Quantifying Potential Socioeconomic Displacements and Land Use Conflicts in Prospective Mining Villages in Ghana

ABDUL-WADOOD MOOMEN
Department of Spatial Sciences — WASM
Curtin University
GPO Box U 1987, Bentley, Perth
AUSTRALIA
a.moomen@postgrad.curtin.edu.au

Abstract: - This study advances that quantifying the potential cost of the mining industry's activities on local communities' livelihood can be an efficient tool for managing company-community land use conflicts. A case study is conducted in the emerging Ghana's North-west gold province. The study combines and uses primary and secondary data that were obtained during two fieldworks. The livelihood activities of 55 sample villages were inventoried and characterised using techniques of regional science. Furthermore, Participatory Rural Appraisal (PRA) and Geographic Information Science (GIS) tools are integrated. These tools are used to develop land use extents base maps of 53 out of the 55 sample villages. The study finds agriculture, manufacturing, wholesale and retail as the major livelihood sectors in the communities. A coefficient of specialisation (LQ) > 1 in non-agricultural livelihood is found in over 75% of the villages; and a location association (La) > 50 between the industries. The study also quantifies the interactions between village space and mining land use interests. The minimum village area potentially displaced by exploration and mining leases is 90 ha, and the maximum is from 2861 to 4576 ha. Following the location association between industries, a displacement of villages' space will have a cumulative effect on major aspects of the local economy. The findings can enhance sustainable mining, local communities' empowerment, and benchmark indicators for land use conflicts management in Africa.

Key-words:-Village, mining, land-use, conflicts, displacement, livelihood, District

1 Introduction

Rural communities in Africa, over the past three decades, are experiencing environmental, social and economic transformations. These transformations are largely a result of the proliferation of mineral resource sector investments. The mineral resource industry is considered as an asset through which Africa's quest for industrialisation and development can be obtained [1]. However, the prospects of developing these assets are creating land use conflicts between local communities and the mining industry. The trends and patterns of the conflicts are increasing. Meanwhile, development of mechanisms for managing these conflicts has been a governance and international policy delusion. The needs and demand of African rural communities at present are food security, livelihood, and infrastructure [2]. Nevertheless, African governments assert that the current needs can be obtained through a reinvestment from the mineral resource sector [1]. It implies compromises of land, although, the economy of African rural communities is based on land resources and related industrial and commercial enterprises. Hence, it is evident in Africa that most violent conflicts are associated with mineral and other land resources [3]. To mitigate such conflicts, the potential impacts of mining on rural livelihood and rural land resources should be identified at the exploration stages [4].

Four fundamental causes of conflicts between communities and the industry have been identified. These range from the distribution of royalties, survival of small-scale mines, land use and resettlement [5]. Land use conflicts have been recognised as the most difficult to manage in corporate-community issues [6]. These have negative impacts on both communities and companies. For communities, land use conflicts may lead to stagnation of economic and social development. For the companies, conflicts with local communities have resulted in the temporary and sometimes permanent close down of projects [6, 7]. It is estimated that corporate-community conflicts have cost over 80% of management working time used in dispute negotiations [8]. It translates into US$ 20 million per week for an operating mine, and about US$ 10, 000 per day of an exploration company [8]. To manage these conflicts and the associated losses requires consultations and mediation tools [9].

Hilson [7] finds communication gap as a major factor in company-community conflicts. Lack of information and communication about the spatial extents and impacts of the industry's interests contribute to uncertainties, communities' anxiety and resistance. It also disempowers local communities from engaging companies and government in meaningful negotiations and mutual consultations. Communities need information about the extent of their land that has been leased to companies. Failure to get answers for their anxieties, tensions and uncertainties leap into violent conflicts [10]. However, most African countries lack spatial information and village maps for an efficient policy decision making and management of rural resources [11, 12]. As in many developing countries in Asia and Latin America, the mining sector policy in most African countries entrenches compulsory extraction of mineral resources [13, 14], whether beneath or above the land surface. It implies that while customary lands are recognised, traditional rights end where they conflict with national interests. As a result, decision makers grant new concessions without understanding the realities on the ground; considerations for the futures of rural livelihoods. Consequently, conflicts escalate when the industry's activities interfere with villages' land use activities.

Furthermore, the rural landscape transformations come at the back of sustainable development [15]; failing to recognise the heterogeneity of the traditional livelihood activities of African rural communities. Development of the mineral resource sector in Africa has the potential to engender the course of an integrated rural development [1]. Thus, resource development has given a new recognition of rural landscapes as multifunctional economic enclaves rather than been monopolistic agricultural landscapes [16]. However, mineral resource development requires large tracts of land, while, at the same time, agricultural production necessitates both arable and pasture lands. Moreover, in recent times, there is a growing need for mix-farming in rural landscapes in Africa. Crops and livestock co-production are encouraged for maximising agricultural output [17]. Besides, it is also identified that rural communities are diversifying livelihood activities, based on land resources, to improve their resilience against impoverishment [18]. Thus, an introduction to mineral resource development brings with it an incipient competition for productive land. As a consequence, there is a deepening growth of land use conflicts. To manage these conflicts between the mining industry and rural communities, the role of sustainable development must be recognised. Sustainable development processes require an analysis and quantification of competing socioeconomic activities in the landscape.

Nonetheless, no study has analysed and quantified the extent of land occupancy, and the potential impact of the mining industry's interests on the socioeconomic activities of rural communities. To this end, this paper aims to develop a framework that will enhance the availability and use of information for informed decision making on village resources. Specifically, the paper seeks to generate data to build a collective knowledge base that is accessible to all stakeholders. It also analyses the spatial interactions between company activities and local communities' socioeconomic activities. That is both agricultural and non-agricultural land use activities. The paper further assesses and predicts the impacts of new proposals on rural communities and potential conflicts. It will facilitate meaningful negotiations between all stakeholders in the mineral resource area. The next section discusses the materials and methods employed in the study. It is followed by detailed discussions of the results. The paper then concludes with a summary of the major activities and findings.

2 Materials and methods

2.1 Study Area

In the context of natural resource endowment and mineral resource development, in particular, Ghana is considered a benchmark indicator for resource-based development and industrialisation in Africa. The country's Medium Term Development Policy Framework aims to achieve a structural transformation of the economy through modernised agriculture and mineral resources [19]. Agriculture and mining contribute more than half of Ghana's Gross Domestic Products (GDP). The agriculture sector employs more than 60% of the labour force and over 80% of rural households [20]. Although progress in the non-agricultural sector of the economy is slow, it is gradually withdrawing labour from the agriculture sector [21]. For instance, the mining industry continues to grow with new approvals granted in areas that have not had mining sector experience before. It converts land from other uses into mineral resource exploration and extraction. Previously, mining sector activities were a Southern fringe land use phenomenon in Ghana. However, recent discoveries of viable quantities of mineral deposits in the three Northern regions of the country have given a different meaning to this phenomenon [22, 23].

Traditionally, the three regions of Northern Ghana's economy is primarily driven by agriculture. The sector employs over 90% of rural populations in these areas, which is mainly attributed to the poverty hikes in the area [24]. Hence, rural communities in the area are diversifying their livelihood opportunities from agriculture to off-farm and non-agricultural activities [25]. Diversified rural livelihood activities include petty trading, wood carving, gardening, and Shea-processing. A minimum of 95% of women in rural communities in the area is engaged in the Shea-processing industry [26]. DFID [27] find that agro-based industries and tourism hold the key to breaking poverty hikes in the three Northern regions. It however, reiterates that the requisite capital to support these industries to sustainable levels may flow from the mineral resource sector returns. Hence, it is worth developing a framework that can enhance a multi-sector production in the rural landscape. Thus, this study takes on the emerging Ghana's North-West Gold Province in the Upper West Region (UWR) (Fig. 1).

