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LAND DEGRADATION DUE TO MINING: THE GUNDA SCENARIO

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ABSTRACT

Several studies have been carried out on the effects of mining on the environment, these have been characterized by landscape devastation, deforestation, it has also exposed the land to both wind and water erosion, water pollution and other environmental hazards which poses threat to humans in diverse ways. The study is set out to examine land degradation due to mining in Gunda area of Biu plateau with emphasis on the landscape. Both primary and secondary data were used. The nature of the environment such as destruction to the landscape, lost in vegetation cover, scattered open pits, alteration of water courses etc were all considered. One of the findings revealed that mining has led to the discovery of diatomite in the pits along stream channels which they use locally for painting purposes in building. The findings further revealed that reclamation work may not likely take place soon, because there are no economic returns from it. The study therefore, recommended among others, that reclamation be encouraged by using some of the pits for wastes disposal with farm and household residues so as to refill it especially those on farmlands, also measures should be taken by the inhabitants in restoring back the altered stream channels to their former glory by filling the cuts.

Keywords: Effects, Landscape devastation, Environment, Scattered pits, Alteration.

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1. INTRODUCTION

The last two decades have witnessed a growing awareness of the need for better understanding of the effects of man`s activities on all facets of the landscape (Bukar, 1997). The search for and extraction of mineral resources is one of such activities through which the environment suffers damages. Man has always been conspicuous in his ability to alter the surface of the earth for various purposes. Some of the most extreme alterations occur in the extraction of minerals. According to Roots (1977), the environment is integrated and its components are linked by dynamic processes. We cannot use or affect any part without affecting some other parts. Udo

(1990) observed that the extraction of minerals in Nigeria especially by the open cast process left undesirable effects on the land surface. The most widespread destruction of the rural landscape according to him is caused by indiscriminate quarrying of sand and laterite as well as gravels for road construction and building purposes. Indeed, mining operations have been envisaged by environmentalist and conservationist alike as causing some of the most devastating and far-reaching consequence to the environment (Ripley *et al*., 1978). In this regard, Day (1985) observes that the very process of mining fossil fuel and minerals defaces the land with great scars and pits, destroys ecosystems and brings on many undesirable side effects such as water pollution and the disturbance of hydrologic systems.

The detrimental effects of mining on the environment at local, regional and global levels will continue to be a topic of public concern. It is against this background that the study is designed to examine land degradation due to mining in Gunda. Sapphire and other minerals such as corundum, zircon, ruby and garnet were the minerals mined in the area. Mining was a primary activity that has competed with farming in the area. This has resulted in degradation of the landscape in the area. Therefore, the study examined the changes on the environment resulting from this degradation.

2. STATEMENT OF THE PROBLEM

Mining and its related activities have always resulted in changes in the environment. These changes differ from one area to another. Saidu (2003) in the study of the potentials of mining lands for agriculture on the Jos plateau, observed that the Ray Field area of the Jos plateau was rendered derelict and considered 'unsuitable' for crop cultivation as a result of the open cast method of tin mining. The study conducted by Mohammed (1996) on the impact of sapphire (precious stone) mining in Gunda and environs, revealed that, sapphire mining has brought about environmental hazards. A similar study conducted on Gypsum mining in Southern Fune area in Yobe state revealed that the very process of extracting gypsum causes varying degrees of landscape devastation characterized by mounds of dumps and ubiquitous open pits (Bukar, 1997), also the clearing of sites of vegetal cover has resulted in deforestation which has in turn initiated both wind and water erosion in form of rills and gullies. It is also evident that while the socio-economic benefits accruing from mining activities are positive and are of prime importance to the inhabitants, the environmental consequences of the mining are blatantly disregarded.

Gana (1999) findings on the effects of mining on socio-economic activities revealed that the immediate benefits in terms of financial returns were more important to the people than the hazard caused to the physical environment. From the foregoing therefore, there is the need to undertake an in depth study to examine changes in the environment due mining in Gunda area with emphasis on the landscape. This study will try to find out what the detrimental effects and environmental hazards caused by the mining as revealed by Mohammed 1996 are, with the view to bringing to light more findings on the above scenarios.

