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Research Article

The Socio–Economic and Biophysical Impacts of Black Granite Mining in Mutoko, Zimbabwe

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Abstract

Mining has impacts especially on the people living in communities where minerals are found. Although many researches have been conducted on the impacts of mining on the environment, few researches have focussed on the impacts of black granite mining in Zimbabwe. This paper identifies the socio-economic and biophysical impacts of black granite mining in Mutoko, Zimbabwe. Questionnaires, interviews and observations were used to collect data for this study. The findings from five black granite mines surveyed in the study showed that the main biophysical impacts of black granite mining are loss of biodiversity due to deforestation, siltation, soil erosion and displacement of wildlife. The main socio-economic impacts are employment, infrastructural development, and loss of prime agricultural land, destruction of sacred sites; cracking of building structures; dust inhalation; and injuries. The study recommends effective implementation of Environmental Management Plans (EMPs) to enhance or reduce the impacts of black granite mining.

Keywords: *black granite, mining, socio-economic, biophysical, impacts*

Introduction

In recent years, black granite mining has become more pronounced in some parts of Zimbabwe such as Mutoko and Mt Darwin (Chigonda, T. 2010) The emerging interests in black granite mining, participation by several players and increase in space and volume of granite rock mined have a bearing on the socioeconomic and biophysical outlook of the mined areas and their neighbourhood (Bhatasara, S. 2013). As mining continues and demand for black granite products in construction as dimension stones and floor tiles; gravestones and memorials the impact continues to escalate. The situation is compounded by more efficient methods of extraction such as diamond wire cutting thereby raising large quantities of granite blocks within a short period of time and the blocks are often littered on adjacent flat and arable or pasture land (Bhatasara, S. 2013). Mining in general is regarded as a 'robber industry' thus wherever it takes place, there is need for continual assessment for appropriate timely policy intervention and review (Mobtaker, M. M. *et al*., 2014; Osanloo, M. 2012). This study seeks to assess the change brought about by black granite mining at operational sites in Mutoko, Zimbabwe.

Foreign companies invested in black granite mining business ventures in the study area but need to address community, biophysical and socio - economic concerns emanating from their operations. Tools such as Environmental Impact Assessment (EIA) and Environmental Management Systems (EMS) guide complaint companies to contend with impacts of mining on the total environment. The companies are expected to adopt and implement best mining practices, ensure that ecological functions are maintained, any damaged parts of the environment as a result of their operations are restored to a condition it was before mining or better and participate

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in community development projects wherever they operate (Bhatasara, S. 2013). Most of the mining companies in Mutoko are EIA certified but their compliance and implementation of environmental management plans need to be assessed.

Black granite extraction entails clearance of overburden, cutting the exposed rocks into rectangular blocks varying in weight from 15 – 30 tonnes as specified by market requirements. Traditionally, black granite mining entailed drilling and blasting that generated noise, rock fly and vibrations; of late it entails a combination of blasting and diamond wire cutting. Diamond wire cutting is noiseless, does not cause any vibrations and enables large quantities of granite to be extracted within a shorter period of time. As the blocks are mined, waste rock is generated from deformed blocks and offcuts as blocks are trimmed to meet market specifications. Thus granite mining companies have to contend with disposal problem of waste rock, space for the large blocks awaiting delivery to the market, loss of aesthetic value and loss of the granitic domes from which the blocks are extracted (Waugh, D. 1995). There is therefore need to determine how the mining methods and the resultant waste rocks activity impact on the socio – economic and biophysical environment.

The expansion of black granite quarrying activities in Motoko, transformed the district into an important black granite mining area associated with resultant impacts (Chigonda, T. 2010). The possible several resultant impacts have to be determined to enhance beneficial impacts and propose mitigation for unanticipated impacts. The mining activity in the area has the potential to affect the socio - economic and biophysical components of the environment that include surface and groundwater resources, soils, the natural landscape, vegetation, ecosystems, river flow regimes, atmospheric conditions, housing structures, mortality and safety or health of employees (Chappell, B. W. *et al*., 2001; Ashton, P. *et al*., 2001; Nilsson, J. A. *et al*., 2008). Mining in general, usually has the highest annual number of traumatic fatalities in industry globally (Mensah, A. K. *et al*., 2015). For example in 1972 a mine accident that occurred at the then Wankie Colliery killed 427 workers, (Eaton, A. J. 1996) measures are employed in modern mining nonetheless there is need to determine the prevailing situation at operational mines – black granite mining is a case in point.