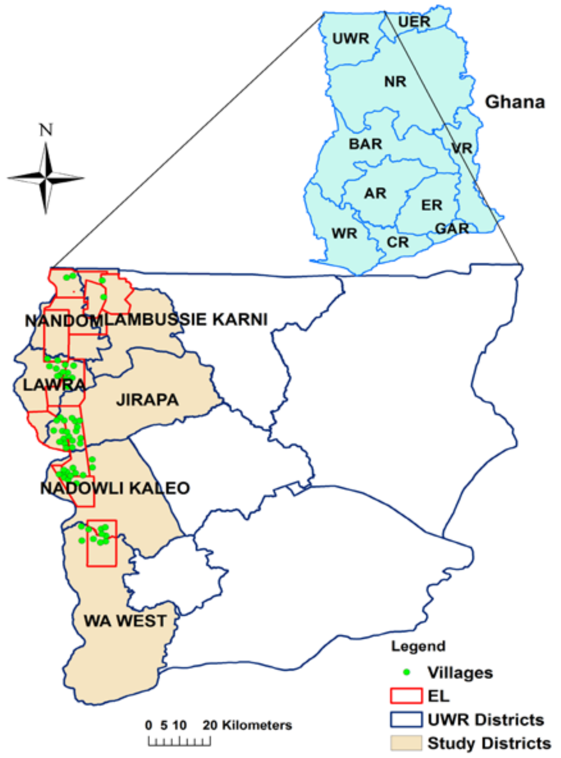


Fig. 1 Study Area

2.2 Data Collection and Preparations

As can be associated to developing countries, there is a lack of spatial data in Ghana, particularly in the rural level. Therefore, the data for this study were collected during fieldworks. Two field visits were done from December 2013 to February 2014; and December 2014 to February 2015. The objective of the fieldworks was to identify sample villages for the inventory of land use and livelihood activities. The names of these villages were then used for a purposive and cluster sampling of other communities in the exploration leases (ELs). Another objective was to map the spatial extents of land use activities across village space. The fieldworks were also an opportunity to source existing data, covering communities' physiological and socioeconomic activities. These objectives were pursued in three stages: community entry, data collection, and data validation. The purpose of the community entry was to explain the goals of the study to the District Assemblies (DAs), the sample villages and to seek their consent. Overall, the DAs and the communities supported the research. Also, under the decentralisation system, community development programs are channelled through the DAs. Assemblymen are members elected to represent the communities' development interests in the DAs.

Agriculture and Forest suitability map for the study area was obtained from the Soil Research Institute (SRI), Council for Scientific and Industrial Research (CSIR) of Ghana. The map has been developed by SRI based on extensive soil inventory and physiographic analysis of the landscape. Details of the survey methods used in developing the map can be found in Adu [28]. The agriculture and forest suitability map was uploaded and digitized in ArcMap. The digitized map was used together with the ELs and land use sketch maps of the villages to identify areas of high impact displacement.

The Centre for Remote Sensing and Geographic Information Services (CERSGIS) at the University of Ghana has developed a land cover scheme. The scheme has been prepared in conformity with the USGS land cover mapping system and used to produce a land cover map of Ghana. This system applies to all the agro-ecological zones of Ghana. Details of the algorithms used in developing the project can be found in Agyapong, et al. [29]. Land cover data generated from this project are obtained from the Department of Geography and Resource Development, University of Ghana, and used for tree density analysis in this study. The data is accompanied by numerical values of estimated tree densities per land cover type.

Digital map, containing shapefiles of all districts in the study area, is obtained from the Ghana Statistical Service (GSS). However, Nandom and Nadowli-Kaleo Districts are new Districts delineated from the former Lawra and Nadowli Districts. Thus, digital maps for the new Districts were not yet available at the time of fieldwork. Therefore, maps for these new Districts were digitized from historical maps of the former Districts. For the purposes of this study, the map digitizing was accomplished with the aid of local authorities.

2.2.1 Sampling

A multi-stage sampling technique was employed in this study. First, the company with exploration and mining interest in the study area was identified. The tenement map for exploration and mining activities was downloaded from the company's website. The map is in the Universal Transverse Mercator (UTM) projection system. The exploration leases together with drill-holes in the tenement map were uploaded onto ArcMap and digitized. In this connection, the assemblymen of lead villages helped to identify further other communities within same EL and also an electoral area in the district assembly system. The sampling was pruned down to villages that share kinship ties and economic space with the lead communities. The lead villages are those that contain drill holes and are also used by companies to name ELs. The purpose of these criteria used is that land is communally owned and managed by kinship ties among the tribes in the area. Issues relating to land in one community affects a host of other communities otherwise not considered as mining communities [30].

Overall, 55 villages have been sampled from five Districts. The communities are Bulituo, Eggu, Oli, Sukpare, and Zan in the Wa West District. Berendari, Butele, Gabilee, Konne, Musama, Mwindaale, Nanga-Wuchema, Niiri, Sabiili, Tangasia, Tanduori, Turi-Dari, Vuuyiri, Yaro, and Yiziri in Nadowli-Kaleo district. Gbetuol, Guoripuo, Kakala, Kul-Ora, Kpannyaga, Kunzokala, Orifane, Tambore, Tampoe, Tanzire, Tikpe, Tie, Tuolung, Wuling, Yagha-Baapari, Yagha-Gbaani, Yagha-Kusoglo, and Yagha-Tohaa in Jirapa District. The rest are Bompari, Buree, Danko, Dazuuri Baapari, Dazuuri Dabozeri, Nayiribog, Naburnye, Toto, Sorgoun, Yagra, Yagra Tangzu, and Zinpen in the Lawra District. Kokoligu, and Kokoligu Gbantakuri in Nandom District; Banwon and Billaw in Lambussie Karni District. However, fieldwork was completed in all the villages except the Kokoligu and Kokoligu Gbantakuri in Nandom District. It was due to challenges in accessing the community.

2.2.2 Focus group discussions and Participatory Mapping

In each village, leaders and village groups were identified and invited to participate voluntarily in focus group discussions and participatory mapping activities. Identifiable individuals and groups were village chiefs, priests, community youth association, village unit committee, and women association. Other village experts such as experienced farmers and hunters were also engaged in the focus group and sketch mapping. These individuals and groups have knowledge about the villages' development objectives and land use patterns. There was at least one representative from each of these groups making a maximum of 10 participants in each focus group and participatory mapping session in each village. The sessions lasted for a maximum of 5 hours and a minimum of 3 hours. In total, 53 meetings were held with a maximum of 530 participants in the field data collection activities. Examples of discussions questions are: "Which livelihood opportunities exist in the village? In respect of animals, plant materials, rock minerals, and soils harvested for food, clothing, medicines, sacrifice; shelter, tools, and rent". "How much land area is used or occupied by existing and previous livelihood activities in the village landscape"? The researchers moderated each session but, the sketch mapping were led mostly by the assemblyman of each village. Places, where the activities are conducted, were described on cardboards for transcription onto ArcGIS. Data generated included village population, economic activities and engagement, and land use extent maps.

2.2.3 Data Validation

At the end of focus group discussions and mapping sessions, transect walks were conducted around the features indicated on the sketched maps. The coordinates of these features were taken using a hand-held GPS with 5 metres positional accuracy. The transect walks were mostly led by the village youth and the assemblymen. Overall, the village land use extents that were georeferenced were the last farmlands along the North, East, South and West cardinal points. It is important to emphasise that these were not supposed to create village boundary maps. This point was extensively discussed at each village, during the community entry process, and was widely accepted before the study was permitted to proceed. The sketched maps were uploaded onto ArcGIS and registered with the respective GPS coordinates for each village. The registered maps were taken back to the villages for validation. There was over 98% acceptance of the accuracies of the geo-referenced maps. The sketched maps were then digitized and were used in this study to represent the land use extents of the villages (Fig.2).

The 2010 population and economic activity data of 20 villages were also obtained from the GSS. These data were used to cross-validate the field generated population and economic activity data of the villages, using the annual intercensal rate of increase. There was over 95% agreement between these data. So it was convincing to go with the rest of the data obtained directly from the villages.

