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Impact of Mining Chemical Waste Management and Disposal on Environment and Water Pollution to Local Communities in Zimbabwe: A Case of Hwange Coal Fields in Matabeleland North Region

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Abstract:

Water pollution has now reached a crisis point in most third world African countries. In Zimbabwe almost every water body is exposed to extensive pollution. The massive legal and illegal mining activities in the country adversely affect the environment. The problems associated with such activities are land degradation, disposal of over burden (OB), deforestation, and extensive water pollution, hazardous to flora and fauna. In order to assess the impact of mining waste management and disposal of Hwange Coal Fields on water pollution and the livelihood of local communities a study was conducted in Deka area of Hwange District in Matabeleland North Region: Zimbabwe. To achieve this random sampling technique was used to come up with a sample of 50 respondents- with subjects drawn from local communities, authorities, environmental organisations and mining companies. In-depth interviews and questionnaires were used to generate views of all stakeholders. Qualitative methods of data presentation and analysis were used to provide for both the backdrop and a detailed explanation of the findings of the research. Research findings revealed that mining activities are a major contributor to massive pollution and environmental degradation in Zimbabwe's mining communities. As massive hazardous chemicals are discharged and seep into fresh water bodies and somewhere along the line people are made to drink the effluent. The findings were intended to assist the Government and other stakeholders in crafting sound water pollution mitigation strategies for sustainable livelihoods of local communities, in areas where massive mining activities are done.

Keywords: *Mining chemical waste, water pollution, waste management, chemical waste disposal*

1. Introduction

With pollution of the environment and water bodies across Zimbabwe and the Sub-Region at its peak, governments and stakeholders in the region, and the corporate world have to chart a road-map to redress the situation through shaping up of a policy framework structured to deter all polluters from engaging in activities which lead to gross pollution and environmental degradation. Zimbabwe is slowly becoming a poisoned country with all the pollutants filtering into water sources, hence depriving its citizenry of the right to clean water which is a fundamental human rights issue. Water and environmental pollution to a larger extent is attributed to mining, industrial activities, poor farming methods and improper dumping of garbage in densely populated towns and cities. Councils are among the major polluters as they discharge raw sewage directly into water bodies and the environment, and coupled by unplanned settlements, pose a threat to human life and the environment as people are congested competing for limited resources and tend to rely on unprotected shallow wells as water sources which are heavily contaminated. Tanneries are a contributor in that they produce organic solids, dyes and paints which are poisonous and dangerous to human and aquatic life. Funeral parlors release the embalming fluid formaldehyde, which kills bacteria that is important in sewage purification. Breweries and beverage producers also produce alkaline that kills bacteria for sewer purification, and abattoirs have fats and organic solids that reduce biological oxygen demand, thus destroying aquatic life. Again lack of a statutory instrument for disposal of babies' and women's sanitary products such as pumpers which are neither classified as solid nor liquid waste aggravates both land and water pollution, an option being reverting back to the use of reusable nappies and pads.

Surveys to probe other causes of water pollution in Zimbabwe however indicated that funeral parlours, service stations, fuel holding depots, food processing plants, chemical processing plants and transport operators' garages are major as they release oil, grease and silt which pollute underground water and corrode sewer systems. The study therefore sought to explore impacts of mining chemical waste management and disposal on water pollution to local communities in Zimbabwe with particular reference to Hwange Coal Fields in Matabeleland North Region. The main objective being trying to bring water issues to the forefront as the general perception is that they had long been neglected.

1.1. Background

In Zimbabwe, mining is a significant contributor to the country's Gross Domestic Product (GDP). The most important minerals produced being gold, asbestos, chromite, coal and base metals. The mining industry contributes approximately 8% towards the country's GDP (Adler and Rascher, 2007) However Mtisi, (2012) cited that mining is associated with numerous environmental challenges, the major one being uncontrolled discharge of effluent into water sources resulting in massive pollution of water bodies. Banks et al, (1997) and Pulles et al, (2005) further state that uncontrolled discharge of contaminated water commonly known as effluent disposal is a major environmental problem relating to mining world over. In Zimbabwe both operational and abandoned mines contribute to water pollution. It is therefore widely acknowledged that this phenomenon is responsible for costly environmental and socio-economic impacts, (Steven and Edmore, 2010).