2.1. Aim and Objectives of the Study

The primary aim of this study is to examine the type of land degradation that has taken place in the study area.

The specific objectives are to:

1. Examine the changes in vegetation resulting from mining activities in the area.
2. Assess the efforts of the inhabitants towards reclamation activity in the mined areas.
3. To examine other changes caused by the mining on the landscape.

3. METHODOLOGY

This section presents a description of the study area and methodology used in the collection and analysis of the relevant data for the study.

3.1. The Study Area

Gunda area is located in southern part of Borno State Nigeria, on the Biu plateau. It is located within latitudes 11^0 50' and 11^0 55' north and longitudes 10^0 45' and 10^0 50' east. It is situated North West of Biu and west of Mirnga; it covers an area of about 5,000 sq km, with an average altitude of about 460 meters above sea level. (Davies, 1954). The climate of the area is strongly influenced by two distinctive air masses. March and April record the hottest temperature and gradually the temperatures fall as the next season is commencing. While the period December to February records the lowest temperatures, when the temperature drops below 18^oc (59^o f). The soils of Gunda area have great variety, which is modified by the climatic condition of area. Very fine dark grey colour soil occurs in fairly low land areas. Black clay, normally known as cotton soils, which become sticky when wet, when dry it has an enormous shrinking capacity giving rise to cracks several feet deep in some places (such areas are to the North-West of Gunda). The vegetation of the area is thick bush that is the guinea savannah type. This reflects the climatic condition and the activities of man on the soil.

The geological formation of Borno region generally, comprises both the Basement Complex and Sedimentary formations which are associated with various types of rocks and mineral deposits of great economic importance. Sapphire (precious stone) in Gunda area of the Biu plateau is one of such. However, the potentialities of this mineral have not been fully explored as no detail geological survey has been carried out to locate the deposits of this mineral of economic value, (Daura, 2001). The geology of Gunda area is dominated by basaltic rocks which are the product of volcanic activity that are prominent in the area, belonging to Mirnga basalt type which is the largest area of volcanic rock occurrence on the Biu plateau.

4. SOURCES OF DATA

The sources of data for this study comprised both primary and secondary sources. The primary sources of data were observation and interview conducted at the various phases of the detailed study; therefore, sample sites were identified and selected within the study area from which studies were carried out .These was done in three phases. Phase one was the reconnaissance survey aimed at familiarizing the researcher with the study area. General

observations of the area were made and sample sites identified. The identification of sample sites was based on the stratified random sampling technique. The study area was divided into sections and sample locations noted randomly. Two sample locations were selected for detailed studies, i.e. degraded area to identify abandoned mined sites and the relatively undisturbed area to measure vegetation parameters. Measurement of the pits were also taken and presented. Phase two involved data collection on existing land uses, thus detailed observation was made to identify the kinds of degradation that has occurred and also to find out the use to which the heavily mined sites have been put. This is with special reference to vegetation cover (density and composition) between adjacent areas and landforms that have developed and measurements taken. The stratified random sampling method was used since there was the prior knowledge of the study area during the initial preliminary survey in phase one. Efforts of the inhabitants toward reclamation of the mined sites were also considered. Photographs depicting environmental degradation of mined sites were also captured at different locations within the study area. Phase three was interview with key informants such as the village head (1), youth leaders (12), elders (10) and others (22). In all 45 people were interviewed, all resident of the area. This was based on the convenience sampling technique due to the situational issue found at the time of administering the interview. The information obtained was deductively approached based on the perception of the people.

5. SAMPLING TECHNIQUE FOR VEGETATION PARAMETERS

The stratified sampling method requires prior knowledge of the study population by conducting an initial preliminary survey. Vegetation parameters measured are the life form composition and tree density.

5.1. Tree density

The term density is applied to the number of plant units per unit area. During the field investigations tree density measurements were taken and obtained by counting the number of trees in each of the sample sites (40m x 35m plot). Shrubs which grow in clumps were also considered as single plant units and were counted. The relative abundance of the species was obtained by dividing the density for a given type of plant by the total density for all types of plants and then multiplying by 100. Density determination is useful in evaluating the number of individuals in a shrub or tree stand. The sample plot of 40m x 35m was large enough to enclose an adequate number of plant species for the purpose of getting the plant species population. Composition of plants in the sample plots differ from one place to another, for the purpose of this study only the life form composition of trees and shrubs were considered.