Despite negative impacts, research has shown that mining has several environmental and socio-economic positive impacts. Mobtaker (Mobtaker, M. M. *et al*., 2014) used the Folchi method found out that modern sustainable mining operations improves environment and enhance opportunities for improved societal wellbeing. Formal mining forms an integral part in the economic development of any country as several benefits such as its contribution to the country's GDP (Gross Domestic Product) accounting for about 60 per cent of foreign exchange earnings, 10 per cent of GDP and five per cent of formal employment in Southern Africa (Zurcom International. 2014; Choshi, S. 2001). Other impacts of mining include infrastructural development, development in communication, transport, educational system, recreation, commerce and medical facilities. This study therefore sought to assess the impacts of black granite mining in Mutoko since there is limited research that has been conducted on this type of mining in Zimbabwe.

Research Objectives

The objectives of this research were to:

- Identify the socio - economic and biophysical impacts of black granite mining in Mutoko.
- Determine the extent of socio - economic and biophysical impacts of black granite mining in Mutoko
- Assess the socioeconomic and biophysical impacts of granite mining in Mutoko

Methodology

The study was conducted in Mutoko District which is 144.7 kilometers northeast of Harare, Zimbabwe. The district is in Mashonaland East Province. Most parts of the district are

within Region Four that receives 450 - 650 mm of rainfall, variably spread during the rainy season (Bhatasara, S. 2013). The dominant activities in the region include cultivation of drought resistant crops, livestock, and semi-intensive farming. Mining, particularly black granite extraction, is part of some of the off farm economic activities in the district. The major geological formations in the study area are the granite/gneiss rocks. The soils thus are paraferrallitic derived from igneous and metamorphosized igneous parent rock, containing low nutrient value to support intensive crop farming. The study area is shown in Figure 1.

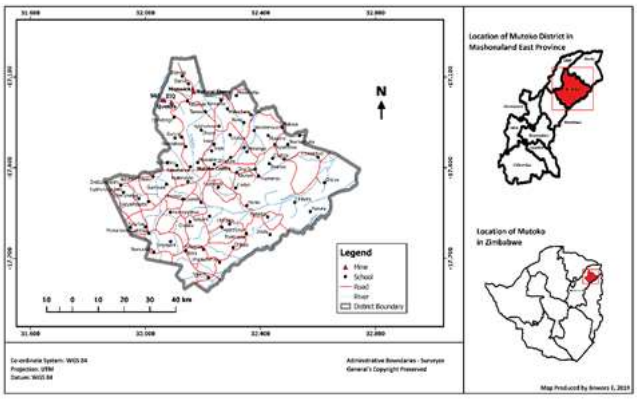

Figure 1: Location map for black granite mines in Mutoko

Data for the study were collected using questionnaires, key informant interviews, and observations. Secondary data were from EIA inspections, EMA audit reports and company records. Five mines were surveyed during the study. These mines are Natural Stone, Manwick, ZIQ, Quenya and Illford Services SG3. Permission to conduct the survey on the five mining companies which were operating was sought. Government departments granted permission for their officers to participate in interviews and for access to their reports. Respondents' consent was sought before questionnaires and interviews were administered. Names of respondents were not revealed in the responses to maintain confidentiality. The respondents were assured that the information they provided was for academic purposes only and they would not be disadvantaged in any way either for voluntary participation or saying their opinions.

Key informant structured interviews were employed to solicit for changes in benefits such as roads, assistance in community projects and infrastructure development and losses of arable land, pasture and impact on houses or community welfare from granite mining. The key informants were representatives from government departments such as Agriculture Extension (AGRITEX), Forestry Commission (FC), Zimbabwe Republic Police (ZRP), Veterinary Services, Mutoko Rural District Council (MRDC), Ministry of Health and Ministry of Education, Sport and Culture; community leadership comprising a councillor, headman and five village heads directly affected by the mining activity, mine management responsible for execution of management plans, school heads as beneficiaries of community support schemes and Environmental Management Agency (EMA) officers. Interviews responses were captured using a voice recorder then transcribed onto an interview schedule for recording and processing.