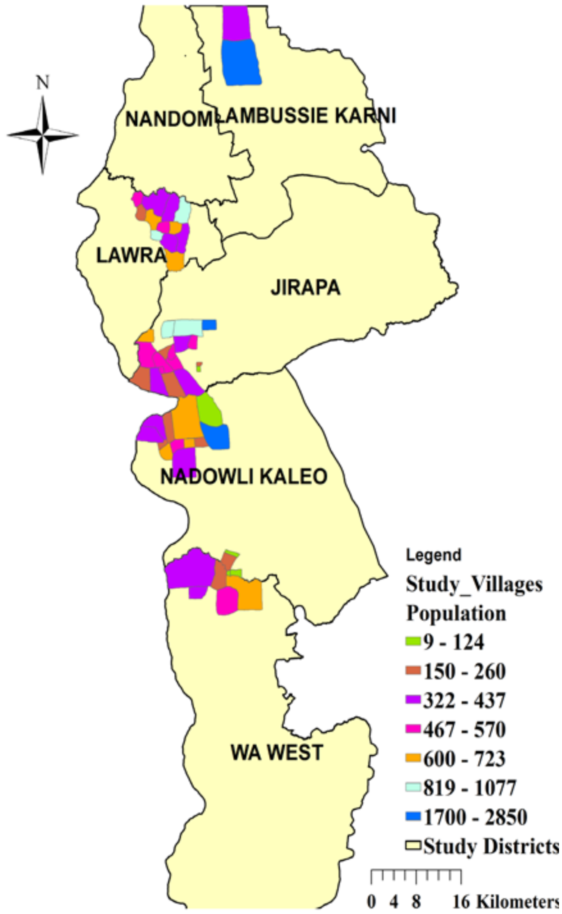


Fig. 2 Sketched sample communities

2.3 Analysis

2.3.1 Principal Component Analysis (PCA)

The major livelihood activities inventoried in each village are aggregated into principal industry categories (Table 1). The aggregation is done using the International Standard Industrial Classification (ISIC) system developed by the United Nations (UN) statistics division. The ISIC is a universal standard format. It is used for the detailed aggregation and analysis of all economic activities in a locality based on consistent, coherent concepts and definitions [31]. The ISIC Rev. 4 is used in this study to put the livelihood activities into a hierarchical, four-level-structure of mutually exclusive categories. The highest level categories are labelled as sections. The parts are coded with alphabets. The sections are then subdivided into divisions; also coded with two-digit numerals. The next lower level groups with a three-digit code. The last level is a class with a four-digit code. For instance, “Agriculture/forestry/fishing” is (section A), “Manufacturing” is (section C). Then “Mining and Quarrying" is (section B), “Wholesale and retailing” is (section G). For instance, Shea butter processing falls under section “C” “division” 10 “group” 103 “class” 1030 (Table 1).

2.3.2 The Location Quotient (LQ) model

The LQ model is used to measure the degree of specialisation of a location in the production of goods and services. It is also used to predict potential changes in a local economy when a new activity is introduced [32]. The LQ is expressed as a ratio of ratios as in the following equation:

$$\left(\frac{\mathrm{E}_{ij}/\mathrm{E}_{j}}{\mathrm{E}_{iJ}/\mathrm{E}_{J}}\right) \quad (1)$$

E = Employment; i = industry; j = village;
J = District;
LQ < 1 means production is unsatisfactory for local demand
LQ = 1 implies production is subsistence; LQ > 1 is production beyond local demand

The number of people engaged in an industry (i) in a village (j) is divided by the total number of people involved in all industries including industry (i) in the same village (j). Then, the same computation is done again with employment figures from the District wherein the village is situated. The index from the village is then divided with that of the District. The LQ is computed for all the industries identified in the communities. It explains that a community is more specialised in a particular industry than the entire District, where the LQ > 1. It also demonstrates that a village can meet its local demand for the output of an industry and can supply beyond its vicinity. An LQ = 1 means that production in that particular industry is subsistence and might not suffice for supplying its output to the market. An LQ < 1 implies that a village is in a deficit of the output of that industry and would always depend on other villages within the same District or nearby Districts, for supply.

Table 1 Principal Component Analysis and Industry categories of livelihood activities

Activities	Principal Components/Industry			
	AGRICFF	MINQUA	MANUF	WRETAIL
Cropping	A0111			
Gardening	A0113			
Shea butter processing			C1030	
Pito brewing			C1103	
Petty Trading				G4620/46
Food processing			C1075/79	
Wood carving			C1629	
Weaving/basketry			C1629	
Pottery & ceramics			C2393	
Sand/clay/gravel Quarrying		B0810		
Haunting	A017			
Livestock	A0141/44			
Firewood/Charcoal Burning			C1629	

AGRICFF: Agriculture/Forestry/Fishing; MINQUA: Mining and Quarrying; MANUF: Manufacturing; WRETAIL: Wholesale and retailing

2.3.3 Location Association (La)

The La model is adopted and used in this study to understand the spatial connections between different categories of livelihood. The following is the model used:

$$La = 100 - \left(\frac{\sum_{k=1}^{n} abs\langle E_{ij1,\ldots,ijn} - E_{lj1,\ldots,ljn}\rangle}{2}\right) \quad (2)$$

i and l = industry
La ≥ 60 means strong location association La < 60 > 50 means existence of association but,
La ≤ 50 means weak association

The La is calculated by taken the sum of the absolute values of pairs of industries. The result is divided by 2 and then subtracted from 100. The expected value of La to establish the location affinity between a pair of industries is La > 60 [33]. A La between 50 and 60 is evident that there is a location association between the pair of industries. But that relationship might not be strong such that the displacement of one affects the other. Implicitly, a La < 50 shows weak relationships between any pair of industries in a location. But to explain further the binding force between a pair of industries, the Input-Output (I-O) table was used.

2.3.4 Input-Output (I—O) model

The I-O model (Leontief model), developed by Leontief [34], analyses the significance of clusters of industries in a location. The model explains the demand and supply relationships between any pair of industries at a given time. To understand this, the model uses an N*n matrix in Table 2 below to show the movement of goods and services from one industry to others. For instance, in a village setting, household constitute labour as input to the agriculture industry. Part of the output of the agriculture sector in turn is consumed domestically by the family, and part of it is supplied to the Wholesale and retail industry as an input for the market. Profits and market returns are reinvested back on farms to provide further input for the Wholesale and retail industry. Column two indicates the demand for the output x of industries 1 to n by industries 1 to N in column six. C shows the final request of the output of industries in column two and X is the total output of industries in the rows. Y is the total inputs of each industry in the columns.

Table 2: I—O flow table Adopted from Yankson [35]

		Demand Sector					
Supply Sector	Industry	1	2	3	N	C	Total X
	1	x_{11}	x_{12}	x_{13}	x_{1n}	$_xC_1$	X_1
	2	x_{21}	x_{22}	x_{23}	x_{2n}	$_xC_2$	X_2
	3	x_{31}	x_{32}	x_{33}	x_{3n}	$_xC_3$	X_3
	n	x_{n1}	x_{n2}	x_{n3}	x_{nn}	$_xC_n$	X_n
	v	v_1	v_2	v_3	v_n		
Total	y	Y_1	Y_2	Y_3	Y_n		

$\sum V = \sum C$; C-final demand for the output of each industry; X-total output of each industry

V-household sector contribution (in terms of labour); Y-total value of inputs used

2.3.5 Normalized units/life cycle thinking

The land use extent maps of the villages are overlaid with the ELs in ArcMap to identify areas of overlaps and potential displacement. The areas of overlaps are used to estimate particular village land use and associated livelihood activities that will be affected by the emerging developments. However, there is no standard model to proceed with this kind of map overlay analysis, considering the mining sector activities and potential land use conflicts. Therefore, normalised units and life cycle thinking approaches [36] are used to develop models for answering the questions in this study. The models take a Boolean approach. These are expressed as following, to determine the potential displacement of each industry in the village economy and its associated impact index:

2.3.5.1 Cultivable lands potential displacement
The types of crop farming systems practiced in the area makes every unit of land valuable for cultivation in the villages [37]. Hence, the equation below is used to calculate the cultivable lands potential displacement per village:

$$CL_{j}\_–S = [(EL_{Aj} – (EL_{Aj} \cap AFu_{Aj} \cap T_{Aj}))] \quad (3)$$

Where: –S = displacement;
CL = cultivable lands
EL = Exploration and mining Lease;
A = Area; j = village
AFu= unsuitable Agriculture and Forest land;
T = total area of village land use extents

The AFu is been excluded from the villages cultivable lands since it might not have much value for agriculture. It is also excluded from the ELs because, the analysis needs to compute the overlaps of spatial units of arable land in each village. However, the units of EL intersection AFu could be residual for the mining industry's activities. Thus, the estimated potential cultivable lands displacement is the total area of ELs in each village excluding the concurrent overlaps of ELs, AFu and villages' land use extents.

