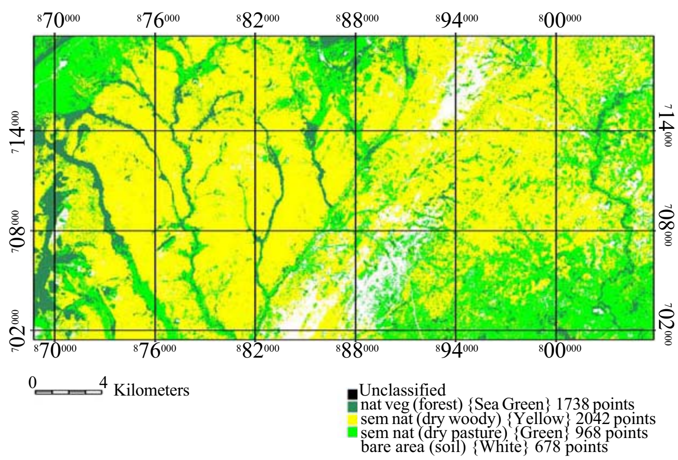


Figure 3. Land cover map of Adaklu Traditional Area 1990.

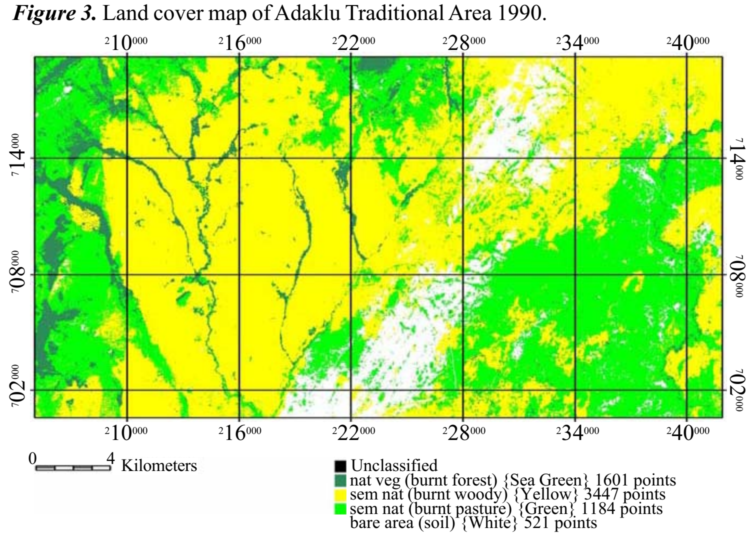


Figure 4. Land cover map of Adaklu Traditional Area 2000.

Result of Pearson Product Moment Chi-square (X^2) analysis based on data in Table 4 shows that the calculated chi-square value of 0.0722 led to the rejection of the null hypothesis. The test asserts the view that the null hypothesis (H_o) of anthropogenic or human activities emanating from woodfuel production encourages or enhances the formation of forests.

The decision rule indicates that when the calculated X^2 value is less than the critical value, at a significant level of 0.05, we do not reject the H_o but accept the H_i hypothesis [8, 9]. Accordingly, the null hypothesis "that human activities emanating from woodfuel production in the study area encourage the formation of forests" was rejected.

In an effort to find out the sources of woodfuel and possible deforestation effects in the study area, a question was posed to the respondents such as "what is the source of your woodfuel". On average, 30 and 69% of the respondents use dead wood and fresh trees, respectively, as their energy source. As regards the cutting of fresh trees for fuelwood or burning of charcoal, Ando has the highest figure of 93%. Between 13 and about 80% of respondents in Dome and Kodzobi obtained their woodfuel from deadwood. Between 20 and 80% of respondents in Kodzobi and Wuve cut down fresh trees for woodfuel. Farmlands are not major sources of woodfuel for the people of Adaklu Traditional Area. The reason for not obtaining much woodfuel from farmlands is due to the fact that the same parcel of land is cultivated repeatedly over the years coupled with annual bush fires such that the natural regeneration hardly takes place.