Random systematic sampling was used to determine participants from local residents and miners. Every fifth household was considered for the survey, thus from 3 688 households in the three wards where mining took place, 200 respondents were identified. The rest were six government departments (AGRITEX, Forestry Commission, Zimbabwe Republic Police, Veterinary Services department, MRDC, Ministry of Health and Ministry of Education, Sport and Culture, five mine managers/supervisors, and twenty – nine mine employees. Questionnaires for households were administered in the vernacular language that was easily understood by the respondents, later translated to English. These questionnaires focused on the problems of and benefits from black granite mining in the area.

Observations were made on impact of black granite mining on infrastructure (schools, houses) along routes to mines and close to mines, bridges and roads as well as mine employees as they worked. The study

observed the number of properties that had cracks, the area covered by mined granite blocks and the space that had lost its trees from mining activities.

During data analysis, the questionnaires were coded for identification and recording of variables before editing to check on trends, similarities, differences, exaggerations and recurrences. Completeness check was done to verify whether all questionnaires had been completed. Every questionnaire returned was considered in the analysis. Responses were grouped and frequency calculations were done to determine occurrence of events in granite mining. Responses were grouped into themes so as to cater for results from interviews.

Results and Discussion

Granite mining resulted in both positive and negative socio-economic and biophysical impacts. The positive impacts were revealed by employment opportunities, revenue generation, road construction, contribution to community projects. The negative impacts that include loss of pasture, displacement of people, loss of vegetation, loss of sacred sites and diversion of water channels were identified in the study area.

Socio-economic impacts of black granite mining

Granite mining in Mutoko takes place in communities that had established livelihoods and lie within conditions meant to improve their welfare. This section outlines the several socioeconomic changes resulting from granite mining activities in the study area.

Employment opportunities

Black granite mining generates off – farm employment for Mutoko communities. As shown in Table 1.

Table 1: Employment opportunities at Black Granite mines (%)

Mine Name	Artisan	Secretary	Manager	Security	General hand
Natural Stone	4	2	2	18	178
Manwick	2	2	1	10	64
ZIQ	2	1	1	12	41
Quenya	2	2	1	15	75
Illford Service SG3	2	3	3	26	92

Source: Field Survey, 2017

The results show that most of the employment opportunities are for security and general labour constituting over 90% put together at all the five companies. The highest such opportunities are offered by Natural stone (96%). The two labour categories are low income and are given to people of low levels of income. Overall the five companies created 560 opportunities in the district, a mere 5% of these opportunities are taken up by outsiders (managers, artisans and secretaries).

The companies beyond any doubt conformed to the requirement for companies that invest had to engage the locals as first priority. The outsiders have specialist skills and earned high incomes – locals lack the requisite skill, however the companies have the capacity to sponsor empowerment of their employees to attain the requisite qualifications.

Gender and Employment

The study sought for gender variations in the employment structure at the five granite mining companies. The gender employment composition is shown in Figure 2.

