ESDA-UNZA MMR PUBLICATIONS

Education for Sustainable Development in Africa

ESDA-UNZA MMR PUBLICATIONS

ESDA-UNZA MMR PUBLICATIONS

School of Mines

UNIVERSITY OF ZAMBIA

TABLE OF CONTENTS

Foreword

United Nations University - Institute for Sustainability and Peace (UNU-ISP) together with leading African universities set up a post graduate program on sustainable development in Africa - Education for Sustainable Development in Africa (ESDA) - in order to shape a new generation of professionals to face the challenges of Africa's sustainable development. Eight African universities, together with the UNU signed an MOU on the 13th of October 2011 implementing the ESDA Master's program and establishing the ESDA Consortium as a steering mechanism to drive the program from project phase to a successful program phase. ESDA is aimed at promoting projects that encourage sustainability in the future of resource management and extraction. The specific fields targeted by ESDA for the creation of these postgraduate sustainable development study programs are; Rural Development, Urban Development and Mines and Mineral Resources Development.

The eight African Universities that signed the MOU are: University of the North (Ghana); Kwame Nkrumah University of Science and Technology (Ghana); University (Ghana); Ibadan University (Nigeria) within the field of Sustainable Rural Development; University of Nairobi (Kenya); Jomo Kenyatta University (Kenya) within the field of Sustainable Urban Development; and University of Cape Town (South Africa) and University of Zambia (Zambia) within the field of Sustainable Mines and Mineral Resources Development (MMR).

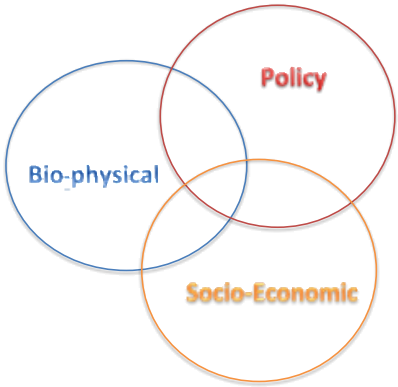
Mining in Africa, as in the rest of the world, has changed from simply balancing production targets with cost control to a complex set of interrelationships including safety, health, the environment, sustainable development and proactive stakeholder management. The development of the Master's programme in Sustainable Mines and Mineral Resources Development in Africa (MMR) provides an interdisciplinary postgraduate qualification that focuses on the critical factors of sustainable development, in the context of mining and minerals processing in Africa; including an understanding of, and a sensitivity and a progressive approach to, managing and interacting with communities, environmental challenges, safety cultures, health-related issues and regulatory frameworks.

ESDA-UNZA, has been recruiting postgraduate students since 2014. This volume takes the liberty to celebrate the contribution of ESDA-UNZA to the academic body of knowledge, by its team of lecturers and students over the period 2014 to 2019. The volume therefore, contains a consolidation of publications made in refereed journals and books, as well as selected conferences, over the period.

The ESDA-UNZA's thematic research areas are: 1. Mining's social economic impacts which looks at site/location specific issues, investor - community interactions and overall community impact; 2. Bio-physical- the impact of mining on Natural resources where the primary considerations are land (forests),

water, and air; and technical aspects of the mining value chain; and 3. Policy in the mining sector; whose ultimate goal is to influence policy makers, as they consider mining, within the context of national or human development. These areas of research are accordingly reflected in the publications.

ESDA-UNZA RESEARCH AREAS IN THE MINING SECTOR



The ESDA-UNZA Research areas in Mining

It is the intent of ESDA-UNZA to continue to strongly encourage its lecturers and students to publish and share knowledge and information from its research and findings. Consequently, ESDA-UNZA will from time to time, avail such consolidated volumes of works to its stakeholders.

Dr. Jewette H. Masinja

ESDA-UNZA Coordinator – 17 December 2019

Acknowledgements

ESDA-UNZA, would like to acknowledge the financial support of the African Development Bank, through a facility created with the Government of the Republic of Zambia in 2017. This has gone a long way in facilitating the consolidation of the MMR programme, and allowed it to recruit a total of 75 postgraduate students between 2017 and 2019/2020. We look forward to a continued collaboration with the Bank in this programme, especially as we look to expanding the student recruitment base beyond Zambia. The direct and multilevel support that the Government has provided to this programme is key, and has enabled the contents of this volume to be available. The long-term commitment of human resource development of the Government in the mining sector, is undoubted, and remains the bedrock of the ESDA-UNZA programme.

ESDA-UNZA, would like to recognise the contribution of its teaching staff, Dr Bunda Besa – also Dean of the School of Mines and Manager of the ESDA –UNZA project, Dr. Stephen Kambani, Victor Mutambo, Edward Siame, Mususu Kaonda and James Manchisi, have put in great work. The support of Ms. Longa Kabuswe in the day-to-day management of the programme is invaluable. Further, the ESDA MMR first year teaching programme includes colleagues from the University of Cape Town-Chemical Engineering Department, the University of Cape Town-Graduate School of Business, and the Sustainability Institute (University of Stellenbosch). The input from the lecturers of these stellar African Universities is fully acknowledged. We intend to continue the joint teaching, which has ensured that our students' learning experience is rich, and rewarding.

Further, ESDA-UNZA has developed a collaborative arrangement for the student internship component of the programme, with the Ministry of Mines- Mines Safety Department, Geological Survey Department, Cadastre Survey Department, and Mines Safety Department, also the Zambia Environmental Management Agency, as well as with the NGOs – Centre for Trade Policy and Development, and the ActionAid Zambia office. All of these have added to consolidating the "learning-by-doing" part of the programme.

The Zambian mining industry has supported the ESDA-UNZA teaching process by giving teaching input when the programme has move the students around the country, as part of the learning process. Management from Konkola Copper Mines, Chibuluma Copper Mine, First Quantum Kansanshi Mine, Maamba Coal Mines, and Barrick Lumwana Copper mines, as well as the respective municipality leadership, and local traditional leaders, in each case, have all

been part of the ESDA-UNZA student teaching fraternity. For which ESDA-UNZA is grateful. We look forward to continuing to secure students for the programme from the mining industry, in the future.

Finally, and not least, the management and leadership of the UNZA School of Mines, and particularly, the Office of the Vice Chancellor and his staff, have been key in ensuring that the ESDA-UNZA course runs smoothly within the confines of the UNZA operating system.

Please enjoy reading this volume.

ESDA-UNZA PROGRAMME MANAGEMENT

PUBLICATIONS IN JOURNALS

Approach and benefits of sustainable solid waste management

(Article in International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064 June 2018)

Beverly Thole*
University of Zambia, School of Mines, Metallurgy Department
**Correspondence: beverlythole@gmail.com*

Abstract

The current utilization of mineral resources has challenged the earth's capacity to withstand the negative environmental problems and this affects the economy, energy and climate aspects of our future. We need to fulfill our human needs and demands now while making use of limited resources. Historically, mining has affected the environment negatively by causing land degradation, household waste production, land, water & air pollution, species extinction, acid mine drainage and imbalance in biodiversity. This paper reviews sustainability in the context of solid waste management in a mine setup. A conceptual Sustainable Solid Waste Management approach model is devised and applied to sentinel mine in Solwezi, Zambia. Results of this study show that the mine waste material that may be generated throughout a mine process can be reduced; reused; recycled; recovered and or disposed in an environmentally friendly way thereby leading to efficient utilization of mineral resource. The study further highlights some of the benefits that may come with this practice and a conclusion is drawn from the same.

Keywords: Solid waste management; Mine waste material; Sustainability; Mineral resources; Environment

1. Introduction

The current utilization of mineral resources has challenged the earth's capacity to withstand the negative environmental problems and this affects the economy, energy and climate aspects of our future. We need to fulfill our human needs and demands now while making use of limited resources. Historically, mining has affected the environment negatively by causing land degradation, household waste production, land, water & air pollution, species extinction, acid mine drainage and imbalance in biodiversity. (Frank, Galloway, & Assmus: 2005; Lottermoser, 2010:36) The geology of Zambia is prospective with diverse kinds of mineral resources which include copper, coal, nickel, gold and zinc among others and the economy is largely dependent

on copper mining hence there has been a huge demand for copper production to meet the demands of the growing economy. It is for this reason that the essay will try to discuss the sustainable solid waste management approach, how this initiative can be structured in Zambia and some benefits of such an method using sentinel mine in North Western Province of Zambia, in Solwezi Town as an example (Frank, Galloway, & Assmus: 2005; FQM, 2018; UNEP, 2005)

2. Defining of Terms

2.1 Mine waste material

Mine unwanted products are produced during excavating and can be extremely deadly to living things that is humans, animals and vegetation because they are very combustible, volatile, or acidic in nature. (Fillip, 2013; Lottermoser, 2010:3)

2.2 Minerals

Minerals are treasured attentiveness of non-living similar metals like copper, gold or nonmetallic, like talc. Minerals are inadequate, non-renewable and have a fixed chemical organization and they occur naturally in the earth. The conversion of metals into useful materials is beneficial now and also in the future hence they should be extracted in a responsible way to avoid exhaustion (Frank, Galloway & Assmus (2005:1)

2.3 Sustainability

In 1987, the Brundtland Commission published its report, Our Common Future, in an effort to link the issues of economic development and environmental stability. In doing so, this report provided the off-cited definition of sustainable development as growth that provides the requirements in the present ensuring that there is enough supply for the forthcoming generations (WCED, 1987:7)

3. Sustainability in Solid Mine Waste Management Approach

Compacted by products from mine processes range in natural and physical arrangement therefore may affect the environment uniquely. The types of solid mine waste include;

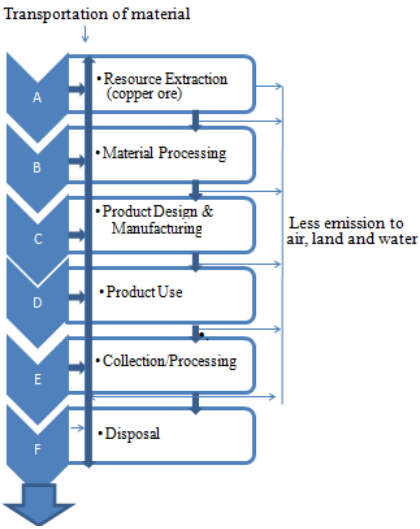
- Waste rock materials containing low mineral concentration and stored in heaps or dumps on the mine site
- Overburden soil or rocks removed during excavation at open pit and pilled, normally reused as re-vegetation during mine closure
- Nonmetallic by-products from metal smelting known as slag which is a raw material in the construction of roads
- Water treatment sludge which consist of the added chemical to the water and the solids that were removed from the water

- Gaseous waste containing particulate matter (dust) produced during smelting

Solid waste management (SWM) system therefore includes the generation of waste, storage, collection, transportation, processing and final disposal. Therefore a sustainable solid waste management approach tries to reduce these impacts by prevention; reduction; reusing; recycling; recovering and disposing waste in an environmentally friendly way like in landfills. This practice has resulted in a more efficient manner of mineral resource utilization and the following benefits can be realized;

- Tailings and slag are used in brick, floor tiles and cement production; backfilling in underground mines; dried and stacked or stored in open pits, thereby avoiding direct contamination into nearby water bodies
- Extraction of minerals and metal from waste rock which can be used in road construction or used in cement & concrete production
- The sulfur oxide emission during copper ore processing at sentinel mine for example may be converted to sulphuric acid which can be reused in the industry or sold
- The high iron content sludge from acid rock drainage treatment can be sold commercially for use in pigments (UNEP,2005 & USGS, 2013)

4. A conceptual Sustainable Solid Waste Management approach model



Key

A: Reduce amount of waste that is generated during mineral extraction as prevention may not be possible, hence it is encouraged to extract only what is needed, prioritize the use of renewable materials and those that can be used in closed loop systems

B: Recycle the post-industrial (tailings) or post-consumer waste (Product Stewardship), waste modification through chemical use

C: Remanufacture or redesign industrial processes to reduce toxic pollution, employ cleaner technologies hence reduction in the toxic or hazardous properties of waste streams

D: Materials that are recovered from waste in the current state are reused

E: Reduction of transport in the supply chain, thus reducing fuel and machinery use.

F: Seepage from the waste is controlled and there is an attempt to preventing waste production (of which is almost impossible), Green House Gas (GHG) emissions are reduced associated with the mineral manufacturing process and disposal. Waste disposal is reduced by reusing it in cement,

tile, brick manufacturing, landfills and construction (Frank, Galloway & Assmus 2005:1; Lottermoser, B.G., 2010; UNEP. 2005:9)
Composting (in landfills, construction, manufacturing of bricks and so on)

Figure 1: A conceptual sustainable solid waste management model (Adopted from UNEP, 2005:9)

5. Declaration

The author declares that every word used in this review has been cited unless otherwise and this review can be published and or referred to for any academic and other purposes. However, B. Thole retains ALL the rights of the writer of this article.

6. Conclusion

There has been a major shift from underground way of extracting mineral resources to open pit mining like in the case of Sentinel open pit mine due to the deterioration in ore grade and this poses a lot of danger to the environment hence with technology advances and changes in management techniques such as the sustainable solid waste management approach, these negative impacts can be reduced or avoided all together in an effort to attain sustainability in mineral processing (Frank, Galloway & Assmus, 2005:1; FQM,2018;UNEP. 2005:9

References

1. First quantum mines (FQM). Available: https://www.first-quantum.com/OurBusiness/operating-mines/Sentinel/default.aspx [March 9, 2018]
2. Frank, D., Galloway, J. & Assmus, K.2005. THE LIFE CYCLE OF A MINERAL DEPOSIT—A Teacher's Guide for Hands-On Mineral Education Activities. U.S. Geological Survey (USGS): Reston, Virginia. Available: https://pubs.usgs.gov/gip/2005/17/gip-17.pdf [March 15,2018]
3. Lottermoser, B.G.2010. Mine waste: Characterization, treatment and Environmental Impacts, 3rd Edition. Springer Heidelberg Dordrecht London New York. E-ISBN 978-3-642-12419-8. Available: http://kamceramics.com/wpcontent/uploads/2017/02/Bernd_G._Lottermoser_Mine_Wastes_CharacterizatiBookZZ.org_.pdf [March 18,2018]
4. Philip M. M. 2013. The Mineral Industry of Zambia in USGS (United States Geological Survey) Mineral Resources. Available: https://minerals.usgs.gov/minerals/pubs/country/2011/myb3-2011-za.pdf
5. United Nations Environment program (UNEP). 2005.Solid Waste Management, ISBN: 92-807-2676-5 Available:http://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/ELearning/Moocs/Solid_Waste/W2/Solid_waste_management_UNEP_2005.pdf [March15,2018]

6. WCED (1987): World Commission on Environment and Development – Our Common Future: Report of the World Commission on Environment and Development, United Nations 1987. Available: http://www.un-documents.net/our-common-future.pdf [March 9, 2018]

Corporate sustainability performance: an approach to effective sustainable community development or not? A case study of the Luanshya copper mine in Zambia

(Published in Molecular Diversity Preservation International and Multidisciplinary Digital Publishing Institute (MDPI), Sustainability Journal Sustainability 2019, 11,577)

Inonge Mutale [1], Isabel B. Franco [2,3,*] and Masinja Jewette [1,*]

1 School of Mines, University of Zambia, Esat East Road Campus,Lusaka 32379, Zambia; mutaleinonge@gmail.com

2 Institute for the Advanced Study of Sustainability, United Nations University, 5 Chome-53-70 Jingumae, Shibuya City, Tokyo 150-8925, Japan

3 Australian Institute for Business and Economics (AIBE), The University of Queensland, St Lucia Campus, Brisbane, QLD 4072, Australia

***(ii)** Correspondence: connect@drisabelfranco.com (I.B.F.); jewette_masinja@yahoo.com (M.J.)*

Received: 27 August 2019; Accepted: 16 September 2019; Published: 18 October 2019

Abstract: Corporate Sustainability Performance (CSP) is being promoted as a way in which corporations in the extractive industry can contribute to poverty eradication in developing resource regions. As such, the international debate on CSP has moved from whether companies ought to do it or not, to the extent to which it can contribute to sustainable development. Corporations worldwide have therefore reshaped their frameworks, rules, and business models to accommodate CSP. This article evaluates whether, through the implementation of CSP, companies are able to contribute to the sustainable development of host communities in developing countries. Against this backdrop, there exists a knowledge gap in Zambia as to what the actual contributions of CSP are towards sustainable community development. Through literature review and community data analysis, the results revealed that there was a mismatch in priorities between CSP and the expectations of community members. Findings show that CSP focused mostly on haphazard donations, an approach that has been proven to be unsustainable. Finally, CSP had little or negligible impact on most selected Sustainable Development Goals (SDGs). In view of these findings, the study suggests adopting sustainability frameworks that are tailored to the local context. Furthermore, formulation of CSP initiatives should take a triangular approach of communication that is inclusive of all stakeholders.

Keywords: corporate sustainability performance; mining industry; sustainable development; community; SDGs; Zambia

1. Introduction

In recent decades, the concept of Corporate Sustainability Performance (CSP) has gradually acquired greater importance in academic and professional fields [1]. However, there has been little empirical research conducted on the impact of CSP in developing resource regions [2–5]. The main concern is that CSP in developing resource regions not only fails to appreciate the uniqueness of each developing context but it is also devoid of the external pressure that exists in such regions and lacks partnerships with the government, the community, and the organization. It is therefore incorrect to just assume that CSP has the same e↵ect on development in developed and in developing resource regions as insinuated by international development organizations [6,7]. In order to understand CSP and its impact on sustainable development, a case study of the China Nonferrous Metals Group Luanshya Copper Mine (hereafter referred to as CLM) was explored.

Yin [8] defines a case study as any empirical enquiry that investigates a contemporary phenomenon within its real life context, more so when the boundaries between phenomenon and context are not clearly evident, and in which several sources of evidence are used. A case study aimed at establishing the exact impacts of CLM's CSP on development was chosen due to the fact that mining is being touted as a possible driver of development in resource rich countries [9]. Other than that, the ongoing criticism of the mining industry, by international trade unions, Non-Governmental Organisations, human rights organizations and environmental groups has caused mining companies to adopt CSP strategies to deflect the negative comments [10]. This study employed the use of both qualitative and quantitative methods in what is called the mixed method [11]. Using this method not only eliminates or neutralizes the biases inherent in any single method but also serves as a transformative purpose to change and advocate for marginalized groups, such as women, people with disabilities, and the poor [12]. This method was therefore considered as best suited in dealing with issues of marginalized people who are normally the intended beneficiaries of CSP initiatives in this case. Data were collected from primary and secondary sources, coded, and analyzed using SPSS and Python programming.

The study found that there was a mismatch between the priorities of CLM and that of the people of Mpatamatu who were the intended beneficiary of CSP. While the company invested more in health and the least in agriculture, the community expected more investment aimed towards agriculture in relation to agricultural support and skills training. The community indicated that health and infrastructure development were least preferred as compared to having employment and provision of education. The results reviewed that CSP focused mostly

on haphazard donations and lacked a guiding framework. The mismatch in priorities also indicates that stakeholders such as the government, community members, and other interested parties are never involved in decision-making processes.

Although the value of corporate sustainability is widely accepted within scholarly literature, these initiatives thus far appear to have achieved very little impact in the achievement of sustainable community development aspirations. This investigation works to increase our knowledge regarding specific priority areas, which, when targeted, will result in more e↵ective pathways towards sustainable development. Therefore, the research reported in this article answers the scholarly literature's call for greater investigation into corporate sustainability and its impact on sustainable community development in order to clearly define research direction and agenda. It also recommends ways to enact global goals at the corporate level. The article begins with a review of the literature on corporate sustainability and sustainable development at global and local levels. This is followed by sections on the methodology and data collection before discussing the final results. The manuscript finishes with a conclusion and recommendations for corporations in the mining industry in Zambia and elsewhere.

1.1. Literature Review

The demand for business sustainability dates as far back as the 18th century, even though the CSP concept only gained prominence during the 1960s [1,10]. Companies came up with ways in which they could give back to society as early as the mid-18th century [13]. The term 'society' in this context was somewhat limited to employee enhancement [14]. Companies normally ensured the comfortability of workers and their families through the provision of skills training, housing, and other amenities. However, after the implementation of neo-liberal economic policies in the 1980s and 1990s in developing countries that attracted massive investments from international corporations, power dynamics were a↵ected within the local context in favor of the investors. Growing increasingly uncomfortable with the negative activities of multinational corporations, the media began to uncover and expose corporate scandals [15]. Suffice to say, these scandals changed the face of CSP. The relationship between business and society moved from just focusing mainly on employees to one that covered a range of diverse issues and became more global in scope [14]. The debate today by international organizations, academicians, and other interested parties isn't whether companies ought to do CSP or not but the extent to which it can contribute to sustainable

development. This review provides an overview of CSP and linkages with sustainable development, particularly in the context of the mining industry.

1.2. Corporate Sustainability Performance: An Overview

In recent decades, the concept of CSP has gradually acquired greater importance in academic and professional fields [1]. However, there has been little empirical research conducted on the impact of CSP in developing resource regions [4,7,16] The main concern is that CSP in developing resource regions lacks collaboration with the government, the community, and the corporations towards the fostering of overall sustainability [7]. There has been a considerable amount of work on the notion of CSP mostly as a philanthropic approach to corporate performance, one which lacked the input of community members and the government [2,17]. Yet, CSP as an approach to sustainable development is an area that remains under-investigated [5]. Some scholars have found that CSP impact on sustainable development is negligible [5,18,19] In the same vein, Lungu and Mulenga [20], while focusing on the Copperbelt, found that CSP was more concerned with profit-making than dealing with the concerns of various stakeholders, particularly those of communities. On the other hand, it has been found that CSP had a general significant positive impact on the local communities of the Niger Delta [21]. Focusing on education, Mayondi [22] found that the CSP of Barrick Gold, Zambia, had a slight positive impact. Still in Zambia, Kumar [23] found that CSP on various mining companies in the Copperbelt Province had a positive impact on education, health, and the environment. In the same vein, Whellams [17,21] found that CSP had a positive impact in Ghana, Peru and Bolivia, respectively, in areas such as health, education, and livelihood. Despite the positive impact, Whellams [17] and Marias [19] are of the view that the extent to which CSP contributed to sustainable development is highly dependent on the design of the initiatives themselves and the composition of the local community.

1.3. Sustainable Development in Mining

Sustainable development (SD) is now a widely used notion to explain development issues [24]. The term became popularized after the 1987 Brundtland Commission's report titled "Our Common Future". In this report, sustainable development was defined as the "ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" [25] . This, however, can only be achieved through the integration and acknowledgement of economic, environmental, and social concerns throughout the decision-making process [26]. In the same vein, Dubinski´ [27] states that the implementation of SD means the integration of activities

that ensure economic growth, natural resources, and environmental protection and, lastly, takes care of varying stakeholder needs.

The Sustainable Development Agenda, which was adopted by the United Nations (UN) in 2015, is a universal, integrated, and human rights-based program. It underscores connections between the environment, social justice, and development. Consequently, its associated 17 Sustainable Development Goals (SDGs) are wider and much more multidimensional in scope compared to the Millennium Development Goals (MDG), which was in vogue between 2000 and 2015 [28,29]. The MDG program was the first concerted e↵ort at a global scale to address extreme poverty and basic health care needs. The eight identified goals were manageable, measurable, and, most importantly, could be easily identified by a wide range of stakeholders across the globe. During the 15-year period, the MDG program was able to achieve certain remarkable outcomes, although the progress was uneven. Therefore, there is a need to create a new framework to achieve inclusive sustainable development.

The SDGs encompass the millennium goals and, at the same time, incorporate several newer goals, such as building resilient infrastructure, promotion of inclusive and sustainable industrialization, and fostering innovation (SDG 9); reduction of inequality within and among countries (SDG 10); making cities and human settlements inclusive, safe, resilient, and sustainable (SDG 11); and ensuring sustainable consumption and production patterns (SDG 12), etc. The SDGs have become a framework to understand development, and therefore, this article focuses on how CSP in the mining industry can contribute to enacting the SDGs. In a nutshell, the SDGs are a set of 17 global goals consisting of an ambitious 169 targets and about 230 indicators [29]. The global goals represent the world's agreed comprehensive plan of action for equitable, socially inclusive, and environmentally sustainable economic development.

In the African context, achieving community development means integrating the SDGs into regional developmental plans such as the African Mining Vision, a continental policy for sustainable resource development and the African Agenda 2063 [30]. The latter seeks to address the many challenges associated with Africa's full maximization of mineral resources so as to enhance sustainable development. The African Mining Vision (AMV) further seeks to foster broad based sustainable growth and socio-economic development through transparency, and equitable and optimal exploitation of Africa's mineral resources. It is

therefore a requirement for African Union (AU) member states, of which Zambia is a party, to adopt the AMV fully and also align it with national mineral sector policies as per the provisions of the framework. It is anticipated that through this action, Africa can fulfill the SDGs and other regional agendas [31].

1.4. Corporate Sustainability Performance and Sustainable Development in Mining: A Local Perspective

Since the beginning of large-scale mining in Zambia, social welfare policies that directly invest in human well-being have been deliberately implemented. For instance, back in the 1920s, the first mine under the private ownership of Roan Select Trust (RST) and Anglo-American Corporation (AAC) provided social amenities to employees [32]. The only problem with these policies was that they were racially biased, with Zambians being the least included for amenities [31]. After nationalization of the mines in the 1970s, the state became the key actor in shaping the economic and social agenda of the country through the creation of Zambia Consolidated Copper Mines (ZCCM) in 1982. The government was in charge of fostering sustainable development for the local people by providing social amenities such as free education for miners' children, subsidized housing and food, electricity, water, transport, raised employment, and also reoriented economic activities in various ways [33,34] This, however, did not last due to ZCCM's decline in copper production as a consequence of a combination of external market conditions, political instability a↵ecting southern Africa at the time, and bad management decisions taken by ZCCM's executives and the Zambian government [35]. These issues led to the privatization programs of 1997 [36]. Despite the mines being in private hands, the practice of CSP in Zambia has continued.

Since the year 2000, Zambia has experienced increased copper production owing to massive investments in the mining industry [37]. Furthermore, the increased world base metal prices experienced in 2001 that were mainly influenced by demand for oil and metals by countries like China, Brazil, India, and a few other emerging markets played a significant role in increasing the copper output from Zambia at that time [38]. The argument is that the positive performance of the economy is directly related to increased investments in the mining sector [39]. Despite the many economic benefits of mining in Zambia, as well as the practice of CSP, poverty remains high in the country, specifically in mine host communities. Evidence shows that Zambia has 54.4% of its population living below the poverty line (K214.26 per Adult Equivalent), with 40.8% being extremely poor [40]. It is then helpful to understand the exact

impacts of voluntary CSP on sustainable development and whether it in fact offers a long-term solution in addressing the poverty that is prominent in many poor but resource-rich countries.

2. Materials and Methods

Conducted in the Luanshya District of the Copperbelt Province, Zambia, this study was performed through the utilization of a mixed method, which involved the combination of a number of qualitative and quantitative methods and techniques, in order to reduce methodological limitations [41]. Specific techniques employed in this study include individual interviews of key informants such as local municipality council, ministry of mines, and the minerals development and public relations officer of CLM. Semi-structured questionnaires were administered to 200 Mpatamatu households, and open-ended questions were administered to a representative from the Ministry of Mines and Mineral

Development and Luanshya Local Council. Purposive and snowballing sampling techniques were used to select respondents. Closed-ended questions were administered to the public relations officer of CLM. The study was also grounded on substantive literature and policy review. Furthermore, triangulation of available data was adopted to increase the reliability of the data collected [8].

2.1. Case Study Location

This study was conducted in the Luanshya District of the Copperbelt Province. The District is located 337 km from Lusaka and 35 km southwest of Ndola (Figure 1). Luanshya borders the Ndola District in the northeast, Kitwe District in the northwest, and Masaiti District in the southwest. The District covers a total of 935 km^2, with 90% being urbanized and 10% rural [42]

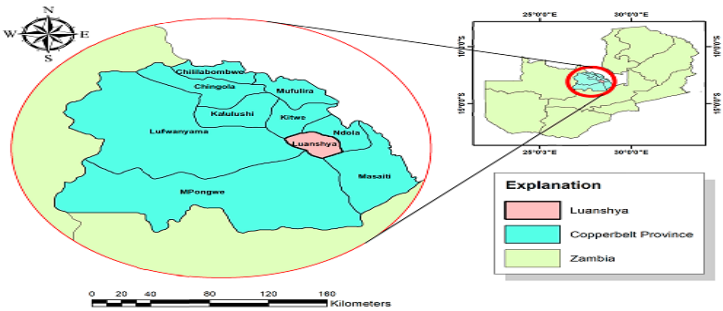


Figure 1. Map showing the location of Luanshya in the Copperbelt Province.

The study was based primarily on a single case study of the impact on CLM's CSP on local communities of the Mpatamatu compound in Luanshya, see Figure 2. The case for CLM is one that clearly demonstrates CSP in Zambia and may perhaps be representative of what goes on in other developing resource regions.

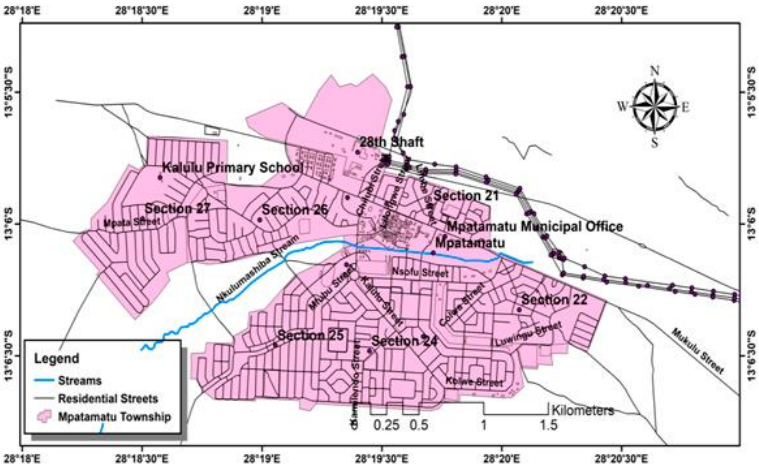


Figure 2. Map showing the Mpatamatu community

2.2. Data Collection and Analysis

The study adopted purposive sampling, which is a form of a non-probability sampling procedure; it is a technique used based on the knowledge, relationship, and expertise of sample members with regards to the research subject. Mpatamatu is the closest to the mine and comprises 4343 households in all seven sections (Sections 21 to 27). Stratified random sampling was used to select participants. The sample size was determined using the Slovin's formula [43,44]. To have a representative sample, 327 households were needed for sampling. The study only covered 200 households due to associated limitations proper to the scope of the project. The respondents were selected from three sections (Sections 21, 26, and 27) of Mpatamatu that were closest to the mine, representing 1784 households.

This study involved collecting and analyzing of both qualitative and quantitative forms of data in what is called the mixed method [11]. Using this method not only reduces or neutralizes the biases inherent in any single method but also serves as a transformative purpose for examining

the current situation of vulnerable groups [11,12]. This method was therefore considered as best suited in dealing with issues of marginalized communities who are normally the intended beneficiaries of CSP initiatives in this case.

Data were collected from both primary and secondary sources. Primary sources of data employed the use of semi-structured interviews with selected key informants such as CLM public relations officers, a representative from the Ministry of Mines and Mineral Development, and Mpatamatu residents. Close-ended questions were used to collect information that could be quantifiable and comparable among participants [45]. On the other hand, open-ended questions were asked to understand and capture the points of view of people—without predetermining those points of view—through prior selection of questionnaire categories [46]. Responses from open-ended questionnaires provided insights about the local people's perceptions of CLM's CSP and how these have impacted their livelihoods. Secondary sources of data included company reports on CSP, official statistics from the Central Statistics Office (CSO), and other government organizations.

3. Results

This section discusses the findings derived from this research and is divided into two parts. The first part provides an outline of Luanshya mine's Corporate Sustainability Performance in alignment with the SDGs as applied to Mpatamatu. It then highlights the perception of CLM's CSP by Mpatamatu residents.

3.1. Priority SDGs for Sustainable Community Development by CLM

The Corporate Sustainability Performance for Luanshya Copper Mine is viewed as a way in which the company is able to respond to the interest of various stakeholders. The company invests in various CSP activities such as health, education, provision of employment through sports, infrastructure development, and agriculture as shown in Tables 1 and 2.

In terms of CSP investment between 2013 and 2016, the study established that CLM invested the most in health (60%). CLM runs the Luanshya mine hospital and six other clinics. Some of the programs being run by the mine include the prevention of mother to child transmission, peer educators training, and the distribution of condoms. Furthermore, CLM has engaged in initiatives to combat epidemics such as Malaria and infectious diseases like Ebola and cholera.

In order to enhance health and wellbeing, CLM ensures that the Mpatamatu community experiences little to no pollution through the use of cleaner technology.

Table 1. Corporate Sustainability Performance (CSP) investment by the China Nonferrous Metals Group (CLM).

Key SDGs	Category	Project Name	Beneficiaries of Project	Duration of Project
SDG 4	Education	Trust and Luanshya Craft School	Luanshya youths	Yearly
		Donations of sports equipment Scholarships	School children	Yearly
SDG 3	Health	Luanshya hospital	Miners and Luanshya residents	Yearly
		Anti-malaria projects	Miners and Luanshya residents	2014/done
		Baby porridge for vulnerable children	Vulnerable children	2012/done
SDG9	Infrastructure development	Construction of Gymnasium	The community	2013/done
		Construction of Zaone market	Luanshya residents	2014/done
		Rehabilitation Kafubu stadium		
SDG 8	Employment Sports	Salaries for Roan United Football Club	Roan United Football Club	Yearly
		House rentals win and draw bonuses	Roan United Football Club	Yearly
		Utility bills for Kafubu stadium	Roan United Football Club	Yearly
SDG 2	Donations (Agriculture)	Fertilizer and seed donations	Selected Luanshya farmers	Yearly

Table 2. CSP expenditure by CLM.

CSP Investment (ZMK)	2013	2014	2015	2016	Total per Sector
Education	4,155,682	5,230,706	5,026,738	2,665,208	17,078,335
Health	11,738,190	11,633,064	10,704,354	4,390,735	38,466,344
Infrastructure development	1,205,000	0	0	0	1,205,000
Employment—Sports	1,797,323	2,195,164	1,756,328	962,114	6,710,930
Donations—Agriculture	97,200	266,072	116,653	57,068	536,933
Yearly total	18,993,395	19,325,008	17,604,074	8,075,126	63,997,605

The study also revealed that 27% of CSP investment is directed towards education. CLM not only operates the Luanshya Craft Training School but also the Luanshya Trust School. While the former is a tertiary education institution, the latter o↵ers primary and junior secondary education. Through the craft school community, members are able to gain various skills such as fitting, metal fabrication, and rigging. The school currently has a total of 110 trainees. The Trust school is also tailored majorly for employees' children and has an enrolment of 630 pupils. In addition to the above, the company provides a bursary scheme for school leavers. Every year, the company awards scholarships to 10 selected candidates to study mining engineering, metallurgy, and engineering at the local universities, i.e., University of Zambia and the Copperbelt University. In relation to employment, the study established that 10% of CSP investment was directed towards the Roan United Football Club. The company was in charge of not only monthly wages for the club but also other logistics during away matches. Infrastructure development constitutes 2% of the community. CLM constructed Zaone market, improved the road network that leads to the mine, refurbished play parks, as well as constructed a modern gym and a swimming pool for the youths. The research revealed that through random donations, CLM invests 1% to supporting selected small-scale farmers in Luanshya with agriculture support inputs such as fertilizer and seed. In order to effectively select the vulnerable but viable farmers to assist with agriculture input, the mine has deliberately taken a step to partner with the government through the district agriculture coordinating officer and the area members of parliament.

In terms of CSP investment between 2013 and 2016, the study established that CLM invested the most in health (60%). Education made up 27% of investments, while 10% was directed towards employment through sport and 2% to infrastructure development. Agriculture was the least invested in, with 1% of CSP investment (see Figure 3)

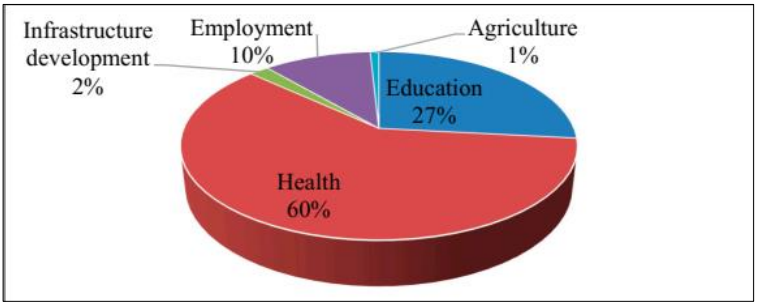


Figure 3. Keys areas of CSP at the company level

3.2. Key SDGs for Sustainable Community Development by the Community

However, at the community level, the study found that 32% of respondents considered agriculture as the most important CSP investment, followed by employment at 26%, then education at 23%. On the other hand, health made up 10% and infrastructure development was at 9%, and these were least preferred, as shown in Figure 4.

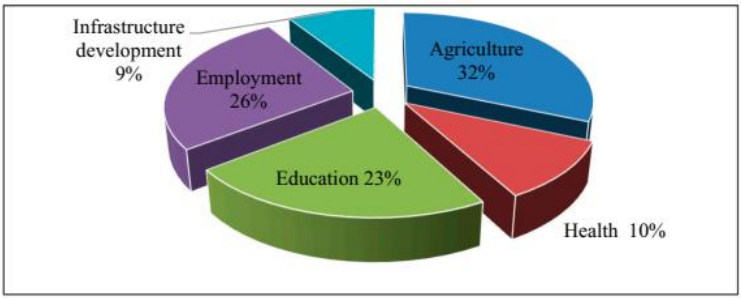


Figure 4. Key CSP areas based on perception of Mpatamatu residents.

3.3. CLM's CSP Contribution to Achieving SDGs

3.3.1. Impact on Agriculture (SDG 2)

The study revealed that out of 78 farmers, 87% were small scale farmers and the rest were commercial farmers. Of all the farmers, 89% had no land of their own, with 77% small scale and 12% commercial farmers on mine property. Of the small-scale farmers, 3% were on customary land and 7% on private property. The study established that only 1% were practicing commercial farming on their own property, as shown in Figure 5.

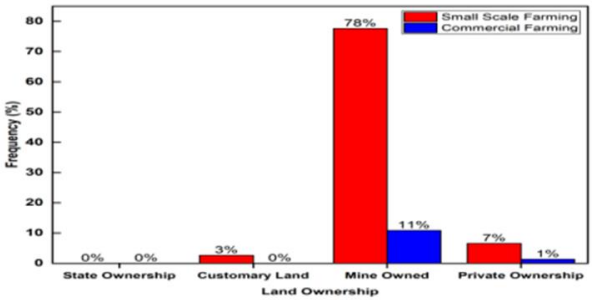


Figure 5. Type of farming and land ownership.

The study therefore established a weak positive correlation between income and land ownership for the people of Mpatamatu, as shown in Table 3. This result implies that the income of households increased with an increase in land ownership, whereas a household earning power increased with owning productive land.

Table 3. Correlation between monthly household income and land ownership.

		1	2
1	Monthly household income	-	-
2	Land ownership	0.27 *	-

Note. N = 76. * $p < 0.0$

Furthermore, over 70% of the households denied knowing any kind of support that CLM renders to farmers. The remaining 30% were split between those who agreed and those who could neither agree nor disagree (Figure 6).

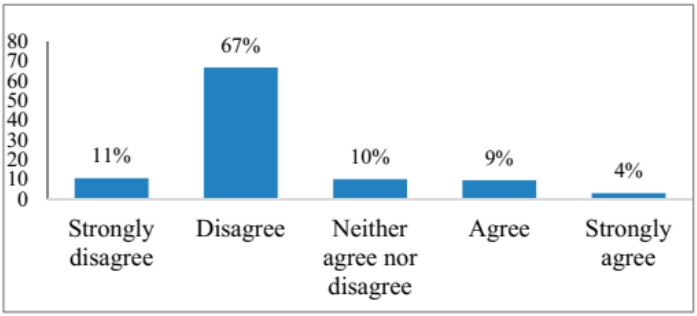


Figure 6. Agricultural support to enhance productivity.

3.3.2. Impact on Health (SDG 3)

With regards to the provision of health facilities and services, the study revealed that 70% of the respondents indicated that they not only attended the mine health facility when ill, they also agreed to the provision of such services by CLM. On the other hand, the remaining 30% who went to the Government health facility also denied or could not confirm the provision of healthcare services by CLM (Figure 7).

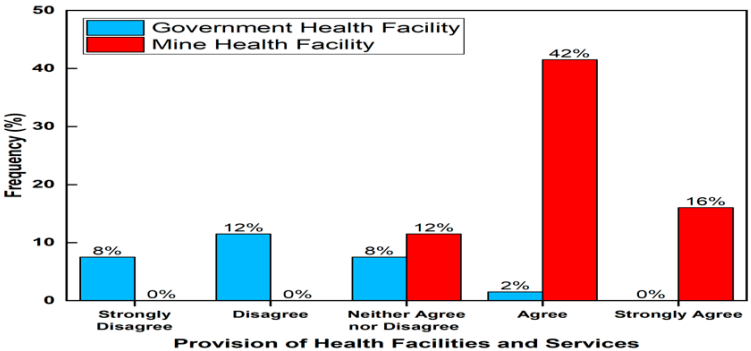


Figure 7. Provision of healthcare services and facilities.

The study further established that 90% of the locals did not experience any mine pollution of any sort. The remaining 10% that experienced pollution were found a stone's throw away from the Muliashi open pit mine project, see Figure 8

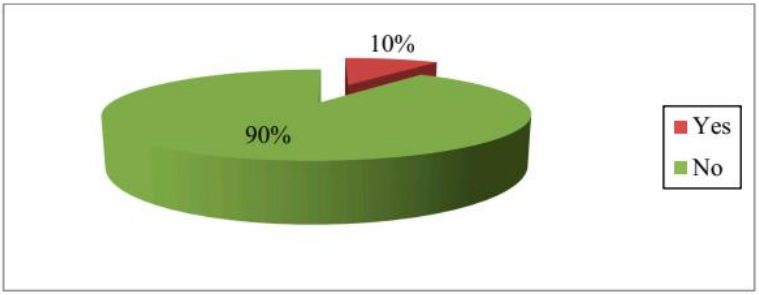


Figure 8. Pollution experienced by Mpatamatu residents.

3.3.3. Impact on Education (SDG 4)

The findings revealed that only 2% of the participants had obtained their tertiary level qualification from the Luanshya Craft School and none from the Trust School. The respondents who had senior secondary qualifications were represented by 33% and tertiary level qualifications by 11%. The rest of the population had junior level qualifications and below. The study found that the government was the major provider of education in the community, with over 90% of the participants having attended government schools during their last level of education (Figure 9).

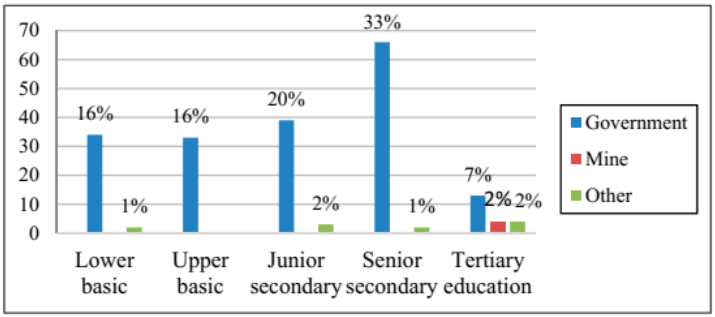


Figure 9. Level of education and school attended.

The study established that the majority of the population, 54% and 82%, disagreed with the fact that CLM provides schools and scholarships, respectively. Furthermore, it was established that only 25% and 6% of the population confirmed the provision of schools and scholarships, respectively, as shown in Figure 10.

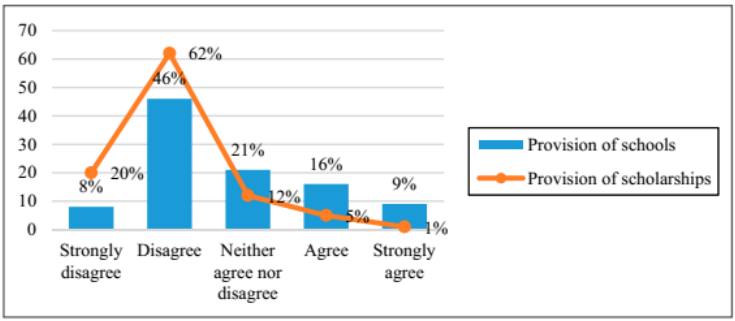


Figure 10. Provision of schools and scholarships.

Figure 10. Provision of schools and scholarships.

Furthermore, the study found that respondents who were more educated also earned more as they were able to get into formal employment. The results also revealed that most locals attended schools o↵ered by CLM at the tertiary level because the Craft school was tailored more for community members while the Trust school was mostly for miners' children (Table 4).

Table 4. Correlation of variables relating to education.

		1	2	3	4	5
1	Education					
2	Provision of schools	0.23 **				
3	Income	0.27 **	0.18 *			
4	Scholarships	0.16 *	0.14 *	−0.02		
5	School attended	0.33 **	0.27 **	0.09	0.39 **	

Note. N = 200. * p < 0.05; ** p < 0.01

3.3.4. Employment (SDG 8)

In relation to employment (Figure 11), the study found that 39% of households were farmers who grew crops and vegetables to sustain their families. Those trading in small merchandise represented 24%. CLM employees represented 20% while 8% were civil servants. Those unemployed made up 9% of the participants.

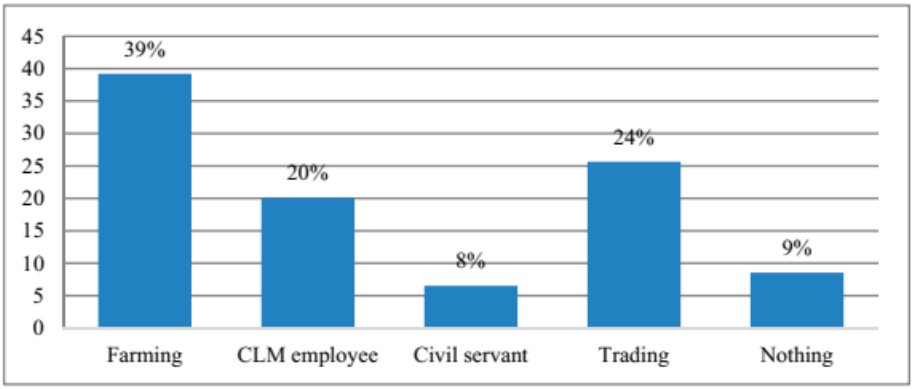


Figure 11. Sources of income for Mpatamatu residents.

The results show that out of 39 mine workers, the majority earned between K501 and K1000 while the rest earned above K1000. The study also revealed that what people did for a living was not sufficient to meet monthly household expenses despite them being in formal or informal employment (see Tables 5 and 6).

Table 5. Cross tabulation of sources of income and monthly household income.

	Below K100	K100–K500	K501–K1000	K1001–K3000	K3001–K5000	K5001 and above
Farming	0	23	34	18	2	0
CLM Employee	0	0	31	6	1	1
Civil servant	0	0	3	6	2	1
Trading	5	22	18	4	0	0
Nothing	11	3	1	1	0	0

Table 6. Correlations of variables relating to employment.

		1	2	3	4
1	Income sources				
2	Monthly income	−0.34 **			
3	Monthly expenses	−0.23 **	0.45 **		
4	People per household	−0.19 **	0.24 **	0.14 *	

Note. N = 200. * p < 0.05; ** p < 0.01.

3.3.5. Infrastructure Development (SDG9)

The study revealed that 37% denied knowing any e↵orts directed towards infrastructure while 16% could not confirm, and 47% knew about CLM's efforts towards advancing infrastructure development. The results are shown in Figure 12.

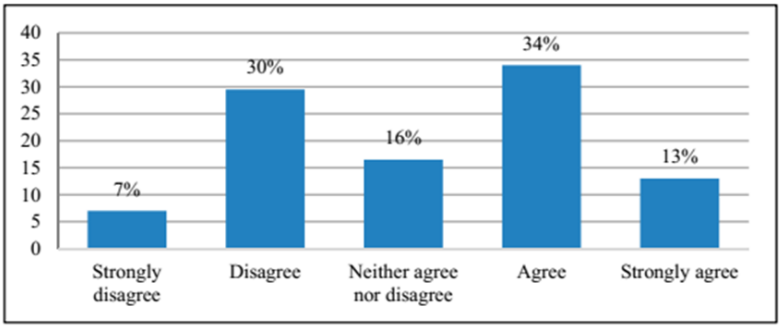


Figure 12. Availability of infrastructure.

4. Discussion

The research found that there was a mismatch in CSP priorities of CLM and local communities. While CLM focused on health, education, employment, infrastructure development, and agriculture, the locals, on the other hand, considered agriculture as very important, followed by employment and educational support as moderately important, and health and infrastructure development as least important. This di↵erence indicates that CSP programs are often done in the absence of various stakeholders. Cheelo [22] established that CSP had a horizontal kind of communication where there was no trickle down of information from shareholders to stakeholders [37]. To avoid excluding stakeholders in decision-making processes, the literature suggests using a triangular kind of communication that allows corporations to be inclusive of all stakeholders [47,48].

4.1. Impact on Agriculture (SDG 2)

According to the Geneva International Centre for Humanitarian Demining (GICHD) and the United Nations Development Program (UNDP), the contributions of mining towards the achievement of SDG 2 are through freeing up access to economic markets and natural resources [49]. In this way, mining firms can provide livelihood opportunities and yield productivity improvements to a↵ected communities, thus helping to address poverty, malnutrition, and food security. This study found that the majority of the households were farmers of which 89% had no land of their own. Jayne et al. [50] argue that there exists a relationship between land access and household income. In the same vein, Muraoka et al. [51] established that constrained access to land impedes long term land investments and productivity, thus a↵ecting national food security and poverty reduction in Africa.

Agricultural support in this case could be the promotion of modern techniques of production including the application of fertilizers, the use of hybrid seeds, and the provision of credit facilities, among other things

[52]. Over 70% of the households denied knowing any kind of agricultural support CLM renders to farmers. The findings show that CLM is not actively supporting the smallholder farmers in a way that increases food productivity and food security as is the aspiration of SDG 2. These findings di↵er from those found by Whellams [17], who established that CSP had a positive impact on the farming community of Yanachocha in terms of the increase in crop yields, promotion of linkages among producers, improvement of agricultural labor quality, and technology transfer.

4.2. Impact on Health (SDG 3)

Mines can contribute to SDG 3 by providing safe access to healthcare facilities and services as in the case of CLM [49]. In terms of pollution, the study found that 90% of the households did not experience any pollution at all. However, the 10% that experienced air pollution were households located a stone-throw away from the new Muliashi open pit mine project. In this regard, CLM actively curbs the impact of the dust produced at the mine project by constantly suppressing the dust using the water spraying technique [53]. The findings show that CLM had a significant positive impact on the provision of healthcare services and facilities and pollution control. These results are consistent with the findings of Whellams [17,23,54], and contradict those found by Mensah [18], who found no impact on health in Ashanti, Ghana.

4.3. Impact on Education (SDG 4)

The need for quality education and lifelong learning opportunities for a full productive life to all individuals and the realization of sustainable development cannot be over emphasized [53]. As such, mining companies must help the communities they found themselves in to acquire literacy and numeracy. The provision of such services must be inclusive and equitable to all boys and girls, and women and men alike. Despite the fact that CLM runs the two schools, the field findings revealed that only 2% of the participants had obtained their tertiary level qualification from the Luanshya Craft School and none from the Trust School. The participants that had secondary and tertiary level qualification were 33% and 14%, respectively. The rest of the population had junior level qualifications and below. The study found that the government was the major provider of education in the community, with over 90% of the participants having attended government schools during their last level of education. The fact that preference for awarding these bursaries was given to miners' children explained why 82% of the research participants were ignorant about the existence of the scholarships. The findings in this study resonate with those of Mayondi [22,23,54], who also found a slight positive impact of CSP on education.

