

Social and Biophysical Impacts of Mhangura Copper Mine Closure

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Abstract

This paper seeks to investigate the social and biophysical impacts that emanated from the unplanned closure of Mhangura Copper Mine(MCM) due to chronic viability problems. It was observed that no environmental impact assessment was carried out before the inception of the mine. Most importantly was the absence of a mine closure plan put in place for rehabilitation work and for continued sustained community livelihood. The physical environment was in many parts left in a state of dereliction, posing a host of ecological, health and safety risks to the community, livestock, other biota and property. It was recommended that a multi – sectoral approach that involves the government, local council, private sector, non-governmental organisations and the local community be adopted.

Introduction

The significant contribution of mining and the mineral sector towards the development of local and national economies worldwide is undoubted. Mining operations have been providing key development inputs into communities. Examples of inputs include social services, infrastructure and employment. The high levels of industrial and overall economic development achieved in Western Europe, North Eastern USA and the Rand region of South Africa are partly attributable to the mining industry (Solomon, 1999; Viewing, 1984; World Bank, 1992).

Whilst the indicators of economic growth associated with mining are easy to measure and appreciate, the question is, to what extent is the mining sector an effective driver of sustainable socio-economic development and environmental management at the local level? This is a cause for concern particularly during the post mine closure era. In other words, to what extent does a given mining operation contribute towards the continued sustainable existence and development of the local community, particularly after the eventual closure of the mining operation?

This bright picture of the mining industry is nevertheless not blemish free. According to Ngonini (2001), mining is inherently a non - sustainable activity as it leaves a mineral resource depleted and often nothing in its place except derelict land. The optimistic picture of the mining sector is as such marred by a legacy of negative environmental and social impacts.

A wide range of environmental and social impacts emerges both during and after mining operations. A few examples include the destruction of the natural landscape, local vegetation and habitats. This culminates into loss of biodiversity. Others include the contamination of soil and water, pollution of the local and regional air, deprivation of arable and pastureland, impingement of human health and safety including extreme cases of death and the creation of ghost towns and derelict landscape (Tilton, 1996; Crowson, 1998; Young, 1992).

The mining industry has in fact demonstrated its indispensability in the form of infrastructure and other socio economic developments at both local and national level. However the optimistic picture of the mining industry in the developing world is not immune to threats and blemishes. These threats include political and social instability, mineral resource depletion, environmental and health risks, and most importantly, the unfavourable micro and macro-economic conditions which make the resource extraction difficult, costly and unviable. Some mines consequently close down leaving the local community vulnerable to adverse social and environmental impacts.

Tilton (1996) suggests that the exhaustibility of mineral resources constitutes the basic principle of conservation in mining designs. On mine closure the environmental management challenge is to restore the land to its original land use. Most important on mine closure is to design a closure plan to ensure continued livelihood for the local community through diversification and community empowerment (World Bank, 2001).

It is the above scenario, which has generated the researcher's interest to investigate the biophysical and social impacts emerging from the premature closure of Mhangura Copper Mine in Zimbabwe..

Statement of the problem

Mhangura mine like all the other mining works is sited on a natural location, that is, where the copper ore occurs irrespective of other situation factors. Mhangura is therefore an isolated, semi-remote single industry settlement with limited local alternative job opportunities. Its economy revolved around the extraction and milling of copper with a scarcity of local backward and forward industrial and commercial linkages.

The mine had a premature closure due to chronic viability problems. In spite of the remarkable contributions the mine might have given to the community, there is a greater possibility that a variety of negative social and environmental impacts could have emerged after the mine closure. The nature and level of the social and economic impacts of the mine's closure depend on the mining company's efforts to compensate the job losses incurred and on the plans and efforts to mitigate and rehabilitate environmental damages incurred during operation.

Research Methodology

Biophysical Variables

These are the biotic and abiotic components of the local environment. This includes the diversity of plant and animal life in the area together with the physical environment that is made up of components such as relief, soils, water and the atmosphere. The following is the list of biophysical variables that have been examined in the field.

- ◆ Landscape/ land Quality
- ◆ State of vegetation/Fauna
- ◆ State of the soil
- ◆ Water resource quality
- ◆ Air quality
- ◆ State of arable/ pastureland
- ◆ Environmental quality of the residential compounds
- ◆ Health and Safety risks

Social Variables

These are aspects or indicators of human welfare manifesting within the Mhangura community. The following is the list of variables which were considered in assessing the social impacts that resulted from the closure of Mhangura mine .