The result of Pearson Product Moment Chi-test of significance based on the data in Table 5 tested the null hypothesis (H_o) that "woodfuel production do not contribute to environmental degradation". The test was carried out using the SPSS module. The Pearson Product Moment X^2 statistic obtained was 9.4153 against the critical or significant level of 0.05. Consequently, the null hypothesis was rejected and the alternate hypothesis that woodfuel production is a contributory factor to land degradation in Adaklu was accepted.

This conclusion is closely associated with the pervasive nature of poverty in the Adaklu Traditional Area and the associated low level or lack of technological resources. The extremely high value of 9.4153 relative to the critical value of 0.05 in the analysis can be attributed to the high density household exploitation of trees for woodfuel production without adequate measures taken to replant trees leading to the observed incidence of deforestation.

Table 6 represents views of respondents regarding the nature of soil erosion in the study area. Moderate soil erosion in the form of wind erosion during the dry season

Table 4. Average number of trees cut in a month and number of trees replanted.

Trees cut	Replant of trees Yes	Replant of trees No	Total
1 – 5	2	20	22
6 – 10	4	35	39
10+	14	114	128
Total	20	169	189

Source: Author's field data, 2006.

Table 5. Sources of woodfuel and number of people who plant trees.

Responses	Dense forest	Moist deciduous forest	Savannah	Total
Yes	1	4	1	6
No	26	33	125	184
Total	27	37	126	190

Source: Author's field survey, 2006.

and sheet erosion during the raining season exists in the opinion of the respondents. Sheet erosion involves the washing away of the top soil surface, which often contains plant organic matter. Indicators of soil erosion identified in the Adaklu Traditional Area are ranked as moderate soil erosion and serious soil erosion. In Wuve, 60% of respondents confirmed moderate soil erosion taking place as against 13% in Dabanu. On average, 30, 38 and 10% of respondents reported moderate, serious and insignificant soil erosion, respectively. Responses for serious soil erosion were minimal except Toglobo and Kpenyikor where 67 and 30% of the respective settlement respondents indicated serious soil erosion as a matter of concern. Descriptions given for serious soil erosion were gully erosion.

The classification of remote sensing data for the period 1975, 1990 and 2000 showed evidence of deforestation in the Adaklu Traditional Area. However, the observed deforestation in the images does not explain the processes of deforestation. The deforestation processes were explained using field data obtained from questionnaires administered. In Fig. 2, there is limited forest cover as represented in the map by the sea green colour. The dry woody vegetation shown in yellow colour depicts evidence of deforestation in most settlements. Deforestation in these settlements may not be attributed entirely to effects of woodfuel production, since a key land use in the various settlements is farming as indicated by 84% of the respondents in the study area. They claim to be farmers as against only 1% who claim to be full time woodfuel producers. It is possible that the low percentage value of 1% full time woodfuel producers recorded may be due to respondents' unwillingness to own up as full time woodfuel producers given the government of Ghana's stand against the cutting of trees for woodfuel production.

The existence of bare soils may imply possible soil erosion due to removal of the tree cover though not so extensive as indicated by the white spots on the map. Cloud and cloud shadow classifications were done purposely to avoid misclassification of cloud pixels as other land cover types that may exaggerate the classification result.

Table 6. Degrees of soil erosion (%) in Adaklu.

Settlement	Moderate	Serious	Insignificant	No response
Ando	20	0	40	40
Kodzobi	33	13	20	34
Vodze	54	13	33	0
Have	20	0	80	0
Dzakpo	13	0	61	26
Wuve	60	0	40	0
Kedzi	33	0	40	27
Kpenyikor	20	30	50	0
Toglobo	27	67	6	0
Aboadi	40	0	40	20
Dabanu	13	7	33	47
Glokokofe	40	0	27	33
Dome	20	0	27	53
Average	30	10	38	19

Source: Author's field survey, 2006.

A confusion matrix calculation for the 1975 classified image produced an over all accuracy of about 90% with a Kappa Coefficient value of 0.8698. The Kappa coefficient values are categorized into 3 main groupings: a value greater than 0.80 (80%) represents strong agreement, values between 0.40 and 0.80 (40 to 80%) represent moderate agreement and values below 0.40 (40%) poor agreement[10]. The Kappa coefficient value of 0.8698, therefore, shows a strong level of agreement and accuracy.