4.4. Impact on Employment (SDG 8)

The findings of the study are similar to those shown by Lungu and Mulenga [20], who found that miners in Luanshya were being paid K400. These findings also resonate with Madeley [55], who notes that most of the

jobs provided by multinational corporations tend to be low-skilled, low-paid, and geared to a particular company operation. Workers therefore perform small, specialized tasks of a large operation. Such tasks, as the author puts it, are likely to turn workers into little more than the arm of a machine and not necessarily equip them with skills they can use elsewhere in domestic enterprises, for example. The creation of jobs and other such opportunities for the local people would guarantee monthly household income, hence offering stability of livelihoods. However, the findings of this study do not explicitly indicate a positive impact on income and livelihood. Whellams [17], on the other hand, established that an increase in income in Yanacocha was not because of direct employment of the locals at the mine but because of skill transfer and entrepreneurial opportunities that increased economic productivity. In a similar study done by Marais [19], it was discovered that through running of di↵erent enterprise development and empowerment initiatives, Anglo American was able to create sustainable and commercially viable businesses for the people of South Africa. Abe and Franco [56] note that achieving higher levels of economic productivity requires more than diversification, an upgrade in technology, and innovation that places emphasis on high added value and labor intensive sectors. In the same vein, it is believed that sustained and inclusive economic growth drives development through the provision of more resources for education, health, personal consumption, transport, water, and energy infrastructure [53]. This way, economic growth can lead to new and better employment opportunities. It therefore cannot be said that CSP has had a positive impact on SDG 8.

4.5. Impact on Infrastructure Development (SDG 9)

CLM has so far constructed the Zaone market, improved the roads, as well as constructed a modern gym and refurbished play parks in the area. The findings in the field revealed that 47% agreed to having the aforementioned infrastructure. Evidence shows that investing in infrastructure, promoting inclusive and sustainable industrialization, as well as supporting technological development, research, and innovation are three driving forces for economic growth and sustainable development [53]. It is believed that these drivers can help countries reduce poverty by not only creating job opportunities and stimulating growth but also encouraging the building and improvement of physical facilities that are essential to the functioning of business and society. With regards to the infrastructure in Mpatamatu, it can be concluded that the investments in infrastructure are not enough to impact on sustainable community development.

5. Conclusions

The study found that there was a mismatch between the priorities of the company and that of local communities. The study further found that the residents of Mpatamatu experienced a general positive impact in health (SDG 3) in regard to the provision of health facilities and environmental management. In terms of agriculture (SDG 2), the residents do not own land of their own as most of them farm on mine property. It was established that CSP had no impact on agriculture as CLM did not provide any farming inputs, skills training, or any financial assistance to farmers. This has limited the productivity of the local community as

farming is done mainly on small scale. The study further revealed that there was negligible impact on education (SDG 4) as CLM provides schooling opportunities for miners' children and those who can afford it. In relation to employment (SDG 8), the study found little impact on employment as the company provides low-skilled jobs. These jobs were, however, not sufficient to meet the needs of most of the residents. In terms of infrastructure (SDG 9), no new buildings have been put up since building a market, stadium, gym, and pool in 2013. CSP, therefore, had no meaningful impact on infrastructure development as the type of buildings the company had invested in were not able to bring industrialization or broader sustainable community development.

The study found that CSP programs of CLM were mostly philanthropic in nature and lacked a guiding framework. The above results confirm that CSP has been used as a green wash strategy by mining firms due to the fact that more effort is placed on charitable short-lived micro-level activities rather than addressing larger failures of corporate accountability and weak governance. In as much as it is argued by Carroll [14] and other proponents of the stakeholder theory that business does indeed have the resources to solve society's problems, the findings of the study support the view point of Mertens [12], who states that it is impossible for businessmen to determine what constitutes society's interest.

The impact that CSP could possibly have on sustainable community development is one that has not been fully investigated in relation to developing resource regions, with an exception of countries like South Africa, Ghana, Nigeria, and a few others. This scarcity of knowledge has created a knowledge gap on the extent to which CSP should be pushed as a panacea in fostering development in resource-rich developing countries. The advancement of CSP as a development agenda is one that neglects the fact that the CSP concept is of western origin and, as such, might not exactly be tailored for developing countries that have deferent political, historical, and cultural backgrounds. It is for these reasons that this research sought to fill this knowledge gap by examining whether CSP does indeed have potential to change the fate of poverty-stricken resource-rich countries like Zambia.

Author Contributions: I.M. engaged in data collection, analysis and development of the manuscript. I.B.F. made major contributions to the developed of the research design, methodology and development of the manuscript. M.J. provided overall supervision, funding and project administration.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Carroll, A.B.; Shabana, K.M. The Business Case for Corporate Social Responsibility: A Review of Concepts, Research and Practice. Int. J. Manag. Rev. **2010**, 12, 85–105. [CrossRef]
2. Jamali, D.; Mirshak, R.J. Corporate Social Responsibility (CSR): Theory and Practice in a Developing Country Context. J. Bus. Ethics **2007**, 72, 243–262. [CrossRef]
3. Eweje, G. The Role of MNEs in Community Development Initiatives in Developing Countries: Corporate Social Responsibility at Work in Nigeria and South Africa. Bus. Soc. **2006**, 45, 93–129. [CrossRef]
4. Idemudia, U. Corporate Social Responsibility and Developing Countries: Moving the Critical Agenda in Africa Forward. Prog. Dev. Stud. **2011**, 11, 1–18. [CrossRef]
5. Franco, I.; Ali, S. Decentralization, Corporate Community Development and Resource Governance: A Comparative Analysis of Two Mining Regions in Colombia. Extr. Ind. Soc. **2016**, 4, 111–119.[CrossRef]
6. Blowfield, M.; Frynas, J.G. Setting new agendas: Critical perspectives on corporate social responsibility in the developing world. Int. A↵. **2005**, 3, 499–513. [CrossRef]
7. Prieto-Carrón, M.; Lund-Thomsen, P.; Chan, A.; Muro, A.; Bhushan, C. Critical perspectives on CSR and development: What we know, what we don't know, and what we need to know. Int. A↵. **2006**, 82, 977–987. [CrossRef]
8. Yin, R. Case Study Research Design and Methods; Sage Publications: London, UK, 2009.
9. Striking, A. Better Balance: The World Bank Group and Extractive Industries: The Final Report of the Extractive Industries Review; World Bank: Washington, DC, USA, 2004.
10. Broomhill, R. Corporate Social Responsibility: Key Issues and Debates Dunstan Pap. 1; The Don Dunstan Foundation: Adelaide, SA, Australia, 2007.
11. Creswell, J.W. Research Design. Qualitative, Quantitative and Mixed Methods Approaches; Sage Publication: Thousand Oaks, CA, USA, 2003.
12. Mertens, E.M.K. Milton Friedman and Social Responsibility: An Ethical Defense of the Stockholder Theory; The University of Oslo: Oslo, Norway, 2013.
13. Katsoulakos, P.; Koutsodimou, M.; Matraga, A.; Williams, L. A Historic Perspective of the CSR Movement. CSR Quest Sustainability Framework **2004**, 5, 28.
14. Carroll, A.B. A History of Corporate Social Responsibility: Concepts and Practices. In Oxford Handbooks of Corporate Social Responsibility; Oxford University Press: Oxford, UK, 2015; pp. 1–20.
15. Jenkins, R. Globalization, Corporate Social Responsibility and Poverty. Int. A↵. **2005**, 81, 525–540. [CrossRef]
16. Kolk, A.; Tulder, V.R. International business, corporate social responsibility and sustainable development. Int. Bus. Rev. **2010**, 19, 119–125. [CrossRef]
17. Whellams, M. The Role of CSR in Development: A Case Study Involving the Mining Industry in South America; Saint Mary's University: Halifax, Canada, 2007.

18. Mensah, V. The Role of Corporate Social Responsibility on Sustainable Development: A Case Study of the Mining Community in the Obuasi Municipality. Master's Thesis, University of Agder, Kristiansand, Norway, 2009.
19. Marias, A. Assessing Corporate Social Responsibility in Terms of its Impact on Sustainable Community Development: Anglo American Plc Programmes as Case Study. Ph.D. Thesis, University of Stellenbosch, Stellenbosch, South Africa, 2010.
20. Lungu, J.; Mulenga, C. Corporate Social Responsibility Practices in the Extractive Industry in Zambia. ResearchGate **2005**. [CrossRef]
21. Amadi, O.B.; Abbudullah, H. Poverty Alleviation through Corporate Social Responsibility in Niger Delta, Nigeria. Asian Soc. Sci. **2012**, 8, 57. [CrossRef]
22. Mayondi, W. Mining and Corporate Social Responsibility in Zambia: A Case Study of Barrick Gold Mine; Victoria University of Wellington: Wellington, New Zealand, 2014.
23. Kumar, R. Corporate Social Responsibility in Copperbelt of Zambia. Int. J. Sci. Technol. Manag. **2016**, 5, 142–149.
24. Hopwood, B.; Mellor, M.; Brien, G.O. Sustainable Development: Mapping Di↵erent Approaches. Sustain. Dev. **2005**, 13, 38–52. [CrossRef]
25. Mining Minerals and Sustainable Development Project. Breaking New Ground; Earthscan Publications Ltd.: London, UK, 2002.
26. Emas, R. Brief for GSDR 2015 The Concept of Sustainable Development: Definition and Defining Principles;Florida International University: Miami, FL, USA, 2015.
27. Dubinski,´ J. Sustainable Development of Mining Mineral Resources. J. Sustain. Min. **2013**, 12, 1–6. [CrossRef]
28. UNDP. The Millennium Development Goals Report; UNDP: New York, NY, USA, 2015.
29. Barbier, B.E.; Burgess, C.J. The Sustainable Development Goals and the Systems Approach to Sustainability. Econ. Discuss. Pap. **2017**, 28, 2.
30. Oxfam. From Aspiration to Reality: Unpacking the Africa Mining Vision. Briefing Paper; Oxfam: Nairobi, Kenya, 2017.
31. Weeks, J.; Chisala, V.; Geda, A.; Dagdeviren, H.; McKinley, T.; Saad Filho, A.; Oya, C. Economic Policies for Growth, Employment and Poverty Reduction: Case Study of Zambia; United Nations Development Programme: New York, NY, USA, 2006.
32. Fraser, A.; Lungu, J. For Whom the Windfalls? Winners and Losers in the Privatization of Zambia's Copper Mines; Springer: Berlin/Heidelberg, Germany, 2007.
33. Lindahl, J. Environmental impact of mining in Zambia: Towards Better Environmental Management and Sustainable Exploitation of Mineral Resources. SGU-rapport. Geol. Surv. Swed. **2014**, 27, 27.
34. Simpasa, M.A.; Meller, P.; Lara, B.; Valdés, G. Role of Copper in the Chilean & Zambian Economies: Main Economic and Policy Issues; GDN: New Delhi, India, 2013.
35. Léniz, F.C. Histories of Nationalization and Privatization: The Cases of the Chilean and Zambian Copper Industries;Fundación Chile: Santiago, Chile, 2001.

36. China Nonferrous Mining Corporation Limited (C.L.M). 2014 Annual Report; Deutsche Post: Bonn, Germany, 2014.
37. Cheelo, K.H. 2008 Behind the Economic Figures: Large-scale Mining and Rural Poverty Reduction in Zambia:the Case of Kansanshi Copper Mine in Solwezi: A Thesis Presented in Partial Fulfillment of the Requirements for the Degree of Master of Philosophy in Development Studies.
38. Adam, C.; Simpasa, A.M. The Economics of the Copper Price Boom in Zambia; Springer: New York, NY, USA, 2010.
39. Ministry of Finance and National Planning. Economic Report 2006; Ministry of Finance and National Planning: Lusaka, Zambia, 2007.
40. Central Statistics Office (CSO). Living Conditions Monitoring Survey Report; CSO: Cork, Ireland, 2015.
41. Singleton, R.J.; Straits, C.B. Approaches to Social Research; Oxford University Press: New York, NY, USA, 2010.
42. Luanshya District and Housing Office. Preliminary Report; Census: Luanshya, Zambia, 2011.
43. Almeda, J.; Capistrano, T.; Sarte, G. Elementary Statistics; Up press: Quezon City, Philippines, 2010.
44. Tejada, J.J.; Punzalan, J.R.B. On the Misuse of Slovin's formula. Philipp. Stat. **2012**, 61, 129–136.
45. Will, A.S. Community-Based Urban Solid Waste Management: A Case Study of SUVA, Fiji; Massey University: Palmerston North, New Zealand, 2007.
46. Patton, M.Q. Qualitative Research and Evaluation Methods; Sage Publication: Thousand Oaks, CA, USA, 2002.
47. Franco, I. Building Sustainable Communities: Enhancing Human Capital in Resource Regions; The University of Queensland: Brisbane, Australia, 2014.
48. Masinja, H.J. The Use of Corporate Social Responsibility as a Means of Engaging the Host Communities. A Case Study of the Zambian Mining Industry; Stellenbosch University: Stellenbosch, South Africa, 2016.
49. UNDP, GICHD. Leaving No One Behind: Mine Action and the Sustainable Development Goals; UNDP: New York, NY, USA; GICHD: Geneva, Switzerland, 2017.
50. Jayne, T.S.; Yamano, T.; Weber, M.T.; Tschirley, D.; Benfica, R.; Chapoto, A.; Zulu, B. Smallholder income and land distribution in Africa: Implications for poverty reduction strategies. Food Policy **2003**, 28, 253–275. [CrossRef]
51. Muraoka, R.; Jin, S.; Jayne, T.S. Land access, land rental and food security: Evidence from Kenya. Land Policy **2018**, 70, 611–622. [CrossRef]
52. Chirwa, W.E. Access to Land, Growth and Poverty Reduction in Malawi; University of Malawi: Zomba, Malawi, 2004.
53. United Nations. The Sustainable Development Goals Report 2017; UNSD: New York, NY, USA, 2017.
54. Boon, K.E.; Ababio, F. 2009 Corporate Social Responsibility in Ghana: Lessons from the mining sector. In Proceedings of the 29th Annual Conference of the International Association for Impact Assessment, Accra, Ghana, 7–22 May 2009; pp. 16–29.

55. Madeley, J. Big Business, Poor Peoples: The Impact of Transnational Corporations on the World's Poor; Zed books: London, UK, 2003.
56. Abe, M.; Franco, B.I. A Model for a Model for Future Sustainable for Future a Model Sustainable; United Nations Publication: New York, NY, USA, 2017.

Critical Review of Dust in the Mining Environment: A Focus on Workers and Community Health

(preprints 2018,2018110602(doi:10.20944/preprints201811.0602.v1 (Not Peer Reviewed)

Brian Chanda Chiluba

The University of Zambia, School of Health Sciences,

PO Box 50110, Zambia, PH- +260977896377

brian.chiluba@unza.zm

ABSTRACT

Dust inhalation is a huge concern in the mining environment and within all its operations. In fact, dust to be one of the most serious occupational hazards in the mining industry. Coal and crystalline silica dust are the causes of serious, sometimes fatal lung diseases such as pneumoconiosis, which affects coal miners, as well as silicosis, tuberculosis, chronic bronchitis, emphysema, chronic obstructive pulmonary disease, and chronic renal disease, which affect coal and other types of miners. The resulting effects both affect workers and nearby communities. The mining industry has in the past, employed several approaches to reduce effects of dust. But these strategies have often been ineffective because the grass withers during the dry season and sprayed water is rapidly absorbed or evaporates. This paper endeavors to review information on dust in the mining environment and how it is a nuisance to workers and communities and establish what strategies exist for this.

Key word: Dust, Mining, Environment, Sustainability, community health, occupational health

1. Introduction

During almost all mining activities there are various forms of activities from mining extraction to refinery that put the risk of workers and communities at risk due to dust from such activities that pollute the mining and nearby surrounding to endanger the health of those in close proximity mining environment [1, 2]. Actually the most notable dust emissions are usually particulate matter (PM), sulfur dioxide (SO2), nitrogen dioxide (NO2) and heavy metals and mostly these are suspended as dust in the mining environment. It should be noted that dust from mine environment is a very big issue as it deteriorate air quality and ultimately affect the human health, flora and fauna in and around coal mining areas [3].

The novella article, by Momoh et al., is a very explicit articles in terms of leveraging mining dust effects to human health both within mining environment and communities within their vicinities [4]. The article "Potential implications of mine dusts on human health: A case study of Mukula Mine, Limpopo Province, South Africa" published in 2013 is an important article because it is very comprehensive in establishing what dust particles are unacceptable by WHO standard.

The purpose of this study was to estimate levels of Suspended Particulate Matter in ambient air within mining environment and the potential risks to mineworkers and communities nearby. While the "Respiratory Diseases Caused by Coal Mine Dust" by Laney and Weissman is informative and insightful because the authors emphasizes a spectrum of respiratory diseases that affect miners as a results of dust from the mine environment termed as "coal mine dust lung disease" though the paper does not address the effects of mining dust on community living in close proximity, the main objective of the paper is to provide an update on respiratory diseases caused by coal mine dust.

The paper by Rey et al., in his paper "Underground Coal Mining: Relationship between Coal Dust Levels and Pneumoconiosis, in Two Regions of Colombia, 2014" published in 2015 observed that there was a high levels of coal dust and silica among the 29 companies that were sampled and that the prevalence of pneumoconiosis was much higher than what has been reported in other studies among mine workers [5]. Other studies focused on levels of dusts observed from small scale mining, like a study done by Bråtveit, Moen, Mashalla and Maalim in 2002 called "Dust Exposure During Small-scale Mining in Tanzania: A Pilot Study". This paper discusses that there is actually more dust produced from small scale mining that what has been assumed and if the focus is only on economic strides this may make sustainable mining difficult. The objectives of this pilot study were to monitor the exposure to dust during work processes, which are typical of small-scale mining in developing countries, and to make a rough estimation of whether there is a risk of chronic pulmonary diseases for the workers [6]. Lastly a paper done by Önde in a paper published in "Investigation of Dust Levels in Different Areas of Underground Coal Mines". The paper found that levels of mining is too high and there is need to control these levels.

All in whole these papers do not seem to address what should be done in order to sustain mining in realm of workers and community people, but simply present merely the effects of dust from mining environments. Therefore the purpose of this review is to identify the gaps in the reviewed papers in light of sustainable development within the mining with respect to mining dust.

2. Summary

In the papers reviewed there will be failure if the papers do not critically examine the meaning of the concept and practice of sustainable development and mining in the contexts of dusts from mining environment and how this is very detrimental to the health of workers and communities. Discussing sustainable development in light of this is important because dust from mining environments is a nuisance to the communities and the workers themselves and hence the need to monitor dust fall out to keep it within the acceptable level that has a minimal impact on communities.

It should be stressed that Health and safety is always the first priority in the mining industry. It requires not only to provide a safe workplace for mining operations, but also to offer a safe and sustainable environment for the communities around the mine-site. Some of the pertinent issues form mining environment that arise during an entire mine life cycle include the following categories: general workplace health and safety and the hazardous substances such as dusts that come as a results of the processes of mining [7].

It should be understood that most if not all mining operations produce dust and this may result in various spectrum of health issues as far as the community is concerned and most importantly the health of workers e.g. chronic bronchitis/pneumoconiosis. Dust in the mining area could simply be viewed as particulates matters and this can be divided into TSP, PM10 and PM2.5. At the same time it is should well be understood that dust is generally measured in terms of weight of particles per cubic meter of air. There is an inherent and well understood association between mining activity and the resulting dust and this association is progressive in every step of mining operations. It should also be well noted that open cast mines produces more dust as compared to underground mines.

From the above rationale, the paper by Abuh et al., does highlight that mine are as a result of mining activities' and the paper explains the different and various constituents of dust, methodologically however the paper does not seem to provide much information on what methods of data collection were used as this could be important to understand the study findings. As far as dust and mining environment is concerned every paper to address this issue should endeavor to address both the workers and community impact of dust. This paper seem to shed much emphasis on community concerns as far as the effects of dust is concerned on their health compared to other papers. The study does not also provide a progressive way for control and monitoring of dust in mining environment in light of sustainable mining. At the same time the study seem to establish an important that exposure for a risk really dependent on the dust levels. While a study by Laney and Weismman states that the most important aspect which is the fact that mining is very important for community and global economies and for the advancement of welfare of workers and community living. The study strikes a balance unlike the other studies, that when addressing dust effects on environments and human health, it is important that the benefits are weighed against the risk because given any situation any mining operations will continue to provide dust, but what matters is the amount of dust that is generated and the levels and how they risk workers and community health as well as the environment. This study however just like the preceding study does not provide for mechanism of sustainable management of dust in mining environments to curtail on the impacts of dust on workers and human health. The study too only addresses the health of workers as far as dust is concerned and fails to addresses the proximity of dust effects on communities [8]

Rey et al., study addresses coal dust mining and its effects on environment within mines and beyond. This was study was methodologically meaningful in proving reliable and valid results and this is because it was carried out as cross sectional analytical interventional study with the use of instruments to measure amount of dust in mining environment as well as the effects of dust on the workers and this was not merely dependent on other

studies reports. The study also did establish one important factors that the other studies seem to fail to addressee and that is the past medical history of workers. This important as other workers smoke and are exposed to other pollutants other than that which come from the mines. This is an important investigation as the findings of a study could be confounded by any other exposure that inherently exist among those that work in the mines [5].

A study by Bratveit et al., despite all the other studies collecting information on large scale mining, this study established that actually there is more dust production from small scale mining and that this should be given the attention it deserves too. This study, unlike all the other study established that actually just a moderate exposure is a risk for health related issues within the mining environment. This study instead of just focusing on what is already the narrative of the scientific community on dust within the mining environments, the authors of this study went on further to physically monitor exposure to dust in small scale mining. There is no mention of community health in this study and this important if we have to understand the effects of dust on mining environments.

Lastly a study by Onder, is methodologically robust among all the studies because this study made use of records of dust measurements in the mining environment since the 1978 until 2006. This could be helpful to understand the trends in dust production over the years. Thus information could be utilized to come up with sustainable workable measures that could address the growing concern of dust in mining. However, this study does no conclusively and comprehensively reports on the findings of such reviews. One feature that seem to fall short in the studies is the mention of an intersectoral approach when doing mining [10]. A study by Billig et a' suggest that an inter-sectoral approach involving community, governmental and nongovernmental agencies, and the management of the mining firm. And from this study it appears success was achieved using this approach in addressing dust from the mining environment [9, 10]

3. Conclusions

This section looks briefly the conclusion of dust in the mining environment and its health dynamics among workers and communities. What is important in this review should be what is needed to address the imbalance within the mining environment moving forward and implications for worker, community health and sustainability. This is quiet important because even when a mine is gone, the men and women who have worked in the mine may continue to experience health impacts for many years. The evidence of long-term impacts of mining on health of workers and communities is important in the context of sustainable development. These impacts imply that the mining sector's activities currently undermine the human objectives of sustainable development, which are to protect the health of current and future generations. This is despite the industry's role in economic development in the short term. Miners and the communities living around mines have fought hard for improvements to their health conditions over many years. This has resulted in great improvements in largescale formal mining where organized labor has worked with

government and management to improve worker health and safety. Communities have also fought to gain health improvements and reduce health risks associated with living near mines.

4. Statement of Competing Interests

This paper has not been published elsewhere, and the author take responsibility and severally over the information provided therein. The author have no competing interests.

5. Acknowledgements

The authors would like to express their profound gratitude to the two anonymous reviewers who made wonderful suggestions to shape this final work. Special thanks also go to the University of Zambia, School of Mines who through the EDSA program made this work publishable. Thanks also to Dr. Jewet Masinja for the support and encouragement.

6. References

1. Baldauf, R.W., Lane D.D., & Marote, G.A. (2001). Ambient air quality monitoring network design for assessing human health impacts from exposures to air-borne contaminants, Environmental Monitoring and Assessment, Vol. 66, pp. 63–76.

2. Collins, M.J., Williams P.L, & MacIntosh, D.L (2001). Ambient air quality at the site of a former manufactured gas plant. Environmental Monitoring and Assessment Vol. 68, pp. 137–152.

3. Singh, A. 2007. Revegetation of coal-mine spoils using Prosopis juliflora in Singrauli coalfield is a harmful practice from an ecological viewpoint. Correspondence, Current Science 93: 1204.

4. Momoh A, Mhlongo SE, Abiodun O, Muzerengi C, Mudanalwo M. Potential implications of mine dusts on human health: A case study of Mukula Mine, Limpopo Province, South Africa. Pak J Med Sci 2013;29(6):1444-1446. doi: http://dx.doi.org/10.12669/pjms.296.3787

5. Rey, C.H, Pinilla,M.I, Ayala, L.B, Guerrero,D.M.C,Torres, G.M., Restrepo, HG and Uribe, M.V. (2015). Underground Coal Mining: Relationship between Coal Dust Levels and Pneumoconiosis, in Two Regions of Colombia, 2014; BioMed Research International Volume 2015, Article ID 647878, 8 pages http://dx.doi.org/10.1155/2015/647878

6. Bråtveit, M., Moen, B.E., Mashalla Y.J.S, and Maalim, H., (2002) Dust Exposure during Small-scale Mining in Tanzania: A Pilot Study; Ann. occup. Hyg., Vol. 47, No. 3, pp. 235– 240,DOI: 10.1093/annhyg/meg027

7. IFC, International Finance Corporation. Environmental (2012). Health, and Safety Guidelines for Mining, 44-55.

8. Laney, S., and Weissman, D.N., (2014). Respiratory Diseases Caused by Coal Mine DusT; J Occup Environ Med. October; 56(0 10): S18–S22. doi:10.1097/JOM.0000000000000260

9. Billig, P., E. Gurzau, et al. (1999). Innovative intersectoral approach reduces blood leads levels of children and workers in Romania. Int J Occup Environ Health 5(1): 50-6.

10. Mustafa Önder, Seyhan Önder, Tuncay Akdag & Firat Ozgun (2009) Investigation of Dust Levels in Different Areas of Underground Coal Mines, International Journal of Occupational Safety and Ergonomics, 15:1, 125-130, DOI: 10.1080/10803548.2009.11076794

Mineral rights and sustainable development in the copper mining industry on Zambia: A case study of Lumwana and Kansanshi mines

(Social Science and Humanities Journal, ISSN 2456-2653, May,2019)

[1]Pamela Malama Masase, [2*]Dr. Stephen Kambani

[1,2]University of Zambia, School of Mines

Abstract: - Sustainable development from mining activities must recognize the finite nature of minerals and hence the needs for the creation of linkages where the benefits from mining continue to be enjoyed long after the natural resources have been depleted. In order to facilitate these linkages, the economic gains from the mining industry should be equitably distributed among all the stakeholders in any project area. Studies show that in Zambia, the economic benefits from the mining projects are not equitably distributed among the stakeholders and that the problem stems from the lack of involvement of all stakeholders in the process of granting mineral exploitation rights to would be investors. So far there is little known about whether indeed there is equitable distribution of economic wealth among stakeholders in the mining projects or whether all the stakeholders are involved in the procedure for granting mineral exploitation rights. The main objective of this research was to evaluate whether the method of granting mineral exploitation rights influences the equitable distribution of economic benefits among the stakeholders from mining projects. A study was carried at Lumwana and Kansanshi Mines of the North-Western Province in Zambia. Specifically the study evaluated: the extent to which the current way of granting mineral exploitation rights affects the equitable distribution of economic benefits among the stakeholders from a mining project; whether a grant of mineral exploitation rights through negotiations by the stakeholders before the commencement of a mining project would be capable of bringing about the equitable distribution of economic benefits from a mining project to all stakeholders; and whether there are other factors which may have impinged on the equitable distribution of economic benefits from the mining projects other than the method of granting mineral exploitation rights. A case study approach was adopted and a qualitative method was employed. The respondents were selected purposively. Six focus group discussions, each consisting of ten respondents were conducted and interview guides were used to collect data from key informants. Data was analysed thematically. The study revealed that the current procedure for granting mineral exploitation does not allow for equitable distribution of economic benefits. The study also revealed that the equitable distribution of economic benefits was achievable through negotiations with all stakeholders before granting mining licences. Furthermore, the study revealed that there are no other factors that affect the equitable distribution of economic benefits. The study concluded by recommending that the procedure for grant of mineral exploitation rights should be revised to include all stakeholders in a negotiation before mining licence is granted. Secondly, that there should be a plan beforehand on how the revenue from mining projects will be expended depending on the needs of all stakeholders involved.

Keywords: *Procedure, Stakeholder, Mining licence, Investor, Local Authority, Community,*

Introduction

Since 1969 the method of granting mineral exploitation rights has been provided for by statutes (Ndulo, 1986). It can therefore be argued that there has been no equitable distribution of economic benefits from the mining activities in the copper. Mining projects in Zambia. The equitable distribution of economic benefits requires that before a mining project commences, all stakeholders agree on what is expected, from their respective perspectives (Masinja and Simukanga, 2014).

The aim of the study was to examine whether the current method of grant of mineral rights to resource exploitation brings about an equitable distribution of economic benefits among the stakeholders. The research went further to:

(i) To examine whether a grant of mineral exploitation rights through negotiations by the stakeholders before the commencement of a mining project would be capable of bringing about the equitable distribution of economic benefits from a mining project to all stakeholders.

(ii) To determine whether there is other factors which may have impinged on the equitable distribution of economic benefits from the mining projects other than the method of granting mineral exploitation rights.

Scope of the Study

The assessment focused on a case study of Kansanshi and Lumwana copper mines located in North-Western Province of Zambia. The study was extended to all stakeholders in the two communities covering all stakeholders as depicted in Figure 1. These included the mining companies (investors), government agencies, local authorities and the communities (the owners of the land and beneficiaries from the mining projects).

Research Methodology

In this research, data collection comprised two parts. The first part was a review of published scholarly writings, especially on the subject of sustainable development in the extractive industry, contract negotiation, and review of laws and other materials on the grant of mineral exploitation procedures. The second part of the research was a case study of Lumwana and Kansanshi Mines. This part involved in-depth interviews and focus group discussions, using the purposive sampling, particularly on the process of grant of mineral exploitation rights. The in-depth interviews were held with government officials at the Ministry of Mines, representatives of mining companies, officials from local municipalities, while focus group discussions were conducted with representatives of community members

Sustainable Mining Development

Sustainable development is development which takes into consideration economic, social and environmental objectives (Blewit, 2008). It is defined as “meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs” (Hilson and Murck, 2000; Kogel, Trivedi and Herpfer, 2014; Swilling and Annecke, 2015).

Mining has the ability to impact the environment and other human activities negatively in a project area and in some cases beyond. Sustainable development in the mining industry requires,

among other things, saving and reinvesting in the industry an amount equal to what has been extracted and sold (Kumah, 2006). It also requires that the economic gains from the mining industry are equitably distributed among all the stakeholders in the industry. In order to sustain wealth from mineral resources they have to be transformed into other forms of capital, as well as sustainable means of livelihood opportunities for people affected by such activities (AfDB, 2007). The finite nature of minerals demands the creation of linkages where the benefits from mining activities continue to be enjoyed long after the natural resources have been depleted (Fessehaie and Mike, 2013; Olanya, 2015).

Zambia is a resource rich country, containing the largest known reserves of copper in Africa accounting for 6% of the world"s known copper reserves (World Bank 2011). The Frazer Institute survey of mining and exploration companies ranks Zambia"s mineral potential 26th out of 79 countries world-wide (World Bank, 2011). It is estimated that Zambia has 2.8 billion tonnes of ore ranging from 0.6 to 4% copper (World Bank, 2011). Global demand for copper is estimated to grow at 3% annually to 25 million tonnes by 2020 (World Bank, 2011). The mineral resource potential coupled with the big demand for copper on the global market provides Zambia with a good prospect of growth in the copper mining industry (World Bank, 2011). Zambia has been in the business of mining and exporting copper for about a century now. Copper contributes about 9.5% of GDP and makes up 75% of Zambia"s total export earnings (AfDB 2016).

Although mineral resources have the potential to generate economic wealth (Azapagic, 2004; UNECA, 2011; ICMM, 2012), mining does not in itself accord a mineral resource rich nation an outright benefit (Manley, 2013). The minerals are part of Zambia"s capital wealth much like farms, factories and roads. It takes good management and distribution of both the mineral wealth and revenues in order for any of the benefits to be realised (Azapagic, 2004; Kumah, 2006; World Bank, 2011; Manley, 2013). The most challenging task that the mining sector faces is to show that it is contributing to the welfare and wellbeing of the present generation without negatively impacting the quality of life of the future generations (Azapagic, 2004).

It has been pointed out that in Zambia, the economic benefits from the mining projects are not equitably distributed among the stakeholders. This has been majorly attributed to the way mineral exploitation rights are granted (Masinja and Simukanga, 2014). The authors argue that negotiations for mining contracts are often cumbered with complications and qualms by both investors and respective governments. It is observed that the investor will normally do their due diligence covering critical areas such as:

- Knowledge about the host government and its political landscape
- Resource base being targeted
- Better understanding of the product
- Market processes and strategies
- Conversant with the host countries" operational industries code as well as any past mining contracts.

The host government on the other hand would be ill equipped with little or no knowledge about the investor and may in certain instances not fully understand the resource and may not have prepared their demands and expectations beforehand. The only tool the host governments normally have is the regulatory framework guideline without working out any possible short term or long-term impact of any possible negotiated outcome on the local or national economies.

In order to maximise benefits from a mining project, it is important for the host country and the investor from the onset to identify their principles, priorities and objectives they wish to achieve from that project (Mensa, 2016). The terms of the agreement should be those which maximise opportunities for achieving the most benefits for both the government of the host country and the investor alike. The current method of grant of mineral exploitation rights is provided for by the Mines and Minerals Development Act No.11 of

2015 as read with the Mines and Mineral Development (General) Regulations, 2016, Statutory Instrument No.7 of 2016.

The concept of sustainable development envisages human activities, inclusive of mining being conducted in a way that the activity and the outcome of that activity brings about a long-term contribution to the livelihood of mankind (Blewit, 2008). Sustainable development has been defined by the Brundtland Commission in the report entitled "Our Future" as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Hilson and Murck, 2000; Kogel, Trivedi and Herpfer, 2014; Swilling and Annecke, 2015).

Sustainable development has further been defined as "the balancing of economic, social, environmental objectives, integrating them through mutually supportive policies, and practices, and trade-offs" (Kumah, 2006). The emphasis here is on the integration of the three pillars of sustainability, that is, the environment, economic and social, into development policymaking. One popular way of depicting the three pillars is shown in Figure 2.

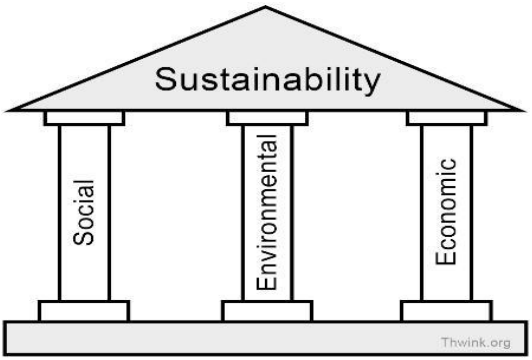


Figure2. Sustainability pillars

Should any pillar be weak, then the system as a whole is unsustainable. It therefore, requires the industry to come up with strategies which recognize and embrace the responsibility to the society, environment in the region and the world at large (Angelakoglou and Gaidajis, 2013).

Human activities not only consume the natural capital by relying on the ecosystem services to support the standard and quality of life, but also frequently impair the environmental services through productive activities (Blewit, 2008). These activities include the consumption of mineral and energy resources that cannot be renewed or regenerated (Blewit, 2008).

Mining by its nature has the capacity to cause serious negative impacts on the environment (Hilson and Nayee, 2002) as well as on other human activities; depletion of non-renewable resources, alteration of landscape, chronic soil erosion, heavy metals overloading, acid mine drainage (Hilson and Nayee, 2002; Azapagic, 2004; Franks, Boger, Cote and Mulligan, 2011) and thus affecting the quality of water for drinking and other uses; agriculture and displacement of local communities; generally threatens the health and safety of both workers and the inhabitants of the project areas (Azapagic, 2004; Hilson and Murck, 2000; Tutu, 2013). The economic, environmental and social issues that arise in mining are summarized in the Table 1.

Table1. Summary of the key sustainability issues for the mining and minerals sector

Economic issues	Environmental issues	Social issues
Contribution to GDP	Biodiversity loss	Bribery and corruption
Costs, sales and profits	Emissions to air	Creation of employment
Distribution of revenues and wealth	Energy use	Employee education and skills development
Investments (capital, employees, communities, pollution prevention and mine closure)	Global warming and other environmental impacts	Equal opportunities and non-discrimination
Communities, pollution prevention and mine closure	Land use, management and rehabilitation	Health and safety
Shareholder value	Nuisance	Human rights and business ethics
Value added	Product toxicity	Labour/management relationship
	Resource use and availability	Relationship with local communities
	Water use, effluents and leachates (including acid mine drainage)	Stakeholder involvement
		Wealth distribution

Source: Azapagic, 2004

There is no blue print for achieving sustainable development, even in the mining sector. Various schools of thoughts have come up with different interpretations and different ways of attaining sustainable development in the mines (Hilson & Murck, 2000). However, the international mineral community came up with the sustainable development principles outlined in Table 2 in 2003 as a guideline for the equal application

Table2. Sustainable development principles

1.	Implement and maintain ethical business practices and sound systems of corporate governance
2.	Integrate sustainable development considerations within the corporate governance
3.	Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities
4.	Implement risk management strategies based on valid date and sound science
5.	Seek continual improvement of our health and safety performance
6.	Seek continual improvement of our environment performance
7.	Contribute to conservation of biodiversity and integrated approaches to land use planning
8.	Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products
9.	Contribute to the social, economic and institutional development of the communities in which we operate
10.	Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders

Source: Kogel, Trivedi and Herpfer (2014) of sustainable development concept across the industry (Kogel, Trivedi and Herpfer, 2014).

Against this backdrop a challenge is posed on demonstrating how mining can contribute "to the welfare and well-being of the current generation without compromising the quality of future generations" (Azapagic, 2004). There is need for an economic output to the mining activities in order for the rehabilitation of the damage caused to the environment by the mining activity to be possible.

According to Tutu, sustainable development is paramount when dealing with non-renewable resources like mineral resources (Tutu, 2013). An evaluation of the contribution of an economic activity to GDP takes into account not just the revenues that are generated but also linkages that

the activity generates. The forward and backward linkages are what contribute mostly to GDP.

Mineral resources should provide positive linkages to economic growth (World Bank, 2006). According to the Africa Mining Vision 2030 (AMV) proposals for exploiting the mineral resources and collecting and managing the revenues are not enough. It is just one of the issues that should be considered in formulating a policy. It is proposed that development corridors, clusters of industrialization and sharing infrastructure should be created. This proposal is the opening up the mining industries to linkages with local, national and regional economies.

It is claimed that the African mining paradox lies in the deficiencies in historical structures. This is mainly from the practice of time immemorial of direct export of minerals to industrialized countries at the expense of African development, in particular the policy of isolating the mining activities from the rest of the local economies. A wrong impression is generally created that African countries benefit from mining because mining makes up the major source of public revenue through taxation.

The Role of Mineral Resources in Development

The conventional view on natural resource wealth is that it is a catalyst for development. The revenues from the extractive sector are meant to translate into capital for education, infrastructure and some other stock from which the nation should benefit and improve its economy (Olanya, 2015; Venables, 2016). It is generally believed that the availability of natural resources would provide an advantage for rapid growth; examples for this have been drawn from such countries as Britain, Australia, Canada, Japan, the United States and Sweden (Joya, 2015; McMahon and Moreira, 2014). Natural resources should generate funds for investment and demand through market linkages (Joya, 2015; McMahon and Moreira, 2014; Olanya, 2015; Fessehaie, 2012).

Sustainability could be attained for mineral reserves by saving and reinvesting in the industry an amount equal to what has been extracted and sold on an annual basis (Kumah 2006). Some positive impacts can be seen from mining activities, amid a lot of controversy in trying to link sustainable development to mining, mainly because mineral resources are finite and non-renewable and therefore there is a high chance of reducing the future generation"s access to the resources (Vintro, Sanmiquel and Freijo, 2014).

However, it has been observed that natural resource endowment does not in itself warrant automatic economic growth; in fact, modern literature suggests that it can have an adverse effect on growth and development (Joya, 2015). Since the 1980s skepticism from most economists as to whether natural resource abundance does induce good economic output has ensued (Joya, 2015; Kumah, 2006; Olanya, 2015). The reasons for failure to extract economic growth from mineral resources range from lack of capital to invest in mining projects, inefficient institutions to poor management of resources (Kumah, 2006) and weak governance (Swilling, 2012). Mineral endowment is considered an implicit form of capital with potential to bring about socio-economic growth where there is equitable distribution and management of wealth and where the revenues from mining activities are invested in infrastructure, facilities and social services especially for communities around the mining areas (Tutu, 2013).

Many theories have followed this skepticism, one of which is the resource curse (Olanya, 2015). Resource curse is a theory that political systems in natural resource endowed countries are the least likely to attain development when the natural resources take centre stage of the economy (Collier, 2010). Closely related to the resource curse theory is another theory which suggests that mineral economies dependency on a single resource for development, mainly through income from its export, is a reason for lack of economic growth, the Dutch disease. The reason advanced for this is that dependency on a single dominant commodity causes other sectors of the economy to be neglected by the resource rich countries (Venables, 2016; Gilberthorpe and Papyrakis, 2015; Collier, 2007).

Other reasons for failure by mineral dependent economies to make economic strides have been attributed to failure to put in place the right growth

promotion policies and strong institutions to manage the development process (AfDB, 2007; Gilberthorpe and Papyrakis, 2015; Swilling, 2012).

According to this theory the discovery of mineral has been seen as a paradox in relation to the prevalence of poverty (Collier, 2007). This view is that there is an adverse relationship between mineral resource endowment and economic development (Gilberthorpe and Papyrakis, 2015). There are many explanations given to support this view. Problems cited include rent seeking as propounded by Jeffrey Sachs (Collier, 2007), which in turn leads to a balance of payments crisis (Pereira, 2010). The conclusion is that governance is at the core of this problem (Collier, 2007; Venables, 2016; Sebatian and Rave, 2016). It has been contended, on the other hand, that mineral wealth can bring about opportunities and develop social relationships. What is highlighted in some research is how intertwined the political process is in resource extraction at a local level and underlines inequalities, social dislocation and conflict that can lead to a resource curse (Gilberthorpe and Papyrakis, 2015).

According to Collier, normally the discovery of mineral resource should be a catalyst for development which sometimes it is but there are some exceptions to this (Collier, 2007). He further notes that countries with discovery of mineral resources end up poor and that the most that the resource rich countries can get to is the middle-income status (Collier, 2007). Growth is said to be facilitated by specific primary products which are connected to the export markets. This growth is explained by using linkages, which are either backward and forward or outside and inside (Fessehaie and Mike, 2013; Olanya, 2015). The fiscal linkages are outside linkages which stand for state participation in the income generated from the exports; forward linkages have the capacity for economic development; inside linkages occur when the state has moved to a state of entrepreneurship away from the status quo, while outside linkages diffuse the concentration of economic power and wealth by introducing other players on the scene (Ramdoo, 2013; Olanya, 2015). Variations in the economies only come about with policies, institutions, state building and political inclusiveness (Olanya, 2015). It is important to harness growth in order to overcome stagnation with only occasional booms and busts (Collier, 2007; Pereira, 2010).

Collier argues that it is difficult to manage volatile revenues because when there is a boom the governments spend excessively. This kind of behaviour, it is argued, does not allow for public investments and also it is difficult for governments to adjust their spending pattern during the time of a bust (Collier, 2007).

The Resource Curse

The term "resource curse" was coined by Gelb (World Bank Group, 2006; Fessehaie and Morris, 2013). It „describes the inverse relationship between resource abundance and economic growth (Sebastian and Raveh, 2016; Gilberthorpe and Papyrakis, 2015; Collier, 2007; Collier, 2010; Swilling, 2012). The resource curse thesis was first proposed by Sachs and Warner and later improved on by Collier (Swilling, 2012).

The Dutch Disease

Related to the resource curse is a situation known as the "Dutch disease". The situation arises where the exploitation of the mineral resources is properly managed to a level where exchange rates appreciate through the export of the minerals. The damaging aspect of this situation comes about when there is over reliance on this single source while other sectors of the economy are neglected and hence destabilises the macroeconomics (Venables, 2016).

More specifically the term is derived from the discovery of large gas deposits in the Netherlands which had a negative effect on Dutch manufacturing in the nineteen sixties (Corden, 1984; Poncela, Senra & Sierra, 2017). The sudden increase of the country‟s wealth due to in flow of unprecedented capital reduced the competitiveness of other sectors (Poncela, Senra & Sierra, 2017).

The natural resource curse and the Dutch disease constitute economic and political and institutional problems (Pereira, 2017). The Dutch disease has

been seen to be an obstacle to industrialisation (Pereira, 2017). On the other hand, it has been argued that the natural resource boom can be a catalyst for growth and development while the resource curse can be avoided by employing the right knowledge, institutions and policies (AfDB, 2007).

The reason for the underperformance of mineral economies, notwithstanding the theories explained above is over spending, spending on wrong things and under-investing (Collier, 2007; Venables, 2016). To leverage this, some suggestions have been given to let private sector create sustainable jobs and economic growth and therefore resource management should be centred on supporting private sector investment (Venables, 2016). The distribution stage of mineral exploitation, where resources are distributed among the investors, government and others is seen as a critical stage in the exploitation of mineral resources. This is in reference to the investments which will flow from the revenues generated which make some investment suggestions and among them investments that ultimately support the private sector investments (Venables 2016).

The limitations in the various studies is that all the suggestions, such as, emphasising on linkages (Fessehaie and Morris, 2013; Olanya, 2015; World Bank, 2006; Ramdoo, 2013); providing checks and balances in governance to avoid corruption; the governments‟ prioritising its expenditure and investment (Collier, 2007); decentralisation of the fiscal economies where local governments of remote areas were not efficient in handling fiscal policies and prevalence of corruption (Venables, 2016), are all theoretical. A more practical solution is required such as the proposed model, where all the foregoing suggestions can be factored including the interpretation of all the linkages in form of a formula into which all the income and expenditure from a mining project should feed.

Bruckner (2009) argues that resource curse is a symptom of societies infested with corruption and lack sufficient checks and balances on political decisions. Politicians are at the core of economic development in resource rich countries (Bruckner 2009). In his finding, Bruckner (2009) identifies that corruption is usually facilitated by many steps and procedures to export the resources. The many steps and procedures present loopholes for government officials to be offered bribes as an incentive to circumvent the process for impatient exporters. This reduces on the much-needed revenue.

As well as identifying the causes of lack of economic development in resource-rich countries, different scholars have come up with different solutions. Another challenge associated with the lack of economic development in mineral economies, which is also linked to a nation‟s policies is the „lopsided trading‟ (Tutu, 2013). This is the kind of trading where natural resources are exported cheaply, as no value is added and later imported as finished products at a much higher price (Tutu, 2013).

In order to address this seemingly multi-dimensional problem, it is suggested that a multi-faceted approach should be employed, that is, legal, institutional, and administrative involving all stakeholders and obtain co-operation all stakeholders (Dolphyne, 2013).

Dolphyne (2013) agrees with Bruckner (2009) that the resource curse or Dutch disease are not conditions shrewd in mysteries, they are realistic outcomes of mismanagement of resources including the revenues from the exploitation of the mineral resources.

The success stories of mineral resources spurring into development in countries like Canada, Australia are attributed to not just the availability of resources but also the transformation in business and financial organisation, education, research and knowledge development, human capital accumulation and infrastructure expansion. They point to stable political institutions that had respect for the rule of law and a good business environment (Dolphyne, 2013). Natural resources are essential for countries to attain addition financial development and consequently there is need to manage, through policy, the resources and the wealth that is produced for future development

(AfDB, 2007). Table 3 shows proposed policy options **Table 3:**

Policy option proposals

1.	Creating a viable, integrated and diversified mining industry throughout the value chain, and sustaining mineral wealth without compromising environmental, social and cultural considerations and ensuring a regulatory framework that encourages mineral creation.
2.	Investing transitory mineral revenues to ensure lasting wealth and deciding how much ought to be saved and how much should be invested and in what.
3.	Distributing benefits from mining equitably, balancing and managing conflicting local and national level concerns and interests and deciding what form the allocation should take to promote pro-poor growth.
4.	Ensuring sound systems of governance and a stable macroeconomic policy, which curbs rent seeking and corruption; addresses issues such as Dutch disease and externalities such as unstable commodity prices and enhances public interest in wealth conservation.

Source: (Dolphyne 2013).

It has also been proposed that in order to judiciously exploit mineral resources, high corporate, social and environmental standards be engaged through policy, legal framework, a good fiscal regime and creation of employment. Table 4 presents a summary of strategies that can be employed in the exploitation of mineral resources.

Table 4: Proposed strategies for judicious exploitation of mineral resources

	Achieving better allocation of revenues from mineral resource and redistribution of the benefits of mineral wealth through improvements in the governance and management of revenue flows derived from mining and through decentralisation of decision-making and resource allocation.
	Promoting a calculated, well informed spending, saving and investment (in other assets) strategy which prioritises human, social and physical capital creation and transformation of mineral wealth into financial assets that yield returns.
	Promoting the stabilisation of mineral resources revenue and reducing fiscal imbalances through greater fiscal discipline, a certain level of fiscal conservatism and increased capacity for forecasting and managing mineral revenues with a view of reducing uncertainties about their magnitude, mitigating market externalities and minimising adverse macro-economic impacts associated with commodity price fluctuations.
	Enhancing governance systems, organisational and institutional capacity, particularly in the ministries of finance and planning, and in local government.
	Forging tri-sector partnerships and creating coalitions of change among public, private (mining companies) and stakeholders to improve community livelihoods and to maximise other socioeconomic and development outcomes.
	Empowering communities in mining regions so that they are able to make informed decisions and better participation in their own development.
	Unbundling the sector and promoting a strategy that encourages local procurement and outsourcing of goods and service, value addition and local beneficiation from minerals, and that also optimises business multipliers and enhances linkages between mining and other sectors of the economy including at the local community level.
	Encouraging mining companies have in a more social and corporate responsibility manner with a view to improving the social relevance of mining.

Source: (Dolphyne 2013).

Dolphyne (2013) observes that the above strategies are general and therefore, there is a need to apply them in a contextual way and in a specific country. Furthermore, for the policies to be effective they should form part of the whole programme of poverty reduction and growth strategy and should be mainstreamed in other development plans. The writer proposes for a people as opposed to a profit-

oriented mining, which is a partnership between the government, local communities and other stakeholders facilitated through policies, legal and regulatory frameworks.

Conceptual Contract Model for Mineral Resource Negotiation

The model proposed by Masinja and Simukanga (2014) for equitable distribution of economic benefits among stakeholders from any mining project requires interface among the stakeholders. The model applies to the entire extractive industry but for the purposes of this study, the application is restricted to the copper mining industry in Zambia. The model identifies three stakeholders in a negotiation, that is, the government, investor and host community. All these have different and specific interests which must be taken into account in order to have a sustainable operation (Azapagic 2004; Masinja and Simukanga, 2014).

Figure 3 best summarises the operational tripartite structure in terms of the interests of the respective stakeholder.

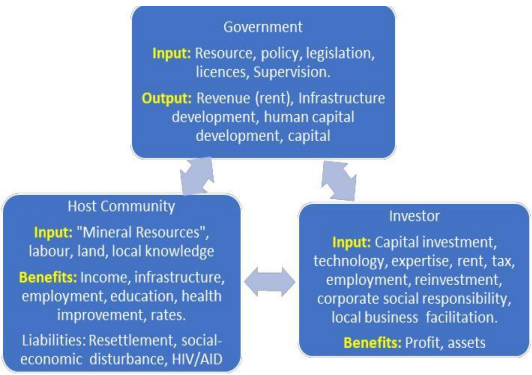


Figure1. Tripartite relationship between Government, Host Community and Investors in the operations of Extractive Industries, Source: adapted from (Masinja JH, 2013).