According to Ermitte, (2004), mine effluent is a term used to describe waste water from mines that includes waste rock or tailings depositories, slimes dams, and/or draining into an adjoining body of water, including streams, lakes aquifers, wetlands, and oceans. Zimbabwe's Ministry of Mines, (1990) asserts that effluent is waste water or other fluid originating from industrial activity, whether the water is treated or untreated and whether it is discharged directly or indirectly into the environment. Mining involves production of large quantities of waste, and gold through use of cyanide and mercury on its extraction, accounts for more than 99% of toxic waste accumulation in water bodies (Adler, 2006). Disposal of such large quantities of waste poses tremendous challenges for the gold mining industry and may significantly impact negatively on the environment.

Chemical waste management and disposal from coal mines is characterized by raised levels of toxic heavy metals, especially mercury, nickel, chromium, copper, titanium, cadmium and arsenic. Their availability in effluent water is not only associated with ground and surface water contamination, but is also responsible for the degradation of aquatic environments, leading to mortality and morbidity of animal species, as well as infection of human beings (Adler and Rascher, 2007) Assessments by the Environmental Protection Agency in 1987 concluded that "problems relating to mining effluent may be second only to stratospheric ozone depletion in terms of ecological risks. Release of mine effluent to the environment has been noted to cause irreversible destruction of ecosystems. In many instances the polluted sites had never be restored fully as pollution is so persistent that remedial measures may be difficult to apply" (EEB, 2000).

Acid rock drainage (ARD) occurs when sulphide minerals are exposed to air and water, for example during soil removal in mining operations (Ashton, et al 2001). Sulphide oxidizes form an acid effluent commonly known as (sulphuric acid) which in turn leaches other metals from existing rocks. The resulting drainage waste becomes very acidic and contains a number of harmful metals, which can have severe impacts on surrounding water bodies. ARD is considered the most serious environmental problem for the mining industry (United States Environmental Protection Agency, 2000). Mining operations also affect water quality as when water infiltrates into the ground it is polluted by contaminants such as metals, sulphates and nitrates (Ashton, et al (2001). Wastewater may also contain sediments that increase surface water turbidity and reduces oxygen and light availability for aquatic life.

The impact of mining chemical waste management and disposal on water pollution include damage to vegetation, health effects on livestock and humans, shortages of water in terms of quality and quantity. Mtisi, (2012) cited that, the long-term impacts on the health of livestock and humans ultimately depend upon the physical and chemical characteristics of pollutants and the exposure of such pollutants.

As compared to many other developing countries, a number of rivers in Zimbabwe are heavily polluted from anthropogenic activities which include industrial, sewage discharges and mining (Chiketo, 2012). The sprouting of several coal mines in Hwange and the discovery of diamonds in Manicaland's Marange area of Zimbabwe has translated the country into a mining giant. However, the pursuit of economic benefits must not be at the detriment of the natural environment upon which biodiversity thrives as well as the livelihoods of millions of people who may not be deriving direct benefits from such mining activities. Focus in the mining sector should therefore not be only on the economic gains, but on sustainable environmental management, which is part of the integrated global efforts for environmentally friendly production processes (Sunguro, Hans, Beekman and Erbel , 2000).

Besides there is also air pollution, going on unchecked at worrying levels in mining, power generation stations and industrial sites. As a result mining settlements and big cities are normally characterised by thick black clouds of smoke and dust hovering around surrounding communities, emanating from mining and industrial activities. Massive dust collects on rooftops, and trees and no one seems to care about the possible threat these mining emissions may pose on health.

