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COAL MINING AND LIVELIHOOD SYSTEMS IN A RURAL AGRARIAN COMMUNITY: A STUDY OF ANKPA L. G. A. IN KOGI STATE, NIGERIA

C. U. Nwajiuba
Department of Agricultural Economics,
Imo State University, Owerri, Nigeria
E-mail: chnwajiuba@yahoo.de

ABSTRACT

A study was conducted in Okaba and Odagbo communities in Ankpa L. G. A. of Kogi State in Central Nigeria to investigate the environmental consequences of coal mining. The study entailed a survey of forty farm households as well as soil and water analyses. Results show that surface coal mining as obtained in the area leads to degraded soil and pollution of the local rivers and water sources. Upturned earth surface materials make the soil unable to sustain plant life, while the effluent from the mine causes water hardness. It is suggested that soils be reclaimed for farming purposes as well as provision of pipe-borne water to the community.

INTRODUCTION

The exploration of minerals, especially coal in Eastern and Central Nigeria is several decades now. The Nigeria Coal Corporation (NCC) has engaged in open cast or surface coal mining in Okaba, Kogi State in Central Nigeria since 1968. The coal mines of Okaba have a proven reserve of 73 metric tones of which 19 metric tones can be mined by open cast mining (Oyeyinke, undated).

Surface Coal Mining is necessary in regions where the coal does not lie deep beneath the earth. This is the practice when coal seems to lie fairly close to the surface, and the rocks above them may not be solidly consolidated. This situation makes driving tunnels into the coal virtually impossible because of the likelihood of the roof collapsing. Therefore the usual way is stripping away the soil to expose the coal for extraction (Schobert, 1987). This is the case with the Okaba mine.

A consequence of surface coal mining is extensive deforestation and land degradation (Nwajiuba, 2000). These may have serious consequences for livelihoods particularly in agrarian communities such as Okaba, whose residents are predominantly arable, crop farmers, with some livestock mostly Goat, sheep and poultry.

The importance of the mining sub-sector includes generating foreign exchange, employment and general economic development (Nwajiuba, 1998). These roles are well known and documented. What has not been fully assessed is the environmental impact of minerals exploration especially, coal mining on host communities.

However, lessons drawn from the relationship between petroleum exploring companies and their host communities, particularly in Nigeria's Niger Delta, suggest need for caution and pre-emptory approach to forestall conflicts. There exists high level antagonism by rural inhabitants towards petroleum related activities in the Niger Delta. These are based on complaints of the negative externalities of petroleum exploration on the environment, and especially agriculture usually the main occupation and source of livelihood of rural inhabitants (Akwiwu *et al* 2002). Such levels of antagonism may not yet be reported with coal mining, although coal and petroleum are hydrocarbon based, and may have similar environmental consequences (Hill, 1979).

This, therefore, is the basis for a study which examined the impact of coal mining on Okaba and Odagbo communities in Ankpa Local government area (LGA) of Kogi State where the Nigerian Coal Corporation is engaged in surface mining. Of specific interest are agricultural resources availability and use, the biophysical environment including soils, crops and water quality, and, the relationship between coal prospecting companies and host communities. However, emphasis is on the social (human) consequences of coal mining especially on livelihood.

METHODOLOGY

The study was conducted in Okaba and Odagbo communities in Ankpa Local Government Area (LGA) of Kogi State where the Nigerian Coal Corporation (NCC),prospects for coal. Ankpa L.G.A. has a population of 248,281 persons (Okaba has 4280 while Odagbo has 1210 persons). Population density in the area is between 100 200 person per km^2 (NPC, 1991). The area is in the humid area of Nigeria with annual rainfall of up to 1,400mm with bimodal peak in June and September (ODNRI, 1989).

Biophysical surveys were conducted. This involved taking soil samples from the earth surface around the mine site and the surrounding farming areas. It also involved the collection of samples of effluents from the coal mines, and water from the adjourning Otakpa stream into which seepage from the mines flows. The samples were collected in sterilized polyethylene bottles and preserved according to recommended standard scientific practices (APHA-AWWA-

WPCF, 1980; Lawal and Singh, 1981). The effluents, soil and water samples were analyzed in the soil science laboratories of the faculty of Agriculture, University of Nigeria, Nsukka. pH was determined with a Beckman direct reading pH meter, model 23A (Central Scientific Co. Chicago, USA). The meter was standardized using an acetate buffer at pH 4.0 and a phosphate buffer at pH 9.2 respectively.