The stakeholders each contribute to the operation of the sector and as such expect a return on their investment. The figure clearly indicates that the benefits arising for each of the stakeholders is highly symbiotic in that, the government collects taxes, creates employment and business opportunities because of the integration of investment into the economy and industrialization. On the other hand, the investor benefits through having access to resources without much encumbrances and profits from the investment. Finally, the community benefits from jobs, business opportunities and corporate social responsibility.

The proposed model suggests that the total revenue generated by the exploitation of the natural resource must equal to the total expenditure and this should be planned by the government at the point of negotiating for the mining contract (Masinja and Simukanga, 2014). The principle objectives of the proposed model are to, firstly, contribute to the improved governance of the mining sector by defining clear responsibilities and roles in any given project for the key stakeholders. Secondly, to propose a method of monitoring the movement of revenue between the key stakeholders so as to make each of the stakeholders accountable. Thirdly, develop a mathematical framework for defining the key considerations in the negotiation of extractive industries contracts in order to attain the most favourable outcome.

The conceptual model envisages that Government at the national level as owner of the resources and chooses to licence it out for exploitation; the investor seeks a permit to exploit the natural resources at its cost and the host community who are the owners of the resource and live within or around the area to be exploited; and each of these stakeholders make a contribution to the operations of the project and ultimately make a profit (Masinja and Simukanga, 2014).

The proponents of the model acknowledge the factors that have been attributed to the failure of natural resources contributing to economic development in Africa. They note that the main reason given is that of governance. This is as a result of the lack of growth promotion policies and secondly, lack of strong institutions to manage the development process. The other reasons given for failure of natural resource wealth to lead to economic development, generally, are identified as the following:

1. The Dutch disease, which is explained as the condition of rising real exchange rates and wages from exploitation of mineral resources driving out exports and imports of other sectors of the economy (Hernandez, I 2006).
2. Rent seeking by the elites; and
3. The volatile nature of prices and the disproportionateness effect it has on public expenditure (Masinja and Simukanga, 2014).

It has been observed that the revenues from exports of the natural resources exploitation are volatile as the price constantly fluctuates on the global market. Since the revenues are unpredictable, there is need to put in place sound fiscal policies to ensure that they are invested in human capital development and the development of long-term production capacity. It is noted that this has proved to be a major challenge, especially on how to transform the revenues from natural resource exploitation into productive capital that could induce and sustain growth over the long term. Furthermore, the challenge of transparency and accountability is seen to remain crucial in the harnessing of natural resource wealth for economic growth. Without adequate checks, resource revenues have induced rent seeking and wide spread corruption. This is said to hamper the quality of institutions and good governance of resources (Masinja and Simukanga, 2014).

Transparency can be identified at two levels; first at the point of grant of exploitation rights and secondly, at the point of controlling and spending revenues from exploitation of natural resources. It is further noted that policy makers and development practitioners have been grappling with the gap between the exploitation of natural resources and
sustainable increases in socioeconomic development in a good number of resource-rich countries; this is contrary to rational economic expectations (Masinja and Simukanga, 2014).

The aim of the proposed extractive industry contract negotiation model is said to be "the support of the development of strong public institutions that would ensure transparency and accountability in revenue management". It has been contended that the model has the potential to help arm and protect the government negotiator from being lured into concessions that are unhealthy for the economy by a more experienced private sector negotiating counterpart (Masinja and Simukanga, 2014). It is further contended that the model can be used as a means of monitoring and tracking revenue movement for both the government and the general public. It would also help minimise dishonesty on the part of those in charge of public resources whether in public offices or in the private sector (Masinja and Simukanga, 2014).

The model has not been subjected to any empirical evidence. It was therefore not the aim of this study to explore the model. The study, instead, focused on whether the current method of grant of mineral exploitation rights, in Zambia, does, in fact, have an effect on the equitable distribution of economic benefits among the stakeholders from the mining industry

Contract Negotiation

A mutual contract is attained when parties have equal bargaining power. In this case parties are entitled to express their expectations out of a project. It is important for the parties to get what they consider fair and beneficial out of every project. According to Edwards, Toohey and Mwiden, it is important for a party to set its clear objectives before engaging in any contract negotiation as outlined in Table 5 (Edwards, Toohey and Mwiden, 2014).

Table 5: Points for consideration before engaging contract negotiation

1.	The value of resources (value of the offer)
2.	A clear mandate from all stakeholders for pursuing the project
3.	Current capacity gaps (training resources, equipment)
4.	Expectations and what the real need is for the partnership
5.	Internal policies, government policies, principles, values ad priorities and an evaluation of the impact on all stakeholders.

Source: (Edwards, Toohey and Mwiden, 2014).

Contract negotiation does not start with the contract document; it starts with preparation and development of policy objectives (Mensa, 2016) which takes into account long term sustainable development (Ramdoo, 2013). What the host government needs to understand first and foremost is the value of the resource in terms of the revenues, including foreign exchange earnings that can be derived therefrom, as well as its role in environmental stewardship (Mensa, 2016; Ramdoo, 2013). The government can then come up with goals that centre on, for instance, downstream opportunities, solid industrial base, infrastructure development, education, training, high quality employment and business prospects for local enterprises (Mensa, 2016; Ramdoo, 2013).

Mineral Exploitation Rights in Zambia

Before independence the mineral rights were obtained as concessions from African Chiefs (Ndulo, 1986). With the coming of the British South African Company (BSAC) in 1912 a statute regulating the mining in Northern Rhodesia, present Zambia was passed. The statute entrusted the BSAC with the mechanism for regulating mining. Under this statute anyone could acquire a prospecting licence upon payment of a minimal fee to BSAC (Ndulo, 1986). On the eve of Zambia"s independence, the BSAC surrendered its mining rights to the Zambian government for a payment of a sum of Two Million pounds. The sum was to be paid by both the Zambian and British governments (Ndulo, 1986).

At independence the Anglo-American and Roan Select Trust, the two companies that had acquired mineral rights through the BSAC were still in possession of those rights. The Zambian government later nationalized the mining industry in 1969. This was pursuant to the Mines and Minerals Acct of 1969, which authorized the government to terminate the undeveloped concessions and special grants owned by the Anglo-American and Roan Select Trust Companies and releasing the areas in which the companies were not carrying out their mining operations. The Act also authorized the government to negotiate for a 51% takeover of equity in existing mines. Through negotiations the government was able to buy the majority shares with dividends within a period of twelve years (Ndulo, 1986).

The Act provided for the grant of licences to individual and mining companies. The terms of the licence, the interpretation of those terms, the definition of rights and their scope, and the reciprocal obligations, between the licence holder and the government, were absolutely fixed by the Act. This has been the case for Zambia to date. An exception is under the repealed Mines and Minerals Act of 2008, which provided for the government to enter into mining agreements with holders of large-scale mining licences. The agreements contained terms that were negotiated between the government

and the respective investors. The Act was repealed in 2008 which saw the cancellation of the Development Agreements. Mineral resource exploitation is currently governed by the Mines and Mineral Development Act, No. 11 of 2015, the Mineral Resource Policy (2013) and the Mines and Minerals (General) Regulations 2016.

For resource development agreements, most countries like Zambia rely on independently enacted laws which govern the mining sector for investments which allow investors to decide whether or not to invest based on those existing laws (Mensa, 2016). In some developing countries, there is no detailed sector specific framework (Mensa, 2016).

The current Mines and Minerals Development Act, No. 11 of the 2015 sets out the procedure, which any person who wishes to engage in mineral exploitation should follow. It is the principal guideline on the exploitation of minerals in Zambia, including the acquisition of mining rights as stated in Part III (three) of the Act.

The guiding policy for the amendment of the Mines and Minerals Development Act is the Mineral Resources Development Policy (MRDP) put in place to govern the direction of the government in the mining sector. The policy was issued in July, 2013 following a review of the 1995 policy. The purpose of the review is said to be the creation of lasting benefits for the people of Zambia (MRDP, 2013).

The policy acknowledges that despite the improvements in the mining sector, facilitated by the MRDP 1995, leading to increased production, there are still a number of challenges. The challenges noted in this study include the following:

(ι) Inefficiency in the administration of mining rights;

(ιι) Low revenues from the mining sector;

(ιιι) Poor infrastructure development in host communities;

(ιϖ) Poor linkages leading to lack of value adding to the products (MRDP, 2013).

The policy projects an increase in the GDP contribution from the current 9% to 20% by 2030 (MRDP, 2013). Among the guiding principles in the current policy is the government"s commitment to ensure sustainable exploitation of mineral resources for the maximum benefit of the Zambian people. This has been incorporated under Section 4 of the current Mines and Minerals Development Act, No. 11 of the 2015, (the Act). The section reads as follows:

"The following principles shall apply to the mining and development of minerals:

a) Mineral resources are a non-renewable resource and shall be conserved, developed and used prudently, taking into account the needs of the present and future generations;
b) Mineral resources shall be explored and developed in a manner that promotes and contributes to socioeconomic development and in accordance with international conventions to which Zambia is a party;
c) The exploitation of minerals shall ensure safety, health and environmental protection;
d) Wasteful mining practices shall be avoided so as to promote sustainable development and prevent adverse environmental effects;
e) Citizens shall have equitable access to mineral resources and benefit from mineral resources development; and
f) Development of local communities in areas surrounding the mining area based on prioritisation of community needs, health and safety."

The grant of mineral exploitation rights is provided for under Part III of the Act. In particular, Division 3 deals with mining licences.

Section 30(1) provides that:

- A holder of an exploration licence may, not later than six months before the expiry of the exploration licence, apply for a mining licence for the mining of minerals within the exploration area.

- An application for a mining licence shall be made to the Director of Mining Cadastre in the prescribed manner and form upon payment of the prescribed fee….”

Section 31 lists the things to be taken into consideration when considering an application. Furthermore, section 32(1) provides that:

“Subject to the provisions of this Act, the Committee shall, within ninety days of receipt of an application under section thirty, grant the applicant a mining licence, in the prescribed form, if the application meets the requirements of this Act.”

The Committee in the preceding paragraphs refers to the Mining Licensing Committee, established under section 6 of the Act. The functions of the Committee are listed in that section as:

- Considering applications for mining rights and non-mining rights and grant or renew or refuse to grant or renew mining rights and non-mining rights;
- Terminating, suspending or cancelling mining rights and non-mining rights;
- Amending the terms and conditions of mining rights and non-mining rights; and
- Advising the Minister on matters relating to its functions under this Act.

The composition of the Committee is stated under subsection (2) of section 6. It comprises the Directors of Mines, Geological Survey, Mines Safety, Mining Cadastre, as Secretary; one representative from the Ministry of Environment, Land, Finance and Labour; as well as a representative from the Attorney General, the Zambia Development Agency and the Engineering Institution of Zambia.

From the foregoing discussion, it is evident that no literature was found on assessing the impact of the current method of grant of mineral exploitation rights on the equitable distribution of economic benefits among stakeholders from the mining industry.

Study Outcomes

The findings from the focus group discussions revealed that the government, the local authorities and the investors derived some benefits from the mining projects, although more benefits were attributed to the investors, a little bit to the government and very little to the local authorities. On the part of the community, the findings revealed that they never derived any benefit the mining project.

With regard to the procedure of obtaining mineral rights, the findings revealed that almost all the participants expressed ignorance on the procedure involved in obtaining a mining license.

Furthermore, the findings from the study revealed that all the participants indicated that the community was not engaged before the issuance of the mining license. Most participants were also not aware of any conditions that are imposed when granting the mining rights while a few were aware.

The study from the focus group also revealed that the best procedure for granting mining license was that the mining investors should first of all consult the local people.

The study further revealed that there was lack of checks and balances in terms of distribution of economic benefits. In this regard, one participant said that government has more power than the investors and therefore, they should be able to direct the investors in a way that could favor the locals

Conclusions

The study investigated on whether the method of granting mineral rights influences the equitable distribution of economic benefits among the stakeholders from any mining project. The choice of the stakeholders consisting of government, the investor and the host community comprising of the local authorities and the local community, was validated by the stakeholder theory. The theory postulates that for an individual of institution to be considered as a stakeholder worth considering, they must have three attributes which are power, legitimacy and urgency. The analysis of the theory in the context of this research shows that the government, investor, and host community are the salient stakeholders in the evaluation of the

procedure for the grant of mineral rights and the equitable distribution of economic benefits from the study. In addition, the stakeholders" entitlement to the economic benefits from the mining projects was analysed in the light of the theory of access, the ability to benefit from resources based on rights ascribed by law, custom or convention.

Results from the case study based on Lumwana and Kansanshi Mines, demonstrated that the current method of granting mineral rights does influence the equitable distribution of economic benefits among the stakeholders to a great extent. The current procedure shows that there is an opportunity for government and other stakeholders, other than the investor to fully understand the resource for which the licence is issued.

References

1. **AfDB (2007),** African Development Report: Natural Resources for Sustainable Development in Africa. Oxford: Oxford University Press
2. **AfDB (2016),** Zambia Country Profile Document.
3. **Angelakoglou, K., Gaidajis, G (2013),** Assessing the progress of mining industry towards sustainability: In need of new methodological frameworks. Sustainable Development in the Minerals Industry Conference, Milos Island.
4. **Azapagic, A (2004),** Developing a framework for Sustainable Development indicators for the mining and minerals industry. Journal of Cleaner Production. 12, 639-662
5. **Bell, J (2005),** Doing your research project: A guide for first-time researchers in education, health and social science. New York: Open University Press
6. **Blewitt, J (2008),** Understanding Sustainable Development. London: Earthscan.
7. **Collier, P (2007),** The Bottom Billion: Why the poorest Countries are failing in what can be done. New York: Oxford Press.
8. **Collier, P., Hoefflier, A (2012),** High-value natural resources, development and conflict: Channels of causation. In High-value Natural Resource and Peace building. Ed. Lujala, P., Rustad, S.A. London: Earthscan.
9. **Conrad, M (2012),** Zambia"s Mineral Fiscal Regime. International Growth Centre. Online. 19th Sept, 2015.
10. **Corden, W. M (1984),** Booming Sector and Dutch Disease Economics: Survey and Consolidation. Oxford Economics Papers. 36, 356-380.
11. **Fessehaie, J., Morris, M (2013),** Value Chain Dynamics of Chinese Copper Mining in Zambia: Enclave or Linkage Development? European Journal of Development Research. 25, 537-556.
12. **Franks, D, M., Boger, D.V., Cote, C., Mulligan, D (2011),** Sustainable development principles for the disposal of mining and mineral processing wastes. Resources Policy, 36, 114-12.
13. **Gilberthorpe, E., Papyrakis, E 2015),** The Extractive industries and development: The resource curse at the micro, meso and macro levels. The Extractive Industries and Society, 2, 381-390.
14. **Hernandez, I (2006**), The "Dutch Disease": Theory and Evidence, **World Bank Institute**. (WBIGC).
15. **Hilson, G., Murck, B (2000),** Sustainable development in the mining industry: clarifying the corporate perspective. Resources Policy, 20, 227-238.
16. **Joya, O (2015),** Growth and Volatility in resource-rich countries: Doe diversification help. Structural Change and Economic Dynamics. 35, 38-55.
17. **Kogel, J.E., Trivedi, N., Herpfer, M.A (2014)**, Measuring sustainable development in industrial minerals mining. International Journal in Mining and Mineral Engineering. 5(1.
18. **Kumah, A (2006),** Sustainability and gold mining in the developing world. Journal of Cleaner Production. 14, 315-323.

19. **Litvinoff, M (2012),** Consultation on IMF Natural Resource Work. London. Publish What You Pay UK.
20. **Manley, D (2013)**, A Guide to Mining Taxation in Zambia. Lusaka. Institute for Policy Analysis and Research.
21. **Masinja, J and Simukanga (2014),** An Extractive Industry Contract Negotiation Model. MINPROC, 2014 Cape Town, South Africa, 7-8 August 2014.
22. **McMahon, G., Moreira, S (2014),** The contribution of the Mining Sector to Socioeconomic and Human Development. Extractive Industries for Development.
23. **Mensa, E.N.Y (2016),** Extractive Industries Taxation. ESOSOC Special Meeting on International Cooperation in Tax Matters, New York, 9th December, 2016.
24. **Miles, M. B and Huberman, A. M. (2013),** Qualitative Data Analysis. California: Sage Production.
25. **Mines and Minerals Act, Chapter 213** of the Laws of Zambia
26. **Mines and Minerals Act, No. 7 of 2008**
27. **Mines and Minerals Development Act, No. 11 of 2015**
28. **Ndulo, M (1986),** Mining Legislation and Mineral Development in Zambia. Cornell Law Faculty Publications. 19(1),1-33.
29. **Olanya, D.R (2015),** Will Ugandan succumbs to the resource curse? Critical reflections. The Extractive Industries and Society. 2, 46-55.
30. **Ominiyi, O (2011),** Sustainable Development: What Role for Economic Intergration, Trade and Investment Policies. African Journal for Sustainable Development. 1(1),1.
31. **Pereira, L.C.B (2010),** Globalisation and Competition: Why some emergent countries succeed while others fall behind. London. Cambridge University Press.
32. **Pereira, L.C.B (2017),** How to neutralize the Dutch disease notwithstanding the natural resources curse. Sao Paulo School of Economics. Working paper to presented to the Likhachev Science Conference, St. Petersburg University of Humanities and Social Sciences, St. Petersburg, May 18-20, 2017.
33. **Poncela, P., Senra, E. and Sierra, P (2017),** Long-term links between raw materials prices, real exchange rate and relative de-industrialization in a commodity dependent economy. Empirical evidence of "Dutch disease" in Colombia. Empirical Economics. 52, 777-798.
34. **Ramdoo, I (2013),** Fixing Broken Links: Linking extractive sectors to productive value chains. European Centre for Development Policy Management.
35. **Sachs, J.D., Warner, A. M (2001),** Natural Resources and Economic Development: The Resource Curse. European Economic Review. 45, 827-838.
36. **Simpasa, A., Hailu, D., Levine, S., Tibana, R, J (2013),** Capturing Mineral Revenues in Zambia: Past and Future Prospects. New York. EU-UN Global Partnership on Land Natural Resources and conflict.
37. **Swilling, M (2012),** Beyond the resource curses: From resource wars to sustainable resource management in Africa. A paper presented at the Winelands Conference on integrity and governance, Stellenbosch, April, 2012.
38. **Swilling, M., Annecke, E (2012),** Just Transitions: Explorations of sustainability in an unfair world. Cape Town. UCT Press.
39. **Venables, A.J (2016),** Using natural resources for development: Why has it proved so difficult? Journal of Economic Perspectives. 30(1) 161-184.
40. **Vintro, C., Sanmiquel. L. and Freijo, M. (2014).** Environmental sustainability in the mining sector: evidence from Catalan companies. Journal of Cleaner Production. 84, 155-163.
41. **World Bank (2011),** what would it take for Zambia"s Copper Mining Industry to achieve its potential? Siteresources.worldbank.org/INTZAMBIA/Resources/copper-mining-summary

Study to Review Benefits Beyond Direct Mine Taxes in Zambia

(IJRDO-Journal of Business Management, ISSN: 2455-6661, August, 2017)

G. Mwamba[1], S. Kambani and E. Chisakulo[2]
[1,2]*Research Fellows, University of Zambia*
[1,2]*Department of Mining Engineering, Lusaka Zambia*

Abstract:

There is a common public perception that the major contribution of mining in Zambia is through direct tax revenues. This study sought to explore and investigate the economic benefits of mining beyond these direct tax revenues. Over seventy percent (70%) of Zambia's copper production is by four mining companies namely Barrick Lumwana Mines, First Quantum Minerals (FQM) Kansanshi mine, Konkola Copper Mine (KCM) and Mopani Copper. These mines were the focus of this study. The objectives of the study were to determine how much they paid in terms of taxes; employment created; investments made in terms of procurement of local goods and services; assessment of the social benefits from the four mining companies and other macroeconomic benefits of mining in Zambia. And finally, to compare mine tax revenue to other benefits of mining in Zambia and determine which of the two is greater. Using data collected from the four mining companies, Zambia Chamber of Mines, Zambia Revenue Authority and Action Aid, the findings were that the four mining giants during the period of investigation, made immense contributions to the country's economy. In 2012, they directly employed 56,300 people, spent about US$3.0 billion on the procurement of goods and services and US$70 million on social investments. However, these companies spent about only US$1.7 billion in form of total taxes.

This study has therefore, demonstrated that the four mining companies comparatively generated significant economic benefits to the country outweighing the taxes paid in three areas of employment, procurement of goods and services and social investments. Clearly, the findings from this research do not support the common perception that the payment of taxes is the main and most important benefit derived from the mining activities in Zambia. The study concludes that tax revenue is but a small benefit of mining in Zambia. There are significant benefits in terms of support for local business, social investments and other macro-economic benefits that needs strengthening through appropriate policy interventions. Being a mineral dependent economy, this conclusion is not meant to demean the desire by the government to have more direct tax revenues to pay for other equally

demanding sectors of the national economy but to create awareness that other important benefits do accrue to the country other than direct taxes.

Keyword*:* Social investment; mine tax revenues; local businesses; macroeconomic benefits; Zambia.

Introduction

Zambia's economy is largely dependent on production and export of copper for its revenue. As expected, this has been a source of intense debate on whether mining companies are paying their fair share of taxes. Besides the general public, many civil society organizations have been very critical of the contribution that mining companies make towards the national treasury in terms of taxes. It is thus a general view that mine tax revenue is the main benefit that mining brings to the country's economy to an extent that when mines do not make much contribution in terms of taxes, the public perception is that having mines in Zambia is not in any way beneficial. However, the general public may not be aware of other benefits that come with mining projects in Zambia which is the focus for this discussion.

The objectives of the study were to determine how much they paid in terms of taxes; employment created; investments made in terms of procurement of local goods and services; assessment of the social benefits from the four mining companies and other macro-economic benefits of mining in Zambia. And finally, to compare mine tax revenue to other benefits of mining in Zambia and determine which of the two is greater.

Review of Mine Taxes in Zambia

Generally, there are two categories of mining taxes applicable in Zambia (Manley, 2013). These are Direct Taxes and Indirect Taxes. Under Direct Taxes there are two categories which are Profit- based taxes and Revenue-based taxes. Profit-based taxes include Company Income Tax and Excess or Variable Profit tax. Under Revenue-based tax, there are Mineral Royalties and Windfall tax. Under Indirect Taxes, there is Value Added Tax (VAT), Customs and Import Duty.

Direct Taxes

Profit Based Taxes: These are categorised according to their tax base which include profit and revenue.

Company Tax: This form of tax is not exclusive to the mining companies but applicable to all businesses. This form of tax is complex because taxable profit upon which this tax is applicable has various definitions and is subject to several deductions which can be used to change the amount of tax payable. This form of tax can be affected by variations such as the Excess or Variable Profits taxes. Many countries with extractive industries apply this form of tax. The aim of Excess Profit tax (EPT) is to be progressive. This means that as a company increases its profitability, so does the tax obligation. This tax is levied on profits above a certain defined threshold. However, the standard corporate tax is still applicable on that portion of the profits below the threshold. Corporate taxes are based on Resource Rent Tax which according to Arnaut and Ross (1975) are intended to reap maximum possible revenue from a mining company without scaring away potential investors so that the mining companies are preserved as a source of government revenue. The general public considers Variable Profit Tax as being fair since an increase in the profits of a mining company would result into an increase in its payment of taxes. This is especially favourable to the general public which expects mining companies that are reaping huge profits, resulting from factors of high mineral prices, to increase their taxes.

Revenue Based Taxes: Revenue-Based taxes are usually applicable where governments find it hard to administer profit-based taxes. These forms of taxes are based on a company sales or its revenues instead of its profits. This form of taxation is easier to administer. Revenue based taxes are categorised into Mineral Royalty taxes and Windfall Taxes.

Mineral royalty tax rate differs, depending on a mineral but are below 10%. Currently, mineral royalty tax on copper mining is 6%. Mineral royalty tax is based on gross sales value, that is, whole sales and not profits. In some instances, however, royalties do permit some deductions like transport, insurance and in some instances processing costs. When costs are added to the deductions, this changes the characteristics of the tax from being royalty to profit-based although the extent to which this effect is made is quiet limited.

Mineral Royalty Taxes have several advantages to the administering government that include their charge being based on the value of the extracted mineral and so are suitable for compensating for the

loss of the resource to the government. Further, royalties are used in influencing timing and level of risk of payments made to the government. They are thus more reliable than profit – based taxes because they are collected when the company start making revenues whether it makes profit or not. For the very fact that mines do take many years to start making profits, the country does not have to wait to reap revenue in form of taxes. The final advantage of royalties is that they are an easy to administer because all the taxing authority needs to know from the mining company is the sales volume and the unit price. Sometimes the pricing that can be disclosed by the mining firm may be unreliable. If that happens, verification can be done by consulting independent price reference published by the London Metal Exchange or another agency.

Windfall Tax is defined as a "tax that is levied on the value of a company's sales of a particular mineral in which the rate increases with the price of the mineral" (Manley, 2013). This is a useful tax instrument which has advantages of a standard fixed rate royalty which aims at eliminating some disadvantages. When the owner of the mineral resource has been sufficiently compensated by the mining company, there is no need to impose regressive taxes. Avoiding a regressive tax may involve lowering the rate of the royalty and tax based on profit that is not regressive. However, the taxing authority should have the capacity to balance this with principle of feasibility. Alternatively, a taxing authority can use royalty tax with a varying rate in accordance to the mineral's market price. When such is done, royalty which is variable-rate becomes less regressive than the one which is at a fixed rate which is affected by rising or falling of prices. Royalty tax however is not as progressive as those taxes that are profit-based. The Zambian government introduced Windfall Tax in 2008 (ibid).

Indirect Taxes

Value Added Tax (VAT) - mining companies are under obligation to pay VAT, but this form of taxation is rarely significant. This is so because exporters such as mines receive refunds from the Zambia Revenue Authority (ZRA) for the VAT which is levied on their inputs. In certain instances, VAT is zero-rated, meaning that the copper export has a VAT tax of 0%. The rationale for zero rating VAT is to avoid levying tax on production instead of consumption. However, since most, if not all, the copper which is produced is for export and not domestic consumption, any VAT the exporter has to pay would be on production and not consumption. Notably, production taxes are inefficient as they counter the desire of many governments to promote economic growth through export industries which

are expected to earn foreign exchange (Otto, 2000). Therefore, without VAT refunds, the taxation system would, effectively, be taxing inputs which would have similar effect as revenue based taxes which are taxes paid whether a company makes a profit or not.

Customs Duty mostly applies on imports, though there are at times export duties. Zambia charges export duties when copper concentrate is exported. This form of tax serves a double function for the government. Firstly, it is a good source of revenue as it is easier to administer than other forms of taxes. Secondly, it is an effective economic tool for protecting local industries against foreign companies. For example, the rationale behind customs duty on the export of copper concentrate is to encourage and promote value addition such as processing of copper into copper cathode of higher value.

Tax Adjustments

Governments make several adjustments to their tax systems in their quest to encourage investment and maximise revenue collection in the extractive industry. There are four notable types of adjustments. These include Depreciation Allowances, Loss Carry Forward Provisions, Ring- Fencing and Tax Holidays (Manley, 2013). Besides their regular cash costs, companies incur depreciation costs. The mining venture has huge capital costs even before commencement of production. This cost percentage is allowed to be claimed as depreciation. For the sake of attracting investments, some governments allow mines to claim what is referred to as 'accelerated depreciation' which is the high rate at which expenses are depreciable. When depreciation rate is increased, profit and tax are reduced in the initial years but are expected to increase in the later years. Essentially, this amounts to postponing payable tax.

The other adjustment is Loss Carry Forward Provisions. If in a particular year a company makes a loss, many governments allow the company to carry the loss to the following year so that taxable income in that year is reduced. When that happens, tax is paid when profits that accumulate are greater than accumulated losses. If a company incurs huge losses for a number of years, then the company can only start paying taxes years after it starts making profits.

The other adjustment that is made to taxable profits is Ring-fencing. This involves separating the operations of the company when calculating taxes. Separating can be based on factors such as geographic positions of the operations of a firm. Ring-fencing is used by companies so as to limit their abilities to use costs from one operation to offset profits for tax purpose in another operation.

The other incentive that government gives to mining firms is Tax Holidays. These are temporal measures to reduce or even eliminate taxes. Its purpose resembles that of loss carry-forward. It is used to help the company with cash flow problems in the early years of production. Keen and Mansour (2010) highlight various dangers that are associated with tax holidays. Since tax-holidays are time-limited exemptions from corporate income tax, they may not be renewed. They are ill- designed form of investment incentive and pose a danger to a wider tax system.

A Review of Benefits other than Taxes

Employment

The mining sector in Zambia has made significant contribution to the country's employment levels. Though the sector has not been the largest employer, there have been significant levels of direct employment which is defined as people that are on the company's payroll and the long-term contractors operating on the mine site. For instance, in the year 1991, the mining sector had a workforce of 64,000 employees. At the time when ZCCM was preparing for privatization, employment had dropped to about 22,000. After privatization, employment levels recovered to 46,706 by 2009 (GRZ, 2011:124). According to the 2012 Labour Force Survey, employment in the mining sector was estimated to be 90,000 representing about 1.7% of the total economy-wide employment on the national level (CSO, 2013). In the same year, the total formal employment in both private and public sectors was 894,175 which accounted for 16.6% of the total employment in the country. Out of this, the mining sector accounted for 74,254 jobs which was 8.3% of the total formal employment and 25% of the total formal employment in the private sector. In comparison to other sectors, data from the 2012 Labour Force Survey shows that only the education sector which had 141,672 jobs, the Agriculture sector with 87,927 formal jobs and the Manufacturing sector with 77,408 formal jobs surpassed the mining sector.

Notably in mining towns, the percentage of formal employment is mostly higher than any other sector. For example, in the Copperbelt and North-Western provinces, the mining sector has the highest percentage employment than any other sector. Further, jobs from the mining sector are well paying and are skills intensive. When compared to other sectors, the mining sector has proved to be outstanding in the aspect of employment creation as shown in Table 1.

TABLE: New jobs created

SECTOR	**2004**	**2005**	**2006**
Manufacturing	4,577	4,691	4,838
Agriculture	2,448	3,575	4,028
Mining	5,574	6,266	18,375
Tourism	1,843	1,957	1,742
Other	1,535	1,680	2,466
Total	15,977	18,169	31,449
Mining Contribution	***35%***	***34%***	***58%***

Source*: Zambia Development Agency (2008)*

The four mining companies are located in both the Copperbelt and North-Western provinces. In these areas, the mining sector is by far the largest employing sector. In 2012, the four mining companies created 56,200 direct jobs (CSO, 2013). Of this, the two Copperbelt province-based companies generated 40,600 jobs or well over two thirds of the total employment of which 16,800 were direct employees while 23,800 were contractors. The remaining one third (15,600) was accounted for by the North-Western province based mining companies. However, those based in the North-Western province have a higher percentage of contractors than their Copperbelt counterparts to the tune of 78% of direct employment. The four mining companies accounted for about 80% of the 74,254 formal employees in the mining sector countrywide (ICMM, 2014).

Indirect and Induced Employment

The mining sector is a great source of indirect employment. This type of employment includes people who are employed by the suppliers to the mining company and work off-site. There is further induced employment which includes people who are employed as a result of direct and indirect employees spending their wages locally. It is, however, common to overlook induced

employment mainly because it is difficult to link it to the mining sector and it is mostly in the informal sector. It is, however, a significant contributor to the local income especially among the poor and forms a strong basis for diversification especially in the agriculture sector. Fig. 1 below shows the direct, indirect and induced employment in the two mining provinces.

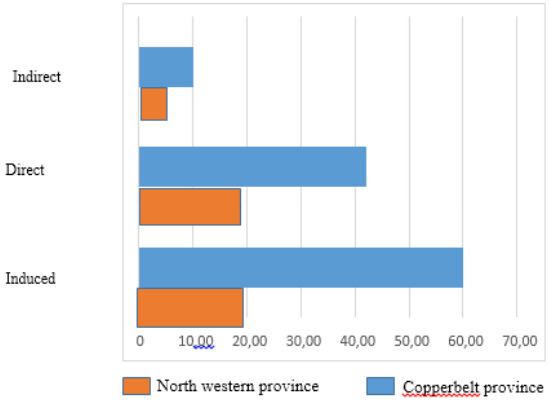


***Figure 1**. Head count of direct, Indirect an Induced employment at the four mining companies*
***Source:** Company data and OPM calculations (ICMM, 2014).*

Procurement of Local Goods and Services

According to data collected by Kasanga (2012), services that are procured by the mining sector are mostly from the Zambian companies but largely imported goods. In 2012, total procurement from the four mining companies was around US$3.0 billion of which US$1.6 billion went to services and US$1.4 billion went towards goods. However, about 80% of the goods procured are not manufactured in Zambia. The total estimate for procured goods is about US$1.75 billion annually of which only US$87 million or 5% are locally manufactured.

Social Investments

Mining companies have been making huge investments in the social sector of their catchment areas. The survey conducted by the International Labour Organization (ILO) indicate that over 200

community development programmes that are performed in the mining area, over 80% are done by the mining companies. This entails that social investments in communities where mines are found are high in relation to company profits and that mining companies undertake social investments in their catchment areas. In the year 2012, the four mining companies spent about US$70 million on social investments. This is about 0.3% of the country's GDP. The largest contributor towards social investment was by the Copperbelt province-based mining companies as shown in Fig.2.

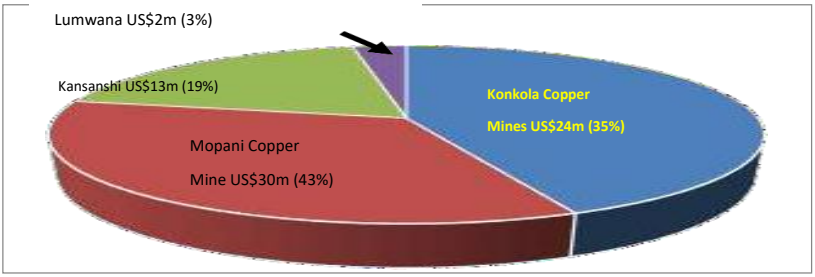


Figure 2: Social investments by mines in 2012 **Source:** Company data (ICCM, 20140

Priorities for social spending differed between the Copperbelt-based firms and those in North-Western province due to community differences. While the Copperbelt is an established urban area with good infrastructure yet high levels of unemployment, HIV and populations which expect a lot from the mining sector, North-Western province on the other hand is predominantly rural, sparsely populated and limited infrastructure. With the coming of mining activities, many people have flocked to mining areas, thereby putting an intense pressure on social spending and increased levels of HIV/AIDS.

These social investments by the two Copperbelt-based mining firms were undertaken at privatisation for running two large mine hospitals each, about eight health clinics each and two primary and two secondary schools each (ICMM, 2014). Running educational and health facilities is unusual for commercial mining companies and the cost of running them, especially hospitals, significantly increase the companies' total spending in social investments and staff numbers (Manley, 2013).

The four mining companies have different approaches to social investment. Lumwana and KCM follow a bottom-up approach where an established process for planning and implementation is followed. This is done through consultation with local communities as well as the local government when deciding which investment to undertake. They also use the available government survey data to assess the current needs of the community. The two firms implement social investments in partnership with others such as the local government, civil society and community members (ICMM, 2014).

Lumwana Copper Mine

Lumwana is involved in social investment activities. According to its Corporate Profile (2014), the mining firm has brought about a lot of economic benefits both to the country as well as thelocal communities. The company explains that it has a responsibility to protect the environment, conduct business that is based on high ethical standards and make a meaningful contribution to the community in which it operates. Its aim is to share the benefits of mining with its employees and the community so as to foster economic and social development. It takes social and cultural concern of the local communities and offers skills training to the local residents and provides economic opportunities through local procurement. In 2014, the company spent $1,360,379 in community development.

Konkola Copper Mines (KCM)

KCM exercises Corporate Social Responsibility commitments in matters of education, health, sustaining livelihoods, the protection of the environment and biodiversity. From 2005 to 2014, the company spent US$150 million on Corporate Social Responsibility (KCM, 2013). The mine operates the Kitwe Trades School which is Africa's largest private vocational training centre. Recently, the company invested US$2.6 million to increase enrolment and upgrade the curriculum. Further, the company provides training programmes to students both locally and abroad. So far, it has sponsored over 250 students for fulltime degree programmes and other tertiary programmes. The company operates two hospitals and eight satellite clinics. It further runs two schools with over 1,900 pupils. It has one of the largest malaria roll-back programmes in Zambia. The company has rolled-out several community health initiatives that include the distribution of 23,000 free eye

glasses, the fitting of artificial limbs and undertaking eye cataract operations. KCM is also involved in the sponsorship of four football teams in the top Zambian soccer league which is referred to as KCM Supper League (Manley, 2013).

Mopani Copper Mine

Mopani spends more on social investments in absolute terms than the other mining companies. However, it adopts more of a top-bottom approach and an ad hoc approach to investment. Through its corporate affairs department, the company engages with communities in a more responsive way than proactive manner. Among the activities that the mining firm has involved itself in as a good corporate citizen include sponsoring of the Council of Southern African Football Associations (COSAFA) Senior Challenge cup. The mining firm has also undertaken the rehabilitation of the Nkana Stadium. This cost the mining firm US$500,000. Between the years of 2000 and 2011, the mining firm spent an average of US$320,000 per annum. In July 2011, the mining firm contributed US$50,000 towards the staging of the regional soccer showpiece. It further provided Man of the Match cash prize amounting to US$4,000 for the four matches that were held at Nkana Stadium. The support that the mining firm has made to soccer clubs such as Nkana Football Club and Diggers Rugby Club has helped in their revival and the restoration of their pride. By investing in the rehabilitation of the stadium, the firm provided an example to other corporate citizens to be involved in CSR.

Besides the Nkana stadium, Mopani Copper Mines has been sponsoring non-soccer tournaments such as the Commonwealth Swimming Gala that was hosted in 2011 at the Olympic Youth Development Centre in Lusaka. Due to rehabilitation works, Nkana Golf Club was able to win the hosting of the prestigious 2014 Zambia Open Golf championship. The mining firm signed a Memorandum of Understanding (MoU) where the mining firm has been able to rehabilitate the Club House, locker rooms and the surrounding, maintaining of the golf course and the provision of golf expertise, labour, course irrigation and a water reticulation system. It has further been maintaining the club's security through electric fencing of the perimeter boundary, increased security patrols and placement of fire breaks around the perimeter. The mining firm contributed about US$30,000 towards the live broadcast of the 2013 Africa Cup of Nations held in South Africa. It further hosted the third league gala of the Zambia Amateur Swimming Union (ZASU) at the newly-built swimming pool in Mufulira for the training and leisure of the community.

Further, the mining firm has been involved in health matters as part of its CSR. It has donated a 30-seater staff mini-bus together with assorted medical equipment worth US$20,000 to Kitwe Central Hospital. The equipment which is aimed at supplementing government's efforts in improving health services delivery included patient trolleys, wheel chairs and other patient monitoring equipment. Other health institutions expected to benefit included Ronald Ross and Kamuchanga hospitals in Mufulira. The company has rehabilitated the first quarter of the 15.1 km of the Sabina-Mufulira road which connects the mining town of Mufulira on the Copperbelt to the rest of Zambia. This is part of the $10.5 million road rehabilitation project launched in 2011 which also involved the rehabilitation of the 6.7 km Central –Street and Mindolo-Chibuluma roads. The company has further been involved in free cervical cancer screening for women, the treatment of congenital disorder and the integrated malaria control programme which has led to reduction in malaria prevalence rates in the company's catchment areas of Kitwe and Mufulira to about 15 per 1,000 when compared to the rest of the Copperbelt area which averages more than 250 per 1,000.

Mopani Copper Mine is also involved in many HIV/AIDS prevention and treatment activities inside and outside the workplace (MCM Corporate Profile, 2015). The beneficiaries amounted to 45,000 to date. These include both employees and non-employees who avail themselves of the company's voluntary counselling and testing programme. About 14,000 have accessed free treatment and care. As far as free cervical cancer screening is concerned, 300 women benefited from the service between November 2012 and May 2013. This screening has been done at Wusakile and Malcom Watson hospitals Kitwe and Mufulira respectively. An amount of US$250,000 was spent to set up two cervical cancer screening centres targeting over 32,000 women aged between 20 and 65 years in Copperbelt province. Fifteen wheel chairs worth US$5,000 have been donated for children with cerebral palsy in Kitwe (MCM Corporate Profile, 2015).

Kansanshi Mine (First Quantum Minerals -FQM)

Though it traditionally uses a top-down approach, Kansanshi mine involves the community. It heavily relies on inputs from traditional chiefs. The implementation of many projects is done with partnership with others. The company's corporate social responsibility efforts are summed up in the idea of respect. Since coming to Zambia, the mining giant has made tremendous contributionto

the community where it operates. In the year 2013 alone, FQM spent about US$44.5 million in community investment. One area in which the mining giant has helped the community is in conservation farming. This involves teaching local farmers simple agriculture technics which makes farming more sustainable. This has been of great help where farmers have exhausted the soil in one area and have moved on to another. Conservation farming involves minimal tillage, teaching farmers to create furrows just deep enough to hold seeds and fertilizer, learning the ideal items for farming, thinning and weed control. They also learn precise standards for spacing, thinning and weed control. These efforts have yielded results. In the first year of the program, some farmers' output increased to about 800% and such results have been sustainable year after year. By 2012, 550 local farmers were supported in conservation farming practices. The company spent US$750,000 in 2012 (ICMM, 2014).

On skills training, US$372,482 was spent and US$1,283 was spent through the Kansanshi Education Quality Improvement Programme (Kan EQuiP). The aim of the project was to improve the quality of basic education for 22,000 pupils in 15 schools. It focusses on improving the teaching competencies of educators, strengthening head teachers, district education managers and provincial education officers and the provision of school instructional resources such as text books and school desks. The company spent US$60,000 in construction of teacher houses and a classroom block. A further US$32,000 was spent on the construction of the Solwezi Public Library (FQM, 2012).

On adult literacy, the company spent US$3,267 in 2012 to roll out adult literacy to 152 community members. On local business development, it spent US$132,820 supporting initiatives that are aimed at building capacity and skills of local businesses (ICMM, 2014). Those who undergo these training learn on register a business, managing money and writing business plans. Further, there are business development workshops held for local entrepreneurs in aspect such as cash flow management, business plan compilation, business registration and local labour laws. There was further training for contractors in which prospective bidders were taught courses in areas such as tendering and estimating, reading and interpreting drawings, planning and organising a construction contract, concrete technology and quality control on construction sites (Manley, 2013).

The mining giant has also been involved in areas of health, education, skills training and the conservation of the environment. In the aspect of biodiversity conservation and protection of the environment, the mining giant spent US$669,746 at Bwana Mkubwa mine and US$5,535,680 at Kansanshi mine in the year 2012 alone. In total, the social expenditure for the mine was US$67,099 at Bwana Mkubwa mine and US$13,535,114 for Kansanshi in 2012. These finances were used for improvement of health care through providing health facilities and service providers, improving basic infrastructure and basic services in communities such as houses, roads, electricity, water, sanitation and others. It further includes improving infrastructure and basic services in communities such as roads, housing, electricity, water and sanitation. The company further facilitates access to enterprise development opportunities for local entrepreneurs. In terms of health, the company spent US$10,000 on radio programmes that focuses awareness on diseases such as cholera, typhoid and dysentery. It further spent US$50,000 on prevention of malaria and water borne diseases. On community health roadshows, the company spent US$30,000 in 2012 alone and US$2.2 million on upgrading Solwezi General Hospital. On HIV/AIDS project training, the company spent US$20,000. The company further offered medical scholarships through sponsoring various professionals. It spent US$150,000. An amount of US$125,000 was spent on the maternal clinic and Child Health Wing.

While many of the CSR that the company engaged itself in occurred in its catchment area and so went unnoticed by the majority of Zambians, FQM undertook a major step in its exercise as a good corporate citizen. It spent about US$260,000 (K1.3 billion of the then local currency) to broadcast live the 2012 Africa Orange Cup of Nations Games (AFCON) on Zambia National Broadcasting Corporation-ZNBC television and radio. The total amount that was required was K2.1 billion of the local currency, hence the mining giant contributed to well over sixty percent (60%) of the total budget for the tournament's broadcast rights.

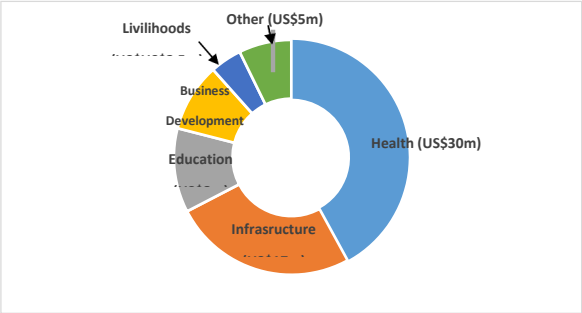


Fig.3. Social investments by all four mining companies across functional areas

Source: *Companies data as compiled by ICMM (2014)*

Training and Human Development

Mining companies in Zambia significantly contribute to the development of the local economy through the provision of training to their direct employees and contractors. Training employees such as through "on-the-job-training" is beneficial both to the employees and the mining companies. The knowledge and skills gained through such training can be passed on to other sectors and has a diverse application, hence promoting diversification. The mining sector has thus made a huge contribution towards human capital development in the country. This is in the face of low educational levels in the country.

Training at the four mining companies includes a mixture of in-house and outsources training. The four mining companies together spent about US$5 million in the year 2012. This has kept on increasing in subsequent years. However, these four companies differ in their approach to training. Kansanshi is more focused on technical and safety training and largely relies on external training providers. Mopani on the other hand provides in-house training with a mixture of technical and managerial training. Konkola Copper Mine on the other hand has mixed approach with a technical and managerial approach and a combination of both external and in-house training. Lumwana largely uses in-house safety training though it is still formalizing its training system. The four mining companies have made the following contributions to skills training:

Further Education Scholarships

The three companies of Kansanshi, Mopani and KCM awards scholarships for further education. In 2012, Kansanshi was sponsoring 33 employees in various disciplines at different levels ranging from diplomas to graduate and post-graduate levels. While the majority were studying at Zambian institutions, others were doing their studies outside the country. Mopani identifies both high school and university students for the award of scholarships in both technical and post-graduate qualifications. One of the main conditions of the scholarship is that a person has to work for Mopani once the studies are completed. KCM on the other hand has wide ranging scholarships which are distributed across employees, their dependants and promising students who learn at KCM trust schools. Other scholarships are provided by those who are high performing at public universities which are in no way connected to the mining company. By 2014, 52 Zambians were sponsored by the mining company in Zambia, India or Namibia (ICMM, 2014).

On-the-Job Training, Apprenticeship and Secondments

Depending on the need, all the four mining companies provide on-the-job-training for both new and experienced employees. Attachments for students from Zambian institutions are offered by Kansanshi and Mopani mines. These mines also run graduate development programmes. KCM on the other hand has a foreign group exchange program where graduates get secondment to other Vedanta operations for periods ranging between 6 and 12 months (Manley, 2013).

Technical and Managerial Training

Technical training is offered to employees of the all mining companies. However, there is a difference in the way training is delivered. KCM provides technical training through satellite technical training schools, courses that are offered at Kitwe Trades School and by technical training officers who are located in various departments. Kansanshi on the other hand provides technical training internally in each department as well as through external training providers while both Lumwana and Mopani have an in-house training. Most of these companies provide their employees with managerial and supervisory training. This is done either through in-house courses such as those offered by Kansanshi and Mopani or Master of Business Administration (MBA) sponsored programmes as provided by

KCM which also provides training for surgeons who work at mine hospitals and pays for the same training to surgeons working at government owned hospitals (Myondi, 2014).

Support for Trade Schools

Support for technical trade schools is provided directly as is the case with KCM which runs Kitwe Trade School and Kansanshi which runs Solwezi Technical Training Institute in conjunction with the government and Mopani which opened its trade school in 2014 (MCM, 2015). Support is also indirectly provided such as Mopani's payment of higher fees for employees who attend training at trade training schools in the process subsidising non-mine students. Besides the provision of training to direct employees, mining companies invest in skills development of those who are employed as contractors.

4. The Macro-Economic Contribution of the Mining Sector in Zambia

The contributions of the mining sector in the above three areas of employment creation, procurement of goods and services and social investments have had a positive impact on the country's economy at the macro level in the aspects of production, exports and Balance of Payments (BoP), the exchange rate and Foreign Direct Investment (FDI) (ICMM, 2014)

5. Conclusions and Recommendations

This study has demonstrated that mining in Zambia is contributing immensely to the social and economic wellbeing of the country. It therefore makes the following recommendations:

1. There should be a win-win situation in the negotiation of taxes with the mining companies. The government should not simply consider taxes as the only benefits that mining companies bring in the country.
2. As presented in the findings, there has continued to be a negative perception of mining companies in Zambia despite the huge investments that the firms have continued to make. This is partly because there has been a perception that taxes are the only major economic benefits that mining brings in the country. There is thus need to bring to the attention of the general public and Non-Governmental Organizations of the many benefits that mining companies have brought to the economy besides taxes. This publicity may be done by the

Zambia Chamber of Mines.

3. As presented in the findings, mining activities are largely located in two provinces of the Zambia: Copperbelt and North-Western Provinces. However, the country's economic mainstay is the production and export of copper. Hence, the country largely depends on the two provinces for its economic livelihood. This in some cases has been a source of contention by people who live in the two provinces, that wealth that is generated in the two provinces benefits other parts of the country in most instances at the expense of the two provinces. It is for this reason that corporate social responsibility activities are done in communities where mining companies operate. However, as explained in the findings, mining firms have their own approaches towards social investments and they are not required by law to exercise corporate social responsibility. It is therefore recommended that the government comes up with a policy guide on corporate social responsibility where it becomes mandatory for a mining firm to carry out social investments in the community in which it is found.

6. Future research

This study recommends that further research be done in the following areas:

- How a win-win situation can be established between mining companies and the government
- A framework for conducting Corporate Social Responsibility in the mining sector.

REFERENCES

First Quantum Mineral (2013) *FQM Social Investment Report (2013). Kansanshi: FQM*

Arnaut and Clunies Ross (1975), *Uncertainty, Risk Aversion and the Taxing of Natural Resource Projects. Economic Journal, Vol.85, No. 338.*

Government of the Republic of Zambia (2009). *National Report on Privatization*. Lusaka: Ministry of Commerce, Trade and Industry.

International Council on Mining and Metals (2014) *Enhancing Mining's Contribution to the*

Zambian Economy and Society. Company Data from the Four Major Mining Firms. Kitwe: Zambia Chamber of Mines

Kasanga, J (2012), *Leveraging Zambia's Industrialization with growth of Copper mining investments: Strategy for expanding local manufacturing capacities to supply the Zambian mining industry. Zambian Mining Local Content Initiative discussion paper.*Keen, M and Mansour, M (2010), *"Revenue Mobilisation in Sub-Saharan Africa— Challenges from Globalisation II – Corporate Taxation,"* Development Policy Review, Vol. 28 (September), pp. 573–96.

Konkola Copper Mines (KCM) (2013). *Corporate Profile*. Chingola: KCM.

Lumwana Copper Mine (2014). *2014 Corporate Profile*. Lumwana: LCM

Manley, D (2013), *A Guide to Mining Taxation in Zambia. Lusaka Institute for Policy Analysis and Research in Zambia.*

Mayondi, *W (2013), Mining and Corporate Social Responsibility in Zambia: A case Study of Barrick Gold Mine. Master's thesis, Victoria University of Wellington.*

Mondoloka, L. M (2013), *Taxation of Mine in Zambia- The Public Perception*. Working Paper Prepared for Civil Society for Poverty Reduction. Lusaka: CSPR.

