



Sustainable Mining Practices in Nigeria: A Case Study of Maiganga Coal Mining in Gombe State

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Authors' contributions

This work was carried out in collaboration between all authors. Author EDO designed the study, performed the statistical analysis, wrote the protocol and first draft of manuscript, did the analysis and report writing. Authors MI and YMA assisted in carrying out the fieldwork observation, recording and data collection. All authors read and approved the final manuscript.

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ABSTRACT

The impact of mining activity on the environment has been well documented. Government efforts at achieving reclamation and rehabilitation of mine land and abandoned mines have been constrained by numerous challenges. Many studies have been carried out on coal mining activities in Maiganga area but little attention or none has been paid to the reclamation strategy of the coal mining company. This study appraises the sustainable practices in coal mining activities in Maiganga community of Akko Local Government Area (LGA) of Gombe state Nigeria. Data were collected through fieldwork and use of questionnaire, interview with key informants and focus group discussion. The findings of the study shows that (79%) of the approved mine land has not been mined, while 13% of the mine land is under active mining at the moment and 8% of the mine land has already been mined and is presently under reclamation and revegetation. The study findings revealed that 6,100 seedlings have been successfully planted on the reclaimed land. Mangifera indica constitute the highest (20%), Azadirachta indica and Tectona grandis had 16%, Anacardium occidentale 15%, Eucalyptus camaldulensis 13%, Acacia senegal 12% and Jatropha curcas 8%.

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The study shows that about 50,000 m² has been reclaimed and planted with these economic trees, while another 40,000 m² of the area has been reclaimed and will be planted with trees any moment. The present revegetation exercise of the Maiganga coal mine demonstrated that reclamation of mined pits and rehabilitation of the ecosystem is not an operation which should be considered only at, or just before mine closure but integrated into the mine operation through all phases, from exploration to construction, operation, and mine closure. This study recommends the need to sustain the present revegetation effort throughout the life cycle of coal mining activity in the area. The study also recommends the replication of this exercise in other mining areas within the country and future study on the effectiveness of the present revegetation exercise on the mined land.

Keywords: Degradation; Maiganga; reclamation; revegetation and sustainable mining.

1. INTRODUCTION

Nigeria is well endowed with abundant natural resources which include arable land for agriculture, natural vegetation, mineral and human resources among others. The country started well on its industrialization and development effort at independent in 1960. The discovery, production and export of crude oil in the 1960s which is supposed to compliment other sectors of the economy turn out to be a curse. The enormous amount of wealth generated from crude oil exploitation and export made the government of the day and subsequent regime to neglect other sectors of the economy. Agriculture which was the main stay of the economy of the country before independence and discovery of crude oil and other sectors of the economy suffered neglect and underdevelopment. For several decades, scholars and economic experts warned of inherent danger associated with over dependent on crude oil production and export and total neglect of other sectors. But the warnings were never heeded to by the Nigerian Government.

Finally, the dooms day long predicted over dependence on crude oil is finally here with us. The continuous fall in price of crude oil at the global market is already taking its toll on the Nigerian people and economy. The government in response is working towards developing other sectors as alternative means of generating income and foreign exchange to meet its responsibility to its citizens. Attention is therefore shifting to agriculture and the exploration /exploitation of solid mineral resources that has long been abandoned.

The solid mineral mining landscape in Nigeria is dominated by artisanal and small scale miners (ASMs) whose operations are largely informal and often not known to the government. The proliferation of these artisanal and small scale

mining activities all over the country has had devastating effect on the physical environment. Most mining activities in Nigeria are open cast mining which has a highly damaging effect on the environment. Some of these environmental effects include loss of prime agricultural land, forest cover, water regime, air quality and biodiversity. The activities of the artisanal and small scale miners have left behind large numbers of abandoned open mines and derelict landscape.