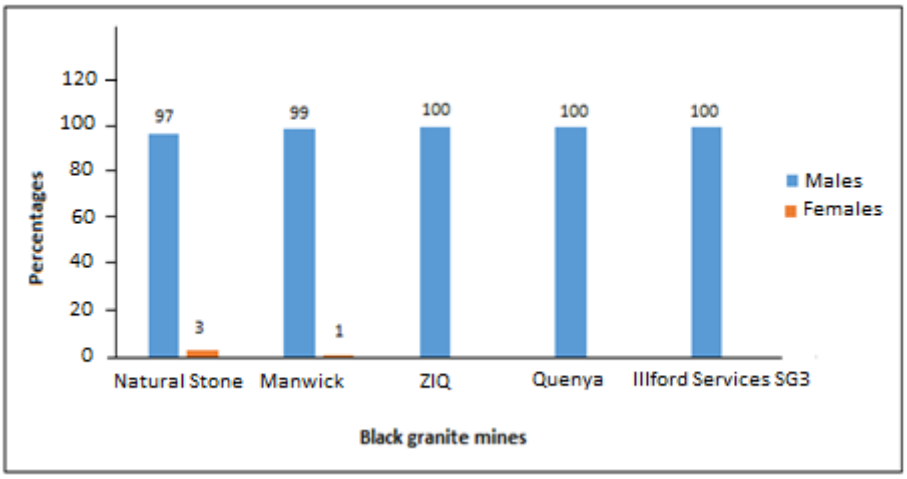

Figure 2: Employment by gender in black granite mines
Source: Field survey, 2017

The results show that three of the mines, Illford Services SG3, Quenya and ZIQ did not have female employees. Manwick had less female workforce (1%), while Natural Stone had the highest number of females (3%). There was thus no gender balance at the mines. Mine managers said that women were not suitable for the type of work done at the mines – the managers claimed that women, who were earlier employed, faced difficulties executing the duties they were employed for. Thus women were not significantly directly benefiting from mining activities in the area. They had to rely on their husbands who were employed by the mines. Gender bias towards men was also witnessed at Ngoyla Mintom, Cameroon where out of 95 miners interviewed, only 3 were women or 3.2% of the sample size (Funoh, K. N. 2014). Most of the women in the neighbourhood would supply the mining community with basic food items and other commodities through petty trading.

Remuneration for Employees

Unskilled labourers are lowly paid in the mining industry as noted by the results of a survey of black granite mines in Mutoko. Salaries of more than 70% of the twenty-five unskilled respondents were below the Poverty Datum Line (PDL) and ranged from US$150 to US$250. The PDL for an average of five persons stood at US$502.90 in May 2017 (ZNSA. 2017). The economic benefits from employment cannot be overvalued, most of the employees at the mines had to supplement their meagre earnings with agricultural activities in order to meet their basic living requirements. The skilled and semi – skilled workers (supervisors, section leaders and managers who were mostly from outside the local community) were better paid but declined to divulge their salaries.

Revenue Generation for the Local Authority

Miners are expected to pay development levies for the stones to MRDC. The mining levy is used for developmental purposes for example construction and maintenance of roads. During an interview, the CEO for MRDC pointed out that miners were being levied US$1 per tonne of stone. The CEO claimed that miners swindle the council of money by under – estimating tonnage of dimensions stones. The council had no weigh bridge to verify the tonnages. In January 2001, MRDC temporarily stopped all mining operations in order to force miners to pay outstanding levies. Some mines that include Quenya and ZIQ said that they paid levies to MRDC but they did not produce evidence of having made such payments. Apart from Rural District Councils, the Ministry of Mines benefit from the activity through mining licenses and royalties which are paid by the miners.

Infrastructure Development

The study reveals that black granite mines helped influence development in the study area as shown in Table 2.

Table 2: Infrastructure Development from Black Granite Mines

Mine	Road (KM)	Dip tank	Borehole	School	Clinic	Electrification Projects
Natural Stone	8	1	2	2	1	1
Manwick	7	1	3	1	0	0
ZIQ	15	0	2	1	0	0
Quenya	7	1	3	1	1	0
Illford Service SG3	16	2	3	3	0	0

Source: Field survey, 2017

The results show that all the mines took part in the rehabilitation or construction of roads, which they used to ferry their blocks of granite to the market. Illford Services SG3 did the largest stretch of 16 km while Quenya and Manwick did the least at 7 km each. The roads are critical for access to the mines and the outer world. The mining companies also took part in dip tank services as each company did one dip tank except ZIQ. The results also reveal that all the companies took part in drilling boreholes for the community at Gurure, Kadiki and Charehwa: each company did an average of two boreholes. The borehole drilling exercise ensured that the community could have access to clean and safe water. The mining companies also constructed at least a classroom block each at Makochera, Gurure, Utonga and Kowo schools as revealed in the results. Quenya and Natural Stone assisted in the construction of a maternity ward at Nyamuzuwe Clinic. Natural Stone Export Company assisted in the electrification of Chief Mutoko homestead thus making it easier for nearby homesteads to draw power to their homes in future. Although the community expected a lot more, the mining companies played a critical part by improving service and community welfare. The community services offered as outlined would make the community and miners work together for a common and effective goal of enhancing the living standards of communities where mining operations take place.

The study revealed that blasting carried out during mining operations had a negative impact on infrastructure. Buildings have developed cracks which are allegedly as a result of the shaking effect of blasting. As observed and reported by residents, at least 50 housing units were reported having developed cracks. Frequent blasting at the mines which produces reverberations that can be felt 20-30 kilometres away, has also been reported to have caused the cracking of houses and other infrastructure in mining areas (Funoh, K. N. 2014). In another research conducted in Gwalior, India respondents reported that blasting causes shaking of the houses and other buildings and cause disturbance among the inhabitants (Ahmad, A. F. *et al*., 2014). Schools such as Kowo, Nyamuzuwe, Chirindi, Nyamakope, Gurure, Utongachira, Chiutsi, Kagonde, Chindenga, Gwariwa and Chimukapa are situated close to mines. Cracks were observed on classroom blocks at Kowo (Plate 1). and Nyamuzuwe schools. Nyamuzuwe School is within 200 – 500 m of Quenya mine.

