

Impacts of Mining Operations on Water Resources and Ecosystems: The Case of Letseng Diamonds in Lesotho

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Abstract— The impact of mining on water resources and ecosystems can be devastating and unsustainable especially in developing countries where policies and monitoring are usually non-existent. Pollution of water, soil and atmosphere can all result when mines are in operation. The management of residuals is important as it has an impact on the health, prosperity and future generations of the surrounding communities where the mine is located. This study seeks to access the impacts of mining by Letseng Diamonds in Lesotho on water resources and ecosystems of Mokhotlong District. As an organisation, Letseng Diamond Mine prides itself as an organisation that operates complying with an ISO 14001 compliant environmental management system which is supported by an updated and comprehensive Social and Environmental Impact Assessment (SEIA) and a Social and Environmental Management Plan (SEMP). All of these meet International Finance Corporation Performance Standards and are aligned with the Equator Principles. The study seeks to establish whether the organisation is adhering to its principles to maximise the benefits that the natural environment offers or seeks to minimise the loss of such benefits.

Key words: Environmental Degradation, Sustainable Development, Mining, Legislation, Future Generations, Preventive Measures, Africa Mining Vision, Lesotho

I. INTRODUCTION

“A transparent and inclusive mining sector that is environmentally and socially responsible...which provides lasting benefits to the community and pursues an integrated view of the rights of various stakeholders...is essential to addressing the adverse impacts of the mining sector and to avoid conflicts induced by mineral exploitation. Public participation in assessing the environmental and social impacts and the enforcement of impact assessment requirements is important in tackling these challenges.”

-The Africa Mining Vision

The mining sector is a billion dollar industry and remains the backbone for many economies in the developing world (Yirenkyi, 2008). Global demand for minerals has been on the rise and there is tremendous opportunity to create jobs and economic opportunities. Diamond prices have more than doubled since 2009. In Lesotho, the importance of diamond mining is illustrated in the National Strategic Development Plan 2012/13 – 2016/17 as it is one of the key growth accelerators and in the Budget Speech 2016/17; the Ministry of Mining was identified as one of the four key ministries to address the following priorities in the NSDP, Strategic Development Goals and Vision 2020:

- Increasing economic growth towards a sustainable level of 5 and 7 percent per annum, and creating 10 000 jobs per year on average.

- Reducing food insecurity by increasing production at an average of 16Ha per year.
- Reducing child mortality by 2/3 and maternal mortality by ¾ by 2017/18.
- Reducing the incidence of HIV prevalence by 25% by 2016/17 and increasing coverage for anti-retroviral treatment (ART) by 80%.

However, mining extraction is associated with both opportunities and challenges. This sector has resulted in many countries developing their infrastructure such as roads; employ many people and improve the standards of people. It is also a sector that is highly capital intensive (especially when the mine is underground), complex and expensive. Mining operations consist of various interconnected projects operating simultaneously to deliver refined commodities like diamonds, gold, silver, copper, zinc, platinum, zinc, coal and iron ore.

According to Cottard (2001), a mine is a waste management project and poses a challenge to organisations as mining generate more waste than many entire industries and 95% of the material excavated from a mine are waste materials.

In the process of mining, the environment can be damaged. Large area of land will be affected and utilized starting from blasting, preparation of tailing ponds & tailing disposals, the crusher plant area, stockpile area for ore materials & waste materials, etc. Chemicals such as mercury and cyanide used in mining will impose health hazards to plants, animals and human. Mining can cause erosion and landslide that will vastly cause death and destroy surrounding environment like farms, rivers or anybody of waters. Mining chemicals also makes soil not suitable for planting and sometimes the damages to the environment made by mining industry cannot be restored in the span of many decades (Oelofse, 2008). An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. Thus humans, wildlife, insects, flora and fauna and vegetation all represent the living organisms in an ecosystem and all these can be either impacted positively or negatively by mining activities.