- ◆ Current income
- ◆ Coping strategies/ alternative employment
- ◆ Family Unit
- ◆ State of Basic amenities
- ◆ General living standards

Data Collection Techniques

The following data collection techniques have been employed:

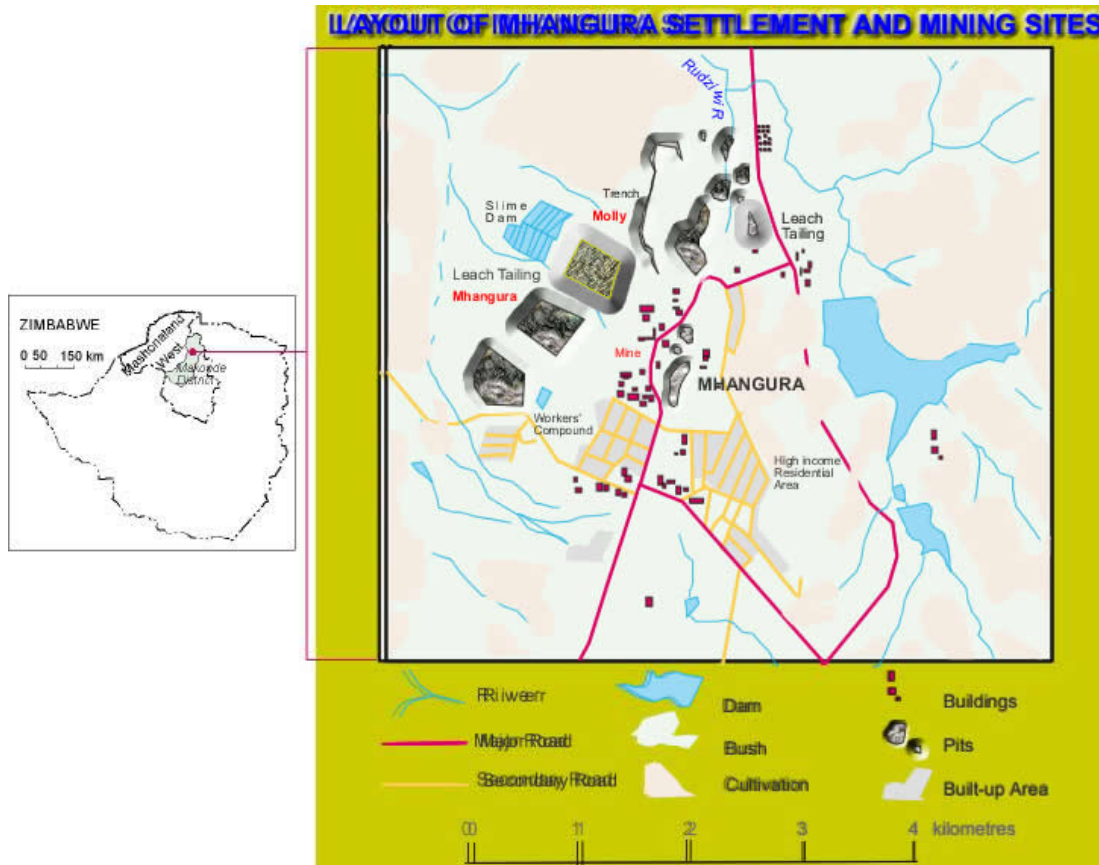
Secondary Data Collection

This involved accessing available information or published material on the subject of mine closure impacts. This constitutes essential background to the research work. Records on the occurrence of dust and other toxicant related sicknesses among former employees and other community members were accessed from Mhangura Mine Hospital.

Field Observations

The field survey was vital particularly in examining the biophysical impacts. The survey covered the residential compounds and five sites that constitute former working grounds of the Mhangura Copper Mine. These include the main open pit, the old leach plant area, the environs of the processing plant, the tailings, and the slime dam area. Figure 1.1 gives a layout of the study sites.

Figure 1.1 Layout of the Mhangura study area



Purposive sampling was employed in selecting the sites for field assessments. In this regard, the site selection was based on the assumption that both the biophysical and social impacts of the mine closure are best represented at these sites.

At each of the sites except the residential compound, a transect cutting across the site was marked. Two quadrats were marked from either edge of the selected site along the marked transect. The quadrats were 20m x 20 square meters in size and at 40m intervals along all the transects.

The transect approach to sampling was used because there was a clearly observable gradation in vegetation, state of the soil, water and other variables. In each quadrat, data was collected for all the biophysical variables manifesting. The presence or absence of rehabilitation efforts was evaluated and any cases of health and safety risk were taken note of. The following are activities carried out in assessing selected variables at the sites.