Mopane Copper Mine (2015). *Corporate Profile*. Kitwe: Mopane Copper Mine

Otto, J (2000), *Mining Taxation in Chile and the Region: A comparative Analysis. UNCTAD*

Oxford Policy Management (OPM, 2014). *Earths Systems Lao, National Economic Institute and National University of Laos, Lao PDR Country Case Study for the International Council on Mining and Metals (ICMM) Report.* Oxford: Oxford University Press.

Zambia Development Agency (2008). *Report on Employment in Zambia's Economic Sectors*. Lusaka: Zambian Development Agency.

The Finnish Sustainable Development of Water and Sanitation; A Case Study Insights for the Lusaka Water and Sanitation System of Zambia

(International Journal of Advanced Research and Publication, ISSN: 2456-9992, April, 2019)

Brian Chanda Chiluba

The University of Zambia, School of Health Sciences,
PO Box 50110, Zambia, PH- +260977896377
brian.chiluba@unza.zm

Abstract: Water and sanitation situation is worse for the cities within the developing countries like Lusaka city of Zambia. currently, more than 2 billion people have been estimated to be living at a reduced access to freshwater resources and by 2050, at least one in four people is likely to live in a country affected that lack proper supply of water and sanitation services. Fortunately, progress has been scored in some countries of the developed world like Finland, whereby n developed communities over 90% of the world‟s population now has access to improved sources of drinking water. This is therefore good platform for insight for the cities of the developing world. According to the sustainable development goal number 6 of water and sanitation, the accessibility of clean water and good sanitation services for every community is an important human endeavor. However, this is not so and it is because of an array of many reasons coupled with bad economics or poor infrastructure, a lot of communities do not have access to adequate water supply and sanitation services. This study set out to understand the Finish sustainable development of water and sanitation system and what insights Lusaka can learn from such undertaking. This review assessed management approaches employed in water supply and sanitation service provision in selected parts of Lusaka, Zambia, following the 1994 Water Sector Reforms in Zambia. One of the successful sustainable development ideas of Lusaka is that of the faecal sludge system which has been presented in this paper to show some strides that Lusaka has scored in this area. In the Lusaka sanitation case study, the purpose of the review is to try to contribute towards measures meant to address the sanitation service delivery model for urban and peri-urban areas of Lusaka. In conclusion to improve sanitation and access to drinking water, there is need to increase investment in management of freshwater ecosystems and sanitation facilities on a local level in Zambia and other several developing countries within Sub-Saharan Africa.

Keywords: faecal sludge system, sanitation, sustainable development, water system.

1. Introduction

In order to have a sustainable city, it cannot go without mentioning that water and sanitation are crucial components requiring sustainable approaches. The global primary needs for water have always determined the location, size and form of our cities, just as water shapes the character and outlook of their citizens, hence the sustainable development goal number six of water and sanitation. The health outcomes due to unclean water and sanitation, sustainability experts have appreciated the potential linkages of water with health and the need for sustainable approaches. Undeniably, the contemporary field of public health should be indebted to the sanitary engineers who endeavor to provide clean water and safe disposal of human wastes in escalating cities of industrialization [1, 2] Most of the developing countries water and sanitation systems face infrastructural and resource deficits, this often leads to cities having limited access to safe drinking water and the access to good sanitation services are also often fragmented in most per urban communities. In sub-Saharan Africa, for example, 38 % of people do not have access to safe drinking water and 26 % practice open defecation. A lack of access to water is even more prevalent among the 800 million slum dwellers worldwide [3] It has been established that Improving sanitation is ideologically installing technological systems, but also about changing the general sanitation practices of communities within any given society. Many communities fail to aspire for appropriate global sanitation because to achieve that it requires application of appropriate sustainable development ideas that support organizational structures, and carrying out awareness programs to provoke a sustained behavior change of communities [4]. It should be noted however that it is very difficult once the bad behavior practices of sanitation are inherent among communities to foster change of motivating individual and organizational change on a more general level [5, 6]. This study set out to understand the Finish sustainable development of water and sanitation system and what insights Lusaka can learn from such undertaking. This review assessed management approaches employed in water supply and sanitation service provision in selected parts of Lusaka, Zambia, following the 1994 Water Sector Reforms in Zambia.

2. Methodology

The Takala [8] paper was chosen as the main paper that highlights the current practice in Finish on water and sanitation in order to categorically settle Takala study the process was consisted of three stages.

This search was carried out in the SciVerse Scopus bibliographic database, the largest abstract and citation database of recent peer-reviewed literature (Elsevier, n.d.). The keywords chosen aimed to capture literature related to water and sanitation in Finland. For this

purpose, keywords were searched in pairs: water, sanitation, or Finland were matched, no date restriction was added but the purpose was to at least arrive at the most comprehensive paper for the last 5 years. This exercise yielded 312 articles.

Abstract review to select relevant papers.

The abstracts of the 312 papers were reviewed in order to identify the works dealing specifically with water and sanitation of Finland. The other articles that were excluded were removed because of recurring themes. Through this process, 8 articles were identified as falling within the scope of the review.

Thematic grouping of selected papers and content review.

The 18 selected articles were then divided into groupings by topic for content review by the author. Articles spanning several topics were grouped according to what was judged to be the primary perspective presented in their content. This lady to the inclusion of the tankala paper as the best representation of water and sanitation systems of Finland.

3. Results and Discussion

A study by Galli et al., [9]. This paper establishes that sustainable development means staying within global boundaries while simultaneously ensuring adequate resources for all [10]. The most applicable paper to discuss the Zambia water and sanitation systems is a realistic paper by Takala [8] "Understanding sustainable development in Finish water supply and sanitation services", this paper has echoed that in order to provide clean and safe water as well as sanitation services there is need to employ sustainable development ideas. Because the services of water and sanitation are at the heart of sustainable development and this is because in order to provide these services there is need to ensure stable environment [11], Takala defines sustainable development as the advancement of human well-being within the planetary boundaries, now considering this definition it covers and captures well all the definitions of sustainable development that have been reviewed in this paper, this is so because social, environment, economic and work conditions of workers, are all well captured in this definition. Human beings survives on the balance of all these tenets. Further, the author discusses her topic of water enshrining it on the sustainable development goals and focusing on goal number 6 which addressed water and sanitation. From the article it is well argued that there are many challenges for many developing countries as there is a challenge is attaining clean and safe water and sanitation for the populations and that about 663 million people lack access to clean water and 2.4 billion to improved sanitation [12]. The argument to be raised in this paper is whether it remains relevant to discuss sustainable development for counties that have already attained these services like Finland, it will be detrimental to bring sustainable development to this level of understanding as strategies in sustainable development are ongoing requiring monitoring and evaluation to ensure a continuous provision of these services without undue interruption. This argument can be supported because countries with improved services of water and sanitation also continue to experience many challenges that endanger the continuous provision of these services [13]. The bigger part of water is that it is not only important for humans but also for the environment and the way we use water may consequently lead to disturbances of

how we need to take care of our environments. The rationale in this paper is that sustainable development ultimate goal is to target environmental challenges and social systems, because these are complex and ever changing, this can be advance by the idea that sustainable development is socially constructed phenomenon. Also it must be understood that sustainable development cannot be defined in absolute terms and this is why in this paper there is not obvious reliance on one single definition of sustainable development. This is because sustainable development changes with dynamics of time and approaches used depends on the prevailing situation [14].

This paper finds that those that manage waters systems seem not to understand what need to be done in water resources area. There is need to embrace sustainability if water issues are to be addressed. Foremost mangers of water need to understand population growth and dynamics of climate change and as well as the ever increasing demand for water as a results of the industrial revolution activities such as agriculture and mining. There is also need to embrace the role of other stakeholders to foster inclusion and participation in establishing approaches or management of water and sanitation services that are more sustainable and progressive [15]. There is no need to use a top down approach if the problem of water is to be addressed and that's why community participation is very crucial in this undertaking.

Funding for sustainable development ideas

Because of the gaps in the preceding article and failure to establish the ideologies that prompted realization of science as the major driver of sustainable development, the following article, "Bridging funding gaps for climate and sustainable development: Pitfalls, progress and potential of private finance" by Clarka, Reeda and Sunderlan [16]. This article seeks to address the importance of funding regarding sustainable development ideas such water and sanitation. What is evident from this study is that it is increasing becoming financially burdensome to invest money in environmental issues as these issues increasingly becoming enormous and needing much more financial investment to handle. there is some strides that has been scored especially after the Paris agreement, and it appears that some funds have been secured and what remain is on how to unlock these funds. From the article it has been inherently established that in order to bridge the gap between the financial investment required and the current obtaining investment that has been reserved, there is need for a private finance to show course by fulfilling some of the sustainable development agendas that has been advanced. However, throughout the literature review it has been established categorically what sort of sustainable development commitments the private finance sector need to fulfil, this paper falls short on that score. Reviewing how private finance should go about fulfilling its commitment could be very helpful for such institutions if such commitments are to be met with the required time. The failure to present such commitments could be attributed to the methodological limitations in what papers were reviewed for the focus and the focus was simply to discuss gaps and not present the needs of public finance sector. The other issue would be the issue of using snowballing to get the data, documents may miss out on certain information if those that are choosing the next set of documents seem to be aligned with a certain type of information as is the case in snowball sampling. According to this paper to leverage Sustainable development certain approaches need to be enforced such

as an approach of "finance mechanisms for sustainable development efforts". The paper also fails to define what sustainable development is and the aspect the author seems to be addressing in light with sustainable development.

Conceptualizing sustainable ideas for community

"Incorporating Sustainability/Sustainable Development Concepts in Teaching Industrial Systems Design courses", the paper highlights how sustainable development will be a key issues among people being trained engineers and hence the inclusion of sustainability in school curricula. This paper defines sustainable development as "development of industrial systems design project focusing on economic, social and environmental dimensions/pillars ", it makes good observation that the concept of sustainable development should be embedded in curricula of those who aspire to design engineering systems so that from the onset the importance of sustainability is appreciated and well advocated for in engineering designs [17]. From the foregoing articles the water and sanitation cases study is discussed in line with this review. The case study is centred on issues of water and sanitation because the two can only be discussed in tandem in order understand the complexity of the other. The case study does not however depict the all of Lusaka but just picked on Peri-urban areas of Lusaka and using Mtendere as a proxy to underpin the water part of the case study, while Kanyama compound to depict the sanitation side of the case study. In the Lusaka sanitation case study, the consideration is to try to address the sanitation service delivery model for urban and peri-urban areas of Lusaka. This case study has been advanced because it tries to show how service adapted to the local conditions, can deliver sanitation services. The other part the case study highlights the fact that there are other many details other than the technical systems if one has to discuss sanitation service delivery. Therefore this case study is cognisant of the financial revenue model as well as sanitation technologies and the focus of the case study is on the faecal sludge management. All these problems presented are as a results of how formerly illegal way of doing things was allowed, however the case study also discusses the formalisation of such illegalities to curtail on the presented problem. It is imperative in this case study to establish a few facts about Lusaka in terms of just population dynamics. Lusaka is a capital city of Zambia and it has an estimated population of about 2.3 million people. Important to note that out of this 60% to 70% live in Peri-urban areas of Lusaka and that 90% use on site sanitation [18]. The high income part of Lusaka seems to have been well planned and most of the high income areas use on site sanitation but by using septic tanks. The issue is that the residents of the low income areas of Lusaka cannot afford to use septic tanks and even those that could afford cannot access the service and this is due to that it is practically impossible because of a lack of access roads to these areas. All these have been compounded by a lack of a well-planned settlement. Based on the premise alluded it should be known that there are no adapted sanitation services that exists for the most of the peri-urban areas of Lusaka. The problem of sanitation is even made worse because most of the peri-urban areas are very densely populated with most of the residents using shallow and elevated pit latrines.

Alternatives of the case

Because of these an initiative called the Faecal Sludge Management Model was developed and funded by the Bill and Melinda Gates foundation in collaboration with Lusaka Water and Sewerage Company. Other partners were also consulted to foster the progress of the initiative. It must be emphasised that there was a lot community engagement right from the start of the project for community acceptability to be built and for the purpose of sustainability. The community was also involved in the planning process of the project. In order for the faecal sludge model initiative to be sustainable it required a business model and therefore the initiative also developed a business model to sustain the operations of the faecal sludge initiative. The funds generated form the model went to help in funding the initiative. Since the target population are from low income areas tariffs are adapted to suit the local financial conditions. A preference was made in terms of what communities could afford, so different services were categorised and each with its own tariff to make a viable project for the underprivileged. The key issue as it can be note was the financial sustainability of the service is a key priority of the initiative. Therefore, the business model was much more than revenue collected from the service provisions. The sludge that was collected from the latrines are treated and fertiliser is made from that which is later on sold for income generations. And the gas extracted from the sludge was used as energy for different purposes. The initiative has scored some success since its inception in 2013. From the time it was realised the sludge management initiative emptied 900 pit latrines in 2 years and most community people expressed pleasure in this initiative. It is therefore concluded based on that the faecal sludge model initiative is responding to the needs of the community. At the same time there are some challenges that have been reported and most of the challenges centred on financial challenges faced. Fromm the financial point of view it is therefore recommended that the faecal sludge initiative be extended to other low income communities. Community people have also advised on the need to scale up the initiative to other communities if more funds have to be realised. This case study is very much in line with the Finish study on water and sanitation services and in line with the UN- General assembly on sustainable development with reference to the sixth goal on clean water and sanitation, it appears meeting this goal is quiet difficult especially in the developing world, were there a lot illegal settlement and most of the people that live in such communities seem to have a high levels of illiteracy and compounding on the problem further. Therefore, there is need for consented efforts from multiple stake holders to come to the table in addressing this growing concern. There has been efforts or attempts that have been made to address this issue though, but it appears there has been little progress scored in this regard. According to Takala [8] this could because of applying mechanic and reductionist principles when addressing these issues of sanitation and from the study the indicated that the better approach to employ is to be able to appreciate the ideas of systemic, holistic and a more plural and contextual approach. On the part of water in the case study a study done will be of help to establish water as a case of some selected parts of the peri-urban of Lusaka. In Zambia a study conducted in Mtendere on the quality of drinking water in basic schools showed that 3 out of the 4 schools had access to contaminated water containing 10 to 100 faecal coliform per 100 milliliters [19]. Another study of effects on siting of boreholes and septic tank on ground water quality in Saint Bonaventure Township in Lusaka also showed that 33% of the boreholes were contaminated with microbe"s indicative of pathogens [20]. Equally, a study in Luapula on community water supply and self-supply models for sustainable water supply indicated that 50% water

samplefrom hand dug wells were unsatisfactory containing from 30FC to more than 100FC per 100 milliliters [21]. In the same study, found that the risk of borehole contamination was less than that of hand dug wells and scope holes. Another study in Mutendere 70% of the water stored for drinking was contaminated by WHO standards. Equally 30% of the water sources for participants in this study were not meeting the WHO standards. It shows that water quality deteriorated to 70% from the initial 30% water contamination at sources of water. This implies that 40% of the sampled water was re-contaminated at home as a result of poor handling during transportation, storage and use. This translates to an increase of water contamination from the water source to stored water at household by 133% [21]. The findings agree with a study that showed that safe storage of water was an important practice for prevention of recontamination from poor handling [22]. In the crude analysis more child diarrhoea cases was reported by households that had poor water results as shown in table 5.2. Only 70% of the water sources passed the WHO standard for microbiological quality. The water quality results of water sources in Mutendere are similar to findings by Banda and others who recorded that 32.5% of water sources in Bonaventure, Lusaka were contaminated [20]. to support the dimensions of these case, a study in South Africa showed that storage of water at household level was susceptible to contamination when the source of water was far from the household [23] It can be seen how common such problems are similar for most developing worlds. Problems to do with water presents with multiple problems ranging from dangerous disease outbreaks in most cases ending in death and this has been the recent picture of Lusaka in the near past, where a cholera outbreak afflicted many communities of Lusaka and posing a very bigger threat to the livelihood of the community. Recurrent clustering of water related diseases in peri-urban settlement of Lusaka has prompted curiosity and investigation into their determinants. Cholera cases have been reported in areas with peaks observed during rainy seasons. To support this cause, WHO indicates that access to safe water is a foundation for prevention and control of diarrhoea [24]. Even though, Zambia has recorded some improvements in the coverage of water, it appears when it comes to water quality there is a compromise due to erratic water supply, poor handling of water during transportation, storage and use. Integrated management of water resources for domestic supply assures household level water safety through continuous flow of water, which is accessible, affordable, and utilised. Due to short supply of safe water, it has been observed that there are varied alternative water sources for domestic use. Handling and storage of otherwise safe water may predispose it to contamination. In the past during the ear of the Millennium of the development goals various strides were made regarding water and sanitation. This was before the formulation of the sustainable development goals. The WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation used monitor progress towards the Millennium Development Goal target to halve, by 2015. At the end of the millennium development goals significant strides were made and most importantly is that number of people without sustainable access to safe drinking water and basic sanitation was significantly reduced.

3.1 Proposed Solutions

Integrated water resources management process brings about pooled approach to scarce resources for constant flow of adequate safe water for families to meet basic water requirements at an affordable cost.

The core functions of water as a resource for the well an individual should include, water being treated as an economic, social, health and environmental good:

1. Management of water should be harnessed as a comprehensive process and not just on the provision of water, but ensure that water is safe and available at all times.
2. The government should support and enable the sustainable water supply through the provision of integrated water policy and regulatory frameworks.

3. Communities should be recognised as central to the provision, management and safeguarding of safe water supply.

Research has shown evidence that people who spend more than half an hour per round trip progressively collect less water, this leads to them failing to meet their families" minimum daily drinking water needs [25]. In such cases the quantity of water collected is often less than 5 litres per person per day which is not sufficient for good hygiene practices such as hand washing (Howard & Bartram, 2003). UNICEF and WHO outlines aspects of drinking water, equity, safety and sustainability. This project proposal will underscore the necessity of basic drinking water systems as the provision of drinking water as it relates to technologies of water supply [12]. Fewtrell et al., examined journal articles with results that generally agree with those from previous reviews, that water quality interventions (point-of-use water treatment) were found to be more effective than previously thought, and multiple interventions (consisting of combined water, sanitation, and hygiene measures) were not more effective than interventions with a single focus. However, there is some evidence of publication bias in the findings from the hygiene and water treatment interventions [12]. The quality of water for drinking is an important factor that determines health of the environment, Therefore the safety of water is crucial for the prevention of many diseases including water borne [24]. People exposed to unsafe water worldwide is estimated at 1.1 billion globally. Poor water quality compromises the benefits of high water quantity coverage. "It is estimated that 10% of improved sources may be high risk, containing more than 100 E. coli or total coliform per 100ml and that drinking water is found to be more often contaminated in rural areas (41%) than in urban areas (12%) " [27]. Communities without access to safe water may opt to draw water from unsafe sources such as shallow well, rivers and scoop holes [28]. These sources may fail to meet the standard for water quality of zero faecal coliform in 100 milliliters [24].

3.2 Recommendation

Many strategies should be considered to address critical issues of water and sanitation for per urban communities if we have to prevent disease occurrence for such communities. However, these strategies maybe it is imperative a wider spectrum of stake holders are part and parcel of such strategies. In any case at the center of this is actually community engagement right from the beginning so that the levels of acceptability for such strategies are high in communities were they will be applied. One of the successful strategies is the one that has been advanced by UNICEF, the strategy called WASH and simply meaning

water, sanitation and hygiene. The all idea of this approach is that we want populations not only survive, but also to thrive. This is an important undertaking for under privileged communities and for most of the developing world if the issue of water and sanitation has to be addressed. The concept of WASH is very cardinal and very applicable if we have to consider the prevention of disease outbreaks, but it is also important in in education of such communities if the initiatives have to be sustainable. Using the WASH strategy much has been achieved especially in the past 25 years as an important achievement as far as the Millennium Development Goals were concerned, but in line with the sustainable development goals, this is even the focus of attention and from the initial measures it appears that things are getting better as many populations and communities of the developing world have at least access to water and sanitation, and hygiene practices seem to have be improving as well for many of the communities.

3.3 Conclusion

The importance of water and sanitation as a service to communities cannot be over emphasized. While some countries have made huge strides in meeting the needs of their people with regard to water and sanitation, especially the developed world. It appears that there is much to be done for the developing world. The author emphasizes that any sustainability approach has water at the heart, because water is not only important for people it is also important for the environment and more or so for the many operations within the human activities. Finish government perform well in this undertaking as presented by the reviewed paper and Zambia has much to learn from the Finish ideas on water and sanitation. The emphasis is on those who manage water systems and what they need to be focusing on. whichever approach to manage water systems, managers need to understand that populations keep on growing, also the activities requiring water are increasing in number in different sectors of the economy.

3.4 Statement of Competing interest

This paper has not been published elsewhere, and the author take responsibility and severally over the information provided therein. The author has no competing interests

References

1. .D. Koutsoyiannis, N. Zarkadoulas, A. Angelakis, G.Tchobanoglous, “Urban Water Management in Ancient Greece” Legacies and Lessons. J Water Resour Plan Manag. 2008; 134:45–54. doi: 10.1061/(ASCE)0733-9496pp.134:1(45) 2008.
2. .M. Melosi, ”The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present”.Baltimore: The Johns Hopkins University Press; 1999.
3. United Nations. “The Millennium Development Goals Report 2013”. New York (NY, USA): United Nations; 2013.
4. .UN-HABITAT. “State of the World‟s Cities 2012/2013 “- Prosperity of Cities. New York (NY, USA): Routledge; 2013
5. Howard, G. & Bartram, J., 2003. Domestic water quantity, service level, and health, World Health Organization Geneva.
6. WHO, 2014. Water Sanitation and Drinking Water Quality.
7. .P. Mondal, A. Nandan, N.A. Siddiqui and B.Siddiqui, B.P. Yadah, “Impact of Soak Pit on Groundwater Table”, Environmental E Pollution P Control C Journal J, 18(1), 2014, 67-69.
8. .A. Takala, “Understanding sustainable development in Finnish water supply and sanitation services”;International journal of sustainable built environment; 6, pp. 501-512, 2017.
9. .A. Gallia, G. Đurović, L. Hanscomc, L. Knežević, “Think globally, act locally: Implementing the sustainable development goals in MontenegroAlessandro”; Env. Sci & Poli 84, pp.159 – 169, 2018
10. .D.W. O‟Neill, A.L. Fanning, W.L. Lamb WL, & J.K. Steinberger, “A good life for all within planetary boundaries”; Nature Sustainability 1, pp. 88–95, 2018.
11. .W. Steffen, K. Richardson, J. Rocktrom, S.E. Conrnell, I. Fetzer, E.M. Bennet, R. Biggs, S.R.Carpenter, W. de Veris, C.A. de Wit, “Planetary boundaries: Guiding human development on a changing planet”. Science; 347,1259855 1259855 10,1126/science.1259855, 2015.
12. .UNICEF, WHO, “Progress on sanitation and drinking water-2015 update and MDG assessment” http://www.wssinfo.org/fileadmin/user_upload/reso_urces/JPM-update-report-2015_English.pdf
13. .J.J. Bos, R.R. Brown, “Realizing sustainable urban water management: can social theory help?” Water sci. Technol; 67 (1), pp.109-116, 2013.
14. A.M. Maldonald, “Rethinking sustainability in the Anthropocene”. Environ. Polit. 22 (3), pp. 428-446, 2013.

15. A.W. Solomon, M. Zondervan, H. Kuper, J.C. Buchan, D. Mabey, A. Foster, “Trachoma control: a guide for programme managers”. Geneva: World Health Organization; 2006

16. R. Clarka, J. Reeda, T. Sunderlanda, “Bridging funding gaps for climate and sustainable development: Pitfalls, progress and potential of private finance”, land use policy; 71, 335-3346, 2018.

17. H.G.Ibrahim,” Incorporating Sustainability /Sustainable Development Concepts in Teaching Industrial Systems Design courses” ; Procedia Manufacturing; 8, pp. 417 – 423, 2017.

18. L.J. Banda, A.R. Mbewe, H.S. Nzala, H. Halwindi, “Effect of Siting Boreholes and Septic Tanks on Groundwater Quality in St. Bonaventure Township of Lusaka District, Zambia”. International Journal of Environmental Science and Toxicology Research (ISSN: 2408-7262) Vol. 2(9) pp. 191-198, 2014.

19. „CromptonDWT(Ed). Accelerating work to overcome the global impact of neglected tropical diseases: A road map for implementation. Geneva, Switzerland: World Health Organization; 2012.

20. M.L.J. Banda, M.A.R. Mbewe, S.H. Nzala, & H.Halwindi, “Effect of Siting Boreholes and Septic Tanks on Groundwater Quality in St. Bonaventure

21. K. Kumamaru, “A comparative assessment of communal water supply and self supply models for sustainable rural water supplies: a case study of Luapula, Zambia” © Koji Kumamaru.

22. J. Brown, S. Cairncross, & J.H. Ensink, “Water, sanitation, hygiene and enteric infections in children” Archives of disease in childhood; 98**,** pp. 629-634, 2013.

23. WHO, 1995. Global strategy on occupational health for all: the way to health and work, Geneeva

24. WHO, Global strategy on occupational health for all: the way to health at work, 1994. Recommendations on the second meeting of the WHO collaborating centers in occupational health, Beijing, China.

25. S. Cairncross, C. Hunt, S. Boisson, K. Bostoen, V. Curtis, I.C.H. Fung, & W.P. Schmidt, “Water, Sanitation and Hygiene for The Prevention Of Diarrhoea”. International Journal of Epidemiology; 39**,** pp.i193-i205, 2010.

26. L. Fewtrell, R.B. Kaufmann, D. Kay, W. Enanoria, L. Haller, J.M. Colford, “Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis”; Lancet Infect Dis. Jan;5(1):pp. 42-52, 2005.

27. R. E. Bain, S,W. Gundry, J,A. Wright, H. Yang, S. Pedley, & J.K. Bartram, “Accounting for water quality in monitoring access to safe drinking-water as part of the Millennium Development Goals: lessons from five countries”. Bulletin of the World Health Organization; 90**,** 228-235, 2012.

28. N. Nala, P. Jagals, T. Bokako, & B. Genthe, “An assessment of the link between stored water quality and the occurrence of diarrhoea in an urban

BOOK CHAPTERS

Potential Industrial Symbiosis between the Mining Cement Industries in Zambia

(Published in "Sustainable Development in Africa, Case Studies, 2019, ISBN 1942876416, 9781942876410)

Evans Musonda
University of Zambia, School of Mines, Department of Metallurgy and Mineral Processing
Email:evans.musonda17@gmail.com

Introduction

The mining and cement industries by nature are highly destructive to the environment. The extraction of ores and minerals from the Earth requires large excavations that highly degrade the land apart from causing resettlements of communities. The overburden disposed near mines site cause, not only further degradation of the land but are an eye-sore and in some cases cause dust pollution in the atmosphere. Heavy mobile equipment is used to excavate and haul huge volumes of run-off-mine, waste rock and overburden from the open pits and shafts to the processing plants or waste dumps. The machinery pollutes the environment with Green House Gases (GHG) due to the use of fossil fuels, noise and fugitive dust. Maintenance of this machinery requires disposal of colossal amounts of used oil and tyres among other wastes. Waste rock and overburden requires a significant acreage of land causing ecosystems degradation. At the mineral processing stage, more waste is generated including slags and tailings which are a challenge to dispose and effluents in river systems affecting aquatic life. Some of these materials are hazardous and sometimes contain heavy metals which endanger surface and underground water systems. Mining companies find it a big challenge to dispose these materials within the stipulated environmental regulations.

Though destructive to the environment, mining is important to every aspects of life. In all economies, the mining sector forms a basis for economic development in other sectors. One cannot talk about agriculture without mining as almost all farming implements including ploughs, irrigation pipes, water pumps, granaries, tractors, combine harvester and many other equipment is made from metals and minerals which are obtained by mining. One cannot talk about hospitals without mentioning surgical equipment which is made of metal, from mining. Road infrastructure, buildings, dams, airport facilities, schools and hospitals, sports facilities are all made from building materials which are manufactured from mined raw materials. For economic growth, mining is inevitable. The question now is: how can mining be done

sustainably?, that is; how can we obtain minerals and metals which are inevitable to achieving the needed economic growth to alleviate poverty, while eliminating environmental impacts and supporting local communities so that there is no marginalization of the voiceless.

As developing and emerging economies seek development, there is also an urgent need to decouple economic growth from resource depletion and environmental degradation. We now live in an era where many organizations have put a lot of effort in upping their performance level in the three sustainability aspects, namely: ecology, social and economic. Ever since the development of the concept and coining of the definition of 'sustainability' by Brundtland (1987) in their report to the United Nations World Commission on Environment and Development (WCED), titled *Our Common Future*, as the "development that meets the needs of the present generation without compromising the ability of future generations in meeting their needs", socio-economic and environmental performance has been of paramount importance for all business organizations (ten Pierick, Beekman, van der Weele, Meeusen, & de Graaff, 2004). The 2016 United Nations Global Compact-Accenture Strategy CEO study results suggest that "business leaders are committed to driving forward this universal ambition, forging a stronger global environment for doing business in the foothills of the fourth industrial revolution. The majority of CEOs surveyed (87 per cent) believe the SDGs provide an opportunity to rethink approaches to sustainable value creation—and 78 per cent already see opportunities to contribute through core business" (https://www.accenture.com).

This paper suggests industrial symbiosis (an application of industrial ecology) between the mining industry and the cement industry in order to achieve sustainability. The cement industry is a destination for most of the mine and metallurgical waste. In this paper the building materials industry refers to the cement, aggregates and concrete production. Cement manufacturing plants do not have a waste stream by design as all feed materials end up in a bag of cement. Co-processing in the cement industry is therefore an optimum way of recovering energy and material from waste thus offering a safe and sound solution for waste disposal (**Cembureau**, 2009). The treatment of municipal, commercial and some industrial waste reduce the need for landfilling or organic and recyclable waste. Substitution of mine waste in the cement industry is an example of industrial symbiosis, an application of industrial ecology, which results in overall eco-efficiency. Waste used in place of primary resources helps to slow down resource depletion thereby decoupling from non-renewable resource depletion and environmental impact from economic growth (well-being of society).

1.2. Introduction to Industrial Ecology

The idea of *Industrial Ecology* has been evolving in the environmental and scientific world for several decades now. The concept was first presented to the National Academy of Sciences in the United States of America in 1989 as a new paradigm for environmental thinking on industrial environmental behaviour (Ausubel & Sladovich, 1991). Engineers, academics and environmentalists were concerned with the problem of waste, the value of materials and the control of pollution. Inspired by the work of Robert Ayres (1997) in his paper "Industrial Metabolism", two of the earliest proponents of Industrial Ecology, Frosch and Gallopoulos (1989) came up with the term "Industrial Ecosystems", thinking of industry as "heavily analogous to the behaviour of the natural world with regards to the use of materials and energy" (Frosch, 1992).

Industrial Ecology is based on the straightforward analogy of the natural ecological systems where organism are interconnected in a web such that nothing that contains available energy or useful material is lost (Frosch, 1992). In nature, organisms live and consume each other and each other's waste to balance the food web. In fact, some organisms will make their living solely by feeding on any waste product that provides available energy or usable material. In the industrial context, Frosch (1992) thought of an organisms being "the industrial processes or the set of processes that lead to a particular product or product family and of the ecology as being the network of all industrial processes as they may interact with each other and live off each other, not just in economic sense but also in the sense of direct use of each other's material and energy waste and products". Frosch and Gallopoulos (1989) explained that "the traditional model of industrial activity – in which individual manufacturing processes take in raw materials and generate products to be sold and waste to be disposed of – should be transformed into a more integrated model: an industrial ecosystem" (O'Rourke, Connelly, & Koshland, 1996).

The concept of Industrial Ecology has been recognised as an effective tool for achieving sustainability in the light of the Sustainable Development Goals (SDGs). Countries such as Denmark, France, Japan and the Republic of Korea, among many others have leveraged this concept to promote sustainable actions to improve industrial competitiveness in line with climate change goals (UNIDO, 2016). Eco-Industrial Parks (EIPs) have been developed in these countries with an overall aim to achieve resource efficiency and cleaner production. There are many definitions for EIPs. The widely accepted definition is the one given by Lowe (2001) as "a community of companies, located in a single region, that exchange or make use of each

other's by products or energy". The EIP in the small city of Kalundborg with about twenty thousand inhabitants in Denmark is considered as a model for industrial symbiosis. Four industries namely, a coal-fired power plant, an oil refinery, pharmaceuticals and enzyme maker, a plasterboard manufacturer as well as the municipal government formed a synergistic network in 1970, where they feed on each other's wastes to transform them into useful products (Desrochers, 2001).

1.3. Mining and the Building Materials Industry in Zambia

Mining is a global industry and often located in remote and less developed areas. If managed properly, it brings about improvement of standards of living (well-being) of people, bring investments in infrastructure and well managed Corporate Social Responsibility (CSR) initiatives improve the social status of communities around the mine sites (Sonesson, Davidson, & Sachs, 2016). The history of mining in Zambia spans over 90 years. In the 1960s, Zambia was the third largest copper producer in the world after the United States of America and the then the Soviet Union (ZDA, 2015). Zambia is currently the seventh largest producer of copper in the world (ZDA, 2015). By 2009, over 700,000 metric tonnes of copper was exported, projected to reach 1,500,000 metric tonnes in 2018.

Since privatization of the Zambian mines 17 years ago, over US$10 billion of Foreign Direct Investment has flowed into the mining sector which produces 80% of the country's exports and providing over 80,000 jobs. Mining is therefore a key driver in global economic growth as it is capable of creating long term impacts on lives, societies and nations (WEF, 2013).

Zambia's endowment in mineral resources is substantial and the mineral wealth includes metals, gemstones, industrial minerals, agricultural, building and energy materials (ZDA, 2015). Total population in Zambia was about 15 million in 2015.

Cement on the other hand is an essential commodity, providing society with what it needs in terms of safe and affordable housing and reliable modern infrastructure. The Zambian cement industry has an installed capacity of over 1,500,000 tonnes cement and about 5,000,000 tonnes aggregates, providing over 15,000 jobs.

Both the mining and building materials industries in Zambia have a huge challenge to control the impact of their operations on the environment.

1.4 Overview of Mining and Minerals Processing

To obtain the information of the location, type and quantity of the mineral deposit, exploration work is done. This may involve clearing large areas of land (vegetation) to give way to large vehicles carrying drill rigs and excavations to expose the rock, living the land degraded. If the exploration results show that the mineral can be mined and beneficiated economically, development of the mine proceeds with construction of access roads, clearing the site for the processing facilities and land for housing for personnel if the location is remotes. Ecosystems are disturbed by these activities.

Normally in open cast mining, the valuable mineral is buried under top soil called overburden that must be removed before mining can commence. The ratio of the quantity of overburden to the quantity of the mineral is called the stripping ratio. With underground mining, a minimal amount of overburden is removed to gain access to the valuable mineral. The minerals are then extracted from the Earth mainly by drilling and blasting. Drilling and blasting is the process of achieving fragmentation of "in-situ" minerals where drill holes are made in the rock, explosives charge and ignited. The mining activities are detrimental to the environment both during mining and after the mine have been closed. The high volume of overburden or material containing low value minerals are deposited on the surface causing land degradation and displacement of communities.

Run-off-Mine ore is hauled to mineral processing facilities where it is beneficiated. During the beneficiation process, the ore is crushed and ground down to a size where valuable minerals are unlocked from gangue material in readiness for separation or concentration. The valuable minerals are separated either chemically or physically producing a concentrate for further processing, and tailings which are disposed. The concentrates are further processed by heat treatment (smelting) or by leaching with an acid. The mineral content in the ore is quite little. It can be as low as one per cent or below, entailing that the tailings from these operations are huge and pose a challenge to dispose.

During the smelting process (which is called pyro-metallurgy), molten metal is produced and cast into sheets or billets for further processing while the resulting slag is disposed at the dump. During the leaching process (also known as Hydro-metallurgy), a solution containing the ions of the valuable metal is concentrated in the process called solvent extraction to produce a high

concentrated solution from which the metal is recovered into sheets (cathodes) by electrolysis (known as electro-winning).

1.5 Environmental Issues in Mining

As mentioned earlier, the main wastes generated during mining and mineral processing are over burden, slags and tailings. Waste oils and used tyres are also generated from the maintenance of mining machinery.

Overburden is deposited on the surface of the earth in large quantities covering a large area of land thereby causing land degradation. Sometimes the material is used to backfill areas in the open pit where the mineral has been depleted. Disposal is usually done close to the mine. Communities are displaced and resettled elsewhere to create space for disposal. In some cases, the overburden may contain toxic substances which may be blown by wind to further areas that degrade vegetation and soil quality.

Tailings dams and slag dams can have the same effect as the overburden dams but even more in that they can contain toxic substances that can be leached into the soil by rains causing the effects of Acid Mine Drainage. This can pollute underground water. Issues of water quality and quantity are among the most contentious issues on the impact of mining activities on the environment (ELAW, 2010). Dust blown from the dams is spread on vegetation causing land degradation.

1.6 Overview of the Cement and Concrete Manufacturing Process

The main ingredient in the manufacture of cement is clinker. Clinker is produced from raw materials of natural origin or industrial products and wastes such as limestone and clay (Duda, 1985). The materials are quarried by drilling and blasting, hauled to processing site for size reduction in crushers. The crushed and blended materials are milled in ball mills or vertical roller mills, then homogenised before feeding into the kiln where the ground material, known as raw meal at this stage, is burnt at a temperature of 1450 degrees Celsius to form a clinker which is an intermediate product. The clinker contains clinker minerals, namely; Tricalcium Silicate (or Alite) Bicalcium Silicate (Belite), Calcium Aluminate and Calcium Alumino Ferrite (Taylor, 1998). The Alite and the Belite form the main part of the clinker and are responsible for strength development in the cement. The fuel used for burning is mainly pulverized coal.

The next phase is the cement (or finish) grinding which involves the grinding of clinker with gypsum and other additional materials such as blast furnace slag, coal fly ash, natural pozzolana and limestone. Cement comes out as a final product stored in silos ready for dispatch.

Concrete is produced by mixing cement with aggregates, other suitable materials and water. When water is added to cement, it reacts with Belite and Alite to form a binder or gel that glues together the other main constituents of concrete.

1.7 Industrial Symbiosis between the Mines and Cement Plants

Hawken et al. (1997) argued that "reducing the wasteful throughput of materials – indeed, eliminating the very idea of waste – can be accomplished by redesigning industrial systems on biological lines that change the nature of industrial processes and materials, enabling the constant reuse of materials in continuous closed cycles, and often elimination of toxicity". This is also referred to as Biomimicry. Industrial Symbiosis falls under a new science in the world of sustainability called *Industrial Ecology*. Industrial ecology conceptualizes industry as a man-made ecosystem that operates in a similar way to natural ecosystems, where the waste or by product of one process is used as an input into another process. Industrial ecology interacts with natural ecosystems and attempts to move from a linear to cyclical or closed loop system. Like natural ecosystems, industrial ecology is in a continual state of flux. Industries are now using industrial ecology to reduce the use of natural resources and generate less waste. Waste streams from the mining industry can be feed in the building materials industry, thereby eliminating the need to dispose waste into the environment. This clearly reduces the use of primary materials as raw feed to the cement plants. Industrial Ecologists, often associated to Ecological Modernisers, analyse flows of materials and energy that connects business enterprise with the natural world in a continuous feedback loop operating roughly in three stages; (i) Natural materials are extracted from the Earth and converted to raw materials and energy, (ii) These raw materials and energy flows are then worked up into useable and saleable products, and finally (iii) the resulting products are distributed, consumed and used, and disposed of by consumers (Blewitt, 2008:48).

Industrial symbiosis, is defined as the synergistic exchange of material and energy between industrial organizations in a locality or region or even virtual community (Salmi, 2007). Industrial parks which are "zero-emissions" are created whose tenants will constitute an

industrial ecosystem in which one company will feed upon the nontoxic and useful waste of the other (Hawken et al., 1997). Industrial Symbiosis brings about Eco-efficiency which is defined as the ratio of inputs and waste outputs to final products (Korhonen, 2008).

The use of waste in the cement industry is known as Co-processing. Co-processing is the substitution in industrial process, or primary and raw materials with suitable waste (Cembureau, 2009). The decision of what type of material can be considered as useful waste that can be substituted as alternative fuel or alternative raw material in a cement plants depends on the added value contained in the waste, i.e., the calorific value and mineral value. The cement industry is therefore able to co-process materials such as used oil, used tyres, paper sludge, municipal sewage waste, municipal solid waste, contaminated soil, slag, etc.

However, not all waste materials can be co-processed in the cement industry due to their chemical composition that may alter the quality of cement or the toxic nature, such as nuclear waste or untreated municipal or animal waste, which would endanger the workforce in the process plant or the environment (Cembureau, 2009).

Co-processing in the cement plants also offers high potential to reduce global CO_2 emissions in that, without co-processing, the wastes and by-products which make up these materials would have to be incinerated or landfilled with corresponding greenhouse gases (CO_2 produce from biomass is climate neutral) (Cembureau, 2009).

Emissions from the cement kiln come from the physical and chemical reactions of the raw materials and from the combustion of fuels (Cembureau, 2009). The main constituents of the exit gases from the cement kiln are nitrogen from the combustion of air, CO_2 from calcination and combustion, water from the combustion process of the war materials, and excess oxygen (Cembureau, 2009). The exhaust gases also contain small quantities of dust (approximately 50 mg/Nm^3), chlorides, fluorides, sulphur dioxide, NOx, carbon monoxide, and still smaller amounts or organic compounds and heavy metals (Cembureau, 2009).

1.8 Integration

Mining activities have been in existence for ages. The hunter-garthers processed iron for weapons to hunt animals. During the agrarian era, iron tools were used for agriculture. During the industrial revolution, large mining operations begun to recover mineral for industries

including fossil fuels, steel, industrial minerals and building materials. All aspects of life today are supported by mining either directly or indirectly. However, mining activities are destructive to the environment as huge amounts of waste are generated.

The cement industry offers a safe and sound option to dispose some of the waste streams from the mining industry. Materials that have some significant calorific value can be used as alternative fuels in the cement industry. Materials that have minerals oxides required for the production of cement can be used as alternative raw materials.

Rock waste from mining operations, that has physical characteristics of aggregates, can be crushed and used in concrete and asphalt used for road construction. Globally, eco-efficiency can be gained. Less primary resources would be required to achieve the same economic growth in infrastructure. This is a perfect example of decoupling resource depletion and environmental impact from economic growth.

The cement industry is not the only able to take in waste from the mining industry but also from other industries such as biomass (rice husks, maize Stover, coffee husks, etc) from agriculture, animal meal from food processing, coal fly ash from thermal power plants, and solid waste and processed sewage pellets from the municipal.

The main wastes which are alternative fuels and alternative raw materials are normally not in the form that can be fed or injected into the cement kiln. They have to be pre-treated elsewhere before being transported to the cement industry. Private Public Partnerships (PPP) arrangements are usually key, and these provide opportunities for local suppliers and thus employment is created for women and the youth.

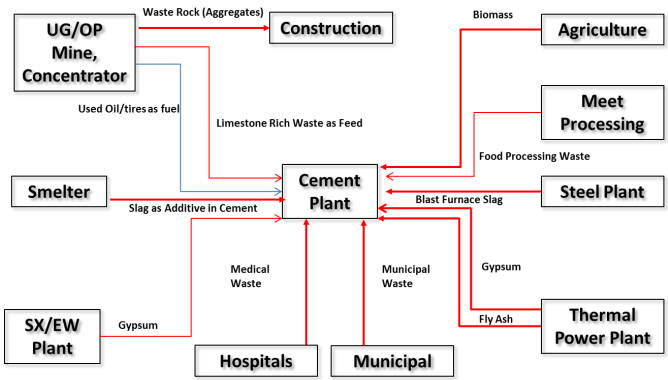


Fig. Industrial Symbiosis between the Mining and Building Materials Industry

1.9 Conclusion

For economic growth with nations, regions and the world at large, the mining industry is an essential player. For mono-economies countries like Zambia, mining is the only foreign exchange earner. The world need metals, minerals and building materials for growth. Mining industries provide huge revenue to the government through taxes, employment opportunities for many and support for schools and hospital. In some cases, mining houses sponsor sports thereby creating recreation opportunities co communities. Mining is inevitable for economic growth and therefore poverty reduction.

However, the mining operations have a heavy impact of the. Huge volumes of overburden are deposited on the earth surface casing land degradation. In some cases communities are displaced and resettled ease where to pave wave way for mine site development or disposal of materials. Emissions in the atmosphere, effluents in underground water and land degradation are issues that should be solved though as mining activities are being undertaken. Mining companies have a challenge of how and where to dispose most of the waste they generate. Some of this waste has high calorific vales and some contain the very minerals sought for in the raw materials into the cement plants.

It has been shown the mining industry and the building materials industry can live symbiotically in that waste from the mining industry containing fuel characteristics and mineral value can be used in the production of cement, aggregates and concrete. Primary energy and

material resources are therefore saved while economic growth is gained. The global result of industrial symbiosis is eco-efficiency, reduction in the consumption of primary resources and relatively smaller environmental footprint.

Reference list/ Bibliography

Ausubel, J. H., & Sladovich, H. E. (1991). Technology and Environment. *Environmental Progress*, *10*(1), F6–F6. https://doi.org/10.1002/ep.670100106

Ayres, R. U. (1997). *INDUSTRIAL METABOLISM : WORK IN PROGRESS* (No. 97/09/EPS). Fontainebleau, France. Retrieved from https://flora.insead.edu/fichiersti_wp/inseadwp1997/97-09.pdf%0A

Blewitt, J. (2008). *Understanding Sustainable Development*. London: Earthscan. Retrieved from www.earthscan.co.uk

Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development. *Medicine, Conflict and Survival*, *4*(1), 300. https://doi.org/10.1080/07488008808408783

Cembureau. (2009). Sustainable cement production. *Europe*, 1–16.

Desrochers, P. (2001). Eco-Industrial Parks. *The Independent Review*, *n.3*, 27. Retrieved from http://41.77.4.165:6510/www.independent.org/pdf/tir/tir_05_3_desrochers.pdf

Duda, W. H. (1985). *Cement Data Book - International Process Engineering in the Cement Industry* (3rd ed.). Berlin.

ELAW. (2010). Chapter 1: Overview of Mining and Its Impact. In *Guide for Evaluating Mining Projects EIAs* (1st ed., p. 122). Retrieved from https://www.elaw.org/files/mining-eia-guidebook/Chapter1.pdf

Frosch, R. A. (1992). Industrial ecology : A philosophical introduction, *89*(February), 800–803.

Frosch, R. A., & Gallopoulos, N. E. (1989). Strategies for Manufacturing 1, *189*(3), 1–7.

Hawken, P., Lovins, A., & Lovins, L. H. (1997). Natural Capitalism. *Ecology*, *148*(April), 1–5. https://doi.org/10.1126/science.167.3926.1673

Korhonen, J. (2008). Reconsidering the economics logic of ecological modernization. *Environment and Planning A*, *40*(6), 1331–1346. https://doi.org/10.1068/a38363

Lowe, E. A. (2001). *Eco-industrial Park Handbook for Asian Developing Countries*. Retrieved from http://41.77.4.165:6510/www.independent.org/pdf/tir/tir_05_3_desrochers.pdf

O'Rourke, D., Connelly, L., & Koshland, C. P. (1996). Industrial Ecology: A Critical Review. *International Journal of Environment and Pollution*, *6*(Nos. 2/3), 89–112. Retrieved from

citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.519.699&rep=rep1...pdf

Salmi, O. (2007). Eco-efficiency and industrial symbiosis e a counterfactual analysis of a mining community REPUBLIC OF, *15*. https://doi.org/10.1016/j.jclepro.2006.08.012

Sonesson, C., Davidson, G., & Sachs, L. (2016). Mapping Mining to the Sustainable Development Goals : A Preliminary Atlas, (January).

Taylor, H. F. W. (1998). Cement chemistry. *Cement and Concrete Composites*, *20*(4), 335. https://doi.org/10.1016/S0958-9465(98)00023-7

ten Pierick, E., Beekman, V., van der Weele, C. N., Meeusen, M. J. G., & de Graaff, R. P. M. (2004). *A framework for analysing corporate social performance - Beyond the Wood model*.

UNIDO. (2016). *Global Assessment of ECO-INDUSTRIAL PARKS in Developing and Emerging Countries*. Retrieved from https://www.unido.org/sites/default/files/2017-02/2016_Unido_Global_Assessment_of_Eco-Industrial_Parks_in_Developing_Countries-Global_RECP_programme_0.pdf

WEF, W. E. F. on L. A. (2013). Responsible Mineral Development Initiative, (April), 32.

ZDA. (2015). MINING: Sector Profile, (July), 1–17.

Sustainability of Community and Mine Workers' Health in a Mining Context: A Rapid Review of Sustainable Development and Livelihoods

(Published in "Concepts and Methodological Approaches, 2019, ISBN978-1-942876-45-8)

Brian Chanda Chiluba
University of Zambia, School of Mines, Department of Metallurgy and Mineral Processing
Email: babchiluba@yahoo.com

Introduction

The health of mining communities is becoming a priority for the mining industry, governments, and researchers. The mining sector has recognized the importance of health, and has made specific commitments to enhancing the health of associated communities and its workers within the industry. For instance, the International Council on Mining and Metals (ICMM) identifies in their sustainable development agenda that corporate members are committed to implement and measure their performance against ten principles These commitments recognize that ''beyond work related diseases, few endeavors attempt to prevent diseases that affect the wider community or to consider the community's broader well-being'' (Mining, 2002); and that ''Ensuring that improved health and education or economic activity will endure after mines close requires a level of planning that has too often not been achieved'' (Mining, 2002).

It is very obvious that considering the mining of mineral resources, there are many economic benefits of the mining sector, at the same time there are also implications that are associated with various environmental risks and socio-economic outcomes that apparently result in affecting the health of mine workers and communities in proximity to mining areas (Jenkins, 2004; Kemp, 2010); the health effects on communities are wide range and diverse such that they include social disruption and dislocation, relocation and resettlement, and adversely impacts on heritage and livelihoods (Danielson, 2006; Kemp, 2010; Owen & Kemp, 2015). Mining activities also lead to various geological and environmental problems that in the long run end up affecting the livelihood of communities especially in terms of the well-being of communities through water resources, geologic hazards and destruction of the ecological landscape (Zhiguo et al., 2011).

The World Health Organization (WHO) defines health as ‘‘a state of complete physical, mental and social well-being and not purely the presence or absence of disease’’ (World Health Organization, 1948) and ‘‘the extent to which an individual or a group is able, on the one hand, to realize aspirations and to satisfy needs, and on the other, to change or cope with the environment’’ (World Health Organization, 1986). There have been recently, publications regarding the health of communities, one of which is the first reference material produced by the mining sector and one of which describes health beyond the presence and absence of disease or environmental exposures, and includes other factors that impact health (International Council on Mining and Metals, 2010).

In order to understand the issues of workers capitals such as human, social, financial and natural capitals through the sustainable livelihood framework, it important to understand how these are linked to health. Some of the social determinants of health like income, social status, working conditions and environments are held up in a conext of the sustainable livelihood framework. This therefore makes the sustainable livelihood framework the alternative way of understanding the workers and community health withing the mining environment (Health Canada, 2004).

Consciousness of how important it is to invest in the protection of working people’s health, and the lack of binding legislation are additional hindrances. Most state authorities do not recognize occupational health as an important link in the healthcare system reform process, in spite of dramatic changes occurring in the area of work and severe consequences to workers’ health. They also ignore the fact that workplaces are places where workers spend most of their time compared to their homes. Most mining in the world have been linked to reports of environmental degradation, and have endangered the health of surrounding communities (Dirty Metals, 2004). The aim and scope of this chapter is to review and synthesize literature on the effects of mining on community health as well as the health of the people working in the mines.