Mining of solid minerals like coal has the potential of causing environmental degradation. Vegetation in form of natural forest and crop land are usually the first casualty in exploration and exploitation of coal in Maiganga. Land degradation associated with coal mining in the area includes deforestation, soil erosion, gulying and disconfiguration of the landscape. As a result of this, best practices in modern industrial mining requires the mining companies to provide funds to plant trees on an area equal or double that of the area of forest they cut down during their mining activity known as compensatory afforestation. The proliferation of abandoned open mine pits from past mining activities in the country was a source of concern. Government efforts at achieving reclamation and rehabilitation of these abandoned mines have been constrained by numerous challenges. This made the decision of the management of the Maiganga Coal mining company to incorporate sustainable practices in its mining operation a welcome development.

Many studies have been carried out on coal mining activities in Maiganga area but little attention or none has been paid to the reclamation activity of the coal mining company. This study attempt to appraise the sustainable practices in coal mining activities in Maiganga community of Akko Local Government Area (LGA) of Gombe state Nigeria. This will help to

provide a better understanding of the practices and effectiveness in achieving sustainable mining in the country.

1.1 Description of the Study Area

The study area, Maiganga village is located in Akko Local Government Area (LGA) of Gombe state. It is located 8 km off Gombe – Yola road. Maiganga village is located west of Kumo town between Latitude 09°18' and 11°59'E (Fig. 1). The study area, Maiganga community covers an area of about 20,129.47 Acres (48.16 Km²) [1]. The study area lies within the tropical continental type of climate characterized by well marked wet and dry season. Rainfall ranges between 850 to 1000 mm³ and the rainy season last between 5

to 6 months. Temperature is relatively high for most part of the year. Geologically the study area is developed on basement complex rocks. The vegetation consists of sparse trees, scrubs and open grasses. Some of the tree species in the area include *butyrospermum*, *Mumparadoxum*, *Tamanrindus indica*, *Pakia biglobosa*, *Balanite aegyptiaca*, *Afzelia Africana*, *fabia*, *albida*. The population of the study area consists of ethnic groups such as Jukun, Fulani and Tangale the dominant group among others. The population of Maiganga village based on the 2006 population census is about 3,520 people. The economic activity of the study area is farming which includes the cultivation of different crops such as maize, millet, guinea corn, groundnut, sorghum and groundnut.