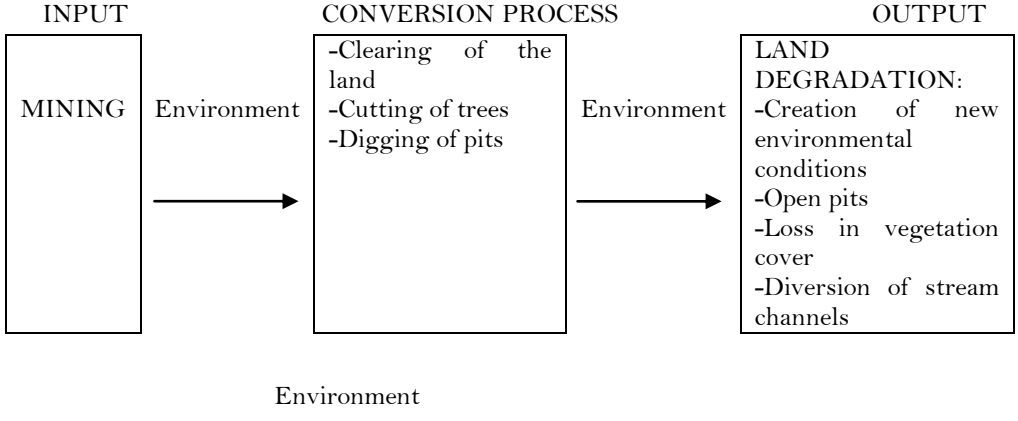
6. CONCEPTUAL FRAME WORK AND LITERATURE REVIEW

The theory guiding this study is the systems theory. This section therefore, reviews the systems theory with a view to bringing out the salient features that would enable this study to fit in. Similarly, the concept of land degradation is also incorporated to further buttress the effect of mining within the system. The general systems theory developed by Bertalanfy (1951), argue

that the natural geology consist of mutually related subsystems and the destruction of one of the subsystem lead to the modification of the entire system. The environment is the sum total of all the external factors that influences the life of an organism, here the physical environment which comprise the land is considered. Consequently in the strive for economic growth, the physical and social environments are subjected to pressure that affect the entire system. He emphasized that real systems are open to, and interact with, their environments, and that they can acquire qualitatively new properties through emergence resulting in continual evolution. Thus rather than reducing an entity e.g. (environment) to the properties of its parts or element e.g. (land), system theory focuses on the arrangement of and relations between the parts which connect them into a whole.

The systems theory conceptualizes land degradation as the response of the mining to the demand of the environment. The theory sees land degradation as an output of the mining. Land degradation such as lost in vegetation cover, changes on the landscape is therefore seen as the reaction of the mining to environmental demands and pressures. The theory shows that the relationships that unite the part to form a whole have a lot of influence on the behaviour of the whole. The theory posits that the whole is more than the sum of the part. The foregoing is shown in the diagram below:

Fig-1. The variant of systems theory adapted from Easton (1965).



Man affect his environment as he respond to the changing condition set by the environment and the environment responds to human manipulation, thereby creating a state of dynamic equilibrium that continues to adjust and readjust in space with time (Olofin, 1989). The systems theory was chosen against other theories because, the world is made up of components and the components are interrelated. Nothing is independent on its own. A change in one will have repercussions on the other parts. With respect to this study therefore, because man depend on the mining and the mining is being done on the land, the environment is in turn affected by such activity and land degradation sets in. The relationship between the two is that the mining as an input was converted into land degradation as the output in this case. The three interrelated components resulted into land degradation. Land is one of the major resources in both developed

and developing countries, and forms the basis of economic sustenance. Degradation is therefore the diminution of the biological productivity expected of a given tract of land (Ayuba, 2005). Land degradation which includes degradation of vegetation and soil has been identified as a major problem in Africa (FAO, 1980). From the foregoing therefore, the systems theory sees land degradation as the output of the mining.