(a) State of the Land

The state of the landscape has been evaluated in terms of the degree and extent of disturbances inflicted. Depths and extent of excavations were measured; height and slopes of waste tailings were also measured. The degree of dereliction was assessed together with rehabilitation works were present. Any manifestation of health and safety risk was examined.

(b) Vegetation Characteristics

Structural and floristic vegetation characteristics were observed in the field. The idea of considering the state and characteristics of vegetation indicators in the analysis of environmental quality is supported by Young (1992) who argues that many ecologists view vegetation as a component of ecosystems which displays the effects of other environmental conditions and historical factors in an obvious and easily measurable manner. Vegetation characteristics were given similar weighting in this project.

(b.i) Vegetation or Plant cover is an estimate of the abundance of vegetation in a specified area. These were estimated on the basis of basal cover of all the plants rooted in the quadrat and were estimated to percentage.

(b.ii) Species Diversity: This measures the total number of different species common in area. In the field, measurement of species diversity involved the simple counting of the total number of species in each quadrat. The data collected needed no further conversions and was used in the same state. With the assistance of the national herbarium the different tree species were identified.

Interviews

Key informants were interviewed and these include the Provincial Mining Officer, Mine Complex Manager, The Hospital Sister in Charge, Chief Grounds man and Local School Head among others.

- A structured interview was conducted with the Mashonaland West Provincial Mining Officer in order to establish the legislation relating to the commissioning and decommissioning of mines.
- A structured interview was conducted with the Mhangura Resident Manager in order to establish the number of people who were once employed by the mine, and the various aspects of retrenchment negotiations, resultant packages and other compensations. Information on the general welfare of the former employees was sought together with the mining company's overall

closure plans and procedures which included the company's position with regards the rehabilitation and reclamation of degraded landscape.

- Structured interview with the Mine Grounds man was conducted to capture the first hand views of the low-income group of former employees on the socio - economic consequences of the mine closure. Special attention was given to this group because it is the most vulnerable to the mine closure due to their low level capacity to adapt to the crisis and seek alternative employment and livelihoods.
- The Hospital Sister in Charge was also interviewed in order to obtain information on the possible mining related health and safety risks prevailing in the post mine closure period.
- The Chief Executive Officer of the local District Council was interviewed to obtain the overall social and environmental impacts of the mine closure upon the entire district. Information on the extent to which the mine closure has satisfied the district level environmental policy and legislation was solicited.
- A structured interview also was conducted with the community school Headmaster to obtain his/ her view with regards the effects of mine closure on school enrolment and pupil welfare.
- A ward leader or community leader was interviewed to obtain information about the general plight of the community in terms of the provision and quality of social amenities such as water supply, sewerage reticulation, power supply, health services and other social welfare demands. The relationship between the mining company and its former employee was examined.
- A structured interview with a business community representative was conducted. The views of the business community about the impact of the mine closure on the trends in business such as trade, commerce and other service providing activities were solicited.

Focus Group Discussions

This is a qualitative technique that was used to compliment other data collection methods. Some salient information which otherwise would have been missed is captured. The researcher took advantage of neighbourhood watch meetings that took place in the compound . The community's coping strategies, and their impacts on the family unit and welfare were unveiled.

Questionnaires

A total of 460 households were identified for sampling. Each household was allocated a number with which random number tables were used to randomly obtain 100 sample subjects.

Information on the environmental and social implications of the mine closure was solicited from the individual members of the community in order to obtain a general view from the community grass roots.

Former mine employees were assumed to be the most reliable source of relevant information. This is on the basis of the fact that the rest of the residents are largely composed of new households who have

recently joined the community to take advantage of the cheap accommodation and houses. As such they have sketchy information on the mine's closure and the resulting impacts. On the other hand, the former mine workers and/or their spouses are witnesses of the background local physical and social environment before closure, which is vital for comparative purposes. They witnessed the mine closure and have got the first hand experience of the mine closure's environmental and social impacts

Results and Discussion

Social impacts of Mhangura mine closure

Due to bankruptcy, Mhangura Copper Mine(MCM) was delisted from the Zimbabwe Stock Exchange during the year of closure. It is important to note that the mine had no capital to follow proper mine closure procedures which include offering socio-economically sustainable exit packages for the former workers and rehabilitation work at mine sites. In fact at closure, the MCM owed several other creditors besides the Zimbabwe Electricity Supply Authority(ZESA). This has seen a judicial manager having to be appointed to oversee the liquidation of the mine. After more than one year of protests by the former mine workers, the government again financed the exit packages for the former mine workers.

At full operation capacity the mine employed 1500 full time workers in its mining sector, that is exclusive of other departments such as sanitation, security and other services. This was later scaled down to 800 at the time when the mine closed.