1.2. Statement of the Problem

Thousands of tonnes of waste are generated during coal mining and processing. This waste if poorly managed like the case in most third world countries pollutes land and water bodies. These pollutants affect the quality of water rendering it unfit for human and animal consumption, thereby affecting fauna and flora in surrounding communities. Downstream of coal mining activities in the Deka River Hwange, water is heavily loaded with effluents and raw sewerage hence has turned yellow and/or greenish in colour, effectively affecting the health of the river system and its ecosystem functions. It is therefore against this backdrop that the study therefore sought

to assess the impact of coal mining chemical waste management and disposal on water pollution to local communities of Hwange district in Matabeleland North province: Zimbabwe.

1.3. Main Objective

Main aim was to investigate the effects of Hwange coal mining activities on water pollution and livelihoods of surrounding communities and mapping strategies to address the challenges, before their damage on soil, water and people's livelihoods reach irreparable and catastrophic levels.

1.3.1. Specific Objectives

1. To determine effects of mining activities on water pollution.
2. To assess the impact of water pollution on livelihoods of local communities.
3. To assess the potential effects and hazards posed by contaminated water to human and animal life.

2. Research Methodology

The study sought to explore the impact of mining chemical waste management and disposal on water pollution to local communities in Hwange district. 50 participants were randomly selected from the community and stakeholders in the district. This is shown in (Table 1) below. Hwange is a coal mining town in Matabeleland North province, situated in the country's largest Hwange national park and closer to the mighty Zambezi River in the north.

Representative Groups	Number of Participants Sampled
Hwange Deka community	20
Local authorities	10
Environmental organizations	10
Mining companies representatives	10
Total	50

Table 1: Sample Composition

3. Results and Findings

3.1. Effects Posed by Contaminated Water on Livestock

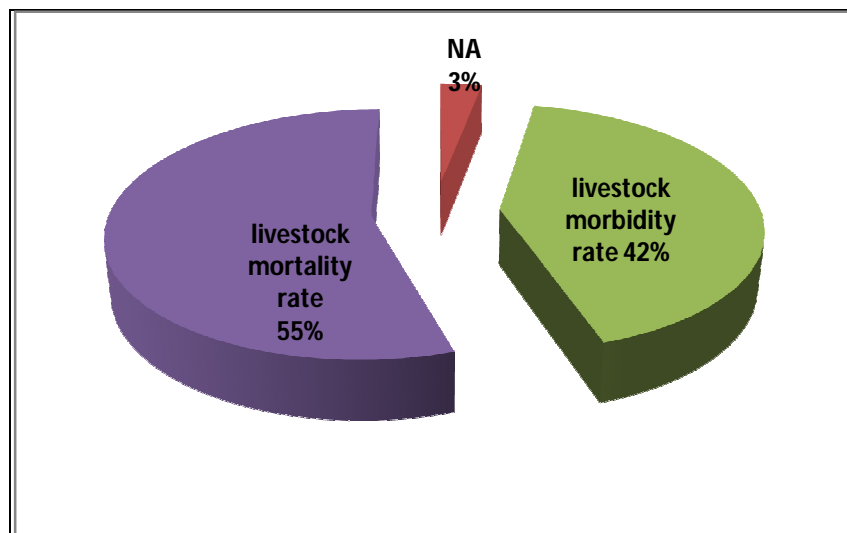


Figure: 1

Source: field study 2014

Figure 1 shows the effects of using Deka River water for livestock watering. 3% of the respondents showed that the hazardous effects of consumption of heavily polluted water by their livestock were not observable hence never noticed any changes. 42% however said livestock become vulnerable to high morbidity or compromised health as a result of consuming contaminated water from the river. Some common conditions noted included abortions, anaemia, pneumonia, rickets and emaciation/weight loss. 55% said the water actually caused high mortality/ death to livestock, as incidences of sudden livestock deaths mostly cattle in communities along the banks of the river had been reported to authorities. High morbidity and mortality had been attributed to consumption of heavily polluted water from Deka River, the only perennial source in the area.