7. LITERATURE REVIEW

Mining is the process of getting minerals etc, from mines. Land degradation is considered as the disturbance of the ecological conditions of a land area rendering it derelict. Wallwork (1974), defined a derelict land as that land which has been abandoned by its owner. land degradation also refers to the decline in the productive capacity of an ecosystem due to the process induce mainly by human activity (Sehgal and Abrol 1992). On the degraded land, soil is eroded, vegetation is diminished, increase surface runoff and contamination of water (Ayuba, 2005).

According to BBC Focus on Africa (July 2002), in Zambia for instance, mining was the engine for economic growth, but now, the country is counting the environmental cost. Kabwe's current problems stem from its former lead mine and smelter operation, which were the biggest on the continent and the very life-blood of the town. From 1904 until its closure in 1994, the mine provided employment for the people of Kabwe and foreign exchange for the Zambian government. After it was shut, poverty level soared and thousands of Kabwe's inhabitants left in search of work. While many people now refer to it as a ghost town, few are aware that Kabwe continues to be haunted by a dangerous environmental legacy of the mine-lead contamination as a result of the mining activities. The mines in Kabwe are largely obsolete and the task now is to reduce their environmental impact. "There is certainly a serious problem in Kabwe because residential areas are situated so close to the mining operations and water supplies have been contaminated". Says Peter Sinkambe, executive director of citizens for a better environment (BBC Focus on Africa, July 2002). Mineral resources are limited which raises important questions. How long will a particular resource last? How much short term or long term environmental deterioration are we willing to accept to ensure that the resources are developed in a particular area? How can we make the best use of available resources? These questions have no easy answers. No technology can be completely free of environmental impact. There is only one solution; man must recognize the necessity of cooperating with nature. He must temper his demands and use and conserve the natural living resources of this earth in a manner that alone can provide for the continuation of his civilization (Osborn, 1948). The mining and processing of mineral resources generally have a considerable impact on land, water, air and biological resources, Environmental degradation tends to extend beyond the excavation and surface plant areas of both surface and subsurface mines. Large mining operation disturbs the land by directly removing material in some areas and dumping waste in others, thus changing the topography. At the very least, these actions produce severe aesthetic degradation. In addition, dust at mine sites may affect air quality (Botkin and Edward, 1998).

In a study of mining activities in Nigeria, Akintola (1978), stated that "there are areas which were affected by mining which have caused great concern, where the landscape is made up of

manmade lakes which conserve water for the mining activity. The mining has tended to increase the susceptibility of the land to erosion; it has increased the occurrence of landslides, mudflow and slumps". Furthermore, Howard and Ramson (1978), stated that, the most problems of mining are the environmental degradation, which ranges from pollution and defacing of the environment as a result of the exploration, processing and miscellaneous activities of the mining. The reclamation of mined lands is referred to here as the rehabilitation of degraded (derelict) lands as a result of mining activities for some beneficial use. For example, some mined areas might be reclaimed for use as farmland now that the original hills have been leveled, while are others are left. The town of Moremella has been reclaimed through infilling of coal basin of 800 million cubic meters of over burden. The present land is used for forestry. Success story about reclamation in different areas include a number of researches from various parts of Africa which have shown that acacia albida (Hausa –gawo) has a beneficial effect on the nutrient status of the soil lying immediately beneath the canopy (Alexander, 1986). This shows that in 30 years of continuous cropping of sorghum beneath the canopy of acacia albida without the addition of any fertilizer will enable yield to remain constant. Langkamp and Dallin (1982), found that another acacia specie i.e. Acacia holosserica had a similar beneficial effect on reclaimed mine spoils.

On the Jos plateau for instance, the promulgation of the Mineral Act of 1946, paved way for the reclamation of mined land on the plateau. However reclamation began in 1949 and was undertaken by Mines Land Reclamation Unit (MLRU) and the Forestry Department of the Ministry of Agriculture and Natural Resources (A.T.M.N, 1969). The reclamation strategy for tin mine on the Jos plateau is of eucalyptus plantation comprising eucalyptus camadulensis have been established on reclaimed mine sites. In their study of mining and the environment, Leong and Morgan (1972) focused on the issue of land dereliction. Theoretically, derelict land refers to land which has been badly damaged as a result of ruthless exploitation of natural resources without consideration for the future. Such mine sites are characterized by ugly landscape denuded of vegetation. In another development, Day (1985) observed that voids left behind after the completion of mining operation cause a number of problems. To this end one should understand that no mining activity ever took place without leaving a scar on the environment. Bukar (1997), also observed that all mine pits are abandoned after operations. Thus, no form of reclamation or restoration takes place at all the sites; it is evident that while the socio-economic benefits accruing from mining activities are positive and are of prime important to the inhabitants, the environmental consequences of mining are blatantly disregarded. Thus, Gana (1999), also discovered that the immediate benefits were more important and their survival is directly dependent on it, not minding the environmental cost.