2.3.5.2 Number of households in crop farming (NhhCropF) potentially displaced
The displacement of cultivable lands has a corresponding impact on rural households engaged in crop farming as a means of livelihood. Therefore, the number of households in crop farming (NhhCropF) potentially displaced in each village due to the mining sector activities is calculated as following:

$$NhhCropF_{j}\_–S = NhhCropF2_{jt} – NhhCropF1_{jt} \quad (4)$$

But,

$$\mathrm{NhhCropF2}_{jt} = \left[\frac{(\mathrm{NhhCropF1}_{jt})(\mathrm{ACL}_{jt})}{\mathrm{CL}_{jt}}\right] \quad (5)$$

ACL= Available Cultivable Lands

The number of households in crop farming potentially displaced is determined by taking the total number of households in a village (NhhCropF1). Then subtract the NhhCropF1 from the number of households that might likely have some space to cultivate crops (NhhCropF2) in the same village, after EL was granted. But NhhCropF2 is determined by a ratio and proportion method. Multiply NhhCropF1 by available cultivable lands in a village. The product is then divided by the entire land use extents of the same village. Available cultivable lands are the suitable agriculture and forest lands in a village.

2.3.5.3 Forage potential displacement
Due to poor agricultural land use planning in the villages, there are no specially delineated grazing zones for livestock. Besides, the seasonality of forage occurrence in the Savannah regions of Ghana allows livestock free ranging. That is, animals roam even beyond villages in search of pasture during the dry season but are tethered during crop cultivation. Therefore, the entire village land, including croplands, are quantified to assess potential forage displacement and its cumulative effects on livestock keeping in villages. The following expressions are used in this analysis:

$$FDM_{j}\_–S = EL_{Aj} \times 2170 \quad (6)$$

FDM = Forage Dry Matter

The FDM per Hectare (ha) in the Northern Savannah regions of Ghana is 2170 kg [38]. Therefore, the FDM per village (FDM1) is calculated by multiplying the area of the village land use extents with 2170. Hence, FDM potential displacement per village is determined by multiplying the area of an EL in the community with 2170. The amount of FDM that might be available for livestock in a year is determined by subtracting the amount of FDM in an EL in a village from the amount of FDM in the village. This FDM is termed as FDM2.

2.3.5.4 Impacts on livestock
The displacement of FDM has negative implications for livestock keeping in each village. Therefore, the potential impacts of FDM displacement on

herbivorous livestock per village is calculated using the following expression:

$$\text{NHL}_{jt}\_\text{S} = \left(\frac{\text{Hpop} \times \text{FDM2}}{\text{Qu\_Fora}} - \text{HPop}\right)_{jt} \quad (7)$$

NHL = number of herbivorous livestock

The average tropical livestock forage consumption (ATLFC) per day is 6.25 kg [39]. Therefore, the quantity of FDM (Qu_Forajt) required to feed livestock in a village is determined by multiplying the herbivorous livestock population (HLPopjt) in the village with 6.25 by 365 days in a year. Thus, the number of herbivorous livestock potentially displaced per village is determined by calculating the number of animals that would suffice FDM2. Then, the herbivorous livestock population in the community is subtracted from the result. A positive value means there would be no impact on animals. Likewise, a negative value means there would be an effect on that much of herbivorous livestock population. The number of livestock that would suffice FDM2 is calculated by multiplying the livestock population by FDM2. Then, the result is divided by the quantity of FDM required to feed herbivorous animals in a year.

2.3.5.5 Trees potential displacement

Through road, pipeline, general infrastructural constructions, as well as direct exploration and mining activities, the industry would remove valuable trees in the landscape. The number of trees potentially affected by the activities of the mining industry was estimated, considering the economic value of trees in the local economy. The techniques below were employed:

$$\text{AvNT}_{(j)}\_\text{–S} = [\textstyle\sum \text{EstNT}_{yELj}] \quad (8)$$

$$\text{EstNT}_{yj} = \text{AvTrDens}_{y} \times (\text{A})_{yj} \quad (9)$$

AvNT = Average number of trees
EstNT = estimate number of trees
y = land cover type
AvTrDens = Average tree density

The tree density per land cover type per EL has been calculated using the mean values of the estimated range of trees per hectare in each land cover. Thus, the average tree density per land cover within the EL multiplied by the area of the land cover in the EL. Therefore, the estimated number of trees potentially displaced in each village is the sum of the expected number of trees per land cover type within the overlaps of villages land use extents and ELs.

2.3.5.6 Potential impacts on Shea

The indiscriminate removal of trees would affect Shea trees in the villages. Shea been the most important economic tree in the Northern Savannah of Ghana, its potential displacement is given a particular focus in this study. The possible displacement is determined using the following expressions:

$$\text{EstNShea}_{j}\_\text{–S} = [\textstyle\sum \text{A}_{ELj} \times (\text{AvSheaDens})] \quad (10)$$

Hence,

$$\text{AvSheaFY}_{j}\_\text{–S} = \text{EstNShea}_{j}\_\text{–S} \times \text{AvNFPT} \times \text{MFW} \quad (11)$$

EstNShea = estimated number of Shea trees
AvSheaDens = Average Shea tree density;
AvSheaFY = Average Shea fruit yield
AvNFPT = Average number of fruits per tree (1247.69)
MFW = Mean fruit weight (16.25g)

The estimated Shea tree displacement is the sum of the estimated average Shea tree density within the overlaps of ELs and villages land use extents. The average Shea tree/ha is derived from dividing the estimated minimum number of Shea trees (9.4×10^6) with the total area of the Northern Savanna (77670 km^2) [40]. Hence, the estimated number of Shea trees per village is calculated by multiplying the index of Shea trees/ha with land use extent of each village. Likewise, the estimated number of Shea trees per EL is the ratio of average Shea density multiplied by the area of the EL.

The mean Shea fruit weight and the average number of fruits per tree are derived from the findings of Yidana [40]. These have been multiplied by the estimated number of Shea trees potentially displaced to obtain the amount of fruits potentially displaced in each village.

2.3.5.7 *Potential impact on village women*

The Shea industry is a dominant women activity in the Northern Savannah of Ghana. Hence, a threat to the Shea is equally a threat to the source of income to village women and children. Therefore, the potential Shea headload per women potential displacement is determined with the following techniques:

$$ShHlPW_{jt}\_–S\ (kg) = ShHlPW2_{jt} – ShHlPW1_{jt} \quad (12)$$

But,

$$ShHlPW2_{jt}\ (kg) = AvSheaFY2_{jt} / FPop_{j}\_95\% \quad (13)$$

And

$$ShHlPW1_{jt}\ (kg) = AvSheaFY1_{jt} / FPop_{j}\_95\% \quad (14)$$

ShHlPW: Shea fruits Headload per Woman in a season; FPop: Female population

The Shea headload per woman potential displacement is determined by subtracting the initial estimated Shea headload per woman (ShHlPW1) from the likely available Shea headload per woman (ShHlPW2), after EL is granted in the village. But the likely available Shea headload per woman after EL is issued is calculated by dividing the estimated likely available Shea fruit (AvSheaFY2) after EL is granted with 95% of the total female population in a village. And the initial Shea headload per woman is also determined by dividing the estimated available Shea fruit (AvSheaFY1) before EL is granted with 95% of the female population in the village. AvSheaFY is a product of the average number of Shea fruits per tree, mean fruit weight, and the estimated number of Shea trees in a community.

3 Results and Discussions

The results in Fig. 3 demonstrate the coefficient of specialisation of all the villages in the production system. Except Banwon, Toto, Turi-Dari, Yagha-Baapari, and Musama, all the other villages have an LQ > 1 in the agriculture industry.