Other stakeholders in the community who were affected by the closure of the mine include the business community that is composed of bankers, retailers, garage operators, suppliers, farmers and various other service providers such as hotels. Others affected include the local hospital, local schools and the civil service. The hospital and the local schools once accustomed to reliable funding and other technical and administrative support from the mine were left to operate on their own.

In terms of compensation for the job losses, an amount totaling to six months salary was paid to individual workers as redundancy package. In addition, a service pay, which amounted to 50% of monthly salary for each year worked, was paid for each worker. Full time workers were also entitled to a package provided by the Mining Industry Pension Fund (MIPF).

It is interesting to note that among the respondents only a few cases have received the highest package range of above Z\$100 000. This group is made up of skilled workers who normally have greater chances of getting employed elsewhere. The majority of members of this group have left the community leaving largely the unskilled, sick and aged former workers.

The most treasured part of the exit package among most respondents has been the opportunity to purchase company houses previously used by employees. This resulted in 90% of the affected workers being house owners in the settlement.

Efforts to facilitate lateral transfer of some mine workers to sister mines were largely unsuccessful because of the general economic difficulties being faced by the entire mining industry. The sister mining ventures were also struggling to survive and were in actual fact shading off their workforce to reduce costs. This initiative saw mostly skilled former workers benefiting whilst the unskilled, the aged and the sick remained stranded at the closed Mhangura mine.

Another initiative has been to offer the mine farm to government so that the government subdivides it into 5-acre plots allocated to interested former workers. This was done and 250 former workers are now plot holders.

In as far as efforts to establish and implement a mutually agreed and beneficial labour compensation and economic regeneration program are concerned, the above is all that the company could offer to its former workers. At this point, the Mhangura settlement including its infrastructure, amenities and residents was adopted by the Makonde Rural District Council (MRDC) This means MCM had nothing more to do with the welfare and plight of the Mhangura community which is largely composed of former mine workers. The same approach was applied at several other closed mines in Zimbabwe. These include Inyati, Kamativi and Empress mines, whereby the local District Councils were ordered to inherit the running of the former mining community and its infrastructure.

Considering the adequacy of the overall exit packages for the former mine workers, the mine's general manager confessed that inflation devalued the packages to meaningless levels. Former employees who have failed to secure meaningful alternative employment elsewhere are living in abject poverty. The questionnaire survey revealed that 14% of the respondents consider their package as adequate while 86% of the respondents consider it inadequate. This serves to confirm the Mine Manager's comment that most of the former mine workers and other residents are living in abject poverty.

For a living, a variety of survival strategies are employed by the former mineworkers. Common livelihoods include merchandising, farming, welding, casual contract jobs and others that include prostitution, thieving and burglary. Thefts include extreme life threatening cases such as stealing live power transmission lines and underground mine cables.

Community Welfare

Among the indicators of poverty affecting households in the community, food shortages, lack of school fees, lack of medical attention and lack of clothing are common problems.

Approximately 60% of the sampled community indicates that they are facing shortages of almost all basic commodities. The Mhangura High School headmaster reiterated the growing problem of poverty in the community. There has been a marked drop in the school's enrolment from 975 pupils in 2000 to just above 700 in 2002. The immigration of indigenous small scale farming communities onto the surrounding farms has lately raised the enrolment to 898 by the end of first term 2003. The school authority has since stopped enforcing school uniform as an obligation due to most parents' proven failure to buy it. Another poverty indicator is the growing incidence of malnutrition, scabies, diarrheal diseases and tuberculosis cases being reported at the local mission hospital. Table 1.1 shows hospital statistics highlighting a comparative analysis of monthly incidence of selected diseases before and after mine closure

Table 1. Per month incidence of selected illnesses in Mhangura (1999/ 2003)

Disease	Cases per month 1999	Cases per month 2003
Malnutrition	2	6
Scabies	30	101
Tuberculosis	7	200
Malaria	80	277
Diarrheal diseases	21	116

The tabled information reflects a marked rise in the prevalence of all the five selected diseases. A conclusion can be drawn therefore that the pre closure health delivery and disease control system was far more efficient and well established than the post mine closure case. In addition, the generally high incidence of diseases such as those tabled above can serve as an indicator of deteriorating welfare and environmental health conditions in the community.

There are certain diseases also occurring among the respondents, which are considered as being attributable to their former mining occupations. These include chest and respiratory diseases, asthma, skin diseases, backache, optical and hearing problems among others. It is sad to note from the information gathered that nothing in the form of compensation or at least medical assistance has been received by the victims from the former employer or other organisations.