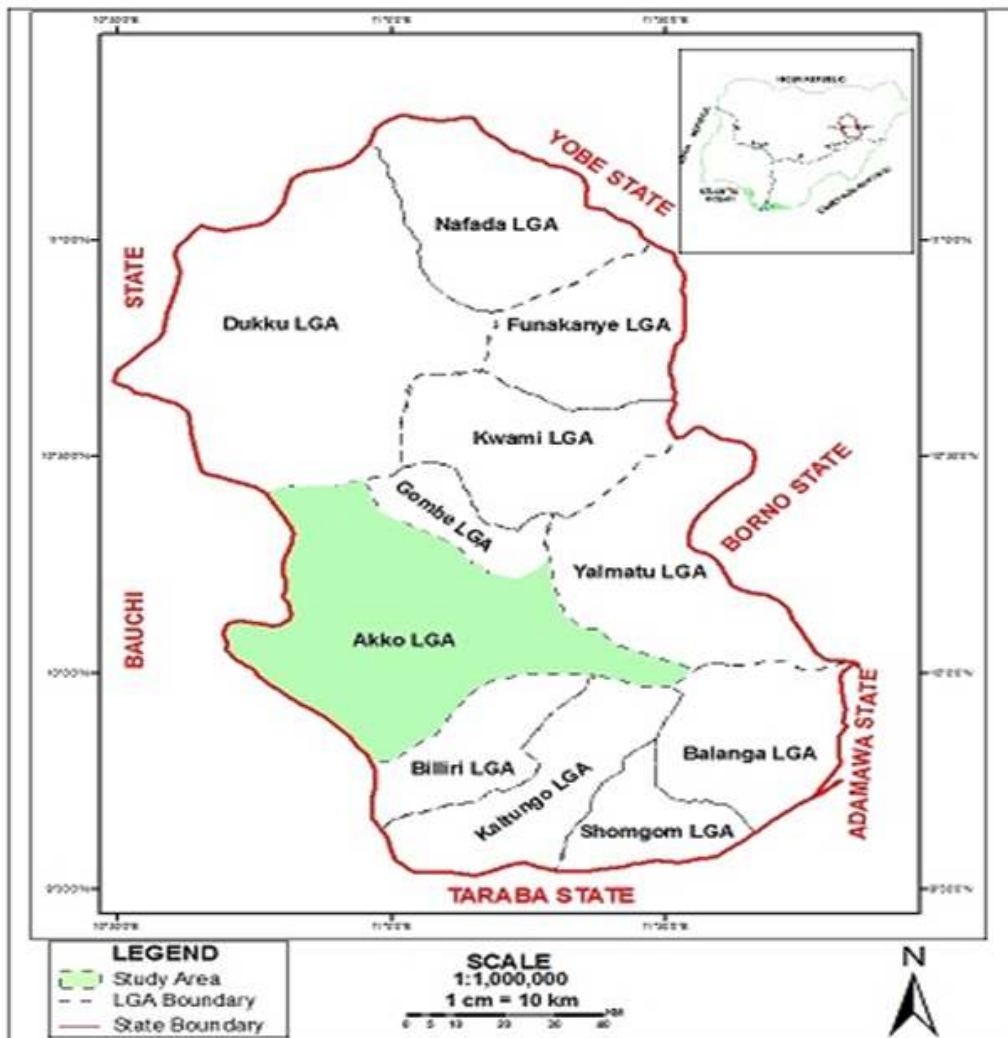


Fig. 1. Gombe state map showing study area

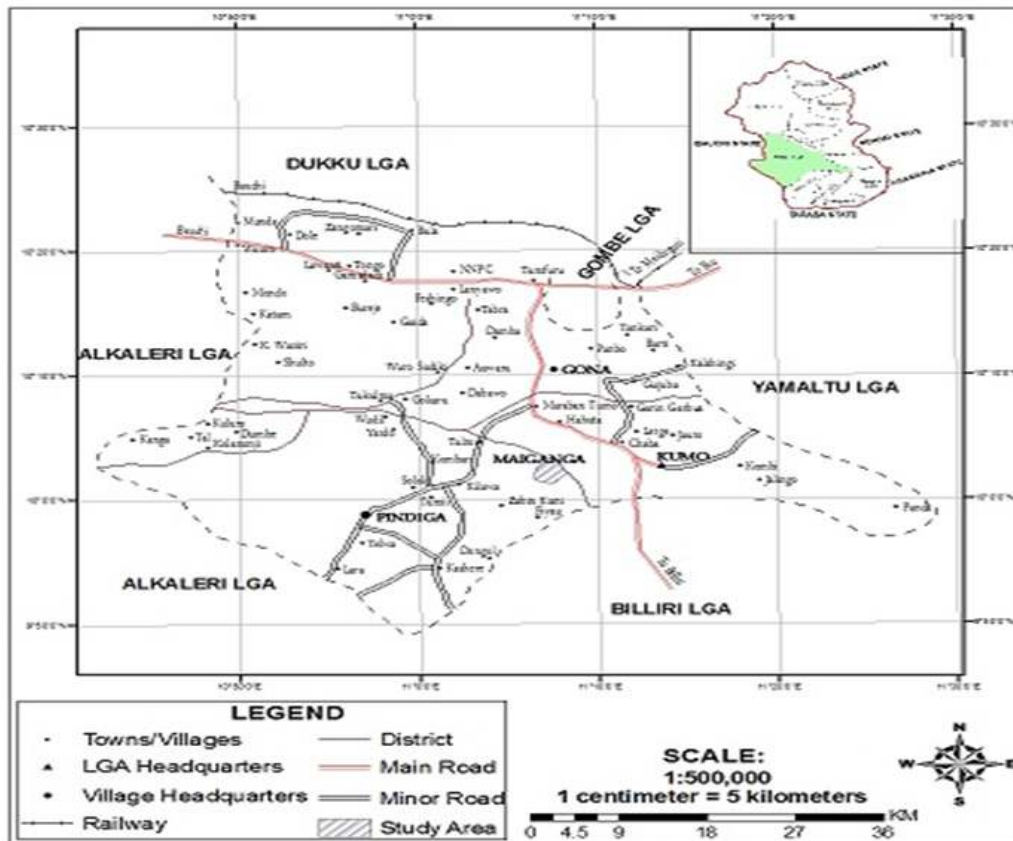


Fig. 2. Map of Akko showing Maiganga

2. MATERIALS AND METHODS

Data used in this study were generated from primary and secondary sources. The primary data were sourced from field observation, interviews and focus group discussion. The secondary data include information from files and memos of Ministries (Land and Survey, Mines and Development etc) and Ashaka cement company (the company responsible for the extraction of coal and reclamation of the mined fields). During the fieldwork, 70 questionnaires were randomly distributed to the rural dwellers in the affected villages. Some officials of the Coal mining company were interviewed (especially the Quarry Manager, Officer in charge of the coal mining site etc) to know the extent of the mining and reclamation activities and the type of tree species planted in the afforestation component of the reclamation.

The Focus Group Discussion (FGD) method was employed in this study. It involved discussion between the team of researcher and the local

community. The team of researcher includes the lead researcher and co-researcher. The local community involves the elderly, women and youth groups. The elderly group is heads of household who are 40 years and above. The women group is married women and the youths are those between 20 – 35 years old. It was applied at the village level, specifically at the village heads residence. The team of researchers comprises of three people; the lead researcher who acts as the recorder, the facilitator who set the discussion going, having the guide questions with him, and the observer who brings the facilitator back to track if he is derailing and reminds him of any forgotten point. Six to ten members of each of the three groups mentioned above suffice for this discussion. The major aim of applying this method was to obtain additional information required for this study. The Information obtained from the questionnaires, individual interviews and focus groups discussion was content-analyzed and subjected to descriptive analysis.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of Respondents