A socio-economic survey was carried out. This involved 40 respondents randomly selected from a sample frame of households in the community obtained with the assistance of community leaders. Information sought included household and community characteristics and relationship with the NCC. Data was analyzed by simple statistics.

RESULTS AND DISCUSSIONS

Coal Mining in Okaba and Odagbo

Coal mining commenced in these communities in mid-1960's. Coal mining is essentially for exports, although limited quantities are used as energy source for household cooking in the Okaba and Odagbo communities. Exploitation is by surface exploration through excavation of the earth overburden using heavy equipment such as tractors by the Nigerian Coal Corporation. This results in extensive deforestation. Compensation is paid for economic trees lost in this process, but not for land. Households are also not re-settled as prescribed by the Nigerian Land Use law, 1978. This could be regarded as a violation of human rights (Omeje, 1995).

Socio-Economic Characteristics and Farm Resources

The average age of the respondents was 35 years. A summary of socio-economic characteristics of the respondents is on Table 1. All inhabitants of the communities are either full or part-time farmers. The main source of farm labour is the household, with some hired labour at the peak of the farming season, usually corresponding with land preparation and weeding in the first half of the year. Average household size is 8 persons of which 42% are males and 58% are females. Higher female population is attributed to cases of widows and higher rate of male migration to urban centres. There were therefore more female-headed households.

Table 1: Summary of Socio-economic Characteristics of Respondents (n = 40)

Age:	Average		-	35 years
Labour:	Average household size		-	8
	of which:	Males	-	42%
		Females	-	52%
	of which:	Children	-	75%
		Adults	-	25%
Occupation:	Full-time Farmers		-	57%
	Part-time Farmers		-	43%
	of which:			
		Trading	-	14%
		Arts & Smith	-	14%
		Others	-	15%
Land:	Average number of plots per Household		-	6
	Average area of land (ha)		-	2.5
	Average area used (ha)		-	1.5

Source: Field Survey, 1999

Further, 25% of household members are adults and 75% are children (less than 18 years). Of these children, about 50.6% are above 10 years and are an important source of farm labour. Male labour uses on farms include for land clearing, tillage, planting and harvesting. Women engage in land preparation, planting, weeding and harvesting. The highly skewed structure of the population towards the younger age group indicates high birth rate and population growth. It therefore portends greater land-use pressure in future.

The traditional land tenure system is through communal access to farmland. This is indicative of low population density and subsistence-oriented agriculture with undeveloped input and product markets (Doppler, 1991). Average number of plots owned per household is 6. Average area owned by each household is 2.5 hectares, which means an average plot size of 0.42 hectares. However, each household used only about 1.5 hectares in the survey year (Table 1). This means about 40% of land holdings were under fallow. Fallow is the main means of soil fertility regeneration.

In the area, 1 year of cropping is followed by a fallow period of at least 3 years. Applying the formula developed by Ruthernberg (1980) this means a Rotation value (R) of about 25% (see Box 1). Such low R-value is typical of subsistence-oriented peasant agrarian societies. This indicates low land use intensification, and therefore greater reliance on the natural ability of the soil to regenerate fertility.

The main form of land utilization is arable cropping of yams, cassava, maize and millet (Box 2). These are mostly mixed cropped. The major combinations of crops are cassava/yam/maize and cassava/maize. The cropping calendar commences in March/April with land clearing and tillage when the rains commence. From April to June there is planting of yam and maize. Cassava planting takes place virtually throughout the year except from September when moisture stress is so much that plants wither. In July and August, there is planting of Guinea Corn and Pigeon pea. The harvesting of early maize and yam is also in July. Late maize, planted between August and September is harvested in November/December.

Box 1: Rotation Value for Farming Systems in Okaba and Odagbo, Kogi State, Nigeria (1999)

$$R = \frac{V}{A + B} \times \frac{100}{1}$$

where R = Rotation value

V = Actually used vegetation period (cultivation periods)

A = Years of cultivation

B = Years of fallow

$$\text{Therefore, } R = \frac{1}{3 \times 1} \times \frac{100}{1} = \frac{1}{4} \times \frac{100}{1} = 25\%$$

Box 2: Calendar of Cropping Systems of Ankpa L.G.A., 1999

March – April	=	Land clearing – tillage when rains come
April – May – June	=	Planting of yams, maize, cassava (cassava is planted all year except about September).
July – August	=	Planting of Guinea Corn, Pigeon Pea, Cassava
July	=	Harvest early maize and yam
August – September	=	Planting of late maize
November – December	=	Harvest late maize

Effects of Coal Exploration

Coal mining exerts considerable effects on natural resources and community livelihood generally, as discussed under various headings below.