Methodology

Methodologically, this study reviewed literature on community and worker’s health with respect to mining and legislation. The review was conducted in two phases. In the first phase, articles were retrieved online. Both peer-reviewed and technical publications were identified through searches in major databases of Web of Science, Scopus, Compendex, PubMed and Google Scholar. Search terms included: “sustainability(able) mining”, “mining community(ies)”, “occupational health”, “community acceptance”, and “environmental

degradation". Studies were included if they were relevant and published as full text articles and not just abstracts. The author screened search results for relevance by reviewing titles and abstracts. The review mostly focused on peer-reviewed journal publications since the intention was to rely on rigorous research in order to address the stated objectives. Some technical reports from reputable government agencies, non-governmental as well as industry groups were included in the list of references for review. Articles were limited to those that were published in English-language journals. During the second stage, titles and abstracts of articles were independently reviewed to assess eligibility for inclusion. If there was any uncertainty, the full text article was retrieved. Primary publications on mining-related health and environmental effect studies in the population living in mining areas were the subject of this review.

A historical review was incorporated for contextualizing the study in light of mining and the resulting community events. A historical review is necessary for understanding past events (Smith, 2015) because it "involves understanding, studying, and explaining past events." It is basically looking at the past events in order to explain the present circumstances and make a proposed solution for the future (Hudtohan, 2005; Gonzalez, Luz, & Tirol, 1984). All in all, the search was able to source up to 32 publications from different authors prior to the end of May 2018. The majority of the evidence reviewed in this report was obtained from studies undertaken in Africa and mostly sub-Sahara Africa.

Health Sustainability within Mining Communities

The Earth Summit held in Rio de Janeiro in 1992 consists of a broader definition of sustainable development, contained in the 27 principles of sustainable development document; concerning the future of the world, the document has elaborated that there are indispensable new ways to foster global sustainability. However, in this document is also the need for cooperation in the creation of a sustainable economy in the industry of acquiring mineral resources, and the creation of new technologies for their use, while at the same time taking care of the health of those who live near such industries. From the summit agenda, in order to implement sustainable development, there is need to integrate in the following areas; technical and economic activities ensuring economic growth and for ecological ensuring protection of natural resources, environmental and social. These summit tenets are therefore necessary for workers in the mining environment and for the community surrounding the mine. (Dubrńki, Turek, Wachowicz, 2007). According to Hendryx (2015), the data show that people in coal mining communities have a 70 percent increased risk for developing kidney disease, a 64 percent

increased risk for developing chronic obstructive pulmonary disease (COPD) such as emphysema and 30 percent more likely to report high blood pressure (hypertension) among many other health issues such as pneumoconiosis, silicosis and TB. Most of the reviewed research showed that exposure to mine dust or living close to a mine is a risk factor for asthma as well. Most of the papers attribute this to the fact that inhaled dust particles can potentially harm the respiratory system. The most at risk among communities are actually women and children, most papers established that children living in communities close to mine dumps were more inclined to show symptoms of asthma (Herrera et al., 2016).

Health impacts both for miners and for the communities living around them, are amongst the most important issues for local communities who rely on mining. Even when a mine is gone/over, the men and women who have worked in the mine may continue to experience health impacts for many years, if not generations (Schwarze et al., 2006; Huertas, 2012). Some mined substances such as uranium will continue to create health impacts for miners up to 30 years after the miner has left the mine. It is likely that many impacts related to some of the more carcinogenic minerals are still to be discovered (Linares et al., 2010). The evidence of long-term impacts of mining on the health of workers and communities is important in the context of sustainable development. These impacts imply that the mining sector's activities currently undermine the human objectives of sustainable development, which are to protect the health of current and future generations. This is despite the industry's role in economic development in the short term (Cooper & Harrison, 2009).

Miners and the communities living around mines have fought hard for improvements to their health conditions over many years. This has resulted in great improvements in largescale formal mining – where organised labour has worked with government and management to improve workers' health and safety. Communities have also fought to gain health improvements and reduce health risks associated with living near mines. However, this review shows that there is still a long way to go before mining becomes a healthy work or a healthy development activity (Boulanger & Gorman, 2004).

Mining companies have started more recently to put health programs into place around mines. Even though this is so, it is the long-term heath impacts related to the mine activities that will remain long after the company goes and there is little evidence that companies are keen to address these long-term responsibilities. So, there is need for deliberate research and inquiry into effects that have already been created. However, the scope of this review could not go

beyond such effects. This review was restricted only to health impacts related to mining, both for miners and the local communities around mines. Comprehensively in the near future there is much more to be done to ensure that mining is a healthy as well as sustainable development practice (Au et al., 1998).

There is need to facilitate the involvement of neighboring communities in decision making process of issues affecting their livelihoods. It is important to enhance these involvement of local people in decision making so that there is an establishment of a trilateral dialogue which is important for fostering sustainable development practice.

Enforcement of Occupational Health and Safety Standards

Mining companies have a clear role in minimizing the spread of diseases within their workforce by adhering to occupational health and safety standards, improving living conditions, providing adequate health services, and investing in preventative measures.

The responsibilities of mining companies in this regard are often enshrined in laws. However, a critical challenge remains in monitoring and enforcing compliance. In South Africa, despite a strong regulatory regime and broad consensus to promote better health and safety practices in the mining industry, occupational lung diseases like silicosis persist. It is important for mining companies to 'avoid shortcuts' and instead adhere to international best practices in occupational health and safety, perhaps most importantly in Africa, where many countries lack the capacity to effectively monitor compliance (Henley et., 2008).

In the case of Zambia, although Zambia has ratified the International Labour Organization (ILO) conventions No. 155 and 161 on occupational safety and health, a number of vital provisions are incompatible with the ILO standards. The incompatibility of the provisions and lack of a comprehensive national policy has rendered Zambia incompliant to the ILO conventions. This non-adherence has had to stretch to investors, who in turn have taken advantage of the gap to exploit their workers. For example, in the mining sector, investors have taken advantage of the lack of regulations on adequate and quality clothing thus compromising the safety and health of workers. The BGRIMM explosion in Chambeshi and the accident at the Nkana Shopping Mall Construction Site, which claimed the lives of workers are examples of non-adherence to occupational safety and health regulations. Historically, occupational safety and health in Zambia is highly recognized in Lusaka and the Copperbelt areas where industrialization first began. This history implies the need to centralize occupational safety and health undertakings (Haglund, 2011).

It is necessary that enforcers of occupational safety and health legislation in Zambia decentralize the functions to allow for efficient coordination and communication. In trying to improve or increase the levels of accessibility to occupational safety and health in the workplace, the Zambian government may consider defragmenting the current legal framework to create a composite one that would include both general and specific occupational safety and health guidelines. There is still need for Zambia to ratify and domesticate more conventions of the International Labour Organization in order to effectively manage and coordinate the occupational safety and health laws. Zambia would also need to expedite the process of formulating and implementing the national policy on occupational safety and health to avoid facing preventable costs, sanctions, and penalties. And employers, probably by linking their existence based on the level of adherence of occupational safety and health norms in their organizations; increasing penalties to an extent that it contradicts the economic gains obtained by violating the safety & health norms stipulated by law; constituting industry specific bodies to re-evaluate the applicability of guidelines, rules and regulations and legislations regularly, keeping in mind the changing environment in which the industry operates; including the financial cost of occupational safety and health measures; and by encouraging the speedy adjudication of cases pertaining to occupational safety and health violations by various statutory bodies constituted to monitor the adherence of the statutory requirements of occupational safety and health. The debate on the impact of the mining and minerals sector on both worker and community health is polarized. The industry tends to highlight the alleged benefits of the sector, whilst community groups and NGOs suggest that the sector is detrimental to health and sustainable development (Hagland, 2009; Frase & Lungu, 2006; Hagland, 2010).

Community Engagement with Mines

There is considerable disagreement between mining communities and mining companies concerning the real health impacts of the industry, as well as the different responsibilities of key role-players. This review reveals that mining activities can impact the health of communities related to mine operations at various levels (Stephens & Ahern, 2001:30. Mining companies should re-brand themselves as honest partners with the best interest of the communities at heart, dispelling the shroud of suspicion they are normally viewed through. To do this it is important for mining companies to better understand how community members think mining will impact on their daily lives. Will they obtain employment? Will mining damage their environment? Will the company procure provisions locally? Will the company

look after their roads? Will crime increase? These are some of the questions they will ask together with a legion of other concerns and expectations. Prior knowledge of these concerns, expectations and perceptions can be of great value to the mining company going forward, perhaps averting unnecessary work stoppages with the resulting loss in income (Hagland, 2010).

For communities related to mine operations, or non-occupationally exposed populations, mining activities can impact health at various levels. First, there are adverse health effects that result from environmental exposures to air, water, soil, and noise pollution. Second, and equally important for community health, are non-environmental exposures such as mining disasters and pit closures, which can affect the community indirectly and directly (Stephens & Ahern, 2001).

Also, the development of mines in Peru has been known to lead to a lot of extreme environmental degradations, some of these damages require a strategic engagement of all stakeholders if this problem has to be addressed (Bury 2002, 2004). Like in figure 8.1, this depression from mining activities endangers the lives of mining communities. Also such environmental degrading may not only lead to loss of life but may also escalate tension between the mining sector and the communities. It is also important to understand that such damages compromise the social status of communities, leading to compromise on water resources and agriculture soils and affecting the livelihood of communities (Ponce and McClintock 2014; Triscritti 2013; Bebbington and Williams 2008; Jaskoski 2014; Fig.4).

Figure 8.2 shows house an impoverished area on the tailing of one of the biggest mine dumps in South Africa. Tens of thousands of South Africans live at the foot of mountains of mining waste and this affects their livelihood.
community indirectly and directly (Stephens & Ahern, 2001).

Figure 8.1: Silver Mine in Peru surrounded by houses

Figure 8.2: An illustration of informal settlements next to mine dumps

Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework is an important framework for identifying structural factors that affect the livelihood of communities living near mining areas; factors such as money, power and resources. However, the focus of this framework is in the light of the association between ways of making a living by getting employed in the mines and community health in the context of other social, political, and economic factors experienced by the very communities, most often located in rural areas. The Sustainable Livelihoods framework suggests that community assets such as money and resources influence the creation and maintenance of institutional policies and practices. Policy and practices subsequently shape the community's resources, opportunities to make a living and the health and wellbeing of the community (Chambers & Conway, 1992; Scoones, 1998). Livelihoods thinking dates back to the work of Robert Chambers in the mid-1980s, further developed by Chambers, Conway and others in the early 1990s. In this study the livelihoods framework was adapted from a model developed by the United Kingdom's Department for International Development (DFID 1999).

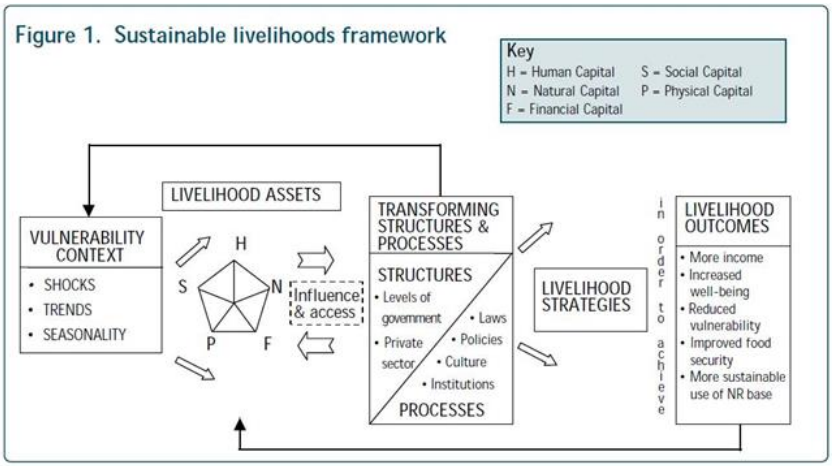


Figure 8.3: Sustainable Livelihoods Framework

The **vulnerability context** establishes the external environment that communities live in and in most cases it is people who are very poor. This includes *critical trends*, such as technological trends or population trends. It also includes *shocks* such as natural disasters or economic inflation, and *seasonality* which refers to the way prices, employment opportunities and production might shift with the seasons. All of these factors will affect the assets that people have and thereby the sustainability of their livelihoods.

The sustainable livelihoods framework is built on the belief that people need **assets** to achieve a positive livelihood outcome. People have different kind of assets that they combine to help them achieve the livelihoods that they seek. *Human capital* is one of these assets, and refers to the skills, knowledge, ability to labour and good health that enable people to achieve their desired livelihoods. Human capital is essential in order to use the other kinds of capitals that exist. *Social capital* refers to the social resources that people can get help from in order to achieve their livelihoods – this could be through networking, membership of formalised groups or mere trust between people that make them help each another. *Natural capital* is to be understood in a very broad manner, since it both covers tangible factors, like natural resources such as trees, land etc., and more intangible products such as the atmosphere and biodiversity. *Physical capital* describes the basic infrastructure and producer goods that are needed to support the livelihoods that people seek. *Financial capital* is the financial resources that people can use to achieve the livelihoods that they are striving for (Carswell, 2000).

Transforming structure and process includes the institutions, organisations and policies that frame the livelihoods of the poor, and they are found at all levels – from the household to the international level. These processes and structures determine the access that people have to different kinds of assets, and therefore the importance cannot be overemphasised. Examples of processes are international agreements, ownership rights and laws to secure the rights of the individuals, whereas structures might be the existence of ministries, banks that give credit to the farmers or self-help groups in the local community. **Livelihoods strategies** are the way that people act in order to achieve their desired livelihood. The access that people have to different kinds of assets affect the strategies that they employ, and the structures and processes in a given society also creates possibilities and constraints on the strategies that people are able to use. Finally, **Livelihood outcomes** are the achievements of people's livelihood strategies. However, outcomes are to be described by the local people themselves, since these include much more than income. For outsiders it can be difficult to understand what people are seeking and why, because this is often influenced by culture, local norms and values (Ellis & Frank, 1999).

The sustainability livelihood framework views people as operating in a context of vulnerability. Within this context, they have access to certain assets or poverty reducing factors. These help them gain their meaning and value through the prevailing social, institutional and organizational environment. This environment also influences the livelihood strategies – ways of combining and using assets – that are open to people in pursuit of beneficial livelihood

outcomes that meet their own livelihood objectives. They all relate the processes of change to the conditions in which people's livelihoods operate and the response of livelihoods to these changes (DFID, 1999). Mining influences all the elements of the sustainability livelihood framework including the social capital. These assets influence policies and institutions and also get influenced by them. Finally, they adopt different livelihood strategies, which result in diverse livelihood outcomes. The livelihood upon which livelihoods are built. That is, people require a range of assets to achieve positive livelihood outcomes. They are; human capital, natural capital, financial capital, physical capital and social capital. These different forms of capital are different forms of livelihood assets that households can use to make a living.

Conclusion

Protecting the health of the local communities is a shared responsibility. Mining companies have a clear responsibility toward preventing the spread of diseases within their workforce, but defining a similar role vis-à-vis local communities is less straightforward. From a corporate standpoint, investing in communities is critical for sustaining a long-term partnership with the host government and the local community, as well as in maintaining a social license to operate. For this reason, mining companies should strive to work with local health authorities to design and deliver preventative and treatment programs for diseases such as malaria, HIV/AIDS, and TB among many others.

The efforts from the mining side are usually part of a broader corporate social responsibility program and are not typically integrated into broader health systems strengthening efforts at the national and local levels. It is critical for mining companies and health authorities to jointly define priorities, align interventions, and capitalize on respective comparative advantages that benefit from the sector.

This section looks briefly at our conclusions related to actions needed to move forward and implications for workers, community health and sustainability. We are aware that despite the breadth of this review, we have hardly skimmed the surface of the issues of mining and health.

The chapter deals with the question of resource wealth and economic development. If occupational health is not put at the centre stage of sustainability, this could affect the productivity of mines and later on the economies of countries, but also if community health is endangered it may affect the business environment upon which mines should thrive and impact sustainable economic growth in the long run. Non-inclusion and consideration of community

health in sustainability frameworks of mining may lead to humanitarian crisis and economic burden for nations.

Community participation for health and wellbeing is very important. Evidence now shows that no matter how elegantly wrought a physical solution, no matter how efficiently designed a park, no matter how safe and sanitary a building, unless the people living in those neighbourhoods can in some way participate in the creation and management of these facilities, the results will not be as beneficial as we might hope.

The strength of this review reflects the various themes identified and their consistency with previous studies. Although we tried to search for all appropriate studies, we might have missed some and that may affect the generalization of our findings. However, we believe that the results identified are compelling and it has been observed that public health measures have been inconsistent in most mining setting leading to poor mine safety. especially in limited resource settings.

Acknowledgements

The authors would like to express their profound gratitude to the two anonymous reviewers who made wonderful suggestions to shape this final work. Special thanks also go to the University of Zambia, School of Mines who through the ESDA program made this work publishable. Thanks also to Dr. Jewette Masinja for the support and encouragement.

References

Au WW, McConnell MA, Wilkinson GS, Ramanujam VMS, Alcock N. (1998). Population monitoring: experience with residents exposed to uranium mining /milling waste. Mutation Research 405: 237–245 36 Hanson, K. Seibel G, Allard S, Wortman G, Kozak, A. AMEC Nova Gold Resources Inc. Donlin Creek

Boulanger A, Gorman A. (2004). Hardrock Mining: Risks to Community Health. Women's voices for the earth. Available: http://www.womenandenvironment.org/newsreports/issuereports/

Bury, J. T. (2004). Livelihoods in transition: transnational gold mining operations and local change in Cajamarca, Peru. *The Geographical Journal.* 170:78–91.

Carswell, G (2000). “Livelihood Diversification in Southern Ethiopia”, IDS Working Paper No 117 (Brighton: Institute of Development Studies (IDS)).

Chambers R, Conway G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st Century*. Brighton, England: University of Sussex, Institute of Development Studies

Cooper RG, Harrison AP. (2009). The exposure to and health effects of antimony. *Indian Journal of Occupational and Environmental Medicine* 13(1):3-10

DFID (1999). *Sustainable Livelihoods Guidance Sheets*, London: Department for International Development.

Dirty Metals (2004). Mining, Communities and the Environment. Earthworks and Oxfam America. Available: http://www.nodirtygold.org/dirty_metals_report.cfm

Danielson L. (2006). Architecture for change: An account of the mining, minerals and sustainable development project Global Public Policy Institute, Berlin

Dubiński, J., Turek, M., Wachowicz, J (2007). Hard coal mining and the idea of sustainable development Proc. Intern. Scientific Conference – School Underground Exploitation, Dniepropietrowsk pp. 27-38

Ellis, F (1999). “Rural Livelihood Diversity in Developing Countries: Evidence and Policy Implications”, Natural Resource Perspective, Number 40 (London: Overseas Development Group). – (2000): Rural Livelihoods and Diversity in Developing Countries, Oxford: Oxford University Press

Frankenberger, R.T., Luther, K., Becht, J. & McCaston, M.K., (2002). Household livelihood security assessments: A toolkit for practitioners, Tango International and Care USA, viewed 27 June 2016, from http://www.chs.ubc.ca/archives/files/Household-Livelihood-Assessment.pdf

Fraser, A. & Lungu, J. (2006). For whom the windfalls. Winners and Losers in the Privatisation of Zambia's Copper Mines.

Gonzalez, F.S.C., Luz, J. M., & Tirol, M.H. (1984). De La Salle mission statement: Retrospect and rospect. Quezon City: Vera Reyes, Inc

Henley, J., Kratzsch, S., Külür, M. & Tandogan, T. (2008) Foreign Direct Investment from China, India and South Africa in sub-Saharan Africa: A New or Old Phenomenon? UNU Wider Research Paper No. 2008/24.

Haglund, D. (2011). From boom to bust: Diversity and regulation in Zambia's privatised copper sector', In M. Larmer & A. Fraser (eds.) *Zambia, Mining and NeoLiberalism*:Palgrave Macmillan, inc.

Hendryx, M., (2015). The public health impacts of surface coal mining / The Extractive *Industries and Society*, 2:820–826

Haglund, D. (2010). Policy effectiveness in the Zambian Mining Sector'. SAIIA Policy Briefing, No 19, July 2010.

Haglund, D. (2009a). It for the Long Term? Governance and Learning among Chinese Investors in Zambia's Copper Sector, *China Quarterly* 199.

Herrera R, Radon K, Ehrenstein OS, Cifuentes S, Munoz DM, Berger U. (2016). Proximity to mining industry and respiratory diseases in children in a community in Northern Chile: A cross-sectional study; *Environmental Health*, 15:66; doi:10.1186/s12940-016-0149-5

Hudtohan, E.T. (2005). Fifty Years of De La Salle Catechetical Program: Retrospect and Prospect (1952-2002). A doctoral dissertation. De La Salle University, Manila.

Huertas JI, Huertas ME, Solís DA. (2012). Characterization of airborne particles in an open pit mining region. *Science Total Environment*. 423 :39–46. doi: 10.1016/j.scitotenv.2012.01.065

Linares B, Guizar JM, Amador N, Garcia A, Miranda V, Perez JR. (2010). Impact of air pollution on pulmonary function and respiratory symptoms in children. Longitudinal repeated-measures study. *BMC Pulmonary Medicine*;10(1):1. doi: 10.1186/1471-2466-10-62

International Council on Mining and Metals, (2008). Sustainable development framework: a sustained commitment to improved industry performance. Available online at: /http://www.icmm.com/libraryS. International Council on Mining and Metals, 2010. Good Practice Guidance on Health Impact Assessment. Available online at: /http://www.icmm.com/ libraryS.

Jenkins, H (2004). Corporate social responsibility and the mining industry: Conflicts and constructs. *Corporate Social Responsibility and Environmental Management*, 11 (1), pp. 23-34

Kemp D. (2010). Community relations in the global mining industry: Exploring the internal dimensions of externally orientated work. *Corporate Social Responsibility and Environmental Management*, 17 (1), pp. 1-14

Measures to Control the Prevalence of Pneumoconiosis in Coal Mining: A Review of the Literature Control of CWP in Coal Mine: https://www.researchgate.net/publication/312411045_Measures_to_Control_the_Prevalence_of_Pneumoconiosis_in_Coal_Mining_A_Review_of_the_Literature_Control_of_CWP_in_Coal_Mines

Muchiri, F.K (1992). Higher Productivity and a Better Place to Work: African Newsletter on Occupational Health and Safety. Institute of OHS, Vol.2, No.3. ILO, Geneva. Occupational Health and Safety Bill NAB No. 35 of 2010Parliament Website.

Owen J.R., Kemp D. (2015). Mining-induced displacement and resettlement: A critical appraisal. *Journal of Cleaner Production*, 87, pp. 478-488

Schwarze PE, Øvrevik J, Låg M, Refsnes M, Nafstad P, Hetland RB (2006). Particulate matter properties and health effects: consistency of epidemiological and toxicological

studies. *Human & Experimental Toxicology*. 25(10):559–579. doi: 10.1177/096032706072520

Smith, J. (2015). *Business Research Methodology*. New York: Arcler Press LLC.

Stephens C, Ahern M. (2001). Worker and Community Health Impacts Related to Mining Operations Internationally A Rapid Review of the Literature. Mining, Minerals and Sustainable Development No. 25:1-59

Ponce, A., and C. McClintock. (2014). The explosive combination of inefficient local bureaucracies and mining production: evidence from localized societal protests in Peru. *Latin American Politics and Society*. 56:118–140.

WHO Website. Health and Safety. http://www.who.int/nmh/a5817/en/ Zambia Congress of Trade Unions Occupational Health and Safety Policy Indecon (2006). "Report on Economic Impact of Safety, Health and Welfare at work; Legislation Department of Enterprise, Trade and Employment, ILO office, Geneva.7

World Health Organization, (1948). Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19–22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the

World Health Organization, (no. 2, p. 100) and entered into force on 7 April 1948. World Health Organization, (1986). Health Promotion Glossary, Geneva, Switzerland. Available online at: /http://www.who.int/hpr/NPH/docs/hp_glossary_en.pdfS

Zhiguo Z., Naiqi S., Yingshuang W., Yongcheng L., Yanyan S., Tao H. (2011). Geological environment problems and countermeasures of shijiaying mine in western Beijing. *Procedia Environmental Sciences*, 11, pp. 1245-1252

PAPERS FROM CONFERENCE PROCEEDINGS

A Study of the Zambian Mine Closure Mien Rehabilitation Model – A Case Study of Bwana Mkubwa Mine

(2nd Zambia Conference on Mining, Metallurgy and Groundwater Resources)

Maxwell Saili*[1], Jewette Masinja[2]
[1-2] *Department of Metallurgy and Mineral Processing, School of Mines, University of Zambia,*
Email: maxwell.saili@yahoo.com

Abstract

Thousands of mines in the world, as well as Zambia in particular, have closed without taking due consideration of their impacts on the environment, people's health and socio-economic impacts. Today, there is increasing awareness of the need to provide for sustainability of ecological and social settings in which mines are developed, operated and closed. This has led to the review of a number of policies to address these impacts of mine closure in the past decade. This study looks at the Zambian Mine Closure and rehabilitation model for the future sustainability of mine sites, surrounding environment and communities affected by mine activities. The study focuses on three features: It provides an overview of the Zambian mine closure legislation, it looks at the mine closure cost algorithm and discusses Bwana Mkubwa Mine closure in Ndola on the Copperbelt Province as a case study. A mixed method research approach using a concurrent triangulation design will be undertaken. Semi-structured interviews by purposive sampling will be conducted with various stakeholders affected by mining activities. Water samples on mine site and surrounding areas will be collected and analysed for pH and heavy metals contamination. Furthermore, field observation of Bwana Mkubwa Mine will be carried out. The data obtained from interviews and water sample results were analysed using Statistical Package for Social Sciences (SPSS) as well as using descriptive analysis. Zambian Mine Closure legislation covered in the Mines and Minerals Act and the Environmental Management Act are adequately covered and internationally applicable, though enforcement needs to be strictly adhered to. The quantum calculation method of mine closure cost estimation adopted needs refinement of multiplication factors to take into consideration the risks that may be involved in mine closure and rehabilitation. The master rates also used in algorithm calculations need continuous updating. Groundwater pollution at Bwana Mkubwa Mine tailings storage facility is a serious concern which needs addressing as not much has been done since the mine went on care and maintenance in 2012 for water quality to be in compliant which statutory standards.

Keywords: *Mine Closure, Rehabilitation, Decommission, Environmental Impact*

INTRODUCTION

Countries have been burdened with a legacy of unplanned closed, hazardous mine sites and unreclaimed lands, which have occurred as a result of inefficient mining legislation which has failed to prevent or reduce the possible lengthy-term environmental effects of mining activities and mine closure. Most mining nations are still to develop sufficient sophisticated corporate governance, regulatory frameworks, or financial insurance provisions to address mine closure planning and mine rehabilitation.

In the past, it was common practice to abandon mine sites, once mineral extraction was completed. The mining site was left poorly vegetated and exposed, and waste minerals remained untreated. It is estimated that there are approximately 5,700 derelict and ownerless mines in South Africa and over 50,000 in Australia (Brown, 2007; Nzimande & Chauke, 2012; Unger et al., 2012). Ventkateswarlu et al. (2016), also reported 6,150 formerly listed deserted mines in South Africa. There has been little concern for the environment and social impacts associated with mine closure, and lack of recognition of post mine land use. This legacy of abandoned mines, their related environmental, social and economic problems and the post mine land use development has led to an increased emphasis on mine closure planning (Sassoon, 2000).

Mining activities lead to loss of landforms, landscapes and land use as well as the overall degradation of the natural surrounding and biodiversity. The heavy metal build-up in water bodies which are in close proximity to mining operations is also a product of improper mine closure. Heavy metal contamination of ground and surface water is the main subject because of their toxicity and threat to human wellbeing and the environment (Baby et al., 2010).

Currently a number of mines, both regionally and internationally, are about to undergo closure and are near the end of their economic life. However, it is realised that most of these mines do not have sufficient financial backing to close mines to an environmentally ideal condition. The major challenges being faced by the mining industry today is the ever-increasing stricter social and environmental legislation and environmental consciousness of the community in which it operates (Du Plessis & Brent, 2006).

The primary concerns for decommissioning and rehabilitation are to ensure public protection and health, and environmentally stable conditions well suited with the surrounding

environment, and consequently decrease the environmental impacts of mining (Du Plessis & Brent, 2006). The closure process must be a life-of-mine process, where risks are determined and managed proactively.

As mining transformed and the need to provide financial surety for closure activity become a priority, the focus of closure cost estimating in many countries is to reduce the liability of the government that would assume responsibility should the operator abandon the site prior to planned closure (Parshley et al., 2009).

One of the mines in Zambia which has not been properly closed in the past two decades whose negative impacts are still being felt to date is the Kabwe mine in Central province, which closed in 1994. Despite lack of employment, this lead and zinc mine has left widespread contamination of the local area, including water bodies. The environmental liabilities are still under the former owners, Zambia Consolidated Copper Mines (ZCCM). Kabwe is identified as one of the top 10 polluted towns in Zambia (Ministry of Health Zambia, EQUINET, 2018).

Bwana Mkubwa Mine which is under study is the oldest mine in Zambia's Copperbelt province whose operations started as early as 1902. It is located 10km southeast of the city of Ndola. The current owners of the mine is First Quantum Minerals Limited who purchased the mine in 1996. The mine was put on care and maintenance in 2012 after it depleted ore stocks from Lonshi Mine in the Democratic Republic of Congo. Decommissioning and closure of Bwana Mkubwa mine started in 2017. At the time of closure, the mine was operating a solvent extraction and electrowinning plant, and an acid plant.

1.1 Research Problem

Despite mining contributing highly to the Gross domestic product of Zambia, mine closure and rehabilitation poses long-term environmental, physical, social and economic impacts. This is evidenced by:

- General degradation of the natural environment and biodiversity.
- Community complaints on water quality.
- Loss of livelihood of communities.
- Loss of landforms, landscapes and land use.
- Detoriation of human health.
- Lack of closure reports on mines and inadequate closure cost estimates.

1.2 Research objectives

Based on the various concerns about the effects of mining, this paper aims to review the current mining legislation and controls on mine closure and rehabilitation. It also looks at the mine closure and rehabilitation cost estimations and investigates the closure of Bwana Mkubwa mining operations on the water and soil quality of the surrounding environment.

1.3 Significance of the study

The results of this study will help policymakers and mining companies come up with detailed and informed mine planning policies, management and enforcement of mine closure and rehabilitation. This study will also add to the existing body of knowledge on mine closure and rehabilitation and save as a backup for future research. The research will also help Zambia and other developing countries in attaining the sustainable development goals (SDGs), especially No.6 on clean water and sanitation, No.11 on the development of sustainable cities and communities and No.15 which looks at stopping and reversing land degradation biodiversity loss.

1.4 Scope of the study

The study will focus on the Bwana Mkubwa Mine in Ndola district of the Copperbelt, the Mines Safety Department and the Zambia Environmental Management Agency. Other stakeholders to be consulted will the Ndola city council, ZCCM IH, civil society groups and Bwana Mkubwa community.

LITERATURE REVIEW

Mine closure refers to the period of time when the operational stage and economic viability of a mine have ceased or ended, and the final decommissioning, mine rehabilitation and mine closure has commenced.

Mine rehabilitation is the process used to repair the effects of mining on the environment. Lima et al. (2016), also defines it as a progression leading to the restoration of the original environment. In other words, it is a process by which the impacts of mining on the environment are repaired through the reconstruction of a stable land surface followed by revegetation or development of alternative land use on the reconstructed landform. The words rehabilitation, restoration, remediation and reclamation are often used interchangeably (Seabrook et al., 2011).

Mining changes the natural topography and discharges large quantities of unwanted materials that pose serious pollution hazards to the environment, human fitness and agriculture (Festin et al., 2017). These mining wastes have typically bad water protecting potential, low organic count numbers, low microbial activity, and elevated levels of heavy metal (O'Dell et al., 2007).

The long-term objectives of mine rehabilitation include the conversion of a mine site and disturbed mine land to an environmentally safe and sustainable natural physical feature, and the recovery of the pre-mining conditions as carefully as possible to assist the future sustainability of the site (McCullough, 2018). A few mining nations have developed and implemented specific mine closure and mine rehabilitation regulations and legislative controls (Dalupan, 2001). The most common feature in almost all national policy and legislation relating to mine closure is the requirement via mining firms to prepare an authorised Environmental Impact Assessment at the initial planning stage of the mine before the commencement of any project.

No proper records of the number of derelict mines in Zambia could be obtained.

Successful mine closure is determined by the initial mine planning process, which identifies the need for improved stakeholder engagement and community consultation. Mine site closure planning should occur within the initial mine planning and feasibility assessment phase prior to the commencement of mine site operations (Limpitlaw, 2004).

Mines provide jobs to a lot of people, providing their main source of livelihood. The post-mining land use for the mine site should be defined in consultation with relevant stakeholders including government departments, local government authorities, non-governmental organisations and private landholders.

Mines must have closure plans that incorporate control of the environment post-mining. Such mine closure plans form part of the need to embrace the concept of sustainability in mining (Hopwood et al., 2005). Sustainable development implies that activities taking place today should not affect the current and future generations negatively (Blewitt, 2008).

Heavy metals are generally referred to as those metals which possess a specific density of more than $5g/cm^3$ and have an effect on the surrounding and living organisms (Jarup, 2003). Heavy metallic pollutants are one of the most important issues in Zambia and cause serious effects on humans and animals (Nakayama et al., 2010; Gaetke & Chow, 2003). These heavy metals disturb growth, development, reduce haemoglobin, create cancer, damage the body organs and nervous system, and in extreme cases death of living organisms. Waste rock dumps occupy massive regions and are an environmental problem because of the acid mine drainage (AMD) from the metal sulphide present (Naiker et al., 2003; Franks et al., 2011). Sulphide bearing materials when exposed to oxygen and water produce AMD (Sheoran & Sheoran, 2006; Akcil & Koldas, 2006) and releases acid, sulphate and metals. The oxidation system in tailings dams also acidifies water in the dams, which then enters the groundwater, affecting water standard

by lowering the pH and increasing heavy metal pollution (Sracek et al., 2010). In the context of the Zambian Copperbelt region, tailings dams are often built near human settlement where the contaminated groundwater can pose a threat to farming communities (von der Heyden and New, 2004). According to Wong (2003), soils infected with raised concentrations of heavy metals also hinders the growth of most tolerant vegetation, leaving mine wastelands devoid of plants for long periods of time. Heavy metals are not degradable and are unsafe to human health as well as cattle and wildlife (Tembo et al., 2006).

The methods for post-mining rehabilitation can be broadly classified into physical, chemical and biological. The physical method focuses on renewing the landform by ploughing, grading, flattening and putting a layer of topsoil. The chemical procedure mainly focuses on removing pollutants (heavy metals and metalloids) from the substrate and correcting soil pH (Mensah, 2015). AMD can be buffered by the application of residual lime to impoundment dams (Von der Heyden and New, 2004). The biological method, which is likewise known as phytoremediation, involves using inexperienced plant life and related microorganisms to decrease the toxic results of capability contaminants in the surroundings (Mendez & Maier, 2007).

Cost estimates should involve thorough estimation of two main components, Direct costs and Indirect costs (DOWL, 2015; Haymont, 2012; Du Plessis & Brent, 2006). The Direct costs involve earthworks, revegetation and stabilization, mobilization and demobilization, post-closure care/maintenance and monitoring, detoxification/water treatment and disposal of waste, structure/equipment and facility removal as well as onsite construction management/support and maintenance. The Indirect costs include contractor profits, overheads, liability insurance, engineering redesign and contingencies.

Evolution of closure cost estimating techniques focuses on improving closure cost estimating for purpose of accurate reporting of financial liabilities to shareholders, lending organisations and governments. The three basic types of closure cost estimates discussed by Parshley et al. (2009), which is also supported by Slight and Lacy (2015) and Peck and Sinding (2009) are financial assurance cost estimate (FACE), life of mine (LOM) closure cost estimate and asset retirement obligation (ARO) cost estimate. There is a need to involve public stakeholders and surrounding communities in the development of mine closure objectives and financial assurance requirements (Parshley et al., 2009). Many models have been developed worldwide to estimate the mine closure costs. Most importantly is that the process and methodology for calculating the cost estimates must be transparent and verifiable.

MATERIALS AND METHOD

A mixed method research approach using a concurrent triangulation design will be undertaken. This method provides a stronger understanding of the research problem. The qualitative method allows for semi-structured interviews by purposive sampling with the Ministry of Mines and the Zambia Environmental Management Agency officials and Bwana Mkubwa mine officials. The Ndola City Council officials and community members will also be interviewed as well as other stakeholders affected by mining activities. The number to be interviewed in the community will be determined by the theory of saturation but also supported by purposive sampling. The semi-structured interviews include major mine closure issues relating to the environment, safety and health, community/public participation, final/alternative land use, legal/financial and any other issues that come up from the interviews. The approach will also involve field observations of landscapes and vegetation in relation to the surrounding baseline conditions. Review of documents and reports was part of data collection.

The quantitative method allows for a mathematical assessment of the state of water bodies around Bwana Mkubwa mine as well as mathematical calculations of closure costs. Sampling points will be identified upstream and downstream of the mine site, with a control point being upstream of the mine. Existing licenced sites for plant effluents will also be identified. Samples collected from all identified sites will be analysed to evaluate the heavy metal concentration and water quality. The sampling exercise will be carried out in both the wet and dry seasons. The instruments to be used for the analysis of water samples are pH meter, turbidity meter, multimeter probe and Atomic Absorption Spectrometer.

Data collected will be presented and analysed using the Statistical Package for Social Sciences (SPSS) as well as descriptive analysis to make recommendations.

The study is being undertaken after getting ethical clearance from the University of Zambia Ethics committee.

4. RESULTS AND DISCUSSION

4.1 The Zambian Legal Framework on Mine Closure

In Zambia, the institutions mandated to look at the regulatory framework for environmental management in the mining sector are the Ministry of Mines and Minerals Development and the Zambia Environmental Management Agency (ZEMA), under the Ministry of Water Development, Sanitation and Environmental Protection. ZEMA was formed under the Environmental Management Act (EMA) No.12 of 2011.

The Ministry of Mines and Minerals Development uses regulations under the Zambian Mines and Minerals Development Act (MMDA), No. 11 of 2015, which outlines the terms to which a mining company can hand over a mine licence site back to the government after the mining activities have fully been wound up and the mining company has no further mining interest in the site (MMDA Section 71). Legally, before closure, the mining company should have submitted the Environmental Impact Assessment (EIA) to the Zambia Environmental Management Agency for approval (EMA Section 29; MMDA Section 12). The Environmental Impact Assessment Report should include, an environmental management plan that promotes progressive site rehabilitation during operations and tracks implementation (Part 7). It should also have a costed decommissioning and closure plan as well as post-closure monitoring plan in part 8 (Mines and Minerals Regulations, SI 29 of 1997). Under Section 86 of the MMDA, all mining companies will have to make a contribution to the Environmental Protection Fund (EPF). Section 87 compels the mine holder/developer to be liable for any damage or harm due to mining activities or mineral processing activities. The mining licence owner is obliged to clear away of mining or mineral processing plant after finishing operations (Section 82).

The mine closure plan should incorporate a post-closure monitoring plan that can be used to demonstrate that the closure plan is effective and the mine licence holder can legitimately seek to surrender the mining licence back to the government. The formal surrender of a closed mine site to government is provided for in section 71 of the MMDA, no.11 of 2015, after all liabilities associated with the licence site have been settled either environmental, financial, social or otherwise. Section 36 of MMDA gives powers to the Director of Mines Safety or Director of Mines to suspend or close a mine when there is a breach of policies. The Director of Mines Safety also has powers to effect compliance order whenever there is a breach in mine licence conditions (Section 75).

The Environmental Management Act (EMA) No.12 of 2011, Section 4, provides the right of every person staying in Zambia to a clean, safe and healthy environment. Section 6 of the EMA talks about the principles under which the act is governed which include among others: sustainable use of natural resources; polluter pays principle; minimization of waste generation; community participation in environmental issues.

Section 29 of the Act prevents any person from venturing into any project without an authorised Environmental Impact Assessment. Section 31 and 32 forbids the release of pollutants into the environment without acquiring a licence from the Zambia Environmental Management Agency

(ZEMA). Water pollution with toxic, ecotoxic, obnoxious or obstructing matter, radiation or other pollutants beyond control standards established by ZEMA is prohibited under Section 46.

Section 60 gives the powers to the ZEMA Director-General to enforce site restriction orders in terms of breach of licence conditions. ZEMA has also been given to direct a person responsible for land deterioration or pollution to carry out rehabilitation obligations (Section 80). Section 91 of the Act gives a mandate to the public/community to play a part in environmental decision making.

Section 95 emphasises the establishment of the Environmental Protection Fund (supported by Statutory Instrument No. 102 of 1998). The Environmental Protection Fund is for mitigating or repairing environmental degradation and adverse effects on the environment. Section 105 & 106 gives the powers to the inspectors and the Director-General respectively to effect a compliance order where there is a breach on any condition of a licence.

Sections 108, 109 & 110 empowers the public to write to the Director-General to effect an order or effect a prosecution. Sections 117-126 look at Environmental offences and penalties.

4.2 The Environmental Protection Fund (EPF)

The Environmental Protection Fund (EPF) is a statutory requirement for all mining related operations in Zambia as provided for under Section 86 of the Mines and Minerals Development Act No.11 of 2015, the Mines and Minerals (Environmental) Regulations (SI No.29 of 1997) and the Mines and Minerals (Environmental Protection Fund) Regulations which was enacted in 1998 under Statutory Instrument No.102. The EPF was set up to provide assurance that the developer or mine licence holder will be able to execute the environmental impact statement in line with the Mines and Minerals (Environmental) Regulations. Secondly, it provides shielding to the Government against the risk of having the obligation to carry out the restoration of the mining area where the owner of the mining licence fails to do so.

The Fund is administered and managed by the Environmental Protection Fund committee consisting of eleven members appointed by the Minister of Mines and Minerals Development. The members comprise the Mines Permanent Secretary as Chairman; the Director of Mines; a member from ZEMA; a member from the Ministry of Finance; and seven members from the mine licence holders.

The contribution to EPF by the developer is in two components: the cash contribution; and the Bank Guarantee. The cash contribution is in three categories 1, 2 or 3 (5%, 10% or 20% respectively of the total estimated closure/rehabilitation cost). Categorization is mainly based

on the assessed environmental performance and other provisions as outlined in Section 66(1) and (2) read together with Schedule 3 and 11 of the Mines and Minerals (Environmental) Regulations, SI 29. Also in Section 67 of MMER on concessions to a developer by the Director. The cash contribution is payable within five years of operation. The remainder will be secured as a Bank Guarantee or Bond which is retrieved in the event of default.

4.3 Zambian Mine Closure Cost Estimation

The Mines Safety Department, under the Ministry of Mines and Minerals Development, provides guidelines for calculating the mine closure cost using the quantum financial calculation format. The information to support the quantum calculations should include among other things the BOQs, survey data, manufacturer's information etc. (as set out in the Third Schedule of SI 29 of 1997).

The mine closure cost must include the decommissioning and closure of the entire infrastructure that is associated with the operations of a mine license site. The elements to be looked at in this list for closure and decommissioning include:

-Infrastructure such as: open pits, underground operations, metallurgical plants, offices, support infrastructures like garages, workshops and clinics, social infrastructures like schools and hospitals, any other elements requiring closure.

-Mine waste such as:waste rock dumps, tailings dams, water reservoirs, slag dumps.

-Domestic waste dumps

The costing estimate is thus based on the fee of dismantling of current infrastructure, disposal of the resulting remains and the subsequent restoration of the site.

The process is to first find the risk of mineral mined categorized as either high, medium, low (category 3, 2 & 1 respectively). Secondly, determine the environmental sensitivity (low, medium or high). You then identify the decommissioning and closure components as described above. Identify the unit rates to these components and apply the weighting factor. The weighting factors are based on three categories. Firstly, the sensitivity of the waste caused in the surrounding environment. Followed by, the nature of the terrain where the mine is located. Lastly, the proximity of the mine to an urban Centre (Mine Safety Department, 2008).

The next approach is to identify areas of disturbance such as measurements and materials of construction that make up the mine site and then apply the master rates for each component of closure to finally calculate the closure costs.

Dismantling of the processing plant and related structures (including overland conveyors and power	Rehabilitation of process waste deposits and evaporation ponds (acidic, metal-rich waste)
Demolition of steel buildings and structures	Rehabilitation of subsided
Demolition of reinforced concrete buildings and structures	General surface rehabilitation, including grassing of all denuded areas
Rehabilitation of access roads	River diversions
Demolition and rehabilitation of electrified railway lines	Fencing
Demolition of housing and facilities	Water management (separating clean and dirty water, managing the impact of grounds water, including treatment, when required)
Opencast rehabilitation including final voids and ramps	Sealing of shafts, audits and inclines
Rehabilitation of overburden and spoils	2 to 3 years maintenance and aftercare
Rehabilitation of processing waste deposits and evaporation ponds (basic, salt-producing waste)	

Table 1 Closure Cost Component

NO.	DESCRIPTION	UNIT	A	B	C	D	E	F=A*B*C*D*E
		(Tons/m^3 /m^2/ha)	Quantity	MasterRate	Factor1	Factor2	Factor3	Amount (USD)
1								
2								
Sub Total								
Contingencies (%)								
GRAND TOTAL								

Table 2 Quantum Calculation Worksheet

Factor 1 – Sensitivity of mineral/waste

Factor 2- Nature of Terrain

Factor 3- Proximity to an urban centre

4.4 Bwana Mkubwa Mine Closure

Field inspection and calculation of disturbed mine licence area and evaluation of the state of water bodies around Bwana Mkubwa Mine are yet to be undertaken or verified. Initial

document review from reports at Zambia Environmental Management Agency (ZEMA) and the Mines Safety Department indicate contamination of surface and groundwater, air pollution, land degradation and loss of productivity, loss of biodiversity, impairment of ecosystem services as well as human health impacts. A review of the mine closure plan report needs to be critically looked at and ascertain progress made to achieve environmental restoration.

5. CONCLUSION AND RECOMMENDATIONS

Zambian Mine Closure legislation covered in the Mines and Minerals Act and the Environmental Management Act are adequately covered and internationally applicable, though enforcement needs to be strictly adhered to. The legislation covers most of the sustainability principles throughout the life of mine up to the time the mine developers hand over the mining licence. The regulatory bodies need to be adequately funded and beefed up with enough manpower to ensure that these regulations a strictly followed and audits on mine site are made to ensure that the closure plans as stipulated in the Environmental Impact assessments are followed to the letter. There has been very little involvement in mine closure issues by the ministry of mines, the surrounding community and other stakeholders in the development of mine closure objectives as has been noted by the surface and groundwater pollution by Bwana Mkubwa mine. The quantum financial cost estimation needs more refinement by looking at determining the weighing factors and continuous updating of master rates. Future research is needed by undertaking a specialist study on aspects of surface and groundwater pollution and remediation of Bwana Mkubwa mine. A study of the water balance around the tailings storage facility which has been a concern in terms of groundwater pollution needs to be adequately looked at. The effects of climate change on mine closure is another area of future research.

Acknowledgement: This research was supported by the University of Zambia. I would also like to thank the lecturers from the University of Cape Town and the University of Stellenbosch for providing insight and expertise that greatly assisted the research. I would also like to show gratitude to the support I received from members of staff at Zambia Environmental Management Agency and Mines Safety Department.

REFERENCES

Akcil, A. & Koldas, S. 2006. Acid Mine Drainage (AMD): causes, treatment and case studies. Journal of Cleaner Production, 14:1139-1145.

Baby, J., Raj, J. S., Biby, E. T., Sankarganesh, P., Jeevitha, M. V., Ajisha, S. U. & Rajan, S. S. 2010. Toxic effect of heavy metals on aquatic environment. International Journal of Biological and Chemical Sciences, 4(4):939-952.

Blewitt, J. 2008. Understanding Sustainable Development. London: TJ International.

Brodie, J. 2013. Considerations in mine reclamation costing. Prepared for British Colombia Mine Reclamation Symposium. BCTRCT, Vancouver, Canada.

Brown, J. 2007. Derelict mines to cost state R100bn. Business Report, 23 May: 22.

Creswell, W. J. 2014. Research Design: qualitative, quantitative and mixed method approaches. 4th ed. SAGE Publications, Inc.

Dalupan, C. 2001. Mining and Sustainable Development: Insights from International Law.

Digby, C. 2016. Mine Closure and Rehabilitation: From Dereliction to Accountability? Centre for Sustainability in Mining and Industry. University of Witwatersrand.

DOWL. 2015. Mine Closure and Reclamation Cost Estimation Guidelines: Indirect Cost Categories.

Du Plessis, A. & Brent, A.C. 2006. Development of a risk-based mine closure cost calculation model. The Journal of The South African Institute of Mining and Metallurgy, 106:443-450.

Festin, E.S., Tigabu, M., Chileshe, M.N., Syampungani, S. & Oden, P.C. 2017. Progress in restoration of post-mining landscape in Africa. Journal of Forestry Research, 30(2):381-396.

Franks, D.M., Boger, D.V., Cote, C.M. & Mulligan, D.R. 2011. Sustainable development principles for disposal of mining and mineral processing wastes. Resource Policy, 36:114-122.

Gaetke, M.L. & Chow, K.C. 2003. Copper toxicity, oxidative stress, and antioxidant nutrients. Toxicology, 189:147-163.

Haymont, R. 2012. Closure Cost Estimating Methodologies: A review of Mine Closure Cost Estimating Methodologies and for different reporting purposes.

Hopwood, B., Mellor, M. & O'Brien, G. 2005. Sustainable Development: Mapping Different Approaches. Wiley InterScience, 13(1):1-15.

Jarup, L. 2003. Hazards of Heavy metal contamination. British Medical Bulletin, 68(1):167-182.

Krzaklewski, W., Barszcz, J., Malek, S., Koziol, K. & Pietrzykowski, M. 2004. Contamination of forest soils in the vicinity of sedimentation pond after zinc and lead ore flotation (in the region of Olkurz, South Poland). Water, Air, and Soil Pollution, 159(1):151-164.

Kothari, R. C. 2004. Research Methodology: Methods and Techniques. Second ed. New Age International Publishers.

Lawrence, D. C. 2006. Optimization of the mine closure process. Journal of Cleaner Production, 14:285-298.

Lima, A.T., Mitchell, K., O'Connell, D.W., Verhoeven, J., Van Cappellen, P. 2016. The legacy of surface mining: remediation, restoration and rehabilitation. Environmental Science and Policy, 66:227.

Limpitlaw, D. 2004. Mine closure as a framework for sustainable development. School of Mining engineering. University of the Witwatersrand, Johannesburg.

Limpitlaw, D. & Smithen, A. A. 2003. Mine Closure in the Zambian Copperbelt: Scenarios for Sustainable Development. University of Witwatersrand and SRK consulting.

Lindahl, J. 2014. Environmental Impacts of Mining in Zambia: Towards better environmental management and sustainable exploitation of mineral resources. Geological Survey of Sweden. SGU, Uppsala.

Lottermoser, B.G. 2007. Mine Wastes: characterization, treatment, environmental impacts. 3rd edn, Springer: New York, USA. 300.

McCullough, D.C., Harvey, B., Unger, C.J., Winchester, S., McCarthy, B. & Coetzee, J. 2018. From Start to Finish – a perspective on improving sustainable development aspects of life-of-mine practices. AusIMM: 395-400.

Mendez, M.O. & Maier, R.M. 2008. Phytoremediation of mine tailings in temperate and arid environments. Reviews in Environmental Science and Biotechnology, 7(1):47-59.

Mensah, A.K. 2015. Role of revegetation in restoring fertility of degrade mine soil in Ghana: a review. International Journal of Biodiversity and Conservation, 7(2):57-80.

Milaras, M., Ahmed, F. & McKay, T.J.M. 2014. Mine Closure in South Africa: A survey of current professional Thinking and practice. University of Witwatersrand, Johannesburg.

Mine Safety Department. Ministry of Mines and Minerals Development. 2008. Procedure for Evaluation of Quantum for Mine-Site Decommissioning and Closure. January, 2008 Version 1.1.