A. Some facts about Lesotho

Popularly known as the Kingdom in the Sky, Lesotho is a mountainous country with all of its land above altitude. The whole country is landlocked and completely surrounded by South Africa and economically integrated with it. Lesotho imports 90% of its goods from South Africa. In the past financial year, Lesotho's economy slowed down substantially because of major political conflicts causing temporary disruption in business activities. In the past five years, there have been three elections. Coalition governments have not been ruling for long as conflicts between the coalitions

leaders resulted in dissolution of the government. Unemployment remains high (above 25%) and is one of the most serious problems facing Lesotho, with poverty still severe as around 50% of the population lives below the poverty line. Population is just above 2.2million and inflation is around 6%. The country's currency Maluti is pegged with the South African Rand 1:1. Efforts to promote inclusive growth are constrained by the pressure of high HIV prevalence (22.9% of the total population) and the volatility of receipts from the Southern African Customs Union (SACU), which used to finance 50% of the budget.

The three main industries in Lesotho are water, diamond and textiles. Water and diamonds are Lesotho's only significant natural resources. Water is being extracted through the 30-year, multibillion-dollar Lesotho Highlands Water Project (LHWP) and was designed to capture, store, and transfer water from the Orange River system and send it to South Africa's Free State and greater Johannesburg area, which features a large concentration of South African industry, population and agriculture. The World Bank, African Development Bank, European Investment Bank, and many other bilateral donors are financing the project. Diamonds are produced in Letseng, Mothae, Liqhobong and Kao mines. The sector suffered a setback in 2008 as the result of the world recession but rebounded in 2010 and 2011. It is a major contributor to the exports of Lesotho. Lesotho has taken advantage of the African Growth and Opportunity Act (AGOA) to become the largest exporter of garments to the US from sub-Saharan Africa and the textile industry employs over 50,000 mainly female workers.

B. Overview of Lesotho's mining industry

Diamond mining dominates the mining industry of Lesotho and as such the mining sector in the country has not played any significant role in furthering its economy (2011 Minerals Yearbook). Apart from diamonds, the country's main mineral resources have been identified as base metals, clays, sandstone, dimension stone, sand, gravel and uranium. The lack of initiative to extract other minerals commercially is mainly attributed to the inadequacy of infrastructure and finances. Between 2000 and 2011, the percentage of GDP contributed by diamond mining to Lesotho's economy rose from "virtually zero" to about 4% (Central Bank of Lesotho Economic Review, 2012).

As a result of the opening up of mines and the increased contribution of mining to Gross Domestic Product (GDP), the government of Lesotho created the Ministry of mining in 2012 with a mission to commit to explore and disseminate information on mineral resources, regulate and manage prospecting and mining activities to develop the mining sector in partnership with our stakeholders in an environmentally friendly and sustainable manner for the socio-economic benefit of the Basotho nation. Previously the Department of Mining and Geology was administered and regulated by the Ministry of Natural Resources.

The mining and quarrying sector currently accounts for 7.9 percent of Lesotho's GDP (Budget Speech 2016/17). While this is lower than the 9.2 percent posted in 2008, before the global financial crisis, it is nonetheless substantially greater than at the start of the millennium, when the sector made up just 0.1 percent of the economy. This transformation

has been shaped by robust growth in the international diamond market, which allowed for the reopening of old mines as well as the establishment of new ones. The industry has grown as in 2011; the Liqhobong and Kao mines were opened.

C. Letseng diamond mine

It is one of the major five diamond mines producing the highest annual capacity in Lesotho owned by Gem Diamonds Ltd of the United Kingdom (70%) in partnership with the Government of Lesotho (30%). It is located in the Mokhotlong District in the Maluti Mountains at an altitude of about 3 100m above sea level. Letseng Mine is a world's leading source of exceptionally large diamonds and has sold the world's 14th largest diamond for \$16.5million in 2011 (Newman, 2012). As an organisation, Letseng Diamond Mine prides itself as an organisation that operates complying with an ISO 14001 compliant environmental management system which is supported by an updated and comprehensive Social and Environmental Impact Assessment (SEIA) and a Social and Environmental Management Plan (SEMP). All of these meet International Finance Corporation Performance Standards and are aligned with the Equator Principles.