Effects on Land and Forest Resources: The inhabitants of Okaba and Odagbo already perceive that coal mining is taking substantial area of land as indicated by 80% of the respondents. They are also aware that coal mining leads to poor soil quality and infertility, and therefore declining crop yield.

Observation shows that plant growth on excavated land is not vigorous, with scanty shrubs after some years. Crops grown on unmined areas but to which the upturned earth materials are washed, especially through water induced erosion, are also affected. Plant leaves turn yellow showing poor soil quality, particularly with respect to acidity. Eroded materials cover farmlands with fine sands, which are high in calcium and clay. This does not allow water infiltration due to the cementing effect it has over the soil surface. This material is composed of clays, sands, laterite and some rocks, schales and limestone.
Ember.

Soil samples taken from within a 500m radius of the mine sites were analyzed (Table 2). Results show an average pH of 3.35 meaning that the soils are highly acidic. Soil acidity hinders the release of available essential plant nutrients where available and reduces crop yield. This can be related to the observed yellowish coloration of plant leaves. In addition, around the mine site it was observed that there was suppressed vegetative growth. This could be attributed to the highly acidic nature of the soil. An organic matter (OM) of 4.26 may be high but not damaging to crops. Cyanide content averaged 342Mg/100g and is detrimental to crop growth. Available phosphorus (P) at 2711m is high. Crops planted on such soils may therefore not require additional P. However, the popular mineral fertilizer supplied to the study area by the state agricultural extension unit is the complete Nitrogen Phosphorus Potassium (N-P-K). In effect, this is inefficient fertilizer use as the soils already have excess phosphorus (P).

Respondents consider schales excavated in the course of surface mining as not good for the farms, and they account for

Table 2: Some characteristics of soil samples around the Mine

pH 3	.35
OM	4.26
Fe	427mg/100g
Cu	220mg 100g
Zn	362mg 100g
Cyanide	342mg 100g
SO_4^-	260mg 100g
Available P	27ppm

Source: Field Survey, 1999

The decline in farm yield. These seal the soil surface, hampering soil, organic and mineral conditions. Compensation paid to effected households for crop loss are considered inadequate by indigenes of the area.

Deforestation is a major consequence of surface mining and this applies to the Okaba mines. Deforestation and land-use pressure lead to soil erosion, declining crop yields and loss of aquatic lives. The consequences of deforestation are ecological degradation including loss of biodiversity and forest resources, and loss of farmland. In the case of the surface mines in the study communities where the earth materials are deeply excavated, the soil structure is affected, and plant growth is hampered even after coal excavation. About 16km^2 has so far been deforested.

Effect on Water Resources: There are six streams and rivulets which are within Odagba, Okaba and neighboring communities and which are all linked, and eventually all flow into the River Benue (the second large river after River Niger in Nigeria). These streams are Otakpa, Majorda, Achokpa, Utowu, Ajigbi and Okaba. These are the main sources of water supply for household use in these communities. We however concentrated on the Otakpa stream because it is the closest to the mine sites, and seepage from the mine flow directly into it.

There are indications of pollution of these streams. The indication, as observed by all respondents, include change in water taste, water hardness as manifested by difficulty of soap/detergent to lather or foam when used for washing. Other effects are fish mortality, itching and whitening cover on the skin when used for bathing. Also when used for cooking, the local red palm oil rarely gives the desired red colour. The communities now use Alum (Calcium carbonate) for treating water from this stream.

Table 3 shows an analysis of pollutants and seepage from the mine sites, which flow into the local Otakpa streams. The effluent has a pH of 2.02 which is extremely acidic. Cyanide content at 7300 mg/L is a high level. Chloride at

Table 3: Characteristics of Mine Effluents Seeping into Local Otakpa Stream

Colour	=	Yellow
pH	=	2.02
Conductivity at 28^0C	=	216
Total hardness	=	43.69mg/C
OM	=	12.96mg/L
Fe	=	6270mg/L
Cd	=	36mg/L
Pb	=	27mg/L
Cu	=	138mg/L
Zu	=	0.6mg/L
Cyanide	=	7300mg/L
Chloride	=	2.7mg/L
NO_3^-	=	2.6mg/L
SO_4^-	=	3.6mg/L

Source: Field Survey, 1999

2.7 is low and safe level for drinking water. Nitrate ion (NO_3^-) at 2.6 is moderately high level for drinking. Sulphate ion (SO_4^-) at 3.6 is low and safe. We can therefore infer that the seepage of this effluent into the Otakpa stream is related to the observed characteristics of the water from the stream listed above. This inference conforms to other studies such as Nwokedi *et al* (1992).