3.2. Effects of Polluted Water on Agricultural Activities

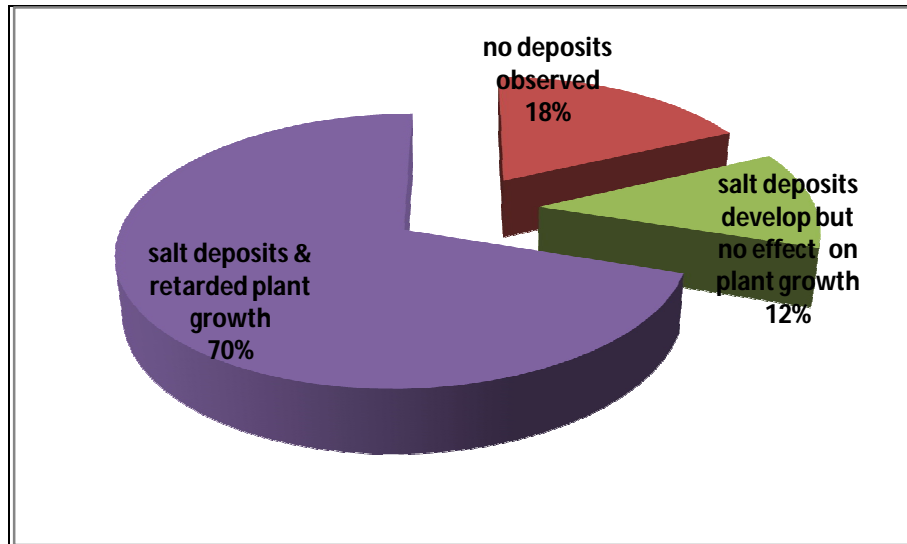


Figure: 2

Source: field study 2014

When polluted Deka river water is used in watering gardens 18% of the respondents did not notice any changes, while 12% observed that salt deposits developed on the soil but did not have negative effects on plant growth. 70% said heavy accumulations of mineral salt deposits in their gardens retarded crop growth and at times had a scorching effect and in severe situations leading to permanent wilting of plants. Some sites were infested with algae /fungus, characterizing poor infiltration and aeration hence creating conditions not conducive for crop growth. Some common observable symptoms of affected plants included, leaves becoming smaller than the normal size of a well-managed plant regardless of all nutrients and water being available to the crop, stunted growth and at times wilting even when soil is moist to field capacity. A total of four (4) hectares which was cleared by local communities for an intended irrigation scheme to be funded by CARITAS, a nongovernmental organization has not been utilized due to high levels of pollution of the water.

These are loosely called heavy metals as heavy metals may be inclusive of even the non-toxic ones.

Substance	Inhalation toxicity	Ingestion toxicity
Arsenic	<ul style="list-style-type: none"> • Carcinogenic. • Causes lung, skin, bladder and liver cancer. 	<ul style="list-style-type: none"> • Carcinogenic, causes lung cancer • Affects the gastro intestinal system
Cadmium	<ul style="list-style-type: none"> • Carcinogenic • Causes bronchial and pulmonary irritation. • Acute exposure causes long lasting impairment of lung function. 	<ul style="list-style-type: none"> • Affects the kidney
Chromium	<ul style="list-style-type: none"> • Causes inflammation of the respiratory tract. 	<ul style="list-style-type: none"> • Causes renal toxicity. • Affects the kidney and liver. • Causes gastrointestinal haemorrhage.
Mercury	<ul style="list-style-type: none"> • Affects central nervous system. • Affects respiratory system. 	<ul style="list-style-type: none"> • Causes kidney damage • Affects the gastro intestinal system • Causes developmental effects to infants.