Infrastructure and Social Services Under The New Authority

On the general welfare of the community, it is now the responsibility of the Makonde Rural District Council to maintain the local infrastructure and provide, water, sanitation, and other amenities for the former mining community. Taking over the running of such an established urban scenario has been an overwhelming task for the council which was institutionally, technically and financially unprepared and under equipped. It simply could not cope with the demands of the local community, which for that matter has traditionally been provided with free water, sanitation, electricity and other services by their employer. The community in protest rejected the proposed water supply, sanitation and waste collection levies among others. This worsened the Council's position such that with its meager revenue base it failed to pay its ZESA bills, which resulted in debt amounting to Z\$4.3m. A bulldozer and other equipment were attached by ZESA to cancel off the debt.

The council could not continue running the Hunyani river water supply system due to prohibitive pumping costs. This plunged the settlement into a serious water shortage situation. A nearby farmer rescued the situation by donating his two farm boreholes to substitute the Hunyani water source. The low capacity of the borehole water source necessitated a strict rationing system, which involved water supply to the community only during the period 6-8 am and 6-8 pm of each day. This is the current scenario for the Mhangura residents and has caused serious environmental health implications to the community.

The old sewer system already overwhelmed by high population growth could not be sustained by the highly rationed water supply. It has virtually collapsed resulting in a situation of widespread and frequent pipe bursts and blockages. Flowing or accumulating raw affluent is common site in the compounds and this problem in particular is widely regarded as the main cause of the increasing cases of diarrheal diseases in the settlement.

In rejecting the payment of levies to the council, the residents' association opted to deal with sanitation and waste collection at section level. Such sections agreed to make contributions to pay volunteers who clean toilets and clear blockages. Waste management was individualized in the form of household composting and refuse burning. The majority of residents failed to comply with the agreed tasks such that the resulting conditions fell far short of meeting the basic environmental health standards. Indiscriminate dumping and burning of refuse posed serious health threats to the community.

The environmental health technician confessed that the local environmental health maintenance and inspection system was once very efficient during the mine's operations. The sanitation department had a large workforce which was composed of toilet cleaners, plumbers, street cleaners, refuse collectors,

water supply and maintenance personnel who were supported by a large group of general workers. Table 1.2 gives a comparison of the relative sizes of workforce in the different departments of the local sanitation sector between 1998 and 2003..

Table 2. Relative sizes of the various departments in Mhangura`s cleansing sector (1998 and 2003)

Department	Workforce size	
	1998	2003
Toilet cleaning	10	0
Street cleaning	15	0
Plumbing	6	2
Domestic waste collection	12	0
General workers	40	0

A comparative analysis of the table information suggests the conclusion that the environmental health conditions of Mhangura before mine closure were adequately attended to, while on the other hand the sanitation department for today`s Mhangura has virtually collapsed. The collapse of the administrative and policing systems has brought about a high prevalence of theft and vandalism of the sanitary infrastructure. This happens to be a common scenario at the closed Inyati, Empress and Kamativi Mines in Zimbabwe.

Since the mine closure and the subsequent coming in of the MRDC the local environmental health conditions have consequently been fast deteriorating. It is a cause for concern that there seems to be no-one making efforts to deal with the problem of residents` reluctance to pay for the services and that of the settlement`s critical water shortage. Without solutions to these two problems, Mhangura is threatened with looming environmental health hazards. A mixture of heaps of uncollected refuse and pools of raw sewage within the residential compounds create visual nuisance and an extremely smelly atmosphere. In addition this provides for breeding grounds for mosquitoes, houseflies, rodents and other disease vectors .

A living environment with a combination of the above problems is most often prone to a variety of communicable diseases. The escalating number of diarrheal diseases reported at the local hospital is indicative of the occurrence of the above environmental health risks.

The community is also exposed to a number of health and safety risks associated with the abandoned mining sites. The pits have unstable edges which are prone to slope failure and since they are largely unprotected, they pose major safety risks to humans especially children. The slime dams generate dust storms, which invade the village with a potential to cause upper respiratory infections. The rock and Leach tailings are high and have steep slopes, which are susceptible to slope failure, which has potential to cause harm or loss of human and animal life.

The mineworkers and their families are not the only ones who have been subjected to the socioeconomic impacts of the mine closure. Local schools have not been spared. The closure of the mine implied an automatic withdrawal of a variety of benefits the schools used to enjoy from the company. The mine provided free water and electricity, waste collection services, free transport, books, sporting facilities, uniforms and equipment. The mine was also responsible for infrastructure maintenance and development in the schools. Teaching and other school staff enjoyed highly subsidized accommodation. The running of the schools was transferred to the MRDC, which in turn due to its perennial financial difficulties has called upon School Development Associations (SDAs) to run the schools.