Plate 1: Cracks on a classroom block at Kowo School
Source: Field survey, 2017

Villagers' houses in Makochera village near Natural Stone mine have developed also cracks. Cracks also develop as a result of the shacking effect of heavy vehicles passing nearby. It must however be noted that although cracks occur as a result of blasting, it is difficult to attribute all the cracks to mining alone. However it was found that the cracks were more pronounced on houses near the mines. Some factors such as natural ones and human error in the construction of structures also lead to the development of cracks.

State of Transport Routes

MRDC blames the bad state of gravel roads on the miners' heavy rock bearing vehicles. During the survey, some roads such as Nyadire road were in a deplorable state. Nyadire and Kanhemba roads that lead to Ilford Services SG3 were full of potholes and in some cases were impassable to small vehicles. In most cases, roads had no mechanical conservation works such as mitre drains. This resulted in the formation of roadside gullies as was noticed along the Kanhemba road. This road poses access problems to trucks that ferry garden produce in the area. All the visited mines claimed that they maintained roads once every month. MRDC argued that in most cases the miners go for more than three months before grading roads. When they repaired the roads, they did not consult MRDC and Ministry of Roads thereby fail to pull critical resources to ensure that joint effort and lasting measures are put in place to tackle the road maintenance challenges. Miners however argued that they did not have a mandate to maintain roads since they paid road taxes that were supposed to be channelled towards road maintenance. MRDC however could not confirm receipt of such funds. Miners were accused of converting scotch carts routes into their access roads thus reducing the extent of crop fields or even displacing people. The conversion of access routes however improved access for farmers to ferry garden produce from one area to the other although it was claimed that miners only maintained roads for their convenience.

Rock bearing trucks were also a threat to bridges. Bridges such as Kanhemba were sagging and cracking possibly due to pressure exerted on them by heavy trucks as shown in Plate 2.

Plate 2: Rock blocks along Kanhemba Road
Source: Field survey, 2017

Interview respondents revealed that rocks sometimes fell along transport routes thus blocking the roads or damaging them. The rocks increase the risk of accidents as they usually fall on the bends. Rocks are usually not removed because of high costs hence becoming a permanent risk along transport routes. Although miners are blamed for damaging roads, they also play a part in their maintenance. During the research, it was observed that miners maintained Loti and Katsukunya roads.

It was however difficult to wholly attribute mining activities to the state of transport routes without considering aging infrastructure. However mining activities i.e. constant use of heavy rock bearing trucks definitely has an impact on road infrastructure. It was evident that tracks and falling boulders on the roads had a damaging impact on the roads. The council civil engineer confirmed and attributed damage to the roads to frequent use by heavy trucks and lack of frequent maintenance.

Loss of Arable and Grazing Land

Locals within the vicinity of mines complained of shortages of arable and grazing land. Land lost to mining activities is shown on Table 3.

Table 3: Arable and grazing land lost to mining activities

Mine Name	Grazing Land (Ha)	Arable Land (Ha)
Natural Stone	6.0	4.0
Manwick	4.5	2.5
ZIQ	2.0	1.0
Quenya	3.0	4.0
Illford Service SG3	3.5	1.5

Source: EMA (EMA. 2017)

Results show that an estimated 32 ha of land was lost to mining. This comprised 19 ha for grazing and 13 ha for arable land. Natural Stone mine took up most of the land - 10 ha. The rest of the mines each had less than 10 ha of land directly affected by mining. Grazing land was lost at the actual mining sites which are all situated in hills used as grazing areas. Former grazing areas could no longer be accessed because of open pits and rock dumps that were left by miners. Arable land was lost due to dumping of rocks in crop fields and gardens. Sections of fields and gardens were rendered useless to cultivation. This resulted in a reduction of agricultural production levels although AGRITEX officers could not quantify the levels. Villagers from Makochera, Chibanda and Mukoneka pointed out that the dumping of rock rubble reduced the extent of their grazing areas.