8. ANALYSIS OF DATA

First of all, the changes in vegetation parameters resulting from the mining activities and the kinds of environmental degradation that have taken place in the area were considered, then an assessment of the efforts of the inhabitants towards reclamation activities.

8.1. Changes in Vegetation Parameters

This subsection deals with the changes in vegetation parameters, such as density and composition within the entire study area and a detail survey of those within the mined area. The density is applied to number of plant per unit area. During the second phase of the study tree density measurement was taken and obtained by counting the numbers of individual trees and clumps of shrubs in each of the sampled plots (40m x 35m). The density of plants for the mined sites were less than that of the unmined sites, clearing of the sites for mining have no doubt accounted for this decline in tree density. Table 1, shows the tree and shrub density per sample plot which is further simplified in table 2.

Table- 1. Tree and Shrub Density at the Mined and the Unmined Sites

Plots		Mined site		Unmined site	
	Density	**No**	**%**	**No**	**%**
1	Tree	1	6.7	6	14.6
	Shrub	2	13.3	4	9.8
2	Tree	0	0	7	17.1
	Shrub	5	33.4	6	14.6
3	Tree	0	0	5	12.2
	Shrub	3	20.0	8	19.5
4	Tree	2	13.3	2	4.9
	Shrub	2	13.3	3	7.3
Total		15	100	41	100

Source: Field work, 2004.

The study revealed that the mining has adversely affected population of trees and grass species found in the area, because of clearing of site for mining. The decline in the tree density particularly in the mined sites has been attributed to cutting down of trees to give way for the mining. The very process which led to this is depicted in the plate below.

PLATE 1

The process which led to vegetal degradation.

The population of trees has reduced due to mining around them and eventual falling down due to lack of support from surrounding area which has hitherto affected tree population and fuel wood extraction to some extent and other animal feeds purposes. The result obtained shows that there are more shrubs on the degraded surface compared to the relatively undisturbed (unmined)

area in Gunda. There are seven times trees in the unmined than the mined sites; the same thing applies to shrubs where they are two times more in the unmined than in the mined sites. The foregoing is presented in table 2.

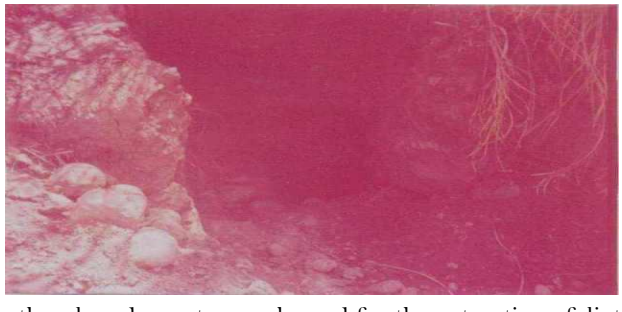
Table- 2. Ratio of Trees and Shrub in Mined and Unmined Sites

Density	Mined	Unmined	Ratio
Trees	3	20	1:7
Shrub	12	21	1:2

Source: Field work, 2004.

While some of the farm lands affected by the mining have been abandoned, some farmers still use the mined farm lands to cultivate crops. When asked to compare crop yield before and after the mining most of the inhabitants said there is no much difference in yield because they practice the use of green manure from former corn stalk which they allow to sprout in early period of the rainy season then cut them down and there after plough the farm land for the green leaves to decay thereby supplying nutrients to the soil. Observations further revealed that the mined areas around stream channels are used for extraction of diatomite (some whitish deposits found along stream channels when dug deeper which is used as a building material for painting in construction work), Plate 2.