Table 2: Local Heavy Metals & their Toxicity

Source: Hwange colliery central laboratory (2014)

Observations from Hwange colliery laboratory studies have shown that lung cancer mortality rates and mortality from heart, respiratory and kidney diseases were highest in heavy coal mining areas, less in light coal mining, and nonexistent in non-coal mining areas. Over the life-cycle of coal, chemicals are emitted directly and indirectly onto the land, into the air and water supplies, from mining activities, coal processing, transportation and power plant operations. Among the chemicals released are trace metals. The trace elements contained in coal are of public concern because at sufficient exposure levels, they adversely affect human health. Some

are known to cause cancer, others impair reproduction, the normal development of children, and others even damage the nervous and immune system. Many are also respiratory irritants that worsen respiratory leading to conditions such as asthma. Some of the common trace metals in coal as shown on table 2 above include mercury, arsenic, chromium and cadmium. Stakeholders' response indicated that exposure to air pollutants from power plants may occur from direct inhalation or indirect exposure through subsequent ingestion of water, vegetation, meat, eggs, dairy products and fish that became contaminated through accumulation of toxins in food chains.

3.3. Environmental Changes Due to Mining

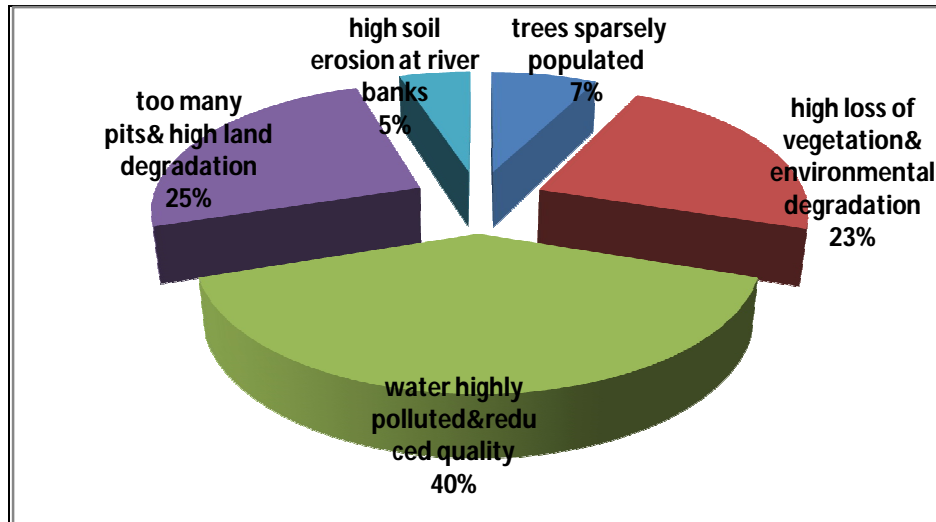


Figure 3

Source: field study 2014

Observations on the study area revealed that 5% of respondents admitted that massive erosion was taking place and ravaging the banks of Deka River, their only reliable and perennial source of water for agricultural activities, generally regarded as the only stable source livelihoods in the area. 7% noted depletion of trees with great concern as they provided fruits, a supplementary income source. 23% of the respondents indicated that there was high loss of vegetation which was critical for livestock grazing and this was associated with devastating environmental degradation. 25% raised concern over open pits as becoming too many hence posing a danger to people and their livestock as well as wildlife. While 40% cited that water quality was being compromised as the river was heavily loaded with effluent and solid waste from the mining activities. The general observation was that coal mining in Hwange does not only affect or pollute water, the environment is degraded and soil erosion is also worsened. Communities around and along Deka are in a rural setup and derive most of their livelihoods from this "great" river so if pollution is unchecked the communities will remain hit hard by poverty and food insecurity for the unforeseeable future.