D. Legal framework for the Environment: Mining policy and Environmental regulation and Laws

Currently Lesotho has a Mines and Minerals Act of 2005 that replaced the Mining Rights Act of 1967. The act has all the regulatory information for establishment and governing of mines Lesotho. Under this act, the Government of Lesotho owns not less than 20% of a proposed mine and a mining lease shall be valid for a period not exceeding ten years. Current concessions under the Mines and Minerals Act of 2005 include exemptions for mining companies from sales taxes on capital items during mine evaluation and construction, as well as exemptions from withholding taxes on dividends and interest payments. Government requires payment of a royalty on diamond sales (8 percent), as well as a 12.5 percent free-carried interest and a similar contributing interest in any mining project. The government also requires that government representatives be at mining lease area for diamonds acting as a public officer. The holder of a lease is also expected not to engage in wasteful mining and treatment practices or conduct his operations otherwise than in accordance with good mining practices. Compensation for disturbance of rights –damage to the land surface, crops, trees, or buildings by mining activities is also expected. However, it should also be noted that the government now has a draft of the Mining and Minerals Policy which was completed in 2014 which is a harmonised policy incorporating the NSDP, Vision 2020 and the Africa Mining Vision policies.

There is also an Environment Act of 2008 that gives a right to every person living in Lesotho the fundamental right to a scenic, clean and health environment. It also stipulates some of the following principles of environment management:

- 1) To ensure that sustainable development is achieved through sound management of the environment.

- 2) To use and conserve the environment and natural resources of the Basotho nation for the benefit of both the present and future generations.
- 3) To maintain stable functioning relations between the living and non-living parts of the environment through preserving biological diversity and respecting the principle of optimum sustainable yields in the use of natural resources
- 4) To publish data on environmental quality and natural resources.
- 5) To ensure that waste generation is minimised and safely disposed of.
- 6) To prevent any interference with the climate and adverse disturbances of the atmosphere and take compensatory measures for any avoidable interference.
- 7) To ensure the cost of environmental abuse or impairment are borne by the polluter.
- 8) To ensure that appropriate measures are taken to prevent soil erosion.

Lesotho has 10 districts and in each there should be a District Environmental Officer acting as a Public Officer. The fines that are paid when a person contravenes the water quality standards, air quality standards, standards for waste, soil quality standards, standards for noise, standards for the control of noxious smells and guidelines for environmental standards; are not less than M5 000 or imprisonment for a term of not less than 2 years or both. The person would also be responsible for the costs that maybe incurred by any Line Ministry or Department in the restoration of the environment damaged or destroyed, and pay the costs incurred by a third party in the form of reparation, restoration or compensation as may be determined by the court.

E. Objectives of the study

This study seeks to;

- Access the impacts of mining by Letseng Diamonds in Lesotho on water resources
- Access the impacts of mining by Letseng Diamonds in Lesotho on ecosystems of Mokhotlong District.
- An assessment of what the company does/uses to curb/mitigate environmental degradation.
- An analysis of the government's role on the mine.

With climate change now sadly a reality in Lesotho, the country is vulnerable to environmental hazards such as floods and droughts, which severely compromise national food security while also threatening protected areas of significant biodiversity (The Lesotho Review, 2015); this study will help to establish if the Letseng Diamond Mine is implementing its environmental preventive measures.

F. Research questions

This study aims to address the following questions

- What are the effects (positive and negative) of mining activities on the water resources around the area where the mine is located?
- What are the effects (positive and negative) of mining activities on the ecosystems surrounding the mining area?
- What measures have been put in place by Letseng Diamonds Mine to reduce/curtail environmental effects?

- What measures have been put in place by Letseng Diamonds Mine to reduce/curtail health effects?
- What are roles does the government play on the mine?

II. LITERATURE REVIEW

A. Theoretical Literature Review: The Theory of Sustainable Development

According to Reed (1996), sustainable development emerged as an issue after many countries had implemented Structural Adjustment Programmes (SAPs). So far there have been 3 international events to mark the evolution of sustainable development:

- The Stockholm Conference in 1972
- The Rio Conference of 1992
- The Rio Conference of 2002

These events are significant as they represent the growing pressure put on governments to address the growing environmental crises.

Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Kates et. al., 2005). According to Reed, sustainable development is people centred in that it aims to improve the quality of human life, and it is conservation based in that it is conditioned by the need to respect nature's capacity to provide resources and life supporting services. – the quality of human life is improved while living within the carrying capacity of supporting systems. This definition embraces the closely interdependent 3 basic components: the economic, the social and the environmental.