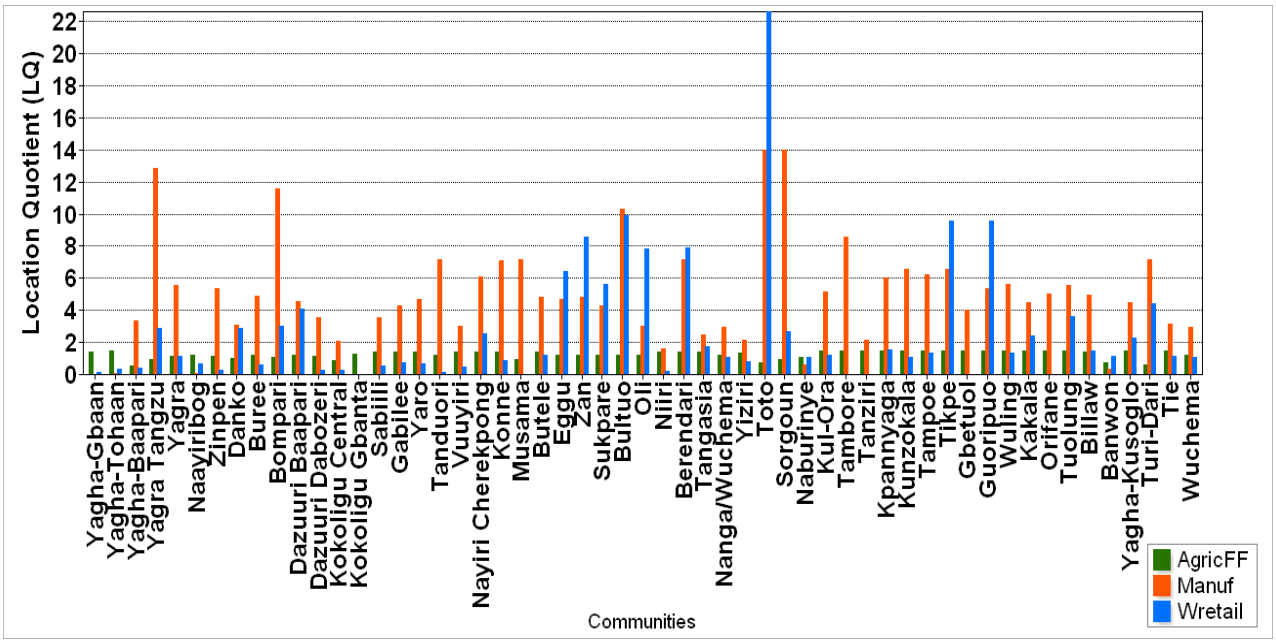


Fig. 3 Location quotient (LQ) of industry types in communities

The implication is that these communities can produce enough agricultural products to satisfy local demand. At the same time, the villages are also able to trade some of the agricultural products like food crops and livestock for income. Those villages with LQ < 1 are rather deficit in agricultural commodities and might be dependent on the more abled villages for supplies. In respect of non-agricultural livelihood activities, except Yagha-Gbaa, Yagha-Tohaan, Nayiribog, Kokoligu Gbantakuuri, Niiri, Naburnye, and Banwon, all other villages have an LQ > 1 in the manufacturing sector. Toto has the highest LQ = 23 in the wholesale and retail industry. Implicitly, a displacement of cultivable lands and accompanying forage in the villages with an LQ > 1 in agriculture would have a cumulative effect on other communities [41].

The degree of specialisation in production and the exchange of goods is a significant factor in the mechanical solidarity that exists between villages in Sub-Saharan Africa [42]. Therefore, a direct threat to anyone of the villages specialised in agriculture has implications for the survival of a chain of other villages. As a matter of food and livelihood security, communities at both producing and consuming ends might resist a common threat from the mining industry. Consequently, the total resistance to the mining industry can be predicted as the total potential displacement of both agricultural and non-agricultural livelihoods in the villages; and their neighbours in kinship and trade ties.

The results in Fig. 4 show the location association between pairs of industries in the villages. Except the mining and quarrying industry, all the industries have a La > 60 with each other. Agriculture and mining and quarrying have La < 20. Manufacturing and mining and quarrying have La = 36; wholesale and retail and mining and quarrying have La = 29. It means that most livelihood activities in these areas are spatially correlated except with the mining industry [43]. The existence of one activity stimulates the practice of a chain of others in the village. The question was whether there is location affinity between any pair of livelihood activities such that the displacement of one activity will automatically affect a chain of others.

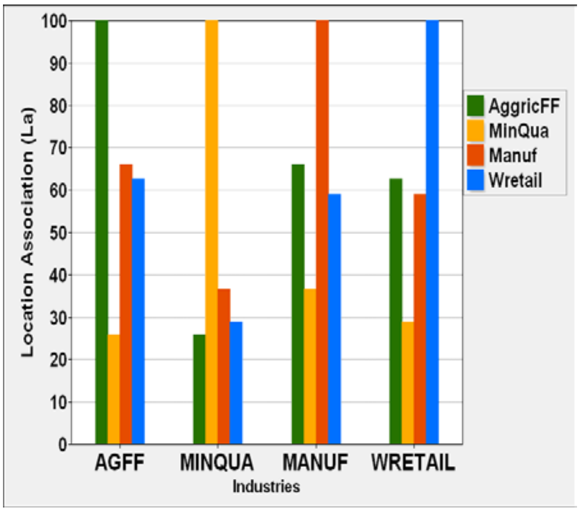


Fig. 4 Location Association (La) of industry pairing

In this respect, it is clear from the results that the displacement of the agriculture industry will affect the manufacturing and wholesale and retail industries. Thus, an introduction of the mining sector activities will have negative implications for a diversifying rural economy in the study area [41].

Importantly, Table 3 in appendix shows the material of exchange and the factors of inter-industry dependence. The agriculture sector reuses some of its outputs as principal inputs for future production. For instance, some stocks of grains of cereals are preserved and used on the farms in the following year. Also, herbivorous livestock such as cattle, are kept on farms as a means of labour and manure during ploughing and harvesting. However, some grains and livestock are sold to middlemen in the retail industry. Besides, women in village households transact wholesale and retail businesses with the family farm's products. Other households consume these in other villages and even nearby urban towns. Women also process food stuff or directly engage in catering and food vending with the farm produce of their family. They prepare local beverages from grains and cereals, which form an important component of household income. Earnings from the sale of agricultural commodities and the trading activities of families are often reinvested on the farms. Some parts of the assets are used to provide family's basic needs like payment of school fees for children, clothing and shelter. These explanations were obtained during the two fieldworks. Hence, a diversifying rural economies can be threatened with a break in the cyclical flow of inputs and outputs between industries. In the event these displacements compound livelihood constraints, village women would resist the mining industry activities.

Fig. 5 shows the overlaps between the ELs and the villages' land use extents. It can be seen from the results that some villages would have to be relocated, especially, in the Nadowli-Kaleo District, where mining licenses have been granted. The affected communities are Nanga-Wuchema, Tangasia, and Yiziri. In the Jirapa District, only Orifane will immediately be affected. However, in case of mine expansion in the current concession, Kpannyaga, Guoripuo, together with Orifane in the Jirapa District would be relocated. With the intensification of exploration, these villages' cultivable lands will be interfered with, as shown in Fig. 6. The displacement comprises a minimum of 845-1575 ha and a maximum of 2861 ha. Butele, Turi-Dari, Niiri and Berendari in the South of Nadowli-Kaleo; Eggu, Zan, and Sukpare in the Wa West District will all be affected.