PLATE 2



Pits further dug along stream channel for the extraction of diatomite.

The conversion of the land for mining has also affected their grazing lands, fuel wood extraction; this is because before the commencement of the mining some sites were used for farm lands, grazing by animals and the rest left for fallow, but due to the mining, the presence of big stones, over burdens, have hitherto forced the inhabitants and farmers to abandoned them due to the threats it poses to lives. Observation revealed that most of the pits get enlarged in the rainy season. Therefore, it has now become difficult for people to move around freely because of the scattered pits around the mined areas. Table 3 shows the distribution of the depth of some selected pits in the area.

Table- 3. Depths of Pits to Show the Dereliction

Depth(m)	Frequency	Percentage (%)
0-.9	11	28.2
1-1.9	9	23.1
2-2.9	12	30.8
3-3.9	4	10.3
4-4.9	3	7.6
TOTAL	39	100

Source: Fieldwork, 2004.

The inhabitants do not like the environment as it is now but said they cannot work on reclamation because it will not fetch them any cash that is to say it has no economic benefits.

Therefore they live it for nature to take its course. This is with the exception of the areas that the mining was not severe. Here individuals have reclaimed their farm lands by the use of stones and the overburdens and in some cases nature helped through rainfall by washing soils downhill and deposited them in the shallow pits. Plate 3 shows a picture of such area. While plate 4 shows young tomato plants thriving well on a reclaimed farmland shortly after the rainy season in 2004.

PLATE 3

Farmland reclaimed by the owner after mining.

PLATE 4

Reclaimed farmland showing young tomato plants shortly after the rainy season in 2004.

Changes in the landscape due to mining

Changes in the landscape that occurred due to the mining are prominent; these include presence of overburdens, gullies, effects on drainage and abandoned mined pits with grasses and shrubs growing around them which represent landscape degradation. Plates 5 and 6.

PLATE 5

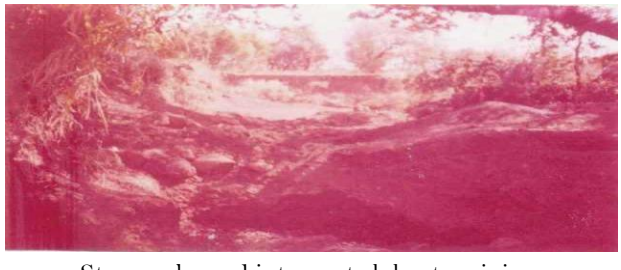
Scattered pit an evidence of landscape degradation.

PLATE 6

The abandoned mined pit with grasses and shrubs growing around it

Drainage systems were affected in the sense that sedimentation and deposition of mineral residues resulting from the washing of the soils with path finder fragments have deposited debris into the water thus making it unhygienic for consumption. Mohammed (1996) observed that streams in the area are heavily polluted due to washing so that valuable minerals are left behind, which are then checked and are picked up. There is also the diversion of the stream channels or its blockage due to such act, Plate 7.

PLATE 7



Stream channel interrupted due to mining.

Alteration of the drainage channels was caused by diversion and expansion due to mined pits and in some cases where the streams are small they are blocked. Some of the pits especially those on the water course are being used for the extraction of diatomite as seen in plate 2 which is use as white wash for painting in building purposes. But the diatomite is found only along the water courses. On the issue of reclamation activity, it is obvious that reclamation activities may not be embarked upon collectively by the inhabitants in the near future for the simple fact that there are no economic returns from it, because there is no legislation on the mining. Although some

farmers have reclaimed their farm lands individually to some extent so as to continue to cultivate on it, but only where the cuts are small as seen in plate 3 and 4. In general environmental damages include the following: destruction of landscape, depletion of vegetation cover, encroachment on agricultural farm, alteration of water courses, degradation of visual environment, effects on grazing lands and scattered pits, plates 8a, 8b and 8c.