Ministry of Health Zambia, EQUINET. 2018. Mining and Public Health in Zambia Meeting report. 10 April. Lusaka: Zambia.

Nakayama, S.M.M., Ikenaka, Y., Muzandu, K., Choongo, K., Teraoka, H., Mizuno, N. & Ishizuka, M. 2010. Heavy metal contamination of soil and sediment in Zambia. African Journal of Environmental Science and Technology, 4(11):729-739.

Naiker, K., Cukrowska, E. & McCarthy, T.S. 2003. Acid mine drainage from gold mining activities in Johannesburg, South Africa and environs. Environmental Pollution, 122(1):29-40.

Nzimande, Z. & Chauke, H. 2012. Sustainable through responsible environmental mining. Journal of the Southern African Institute of Mining and Metallurgy, 112(2):135-139.

O'Dell, R., Silk, W. Green, P. & Claasen, V. 2007. Compost amendment of Cu-Zn mine spoil reduces toxic bioavailable heavy metal concentrations and promotes establishment and biomass production of Bromas carinatus. Environmental Pollution, 148:115-124.

Ortiz, C., Pizarro, J. Veliz, D., Rioseco, H. Castillo, X., Cid, H. & Barros, D. 2014. Water treatment technologies for rehabilitation purposes. Proceedings of Mine Closure Solutions. 26 April 2014. Ouro Preto, Brazil.

Parshley, J. V., Bauma, W. & Blaxland, D. 2009. An evolution of the methods for purposes of mine closure cost estimating. Australian Centre for Geomechanics. Perth: Australia. 187-200.

Peck, P. & Sinding, K. 2009. Financial assurance and mine closure: Stakeholder expectations and effects on operating decisions. Resources Policy, 34(4):227-233.

Peck, P. 2005. Mining for Closure: Policies and Guidelines for Sustainable Mining Practice and Closure of Mines.

Richards, A.K., Miller, R., Murphy, D.P. & Smith, M.A. 2018. Understanding Closure Cost Models and their Ongoing Viability as a Tool for Calculating Closure Liabilities. Unpublished paper delivered at the 12th International Conference on Mine Closure. 3-7 September 2018, Leipzig, Germany. 127-137.

Sassoon, M. 2000. Environmental Aspects of Mine Closure. In Mine Closure and Sustainable Development Workshop. World Bank & Metal Mining Agency of Japan. Washington D.C.

Seabrook, L., McAlpine, C.A. & Bowen, M.E. 2011. Restore, repair or reinvent: options for sustainable landscapes in a changing climate. Landscape and Urban Planning, 100(4):407–410.

Sheoran, A.S. & Sheoran, V. 2006. Heavy metal removal mechanism of acid mine drainage in wetlands: a critical review. Minerals Engineering, 19(2):105-116.

Sikamo, J., Mwanza, A. & Mweemba, C. 2016. Copper mining in Zambia – history and future. The Journal of The Southern African Institute of Mining and Metallurgy, 116(6):491-496.

Siraj, K. & Kitte, S.A. 2013. Analysis of Copper, Zinc and Lead using Atomic Absorption Spectrophotometer in ground water of Jimma town of Southwestern Ethiopia. International Journal of Chemical and Analytical Science, 4(2013):201-204.

Slight, M. & Lacy, H. 2015. Managing and Estimating Closure and Reclamation Liabilities – A Practitioner's View. Journal American Society of Mining and Reclamation, 4(2):122-132.

Sracek, O., Mihaljevic, M., Kribek, B., Majer, V. & Veselovsky, F. 2010. Geochemistry and mineralogy of Cu and Co in mine tailings at Copperbelt, Zambia. Journal of African Earth Sciences, 57(1):14-30.

Stacy, J., Nauda, A., Hermanus, M. & Frankel, P. 2010. The socio-economic aspects of mine closure and sustainable development: literature overview and lessons for socio-economic aspects of closure- Report 1. The Journal of The Southern African Institute of Mining and Metallurgy, 110.

Tembo, B.D., Sichilongo, K. & Cernak, J. 2006. Distribution of copper, lead, cadium and zinc concentration in soils around Kabwe town in Zambia. Chemosphere, 63(3):497-501.

The Environmental Management Act, No.12. 2011. Lusaka: Government Printer.

The Mines and Minerals Development Act of Zambia, No.11. 2015. Lusaka: Government Printer.

The Mines and Minerals (Environmental) Regulations, 1997. Statutory Instrument No. 29 of 1997. Lusaka: Government Printer.

The Mines and Minerals (Environmental Protection Fund) Regulations, 1998. Statutory Instrument No. 102 of 1998. Lusaka: Government Printer.

The United Nations World Commission on Environment and Development. 1987. Our Common Future.

Twerefou, D. K. 2009. Mineral Exploitation, Environmental Sustainability and Sustainable Development in EAC, SADC and ECOWAS Regions. African Trade Policy Centre. Work in Progress No.79.

Unger, C., Lechner, M.A., Glenn, V., Edraki, M. & Mulligan, R. D. 2012. Mapping and Prioritising Rehabilitation of Abandoned Mines in Australia. Life of mine Conference. Brisbane, QLD. 10: 259-265.

Vaishaly A. G., Mathew, B.B. & Krishnamurthy, N.B. 2015. Health effects caused by metal contaminated ground water. International Journal of Advances in Scientific Research 2015; 1(02): 60-64.

Venkateswarlu, K., Nirola, R., Kuppusamy, S., Thavamani, P., Naidu, R. & Megharaj, M. 2016. Abandoned metalliferous mines: ecological impacts and potential approaches for reclamation. Reviews in Environmental Science and Biotechnology, 15:327-354.

Von der Heyden, C.J. & New, M.G. 2004. Groundwater pollution on the Zambian Copperbelt: deciphering the source and the risk. Science of The Total Environment, 327(1-3):17-30.

Wong, M.H. 2003. Ecological restoration of mine degraded soils, with emphasis on metal contaminated soils. Chemosphere, 50(6):775-780.

World Bank. 2002. It's Note Over When It's Over: Mine Closure Around the world, Mining and Development Series. World Bank and International Finance Corporation.

An assessment of water supply and sanitation by Lusaka Water and Sewerage Company: a case of Kaunda Square compound, Lusaka, Zambia.

(2nd Zambia Conference on Mining, Metallurgy and Groundwater Resources)

Charlotte Nganga and Dr Bunda Besa /

University of Zambia, School of Mines, Department of Metallurgy and Minerals processing
Email: Chalotte.nganga@gmail.com

Abstract

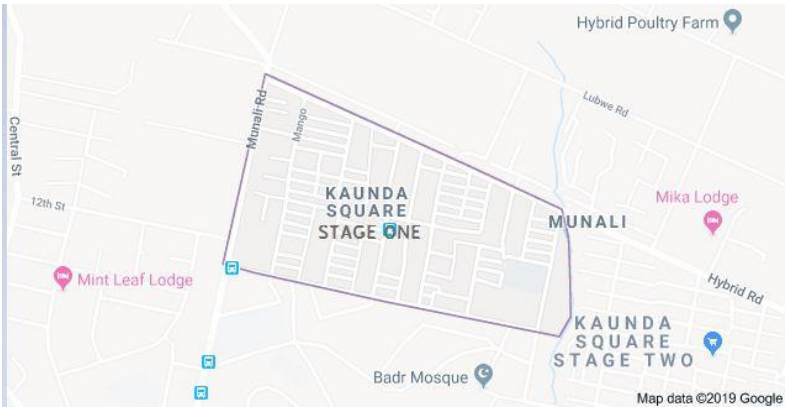
The purpose of this study is to assess the water supply and sanitation services to peri-urban area by Lusaka Water and Sewerage Company in Kaunda Square compound. The water supply and sanitation services has been a major concern in Lusaka, Zambia. The water supply capacity current is at 35,000litres per day insisted of 80,000 litres per day for population about 3,311 households. Therefore, Lusaka Water and Sewerage Company the service provider are not meeting the demand for water supply. The main objective of this study is to improve on water supply and sanitation services in Kaunda Square. Other objectives include determining the causes of low level of water supply and sanitation service in the township. Identifying socio-economic impacts associated with the low or shortage water supply to be identified. The convenience selection was used of household respondents and purposive selection for service provider and other institution stakeholders in water supply and sanitation sector. The sample size population was hundred (100) households and six (06) from stakeholder's institution that is two (02) from Lusaka Water and Sewerage Company (LWSC), two 02 from Lusaka City council (LCC) and two (02) National Water Sector and Supply and Sanitation (NWASCO) respectively. The data was collected by using semi-structured questionnaires, and semi-structures interviews guides, as well as secondary data from UNZA library then other documents published and unpublished related to my research topic. The study revealed that water supply is insufficient to meet the demand and water supply hours has been reduced due climate change, lack of investment in water infrastructures resulting in shortage of water. In addition, the large family size coupled with the extended family system in Zambia meant that households required more water. Another problem was that most of people are informal employment thus, they do not manage to pay their water bills. Furthermore, there is inconsistent of monitory of the quality of water in terms clean or dirty. The sanitation services has deteriorated due to increasing population in the community, the system is overloaded to the maximum and there is no maintenance at all. In order to improve service in the study areas the

service providers should invest in water infrastructure as the current capacity is small to cater for increasing population so that water supply and sanitation service delivery is improved.

Key words: Institution, Sanitation, Population, Water and Sewerage

1.0 Introduction

Water is a natural renewable resource and one of the important public resources. Access to sufficient and clean water is critical to the development of any area such as wealth creation, poverty reduction, food security and disease prevention. Water is usually considered as a public good due to its multi-purposes natural and also an economic good. Most of the developing countries water and sanitation systems face infrastructural and resource deficits, this often leads to cities having limited access to safe drinking water and the access to good sanitation services are also often fragmented in most per urban communities (Chanda, 1997) Kaunda Square Stage 1 and 2 compound, a peri-urban area in Lusaka can be understood from a historical development of Lusaka City. Schlyter and Schlyter (1980) stated that Lusaka City was established by the colonial leadership to serve as an administrative centre for Northern Rhodesia. The original plan for the city did not mark out any land for African settlements. The indigenous people were expected not to settle permanently in the city. But in 1933 the plan was modified to accommodate African settlements and this saw the emergence of Kabwata, Kamwala, Kaunda square and Chilenge etc. Therefore, the situation changed more at independence were rapid urbanization was experience and due to limited accommodation. The water service provision in Kaunda square has history alongside because the township started off as planned settlement with many others townships in Lusaka city where there was properly planned water infrastructure and sanitation service. The early settlers used to draw water from shallow wells but this water was certified unsafe for human consumption by the Department of water.



1.1: Location of study area (Kaunda Square compound stage 1&2)

2.0 Material and Methods

2.1 Statement of problem

Despite providing water and sanitation services in Kaunda Square by service provider suppliers 35,000 liters per day. However, the demand has gone up to 85,000 liters per day. This that the service provider do not seems to be meeting the demand for water supply.

Figure 2.1: The figure below shows the amount of water supplied in Kaunda Square Stage 1 and 2 in 2018 was 39, 000 litres per day and in 2010 was 80,000 litres per day, the water supply has been reduced and this means that people unable to meet their daily need.

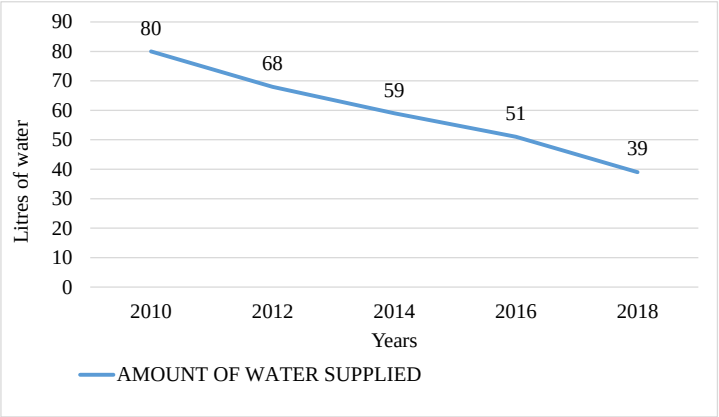


Figure 2.1 Amount of water supplied at Kaunda Square (LWSC,2018)

The water demand in 2010 was at 35,000 litres per day the demand was low and the water demand gone up to 85,000 litres per day in 2018.

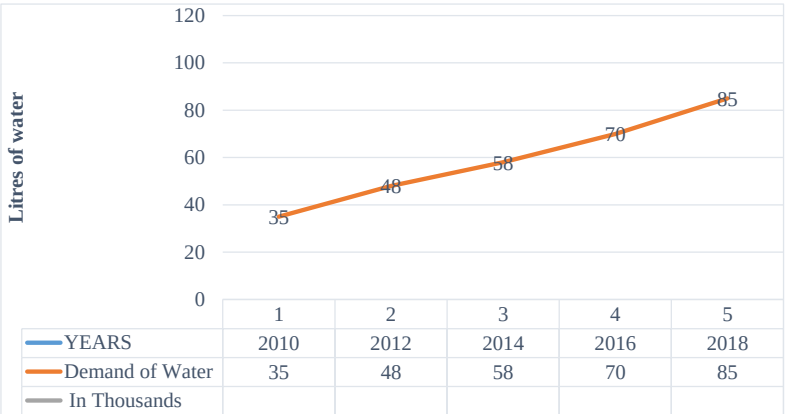


Figure 2.2: Demand of water in Kaunda square (LWSC, 2018)

According to Figure 2.1 and Figure 2.2 This it shows that the water service provider not meeting the demand for water supply in the area, people are unable to meet their daily need. Therefore, people in the area are forced to walk long distances to outsource water from other source for example, nearby stream, shallow wells and borehole respectively.

2.2 Main Aim

To come up with ways to improve water supply and sanitation in Kaunda Square

2.2.1 Special Objectives

1. To determine causes of low level of water supply and sanitation service in Kaunda Square
2. To identity socio- economic impacts associated with the low water supply to be identified.
3. Suggest ways of improving water supply and sanitation services in Kaunda Square

2.3 Methods

The results were qualitatively presented and analyzed. Convenience for residents and purposive organization. Semi-structured questionnaires and interview schedules was used. Data obtained was analyzed by coding and grouping them in themes. The data was converted manually and summarized by using descriptive statistic.

2.4 Literature review

According to the UN World Water Report 2 (2006) Water is the primary living resource and one billion of people world –wide are living into poverty due to lack of adequate of safe drinking water and this represents one-sixth of the total world population who through sickness, hunger, thirst, destitution and marginalization. Water quality provision and management can only be understood within the context of the water's roles in the world today as many of the socio- economic systems are becoming linked at an unprecedented rate. Economic and social development it depend on exploiting natural resources such water.Water scarcity, poor water quality, and inadequate sanitation negatively impact food security (UN, 2006)According to UNEP (2002). Africa is one of the world driest continents. The diminishing availability of usable water in the face of rising demand create the potential for disputes and conflict over water resource both within countries and between countries. The continents water resource are scatted in that, while some areas receive more than enough water, other experience drought. This result in recurring cycles of long drought in some parts of the continent and sometime followed by floods, accentuate water scarcity and unbalance of the continent. According to Namafe, 2013. He that there is insuffient of water supply to meet the demand for domestic as well as small business. Currently, the water supply capacity to Ng'ombe compound stands at approximately one million litres per day enough to service about 50,000 people out of 80,000. Further, explained that inadequate distribution of network, being a peri-urban areas, it has proved to be difficult for the service provider to facilitate expansions works through

proper pipe installation due to overcrowding in the community and utility company had found it difficult to negotiate with some residents over network expansion as some of these pipes have to pass through residential buildings. And also, the lawlessness of people in the area the vandalism on the water equipment's, some residents deliberately destroy water pipes and taps while others do so as theft to sell the equipment and earn some money. Furthermore, Carol, 2013. She has explains that most of the investments in water supply and sanitation come from international finance and donors agencies but these were by far below the funds required by the sector and also, the local funds from the government were in short supply as the result as that huge gaps in terms finances were created and service delivery was problems in most cases.

3.0 Results /Discussion

3.1 Objective 1: What determine shortage of water?

Generally, NWASCO who came up with time frames to show suitable supply hours for each community type. As provided for in their brochure, NWASCO (2011) stipulated that service providers should aim at providing their customers of a certain daily time average of water supply at connections, as well as the operating hours of public service points. The targets of water supply hours were such that big towns should have 24 hours of water supply, while small towns should have at least 16 hours of water supply. The time recommended for public standpipes posts, particularly in peri-urban areas or the so called low income communities, on a daily basis, was at least 12 hours (Table 1).

Table 3.1 Suitable Water Supply hours recommended by (NWASCO, 2011)

AREA	SERVICE HOURS
Big towns	24 hours
Small towns	16 hours
Public posts	12 hours

According to the figure 3.1 below the 70% representing of the respondents have water available for at least 6 hours or less in a day which is not adequate water supply to meet their demands. It was observed that those who are able to meet their water demands are those who people whose sources of water are boreholes at 7% and wells they were 3%.

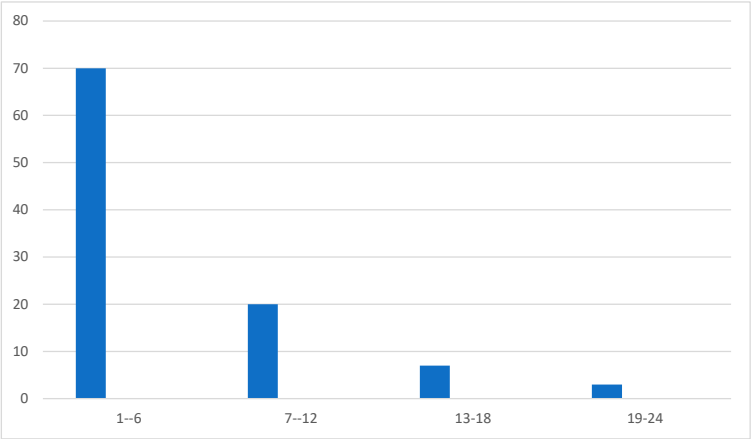


Figure 3.1 Frequency of Water Availability of respondents in Kaunda Square Lusaka, Zambia.

Demand of water and deficit of 50,000 litres per day.

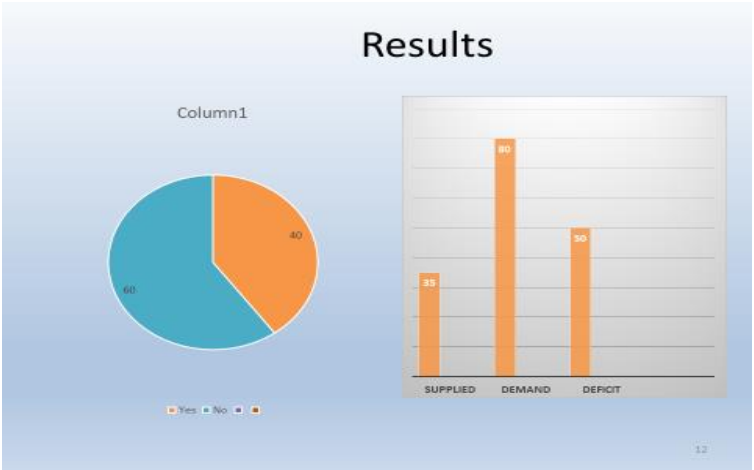


Figure 3.2 Meeting the demand of water and deficit of 50,000 litres per day.

Figure 3.3 Shallow wells

The people have to search for water a distance of 100m and some have to walk 400m in search for water. These distance represent those which the residents in the study area had to cover in the procees of scouting for water figure 13. The (LWSC) acknowleged that this this adversely affected the health of women and children leading to possible chest complication. It was observed that those residents not having access to clean water they make use of alternative sources which are boreholes, wells and streams.

Quality status of water that be provided

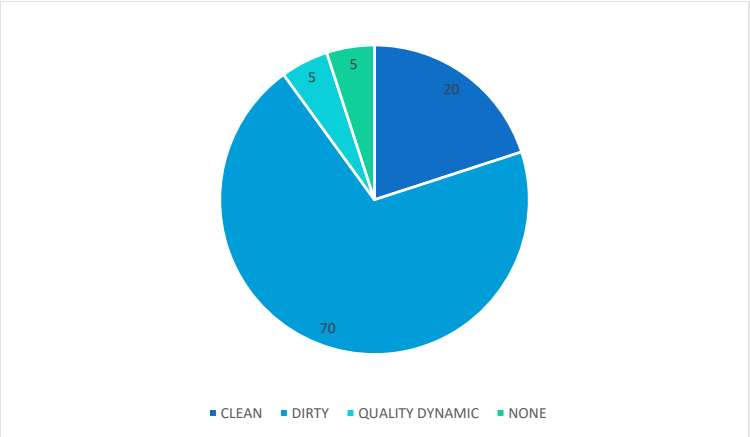


Figure 3.4 Quality status of water provided

The 70% represented of residents in the described the water as being dirty whereas 20% of them described the quality status of the provided water as being clean and this was in terms of either colour appearance, taste of the water or indeed both. In contrast only 5% of the residents

in Kaunda Square Township had no comment at all and 5% they said quality is dynamic. Water quality is very important due to the health impact on the consumers.

Family sizes in the households connected to water

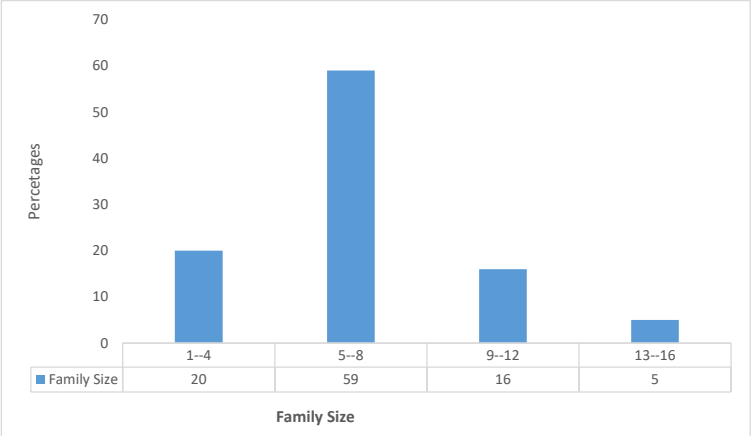


Figure 3.5 Family Size of Respondents in Kaunda Square Lusaka, Zambia.

This shows that family sizes of respondent in Kaunda Square Township, many house had an average family sizes of 5-8 people amounting to 59% of the total population sampled. This means that almost half of the population requires water for day to day uses to cater for 8 individuals in and per household. This exerts more pressure on the limited fresh water sources.

Pipe breakdown, interruption and slow in response from complaints

Figure 3.6 Pipe leaking **Figure 3.7 Replacement of the Pipe**

Furthermore, all these problems instigate inadequate, low expansion to underserve area and low levels in access to water supply and sanitation. In addition, lack of financial resource was seen through the service provider by failing to meet operational cost from service bills because water supply and sanitation bills are sub-sided in Zambia this is to ensure that all consumers can afford to access the services. This has implicated on operational costs incurred by service providers to enable them improve service delivery in study area. . Another important cause of problem in water supply and sanitation in the country is inappropriate political interference on operating decisions such as personnel policy or tariffs set by services provider. This complicates the establishment of effective and efficient supply structures and their sustainability.

Objective 2: Socio- economic impacts

Inadequate water supply and sanitation services have adversely affected the quality of life and public health conditions of the people living in the study areas. The hardship experienced by the people, especially women and young girls in obtaining water severely constrains their ability to improve their living conditions. The poor households are particularly vulnerable because they lack resources and alternatives to protect themselves against these adverse impacts Therefore, ill health imposes economic hardship and impoverishment particularly on poor household as a result of the reduced capacity of the sick and those who support them to engage effectively in productive work to poor peri-urban settlements where water supply and sanitation conditions are currently in a deplorable state? The spread of diseases is attributed to the use of water from unprotected shallow-wells or streams, which are easily contaminated from broken down sanitation facilities in close proximity and low awareness of personal hygiene among the population. Due to the poor living conditions, the main problems facing the people in the project area include: poor health and morbidity, loss of productivity resulting from illness, and loss of school hours by children particularly girls, are all related to the poor quality and low coverage of water supply and sanitation services.

An assessment on sanitation is still low with many people lacking public sewerage and the sewage is virtually untreated. The results are a constant threat to the health of the entire population, a perpetuation of unmet basic needs of the poor, and a steady deterioration of the environment.

Example given below on figure Outbreak of water borne diseases.

Figure 3.8 Overflow of sewer Kaunda Square Figure 3.9 Sewage resaving facility (ADB, 2018)

Socio-economic activities adversely

The majority of people in Kaunda Square are employed informal sector as it shown in (figure 10) below such as running small business enterprises, bricklayers, traders and so on. It was further observed that the shortages of water affects their socio- economic activities adversely. These informal activities require a lot of water, for example, traders such as hair saloon wash the hair for customers, marketers have to often times wash their vegetables and other foods to keep them fresh whereas bricklayers requires a lot of water for making blocks for sale. Those who runs restaurants they need a lot of water for cooking, washing plates and also to keep their surrounding cleans. Figure 3.10 below was the examples of Kaunda Square Market

Objectives 3: Ways to improve water

Strengthening collaboration among key stakeholders, the service provider realised that, there should systematic techniques put in place to effectively recover operations and maintenance costs from water users. Further, they should be an adequate tariff policy to promote effectives cost recovery of capital resources and preserves the social objective of providing equity of

access and free basic water supply for poorer consumer groups. The capacity building of personnel providing service to improve service; improved funding to the water supply and sanitation sub-sector and stakeholder participation among others.

In addition, the stakeholders formed a collaborative platform called the Lusaka Water Security Initiative which plan and implement projects that could address the threat and improve water security for the city residents and its business. And also to Identifying training needs and training personnel was important for improving water supply and sanitation service delivery. The ways of improving water supply and sanitation service such as in-house capacity building was done for individuals implementing Operations and Maintenance on the ground; financial management; and various activities in water supply and sanitation to equip them with skills and techniques necessary for their assignments.

Furthermore, the best application of financial management and office management are cardinal to sustain service and ensure customer responsiveness. Essentially, the two ensure financial viability on the part of the service provider while ensuring quality service for the consumer. Good water supply and sanitation reticulation networks do not encourage leakages of water hence losses on unaccounted for water are avoided; leakages in sewer waste are also avoided hence environmental contamination ceases to be a problem; and clean pipes reduce the risk of providing water to consumers hence improving consumer service. Service providers understand these important aspects hence the importance placed in building employee capacity in the study area. The need for identifying training institutions with relevant courses should, therefore, be prioritised, as well as the reviewing of existing training modules. At times, in-house training activities work best particularly when internal knowledge gaps exist and training is most tailored to fill those specific gaps identified.

4.0 Conclusion

In conclusion, the importance of water and sanitation as a service to communities cannot be over emphasized. While some countries have made huge strides in meeting the needs of their people with regard to water and sanitation, especially the developed world. It appears that there is much to be done for the developing world. Water is not only important for people it is also important for the environment and more or so for the many operations within the human activities. The bigger part of water is that it is not only important for humans but also for the environment and the way we use water may consequently lead to disturbances of how we need to take care of our environments.

Sustainable development ultimate goal is to target environmental challenges and social systems, because these are complex and ever changing, this can be advance by the idea that

sustainable development is socially constructed phenomenon. Also it must be understood that sustainable development cannot be defined in absolute terms and this is because sustainable development changes with dynamics of time and approaches used depends on the prevailing situation. In additional, those that manage waters systems seem not to understand what need to be done in water resources area. There is need to embrace sustainability if water issues are to be addressed. Foremost mangers of water need to understand population growth and dynamics of climate change and as well as the ever increasing demand for water as a results of the industrial revolution activities such as agriculture and mining. There is also need to embrace the role of other stakeholders to foster inclusion and participation in establishing approaches or management of water and sanitation services that are more sustainable and Progressive. There is no need to use a top down approach if the problem of water is to be addressed and that is why community participation is very crucial in this undertaking and there is insufficient of water supply to meet the demand for domestic use as well as small business such as restaurant and bricklaying .In addition, inadequate distribution network in the area it has proved it very difficult for service provider to facilities the expansion works through installed pipe line in this area which is called closed up area where population keep on increasing but the capacity of water supply remains the same. Further, large family size coupled with the extended family system in Zambia which has resulted in increased water demand. This assessment established that the service hours were fewer than the general recommended proposed NWASCO more supply hours were need in the area in order the residents can meet their daily demand.

Furthermore, the water supply in terms of quantity, quality and availability was not satisfactory accordingly to the SDGs standards. Although, the Lusaka Water and Sewerage Company (LWSC) provide piped water supply through in house water connection and yard taps connection, the service are still in inadequate. This was evidenced enough through frequent pipe breakdown, services interruption, slow in response from complaints from consumers and water supply shortages. Therefore, there is need to increase the services in order to improve access to water supply and sanitation services and it is necessary to consider alternative that can suit the community condition in high density areas. Equally, access to sewerage services that are safe is low and inadequate. The lack of running water for most households prevented households in the area to have a safe clean water supply and access good sanitation services.

However, efforts had been made by service provider to improve this services. The water supply and sanitation service provision in many countries experience a number of problems which can be classified into financial, institutional, operational and technical. Another, important cause of problems in water supply and sanitation in country is inappropriate political interference on

operating decisions such as personnel policy or tariff setting by providers. This complicates the establishment of effective and efficient supply structure and their sustainability. Being a peri-urban area, it has proved to be difficult for service provider to facilities expansion works through pipe installation due to over-crowding in Kaunda Square. The water utility company has found it difficult to negotiate with some residents over network expansion as some of these pipes have pass through residential building.

5 .0 Recommendation

- To improve on the quantity, quality and availability of water supply and sanitation services. There should be stringent measure to put in place at time and to ensure that all requirements are meet by service providers.
- Residents and their water provider need to be driving efforts together in improving the water supply and sanitation services.
- The community participation should be encourage through bottom up approach by using women groups such as religion and traders to enable them discuss how to use water wisely.
- The LWSC need to increase its water capacity to the study area if the residents are able to be served with adequate of water supply and sanitation service.
- There is need for NWASCO to increase its monitoring activities of the water sector to make sure that they are committed to the affordability sustainability and improvements of the water supply services.
- The Government should review its budgetary allocations so as to direct sufficient financial resource to the water sectors empower them.
- The Government should include water use and conservation be part of the school curriculum for children who will then be ambassadors for change.

Acknowledgements

My sincere gratitude goes to my supervisor Doctor Besa B. for his tireless guidance and support during my research process. Many thinks also go to my sponsors The University of Zambia in school of Mine, ESDA and my family for the financial supported provided to me during my research.

REREFENCES

Africa Development Bank ADB, 2018. Master plan 2011, Lusaka. Zambia.

Chanda, O.M., 1997. Investment requirement for the water supply and sanitation scheme water sector ground, Lusaka, Zambia.

Cheartle, M.E., 1996. Water supply, Sewerage and drainage, in Williams, G.J. (ed).Lusaka and it Environments. The Geographical Association.

European Commission, 1998. Guidelines for water resources development cooperation Brussels.

Ekpo, Odoemene & Wobo, 2008 .Helminthiasis and Hygiene Conditions of Schools in Ikene, Ogun State, Nigeria. Department of Bio-Science and Agriculture at the University of Nigeria. "Journal Science Daily.

Government Republic of Zambia (GRZ) 1994. National Water Policy. Lusaka. Zambia.

Government Republic of Zambia (GRZ) 2008. Integrated water resource management and water efficiency (IWRM/WE) Implantation plan volume1 main report (2007- 2030) Lusaka. Zambia

Lusaka Water and Sewerage Company (LWSC), 2018. Challenges of domestic water supply and sanitation. The LWSC experience, Lusaka Zambia.

Lusaka Water Supply Sanitation Drainages (LWSSD), 2010. Lusaka Water Supply and Sanitation and Drainage. Lusaka, Zambia

Mbilima, K.C (2008) Water Supply and Sanitation in Zambia: Reform and

Regulation, Lusaka, Zambia.

Ministry of Local Government and Housing (MLGH) 2005. National rural water supply sanitation programme (2006-2015) Lusaka. Zambia.

Ministry of Local Government and Housing (MLGH) 2005. Sanitation and hygiene component of the national rural water supply and sanitation programme (2006-2015) Lusaka. Zambia.

MLGH (2008) National Urban Water Supply and Sanitation Programme 2009 – 2030. Background and Analysis. Lusaka, Zambia

Namafe, N. 2013. Challenges of quality water provision to peri-urban areas by Lusaka water and sewerage company .UNZA. Lusaka, Zambia.

National Water Supply and Sanitation Council (NWASCO) 2017. Urban and peri-urban water supply and sanitation sector report, Lusaka. Zambia.

National Water Supply and Sanitation Council (NWASCO) 2014. Water Supply and Sanitation Sector, Lusaka. Zambia. NWASCO (2011) Urban and Peri-Urban Water Supply and Sanitation Sector Report
2010/2011. Lusaka. Zambia.
National Water Supply and Sanitation Council (NWASCO) 2010. Calendar. National Water and sanitation Council.
National Water Supply and Sanitation Council (NWASCO) 2004-2005. Urban and peri-urban water supply and sanitation sector report .Lusaka. Zambia.

Schlyter, A. and Schlyter, T., 1980. George the developing of a squatter settlements in Zambia, Lusaka. Swedish Council for Building Research.

Seifu A. el at., 2012. Water supply and sanitation in Amhara region. Learning and communication research report. Bahir, Dar. Ethiopia.

Southern Africa Development Community (SADC) 2000. Water for the 21st Century – A vision for Africa. Water Sector coordinating Unit.

Southern Africa Development Community (SADC) 2004. Region water supply and sanitation programme.

UNEP, 2002. Africa environmental outlook; past, present and future, perspectives; UNEP; Hertfordshire world resource institute.

United Nations (UN), 2006. Water –a shared responsibility; The U.N world water development report 2, UNESCO, New York.

UN-Habitat, 2006. State of world cities 2006-2007; Report presented at the MDGs and sustainability'

United Nations (UN) 2018. Sustainable Development Goals; synthesis report on water and sanitation.

Assessing the socio-economic impacts of mining: a case of Kalumbila District

(2nd Zambia Conference on Mining, Metallurgy and Groundwater Resources)

Bustone Chibwe, Bunda Besa, Lordwell Witika
Department of Metallurgy and Mineral Sciences.
School of Mines, University of Zambia
Email: chibwembustone@gmail.com

Abstract

Kalumbila District of the North-Western province of Zambia has become a hub of economic activities. Since commencement of mining in 2008, the district is now home to two large mines namely, Lumwana and Kalumbila mines. Commercial mining in Kalumbila district offers a mixture of socio-economic challenges and opportunities to local communities and chiefdoms. Linked to resolutions of the African Mining Vision (AMV), the favorable impact of mining in the district is evidenced by such things as promotion of local content which creates opportunities for local products and businesses. Other observed benefits include creation of employment opportunities, enhanced healthcare, quality education, business opportunities, good roads and transport systems. However, when you look through the lens, the positive impacts of mining are eclipsed by the potential negatives. Occurrences such as displacements from ancestral land, loss of cultural values, increased crime, slum settlements and road traffic accidents cast a shadow on the benefits. Therefore, the paper deliberates both beneficial and adverse socio-economic effects of mining in Kalumbila district.

Key Words: Mining, socio-economic and sustainability.

Introduction and Background

Mining in Kalumbila district offers a mixture of opportunities and challenges to local communities. Despite hosting Two giant mines, Kalumbila district of the North-Western province of Zambia suffers from a resource curse and is still one of the poorest regions of the country (Chisukulu, 2014). Proceeds from the mines do not directly translate into improving the area and people's lives. Infrastructure development in Kalumbila trails behind other districts with similar or no mineral wealth. In the social context, the influx of people in the district has caused significant changes in the social dynamics of the area. Slums in Kisasa and Manyama have grown to levels where modernization of such settlements to improve service delivery is not an easy option. Town planning for expansion was inadequate. There are complaints of compromised water quality and deliberate displacement of people in Musele Chiefdom caused

by manmade dams. Dependence on corporate social responsibility (CSR) is rife among communities. In the mind of most community members, there is no clear distinction between government and mining company responsibilities in delivering social services.

An implication for the government is that, upgrading and modernizing slum settlements for improved service delivery have become a challenge. Government must therefore look to planning new settlements that will be organized and furnished with necessary social amenities. Learning from such experiences, planning authorities must be proactive to end the trend in future large scale mining investments. The growth of modern cities and settlements is at the heart of Sustainable Development Goals (SDGs). Therefore, the government must look for incentives to encourage mines like Lumwana to build a modern township that will attract growth of other economic activities and shopping malls outside the mine license area. Dependence on CSR must not be an option because, it is expressed out of the company's good will. Equally, the mines have other statutory obligations to meet. Therefore, there is need to consider negotiating shares for the government and local chiefdoms especially in future investments. Additionally, the government should consider changing legislation to ensure at least a minimal percentage of revenues from the mines are ploughed back into developing host communities.

Material and Methods

A qualitative approach to data collection was adopted in this study. Methods employed included: focus group discussions, questionnaires, and interviews with communities around Kalumbila and Lumwana mines. A variety of sources including literature and company publications were also consulted. Where practically possible, respondents were stratified into sex and age groups. Village group leaders were also interviewed separately to accord the subjects freedom to express themselves when it comes to disclosure of sensitive matters. Convenience sampling was employed in most cases especially were filling questionnaires required some level of understanding and expression in English. Interviews and focus group discussions were more appropriate for those who could not express themselves in English. The researcher had to rely mostly on the availability of an interpreter as well as his limited understanding of the local languages. Quota sampling technique was used to determine the sample size.

Results and Discussion

With the research in progress, partial results and a prognosis have been given and discussed. Results have been classified as either positive or negative as shown.

Positive socio-economic impacts:

The study presents many positive socio-economic impacts as follows:

(a) Promotion of local content

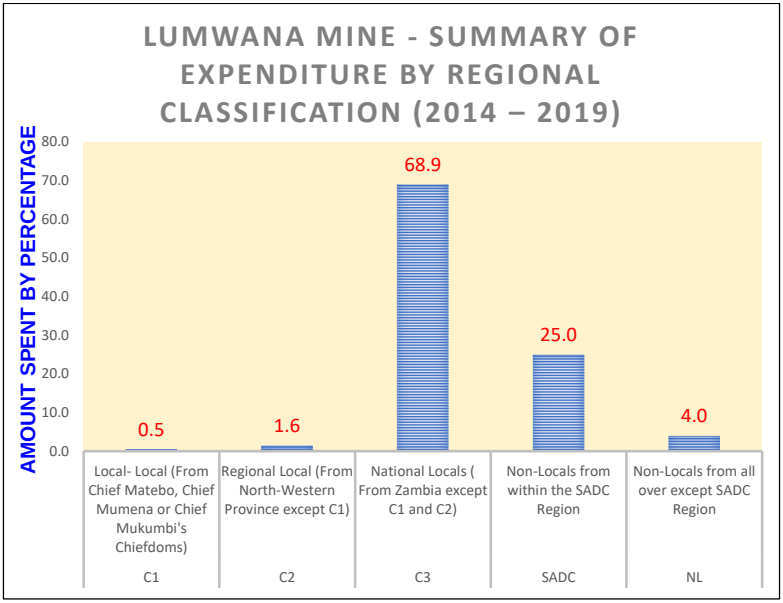


Figure 1: Lumwana mine six year summary expenditure by regional classification (2014 - 2019)

The last six years average spent for Lumwana shows that, most of the products and services acquired were locally produced. However, supply from local chiefdoms and the Northwestern province were minimal at 2.1% total. This is partly due to lack of specified skills and capacity by community members from local Chiefdoms and the province. However, there is need to focus more on capacity building to increase the share from within the province and local chiefdoms.

Linked to the African Mining Vision (AMV), the mines in the district are committed to promote local content (UNECA, 2009). For Lumwana, this is exercised through the awarding of most contracts to local businesses and purchase of quality local products. Examples include the purchase of locally produced grinding media by Lumwana mine and to some extent, Kalumbila mine. Between 2014 and 2019, Lumwana spent 71% of its total expenditure on locally

produced goods and services. The SADC region and the rest of the world got 25% and 3% respectively. However, there are still questions on who constitutes the 68.9% owned by local Zambian companies.

(b) Improvement in social service delivery and employment creation

Mining in Kalumbila district has caused an improvement in employment opportunities. In this regard, local people with prescribed minimum education have been given preference for jobs where no special skills are required. In both mines, recruitment for semi-skilled jobs is done through local registers from Chiefdoms. 65% of the workforce at Lumwana mine is sourced from the Local Chiefdoms and the entire North-Western province. This is according to the Sustainability presentation made available to ESDA in October 2019.

In the social sector, the mines have greatly contributed towards healthcare improvement and delivery of quality education. According to Silimina (2019), Lumwana mine through the Lumwana community trust (LCT) has constructed a three-classroom block at Kambulumbulu, Mukonzhi, and Mushingashi primary schools. Additionally, the mine has constructed a two classroom block at Kakaindu primary school. Still in the education sector, Lumwana mine has constructed three staff houses at Matebo, Tundula and Lumwana East primary schools. Other assistance includes improved sanitation through construction of toilets at Kipemba, Mbulungu and Tundula primary schools. Lumwana mine also facilitated the rehabilitation of Mwajimambwe Day School where the roof had been blown off (Silimina, 2019). Still in the education sector, community members in Kawelang'a of Musele chiefdom reported that, Kalumbila Minerals Limited (KML) has constructed a one by three (1 x 3) classroom block at Mukila Wantambo and Musele primary schools. Additionally, KML has eased teachers' accommodation by building three staff houses at Musele primary school.

In the health sector, Lumwana has constructed a maternity wing at Mukumbi clinic and an incinerator at Holy Family Clinic to improve health management. On the other hand, KML has built a maternity wing at Musele clinic and two staff houses.

Some respondents believe that, construction of the first ever hospital (Lumwana hospital) in the area and creation of Kalumbila district itself by government was motivated by the presence of mines. It is appreciated that this has brought healthcare and service delivery closer to the people. Other people interviewed acknowledged the increase in business opportunities and improvement in money circulation. There has also been an improvement in roads and transport availability. Previously, people used to wait for days to travel outside the district.

The mines are also helping women and men through creation of cooperatives and provision of start-up capital. According to the District Agriculture Assistant, Louis Mwape, LCT has constructed a poultry building at Kantu Women Club with 200 chickens as start-up capital. LCT has also set up a hammer mill and provide empowerment to Kaselu Club at a cost of K115,000 and K84,000 respectively (Silimina, 2019).

Negative socio-economic impacts:

Negative socio-economic impacts of mining in the district have also been recorded. According to the Oxfam (2018), the positive impacts of mining cannot offset the potential negatives. These have been presented and discussed as follows:

(a) Inadequate promotion of local content within the province

Statistics for Lumwana mine have shown that promotion of suppliers from local chiefdoms and the North-western province is inadequate, accounting for only 2.1% of total procurement in the last 6 years. Local suppliers from Chiefs Matebo, Mumena and Mukumbi only got 0.5%, and Suppliers from the rest on Northwestern province received 1.6%. One would argue that this is one of the major reasons for inadequate development in Kalumbila district and the entire North-Western province. Statistics need to change to ensure a bit more money remains in the district. Partnering of local suppliers with seasoned counterparts from the rest of Zambia and International companies can be one way to build capacity in local businesses.

(b) Inadequate infrastructure and economic diversification to support growth

Infrastructure development in Kalumbila district itself trails behind other districts with similar or no mineral wealth. There are fewer banks and lending institutions which in any case charge exorbitant interests on funds borrowed. Compounded by inadequate planning for the use of funds, most people in the district have been thrown into never ending debts. Diversification into such economic activities as agriculture is happening at a very slow pace. This is mostly worrying because, sustenance beyond mining days will be a challenge. The district is blessed with fertile soils and a good rainfall pattern to support agriculture.

(c) Population explosion

Kalumbila Town Council (KTC) reports that, population in the district has increased by 66.6%, from 85,505 in 2010 to 142,444 in 2018 (DSA, 2018). In the social context, the influx of people in the district has caused significant changes in the social dynamics of the area. This has given rise to loss of cultural values and an increase in sexually transmitted diseases. Competition for jobs and accommodation has increased while prices of goods and services have escalated, often

disadvantaging the indigenous people with no means. Schools are overcrowded and cases of communicable diseases have increased while cultural values are eroding. At Mwajimambwe Secondary School for example, an average class has 55 pupils against the recommended 40 per class (SACMEQ, 2011). Due to inadequate classrooms, a one by three (1 x 3) classroom block has been divided into six classrooms using traditional mats as shown in Figure 2. At the same school, pupils are sharing an improvised science laboratory, not conducive for learners. Figure 3 refers. Crime has increased while the improvement in roads and transport systems has increased cases of road accidents which are often claiming lives.

Figure 2: Learners in classroom blocks demarcated with traditional mats at Mwajimambwe Secondary School in Kalumbila District

Figure 3: Science Laboratory at Mwajimambwe Secondary School

According KTC, the rapid demographic growth has caused an increase in demand for accommodation. This has led to an increase in unplanned settlements and slums in locations like Kisasa and Manyama compounds of Kalumbila district. Provision of social services to such areas is a great challenge for the local authority. The growth of unorganized settlements and slums works against the attainment of Sustainable development goals (SDG). SDG number 11 advocates for building cities and human settlements that are sustainable for all (Osborn, Cutter and Ullah, 2015). In the case of Manyama (near Lumwana mine) and Kisasa (near Kalumbila mine), it is rather late for the Local Authority to reorganize such settlements.

(d) Displacement of people and negative effects of artificial dams by the mines

Most people have been displaced to pave way for mining activities. Crops have been destroyed by water from artificial dams created by the mines. A typical example of where such is happening is Kawelang'a community of the Musele Chiefdom where cassava crops have been destroyed, the traditional graveyard is said to be submerged in water and people must travel 8km to another village to bury their loved ones. The Musele palace is now a few meters from the advancing water from the Kawelang'a dam. It is believed by community members and Civil Society Organisations (CSOs) consulted that, the mine has blocked the Kawelang'a River causing the water to start advancing towards the village and the Musele capital. According to community members, this is a deliberate plan by the mine to push them out of their ancestral land. However, there is evidence of disagreements over ownership of land in question as both the mine and community members subscribe to the claim. There are also widespread concerns among the local people that the mine (Kalumbila) has acquired too much land which is held under many licenses. Jessica and Dimuna (2015) report that, KML's Trident project owns a total space of 51800ha (518km^2) held under five large-scale mining licenses acquired in April 2011 (15868-HQ-LML, 15869-HQ-LML, 15870-HQ-LML, 15871-HQ-LML and 15872-HQ-LML).

Figure 4: The researcher interacting with Kawelang'a community members (a) and group discussions (c - d) - women above 30 years joined by the Village head man (b), male and females below 30 years (c) and men above 30 years (d)

Figure 5: Women of Kawelang'a Community watching the extending dam helplessly (Left) and Kawelang'a Dam (Right)

Figure 6: Cassava Ridges (Left) and a Banana Tree surrounded by water in extending Kawelang'a Dam

Figure 7: A woman of Kawelang'a Community displaying spoiled Cassava (Left) and the same woman harvesting Cassava from a ridge surrounded by water (middle) before displaying an empty stem (Right)

Figure 8: A Woman of Kawelang'a community (left) displays some of the good cassava salvaged from the land

while a man on the right shows the spoils. Behind the woman, some community members have taken advantage

of the water to grow vegetables.

(e) Inadequate preparation for sustenance beyond mine closure

Implementation of sustainable programs for continuation of life after mine closure in the district is inadequate and happening at a very slow pace. Although this is happening at a small scale through funding of cooperatives, there is no evidence of serious diversification. Against the AMV, there is no collateral use of proceeds to open-up other resource potential such as agriculture, forestry and tourism (UNECA, 2009). In the absence of "future funds" and investments in other sectors of the economy, life after mine closure is expected to be challenging. There is also too much dependence on Corporate Social Responsibility (CSR) among the locals for provision of social services and funding of empowerment programs.

Conclusion

Mining in Kalumbila district offers a mixture of positive and negative impacts. Socio-economic benefits from mining are trickling into the district but minimal considering that it is out of good will expressed through CSR. Sustenance after mining is not very much assured considering that diversification into other economic activities is not visible. Despite the many benefits proceeding from the presence of mines in Kalumbila district, more needs to be done by all stakeholders to ensure mining benefits all (Share holders, government and ordinary community members living around the mines)

Recommendations

The government should consider changing legislation to ensure at least a minimal percentage of revenues from the mines are ploughed back into developing host communities. Secondly, there is need to move away from dependence on Corporate Social Responsibility (CSR) which is expressed out of good will, to consider negotiating shares for the government and local chiefdoms. This will not be easy for existing mines. However, it must be especially considered for new mining projects. Upgrading and reorganizing slum settlements like Kisasa and Manyama will be challenging for the local authority. Therefore, the Government working with the local authority should entice mines like Lumwana to build good and affordable houses outside the mine license area for development of Kalumbila district. To avoid reoccurrence, responsible government planning departments must be proactive to take care of such in future large scale mining projects.

References

Chisukulu, D. C., 2014. *Mine growth and socio-economical impact in North-western province of Zambia: Lumwana,* Netherlands: Leiden University.

DSA, 2017. *District Situational Analysis,* Kalumbila: s.n.

Jessica, C. & Dimuna, P., 2015. *Large-scale land acquisition in Zambia: Evidence to inform policy,* Cape Town: University of the Western Cape.

Osborn, D., Cutter, A. & Ullah, F., 2015. *Universal Sustainable Development Goals: Understanding the Transformational Challenge for Developed Countries,* s.l.: Stakeholder Forum.

Oxfam, 2018. *Impact of Mining.* [Online] Available at: https://www.oxfam.org.au/what-we-do/mining/impacts-of-mining/ [Accessed 5 November 2018].

SACMEQ, 2011. *Quality of primary school inputs in Zambia,* s.l.: Southern and Eastern Africa Consortium for Monitoring Educational Quality.

Silimina, D., 2019. Solwezi Today. *Monthly Bussiness News Magazine,* October, Issue 98, pp. 12-16.

UNECA, 2009. *Africa Mining Vision,* s.l.: African Union.

Characterization of land transformations due to coal mining at Maamba collieries, Southern Zambia

(UNESCO 6th Africa Engineering Week and 4th Africa Engineering Conference)

Susan Sichalwe, Bunda Besa, James Manchisi and Jewette Masinja

University of Zambia, Box 32379, Lusaka; +260977367725; susan.sichalwe7@gmail.com;
University of Zambia, Box 32379, Lusaka; +260979351754; bbesa@unza.zm;
University of Zambia, Box 32379, Lusaka; +260969822005; jay.manchisi@gmail.com;
University of Zambia, Box 32379, Lusaka; +260977367725; hichikoko.masinja@unza.zm;

Abstract

In this study, a multifaceted approach involving post-classification change detection method, Remote Sensing (RS), Geographic Information System (GIS) and qualitative methods were evaluated to detect impacts of open pit coal mining on land use/land cover (LULC) and the environment in Maamba, Southern Zambia during 1980-2010. RS, GIS tools and a qualitative approach were used to detect impacts of coal mining on LULC dynamics. The different land use classes primarily settlement, agriculture, water body, forest cover and mining in Maamba coal field area were identified and the impact of land use/land cover change on the environment quantified. The land use/land cover changes were analysed for a period of 26 years from the year 1984 to 2010. The study revealed that settlements increased by 13.97 km^2 (9.8 %) from 1984 to 2010. Cultivated land reduced by 1.47 km^2 representing 1.03%. On the other hand, the water body shows an increase of 0.54 km^2 (0.38 %) during 1984 to 2010. Forest cover shows a decrease of 13.53 km^2 (9.05 %) in the area during the study period. The mining area occupied an area of 3.10 km^2 (2.18 %) during 1984 and 3.60 km^2 (2.52 %) during 2010. This study shows the importance of continuous monitoring of these lands for their effective reclamation and aids urban planners and decision makers to have accurate and up-to-date information as well as help attain sustainable development in the mine. It further demonstrates the effectiveness of a comprehensive approach to study mine impacts on the environment.