Loss of land has occurred in some instances with people's land being taken over to pave way for the mining operations or road

construction. This has a negative impact on agricultural activities since rural economies are mainly agro-based. It is unfortunate that communal farmers do not have title deeds rights to land and this makes it difficult for them to claim compensation for lost land. In some instances, some of the land that is lost to mining is among the most fertile in an area thus threatening food security. No one was reportedly compensated by the miners for the loss of agricultural land and or grazing land.

Displacement of People

When mines are pegged, some of the claims are inhabited by people. Mine managers refused that present day locations of their mines were inhabited before the commencement of mining. Evidence on the ground showed that areas within the mine claims were still inhabited. More than 10 homes that have become derelict are evidence that some people had moved away. The settlers were allegedly threatened by flying rocks, noise, dust and blasting tremors which cracked their structures. It was alleged that miners had promised to construct houses for affected people. There was no record for compensation or displacement, nonetheless, evidence reveals there was once settled areas near the mines that have since moved.

Occupational Health and Safety of Mine Employees

The health of miners in black granite mines is at stake due to the physical nature of the work involved and exposure to hazardous conditions such as dust. Miners reported that five accidents were recorded over a seven year period. They depicted a picture that the mines are very safe and rarely have accidents. Mine employees however painted a different picture from that of their employers on the issue of their safety and health.

Figure 3 shows that about 20% of mine employees questioned in the questionnaire surveys claimed to have had accidents whilst 50% had witnessed accidents taking place. Approximately 30% had never witnessed or were involved in an accident.

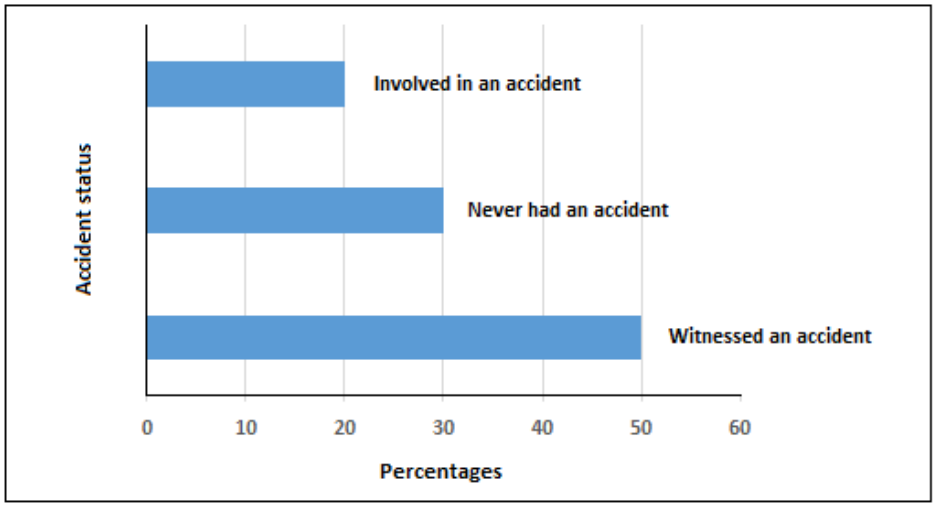

Figure 3: Mine employees' involvement in accidents
Source: Field survey, 2017

Questionnaires and observations revealed that employees' safety was at risk. Although all mining companies claimed that they provided adequate protective clothing and or equipment some employees were observed working in dusty and noise conditions with no dust masks and ear plugs. This exposed them to safety and health risk. Approximately 65% of the employees complained that protective clothing or equipment was not adequate. About 30% of the employees said that they had no protective clothing or equipment. A smaller proportion of the mine workforce (5%) claimed to have been issued out with adequate protective clothing or equipment although some had nothing on during mining operations. Mine employees also complained that there were not

compensated for injuries sustained at work though this was disputed by mines management.

More than 50% of the employees were worried with the dust they were inhaling. Continued exposure to dust as feared by some of them would result in respiratory complications. In a research conducted in Gwalior, India, interviews revealed that a significant number of the respondents were affected by the air pollution generated from the mining area (Ahmad, A. F. *et al*., 2014). High noise levels were also a threat to the health of mine employees. At least 10% of the employees complained of ear problems and had difficulties in hearing. Goswami (Goswami, S. 2013) support the findings made by stating that mining noise is now being recognized as a major health hazard; resulting in annoyance. Partial hearing loss and even permanent damage to the inner ear is noticed after prolonged exposure.