PLATE 8a

PLATE 8b

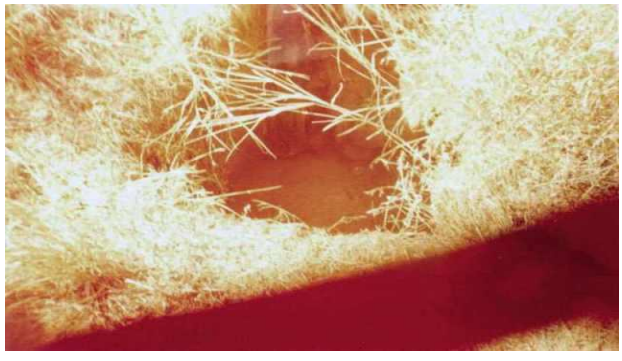


PLATE 8c

Scattered open pits.

To this end one should understand that no mining ever took place without leaving a scar on the environment as observed also by Dan'azumi (1986), this goes further to be in agreement with

Bukar (1997) where it states that the mining and extraction of the gypsum causes varying degrees of landscape devastation characterized by mounds of dumps heaps and ubiquitous open pits.

9. DISCUSSION OF FINDINGS

The study has revealed that mining has devastated and brought about changes on the landscape, with scattered pits, loss in vegetation cover. This corroborates with the findings of Mohammed (1996), that the mining of sapphire in Gunda and environs has been largely responsible for changes in the landscape pattern over the years. The findings further reveal that there are obstruction of stream channels characterized by blockage of passage ways due to deposit of residue and debris from dug pits which are being dug further to extract diatomite use for painting in building work.

The scattered open pits are left for nature to take its course, because there is no effort collectively by the inhabitants towards reclamation simply because there is no economic return from it. But some concerned individuals have reclaimed mined areas that affected their farmlands where the cut made are shallow so as to cultivate crops on it. However, there is the need to tackle the problem of waste generation and environmental degradation through adequate cooperation of the individuals and the government (Kagu *et al*., 2004). So far the farmers said crop yield is still sufficient since only shallow pits are reclaimed it does not make any significant difference to them but said may be there may be a difference if the deep pits are reclaimed and crops grow on them.

The waste materials also created problems of pollution to water and land surfaces. "The environment experiences a lot of problems as a result of mining, landforms, landscape, vegetation are all affected therefore land cover meets a fundamental attention in studies of landscape changes" (Richling *et al*., 2000). From the foregoing therefore, it is evident that all mining exploration leads to one problem or the other, causing diverse kinds of disruption to the environment.

10. CONCLUSION

Land degradation due to mining was examined. The study showed that mining has resulted into land degradation in the area. The pits which are further dug to extract building materials and the overburden dumps are indicators of land disturbance in areas affected. Vegetation cover has reduced as a result of deforestation, which has in turn led to the exposure of the soil surface, which in some cases has initiated gully erosion and has expanded the cuts. The drainage system of the area has also been affected by the mining activities, while some streams were obstructed by blockage of passage ways due to deposits of residue, the direction of flow of other streams were diverted and tampered with due to further digging to extract diatomite. The land degradation has resulted as an output of the mining which was as a result of reaction of the inhabitants to demands and pressure from the environment and strive for economic growth, which the systems theory conceptualizes. The theory sees land degradation as an output of the mining because man depends on the mining and the mining was done on the land, the environment is in turn affected by such activity which has resulted in land degradation. In a nut shell it has brought to light some of the detrimental effects mentioned by (Mohammed, 1996) in his findings.

11. RECOMMENDATIONS

This study has succeeded in getting a logical end, and it has developed a positive starting point for the assessment of other activities in the area. This is in no way been exhaustive due to many reasons; other issues need to be documented. Therefore, further investigation of some aspects is required, because it will provide a continuous assessment of the environmental effects of the mining and this in turn will provide adequate data base for effective land restoration planning. The following conservation measures are therefore recommended –

1. Increase the level of awareness of environmental hazard due to mining among inhabitants. The importance of maintaining environmental quality should be emphasized particularly the threats that are encouraged by mining such as deforestation, erosion and ultimately desertification should be addressed. This could be achieved through public campaigns and enlightenments.
2. Measures should be taken by the inhabitants in restoring back the stream channels to their former glory by filling the cuts.
3. Effective land restoration plans such as reclamation should be undertaken collectively by the inhabitants to reclaim the areas affected by mining.
4. Some of the pits should be use for waste disposal with farm and household residues so as to restore it.