4. Discussions and Conclusions

Pollution due to mining activities is present in the Deka River. This is seen by the change in the physical state of water. Particles from coal mineral are suspended in water. When the particles are discharged into water bodies they react forming a solution which changes the natural composition of water. Deka River is also polluted with oils. Contamination by oils is common during the rainy season. The unpleasant offensive smell that Deka river water has is attributed to the presence of heavy metal loads discharged into the water by mining activities. The water might appear normal, colorless but people and animals fail to drink because of the unpleasant smell. Zwabo and Makuyu villages appeared to be the most affected areas.

When polluted Deka river water is used in watering gardens heavy accumulations of mineral salt deposits develop on the soil. These tend to retard crop growth and at times have a scorching effect, and in severe situations lead to permanent wilting of plants. Some soils are exposed to high infestation levels of algae or fungus, signaling poor infiltration and aeration, conditions not conducive for crop growth hence rendering fertile soils unfit for agricultural purposes.

Consumption of polluted water exposes livestock to high morbidity or compromised health, leading to conditions such as abortions, anaemia, pneumonia, rickets and emaciation or weight loss. At times contaminated water can lead to high mortality in livestock and wildlife, as evidenced by incidences of sudden livestock deaths mostly cattle in the study area

Over the life-cycle of coal, chemicals are emitted either directly or indirectly onto the land, into the air and water bodies, from mining activities, coal processing, transportation and power plant operations. Among the chemicals released are trace metals & heavy metals, such elements are of public concern as at sufficient exposure levels, adversely affect human health. Some are known to cause cancer, others impair reproduction and the normal development of children, and a range of others damage the nervous and immune systems. Many are also respiratory irritants that worsen respiratory conditions leading to asthma. It has also been noted that exposure to air pollutants from power plants may occur from direct inhalation or indirect exposure through subsequent ingestion of water, vegetation, meat, eggs, dairy products and fish that became contaminated through accumulations in the food chains.

The research agrees with the notion that mining is not friendly to the environment as it leads to massive erosion which ravages the landscape leading to denudation of the fertile lands upon which productive farming has to be done. Vegetation which is regarded critical for livestock grazing is also severely damaged leading to devastating environmental degradation. Communities around mining areas live mostly in rural setups and derive most of their livelihoods from farming but in most cases their water sources are heavily polluted by mining activities and as pollution goes on unchecked the communities remain vulnerable and hit hard by poverty and food insecurity for the unforeseeable future, faced with a predicament that is very uncertain.

5. Recommendations

Companies carrying out mining activities should be held responsible for the hazardous effects caused by their production operations. Volumes of waste generated should be controlled from the point of generation to final disposal in a manner that prevents and minimizes pollution, thereby encouraging companies to recycle their waste. This therefore calls for establishment of pre-treatment plants before companies commence operations.

Government has to come up with a statutory instrument that mandates such companies to immediately install waste interceptors and pre-treatment plants to curb pollution, of which failure to comply would attract a penalty that calls for closure of such companies.

Stakeholder committees need to be put in place and such committees should come up with recommendations that will advise the responsible Ministry of Environment, Water and Climate to gazette a Statutory Instrument enforcing the "polluter pays principle".

As local authorities also contribute significantly to water pollution by discharging waste into water bodies, recommendations should mandate them to install operational sewage reticulation systems with the capacity to cope with the ever expanding urban populations, and the obsolete defunct sewage pump stations be rehabilitated.

The Zim-Asset cluster on infrastructure and utilities stipulates that for the economy to register growth in a competitive and effective manner there is need to develop robust, elaborate and resilient infrastructure in water and sanitation, this therefore calls for active participation from all stakeholders.

There is need for a special statutory instrument which stipulates proper disposal of babies' and women's sanitary products such as pumpers which are neither classified as solid nor liquid waste, or alternatively advocate for reusable nappies and pads.

As funeral parlors release the embalming fluid formaldehyde, which kills bacteria that is important in sewage purification & breweries and beverage producers produce alkaline that also kills bacteria for sewer purification and abattoirs have fats and organic solids that reduce biological oxygen demand, thus destroying aquatic life, emphasis should be on the proper treatment and dumping of such waste so that it is not discharged directly in to water bodies.