The demographic data shows that 80% of the respondents are male and 20% are female as shown in Table 1 below. The Table shows that 11.4% of the respondents have no formal education, 60% has primary education, 25.7% have secondary education while only 2.9% have tertiary educational qualification. The demographic data also shows that 15.7% of the respondents are within the ages of 15 - 25 years, 38.6% are between 26-35 years, 30% between 36 - 45 years and 15.7% are above 46 years. The result also shows that 65.7% of the respondents are farmers, 21.4% are cattle rearers, 4.3% civil servant, while 8.6% are traders.

Table 1. Demographic characteristics of respondents

Gender		
Gender	Frequency	Percentage (%)
Male	58	82.9
Female	12	17.1
Total	70	100
Educational attainment		
No education	08	11.4
Primary Education	42	60
Secondary Education	18	25.7
Tertiary Education	02	2.9
Total	70	100
Age		
15 – 25 yrs	11	15.7
26 – 35 yrs	27	38.6
36 – 45 rs	21	30
46 yrs and above	11	15.7
Total	70	100
Occupation		
Farming	46	65.7
Civil Servant	3	4.3
Cattle rearers	15	21.4
Traders	6	8.6
Total	70	100

Source: Fieldwork 2015

3.2 Coal Mining in Maiganga

The need for alternative fuel to leverage on the risk of fuel price increase by the Ashaka cement company led to the search and discovery of coal at Maiganga village in Akko LGA of Gombe state.

The Ashaka cement factory initially buys coal from other parts of the country before the discovery of the Maiganga coal mine. The major type of coal discovered in the area is lignite which is a low grade of coal because of its high moisture and ash content. The Ministry of Solid Minerals Development approved the mining and exploratory licenses within 153 and 30 cadastral units for 21 years with effect from May 2006. Mining activity in Maiganga area commenced in October, 2007. The type of coal found in Maiganga area is of the lignite grade. The coal mineral proven reserve has been estimated to 4.5 million tons. It is believed that this deposit will meet the company's requirement for more than 25 years. Findings from the study show that greater part of the area has not been mined as indicated in Table 2.