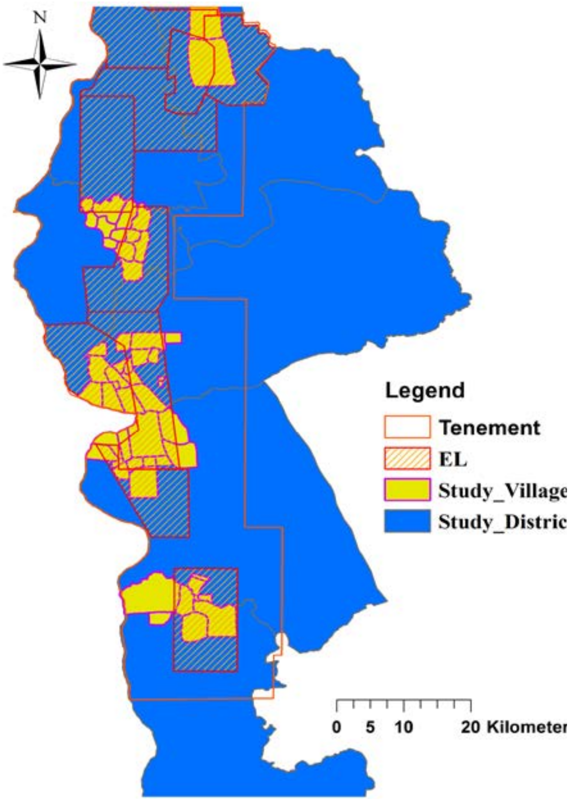


Fig. 5 Spatial interactions of villages and ELs

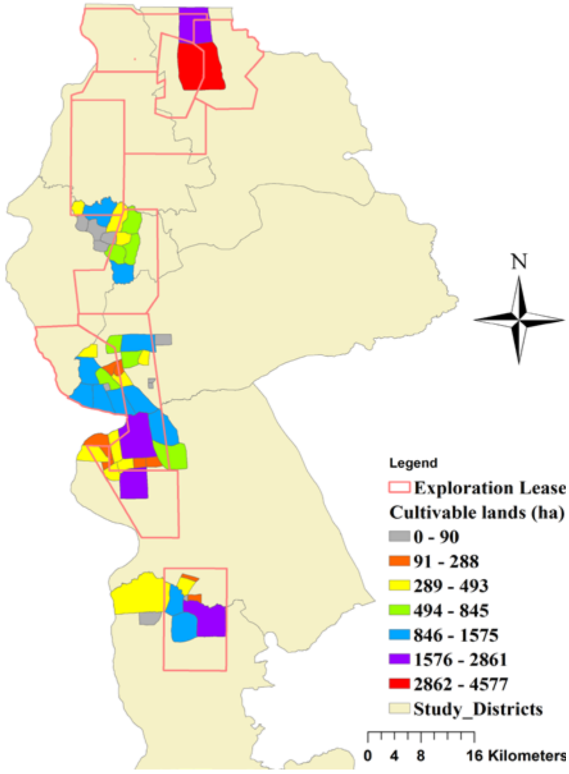


Fig. 6 Cultivable lands potential displacement

Except Tampoe, almost all the sample villages and surrounding communities in the Jirapa District will be affected by an intensification of exploration activities. Apart from Bompari, Yagra and Toto, all the sample villages in the Lawra district will be affected by exploration disturbance and future mining considerations. Billaw and Banwon in the Lambussie Karni District are no exceptions to the disturbance of the mining industry activities. Billaw has the largest land use area under the ELs. During fieldwork, it was noticed that the primary livelihood activities in the villages are land dependent. For instance, food processing, 'Pito'-brewing, and petty trading derive their inputs from cultivable lands (Table 3). Therefore, land displacement in the villages has a direct negative impact on the manufacturing, wholesale and retail industries.

Fig. 7 shows the number of trees that would potentially be displaced in each village. Billaw, in the Lambussie Karni District, will have the highest number of trees displacement, between 43781 and 69920 trees. Billaw records the highest tree potential displacement because, it is covered by the close Wooded Savanna land cover type.

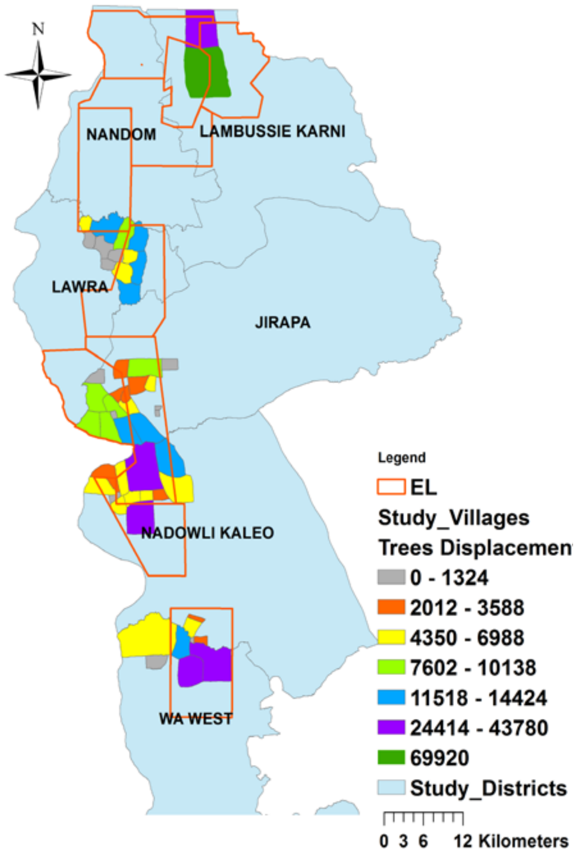


Fig. 7 Trees potential displacement

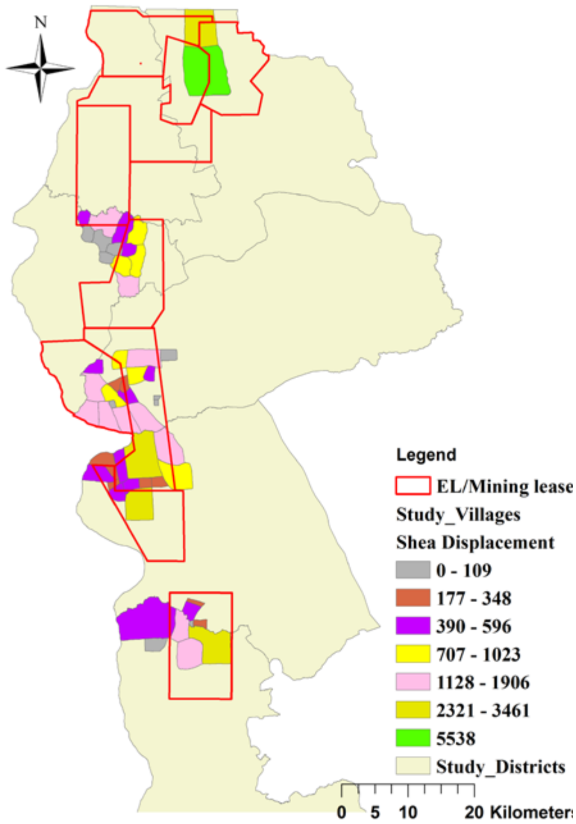


Fig. 8 Shea trees potential displacement

The next most potentially affected villages are Eggu, Zan, in Wa West; Konne, Nanga-Wuchema in Nadowli-Kaleo; and Banwon in Lambussie Karni districts. Villages in the Jirapa and Lawra districts will be the least affected in terms of potential tree removal. These villages are covered by the open cultivated Savanna woodland; with or without scattered trees. Tree densities in these land cover types are 6-10 trees/hectare (ha), and 0-5 trees/ha respectively. The sizes of land use extents in most of them are relatively small and, they have a comparatively small area of overlap with the ELs. Consequently, tree displacements have negative implications for the supply of inputs to manufacturing and wholesale and retail industries. Activities like wood carving, weaving, firewood and charcoal burning derive their inputs from wild trees.

Shea trees potential displacement is shown in Fig. 8. Similar to trees displacement, Billaw will experience the highest number of Shea displacement with an average of 5538 trees.

Nanga, Konne, Banwon and Eggu will also record the next highest Shea displacement with averages between 2321 to 3461 trees. The Shea-processing sector will be affected in most of the villages since trees displacement has an inadvertent impact on fruits loss. A minimum of 2211 kg and a maximum of 112277 kg of Shea fruits would be displaced (Fig. 9). Accordingly, Yiziri would record the highest amount of Shea headload per woman displacement. It records an average of 404 kg Shea headload per woman displacement. Nanga, Orifane, Konne, Gbetuol, Eggu and Banwon would also record between 178 kg to 265 kg of Shea headload per woman displacement (Fig. 10). The least affected villages in respect of Shea headload per woman potential displacement are Tampoe, Bompari, Toto, Yagra, Bure, Tanzire and Guoripuo. These villages either share little space with ELs or are small in size.

Thus, a displacement of Shea has an extensive negative implication on the livelihood of village women. The Northern Savannah regions have the highest female illiteracy rates in Ghana [24].