Keywords: land use/land cover, remote sensing, mining, sustainable development

1. Introduction

Land as a resource is considered of utmost importance and a source of all material wealth of human beings. Mining of these resources, therefore, is invariably associated with land use and land cover changes (Prakash and Gupta, 1998). In this regard, mining has impacts on the LULC and therefore, earth resource satellite data are critically important and useful for land use/land cover change studies (Yuan et al., 2005). From an environmental point of view, the dynamic process of land use/land cover change is an indispensable concern all over the world, which indicates global environmental change (Ruiz-Luna and Berlanga-Robles, 2003) and this has been recount as the most remarkable regional anthropogenic disruption of environment (Lambin et al., 2003). These changing aspects alter the availability of different biophysical resources including soil, vegetation, water, animal feed and others. Consequently, land use and cover changes could lead to a decreased availability of different products and services for humans, livestock, agricultural production and damage to the environment as well. However, the increased demand for mineral resources has led to increased mining activities and unfortunately let to land use and land cover alterations.

Zambia as a developing country, has over the years experienced an increase in demand for the energy requirement and the coal mining industry is eventually increasing its production to meet the requirement of energy production through thermal power plants, where coal is used for generation of electricity. Zambia's population was at 10.2 million according to the census conducted in 2000 and currently is at 17,609,178 of which 62 percent live in rural areas, (CSO:2000). Population densities are higher in urban areas as compared to rural areas. In third world countries, the livelihood of the majority of the population relies on exploitation of natural resources in a direct manner. As a result, if the population is high, environmental concerns are also high. The Human Development Report for Zambia has shown that there is a strong correlation between poverty and environmental degradation due to poor people's high dependency on exploitation of natural resources for their survival. Population increase in recent years has resulted in an increasing demand for natural resources. On the other hand, Coal production and utilization of coal in Zambia has increased and is confined mainly to the mining industry (54 percent), commerce and industry (37 percent) and the government and service sectors (9 percent) (Sooka and Sikaundi, 2007). However, the contribution of coal to the total energy balance had declined over the years due to operational constraints at Maamba Collieries. However, production has gone up due to fresh investments in the mine after privatization. Proven coal deposits are estimated at over 30 million tons while potential coal resources are

estimated to be several thousand tons. In Zambia, all the coal is mined by a company called Mamba Collieries Limited (MCL) in the southern region of the country. Apart from improving the welfare of the local people through employment and cooperate social responsibilities activities, coal mining has caused degradation of the environment such as soil erosion, increased sediment load, acid mine drainage, air and water pollution (Cao, 2007). Besides, considerable amount of solid waste piled in the form of huge overburden dumps, destruction and degradation of forest, agricultural lands, and discharge of effluents from mines into nearby water-bodies are some of the other associated problems that have adverse environmental impact. Continuous monitoring of these lands is, therefore, essential for their effective reclamation and management. However, reliable and timely information on the nature, extent, spatial distribution pattern and temporal behaviour of degraded lands including land subject to mining, which is a prerequisite for their reclamation and management, is generally not available. Therefore, mapping mining activities and evaluating associated environmental concerns are difficult problems because of the extensive area affected and the large size of individual mines. Monitoring and controlling these changes have been more difficult because of the expense and time in producing reliable and up-to-date mapping.

Besides, a successful monitoring approach for evaluating surface mining processes and their dynamics at a regional scale requires observations with frequent temporal coverage over a long period of time to differentiate natural changes from those associated with human activities. In order to meet such challenges, urban planners and decision makers need to have accurate and up-to-date information for the Proper planning, management and monitoring of the natural resources. Remotely sensed data especially satellite data can be effectively used in mapping as well as monitoring of temporal changes in land use/land cover. On the other hand, decision makers should adopt the use of remote sensing and GIS tools as this would enhance identification of areas that are degraded, their rate and extent. In this context, it is essential to scrutinize the effect of mining on land use land cover change to minimize its impact on environment as well as for proper land management and decision making (Bocco et al., 2001, Laskar, 2003, Turner et al., 2003). To ascertain such changes, earth resource satellite data are critically important and useful for land use/land cover change studies (Yuan et al., 2005). Therefore, this study aims at mapping, quantifying and assessing the land use and land cover changes that have occurred in Sinazongwe, Maamba due to mining at Maamba Collieries Southern Zambia.

2. Materials and Method

2.1 Study Area

Maamba town located within Sinazongwe district of Southern Zambia covers an area of approximately 4,964 km^2 (Figure 1). The catchment has a relatively hilly topography, with altitude ranging from 575m to 689m. Maamba is a coal mining town. The town is located about 250 km from the country's capital city, Lusaka, and has a total population of approximately 13 000 residents. Most of it lies in the Zambezi rift valley with a hilly terrain and is about 30 km from Lake Kariba shore (Besa, 2001).

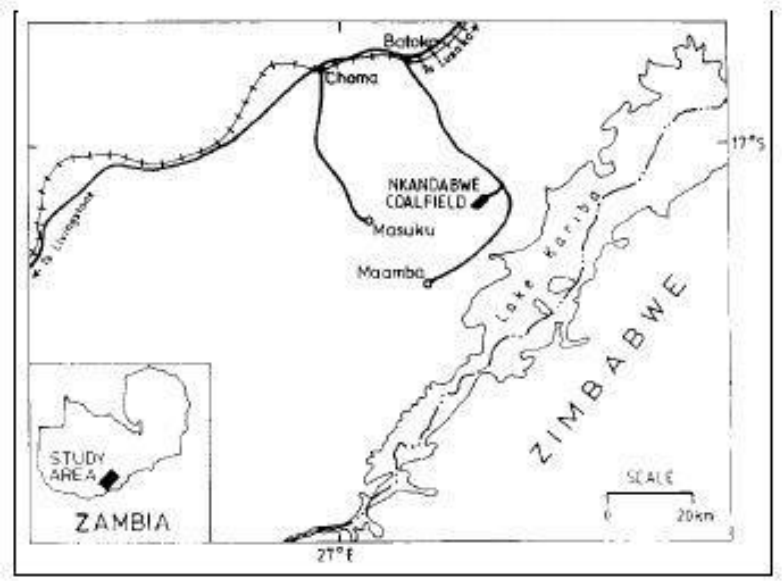


Fig 1: Location of Maamba Collieries Limited

Access to Maamba is by a road that extends southeast from the Great North Road that links Livingstone, Lusaka and the Copperbelt. The mine is 88 km from Batoka. MCL lies within the Siankondobo coalfield comprised of Karoo age sediments, exposed within the current Zambezi

River valley. These coal bearing sediments stretch into neighbouring Zimbabwe. MCL extracts coal from the Gwembe coal formation which comprises lower Maamba sandstone overlain by carbonaceous mudstones. Maamba Collieries was incorporated in 1971 under the ownership of Government of Zambia. Maamba Collieries was mining for high grade coal which was only saleable product and low-grade coal was dumped as waste, resulting in severe environmental pollution. Over a period of time, the company faced challenges, including low production and

lack of a capitalization. Various reasons, including poor overall management of the company led to complete stoppage of mining operation. Total Mining Lease Area is 7,876 Ha. The exploration completed area is 1,432 ha. The mine was taken over by Nava Bharat acquisition and MCL has revamped the mine and commenced operations from October 2011, and has produced: 2,701,000 metric tonnes of thermal grade coal; and 2,420,000 metric tonnes of high-grade coal.

The majority of land cover is degraded disturbed woodland. The project area is affected by shifting cultivation practices, burning, and charcoal burning activities. A recent review of irrigable soils indicated that the area required for the mining lease tends to be rocky, with numerous bare back granite outcrops. As a result, the mining lease is generally not suitable for large scale arable farming activities, including irrigation, even though there is a lot of small-scale agriculture activities' taking place especially along the flat land found along the streams in the surrounding areas. Maize fields are common in the area and cultivated for up to five years before planting a drought resistant crop such as sorghum, millet etc. Animal husbandry is limited to the keeping of goats, pigs, chickens, ducks and cattle. Mountains dominate the land so much that land for settlement is only found in isolated pockets. However, most of the habitable land is used for agriculture. There is no manufacturing or any other industry within the mining license area, or within the larger area surrounding the project. Nearby urban areas include Sinazongwe and Choma. Traditionally, men control most of the land. They decide on the use of the land while women have limited say over what to do with the land.

2.2 Sources of Data

In this study, spatial data-sets were obtained from Landsat 7 and Landsat 8 archives from U.S Geological Survey (USGS) and LISS-III satellite images of the year 1984 and 2010 was used and explored through supervised classification in Arc GIS imagine and ground observations obtained from Google Earth. The supervised classification method used is a vital tool in the determination of a statistical relation between the obtained data sets and the ground truth observations (Joshi and Dharaiya, 2018).

2.3 Methodology

2.3.1 Change detection

To obtain changes, all the land use land cover classes were evaluated among the satellite images. Among different classification algorithms, the maximum likelihood was used for supervised classification by taking 50 training areas for five major LULC class categories (10 training points for each LULC class) (Temesgen et al., 2014). The LULC classes include Agricultural Land, settlement area, Water bodies, grassland and forest area as well as Mining area. ERDAS Imagine® 2014 and Arc GIS® 10.2 were used for satellite image processing and LULC change analysis (Agaton et al., 2016). Digital land use land cover classification through supervised classification method was performed for the LULC classification. Recoding method is also done for converting pixel value into a proper class. Area statistics of each land use category is calculated in square kilometres. The rate of change was calculated for each LULC class using Equation 1:

$$Rate\ of\ change\ \left(\frac{km^2}{year}\right) = \frac{LULCT_{2010} - LULCT_{1984}}{Time\ Interval}$$

Where $LULCT_{2010}$ = Land use/Landcover map of 2010, $LULCT_{1984}$= Land use/Landcover map of 1984, = Period between 1984 and 2010 in years

The classified images were edited on the basis of the ground truth data collected from the field and then final classified maps were prepared with assessing classification accuracy using accuracy assessment tool of ERDAS® where LULC maps were used in raster format. By applying random points in accuracy assessment window. Image analysis operations have been carried out using GIS and finally, the changes in various LULC classes are obtained using post-classification comparison method. Error matrix and KAPPA analysis were done for accuracy assessment classification. The final maps were prepared after the ground truth and changes were estimated in GIS. The results obtained were used in order to assess the stress of land use on the ecosystem for the better natural resource management.

3. Results and discussion

The land use/land cover categories delineated in the study area are agricultural land, settlements, forest area, water body and the mining area. Table 1. shows the changes in land use/land cover statistics (in km^2 and percentage) that have taken place during the period between 1984-2010. The results of the land use/land cover analysis are also graphically represented in Figure 2.

Table 1: LULC change in Maamba from 1984 to 2010

Land use categories	Land use/Land cover (1984)		Land use/Land cover (2010)		Net Change (km^2)	Net change (%)
	Area (Km^2)	Area (%)	Area (Km^2)	Area (%)		
Settlement	25.35	17.79	39.32	27.60	13.97	9.80
Agriculture	7.23	5.07	5.76	4.04	-1.47	-1.03
Water body	0.02	0.01	0.56	0.39	0.54	0.38
Forest	106.79	74.94	93.26	65.45	-13.53	-9.50
Mining area	3.10	2.18	3.60	2.52	0.50	0.35

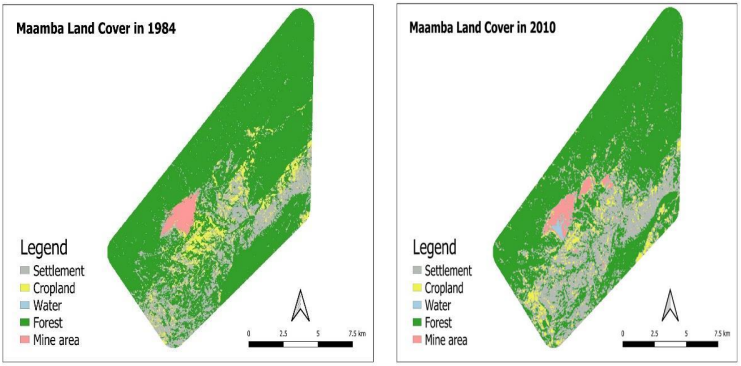


Fig 2: Landuse/Landcover maps for 1984 and 2010 in Mamba

The study depicts that Maamba has undergone a huge change in various land use categories from 1984 to 2010. The land use assessment show that the total area of 142.49 km² in the year 1984 was classified into agricultural land (5.07 %), settlement (17.79 %), water body (0.01 %), forest (74.94%) and mining area (2.18%) as can be seen in Figure 3. While in 2010, not much change was detected in mining area and waterbody; however, agriculture and forest land reduced by - 1.03 and -9.50% respectively while the mining area had a slight increase of 0.35%.

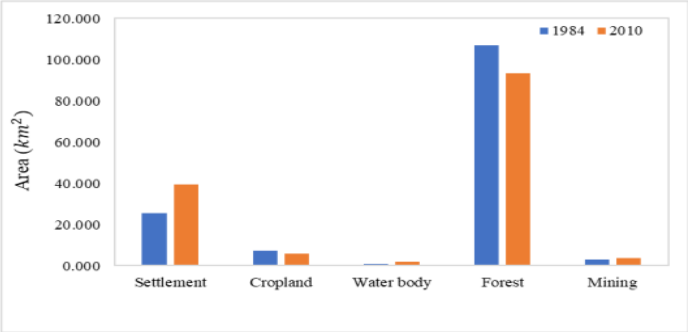


Fig. 3: Changes in LULC between 1984 and 2010

3.1 Settlement

The settlement occupied an area of 25.35 km^2 (17.79 %) during 1984 and 39.32 km^2 (27.60%) in 2010. The settlement shows an increase of 5.1 km^2 (0.70 %) during 1984 to 2010. The increase in settlement area is due to the development of industrial sector which requires residential colonies, industrial buildings, schools, community halls etc and increasing demand for labour work has attracted people from other states to settle in this industrial belt resulting in expansion of villages, towns and cities.

3.2 Crop land

Cultivated land is recognized by its yellow tone, smooth - medium texture having non-contiguous pattern with regular - sub regular outline shape. Cultivated land which was 7.23 km^2 (5.07 %) area during 1984 has been decreased to 5.76 km^2 (4.04 %) in 2010. The loss of 1.47 km^2 (1.03%) in the cultivated land has been observed during 1984 to 2010. The development of infrastructure, residential complexes of mining industries and the thermal power plant may result in loss of agriculture land. Development of agriculture is mainly affected by lack of irrigation. The decrease in area under cultivated land is attributed to decline in rainfall which adversely affects the rain fed agriculture as has been verified by rainfall data analysis. The irrigation from the borehole wells is not successful because in the Maamba average ground water level is 125 meters and the mining pits are more than 100 meters deep which can be attributed to the depletion of ground water in the surrounding area which results in the decrease in agriculture area.

3.3 Water body

Water body on the imagery is identified by its light blue to black tone, smooth texture and irregular shape. The water body occupied an area of 0.02 km^2 (0.01 %) in 1984 and 0.56 km^2 (0.39%) in 2010. The water body shows an increase of 0.54 km^2 (0.38 %) during 1984 to 2010. The increase of the water body can be attributed to the fact that Izuma stream is located right in the mining area and due to the mining going on, more ground water is released from the ground into the stream thus increasing the quantity.

3.4 Forests

The forest covered an area of 106.79 km^2 (74.94%) of the total area during 1984 and 93.26 km^2 (65.45 %) during 2010. Dense forest shows a decrease of 13.53 km^2 (9.05 %) in the area from 1984 to 2010 during 26 years. Most of the coal mining activities are taking place in dense forests area because most of the coal resources are located beneath the dense forest region. So the decrease in the dense forest is due to the removal of trees which is the first step of the expansion of coal mining activities, removal of forest for the development of infrastructure for heavy industrialization and increase in the population is another cause because peoples use wood for their livelihood so excessive felling of trees for fuel and fodder.

3.5 Mining pit and Overburden dumps

Coal mining is a very prominent activity in the area for having good reserves of coal. Mining pits are interpreted on the imagery by its pink tone. The mining occupied an area of 3.10 km^2 (2.18 %) during 1984 and 3.60 km^2 (2.52 %) during 2010. The increase of 0.50 km^2 (0.35 %) in the mining pit area has been observed from 1984 to 2010. The increase in the area of overburden dumps is because of huge removal of material from mining blocks which were dumped along the periphery of the plains and forms artificial landscapes.

4. Conclusion

The present study has revealed that considerable land use/land cover changes have taken place in and around the Maamba coal field during 1984 to 2010. Before the start of coal mining and other industrial activities the region was covered with tropical deciduous forests. Coal mining operation on large scale has significantly changed the pre-mining environment scenario. The

mining shows increase of 0.50 km2 during twenty-six (26) years which is due to the rapid increase in the coal production, dense forest areas are decreasing but the plantations at overburden dumps under reclamation schemes have also been going on. In addition to mining activity, the industrialization especially the thermal power plant in the surrounding have also adversely affected the land use/land cover, air and water quality of the study area due to the discharge of waste products in the form of ash, smoke and chemical effluents. It may be concluded that the land use/land cover change in the Maamba coal field has taken place due to the rapid expansion of mining and industrial activity during the period 1984 to 2010. This has resulted in the drastic changes in the land cover dynamics of the fragile ecosystem.

References

1. Agaton, M., Setiawan, Y. and Effendi, H. 2016. Land use/land cover change detection in an urban watershed: a case study of upper Citarum Watershed, West Java Province, Indonesia. *Procedia Environmental Sciences,* 33**,** 654-660.

2. Besa B. (2001). 'Environmental Impacts of Coal Mining on Land at Maamba Collieries Limited in Choma, Zambia'. *Published in First Botswana International Conference on Mining,* Published by; Printing and Publishing Company (Pty) Ltd, Botswana, November 2002. ISBN 99912–950–6–2. pp 321 – 330.

3. Bocco, G., Mendoza, M. and Velázquez, A. 2001. Remote sensing and GIS-based regional geomorphological mapping—a tool for land use planning in developing countries. *Geomorphology,* 39**,** 211-219.

4. Cao, X. 2007. Regulating mine land reclamation in developing countries: The case of China. *Land Use Policy,* 24**,** 472-483.

5. CSO 2000: *Summary Report for the 2000 Census of Population and Housin*g Central Statistical Office;

6. Joshi, K. and Dharaiya, N. 2018. Assessment of Land Use Land Cover at Mining Areas in Panadhro, KachchhusingRemoteSensingandGIS.

7. Lambin, E. F., Geist, H. J. and Lepers, E. 2003. Dynamics of land-use and land-cover change in tropical regions. *Annual review of environment and resources,* 28**,** 205-241.

8. Laskar, A. Integrating GIS and multicriteria decision making techniques for land resource planning. 2003. ITC Netherlands.

9. Prakash, A. and Gupta, R. 1998. Land-use mapping and change detection in a coal mining area-a case study in the Jharia coalfield, India. *International journal of remote sensing,* 19**,** 391-410.

10. Ruiz-Luna, A. and Berlanga-Robles, C. A. 2003. Land use, land cover changes and coastal lagoon surface reduction associated with urban growth in northwest Mexico. *Landscape ecology,* 18**,** 159-171.

11. Sooka, M. and Sikaundi, G. 2007. The environmental indicator development process. The case for Zambia.

12. Temesgen, G., Amare, B. and Silassie, H. 2014. Land degradation in Ethiopia: causes, impacts and rehabilitation techniques. *Journal of environment and earth science,* 4**,** 98-104.

13. Turner, B. L., Kasperson, R. E., Matson, P. A., Mccarthy, J. J., Corell, R. W., Christensen, L., Eckley, N., Kasperson, J. X., Luers, A. and Martello, M. L. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the national academy of sciences,* 100**,** 8074-8079.

14. Yuan, F., Sawaya, K. E., Loeffelholz, B. C. and Bauer, M. E. 2005. Land cover classification and change analysis of the Twin Cities (Minnesota) Metropolitan Area by multitemporal Landsat remote sensing. *Remote sensing of Environment,* 98**,** 317-328.

Establishing a mining environmental monitoring and compliance mechanism for local authorities in Zambia: A case study of North-Western Province.

(2nd Zambia Conference on Mining, Metallurgy and Groundwater Resources)

Festus Mukuka Kakana and Dr Victor Mutambo
Ministry of Local Government, Shibuyunji Town Council and The University of Zambia, Department of Metallurgy and Mineral Science, School of Mines,
Tel: +260 979 or 950 221250, email: kakanafestus@ymail.com

1.0 Abstract

The mining industry is witnessing a momentous revolution due to a growing demand for mineral resources all over the world. Mining has been a vital part of the Global economy but one of the most widespread management problems relates to the environmental issues on the surrounding communities. Zambia been endowed with a wealth of natural resources and has largely been a mining country and mining has played a key role in economic growth, social development and poverty alleviation but the supply of these resources has come with a lot of environmental and social costs. Environmental issues are cross cutting and requires an integrated environmental management approach. Zambia has also implemented adequate environmental legislation and signed international/regional agreements aimed at addressing environmental concerns. Despite such tremendous efforts, the implementation of these existing adequate environmental regulations has not been satisfactory. It is therefore, very paramount that Zambia's Environmental Management Strategy is understood so as to identify the gaps, weakness and establish contributions that local authority can make in environmental management by determining factors that have contributed to weak monitoring of mining environmental issues by Local Authorities and designing an environmental audit tool that may be adopted. A case study was carried out on North Western Province, particularly Kalumbila and Solwezi District Councils respectively. The study utilised survey research through the use of interview guides, questionnaires and observations. A total of 40 questionnaires were administered with response late of 82%. The primary data obtained from questionnaires was analysed using Statistical Package for Social Science (SPSS) and Excel. A six-week internship was also conducted at ZEMA were guided interviews and observations were administered and utilized to establish an environmental audit tool. The study reviewed that communication failure, political interference and lack of coordination, extension officers and technical capacity are the gaps and weaknesses identified in the ZEMA's environmental management strategy. To the contrary, lack of institutional capacity, coordination and tools to measure environmental

issues, insufficient knowledge in sustainable mining and Corporate Social Responsibility are some of the factors that have hindered local authorities from monitoring mining environmental issues. It can be concluded that mining environmental issues are cross cutting among a variety of sectors and hence the need for integrated environmental management approach. For sustainable environmental management to be achieved, there is need to ensure that the ordinary citizens are given an opportunity to participate in the planning, implementation, monitoring and evaluation of interventions meant to improve their well-being and of their surrounding environment. Its only through such that everyone is guaranteed of an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that; prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. Engagement of local authorities (district councils) in environmental management is one way of ensuring efficiency as creation of a safe and healthy environment starts locally.

1.1 Keywords: *Environmental Management, Environmental Management Strategies, Integrated Environmental Management, Sustainable Development, Sustainable Mining.*

1.2 Abbreviations:

Abbreviation	Description
CSR	Corporate Social Responsibility
EAT	Environmental Audit Tool
EM	Environmental Management
EMA	Environmental Management Act
IEM	Integrated Environmental Management
IEMS	Integrated Environmental Management System
LA	Local Authorities
SD	Sustainable Development
SDG's	Sustainable Development Goals
SM	Sustainable Mining
ZEMA	Zambia Environmental Management Agency

1.3 Introduction / Background

Mining is part of everything we do and everything we touch. Mining products are used in: infrastructure and housing development, energy production, technological advancement and food production (Azam, 2008). Mining contributes more than 45% of the world's measured economic activity and considering the seven billion world's population and its expected increase by 700 million by 2020 and the 3% economic growth, the appetite for raw materials to build infra-structure, generate energy, create products and produce food will also grow. Mining is a vital part of the Global economy, but the extraction of metals, metalloids, and other mineral products generates vast quantities of liquid and solid waste (Hudson-Edwards & Dold, 2015). One of the most widespread management problems in the mining industry relates to the environmental effects that mining activities and processes have on the surrounding communities, humans and ecosystem due to air and water pollution, land degradation as a result of sheer volume and chemical composition of waste material generated ((IIED, 2002) and (Mudd, 2007)). There is now, enormous recognition of the adverse impacts that mining has on social, economic and the environment. Decrease in mining activities has direct and indirect effect on the social-economy development and less destructive on the environment. This can be commended to be a good thing but because of the demand for mining products, mining will grow again unless we achieve 100% recycling (Jeswiet, 2017). Of all the human endeavours, mining has been identified to move more earth than any other yet mining industries claim to practice Sustainable Mining (SM). Sustainable mining has been defined as a link between social-economic developments to environmental wellness (American, 2018). Statistics shows that mines consume 10% of world's energy, responsible for 13% sulphur dioxide emissions and threatens almost 40% of world's undeveloped forest while accounting for 0.5% employment and 0.9 Gross Domestic Products (GDP) ((Kirsch (2010); (Masinja (2015) and Whitmore (2006)).

According to Mudd (2017), the issue of waste management is correctly perceived to be a major issue for local authorities, the manufacturing, construction and chemicals industries. Mineral resources are finite and, therefore require management that benefit the current and the future. In order to mitigate these environmental risks, there is a need to implement an appropriate management and compliance schemes (Hudson-Edwards & Dold, 2015). Since environmental issues are cross cutting, different government departments mandated with environmental management and compliance must re-align their strategies and ensure that their policies, plans and programs have mainstreamed environmental issues in their operations.

However, collaboration in environmental management and compliance especially on mining environmental issues that have direct or indirect impacts on the local authorities service

provision such as; health, sanitation, rural and urban planning and agriculture related activities should be recommended so as to safeguard human health and the environment. Environmental wellness is one of the key pillar of Sustainable Development (SD) and Zambia been one of the African country committed to attain Sustainable Development Goals (SDG's) according to the Vision 2030 should put in place effective environmental management strategies.

Zambia been endowed with a wealth of natural resources has largely been a mining country and mining has played a key role in economic growth, social development and poverty alleviation but the supply of these resources has come with a lot of environmental and social costs. Poor mining practices and mineral processing has continued to poison the air, land, water and leaves the environment to suffer a slow death and these impacts have resulted from both historical and ongoing mining operations and are quite significant and often more severe, especially the fact that Zambia do not yet have an adequate management system of the sector (Banda (2016); Chifungula (2014) and Lindahl (2014)). In an effort to enhance environmental wellness from mining environmental issues, Zambia has put in place registrations and signed international and regional agreements aimed at addressing environmental concerns, social - economic development and sustainable growth whose implementation has not been successful. Environmental issues are cross cutting and creating synergies for a clean and green environment and achieving SD through SM should then starts locally hence the need for involvement of all key stakeholders' in environmental management.

Though extensive research has been done regarding mining environmental management strategies in Zambia. This research is often not only concerned with the environmental management, but also establishes an environmental audit tool that counteract on weakness and gaps in Zambia's environmental management strategy and factors that have led to weak monitoring of mining environmental issues by Local Authorities as mandated by the Local Government Act No. 2 of 2019 so as to maintain a productive healthy environment. However, most of the research done around environmental management strategies has largely focussed on impacts of mining on the environment which has continued increasing, sustainable mine waste management approaches, models and has not been extended to the contribution that Local Authorities can make in mine fetched areas to safe guard human health and the environment as well as support the adequate existing Zambian laws and regulations regarding environmental management and protection.

This study, therefore, aims to establish factors that hinder Local Authorities from monitoring mining environmental issues and formulate an environmental audit tool that can be used to aid

local authorities to establish and maintain environmental health services. Further, the study also identifies areas of weakness and gaps in the Zambian environmental management and conservation strategy to help plan and implement an appropriate response (An Environmental Audit Tool) that is more engaging (local authorities and communities) for monitoring results and learning to ensure progress in mineral development. Since environmental issues are cross cutting, an audit tool is aimed at providing a platform for Local Authorities to work with ZEMA, government institutions and other stakeholders to champion environmental stewardship and facilitate institutional capacity for relevant Local Authorities and the community in environmental management to safe guard human health and the environment.

2. 0 Materials and Methods

2.1 Introduction

This chapter discusses the various steps that were undertaken by the researcher to explore the objectives of the study which included: to determine factors that has contributed to weak monitoring of mining environmental issues by Local Authorities and to design an environmental audit tool that could be adapted by Local Authorities to aid in environmental management and compliance to safeguard human health and the environment. The study adopted both qualitative and quantitative method known as the Mixed Method (MM) because of its ability to alleviate the weaknesses and provide richness and details that are otherwise unavailable if each method were to be pursued separately. The use of a Mixed Method approach was rooted in both philosophical and practical reasons, which are explained in detail to justify the Mixed Method approach for this thesis.

The chapter consists of the following sections: study location, the research design, research approach and the Delphi method.

2.2 Location of the study area

Zambia is located in the southern-central part of Africa between 8˚ and 18˚ south of the Equator, and between 14˚ and 35˚ east of the Prime Meridian and comprises10 provinces. These are Central, Copperbelt, Eastern, Luapula, Lusaka, Northern, North-western, Southern, Muchinga and Western Province. North-western Province is located between latitudes 10˚ 4’ and 14˚ 00’ south, longitudes 22˚ 00’ and 27˚ 10’ East; Solwezi district and Kalumbila district are within the same boundaries. The study focuses on establishing factors that has led to weak monitoring

of mining environmental issues in these two districts. The study used Solwezi and Kalumbila district as case study because the districts are currently is housing three biggest copper mines in Zambia which includes Kalumbila, Lumwana and Kansashi. The 40 participants from Local authorities, mining representatives and community representatives were purposely sampled for this study to establish factors that affect efficient monitoring of mining environmental issues (Malambo, 2013).

2.3 Research Design

The Mixed design approaches was adopted in the study to obtain answers from key important institutions, stakeholders and knowledgeable people involved in mining environmental management and compliance in Zambia, ZAMA and LA.

The study was limited to Kalumbila and Solwezi districts of North Western Province which are housing three biggest mines in Zambia. Guided interviews, questionnaires and a six (6) weeks internship at ZEMA Lusaka was used/done by the researcher to get required information in respect with the two study objectives.

2.4 Research Approach

The research was achieved by targeting the following important key institutions and stakeholders involved in environmental management and compliance in Zambia.

1. Zambia Environmental Management Agency (ZEMA) is an institution tasked to provide for ***integrated*** environmental protection and conservation of the environment and the sustainable management and use of natural resources. ZEMA was purposely chosen to perform a benchmark study regarding environmental management and compliance strategies. The basic objective of doing an internship with ZEMA was aimed at understanding the mining environmental management strategies used in Zambia so as to come up with an environmental audit tool that can aid Local Authorities in the entire 116 district to monitor mining environmental issues in future. This was the second objective of the study.

2. Solwezi Municipal Council and Kalumbila Town Council are the two local authorities housing the three biggest mines Kansanshi and Kalumbila and Lumwana respectively. Information about factors that have led to weak monitoring of mining environmental issues was obtained from literature reviewed, Zambian regulations and policies on environmental management combined with information analysis from questionnaires and observations in Kalumbila and Solwezi districts respectively. A total of 40 questionnaires were administered with response late of 82%. The respondents were as follows, 40% from Solwezi Municipal Council (16 responded) and 42% from Kalumbila Town Council (17 responded). The primary data obtained from questionnaires was analysed using Statistical Package for Social Science (SPSS) and Excel to deduce factors that have hindered LA

from monitoring mining environmental issues. Recommendations were then made to form part of the information for formulation of an environmental audit tool.

3.0 Results and Discussions

3.1 Introduction

This Chapter presents an analysis of all the data gathered by the approach of the methodological framework discussed in Chapter 4. It discusses the research findings and answers questions posed in Chapter 1.

The section presents findings from analysed questionnaires by first factors that have led to weak monitoring of mining environmental issues by local authorities in Zambia. The second section presents gaps and weaknesses against their appropriate response as contained in the EAT from the case study at ZEMA mining environmental management strategy and their respective recommendations. The section ends by presenting the recommended environmental audit tool for Kalumbila and Solwezi District Councils.

3.1.1 Factors that Hinder Local Authorities from Monitoring Mining Environmental Issues

i. Lack of collaboration between Local Authorities, ZEMA and Conservancy Authorities.

Environmental issues are cross cutting hence the need for an Integrated Environmental Management (IEM) kind of approach. This integral approach should ensure continuous engagement of all stakeholders. By law, local authorities are required to make comments on any development projects to be undertaken within their respective districts. This has been received with many challenges from both sides, Zambia Environmental Management Agency has expressed concern over non response by local authorities while local authorities have also expressed concern over late recipient of Environmental Project Brief or Environmental Impact Statement for comments which gives the local authorities inadequate time to conduct verification exercise.

Despite the results from respondents confirming the need for ZEMA, local authorities and other conservancy authorities to coordinate in order to enhance environmental management as shown in figure 1 were 23 participants transcending to 69% confirmed. Collaboration among conservancy authority as much as it is cardinal in safeguarding human health and that of the environment will require consented efforts and innovative ways from conservancy authorities such as that presented in the EAT.

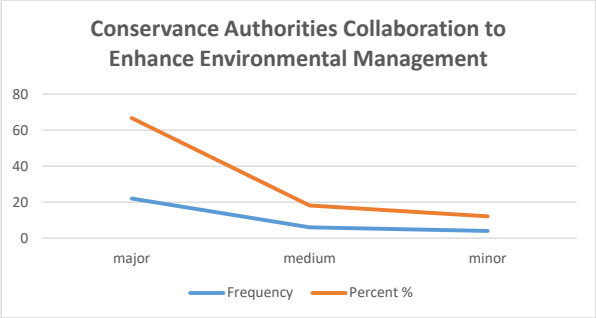


Figure 1: Environmental Management though strengthened coordination / collaboration

ii. Lack of Knowledge in sustainable mining and mineral development

Beside the social economic development resulting from mining, there has been now, enormous recognition of the adverse impacts that mining has on the environment hence the need for sustainable mining. The five most important areas that sustainable mining must should include: Environmental wellness, Economic development, Community engagement, Safety and Resource Efficiency.

Despite such indicators for future mining, results obtained in figure 2 below shows that there is diminutive knowledge and understanding of sustainable mining by local authorities. As revelled in the literature that future sustainable mining should be a balance of the three pillars sustainable development including; economic development, social equity and environmental wellness. Kalumbila and Solwezi council prioritised economic development over environmental wellness and social equity. If the local authorities are one of the key stakeholders in environmental management, then it cardinal that they are well informed and capacity built so as to carry out their function efficiently and prudent. As proposed in the EAT, ZEMA working together with LA and other conservancy must take a proactive step in capacity building such institution who they depend on to make an informed decision when approving and licencing a developer on the dynamics of the environmental related issues.

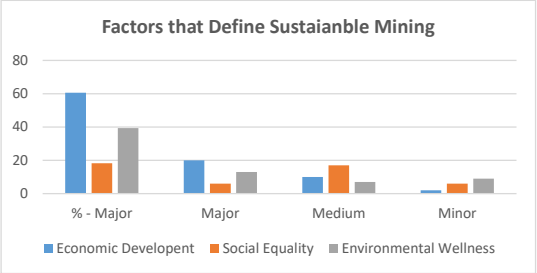


Figure 2: Scaling factoring of sustainable mining by Solwezi and Kalumbila District Councils

Local authorities need to be well informed and continuously engaged so that from the inception of such mining projects they are able to establish or put in place parameters that will help them achieve social economic development and environmental wellness.

Lack of knowledge in sustainable mining can also be attributed to local authority's prioritised role of revenue collection through land rates as opposed to other pillars of sustainable mining.

iii. Lack of Human Resources

Lack of technologist field inspectors from ZEMA and local authorities has posed a challenge to supervise mining after licence and just resorted to dependence on the developers BI Returns for environmental compliance. Lack of technical capacity to monitor environmental issues is another factor that has continued to hinder local authorities to monitor mining environmental issues. Civil engineers, environmental health inspectors, planners and public health officer are occasionally in the field to monitor such issue.

ZEMA working together with local authorities can capacity build local authorities technical staff and Ward Development Communities in environmental monitoring and compliance to overcome this deficiency and ensure that every corner of the 116 districts of Zambia is well covered to safeguard human health and environment as proposed in the EAT.

Figure 3 below shows that the Local authorities despite not having mining professionals and technologist have enough engineers, public health officers and environmental scientists who may work in collaboration with ZEMA to increase technical capacity so as to enhance environmental management and protection.

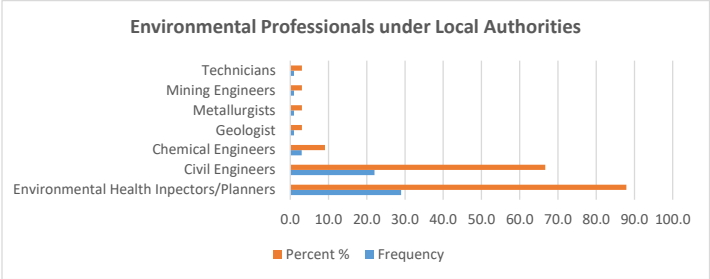


Figure3: Professionals under local authorities

i. Lack of Local Authorities Engagement during Mining Licences Period

As already indicated, lack of collaboration among conservancy authorities was one of the factors hindering local authorities from monitoring mining environmental issues. This can at a large scale be attributed to lack of engagement of local authorities during and post mining licences period.

The Zambia Environmental Management Agency (ZEMA) does not inform the local authorities of the proceedings after submission of comments on a development projects. Local authorities are also not informed about conditions governing the licence hence they are not aware of the air and noise emission and water discharge limits. Collaboration to enhance environmental management should not be a one off thing, it should be continuous and all stakeholders kept well informed so as to help manage and monitor mining operations efficiently and successfully.

ZEMA has at many times not advised local authorities on condition governing the developers mining operations licence in the district hence creating a gap for local authorities to effectively monitor such operations efficiently.

Lack of engagement of local authority during mining licence period was ranked 2nd at 58% as shown in figure 5 below. This show the importance of continuous engagement of LA in environmental management and compliance.

ii. CSR has blinded Local Authority from Monitoring Mining Environmental Issues

CSR projects are supposed to fulfil *capital's basic principles* and *environmental standards.* Judging from the list of CSR projects as presented in figure 4 below, it can be concluded that these projects are capital in nature and facilitates social development as well as environmental wellness.

Support of agriculture programs through conservation farming are not just meant to make a specific land productive, it also supports micro biodiversity which is the so purpose of making

the environment safe and health for all living organisms. Provision of adequate clean water and sanitation provides a platform that supports life under water.

Infrastructure development and sensitisation services does not only improve peoples access information and public facilities such as schools, hospitals / clinic and recreation to enhance social development but combined with training of communities with survival skills coupled with road development supports economic development and in the long run helps alleviate poverty and improves community lives.

Projects such as Agriculture Support Program, Infrastructure Development (Roads, Schools and Clinics), Provision of Clean Water and Sanitation Services, Training of Local Stakeholders with Survival Skills and Sensitization Services (HIV/AIDS) are the major mandate for the Local Authorities. Mining engagement in provision of such projects through CRS was preserved to move Local Authorities attention from pollution control related activities to attainment of CSR projects. Figure 5 below shows some of the projects undertaken by Kalumbila, Lumwana and Kansanshi mines in Kalumbila and Solwezi Districts.

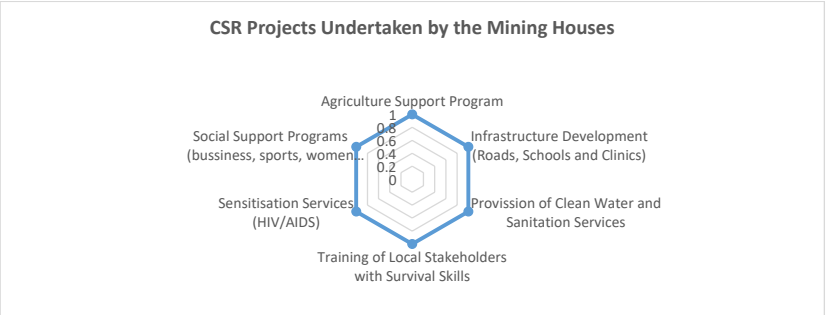


Figure 9: CSR projects undertaken by mining houses in Solwezi and Kalumbila districts

iii. Lack of Tools to Use in Monitoring Mining Environmental Issues

As mandated by the Public Health Act and the Local Government Act to monitor environmental issues and act on them as provided in the law. Lack of machinery to be used to monitor environmental issues such as air emission, water discharge and noise pollution limit plus other environmental issues has continued to be a challenge.

This can be shown by figure 5 below which ranks all the established factors together were lack of tools for monitoring mining environmental issues was ranked first at 70%.

This factor can also be linked to lack of resources to facilitate environmental management programs as this require a lot of resources to educates all stakeholders on environmental management strategies. This is in light that when all stakeholders are aware on the negative impacts of mining environmental issues, mining developers will become responsible for their operations. Lack of resources was ranked 3rd at 58% as shown in figure 5.8 below.

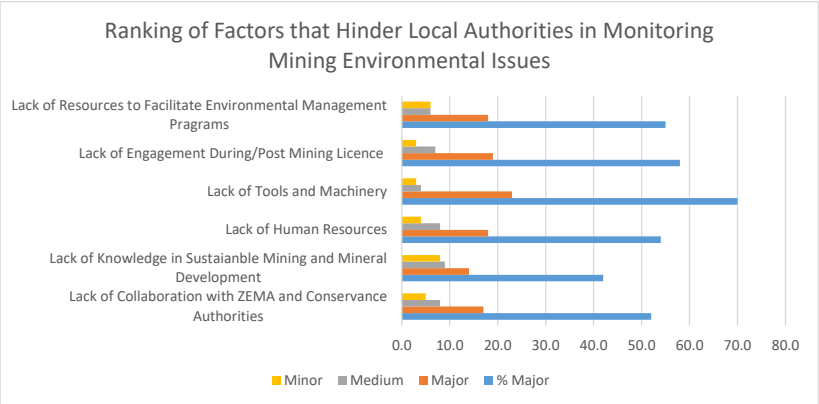


Figure 5: Ranking of factors that hinder LA from monitoring mining environmental issues

3.2 Case Study – ZEMA

3.2.1 Introduction

The Environmental Management Act (EMA) gives mandate to the Zambia Environmental Management Agency (ZEMA) to do all things as are necessary to ensure the protection and conservation of the environment and sustainable management of natural resources.

The Environmental Council of Zambia (ECZ) was created in 1992 following enactment of the Environmental Protection and Pollution Control Act (EPPCA) CAP 204 of the Laws of Zambia. In 2011, the Environmental Management Act No. 12 of 2011 repealed and replaced EPPCA to continue the existence of the Environmental Council and re-name it as ZEMA.

The Environmental Management Act No. 12 of 2011 (Now amended as No. 10 of 2013) (EMA) is an umbrella and principal law which stands over all other environmental legislation in Zambia. The following regulations have since been derived and applied together with EMA; the Environmental Management (Licensing) Regulations, 2013 and The Environmental

Management (Extended Producer Responsibility) Regulations, 2018. The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 are however, still enforceable under the EMA although they were enacted under the EPPCA

The main objective of this section was to identify gaps and areas of weakness in the Zambian environmental protection and conservation regulation strategy and devising or implement an appropriate response that is more engaging (local authorities and communities) for monitoring mining environmental results through formulation of an Environmental Audit Tool to safeguard human health and the and enhance environmental compliance.

3.2.2 Gaps and weaknesses in ZEMA's Environmental Management Strategies and there Appropriate Response through the EAT

The following findings, gaps and weaknesses were established regarding ZEMA's environmental management strategy and their appropriate response through the EAT as detailed below.

1. Findings from the review of the Environmental Management Act and its supporting Regulations ascertained that Zambia through ZEMA has put in place adequate Regulations to safeguard human welfare and the environment through effective environmental management systems such as; air, water and noise pollution control, waste management, pesticide and toxic substances management and environmental impact assessment. Additionally, ZEMA has a unit that deals with climate change related programmes while another unit deals in research to ensure effective handling of environmental dynamics. To continuous strengthening of these regulations, EAT has emphasises strongly on strategic engagement of all conservancy authorities and key stakeholders involved in environmental management, protections, monitoring and compliance.
2. Environmental issues are cross cutting hence the need for ZEMA to strategically engage all key stakeholders to champion environmental stewardship but this has been affected by lack of coordination and timely communication failure between conservancy authority stakeholders and ZEMA. On the other hand, The EAT provides a platform that ensures that all spheres of government mandated with environmental management issues should align their functions and responsibilities and ensure that their policies, strategies, plans and programs are clearly streamlined for the purpose of working together in the spirit of mutual cooperation and safeguard human health and the environment. Adoption of the EAT will ensure that continuous engagements between LA and ZEMA to overcome communication failures and improve coordination between the two institution. This will result into a well -

integrated coordinated environmental management system between district local level and ZEMA at provincial level.

3. The main two major gaps observed were lack of ZEMA's extension officers in all the 116 districts of Zambia and also to a large extent lack of manpower and technical capacity. This has limited ZEMA's responsibility to witness and appreciate how bi–annual statutory returns sampling is done on site and have hands on experience with the equipment being used but rather depend on the developer's submissions but are these bi – annual returns submitted by the developer the true reflection of what goes on the ground? However, adoption of an EAT tool provide a platform for ZEMA to utilise engineers and Environmental Health Practitioners from LA to do extension works at district level. This will entail that ZEMA will be able to cover the entire 116 districts of Zambia in monitoring environmental issues and compliance on daily basis. The use of EAT provide an advantage in environmental monitoring and compliance due to the established Ward Development Committees which is basically living around these mining houses. WDC working together with LA and ZEMA can devise a system to ensure effective environmental monitoring and compliance and ensure the mining developers take responsibility of the environmental actions.
4. Lack of supervision towards the industry after projects have been authorized and pertained all its licenses and permits. This to a large extended is attributed to inadequate human resource at ZEMA but as already stated above, EAT provided a platform for LA and ZEMA to combine human resource to provide technical supervision and support during and post licence period.
5. Democracy, regulation and rule of law are an aspect of the Environmental Management that is hard to quantify as well as its impact on ZEMA's democracy, its capacity and willingness to regulate environmental activities and respect for the law. Findings reviewed that several prominent politicians, their relatives and associates are involved in mining. This makes it a high career risk activity for ZEMA officials of any rank to act against offenders. There are large numbers of mines operating without compliance and hence they face no consequences for it. Mining has continued to receive political protection and this has made regulation impotent to a point where developers have become answerable to political offices as supposed to the ZEMA and other conservancy authorities as per the laws of Zambia. This to a large extended is attributed to a political will. Nevertheless, EAT provide a platform for engagement of civic leaders at local level with the view that when these leaders are aware and well informed of the adverse effect of mining environmental issues they may become responsible in decision making both at local and national level regarding activities to do with the environment.

3.3 The Local Authorities Proposal Environmental Audit Tool

3.3.1 Introduction

The Environmental Audit Tool (EAT) is a formal proposal document making reference from the Environmental Management Act, the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997, the Environmental Management (Licensing) Regulations, 2013, The Environmental Management (Extended Producer Responsibility) Regulations, 2018, the Local Government Act, the Decentralisation Policy, the Solid Waste Regulation and Management Act, 2018, the Public Health Act, the Urban and Regional Planning Act while supported by the Constitution of Zambia. It defines a systematic, documented, periodic and objective evaluation of how well District Councils working together with ZEMA and other conservancy authorities can safeguard human health and that of the environment. It establishes a scope, checklist and a set of environmental principles for stakeholders and conservancy authorities to manage environmental conditions governing air, water, land and noise pollution control, waste and hazardous waste management. This helps District Councils to monitor environmental issues as provided in the Local Government Act, 2019, Part III section 16 and 17.

Environmental issues are cross cutting among a variety of sectors and hence the need for an integrated environmental management kind of approach. The main purpose of the Environmental Audit Tool is to provide such a platform for an independent, objective assurance and integrated environmental management system that engages Local Authorities (district councils) and their established WDC, ZEMA and other stakeholders to strengthen environmental monitoring and compliance to safeguard human health and the environment.

The EAT is not meant to discourage investors but to instil a sense of responsibility for their action as it supports the three tiers of sustainable growth through social-economic development and creation of a productive, health and safe environment. It is also meant to provide an appropriate response to the established gaps and weakness stated above. Details of EAT, check appendix 1.

4.0 Conclusions and Recommendations

4.1 Conclusion

For sustainable mining to be achieved, there is need to ensure that the ordinary citizens are given an opportunity to participate in the planning, implementation, monitoring and evaluation of interventions meant to improve their well-being and of their surrounding environment. Its only through such that everyone is guaranteed of an environment that is not harmful to their

health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that; prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Implementing an integrated environmental management approach through stakeholder's engagement is key to creating a more "meaningful existence and sustainable planet". Local authorities in mine fetched areas, mining companies, the communities, private sectors that depend each other for survival, must work together to help create a prosperity and eliminate poverty in the context of a liveable and inherently sustainable planet. Stakeholders engagement moves us from the insular current state of mining to a more innovative and collaborative future.

Results have shown that mining environmental issues are cross cutting among a variety of sectors and hence the need for integrated environmental management approach. Engagement of local authorities in environmental management is one way of ensuring efficiency as creation of a safe and healthy environment starts locally. As supported by Zambian legislations, WDC should work very closely with the community/zonal representatives in monitoring mining environmental issues and always provide a report for the attention of the local authorities for action for environmental issues that falls within their jurisdiction or onward transmission to ZEMA on environmental issues that fall outside their mandate.

Results have further shown that local authorities and communities are only consulted at the inception of every developmental project and never involved during the license period. Local authority/community engagement should be continually told about the company's plan, conditions governing their licence and inviting them to modify them. Public participation in environmental management and development decision making is key element of governance for development. Community involvement will promote accountability and transparency in utilization of resources as well as safeguarding human health and the environment. This is also supported by the Constitution of Zambia (Amendment) Act No. 2 of 2016 and provides for the establishment of a platform through which the citizens of Zambia will participate in planning, monitoring and evaluation of development initiatives in their areas.

Two major reasons for the justifications of establishment of WDCs are to improve the living standards of its people through community participation in development processes and address issues of escalating poverty levels which is linked to environmental health and its wellness. Poverty has merely been caused by exposure to worst environmental health and risks.

This study there attempts to advocate for the implementation of an integrated environmental management strategies that supports inclusion, organization, monitoring, participation in EIAs processes, lobbying government officials, and parliament, and working with the media with the belief that when all key stakeholders understand the risks of mining environmental issues, the tide will be stopped.

4.2 Recommendations

i. In view of the findings, gaps and weaknesses identified in section 4.2 above, the following recommendations are hereby made: Under public consultation as provided for in The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997, Part II, Regulation No. 10, ZEMA must consider engaging public consultation and participation through the use of established Ward Development Committees under local authorities as provided in the Local Government Act No. 2 of 2019, Part V, and section 36. This is also supported by the Constitution of Zambia (Amendment) Act No. 2 of 2016 and the National Decentralization Policy which provides for the establishment of a platform through which the citizens of Zambia will participate in planning, monitoring and evaluation of development initiatives in their areas.

ii. Subject to the section 17, Part II of the Environmental Management Act No. 10 of 2013, ZEMA must collaborate and consider appointing honorary inspectors from Local Authorities so as to ensure they cover all the 116 districts of Zambia and overcome lack of human resource and technical capacity in supervising monthly bi–annual statutory returns sampling and testing and other environmental services. Further, ZEMA must include Local Authorities human resource in capacity building related programmes so as to enhance Environmental Management and compliance.

iii. ZEMA must **direct** developers to apart from submission of bi – annual returns twice to the agency, also submit and engage local authorities in monthly sampling and test report meant for their bi – annual statutory returns for verification purpose. Developers should further be directed to report returns to the Local Authorities Quarterly Committee meetings as proposed in section 4.2 under the Environmental Audit Tool below to enhance environmental pollution control and compliance.

4.3 Suggestions for further work

The outcomes of the research have raised the prospect of further research. The following are the likely avenues worth investigating:

- Investigating the quality of input of Conservancy Authorities and Communities through public hearing prior to mining project licencing
- Identification of loop holes in the current environmental management strategy from all conservancy authorities and devising an appropriate response.
- Investigate the authenticity of mining BI returns to ZEMA and their effect on the environmental compliance.