Fig. 3a and b. Coal mining at Maiganga coal mine

The Table 2 shows that greater portion of the approved coal mine land (79%) has not been mined, an indication that the mining activity in the area is a recent development. 13% of the mine

land is under active mining at the moment, while 8% of the mine land has already been mined and is the area been focused for this present study where reclamation and revegetation are taking place.

A study by Benjamin [1] on the impact of coal mining activity in the study area shows that natural vegetation has decreased from 7126.30 acres in 2005 to 1391.54 acres in 2016. Mining activity in the area was associated with site clearance of vegetation which exposes the soil to sun and wind activity. The study also show that farmlands have also reduces from 5771.23 acres in 2005 to 3344.65 acres in 2015 [1].

In line with the new government policy on mining, progressive reclamation is supposed to be incorporated for implementation in any approval for industrial mining activity as stipulated in the Nigerian Minerals and Mining Acts 2007. Progressive reclamation will enable the prospective mining company undertake reclamation of depleted sector of a mined area while active mining in other sectors of the coal mine continue. This requires that mining activity and reclamation exercise takes place at the same time simultaneously. Materials from newly opened areas are used to reclaim abandoned or exhausted site. As the coal minerals are removed, the depressions created as a result of excavation are filled backwards (in the reverse order) with the heaps of the overburden. The red lateritic material followed by the topsoil at the site. As these depressions are filled up with the overburden waste, tree seedlings are planted on the reclaimed land to facilitate stabilization and

total restoration of the mined land. In an interview during a fieldwork at the site, the Officer in Charge of the Coal mining activity claimed that the area under afforestation exercise (Fig. 6a and b) is about 50,000 m², while the area reclaimed (Fig. 5a and b) that will be planted any moment is about 40,000 m².

3.3 Level of Awareness of the Afforestation

The study sought to find out the level of awareness of the local people of the afforestation component of the reclamation project of the coal mine company. The findings of the study show that almost all the respondents (94%) were aware of the afforestation activities of the Ashaka Cement Company in the area, while only 4% of the respondents claimed not aware of the afforestation activity. The respondents went on to identify some of the plant species used in the afforestation exercise which include Mango, Neem (*Azadirachta indica*), *Eucalyptus gamadullensi*, *Jatropha caucuss*, Gum Arabic, Chasew (*Anacardium occidentale*) and Tectona grandis teak or Umbrella trees (Table 3).

The Table 3 shows that Mango tree has the highest percent (20%) of the trees so far planted in the afforestation exercise of the reclamation strategy of the mine land. Neem and Umbrella trees had 16% each, cashew 15%, Eucalyptus 13%, Gum Arabic 12% and Jatropher 8%. Most of the trees planted were economic trees that will serve as source of food (vitamins and minerals) and cash crops to the workers and local community in the area.

Table 2. Proportion of land under mining and reclamation in the area

S/No.	Status of land	Total area (hectares)	Percentage (%)
1	Total land area for Mining	474	79
2	Land area under mining	78	13
3	Total Land area under reclamation	48	8
4	Total	600	100

Source: [2]

Table 3. Plant species identified in the Reclaimed area

S/No	Name of plant species	Number planted	Percentages
1	<i>Mangifera indica</i>	1,200	20
2	<i>Azadirachta indica</i>	1,000	16
3	<i>Eucalyptus camaldulensis</i>	800	13
4	<i>Acacia senegal</i>	700	12
5	<i>Jatropha curcas</i>	500	08
6	<i>Tectona grandis</i>	1,000	16
7	<i>Anacardium occidentale</i>	900	15
8	Total	6,100	100

Source: [2]



Fig. 4a and b. Degraded mine land at the Maiganga Coal Mine site

4. DISCUSSION OF FINDINGS

It has been observed that mining of mineral resources often results into extensive soil damage, capable of altering microbial communities and affecting vegetation leading to destruction of vast amounts of land [3]. The challenges of modern mining development are how to achieve minimum disturbances to environment without compromising economic growth and quality of life [4]. Land degradation is an unavoidable outcome of mining activity. It can be defined as a human induced or natural process that negatively affects the land to function effectively [4]. Mining operation irrespective of the techniques used, from mineral explorations to production and transport have a devastating effect on the environment in many ways. These effects includes deforestation, loss of top soil, accelerated soil erosion, soil contamination, qualitative and quantitative depletion of surface and ground water resources,

migration of wild life and avian fauna, and addition of air pollutants and dust in the atmosphere [4]. Many of these problems are exceptionally difficult to avoid in surface mining as practiced in the coal mine of Maiganga.