The maximum likelihood classification for Landsat TM 25th December 1990 image shows limited forest cover as depicted by the sea green colour. Conversely, there is predominance of dry woody vegetation over the land area as shown by the yellow colour. There is also evidence of bare soil at portions of the map hence the possibility of soil erosion occurring. A confirmation of the accuracy of the image classification shows a calculated Kappa Coefficient overall value of 0.9499 and a percentage value of 97%.

In Fig. 4, the maximum likelihood Landsat ETM+ 2000 land cover classification for Adaklu Traditional Area again shows limited forest cover with more dry woody savannah vegetation covering the landscape. Bare soil appears to be more extensive in this image. The extensive nature of the bare soil may be attributed to deforestation and creation of settlements. A confusion matrix calculation to verify the accuracy of the classified image confirms the accuracy of the classified image with an overall accuracy of 96% and Kappa Coefficient value of 0.9430.

Change detection: The change detection statistical approach has been used to calculate change in forest cover for the period 1975 to 1990 and 1975 to 2000. The 1975 classified image has been used as the initial stage image and 1990 and 2000 classified images used as the final stage images. The change detection statistics calculation shows the classes into which the initial state classification pixels of 1975 image pixels have changed into the final state images of 1990 and 2000.

Table 7 shows land cover changes in hectares for the period 1975 to 1990. The table contains the initial state classes (1975 classified image) in columns depicting only the paired classes while the final state classes (1990 classified image) are in rows. Essentially, the table shows how pixels of land cover classes in the rows and columns have been classified. For example, 62,604 hectares of forest cover pixels classified as natural vegetation (forest) in the initial state (column) have changed to semi natural (dry pasture) in the final state image (rows). The class total row shows the total number of pixels in each initial state class. For example, 52,331 hectares of forest cover pixels were classified as natural vegetation (forest) in the initial state image while 11,616 pixels were classified as natural vegetation (forest) in the final state. The row total column is composed of a class by class summation of all final state pixels that fall into the selected initial state classes.

The class change row indicates the total number of initial state pixels that changed class. The total class change for natural vegetation (forest) for instance is 10,092 hectares. This means that 10,092 hectares initially classified as natural vegetation (forest) changed to final classes other than natural vegetation (forest). The image difference row shows the difference in the total number of equivalent classified pixels in the two images. This was computed

Table 7. Change detection statistics report from 1975 to 1990 (area in hectares).

Land cover classes	Natural veg (forest) sea green	Semi natural (dry woody) yellow	Semi natural (dry pasture) green	Bare area (soil) white	Row total	Class total
Unclassified	32,652	9,620	94,870	22,613	16,095	17,837
Nat veg. (forest) sea green	15,237	20,865	73,232	39,507	47,376	52,331
Semi natural (dry woody) yellow	62,604	24,171	17,603	33,844	35,577	39,032
Semi natural (dry pasture) green	30,024	59,109	26,778	25,881	14,179	17,771
Bare area (soil) white	50,294	18,113	41,912	14,029	41,363	51,278
Class total	1,1616	34,942	56,844	79,967	0	0
Class change	10,092	10,770	30,066	65,938	0	0
Image difference	-63,829	40,898	12,087	-28,688	0	0

Source: Author's field data.

by subtracting the initial state class total from the final state class total. A positive image difference indicates an increase in the class size while a negative image difference indicates a decrease in class size. On the basis of this principle, the image difference for natural vegetation (forest) is -63,829 hectares showing a decrease in the forest cover in the Adaklu Traditional Area. The image difference for semi natural (dry woody) vegetation is 40,898 hectares indicating an increase in size. An increase in the size of dry woody vegetation by 40,898 hectares may be due to deforestation.

Table 8 shows the extent to which various land cover classes have increased or decreased in hectares. For example, a total of -74,291 hectares of forest classified got lost from 1972 to 2000. A positive image difference value of 65,174 hectares of semi natural savannah woody vegetation was created within a period of 25 years possibly due to the effects of deforestation in the Adaklu Traditional Area. The explanatory logic behind this result is that as the forest vegetation gets degraded more savannah woody vegetation spreads over the land area. On the other hand, when the forest area increases it is logically expected that the woody savannah vegetation will decrease in size all things being equal.