The SDAs can only get finance through levying. The community being largely made up of retrenched mine workers and newly resettled farmers, the levies cannot be raised to economically viable levels due to poverty that is characteristic of most local households. The schools therefore find themselves having to operate with a low revenue base. As a result schools are failing to pay their general workers in accordance to set minimum wage and salary structures. The schools are having to do with insufficient old books and other equipment. Several experienced teachers who have been used to a tradition of free or subsidized services have escaped the falling standards through transferring to other mine schools. This compromised the standard of teaching and learning in the schools, which in turn impacts negatively on the local community.

The local hospital has also been grossly affected. The whole local health system was once run by the mine before its closure. It had to be closed for a while before it was taken over by the Church of Christ on a humanitarian basis. The hospital is donor-funded to maintain and subsidize medical services and medication for the benefit of the local community. The smooth running of the hospital is largely undermined by the critical shortage of water in the settlement. This compromise the degree of hygiene that is expected of a hospital. This again is to the disadvantage of the local community.

The business community has suffered significant shrinkage as a result of the mine closure. This is because the mine and its workers constituted the major pull factor to investments in the town. Quick to respond to the impact were establishments such as Barclays Bank, the Standard Chartered Bank,

Commercial Bank of Zimbabwe, the local Hotel and a couple of high order retail shops which had no choice but to withdraw their services from the settlement. To the local community the implication is in the form of deprivation of high order, specialized services and goods. The remaining business community had to do with low clientele and sales. To match this economic atmosphere, they scale down and simplify their businesses and services which are symptoms of underdevelopment. Table 1.3 illustrates relative numbers of commercial service units available in Mhangura in 1998 and 2003.

**Table 3. Relative numbers of commercial service units in Mhangura
(1998 and 2003)**

Type of commercial service	Number of units (1998)	Number of units (2003)
Grocers	12	6
Supermarkets	4	1
Banks	4	1
Chemist	2	1
Restaurants	5	2
Hotels	2	0

What is reflected in the above table is a case whereby the mine closure has plunged a variety of essential commercial services into viability problems which forced them out of business at Mhangura. The local residents have been deprived of medium to high order services and goods by the mine closure. The absence of a hotel facility and the remaining of one supermarket and one Bank in the once busy settlement are indicative of this.

The mine was once known to be a hub of highly advanced sporting and clubbing facilities with nationally competitive sporting teams and personalities. Soccer is an outstanding example. In terms of sports and recreation, the town is dead. The sports stadium, which was once among the best in the country, has evolved into a basin of overgrown grass with structures falling apart.

In conclusion the closure of Mhangura mine has thrown thousands of people out of employment, and plunged the town into poverty, ripping out a vast company – founded network of social infrastructure. No one including government has so far made significant effort to design a plan for alternative socio-economic use of the fast depreciating infrastructure, plants and equipment abandoned by the mine.

Biophysical impacts of the mine closure

The operations of the mine were largely confined to three main sections namely the extraction sites, the processing sites and the dumping sites. In these three sections there is clear evidence of absence to minimal consideration of environmental and social interests both during operation and after mine closure.

Extraction sites

Both opencast and subsurface mining has been carried out at the mine. More attention will be given however to the open pit sites where the landscape in general and several other biophysical variables have been extensively disrupted.

Work on the open pits was started in 1955 at the project inception. The pits in terms of extent cover an estimated total area of 1.2 square kilometers with depths ranging from 10 meters to 45 meters in certain parts. The pit edges are generally steep sloping to free faces that are bare of vegetation cover. This has created conditions conducive for landslides, land slumps and rock falls, which are clearly evident in many parts.

There is virtually no sign of backfilling or slope stabilization in the form of revegetation or other rehabilitation methods. There is a frightening case of possible slope retreat towards the hospital premises if nothing is done to stop slope failure. In fact one of the pit edges has eaten up a section of an access-tarred road, which has since been closed. In the same direction of slope retreat, there is the hospital premises upslope.

The main pit in particular happens to lie above the underground workings. This has resulted in one incident whereby part of the pit floor collapsed and exposed the underlying tunnel. This is indicative of the structural weakness created in the geology of the local area. This particular collapse in fact triggered localized earth tremors whose recurrence could have unforeseen safety implications. Because of this particular risk, the mine's general manager argues that the idea of filling up the pits would create an additional strain on the underground network. This will result in the compounded risk of the possible localized tremors.