Water pollution is a vital problem, and the communities expect improvement in present water supply situation which is the local streams, and which are affected by Coal mining. This is considered their most pressing problem by all of the respondents.

Table 4 Shows the characteristics of the water sample after the mine effluent has mixed with the local Otakpa streams, and allowing for a flow of 20 metres. It however should be expected that the concentration of the effluent in the water down stream, which is available for use by the communities, decreases with distance. Analysis of the water sample shows that the water is still highly acidic with a pH of 2.62 though this might decrease further down-stream. Drinking water standards as established by the US public service and the World Health Organization discussed in Renn (1970) is presented in Appendix 1. Other characteristics of the stream at this point remain largely unwholesome for human utilization (Table 4). For instance pH of 2.62, Iron (Fe) of 3000mg/L, Lead (Pb) of 21mg/L, Copper (Cu) of 327mg/L, Zinc (Zn) of 0.6mg/L among others are unwholesome for human consumption.

Table 4: Characteristics of Water Sample from the Otakpa Stream

Total Dissolved Solid	=	50.7mg/L
pH	=	2.62
Conductivity at 28^0C	=	285 US/CM
Total hardness	=	33.68mg/L
OM	=	8.62mg/L
Fe	=	3000mg/L
Cd	=	60mg/L
Pb	=	21mg/L
Cu	=	327mg/L
Zn	=	0.6mg/L
Cyanide	=	1300mg/L
Chloride	=	2.6mg/L
NO_3^-	=	1.8mg/L
SO_4^-	=	3.4mg/L

Source: Field Survey, 1999

Effects on Community Livelihood

Negative environmental externalities of mining may constrain livelihood of host communities by hampering agricultural resource uses. Such possible consequences as soil quality have clear economic importance. The possibility of long-term soil productivity degradation has potentially significant implications for economic welfare (Kim *et al,* 2001). Further, contaminated ground water can have negative impact when consumed, or it can contribute to surface water degradation by moving laterally into streams (Parker, 2000).

The specific positive impact of Coal mining on Okaba and Odagbo as identified by respondents include employment generation, increased income, increased economic activities and increased infrastructure and transportation facilities. On the negative side, coal is said to exert pressure on the village livelihood systems through deforestation and declining land area. Seepage into the village streams also has adverse effects on the quality of water. Some of the specific negative effects have already been discussed.

There is nevertheless appreciation of the role of the Nigeria Coal Corporation (NCC) by the communities in the provision of the following: electricity, health centre, and transportation. About 50% of the respondents commend the electricity project embarked on by the NCC, 75% appreciate the health centre project, while 80% believe transportation has improved. The community however, expects further aid by the NCC in the following areas: improvement of the health centre, educational opportunities, drinking water and extension of electricity supply.

Labour and Employment: Coal mining offers direct employment opportunities to some indigenes and inhabitants of the Odagbo/Okaba area. Indirectly, some other employment generating activities are stimulated by coal mining operations. These include trading and transportation, which service the workers at the mines. With respect to labour use for farming, due to the activities of the NCC, there is by an average of 2kms.

Effect on Income and Living Standards: Workers employed at the mines reside in Odagbo, Okaba and Ankpa town, and earn some income. This is an important contribution to rural liquidity and therefore living standards.

Community Development Associations obtain money from Coal transporters. This is used for development activities and is considered by the respondents as a positive effect of Coal mining on the area. The Okaba Development Association uses this in repairing and building schools, and maintaining roads in the community.

There is a high awareness and interest on coal mining by the community. The community desires development and establishment of coal related industries that can use coal and coal tar to generate more employment and incomes.

The community expects the NCC to engage in some form of land reclamation so that they can use the areas already mined by the NCC for farming. All the respondents (100%) desire this. This is not suprising considering that the communities are agrarian, with all inhabitants dependent on the land.

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APPENDIX 1: DRINKING WATER STANDARDS (in millions, except pH values)

Calcium	200.00
Magnesium	150.3
Iron	0.3
Manganese	0.1
Chloride	250.0
Sulfate	250.0
Detergents (ABS)	0.5
Total of all Dissolved Solids	500.0
pH	7.0,9.0

Source: Renn, (1970)