The economic dimension of sustainability requires that society pursue economic growth paths that generate true income, not short term policies that lead to long term impoverishment; requiring that organisations internalise all costs (including the societal and environmental costs associated with the production and disposition of goods thereby implementing the full cost principle. The social component requires that for a development path to be sustainable over a long period of time, wealth, resources, and opportunity must be a shared in such a manner that all citizens have access to minimum standards of security, human rights, and social benefits, such as food, education, shelter and opportunities for self-development; and it also demands the active participation of all social sectors. The environmental aspect advocates maintaining the long term integrity and therefore productivity of the planet's life-support systems and environmental infrastructure. Using these 3 components of sustainable development should converge in such a way as to generate a steady stream of income, ensure social equity, pursue socially agreed upon population levels, maintain man-made and natural capital stocks, and protect the life-giving services of the environment. The table below illustrates the six concepts of sustainability.

1.	A sustainable state is one in which utility (or consumption) is non-declining through time.
2.	A sustainable state is one in which resources are managed so as to maintain production opportunities for the future.

3.	A sustainable state is one in which the natural capital stock is non-declining through time.
4.	A sustainable state is one in which resources are managed so as to maintain a sustainable yield of resources services.
5.	A sustainable state is one which satisfies minimum conditions of ecosystem stability and resilience through time.
6.	Sustainable development as capacity and consensus building

Source: Perman et. al. (1999)

Table 2.1: Six concepts of sustainability

B. Empirical Literature Review

Balanay et. al. (2014) using an Instrumental Variables (IV) approach to analyse the income effects of mining in Caraga Region of Philippines found that mining can clearly bring opportunities that can spur sustainable economic development through the proper management of its associated mining effects. The impact of mining on income was found to be positive and they concluded that mining could help in strengthening local economies in Caraga Region for poverty reduction and nation building. However, they also noted that mining needs to be supported with good insights in the management of mining benefits to direct these benefits and future efforts to the right context of human and socioeconomic development; addressing the concern on environmental health and protection and sustainable development in the optimisation of mining benefits in the region.

According to the De Beers Analysis 2014, environmental effects of mining and milling stage include contamination of surface water and underground water, increased erosion and sedimentation of lakes and streams, wildlife and fisheries habitat loss, heavy metal leaching from acid mine drainage, changes in local water balance, potential acid generation from waste rock and pit walls, noise and wind borne dust, and land and forests covered by waste rock piles and tailings disposal areas (land alienation).