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REFERENCES

A.T.M.N, 1969. The plateau minefield. A book prepared by the amalgamated tin mining company.

Akintola, F.O., 1978. Mineral and energy resources Heinemann: Ibadan: Geography of Nigerian Development.

Alexander, M.J., 1986. Is agriculture a viable alternative for eucalyptus plantations on the reclaimed tin mine spoils of the jos plateau? Environmental conservation.

Ayuba, H.K., 2005. Environmental science. An introductory text. Apani publisher.

BBC Focus on Africa, July 2002. World summit on sustainable development/environmental degradation. Paying for Pollution: 56-57.

Bertalanfy, L., 1951. An outline of general systems theory. British Journal of Philosophy of Science theory, 1: 143.

Botkin, D.B. and A.K. Edward, 1998. Environmental science. Earth as a living planet 2nd Edn.: John Wesley & Sons, Inc.

Bukar, Y., 1997. The effect of mining on the environment: A study of gypsum mining in southern fune local government area, yobe state. Unpublished M.Sc Dissertation, Geography Department. University of Maiduguri.

Dan'azumi, B., 1986. Tin mining and peasant impoverishment in jos division 1900-1950'. Unpublished M.A. Dissertation. ABU Zaria.

Daura, M.M., 2001. The physical environment and development: A study of borno region. Seminar series vol. 1, The Faculty of Social and Management Sciences. University of Maiduguri.

Davies, J.G., 1954. The biu book. Gaskiya corporation zaria.

Day, G.D., 1985. Surface coal mining and the geomorphic environment in Eastern Australia.

Easton, D., 1965. A framework for political analysis. Englewood Cliff, N.J Prentice Hall.

FAO, 1980. Natural resources and the human environment for food and agriculture. Environment Paper No. I. Rome. File:///A:\Population and Land degradation (Text).htm.

Gana, R., 1999. The effect of mining on socio-economic activities in gunda, biu l.G.A borno state. Unpublished B.Sc. Final year Project Department of Geography. University of Maiduguri.

Howard, A.D. and I. Ramson, 1978. Geology in environmental planning. London: McGraw – Hill Inc.

Kagu, A., J.O. Olokor, B.M. Gwary and H.A. Sulaiman, 2004. Refuse generation, disposal and health implications for the residents in new bussa niger state" in majass. Maiduguri journal of Arts and Social Sciences, 2(1).

Langkamp , P.J. and M.J. Dallin, 1982. Nutrient cycling in a strand acacia holoscrria a. Gunn ex g. Don, 11 phosphorus and ectomycorrhiza, aust.J. Bot.

Leong, G.C. and G.C. Morgan, 1972. Human and economic geography. Oxford: Oxford University Press.

Mohammed, A.G., 1996. Impact of sapphire (precious stone) mining in Gunda and Environs, Biu l.G.A Borno State. Unpublished B.Sc Project. Department of Geography. University of Maiduguri.

Olofin, E.A., 1989. Human response to the natural environment in the kano region. Kano and Some of Her Neighbours. ABU Press.

Osborn, F., 1948. Our plundered planet. Little. Brown & Co. Boston. An early Warning on the Population Resource Environment Crunch.

Richling, A., J. Lechnio and E. Malinowska, 2000. Landscape ecology-theory and applications for practical purposes. Pultusk School of humanities, IALE Poland, Warsaw.

Ripley, E.A., R.E. Redman and J. Maxwell, 1978. Environmental impact of mining in canada. National Impact of Mining Series No. 7, Kingston: Queen's University Centre for Resource Studies.

Roots, E., F. , 1977. Mining, environment and control Vancouver: University of British, Columbia Press.

Saidu, J., 2003. The potentials of mining lands for agriculture on the jos plateau: A case study of the ray field area. Unpublished M Sc. dissertation. Department of Geography, University of Maiduguri.

Sehgal, J. and I.P. Abrol 1992. Land degradation status. India: Desertification control bulletin.

Udo, R.K., 1990. Land use policy and ownership in Nigeria. Lagos: Ebuakwa Ventures Ltd.

Wallwork, K.L., 1974. Derelict land. David and Charles Newton, Abott.