It must however be noted that no measurements of dust emissions and noise levels were done due to lack of proper equipment. Some employees complained of backaches as a result of heavy back breaking work. Mine employees in Cameroon also reported a series of health problems notably body pains during a research conducted by Funoh (Funoh, K. N. 2014).

It was also claimed that some employees had died of injuries sustained in mine accidents. Statistics could not be obtained to verify these claims. Mine managers/supervisors dispelled such reports and actually claimed that the very few accidents that occurred in the past were 'minor' in nature.

Mining is a hazardous activity which sometimes threatens lives. Eaton (Eaton, A. J. 1996) supports this with evidence of the 1972 Wankie Colliery mine disaster when 427 workers were killed in an underground explosion. It must however be noted that no accident of such a magnitude has been recorded in black granite mining. Poor workplace health and safety standards in some of the black granite mines in Mutoko have resulted in illness, injuries and even deaths to some workers. This has impacted negatively on the lives of the workers and their families with the injured and ill workers failing to fend for their families.

Safety and Health of School Children and Local Communities

Research findings show that communities and school children's health and safety were also threatened by black granite mining activities. Transport routes act as sources of dust which has become a health hazard especially to school children. The acting head of Kowo Secondary school and the Headmaster of Kanhemba Primary School complained of dust emanating from the roads used by the miners when the heavy vehicles pass by their schools. The deafening noises made during the passage of heavy vehicles play a role in disturbing lessons hence the learning process.

Open pits left open by miners are a threat to human life especially children. About 5% of the injuries sustained by children were linked to the open pits although this could not be verified. Open pits that are breeding grounds for mosquitoes that cause the deadly malaria disease were blamed by health officials for the high prevalence of the disease during the wet season. Some locals complained that they were exposed to flying rocks and tremors during blasting at the mines. This complaint was raised mainly by people with homesteads within the proximity of the mines.

On the more positive side, villagers admitted that they were sometimes assisted by miners to ferry their sick to Mutoko Hospital by the miners. Some villagers however expressed anger at the miners' refusal to assist them with transport to help ferry their sick to hospital. Quenya mine manager said that they also assisted at funerals although without specifying the form of assistance.

Crime Trends

The presence of miners in Mutoko has a negative impact on crime. A police officer with the Mutoko ZRP argued that the presence of miners has generally increased criminal activities. He however could not give

supporting statistics since he claimed that it was confidential information. However mines reported that they experience theft of equipment by both mine employees and villagers. Mine employees steal equipment such as jack hammers from mines. Mine employees steal possibly to supplement their meagre salaries. Villagers also have a tendency of stealing from the mines in some instances as a way of registering their dissatisfaction with mines authorities. Extortion cases are also reported when the local leadership demands money from the miners. ZRP has been called to intervene in wrangles between politicians and miners.

Disturbances of Sacred Sites

Miners were blamed for disregarding cultural values and norms. A village head from Nyerenyere village bitterly complained of the miners' disregard of cultural sites. Without giving specific examples, the village head said that there were no proper consultation of spirit mediums and chiefs before commencement of mining activities. A headman from Kabasa ward admitted that miners did not respect sacred sites. At some point they are said to have planned to mine a hill in Charehwa village that housed Nehoreka's artefacts. The production manager for ZIQ denied the allegations maintaining that there was proper consultation before mining.

Sacred shrines were alleged to have been destroyed by miners although they (miners) professed ignorance to this. Graves have also not been spared by the miners. Locals claimed that some of their ancestral graves in caves were decimated with the miners refusing to hold traditional ceremonies to appease the spirits of the dead. Although no evidence of desecrated graves was found during the research, a research conducted by Chigonda (Chigonda, T. 2010) found out that mining activities in the Kawazva area uncovered human remains and this resulted in conflicts between villagers and a miner.

Biophysical Impacts of Black Granite Mining

Mining of black granite had associated biophysical impacts identified and assessed in this section. No biophysical positive impact was identified in the study area.

Loss of Vegetation

During mining processes trees and other vegetation are cleared to access the rock, to construct mining compounds and offices as well access roads. Removal of trees without replacement (deforestation and other vegetation was observed at all mining sites (Plate 3).