Fig. 5a and b. Reclamation work ongoing at Maiganga Coal Mine

Siddarth [4] observed that ecological restoration and mine reclamation have become important part of the sustainable development strategy in many countries. It is believed that good planning and environmental management will go a long way in reducing the negative impacts of mining on the environment and help in preserving eco-diversity. This brings to the fore the importance of sustainable mining which according to Siddarth [4] is “ensuring that the mineral raw materials need of society are met, without compromising the ability either of future societies to meet their needs, or of natural environment to sustain indefinitely the quality of environmental services such as climate systems, biological diversity and ecological integrity”. Such

sustainable development according to Siddarth [4] conserves the resources like land, water and biodiversity. Sustainable mining in the study area has the potential of reducing the negative impacts that the coal mining activity will have on the area because sustainable systems are less risky, environmentally non-degrading, technically apt, economically feasible and socially acceptable [4].



Fig. 6a and b. Neem trees and Jatropha planted at the Maiganga reclaimed mine land

Reclamation can be seen as the process of restoring the ecological integrity of degraded mine land. According to Yelapaala [5] reclamation is the rehabilitation of disturbed areas resulting from surface or underground mining. In the majority of cases, reclamation of abandoned mine requires the establishment and maintenance of vegetation on degraded land. It is believed that there is no other medium can achieve rapid visual integration, surface stabilization, or reduction in air and water pollution, nor offer a wide variety of land-use

possibilities, which can be achieved at acceptable cost [4] as vegetation. This was corroborated by Shareon [3] when they observed that revegetation constitutes the most widely accepted and useful way to reduce erosion and protect soils against degradation during reclamation.

Vegetation has been reported to play important role in protecting the soil surface from erosion and allowing accumulation of fine particles [6,7]. Vegetation has the potential to reverse degradation process in an area by stabilizing soils through development of extensive root systems. Once they are established, plants increase soil organic matter, lower soil bulk density, and moderate soil pH and bring mineral nutrients to the surface and accumulate them in available form [3]. Their root systems of the vegetation allow them to act as scavengers of nutrients which are not readily available. The plants accumulate these nutrients and redeposit them on the soil surface in organic matter from which nutrients are much more readily available by microbial breakdown [8-10]. Re-vegetation in a reclamation exercise is effective where native multiple species including ground covers are used [11]. This informed the choice of the local species of trees used in the afforestation project. Their economic importance as edible fruits and cash crops is an added advantage to the scheme and beneficial to the local communities in the study area.

5. CONCLUSION

Reclamation of mine land is a very complex process. This study has examined revegetation or afforestation activities in Maiganga coal mine as part of a strategy of progressive reclamation activities of the mine land in the area. Revegetation or afforestation constitutes the most widely accepted and useful way of reclamation of mine land. The present revegetation exercise of the Maiganga coal mine demonstrated that reclamation of mined pits and rehabilitation of the ecosystem is not an operation, which should be considered only at, or just before mine closure but integrated into the mine operation through all phases, from exploration to construction, operation, and mine closure. The consensus of experts is that the effectiveness of reclamation must be measured by more than the presence of vegetation on the site. There is the need therefore for future studies that will examine the effectiveness of the present revegetation or afforestation exercise in

the coal mine area of Maiganga. The present choice of economic trees in the revegetation and afforestation exercise will go a long way in benefitting the local communities and management of the company by serving as source of food (vitamins and minerals) and cash crops to the workers and local community in the area. This study recommends the need to sustain the present revegetation effort throughout the life cycle of coal mining activity in the area. The study also recommends the replication of this exercise in other mining areas within the country and future study on the effectiveness of the present revegetation of mined land in the study area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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