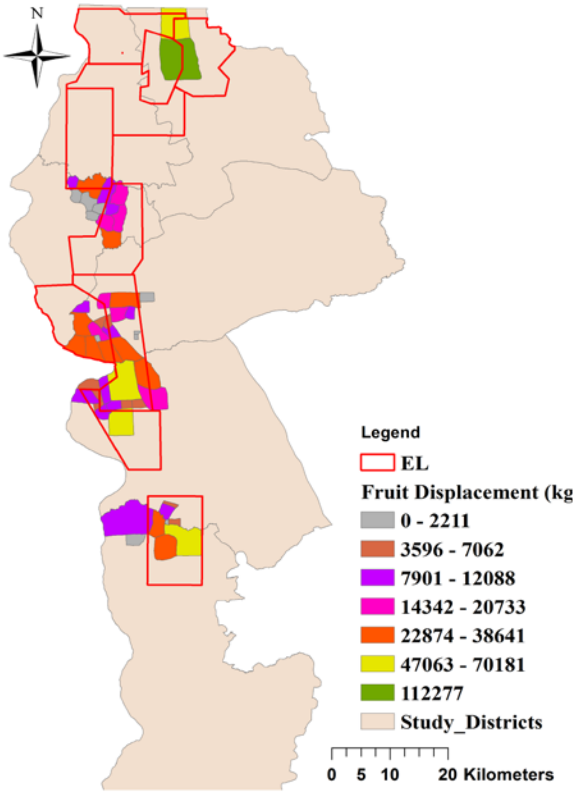


Fig. 9 Shea fruits potential displacement

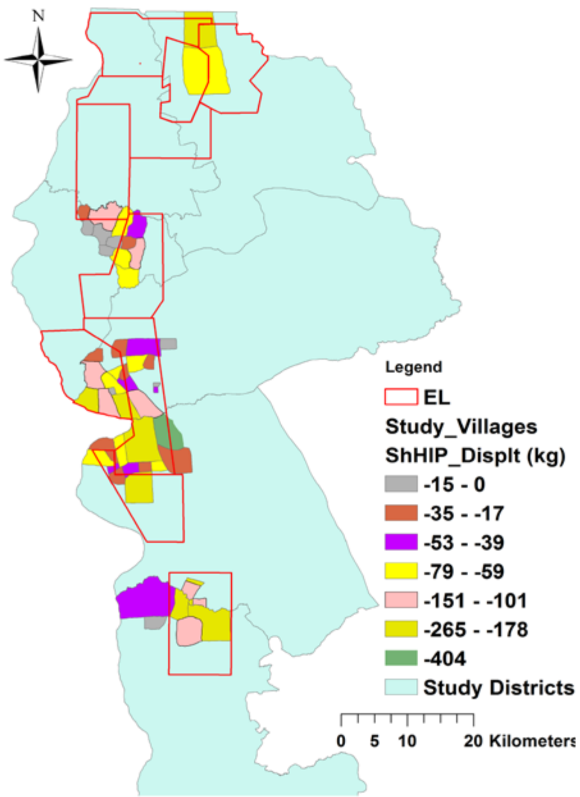


Fig. 10 Shea headload per woman potential displacement

For that matter, job opportunities for women in the villages are usually limited to on and off-farm activities, accounting for the high poverty incidences in the area. Village women in these regions depend on the Shea sector as a primary source of income with which they support their families [44]. Therefore, most development initiatives in Sub-Saharan Africa focus on the Shea sector promotion [44]. Hence, women and children would be most vulnerable to mining industry induced Shea displacement. It can, with this, be predicted that a mining sector lead displacement of Shea trees would be resisted in the area.

Lack of information and knowledge is a barrier to efficient communication and could be the primary cause of conflicts between local communities and the exploration and mining companies [4, 10]. Therefore, this study posits that there can be no efficient communication without quantifying the potential cost of the industry's activities on local communities' livelihood. Thus, the study provides necessary information about the spatial extents of the mining industry's land-use interests in the local landscape. The findings would further empower local communities and governments to understand the futures of livelihood. An understanding of communities' economic futures would stimulate efficient planning for adapting to expected economic changes. With this shared information, local communities can hold meaningful negotiations with companies and government for a better beneficiation of mineral resource returns [1, 9].

4 Conclusion

This study's primary hypothesis was that land use conflicts between local communities and the mining industry can be managed efficiently if the elements of the conflicts can be measured. Firstly, the study inventoried and characterised the livelihood activities of 55 sample villages in the study area. Agriculture, wholesale and retailing, and manufacturing all contribute to the communities' economy and lifestyle. It was found that the diversity of the rural economy makes it resilient through changing economic conditions. The study further quantified and analysed the spatial interactions between the mining industry and the livelihood activities in 53 of the 55 villages. Villages have both social and trade linkages with neighbouring communities. Therefore, indicators of socioeconomic displacement can provide efficient standards for addressing the future cumulative impacts of the mining industry on rural livelihoods.

References

[1] Africa, M.V., "Africa Mining Vision", *AU, Addis Ababa*, 2009.

[2] FAO, "Land tenure and rural development", *FAO Land Tenure Studies*, Rome, 2002.

[3] Wehrmann, B., *Land conflicts: A practical guide to dealing with land disputes*: GTZ Eschboen, 2008.

[4] Hilson, G., and B. Murck," Sustainable development in the mining industry: clarifying the corporate perspective", *Resources policy* Vol. 26, No. 4, 2000, pp. 227-238.

[5] Twerefou, D.K., *Mineral Exploitation, Environmental Sustainability and Sustainable Development in EAC, SADC, and ECOWAS Regions*: African Trade Policy Centre, Economic Commission for Africa, 2009.

[6] Jenkins, H.," Corporate social responsibility and the mining industry: conflicts and constructs", *Corporate Social Responsibility and Environmental Management* Vol. 11, No. 1, 2004, pp. 23-34.

[7] Hilson, G.," An Overview of Land Use Conflicts in Mining Communities", *Land Use Policy* Vol. 19, 2002, pp. 65-73.

[8] Davis, R., and D.M. Franks, "The costs of conflict with local communities in the extractive industry", *Proceedings of the First International Seminar on Social Responsibility in Mining, Santiago, Chile*, 2011.

[9] Andrew, J.S.," Potential Application of mediation to land use conflicts in small-scale Mining", *Journal of Cleaner Production* Vol. 11, No. 2, 2003, pp. 117-130.

[10] Thomson, I., and S.A. Joyce," Mineral exploration and the challenge of community relations", *BC Yukon Chamber of Mines*, 1997.

[11] Cuba, N., A. Bebbington, J. Rogan, and M. Millones," Extractive industries, livelihoods and natural resource competition: Mapping overlapping claims in Peru and Ghana", *Applied Geography* Vol. 54, 2014, pp. 250-261.

[12] Pabi, O., "Decentralised and participatory information system development in the Kintampo districts.", *Natural Resources System Program.pd*: Institute of African Studies, University of Ghana, 2005.

[13] Lange, S., *Land tenure and mining in Tanzania*: CMI, 2008.

[14] Tsuma, W., "Institutionalizing and Letigimizing Large-Scale Land Deals and Acquistions in Rural Communities of Western Ghana, Ch.1", *Gold Mining in Ghana: Actors, Alliances and Power*, Bonn, Germany: LIT Verlag Munster, 2010, pp. 240.

[15] Cornel, L., and L. Mirela, "Proposal of a sustainable development synthetic indicator at local level", *Proceedings of the 9th WSEAS International Conference on Mathematics and Computers in Business and economics (MCBE'08)*, 2008, pp. 24-26.

[16] Horlings, L.G., and T.K. Marsden," Exploring the 'New Rural Paradigm'in Europe: Eco-economic strategies as a counterforce to the global competitiveness agenda", *European Urban and Regional Studies*, 2012, pp. 0969776412441934.

[17] Abdou, F., "Sustainable intensification of crop-livestock systems in northern Ghana: Report on 2012 activities",

www.africarising.net: International Livestock Research Institute, 2012.

[18] Yaro, J.A.," Is deagrarianisation real? A study of livelihood activities in rural northern Ghana", *Journal of Modern African Studies* Vol. 44, No. 1, 2006, pp. 125.

[19] Kolavalli, S., E. Robinson, X. Diao, V. Alpuerto, R. Folledo, M. Slavova, G. Ngeleza, and F. Asante, "Economic Transformation in Ghana, Where Will the Path Lead?": International Food Policy Research Institute, February 2012.

[20] GSS, "2010 Population and Housing Census Analytical Report", Accra, Ghana: Ghana Statistical Service, 2013, pp. 409.

[21] Bloch, R., and G. Owusu," Linkages in Ghana's gold mining industry: Challenging the enclave thesis", *Resources Policy* Vol. 37, No. 4, 2012, pp. 434-442.

[22] Griffis, R.J., & Agezo, F.L., "Mineral occurences and exploration potentials of northern Ghana", Accra, 2000, pp. 113.

[23] Coffey, "Wa Gold Project, Ghana", Perth AUstralia: Azumah Resources Pty Ltd 2012.

[24] Al-Hassan, R., and C. Poulton," Agriculture and social protection in Ghana", 2009.

[25] Marchetta, F.," On the Move Livelihood Strategies in Northern Ghana", *Post-Doctorante CNRS, Clermont Université, Universitéd'Auvergne, CNRS, UMR* Vol. 6587, 2011.

[26] Hatskevich, A., V. Jeníček, and S. Antwi Darkwah," Shea industry–a means of poverty reduction in Northern Ghana", *Agricultura Tropica et Subtropica* Vol. 44, No. 4, 2011, pp. 223-228.

[27] DFID, "Economic Growth in Northern Ghana", London and Accra: Uk Department for International Development (DFID), 2005.