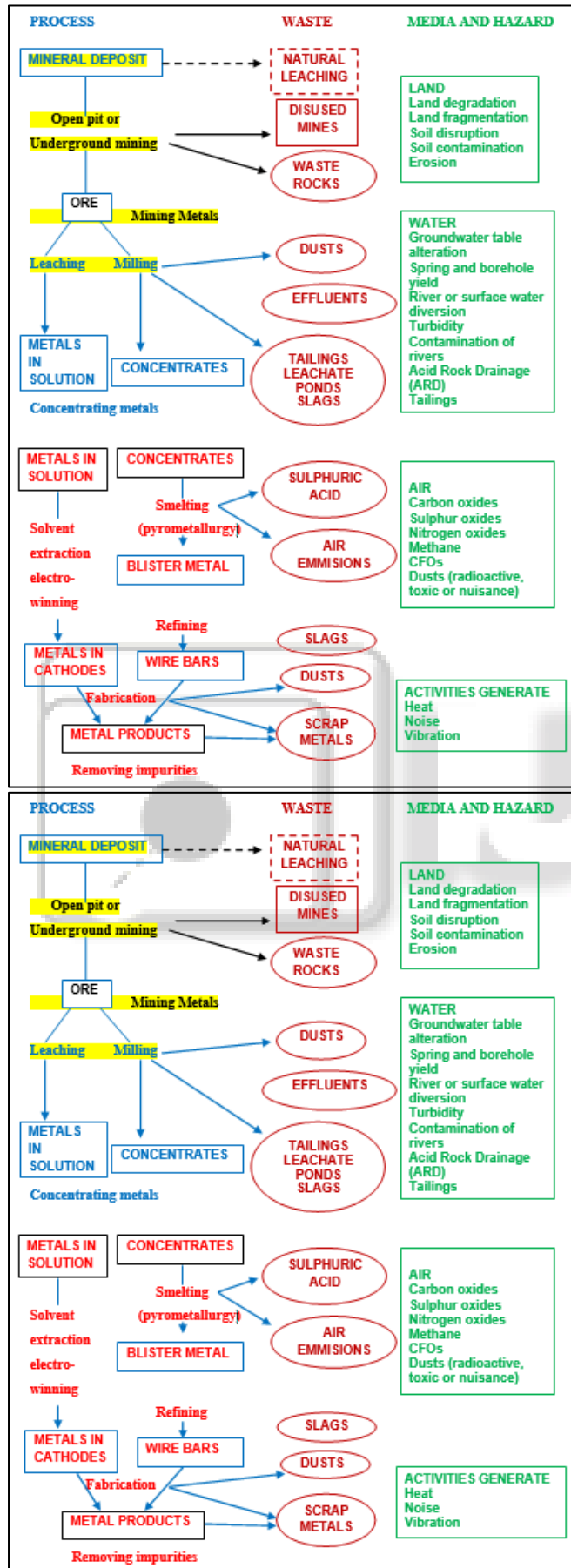
In a study of impacts of mining on water resources in South Africa by Ochieng et. al. (2010) found that there was increase of acid mine drainage (AMD) presence in the streams/rivers which threatened the scarce water resources of SA, and as a result also human health and food security in the mining areas. The water qualities of the sample area and that discharges by the mine into the rivers both exceeded the standards set. It was thus recommended that some of water treatment and prevention to nullify or neutralise the acid levels of the mine water was necessary.

Nkulu et.al (2012) in a study of populations living in Katanga in the Democratic Republic of Congo found that subjects living close to the sources of industrial pollution had high concentrations of metals in their urine. Both diet and contaminated dust were found to contribute to the intake of cobalt (Co) contamination of locally grown vegetables and locally caught fish represented significant sources of exposure to cobalt. The contribution of dust was also found to be substantial in adults and even more in children.

Menhta (2002) on a study in India on the impacts of the mining sector on the environment and FDI flows the extraction of minerals from nature creates imbalances which

adversely affect the environment. The key environmental impacts of mining are on wildlife and fishery inhabitants, the water balance, local climates and the pattern of rainfall, sedimentation, the depletion of forests and the disruption of the ecology. It was concluded in this study that management of a country's mineral resources must be closely associated with her overall economic development and, environmental protection and preservation strategy. The diagram below clearly shows the impacts of mining activities on water and the ecosystem.

C. Environmental and Social Impacts of Mining



Source: Cottard (2001)

Fig. 2.1: The Mining Life Cycle

Air pollution, soil contamination, water pollution and siltation, geotechnical issues and land degradation are some of the many environmental impacts resulting from mining activities in Zambia (Lindahl, 2014). Environmental issues with impacts on a global scale such as emission of greenhouse gases are sometimes difficult to evaluate.

III. METHODOLOGY

This makes use of both the qualitative and quantitative analysis. Data is from both primary and secondary sources. Data was also collected using interviews, observations and from government ministry agencies publications. The sample is drawn from the local residents living near Letseng Diamonds, staff of Letseng Diamonds, government representatives from the Ministry of mining and Ministry of Tourism, Environment and Culture, and Health Officials from the local clinics. Data was analysed using SPSS and summarised using tables, charts and statistical techniques such as chi square were used.

IV. RESULTS

Most respondents said that they had had no benefit from the presence of the mine (97.5%); and most of them had an idea of mining operations by Letseng Diamond (95%) and that it had some effect on the natural environment (92.5%). Those who had no idea of mining operations were females (7.5%), benefits from the mine by the local residents - part-time jobs, water taps/tank, school bursaries, sheep shearing structure. Degradation of land, air pollution and noise pollution are the most viewed as the effects of mining activities.