The deep earth scars, and bare free face hill slopes create an unpleasant visual intrusion. The magnitude of the pits and other possible environmental and safety implications are easy to judge. The land on site can rightfully be described as derelict.

The amount of vegetation that has been removed is enormous with an overall impact of habitat loss contributory to subsequent loss of biodiversity. Baseline information reveals that 23 woody species were affected. Common ones include *Jurbernardia gloriforma*, *Terminalia stenostachya*, *Brachystegia*

speciformis, *Flacortia indica*, *Salix subserrata*, *Dichrostachys cinera*, *burkea africana*, *Bauhinia petersiana*, and *Terminalia sericea* among others. An assessment of the transect reveals that vegetation cover within 20 meters from the pit is 5 to 20 percent and tends to increase with increasing distance from the pit. This is due to the high intensity of earth movement in areas close to the pits. Species diversity also assumes the same pattern with the first quadrat containing 8 species while the second contains 18 species. In addition to the pit's effects on biodiversity the pits are a hazard to both humans and animals. They also constitute physical barriers to flora and fauna and this could have major ecological implications in terms of breeding, migration and extinction.

The processing sites

The Old Leach plant

Evidence suggest that while much of the leach plant waste was disposed of at the designated leach tailings, large amounts of the gravel and stones are strewn all over the surroundings of the plant extending to a radius of about 300 meters. Soil in most parts of this area in question has been buried and contaminated with residual acid from the plant. This is evidenced by the absence of vegetation cover in many parts. The percentage vegetation cover ranges from 10 percent in the first quadrat to 25 percent in the second. In some isolated patches, stunted plant growth is observable. Thorny bushes and hard grass are the ones, which appear to cope with the harsh edaphic conditions. Around the acid ponds only fungal species tend to thrive while the rest of the area is dominated by *Dichrostachys cinera* and *Maytenu senegalenses*

The acid ponds are near to a seasonal stream, which drains into the Murereka River such that the possibility of acid finding its way to the aquatic ecosystem exists.

More than 20 years after the plant's closure the plant's environs remain in a state of disrepair. Without reasonable reclamation, there is little chance that soil development and plant succession will overcome the ecological disaster left in 1979 when the plant was decommissioned. The old broken down crushing and processing plants and equipment, the extensive surfaced area and together with the stretches of rock waste around provide for an environmental state of dereliction.

The more recent milling plant

After the closure of the local plant in the name of modernization, a new milling plant was opened to process ore from the newly established underground extraction works. It was an integrated plant, which did both crushing, and separation. The crushing of the ore was done to produce powdered ore such that after collecting the concentrate, the powdered rock waste would be transported to designated dumpsites by piped water. The new plant used a lot of oil and acid of which their use is still evident today at the plant site. Oil spillages around the dumpsite are observable. There is an acid pond still full

though being diluted over time by rainwater. Runoff has got the potential of taking these oils and acids to the nearby aquatic systems while seepage has got the potential of taking the hazardous substances to underground water reserves

Assessment of the dumpsites

The Leach tailings

The old Leach plant's rock waste material was disposed of at the rock waste or leach tailings 0.7 kilometers to the north west of the mine compound. In terms of the extent the heaps stretch along an estimated area of 0.6 km² with height averaging 35 meters. The slopes are generally steep. There is evidence of slope failure on the tailings due to the excessively steep slopes. This provides for increased chances of runoff, acid seepage, and massive slides that could be risky to animal and human life. Runoff, which is evident on the slopes, has created a large source of siltation on the nearby swamps, which as a result are fast drying up. *Salix subserrata* and other hydromorphic plant species have been affected. Ecologically wetland ecosystems are affected while economically gardening has traditionally been carried out on the swamps will be crippled.

The slime dams

The slime dams in essence constitute the disposal sites for the powdered rock waste that is brought in suspension by pipes from the new mill. Over many years of disposal the dams have grown into plateau like mounds. The fine textured waste is spread down slope by runoff. Due to the acidity of the material plus the general barrenness of crushed rock a desert like landscape has been created. Tree species like eucalyptus, water-loving *Salix subserrata*, *Vertiver grass* and a few more exotic species which are water and acid tolerant have been grown scantily on the slime dams to stabilize them and to control dust otherwise much of the area has no vegetation cover. In terms of fauna a few bird species are noted with rare cases of rodents, reptiles, insects and other organisms being sighted.

During dry periods the fine textured rock particles generate dust storms, which invade the compounds. The vegetation in the area including the compound area turns whitish with dust accumulating. This creates a health hazard to the community members and also has negative physiological effects on the plants' functioning such as photosynthesis.