[28] Adu, S.V., and Asiamah, R. D., "Soils of the Lawra-Wa Region, Upper West Region, Ghana", *Lawra-Wa Region*, Kumasi, Ghana: Council for Scienticfic and Industrial Research (CSIR); Soil Research Institute (SRI), 2003.

[29] Agyapong, G., S. Duadze, J. Annor, S. Donyuo, E. Tetteh, and A. Gyeabour," Land use and land cover map of Ghana", *Technical Bulletin*, No. 3, 1999.

[30] Hintjens, H.," Environmental direct action in Australia: the case of Jabiluka Mine", *Community Development Journal* Vol. 35, No. 4, 2000, pp. 377-390.

[31] Popkin, J.," Labor Statistics", *Encyclopedia of statistical sciences*, 1990.

[32] Rupasingha, A., and J.M. Patrick," Tools for understanding economic change in communities", 2009.

[33] Wei, H.," Modern Regional Economics", *Beijing: Economy & Management Publishing House*, 2006.

[34] Leontief, W.," Input-output analysis", *The new palgrave. A dictionary of economics* Vol. 2, 1987, pp. 860-864.

[35] Yankson, P.W.K., *Techniques of Regional Science*, Accra Ghana: Institute of Continuing and Distance Education (ICDE, University of Ghana, Legon, 2011.

[36] Azapagic, A.," Developing a framework for sustainable development indicators for the mining and minerals industry", *Journal of cleaner production* Vol. 12, No. 6, 2004, pp. 639-662.

[37] Blench, R., "Background conditions in Upper West Region, Northern Ghana", *Interim Evaluation of UWADEP*, London: IFAD, 2006.

[38] Oppong-Anane, K.," Country Pasture/Forage Resource Profiles", *Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extensions, FAO, Rome, Italy*, 2006.

[39] Jahnke, H.E., and H.E. Jahnke, *Livestock production systems and livestock development in tropical Africa*: Kieler Wissenschaftsverlag Vauk Kiel, 1982.

[40] Yidana, J.A.," Progress in Developing Technologies to Domesticate Cultivation of Shea Tree (Vitellaria paradoxa L.) in Ghana", *Agricultural and Food Science*

Journal of Ghana Vol. 3, 2004, pp. 249-267.

[41] Adjei, E., "Impact of Mining on Livelihoods of Rural Houeholds: A case study of farmers in the Wassa Mining Region, Ghana", *Department of Geography*, Norway: Norwegian University of Science and Technology, 2007.

[42] Ellis, F.," The Determinants of Rural Livelihood Diversification in Developing Countries", *Journal of Agricultural Economics* Vol. 51, No. 2, 2000, pp. 289-302.

[43] Feng, J., and M. Ji, "Integrating location quotient, local Moran's I and geographic linkage for spatial patterning of industries in Shanghai, China", *Geoinformatics, 2011 19th International Conference on*: IEEE, 2011, pp. 1-6.

[44] Pouliot, M.," Contribution of “Women’s Gold” to West African livelihoods: The case of shea (Vitellaria paradoxa) in Burkina Faso", *Economic botany* Vol. 66, No. 3, 2012, pp. 237-248.

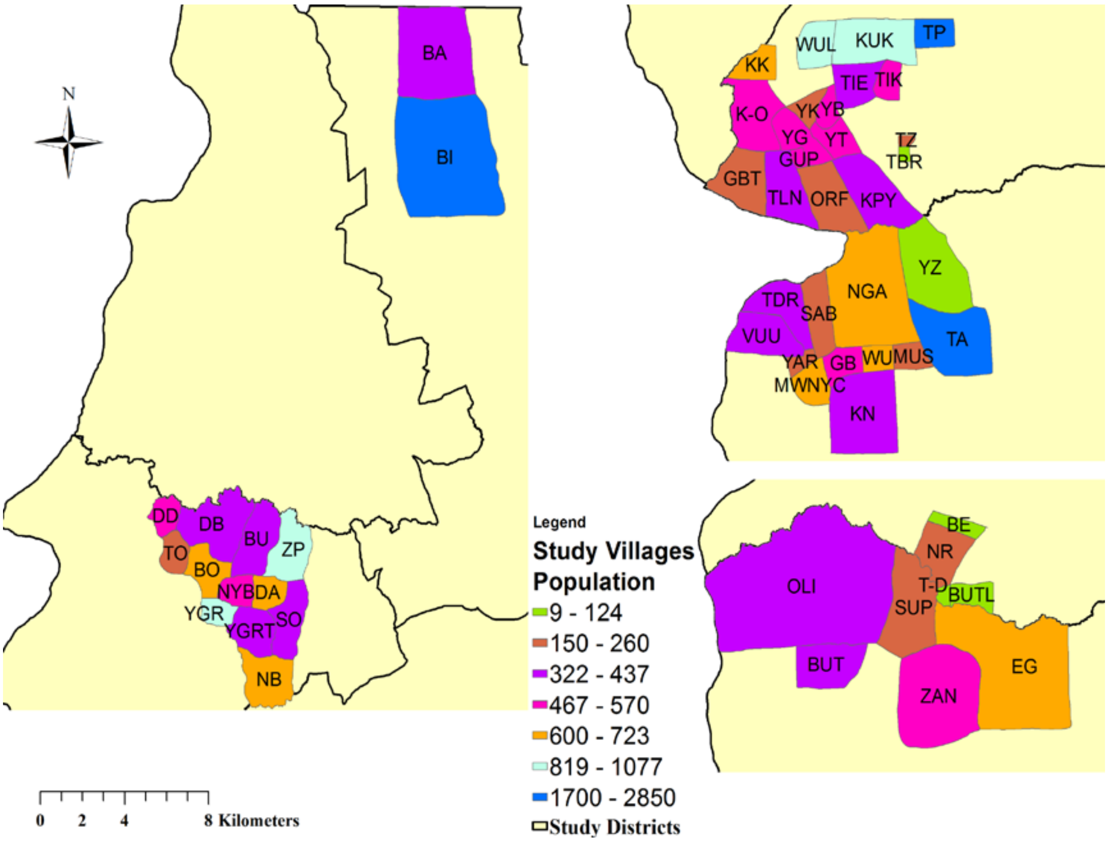
Appendix A

Table 3 The Input-Output flow table

		Demand Sector					
Supply Sector		AgricFF	MinQua	Manuf	Wretail	Household	X
	AgricFF	Seeds, animal dung/Labour	Food/land & labour	Raw grains & nuts	Raw grain, meat & Food	Food, meat & income	
	MinQua		Profits	Materials		Income, construction materials	
	Manuf	Implements	Riggings	Apparatuses	Utensils, brews, medicines, cosmetics, weaves, biofuels, construction supplies	Utensils, biofuel, drinks, medicine, cosmetics, clothing, building	
	Wretail	Fertilizers, implements, grain/seeds, pesticides, capital etc.	equipment capital	capital, tools, apparatus etc.	Capital	Income, equipment and utensils, clothing, grain and meat, beverages, cosmetics, medicines,	
	Nhh	labour	labour	labour	labour		
Total							

X: Total output Nhh: Number of households

Appendix B Labels of sample villages on Map



NAME & ABBREVIATIONS							
Dazuuri Dabozeri	DD	Gbetuol	GBT	Yagha-Tohaan	YT	Sabiili	SAB
Toto	TO	Guoripuo	GUP	Yagha-Baapari	YB	Sukpare	SUP
Bompari	BO	Kakala	KK	Yagha-Gbaan	YG	Tambore	TBR
Buree	BU	Konne	KN	Yiziri	YZ	Tampoe	TP
Yagra	YGR	Kpannyaga	KPY	Tangasia	TA	Tanduori	TDR
Naayiribog	NYB	Kul-Ora	K-O	Wuchema	WU	Tanziri	TZ
Zinpen	ZP	Kunzokala	KUK	Banwon	BA	Tie	TIE
Yagra Tangzu	YGRT	Musama	MUS	Berendari	BE	Tikpe	TIK
Naburinye	NB	Naayiri Cherekpong	MWNYC	Billaw	BI	Tuolung	TLN
Sorgoun	SO	Nanga	NGA	Bultuo	BUT	Turi-Dari	T-D
Danko	DA	Niiri	NR	Butele	BUTL	Vuuyiri	VUU
Dazuuri Baapari	DB	Oli	OLI	Eggu	EG	Wuling	WUL
Yagha-Kusoglo	YK	Orifane	ORF	Gabilee	GB	Yaro	YAR
						Zan	ZAN