Mining companies should uphold their social responsibility mandate by ploughing back to the communities they work in. they should thrive to improve the livelihoods of their surrounding communities as opposed to the general observation in the study area where people live under abject poverty and starvation, exposed to life threatening man-made disasters, of heavily polluted environments while companies exploit their resources and are not exposed to any dangers as they have improved water and sanitation infrastructure.

6. References

1. Adler, R. and Rascher, J. (2007): A Strategy for the Management of Acid Mine Drainage from Gold Mines in Gauteng, Report No CSIR/NRE/PW/ER/2007/0053/C, Pretoria, CSIR.
2. Alder (2006): The Challenge of Micro pollutants in Urban Water Management,
3. IWA, publishing London,
4. Aragon and Rud, (2012): "Mining, Pollution and Agricultural Productivity:
5. Evidence from Ghana retrieved https://www.dartmouth.edu/~neudc2012/docs/paper_7.pdf. Accessed 12/11/14
6. Aragon, Fernando M. and Juan Pablo Rud, (2012): "Natural resources and local communities: evidence from a Peruvian gold mine," American Economic journal: Economic policy, American Economic Association, Vol 5 (2), 1-25
7. Ashton P, Love D, Mahachi H and Dirks P (2001): An overview of mining and mineral processing operations on water quality in the Zambezi, Limpopo and Olifants catchments in Southern Africa, Harare, University of Zimbabwe
8. Banks, David, Paul L. Younger, Rolf-Tore Arnesen, Egil R. Iversen and S. B. Banks, (1997): Mine-water chemistry, the good, bad and the ugly, Environmental Geology 32: 157-174, Pacific Institute,
9. Chiketo B, (2012): The story of Zimbabwe's Marange Diamonds, Pollution, Politics, Power. Paper funded by Environmental Justice Trade and Liabilities Project, retrieved @theafricareport on Twitter | theafricareport on Facebook, accessed 12/11/14
10. EEB, (2000): Environmental performance of mining industry in the work of Tisza Danube Pollution, European Environmental Bureau, United Kingdom.
11. Environmental Protection Agency, (2000): Mine water pollution - acid mine effluent and treatment: a consideration of key emerging issues that may impact the state of the environment, department of environmental affairs and tourism, South Africa.
12. Ermite N, (2004): Mining Impacts on the Fresh Water Environment: Technical and Managerial Guidelines for Catchment Scale, Journal of Sustainable Development in Africa (Volume 12, No.3, 2010) ISSN: 1520-5509 Clarion University of Pennsylvania
13. Steven and Edmore, (2010) The Environmental Effects of Effluent Disposal at Gold mines in Zimbabwe: Journal of Sustainable Development in Africa (Volume 12, No.3, 2010) ISSN: 1520-5509 Clarion University of Pennsylvania,
14. Mtisi, (2012): Zimbabwe Environmental Law Association. Odzi River pollution retrieved www.rough-polished.com/en/news/66005.html accessed 12/11/14

15. Pulles, W., Banister, S. & Van Biljon M, (2005): The development of appropriate procedures towards and after closure of underground gold mines from a water management perspective. Report No, 1215/1/05. Water Research Commission, Pretoria. South Africa
16. Ministry of Mines, (1990): Mines and Minerals Act Chapter 21:05 Chamber of Mines, Harare Zimbabwe.
17. Sunguro S, Hans E. Beekman and Erbel K (2000): Groundwater regulations and guidelines: crucial components of integrated catchment management in Zimbabwe" Department of Water Development, Causeway, Harare
18. ZimTrade, (2006): Zimbabwe Economic Challenges, Zim-trade publications, Harare Zimbabwe.
19. Zimbabwe National Water Authority (ZINWA), (2000): Operational Guidelines for the control of water pollution in Zimbabwe. ZINWA, Harare.