Plate 3: Hill cleared of vegetation
Source: Field survey, 2017

Deforestation levels on the five mining sites were severe to very severe (above 50% of a hectare affected). Mine employees were also responsible for cutting down trees as they used wood for fuel. A study on environmental impacts of mining conducted

in Ghana also revealed loss of vegetation in mined areas in Nankaba, Asoampa, Ashtown, Bondaye, Ankobra and Anfegya (Mensah, A. K. *et al*., 2015). A research carried out in Cameroon also revealed that miners clear trees at mined areas to have larger mining surfaces and for safety purposes (Funoh, K. N. 2014). Deforestation in Atiwa, Ghana has resulted in serious land and forest degradation (Amankwah, E. 2013).

Displacement of Wildlife

Wild animals usually prefer peaceful and undisturbed environments. Disturbances of their habitats and niches due to noise and loss of vegetation result in migration to other more favourable sites. Locals pointed out that there used to be abundant rock rabbits in their areas before the commencement of mining but these had since become 'extinct'. Mine employees and locals could also have contributed extent to the loss of wildlife through hunting. Locals point out that most of the quarry sites were habitats for wild animals such as leopards, hyenas, baboons, and monkeys. Whilst baboons and monkeys are still found within mining areas maybe because of highly adaptive capacities, leopards and hyenas have completely disappeared. Loss of habitats and high noise levels from blasting beyond thresholds acceptable levels has driven away these animals. Migration of some animal species may trigger ecological imbalances.

Soil Erosion

Mutoko is mainly characterised by loose sand to sandy loamy soils which are erodible once vegetation is removed. During the survey, soil erosion was observed along access routes, around and on mine premises and on site works. The use of heavy vehicles leading to intense soil compaction was also to blame for soil erosion. Severe soil erosion due to mining was also observed at one abandoned mined site at Prestea, Ghana (Funoh, K. N. 2014). Land clearing was a major driver for soil erosion at the mining sites.

Measurements were however not carried out to determine the rate of soil loss in the mining areas. These measurements are important in future to determine how much soil is being lost to the mining activities. The site works located on hilltops devoid of vegetation were found to be prone to soil erosion with gullies beginning to develop within the mines and surrounding areas. Soil erosion on these mines is exacerbated by lack of rehabilitation on mines.

The quarry managers argued that they had plans to reduce soil loss through rehabilitation of mined sites. No evidence of rehabilitation was however found at any of the surveyed mines. Quenya mine however had a project on vertiver grass and the rearing of indigenous trees. They had plans to plant vertiver grass on slopes. ZIQ mine claimed to have assisted communities in establishing plantations although no verifications could be made on this claim.

Siltation and Diversion of Water Ways

Locals accused the miners for siltation of water sources as they critical for their gardening activities. Dukwa River near Natural Stone mine for instance is heavily silted on stretch of over 3 km from the mine. Some of the miner streams have become seasonal and dry during the dry season Mining activities are blamed for causing siltation although many factors such as poor farming methods such as stream/riverbank are also to blame. Some market gardeners claimed that they experienced water shortages during the dry season and blamed mining for worsening the shortages. River diversion was also blamed on the mining activities.

Conclusion

The findings reveal that black granite mining companies play a part in enhancing socio-economic development in the study area as evidenced by support in infrastructure development and assistance delivery. The benefits derived from black granite mining are however voluntary. Communities and the local authority are passive players thus are not the optimum that could be achieved. Although other factors such as the state of infrastructure could be attributed to its deterioration, black granite mining that

frequently uses heavy trucks, is predominantly responsible for damage to roads and bridges. There is however potential for synergies between mining and local communities to enhance sustainable development from black granite mining.

Recommendations

The mining companies need to employ EMPs to enhance and/or reduce the impacts of black granite mining. EMA should effectively perform its monitoring role to achieve this end.

The mining companies, the local authority, MRDC and the miners need to work together as an integrated team to address community development needs; meant to achieve consolidated development initiatives. Community share ownership trusts established in black granite mining industry should be strengthened with some benefits accruing to the communities and be channelled towards development and addressing gaps created by black granite mining.

Mining companies need to put in place measures and programmes to tackle workers' health and safety issues. This can be done through the establishment of Safety and Health sections on mines. The National Social Security Authority (NSSA) should monitor safety and health issues in black granite mines.

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