Discussion

The results show that the people of Adaklu prefer to use freshly cut wood to produce charcoal unlike in some other West African countries where preference is given to chords which are dry since it takes more time for fresh wood to burn during the charcoal production process [11].

Table 8. Land cover change (in hectares) from 1975 to 2000 in Adaklu Traditional Area.

	Nat. veg. forest	Semi natural dry woody	Semi natural dry pasture	Bare area soil	Row total	Class total
Unclassified	0	0	0	0	0	0
Nat. veg. burnt forest	14,532	16,043	70,015	19,753	39,553	41,275
Semi nat. burnt woody	55,031	23,867	12,372	25,715	33,179	35,580
Semi nat burnt pasture	40,430	69,067	32,756	33,344	17,559	22,537
Bare area soil	55,720	25,504	42,107	19,029	54,316	65,961
Class total	11,556	34,929	56,340	80,065	0	0
Class change	10,103	11,061	23,584	61,035	0	0
Image difference	-74,291	65,174	16,903	-14,103	0	0

Source: Author's field data.

Test of hypothesis (b) confirmed the null hypothesis that the pervasive nature of poverty coupled with lack of technological resources, over exploitation of woodfuel is contributing to environmental degradation. Earlier studies show that 10% of Ghana's national capital Accra obtained its charcoal supply from the Volta Region, specifically Adaklu [4]. The situation at present has changed since the flow of charcoal to Accra is close to nothing. The stop of charcoal flow to Accra may be attributed to the limited available quality wood for charcoal production. It is sufficiently clear from these figures that the various sources of woodfuel, particularly the cutting of trees for fuelwood, may have detrimental effects on the environment. These results, therefore, negate the conclusion that rural fuelwood collection rarely contributes to deforestation [12]. It is, however, important to note that factors such as overgrazing and uncontrolled bush burning are other major contributory factors to deforestation in Adaklu and not solely woodfuel production [13].

While the number of trees cut for woodfuel production may be a strong determining factor of deforestation the use of poor technology in preparing cooking stoves also has a role to play. For example, analysis of the thermodynamic performance of stone fire shows that heat energy produced from stone fire is relatively inefficient at transferring heat to the content of the cooking port [14]. Given this knowledge of inefficiency in using stones as stoves there has been an improvement in the construction of stoves since the oil crisis in the mid 1970s. During the oil crisis Asia developed single burner clay stoves using local clay which required no capital investment. The technology later spread to African countries such as Ghana [15]. The clay stove technology is still being used in most towns and villages in Ghana.

Charcoal producers in the various communities interviewed face various health problems ranging from eye irritations to hernia. On average, fever is the most common health problem (29%) followed by eye pains (24%) and upper respiratory track infections (16%). The existence of eye problems in the Adaklu Traditional Area is confirmed by another study in Ghana, which shows that the development of poor eye sight or cataract by women occurs while they cook and carry out household activities in their kitchen due to smoke from fuelwood[16].

The land cover of Adaklu Traditional Area as at 1975 showed evidence of a little more forest cover than the 1990 and 2000 image classifications. The change detection calculation shows evidence of considerable deforestation from 1975 to 1990 and 1975 to 2000. From 1975 to 1990, for example, -63,829 hectares of forest land was lost while -74,291 hectares were lost from 1975 to 2000.

Conclusions

In an effort to develop themes, debates, research methods and questions for the study the literature was extensively reviewed. Questionnaire surveys have also helped to unearth the social and economic dimension of woodfuel production and its effects on human life and the physical environment. Opinions of respondents regarding perceptions of deforestation in the study area has been confirmed using scientific evidence such as analysis of remote sensing images covering the study area for a period of 25 years. The combination of social data and analysis of remote sensing images offered the opportunity to get detailed explanations for the deforestation problem. This is because it is not enough to know from only satellite image analysis that deforestation is taking place without understanding the driving forces behind it. The methodology followed in classifying the three images is very appropriate since the method is in conformity with remote sensing image classification procedure. It is the expectation that findings from this study would help policy makers in Ghana address the identified problems associated with woodfuel extraction as well as its attendant health consequences on the life of the people of the Adaklu Traditional Area.

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