Most of the respondents were male respondents. On water quality, 92.5% respondents viewed water quality as either good or very good. Not many injuries or mine disasters have been yet reported and this shows that the mine's motto of "we care, we protect and we achieve" is working as this past year they have had 255 days without a single injury on the mine.

Causes of Pollution	Percent (YES)
Presents of tailing dams	15
Use of toxic materials	37.5
Use of heavy machines	85
Clearing of vegetation	60
Long period of excavation	17.5

The most common diseases prevalent are cold cough, diarrhoea and skin diseases. The staff employed by the mine reported that economically their lives were better. A local clinic built by the mine and serviced both employees and locals for free.

Measures being undertaken to curb adverse effects	Percent (YES)
Reforestation	30
Water treatment	75
Providing alternative sources of drinking water	60
Recycling of water	62.5
Compensation of affected communities	2.5
Newer greener technologies	12.5

V. DISCUSSION

Minerals are non-renewable and limited natural resources (Mehta, 2002). Lesotho, the mining sector contributes a lot to economic development, revenues, export earnings, exchange rate stabilisation, employment, infrastructure development and the multiplier effects to other sectors both locally and regionally.

However, to ensure sustainable development mining impacts should be taken into consideration. The impacts include erosion, contaminated sites, drinking water quality, non-biodegradable litter, waste volumes, landfill quality and management of hazardous waste stream.

Although most of the local respondents (97.5%) said that they had no benefit from the presence of the mine, most of them showed that they have access to free medical help and for the Sefate Village, the mine does provide water for them as it is a scarce resource in this area. A few also recognised the scholarships that the mine awards to Basotho and the building which was constructed for the shearing of sheep by locals.

Most respondents (92.5%) viewed water quality as either good or very good. This shows that Letseng Diamonds is making sure that no contaminated water leaves the site as they also implement recycling of water and engage in water management and treatment. This is an important issue as Letseng Diamonds operates on the watershed between Khubulu and Matsoku drainages, which flow to the proposed Polihali Dam and Katse Dam.

The sustainability principles of Letseng Diamonds seems to be supported by the stakeholders as most of them perceived that the mine makes attempts to reduce the adverse effects of mining activities. Letseng Diamonds has thus taken the following measures to curb the adverse effects: forestation, water treatment and use of green technologies.

Diseases that are most prevalent are respiratory infections and colds. This can be explained by the presence of fine dust on site and also the cold weather conditions in the Mokhotlong District which is usually in the single digits. Not many injuries or mine disasters have been yet reported and this shows that the mine's motto of "we care, we protect and we achieve" is working as this past year they have had 255 days without a single injury on the mine. The mine has a clinic that is also able to attend to the current diseases (staff and resources) and that should be commended to management of the mine.

VI. CONCLUSIONS

Minerals are non-renewable and limited natural resources (Mehta, 2002). In Lesotho, the mining sector contributes a lot to economic development, revenues, export earnings, exchange rate stabilisation, employment, infrastructure development, and the multiplier effects to other sectors both locally and regionally. However, to ensure sustainable development mining impacts should be taken into considerations. The impacts include erosion, contaminated sites, drinking water quality, non-biodegradable litter, waste volumes, landfill quality and management of hazardous waste stream.

While contributing substantially to the economy, the mining sector offers limited employment creation due to its

highly mechanised nature. The development of a mining and minerals policy and the review and modernisation of the existing regulatory framework is critical to maximising benefits from the sector. This includes the completion of geochemical mapping and the development of downstream industries. To achieve sustainable development there is need to carry out an analysis of the environmental, economic and social impact of the whole mining industry on Lesotho's ecosystems. Implementation and monitoring of environmental laws has been difficult especially due to the political situation in Lesotho over the past few years, which has not been conducive for good governance.

VII. RECOMMENDATIONS

Participation of stakeholders such as mine workers, local residents, civil society and environmental organisations would help in the effective implementation of environmental laws and regulation. It should be mandatory for mining companies to obtain environmental certificates (for example by use eco-rating) as this ensures that they are maintain the required standards because as Perman et. al. (1999) reiterates, a sustainable state is one in which utility or consumption is non-declining through time. When it comes to mitigating the impacts of mining on water systems and ecosystems taking the prevention (Cottard, 2001) and being proactive is the key.

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