Table 1.4 below gives a summary of the biophysical impacts prevailing at selected study sites. At each of the selected sites there is evidence of environmental degradation which can generally be described as severe when considering the high degree of dereliction at almost all the sites. Of major concern is the alteration of the land surface which is in the form of excavation, mounting rock waste or a concentration of scrap equipment and concrete pavements. Consequently, vegetation, soils, fauna and drainage are adversely affected with no rehabilitation work being observed on the ground.

Table 1.4 Summary of selected biophysical impacts at the study sites

Site name	Quadrat	Percentage vegetation cover	Number of species	Soil depth or quality	Water quality
Open pit	1	10	8	0.2 m	-
	2	55	18	1.2 m	-
Leach plant	1	5	6	Gravel and stones	Contaminated with acid
	2	30	11	Gravel	Contaminated
Processing mill	1	15	9	Oil / acid leach	Contaminated
	2	21	17	1.4 m	-
Tailings	1	40	11	Rock silt	Silted / acid contamination
	2	70	20	1.4 m	Contaminated
Slime dams	1	30	6	Slime material	Silted/ contaminated
	2	70	20	Silt	Contaminated

Conclusion

No Environmental Impact Assessment was carried out both before and during the mining operations at Mhangura Copper Mine. This is evidenced by the absence of an EIA document and the non-existence of an Environmental Management Plan during its operation stage. This together with circumstances surrounding the Mine closure reveal that the mine had no closure plan in place to promote sustainable environmental management and socio-economic development for Mhangura after the closure of the mine. Various forms of environmental degradation that are mining induced prevail with no evidence of rehabilitation work at the mining sites. This has seen flora, fauna and other land resources suffering with the overall landscape incurring adverse alterations

Recommendations

- ◆ There is need for government intervention in order to promote sustainable post mine closure environmental management and local economic development for the Mhangura community. This can be done through the facilitation of partnerships, which seek to bring together a variety of resources, skills and other inputs in order to implement well tailored strategies that are specific to local needs and opportunities. The partnerships should be both vertical and horizontal in order to capture all potential opportunities.
- ◆ The government and the local authority should embark on an aggressive drive to attract investors as alternative users of the mine infrastructure. This is done on the basis of thorough research in

order to come out with development strategies centred on integrating and productively using the post-operation mine project infrastructure and diversifying the local economy. In this regard, for an example, agro-based investment is likely to succeed in the face the current land reform program.

- ◆ Non-governmental organisations should be accorded a friendly and conducive environment in order to assist in community based poverty alleviation and environmental conservation programmes.
- ◆ In order to deal with the perennial budget deficit which has crippled service provision in the town, there should be the implementation of cost recovery programmes taking into account the fact that cost recovery measures and relative success are dependent on the willingness of service recipients to pay for the services. The local authority could also sale numerous valuable assets left by the mine and also sale scrap metal to various companies in the country involved in this business. The income will then be invested in the resuscitation of the settlement's service provision sector.
- ◆ The informal sector could be promoted through the introduction of waste recovery business which involves construction material from the dumpsites and the scrap metal strewn all over the mining areas. The government and local authority could help by promoting and securing market for this waste recovery business. In the process the rehabilitation of the mine sites is aided.
- ◆ The new Environmental Management Act should be implemented with immediate effect particularly for mines that are still in operation in order to avoid the same environmental and social crisis that has emerged in the case of Mhangura.
- ◆ Further research is recommended to undertake quantitative analysis of the pollution levels and their potential impacts on water, air, land, plant, animal and human health.

References

- Crowson, P, (1998) "Environmental and Community issues and the mining Industry, Natural Resources Forum, 22(2), PP, 122 – 130.
- Ngonini, X, (2001): "Waai – Waai" the impact of retrenchment, South African Labour Bulletin, 25 (2), pp. 35 – 40.
- Solomon, M. (1999) "Minerals Driven Sustainable Development" In Africa Mining 3(6), pp 64-70
- Tilton, J.E. (1996) "Exhaustible Resources and sustainable Development: Two different paradigms" In Resources Policy, Vol. 22 Nos. 1/2, pp 91-97

Viewing, K.A. (1984) "Mining and the Development of Zimbabwe" Chamber of Mines Journal, Harare, Zimbabwe, January 1984, pp21- 51.

World Bank (1992) " Strategy for African Mining" Africa Technical Department Division, Note No.12, World Bank, Washington D.C.

World Bank, (2001), Local Economic Development, (LED) Quick Reference, Urban Development Division, Washington, D.C.)

Young J.E (1992) "Mining the earth" in Brown L.R. et eds. (1992) State of the World Norton publishers, New York, USA.