5.0 Acknowledgements

5.1 Almighty God

My special and most great thanks goes to almighty God my heavenly father who has given me this opportunity and sufficient grace and blessings to undertake this study.

5.2 Faculty and Research Staff

I am highly grateful to my mentor Dr. Victor Mutambo for his valuable and excellent motivation, moral and academic guidance to finalize this project. I am grateful to faculty members in particular Dr. Bunda Besa, Dr. Jewette Masinja and Mss Longa Kabuswe for the endless effort rendered in helping me to be a successful graduate.

5.3 Family and Friends

I am very much thankful to my brothers, sisters, nephews and nieces for the full support rendered in completion of this project.

Lastly, but not the least, I am thankful to all my friends who always wished me success and helped me whenever an opportunity arise

References

American, A. (2018). *Anglo American plc Sustainability Report 2018.* online at: www.angloamerican.com.

Azam, S. (2008). *Sustainable mining through innovation in waste disposal.* Regina: Forum on Public Policy.

Banda, W. N. (2016). *Environmental Impacts of Large Scale Mining in Zambia.* Avialable at: http://www.academia.edu/28806408/ENVIRONMENTAL_IMPACTS_OF_LARGE_SCALE_MINING_IN_ZAMBIA_.docx.

Chifungula, D. A. (2014). *Report of the Auditor General on the Management of Environmental Degradation Caused by Mining Activities in Zambia.* Lusaka: Avialable online at: http://41.77.4.164:6510/www.ago.gov.zm/reports/Special/2014/OAG%20Management%20of%20Environmental%20Degradation.pdf.

Hudson-Edwards, K. A., & Dold, B. (2015). Mine Waste Characterization, Management and Remediation . *minerals*, 82-85.

IIED. (2002). *Mining for the Future.* Landon: Mining, Minerals and Sustainable Development.

Jeswiet, J. (2017). Including Towards Sustainable Mining in evaluating mining impacts. *Direct Science*, 494-499.

Kirsch, S. (2010). Sustainable Mining. *Dialect Anthropol*, 87-93.

Lindahl, J. (2014). *Environmental impacts of mining in Zambia:Towards better environmental management and sustainableexploitation of mineral resources.* Sweden: Avialable on: http://41.77.4.164:6510/resource.sgu.se/produkter/sgurapp/s1422-rapport.pdf.

Malambo, A. H. (2013). Land administration in Zambia since 1991: History,opportunities and challenges. *Global Advanced Research Journal of History, Political Science and International Relations ISSN*, 053-066.

Masinja, J. H. (2015). Environmental Management in Mining , and a Conceptual Extractive Industry Contract Negotiation Model . *MCM - MCTC PROCESS TRAINING-LECTURES* , 2-39.

Mudd, D. G. (2007). Sustainability and Mine Waste Management – . *Waste Management & Infrastructure Conference – IIR Conferences* (pp. 1-12). Melbourne: Department of Civil Engineering, Monash University, Clayton.

Whitmore, A. (2006). The emperors new cloth: Sustainable minining. *Journal of Cleaner Production*, 309-314.

Appendix 1: The Local Authorities Proposal Environmental Audit Tool

1.0 Introduction

The Environmental Audit Tool (EAT) is a formal proposal document making reference from the Environmental Management Act, the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997, the Environmental Management (Licensing) Regulations, 2013, The Environmental Management (Extended Producer Responsibility) Regulations, 2018, the Local Government Act, the Decentralisation Policy, the Solid Waste Regulation and Management Act, 2018, the Public Health Act, the Urban and Regional Planning Act while supported by the Constitution of Zambia. It defines a systematic, documented, periodic and objective evaluation of how well District Councils working together

with ZEMA and other conservancy authorities can safeguard human health and that of the environment. It establishes a scope, checklist and a set of environmental principles for stakeholders and conservancy authorities to manage environmental conditions governing air, water, land and noise pollution control, waste and hazardous waste management. This helps District Councils to monitor environmental issues as provided in the Local Government Act, 2019, Part III section 16 and 17.

Environmental issues are cross cutting among a variety of sectors and hence the need for an integrated environmental management kind of approach. The main purpose of the Environmental Audit Tool is to provide such a platform for an independent, objective assurance and integrated environmental management system that engages Local Authorities (district councils) and their established WDC, ZEMA and other stakeholders to strengthen environmental monitoring and compliance to safeguard human health and the environment.

The EAT is not meant to discourage investors but to instil a sense of responsibility for their action as it supports the three tiers of sustainable growth through social-economic development through creation of a productive, health and safe environment. It is also meant to provide an appropriate response to the established gaps and weakness stated in section 5.2 above.

2.0 Scope

The scope of the EAT is limited to copper mines only but it may be extended to cover other industries upon advice from ZEMA and developers. The EAT is meant to help district councils monitor any activity or phenomenon to enhance environmental monitoring and compliance. The tool is focused on local authorities that are housing mines in their respective jurisdictions. Despite mining having many environmental issues, the EAT only focuses on environmental impacts with mostly local and regional effect and those that have direct or indirect impacts on local communities and district councils services provision such as;

- Water, air and noise pollution
- Land degradation
- Waste
- And hazardous waste Management

3.0 Statutory Environmental Compliance Guidelines

3.1 Emissions to Air

The permits to emit air pollutants relate to specific operations undertaken at a particular mine. In order to comply with the Environmental Management (Licensing) Regulations, 2013, mines need to confine to the following generic ZEMA Emissions Limits as tabulated in table 3 below.

Table 1: Generic air emissions limits

Description	Pollutant Concentration (mg/Nm3)											
Emissions	Dust	CO	SO2	NOx	Cd	Cu	Pb	Hg	Acid mist	CO2	Co	As
ZEMA Limits	**0-50**	**0-175**	**0-1000**	**0-600**	**0.05**	**1.0**	**0.2**	**0.05**	**-**	**-**	**-**	**0.5**

3.2 Discharge of Effluent

3.2.1 Surface water

The permits to emit effluents from plant combined drainages and tailing dams to nearby streams or rivers should comply with the following Generic Physical, Biological, Chemical, and Metal ZEMA Limits detailed in table 4. These parameters should be obtained at a temperature less than 40 ºC and colour less than 20 Hazen Units as well as ensuring that the effluents does not cause any deterioration in odour as compared with natural state.

(i) Physical Parameters

Table 2: Physical Parameters Emission Limits

No.	Parameter	Effluent and waste water limits into aquatic environment
1.	Turbidity (NTU scale)	≤ 15 Nephelometer turbidity units
2.	Total suspended solids(Gravimetric method)	≤ 100 mg/L must not cause formation of sludge or scum in receiving water
3.	Settleable matter sedimentation in 2 hours (Imhofffunnel)	≤ 0.5 mg/L in two hours. Must not cause formation of sludge in receiving water
4.	Total Dissolved Solids (Evaporation @ 1050 C and Gravimetric method)	≤ 3000 mg/L The TDS of waste water must not adversely affect surface water
5.	Conductivity (Electrometric method)	≤ 4300 mS/cm

(ii) Biological Parameters

No.	Parameter	Effluent and waste water limits in aquatic environment
1.	Total Coliform/100 ml (Membrane Filtration method)	≤ 25000 cells
2.	Faecal Coliform/100ml (Membrane Filtration method)	≤5000 cells
3.	E. coli counts/100 ml	≤ 10 cells
4.	Algae /100 ml (Colony counter)	≤ 1000 cells

(iii) Chemical Parameters

No.	Parameters	Effluent and waste water limits in aquatic environment
1.	pH (0-14 scale) (Electro-metric method)	6.0 - 9.0
2.	Dissolved oxygen mg Oxygen/Litre (Modified Winkler method and membrane electrode method)	≤ 5 mg/L after complete mixing extreme temperature may result in lower values
3.	Chemical Oxygen Demand (COD) (Dichromat method)	COD based on the limiting values for organic carbon ≤ 90 mg02/L average for 24 hours
4.	Biochemical Oxygen Demand (BOD) (Modified Winkler method and Membrane Electrode method)	≤ 50 mg 02/L (mean value over 24 hours period) According to circumstances in relation to the self-cleaning capacity of waters
5.	Nitrates (NO3 as nitrogen) (Spectrophotometric method and electrometric method)	The nitrates burden must be reduced as far as possible according to circumstances: water course ≤ 50 mg/L; Lakes 20 mg/L
6.	Nitrite (NO2 as nitrogen/L Spectrophotometric sulphanilamide)	≤ 2.0 mg NO2 as N/L
7.	Organic Nitrogen (Spectro-photometric method NKjeldal)	≤ 5.0 mg/L Mean* (* the % of nutrient elements for degradation of BOD should be 0.4 - 1 % for phosphorous (different for processes using algae)
8.	Ammonia and Ammonium (Total) (NH3 as N/L) (Nesslerization method and Electrometric method)	The burden of ammonium salts must be reduced to ≤ 10 mg/L (depending upon temperature, pH and salinity)
9.	Cyanides (Spectro photo-metric method)	≤ 0.2 mg/L
10.	Phosphorous (Total) (PO4 as P/L) (Colori-metric method)	Treatment installation located in the catchment area of lakes: ≤ 1.0 mg/L; located outside the catchment area: reduce the load of P as low as possible (PO4 = 6 mg/L)
11.	Sulphates (Turbidimetric method)	≤ 1500 mg/L
12.	Sulfite (Iodometric method)	≤ 0.1 mg/L (presence of Oxygen changes SO3 to SO4)

13.	Sulphide (Iodometric and electrometric method)	≤ 0.1 mg/L (depending on temperature, pH and dissolved O2)
14.	Chlorides CI/L (Silver nitrate and Mercuric nitrate)	≤ 800 mg/L
15.	Active chloride Cl2/L (Iodometric method)	≤ 0.5 mg/L
16.	Active Bromine (Br2/L)	≤ 0.1 mg/L
17.	Fluorides F/L (Electro-metric method and Colorimetric method with distillation)	≤ 2.0 mg/L

(iv) Metals, Radioactive and Organics Impacts

No.	Parameters	Effluents and waste water limits in aquatic environment
1.	Arsenic (As) compounds (Atomic Absorption method)	d" 0.05 mg/L
2.	Cadmium (Cd) compounds (Atomic Absorption method)	d" 0.5 mg/L
3.	Cobalt (Co) compounds (Atomic Absorption method)	d" 1.0 mg/L
4.	Copper (Cu) compounds (Atomic Absorption method)	d" 1.5 mg/L
5.	Lead (Pb) compounds (Atomic Absorption method)	d" 0.5 mg/L
6.	Mercury (Hg) (Atomic Absorption method)	d" 0.002 mg/L
7.	Oils and grease (Mineral and Crude) (Chromatographic method and Gravimetric method)	d" 5.0 mg/L
8.	Uranium (Mass spectrometry or Laser photometry)	d" 0.03mg/L
9.	Any other radioactive materials	0

3.2.2 Ground Water

Ground water inspection boreholes should be used to monitor ground water quality. Boreholes should be reinforced and well protected to prevent chances of vandalism. Monitoring boreholes should be installed at all dump site and around mining sections/area.

Inspection boreholes at dumping sites should be monitored monthly and district councils and other conservancy authorities should rehearse with ZEMA and the developer on the statutory effluents discharge limits allowable to infiltrate into the underground water aquifers. Faecal and Total coliforms among other dangerous parameters that are harmful to human health and biodiversity should be limited to zero as most communities in Zambia depend on underground water for domestic use and livestock.

In collaboration with Water Resource Management Agency (WARMA), ZEMA, District Councils and other government Authorities and partners should consider introducing Monitoring boreholes to be installed around mining section area to monitor and maintain aquifer water flow rate so as not to disturb communities accessing underground water after the mining area. The developer should sink boreholes before the mining section to pump water out of the aquifer to prevent pollution and to disturb its flow rate and inject the water back into the aquifer after the mining area using the other boreholes after the mining section. This will ensure that access to underground water from the disturbed aquifer has no effect on surrounding communities. This regulation has not been provided for in the Environmental Management (Licensing) Regulations statutory instrument. The Agency has sited cost associated with it to be one of the major reasons to why it has not been implemented yet.

3.3 Waste Management

As the Local Authorities includes, regulate, inspect, supervise and license the undertaking, service or facility within their jurisdiction and monitors monitor's environmental issues. The offices responsible should be aware of the following generic disposal site waste management conditions subject to prevention and control outbreak of dieses and air, water and land pollution.

1) The developer shall restrict access to the dumpsites to authorized personnel only.
2) The developer shall ensure that **hazard warning and safety signs** are displayed at appropriate places around the overburden dumps.
3) Disposal of waste **should be authorized / licensed by** the Zambia Environmental Management Agency (ZEMA) through established procedures.
4) The developer shall appoint a competent person to inspect the dump and its surrounding to ensure that:
    i) The drainage of the dump site is good;
    ii) The dump wall is stable;
    iii) The dump has no tension cracks;
    iv) Formation of gullies is controlled; and
    v) Dumping of the waste is supervised if the dump is active.
5) The competent person referred to in (4) above shall record all non-compliances and the developer shall take necessary measures to correct the non-compliances.

6) The developer shall drill monitoring wells at appropriate sites around the dump sites for monitoring of surface and ground water contamination against the parameters described under emissions of effluents.
7) The developer shall ensure that ground water samples from monitoring wells are taken weekly for analysis.
8) The developer shall conduct progressive rehabilitation activities on the overburden dump throughout the licence period.
9) The developer shall ensure that the materials dumped is managed in such a way as to:
   i) Ensure its stability and minimize risks to other adjacent land uses; and
   ii) Avoid polluting surrounding areas including surface and ground water bodies.
10) The developer shall ensure that all personnel working at the dump site are provided with appropriate safety and protective wear together with first aid facilities and training.
11) The developer shall fully comply with all the Zambian regulations regarding waste management.
12) The developer shall ensure that a copy of the licence and conditions are distributed to all employees that shall be responsible for management of the overburden dump and ensure that all the licence conditions are understood by responsible officers.
13) The developer shall be invited to give a quarterly **compliance report** in the Local Authorities Subcommittee that deals with environmental management.
14) Local Authorities health inspectors **shall be allowed** at any reasonable time to inspect the dump site and check any documents relating to management of the dump site in order to determine compliance to these Licence conditions issued by **ZEMA**.
15) Contravention of any of the above conditions may prompt the local authority as a conservancy authority to recommend to ZEMA for revoke of Licence, prosecution or any other suitable action.

3.4 Hazardous waste

The different hazardous materials produced by the plant should be stored at certified licensed stored areas and disposed by a licensed vendor for recycling, reuse or safe disposal. The following conditions then should guide hazardous waste management.

1. Segregation shall be carried out by the trained workers or any other responsible person generating waste. This shall be done as close to the point of generation as possible.
2. Suitable Hazardous Waste receptacles of **appropriate size and number shall be readily available** at the point of generation, located away from populated areas to avoid accidents or emergencies.
3. The developer shall monitor the stored hazardous waste to prevent contamination of the environment and submit the results of the monitoring to the Local Authority as described above.
4. The developer shall comply with the requirements for storage of hazardous waste as prescribed by ZEMA
5. **Reusable waste containers shall be washed with a suitable disinfectant.**
6. The storage area shall be of appropriate specifications including:

a. An **impermeable** and **banded wall constructed** around it;
b. Adequate ventilation to avoid build up of hazardous fumes;
c. Limited **access to authorized** personnel only;
d. **Safety signs visibly displayed** at appropriate points.

7. All Hazardous Waste receptacles **shall be clearly labelled** with name of the type of waste and the source of the waste. This information may be written directly on the receptacle or on pre-printed labels, securely attached. The basic information to be placed on receptacles shall be:

a) Waste type
b) Source of waste
c) Date and time of waste generation
d) Amount of waste generated

8. The personnel involved in the handling of the Hazardous Waste shall be provided with:

a) Adequate protective and safety clothing i.e. Heavy Duty PVC Gloves, Gum Boots, Gas Mufflers, etc.
b) Adequate and appropriate equipment or facilities for loading and off-loading waste.

9. Local Authorities Health Inspectors **shall have the right to inspect the Storage facilities at any reasonable time.**

16) Contravention of any of the above conditions may prompt the local authority as a conservancy authority to recommend to ZEMA for revoke of Licence, prosecution or any other suitable action.

4.0 Responsibility

Subject to the Environmental Management Act and its supporting regulations, the Local Government Act and Public Health Act, local authorities have the responsibility as the "conservancy authority" to manage, conserve, preserve, maintain or protect the environment from air, water, noise and land pollution as they control an undertaking, service or facility and prohibit use of it by the public or any class of the public.

It shall be the duty of the district council to join with the government, conservancy authorities, private partners, or any other person or authority and the Agency like ZEMA in areas to deal with environmental management so as to establishing and maintaining the undertaking, service or facility within their jurisdictions to comply with prescribed environmental laws and regulations.

The work regarding environmental monitoring and compliance shall be carried out by qualified officers from LA appointed by ZEMA as honorary inspectors and other relevant authorities using established laws and local government's procedures.

It shall be the responsibility of the local authority to take punitive action for any contravention of environmental related issues that falls within their mandate or engage ZEMA for suitable action for cases outside their mandate.

It shall be the responsibility of the Local Authority to ensure that the up to date records of all environmental compliance report as stipulated by the Environmental Management (Licensing) Regulations of 2013 are reported to the subcommittee that deals with environmental related issues as well as keeping the Committee informed of emerging trends and successful practices in environmental management.

The local authority through the Public Health, Planning and Engineering Department will be responsible for conducting and planning for/an Annual Environmental Audit (AEA), using a safe procedure for identifying and monitoring environmental issues outlined above after approval from the Controlling Officer / Management and Acceptance by Environmental related Subcommittee / Council.

ZEMA working together with local authority shall maintaining officers, partners and supporting committees such as WDC with sufficient knowledge, skills, and experience in environmental related activities and capacity building to manage the dynamics of environmental issues.

Evaluating and assess significant merging / consolidating functions and new or changing services, processes, operations, and control processes coincident with their development, implementation, and / or expansion.

Assist in the investigation of significant suspected environmental contravention activities within its jurisdiction and notify management, Environmental Committee or ZEMA of the results for punitive action.

5.0 Authority

The Local Government Act provides for the establishment of Councils in districts, the functions of local authorities and the local government system. Some of the functions relate to pollution control and protection of the environment in general. Councils are spread throughout Zambia and this provides a very reliable platform to promote environmental manage and ensure environmental compliance through collaboration with ZEMA.

The Urban and Regional Planning Act No. 3, 2015 provides for the appointment of planning authorities whose main responsibilities are the preparation, approval and revocation of development plans. It also provides for the control of development and subdivision of land.

The Public Health Act, Cap 295 of the Laws of Zambia provides for the prevention and suppression of diseases and general regulation of all matters connected with public health in the country such as drainage, waste disposal and treatment of sewage. This is supported by **the Occupational Health and Safety Act of 2010** which provides for the health, safety and welfare of persons at work.

The Environmental Management Act No 12 of 2011 (amended as Act No. 10 of 2013) is an umbrella and principal law which stands over all other environmental legislation in Zambia. The Act which was renamed from the Environmental Council of Zambia to Zambia

Environmental Management Agency (ZEMA) which now is mandated to ensure the sustainable management of natural resources and protection of the environment to provide for the health and welfare of people, animals, plants and the environment in general. Subject to this act, local authorities being conservancy authorities, it mandates and promotes communities and relevant stakeholder engagement in environmental management.

6 Community Participation in Local Governance and Development

Local Authority shall ensure communities participate through WDC in environmental monitoring and compliance with the view to achieve the following; supports sustainable development, sustainable mining, communities enjoy and appreciate the benefits, communities own the development processes and accept development messages and adopt new ideas.

The quality of participation in environmental monitoring and compliance will be accessed through a number of attributes with the following characteristics:

1. **Inclusiveness –** ensure that beneficiaries participate in environmental monitoring and compliance without feeling distanced from the project and policy makers.
2. **Willingness -** communities participate in the planning process without feeling coerced, constrained or left with no other choice.
3. **Comprehensiveness -** All key stakeholders participate in the planning process.
4. **Accountability and transparency –** ensure that developers or development facilitators are procedurally accountable to the beneficiaries; and the planning and implementation process is also publicly visible.

7.1 Ward Development Committees (WDCs)

Local authorities should utilize established WDCs as mandated by the Local Government Act to enhance community participation in environmental monitoring and compliance with the understanding that Development can only be sustained if the beneficiaries of the development are meaningfully involved in order that: government and developers becomes more responsive to local needs. Community participation in environmental monitoring and compliance is assured process making conduct of public affairs more visible and government and developers more transparent. Encouraging such an integrated environmental management approach will make communities become more capable of managing their own lives and improved service delivery that is flexible and more likely to be directly relevant.

The WDC therefore, will be based on the rationale that environmental stewardship can better be sustained if managed in a decentralized context – where all key stakeholders, both female and male, and various interest groups, take part in activities from the planning, implementation and decision-making.

7.2 Composition of Ward Development Committees

Section 36 of the Local Government Act No. 2 of 2019 provides for the establishment in each ward a Ward Development Committee in the area of a local authority consisting of the following part time members appointed by the Town Clerk or Council Secretary:

a. an elected zonal representative from each zone;
b. an extension officer from the department responsible for agriculture, fisheries and livestock or economic sectors appointed based on the economic activity predominant in the ward as determined by the local authority;
c. an extension officer from the department responsible for education;
d. an extension officer from the department responsible for health;
e. an extension officer from the department responsible for community development;
f. a representative from a local nongovernmental organisation in a ward;
g. a representative of the Zambia Agency for Persons with Disabilities;
h. a representative from a marginalised group;
i. a representative of the Chief in the ward;
j. Ward Councillor;
k. a trustee from the local authority;
l. a youth,
m. sports and recreation focal point person;
n. and (m) a gender focal point person.

The members under subsection (1) (b), (c), (d) (e), (k), (l) and (m) shall be appointed as ex-officio members. The members under subsection (1) (b), (e), (f), (g), (h), (i), (j) and (l) shall be nominated by their respective institutions or organisations.The term of office for WDC members is five (05) years.

7.3 Roles of WDCs

The main roles of WDCs are outlined below:

- Link between communities, the council and external development agents
- Mechanism enabling communities to access development information and knowledge
- Means of disseminating community needs, potentials and capacities
- Forum for mobilization of communities for common development efforts
- Forum for democratic involvement of communities in the development process.

7.4 Functions of the WDCs

There are a lot of functions of WDCs as described under section 37 of the Local Government Act which can be summarised into these three main functions; development planning and coordination resource mobilization and Monitoring and Evaluation.

Executive Committee

Section 38 of the Local Government Act No. 2 of 2019 gives the composition of established a Ward Development Executive Committee. The committee shall be elected from among the Members of the Ward Development Committee consisting of the following part time members:

a. a Chairperson, who shall be elected from among the elected members from zones;
b. the Vice Chairperson who shall be elected by the members from among themselves;

c. secretary;
d. treasurer;
e. And four committee members. A Ward Development Executive Committee shall perform the executive functions of a Ward Development Committee.

7.5 Reporting

7.5.1 Structure

To enhance Environmental Management at Local Authorities level:

The engineering, planning and public and health department shall report for administrative and legislative action to the controlling officer and the standing committee. Further, the departments under question and developers shall report legislatively to the environmental committee and notwithstanding the report structure provided in the licence conditions as provided by ZEMA.

7.5.2 Reports

The engineering, planning, public health department and the developer shall submit the following reports to the controlling officer and the subcommittee in charge of environmental activities and notwithstanding the conditions provided in the licence from ZEMA.

i. Environmental impacts and there mitigation measures
ii. Quarterly environmental compliance returns sampled every month
iii. Developers Annual Environmental Plan

8.0 Environmental Audit Tool Approach

The environmental audit tool follows a risk based audit approach which places emphasis on the identification of environmental impacts of any project, there mitigation measures and evaluating of the annual environmental management plan as controls put in place to manage key related risks down to statutory acceptable levels. The audit approach combines two types of audit engagements, i.e. assurance and consulting (advisory) services.

9.0 Assurance Services

An objective examination of protection, conservation and sustainable use of various elements of the environment by local authorities will include project performance and compliance. These services refer to the evaluation of the adequacy, effectiveness and efficiency of the local authorities' environment monitoring and compliance control systems. Communities and stakeholder's engagements such as ZEMA and conservancy authorities among other will provide reasonable assurance that these environmental management processes are functioning as intended and will enable local authorities to achieve its goals and objectives, as well as provide recommendations in consultation with management or relevant authorities on how to improve its operations. The nature of the engagement will guided as stipulated in the Local

Government Act and the Environmental Management Act and supported by the Environmental audit Tool Work Plan.

10.0 Consulting Services

Advisory and related service activities, the nature and scope of which covers consulting from ZEMA or institution who's, either voluntarily or under the authority of any law, manages, conserves, preserves, maintains or protects the environment is intended to add value and improve the local authorities environmental monitoring and compliance. The following categories of consulting engagements could be performed:

- Formal consulting engagement-planned and subject to written agreement.
- Informal consulting engagement-routine activities such as participating in standing committees, projects life cycle and routine information exchange.
- Special consulting engagement-participation in capacity building on Environmental Management and Compliancy
- Emergency consulting engagement-participating in an advisory role on a developmental agenda to meet a special request or tight deadline.

The officer in charge should however maintain objectivity when drawing conclusions and offering advice to management, committee or ZEMA.

11.0 Timing and Corrective Measures

Where a critical environmental issue is identified, the local authority shall serve the developer on the environment issue for immediate course of mitigation action. If considered necessary, the matter will be brought to the attention of the Controlling Officer and ZEMA.

In a case of a non-compliancy from the developer, the local authority shall take such procedure as stipulated in the Local Government Act, Public Health Act or any other environmental related regulations.

12.0 External Relationship

Environmental Audit Tool supports Strategic Social Partnership Engagement (SSPE) as key to creating a more "meaningful existence and sustainable planet". Decentralizing environmental management and compliancy will help Local Authorities and ZEMA to work together for this common noble goal. Local Authorities departments in charge of environmental related issues, ZEMA and other conservancy authority should have regular contact in order to maximize the benefits that council receives from the combined assurance process.

13.0 Review and update of the Environmental Audit Tool

The Environmental Audit Tool will be reviewed annually by the Local Authorities Internal Audit Unit and tabled at the 1st quarterly meeting of the subcommittee responsible for Environmental related activities.

14.0 Quality control of the Engineering, Planning and Public and Health Department

The Department's responsible for environmental related activities performance will also be evaluated annually by the Controlling Officer and Audit Committee members and were necessary engage ZEMA.

Appendix 2: Plan for the Establishment of an Environmental Audit Tool

Table 1: Establishment of an EAT

S/N	ACTIVITY	OFFICER or INSTITUTION RESPONSIBLE
1	Orientation Workshop for Kalumbila and Solwezi District Councils on EAT	Researcher
2	Forward of the EAT to mining houses for comment	Kalumbila and Solwezi District Councils and the researcher
3	Forward for EAT to Ministry of Local Government (MLG) for guidance	Kalumbila and Solwezi District Councils and the Researcher
4	Engagement of ZEMA	MLG, Kalumbila and Solwezi District Councils and the researcher
5	Orientations Workshop for Councillors	ZEMA, Kalumbila and Solwezi District Councils and the researcher
6	Orientation Workshop for WDC's	ZEMA, Kalumbila and Solwezi District Councils and the researcher
7	Presentation to Sub committees for adoption	Kalumbila and Solwezi District Councils
8	Approval by Full Council	Kalumbila and Solwezi Districts Councils
9	Implementation of EAT	ZEMA, Kalumbila and Solwezi District Councils
10	Monitoring and Evaluation	Researcher, ZEMA, Kalumbila and Solwezi District Councils and the researcher

11	Roll over to other mining districts	Researcher, ZEMA, Kalumbila and Solwezi District Councils and the researcher

Impacts of Small-scale Mining on Crop Production, a Case of Development Minerals Excavation in Siavonga District of Zambia

(2nd Zambia Conference on Mining, Metallurgy and Groundwater Resources)

Beverly Thole[1], Jewette Masinja[2]
[1]*University of Zambia, School of Mines, P. O. Box 32379 Lusaka, Zambia*
beverlythole@gmail.com
[2]*University of Zambia, School of Mines, P.O. Box 32379 Lusaka, Zambia*
jewette_masinja@yahoo.com

ABSTRACT

Over the years, Southern province of Zambia has observed an increase in mining activities with 248 mining rights recorded in January 2019. Mining presents local economic opportunities and challenges to livelihood. Food security is important for active and healthy living. Globally, more than 800 million people lack access to adequate food due to reduction in food production in developing countries. This decrease is due to climate change, deforestation, pollution and unsustainable mining practices. Development minerals play a very important role in the construction industry and the demand has affected food production in Siavonga.

This study used primary and secondary data to investigate the trend in development minerals extraction and its impacts on crop production in Siavonga. Purposive sampling technique was done within identified farming communities affected by mining activities in Sianyolo area of chief Sinadambwe, Hanunka area of chief Simamba, Hambabala village of chief Chipepo and Kariba stop area in Bbakasa Village. 52 farmers and 47 small scale miners from each of the 4 communities were administered with questionnaires according to the proportion of the labor force engaged in farming and mining. 5 respondents were interviewed based on theoretical saturation; 1 from Zambia Environmental Management Agency, 1 from Food Reserve Agency, 1 from Ministry of Agriculture, 1 from Small-scale Mining Association and 1 from Ministry of Mines. Overall sample size was 401. The data was analyzed using SPSS in line with the study objectives. Literature on small scale mining, agriculture and policy documents was reviewed.

Small-scale mining techniques and methods pose numerous occupational safety and mine-related accidents due to inadequate safety provisions and lack of monitoring because of the illegal nature. Due to increased demand for sandy flat stones (Siavonga slates), quarry crushing stones, gravel, fluorite and feldspar, crop production dropped drastically from 4.5 to 2 Mt/Ha between 2013 and 2017

Local investors and stakeholders should take an inclusive approach and collaborate with Government and communities to understand impacts of mining and invest in advanced technology. This will contribute to SDG 1- End poverty and 8-Decent Work and Economic Growth. There is need for wide consultation, involvement, sensitization with all stakeholders and environmental impact assessment

Keywords: *Small-scale mining; Food security; Natural resources; Development minerals; Zambia*

1 Introduction

The most recent publications agree that there is an increase in small-scale mining across the globe and this is linked to high demand for minerals and metals due to increased mineral prices; population growth; high poverty and unemployment levels (IGF, 2018; IMF, 2016; Siwale & Siwale, 2017). Global trends indicate an increase from six million miners in 1993 to 13 million in 2002 (ILO, 2002) to 30 million in 2004 (García et al., 2015) and 40.5 million in 2017 (ASM website, 2017)

This trend has been observed in Zambia and 248 mining rights were recorded by January 2019 in Southern province alone. In Siavonga, development minerals excavation is on the rise due to its potential to generate jobs and is a source of readily available income. The excavation of development minerals in Siavonga employs the use of small equipment such as hammers, picks, shovels, grinders and table cutting machines normally on a small scale. There has been a shift from other economic activities like farming and the clothing industry to mining due to high levels of poverty, urbanization, unemployment and the need for economic independence. The growth in Zambia's population estimated at 16,000 in 2016 (CSO, 2012) is another contributing factor to the demand for the mineral resources and the most pronounced factor however is the sustainable market for these development resources from the construction and manufacturing industry which has been predicted to increase (Kambani, 2003; UNDP ACP-EU Zambia, 2014; WHO| Zambia, 2018)

For the past decade according to a report by the FAO, there has been a decline in the quality of food production due to several factors which directly or indirectly affect the elements that support agriculture. Hilson & Hilson (2015) elaborate that the effects of small-scale mining include environmental and socio-economic issues such as land degradation, pollution, poverty, and conflict. There is, therefore, a direct link between food production and mining because these economic activities both make use of natural resources. Furthermore, the mining methods

may displace farmland; cause land, air, and water pollution; and degrade agriculture land. Hence, if food security must be realized, the socio-economic and environmental issues of small-scale mining especially of development minerals have to be addressed urgently (ACP-EU Development minerals, 2015; Kambani, 2003; Limpitlaw, 2014; Van Straaten, 2002)

2 Methodology

This study employed a mixed method approach of research for collecting primary and secondary information. Both the qualitative and the quantitative methods of research were used. The qualitative was used to acquire deeper understanding on how small-scale mining of development minerals affected food production in Siavonga District in terms of crop production trends and quantity and quality of crops produced within the time frame of 2003 to 2017. Interviews were conducted with key informants from the Ministry of Mines, Ministry of Agriculture, Zambia Environmental Management Agency, Mine Workers Association and Food Reserve Agency. The quantitative method was used to address most of the proposed questions by using a combination of theories, measurements, validation, and hypothesis. Questionnaires were administered to farmers and small-scale miners. The following are the detailed stages;

2.1 Identifying and searching for key words

The key words were searched from already published research papers in Research gate and Elsevier. The identified key words were in line with the main title and these are; *Small-scale mining; Food security; Natural resources; Development minerals; Zambia*

2.2 Selection of relevant papers and content review

120 abstracts were reviewed in order to identify and select from already published journals on mining and agriculture. 8 journals relevant to the study were selected and used in literature review. Furthermore, in order to understand the current trends in food security and mining, several reports were reviewed including ILO on social and labour issues in small scale mining; WCED on sustainable development; FOA; UNDP on development minerals; IMF, WHO; Zambia Agriculture Status Report; and Central statistical report. The author also reviewed Mines and mineral development Act 11 of 2015 of Law of Zambia, Environmental management Act 12 of 2011 and policy documents including the 7th National Development plan and UNDP ACP EU on Development minerals.

2.3 Collection of data

Data was collected using a total of 396 questionnaires which were administered through purposive sampling technique to 188 small scale miners and 208 farmers within the identified areas genuinely affected by mining activities and were randomly selected. Interviews were conducted with 5 key informants from government sector and NGOs

3 Results and discussion

Mining in the Southern Province of Zambia

According to a report by the ministry of mines, Geological survey department, 248 mining rights were recorded in January 2019 and six mining areas in the southern province. These are; Mamba; Nega Nega in Munali Hills in Mazabuka; Chivuma in Mazabuka; Lochnivar in the Kafue flats in Monze; Mapatizya in Kalomo; and Siavonga. Siavonga District is known for emerald, uranium and development minerals excavation both on large and small-scale.

Mining in Siavonga provides several gains which include; employment creation to miners, drivers and equipment operators; is a source of revenue for the local council and chiefs; encourages infrastructural development such as the 'Bottom road' which runs from Siavonga to Munyumbwe and housing; generates income which is used in trade of agricultural produce, goods and services; provides raw materials for other industries such as construction and agriculture industries; provides new housing units for displaced communities; and other benefits from the CSR such as education, recreation and health facilities (Kambani, 2003; Van Straaten, 2002; ZANP, 2017; ZASR, 2017; Field survey, 2019)

Small-scale mining and food security

Results of the study show that small-scale mining is commonly practiced in the remote rural areas by people mostly with little or no educational background and employment alternatives as discussed by Hilson & Hilson (2015) and documented in the MOFED (2001:15,19). The areas identified in this study include; Sianyolo area of chief Sinadambwe, Hanunka area of chief Simamba, Hambabala village of chief Chipepo and Kariba stop area in Bbakasa Village all located in the remote rural areas in Siavonga district. The study reviewed that 45% of the small scale miners diverted from farming due to high demand of development minerals from the construction and manufacturing industries as documented in the IGF (2018) that 'small scale mining is a major supplier of useful raw materials in the manufacturing industries'.

Furthermore, the study reviewed several socio-economic issues associated with this practice such as displacement of habitats in newly opened areas, taking up of farmland for settlers and

conflicts due to lack of wide consultation, involvement, sensitization or social-environmental impact assessment as discussed by Siwale & Siwale (2017: 198) and agreed by Franks et al (2016) which affected food production negatively. Crop production dropped drastically from 4.5 to 2 Mt/Ha between 2013 and 2017 (plate 3.4). This was observed mainly in Sianyolo area of chief Sinadambwa within the past five years and the introduction of Chabonkonono mining site located in the Sianyolo Integrated Mining Resources Company Limited might have played a role. The development mineral mined in this area is fluorite which is major source of hydrogen fluoride a chemical used in the manufacturing industry to reduce the melting point of materials. One of the small scale miners reviewed that this may be as a result of the shift in the labour force from farming to mining because of the ready market for the development minerals.

Food security is a complex sustainable development issue linked to sustainable socio-economic development (FAO, 2016) and the results illustrate that withine the past decade, there has been a decline in the quantity of food production due to several factors which include climate change, high HIV AIDS prevalence, poor agricultural management, low farm productivity and mining activities contributing to a drop of over 50% in Siavonga district. In 2015, impacts of climate change contributed to this drop and over the period of 10 years small scale mining has contributed more than 50% of this drop due to destruction of farm land, convention of farm land into mining land and shifting from farming to mining as the main economic activity. The following table illustrates the awareness of negative impacts of mining on food production in Siavonga district as presented by the respondents.

Table 3.1 Impacts of small scale mining on food production

IMPACTS	AWARE		NOT AWARE		TOTAL	
	No. of respondents	Proportion (%)	No. of respondents	Proportion (%)	No. of respondents	Proportion (%)
Pollution of water bodies	300	76	96	24	396	100
Destruction of farm land	279	70	117	30	396	100
Land degradation	351	89	45	11	396	100
Loss of human resource in farming	126	32	270	68	396	100
conflicts	309	78	87	22	396	100

Source: Field survey, September, 2019

Small scale mining and regulatory framework

In Zambia, an act exists to revise the law relating to the exploration for, mining and processing of minerals. According to this Act, exploration, mining or mineral processing without license or environmental impact assessment is prohibited (MMA 11 of 2015, part III, section 12). The study reviewed that over 40% of small scale miners are mining illegally due to several challenges which include; procedure of mining license acquisition is too long; long distance to the Capital city of Zambia where the mining rights are acquired; lack of startup capital as most of the these miners are from unemployed background represented by 70%; and the pressure to earn a living for most of the youths to support themselves and their families

During the study, it was established that over 90% of the respondents were aware of the national policy and legislation on mining and the environment. The environmental management Act No. 12 of 2011 is the principle tool in environmental management in Zambia**.** According to this Act, all license acquisition is governed by the Environmental management licensing regulations, statutory instrument No.112 of 2013 and every project proponent must submit an environmental impact statement (EIS) or an environmental project brief (EPB) to Zambia Environmental Management Agency (ZEMA) before a project is developed and implemented as provided in the Environmental Impact Assessment (EIA) regulations, statutory instrument No.28 of 1997. However, 40% of small scale mining is illegal in Siavonga district and this is a global concern as discussed by Hilson (2015) and Siwale & Siwale (2017)

Mining methods and techniques

Small-scale mining techniques and methods pose numerous occupational safety and mine-related accidents due to inadequate safety provisions and lack of monitoring because of the illegal nature. Results show that 77% of the economically active proportion that is from 15 to 35 years (CSO, 2012) is engaged in small scale mining and only 17 % is engaged in agriculture. This shows that there is a small proportion of economically active population in the agriculture sector and this has a negative impact on crop production. 25% of the respondents disclosed that their heath is at risk and they may not be able to engage in other economic activity such as farming when they retire as evidenced in the finding in Table 3.2

Table 3.2: Proportion of the labour force engaged in farming and mining by age

Age	Small scale miners				Farmers			
	m	f	Total	Total (%)	m	f	Total	Total (%)
15 to 25	68	22	90	48	0	0	0	0
26 to 35	40	14	54	29	21	15	36	17.5
36 to 45	23	7	30	16	36	27	63	30.5

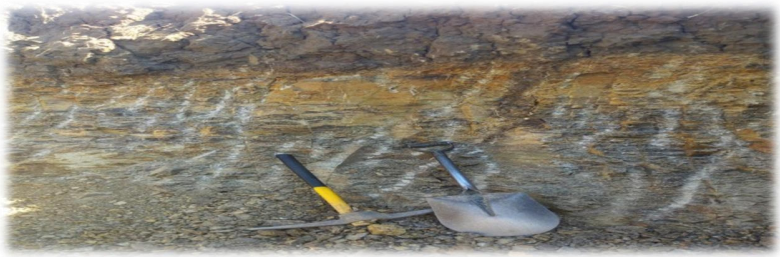
46 to 65	**12**	**0**	**12**	**6**	**42**	**35**	**77**	**37**
65 plus	**2**	**0**	**2**	**1**	**20**	**12**	**32**	**15**
Total	**145**	**43**	**188**	**100**	**119**	**89**	**208**	**100**

Source: Field survey, September, 2019

In the case of illegal small scale mining of gravel, fluorite, sand, feldspar and Siavonga Natural flat stone, huge amounts of land including inhabited and agriculture land was disfigured and the pits and holes that were dug were left uncovered, which made the land unsuitable for other land use which resonates with the environmental impacts summarized in table 3(Kambani, 2003:145). Clearly crop production was affected negatively by ASM. Plate 3.3 illustrates that as small scale mining activities increased crop production reduced tremendously. Furthermore, a number of health hazards may arise from the quarries due to stagnant water which may accumulate in rainy season, pollution of surface and underground water, and dust emissions from the explosives and blasting of aggregates which affected vegetation and animals (ACP-EU Development minerals, 2015; Franks et al., 2016; Hilson, 2015; Hilson and Hilson, 2017; Limpitlaw, 2014; Siwale & Siwale, 2017: 192-200; WHO| Zambia, 2018)

Fresh evidence from the field reviewed that small-scale mining methods involve removal of topsoil, digging of trenches and pits which pose a threat to livestock and humans as discussed by Kambani (2003) and Limpitlaw (2014), therefore if a proper closure and rehabilitation plane does not exist then the land may not have alternative use. Furthermore, natural streams may also be diverted or polluted which are an important source of irrigation for crops and animals (IGF, 2018: 13, 38, 39). In Siavonga District, fishing is a very important economic activity and Lake Kariba is the main source of water

Plate 3.1: Common tools used in development minerals excavation

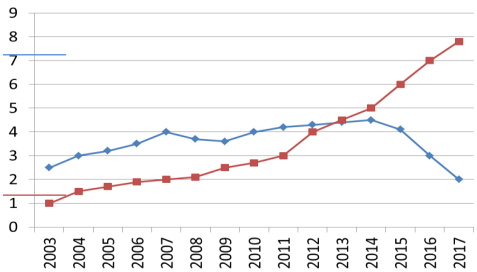


Source: Field Survey, September, 2019

Plate 3.2: Impacts of small scale mining on agriculture land

Source: Field Survey, September, 2019

Plate 3.3 Trend of major crop production and development minerals excavation in Siavonga



Key

Crop production in Metric tonnes

Quantity of development Minerals mined in metric tonnes

Source: Research findings, 2019

4 Conclusion

Farmers and farm owners play an important role in food production. The study showed an increase in the mining activities of sand, fluorite, gravel, Siavonga slate, granite and clay in Siavonga which translated in a drop in food production. This trend is observed in global statistics and is attributed to several factors including climate change, poor agriculture practices and mining activities being the major contributor. The results confirm that mining activities have contributed tremendously to the drop in crop production. Maize production has reduced drastically between 2013 and 2017when the quantity of development minerals increased. The reduction in food produce has been observed within the past decade across the country of

Zambia as reported by food reserve agency. Therefore the following recommendations have been given.

- Collaboration between large scale mines, the government and small scale miners;
- Flexible and accessible legal frameworks on mining and agriculture; There is need to make these available in local language and sign language
- Financial and technical support to artisanal and small scale miners
- Invest in technology to integrate small scale mining and food production
- Streamlining licensing process for the small scale miners to make it cost effective
- Provide special attention in terms of policy and legislation through constant monitoring and evaluation of small scale mining
- Invest in skills training and internship for the youths both with and without education background
- There is need to find a way of legalizing and monitor artisanal small scale mining in Zambia and across the globe

Statement of competing interest

This paper has not been published elsewhere, the author takes full charge and severally over the information presented therein. The author has no competing interests.

References

ACP-EU Development Minerals Programme, Stones for Development Inception Workshop Report. 2015. Implemented in Partnership with UNDP. http://www.developmentminerals.org/index.php/en/ Full report available here: http://www.developmentminerals.org/images/pdf/Inception_Report_EN.pdf

Artisanal and Small-scale Mining Knowledge Sharing Archive. (2017). ASM inventory. Retrieved from http://artisanalmining.org/Inventory

Central statistics office (CSO). 2012. CENSUS OF POPULATION AND HOUSING VOLUME 11. NATIONAL DESCRIPTIVE TABLES of 2010 CENSUS. Lusaka www.zamstats.gov.zm,

Environmental Management Act No. 12 of 2011, Part I section 4, part III section 29, part IV section 32 subsection 1, section 33 and section 36 subsection 1 of the Laws of Zambia

Food and agriculture organization of the United Nations office of evaluation June 2016, Available online at http://www.fao.org/evaluation

Franks, D.M., Pakoun, L., Ngonze, C. 2016. Development Minerals: Transforming a neglected sector in Africa, the Caribbean, and the Pacific. United Nations Development Programme

García, O., Veiga, M.M., Cordy, P., Suescún, O.E., Molina, J.M. & Roeser, M. (2015). Artisanal gold mining in Antioquia, Colombia: A successful case of mercury reduction. Journal of Cleaner Production 90, 244–252.

Hilson, G. & Hilson, A. (2015). Entrepreneurship, poverty, and sustainability: critical reflections on the formalization of small-scale mining in Ghana (International Growth Center working paper). Retrieved from www.theigc.org/wp-content/uploads/2015/04/Hilson-Hilson-2015-Working-Paper.pdf

Hilson, G. (2017). Towards a harmonious existence? The dynamics of artisanal and large-scale mine conflicts in sub-Saharan Africa. Presentation at Imp@ct Stakeholder Meeting: Ethics in Small-Scale Mining, London, 27 March 2017. Retrieved from http://blogs.exeter.ac.uk/impactmine/files/2017/03/Stakeholder-Ethics_Programme.pdf

Intergovernmental Forum on Mining, Minerals, Metals, and Sustainable Development (IGF). Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues. Winnipeg: IISD. https://www.researchgate.net/publication/322661184_GLOBAL_TRENDS_IN_ARTISANAL_AND_SMALL-SCALE_MINING_ASM_A_REVIEW_OF_KEY_NUMBERS_AND_ISSUES

International Labour Organization (ILO). (1999). *Social and labor issues in small-scale mines* (Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale mines). Retrieved from https://unites.uqam.ca/gmf/globalmercuryforum/files/articles/small_scale_mining/General%20ILO%201999%20-%20Social%20and%20labour%20in%20small-scale%20mines.pdf

International Monitoring Fund (IMF) report, Zambia; poverty reduction strategy paper. https://www.imf.org/en/Publications/CR/Issues/2016/12/31/Zambia-Poverty-Reduction-Strategy-Paper-21255

Kambani, S., M. 2003. Small-scale mining and cleaner production issues in Zambia. Journal of cleaner production 11: 141-146

Limpitlaw, D. Aken, M., Lodewijks, H. and J. Viljoen, J. 2015. Post-mining rehabilitation, land use and pollution at collieries in South Africa. Research Gate. The South African Institute of Mining and Metallurgy, South Africa. https://www.researchgate.net/publication/237436743 uploaded by Daniel Limpitlaw, D on 11 July 2014.

Mines and Minerals Development Act No. 11 of 2015 of the laws of Zambia. Available https://iclg.com/practice-areas/mining-laws-and-regulations/zambia

Ministry of Finance and Economic Development (MOFED). 2001. The government of the Republic of Zambia. Poverty Reduction Strategy Paper: Agriculture Sector. Lusaka, Zambia

Ministry of National Development Planning (MNDP). 2017. Seventh National Development Plan 2017-2021. Lusaka, Zambia

Siwale, A & Siwale, T. 2017. Has the promise of formalizing artisanal and small-scale mining (ASM) failed? The case of Zambia. Journal on extractive industries and society 4(2017): 191-201 African mining vision 2009. African Union

The World Bank in Zambia http://www.worldbank.org/en/country/zambia/overview

UNDP ACP-EU Development Minerals Programme Zambia (UNDP ACP-EU Zambia) .2014. http://www.zm.undp.org/content/zambia/en/home/operations/projects/poverty_reduction/acp-eu-development-minerals-programme-.Html

Van Straaten, P .2002. Rocks for Crops: Agro minerals of sub-Saharan Africa. Nairobi, Kenya, 338pp.

WHO| Zambia. http://www.who.int/countries/zmb/en/

World Commission on Environment and Development (WCED). 1987. Our Common Future. Oxford: Oxford University Press. Available: http://www.un-documents.net/our-common-future.pdf

Zambia Agriculture National Policy (ZANP). 2017. Ministry of Agriculture and cooperatives http://gafspfund.org/sites/default/files/inline-files/5.%20Zambia_strategy.pdf

Zambia agriculture status report (ZASR). 2017. https://www.researchgate.net/publication/322676437_Zambia_Agriculture_Status_Report_2017

Socio-economic impact of mine closure and development of exit strategy for rural mining areas in Zambia: A case study of Kalumbila District

(28th International symposium on Mine Planning and Equipment Selection – MPES 2019, Springer Series in Geomachanics and Geoengineering, pp411-421)

Bunda Besa[1*], Jimmy Kabwe[2], Jewette Masinja[3] and Webby Banda[4]

[1]*Senior Lecturer and Dean, The University of Zambia, School of Mines, P.O. Box 32379, Lusaka Zambia*
[2]*Postgraduate student, The University of Zambia, School of Mines, P.O. Box 32379, Lusaka Zambia*
[3&4] *Lecturer, The University of Zambia, School of Mines, P.O. Box 32379, Lusaka Zambia*
bbesa@unza.zm

Abstract: Lumwana and Sentinel mines both located in Kalumbila District of Zambia are still fully operational and are planned to continue operating until 2038 and 2033 respectively when they are scheduled to close down. However; it is anticipated that their closure would have a significant impact on the well-being of the local communities similarly to the experiences of host communities other areas where mines that have been closed in Zambia. The local communities in Kalumbila District rely heavily on these mines for their socio-economic development in that the mines provide employment, education, social facilities and health services to the community. In order to avoid the negative experiences of these communities, an appropriate exit strategy is required for Lumwana and Sentinel mines, as part of their mine closure plan. This paper proposes a community exit strategy (CES) that would mitigate the socio-economic impact of mine closure on the communities of Kalumbila District to avoid unsustainable communities' post-mine closure, in line with Sustainable Development Goal 11.

The first step in developing the proposed community exit strategy is re-establishing communication among the three key stakeholders in order to provide a basis for the key stakeholders to have a common and clear understanding of their objectives and expectations. It is then important to carry out an assessment of the livelihood of the local community through a demographic study of the four main villages in the area namely; Mumena, Matebo, Mukumbi and Musele aimed at determining the subsisting socio-economic characteristics of the population in these areas. There after an investigation of the potential socio-economic activities that can be undertaken in the area after mine

closure in line with pre-mining land uses would be carried. Hence, the findings of that investigation will form the basis upon which the proposed community exit strategy will be implemented.

Keywords: Socio-economic, Mine closure, Kalumbila, Community, Natural resources, Zambia

1 Introduction

Zambia's economy is significantly driven by mining as it accounts for 12% of its Gross Domestic Product (GDP), 70% of total export value and 62% of foreign direct investment ([28], [28]). Traditionally, Zambia's economy has benefited greatly from copper mining and it still remains as one of the key industries for economic growth (World Bank, 2011). The country's copper production increased by about 4% to 4.5% in 2018 and is projected to increase by 4% to 4.5% in 2019 (African Development Bank, 2019). However, the country's reliance on copper mining puts it at risk to fluctuating world copper prices. Therefore, the Zambian government has been developing an economic diversification program, to minimise the country's dependency on the copper industry. The program comprises of initiatives that encourage the utilisation of alternative industries like agriculture, hydropower and tourism [2].

Zambia is among the highest copper producing countries in the world even though historically it has been experienced ups and downs in production output. For instance, it produced 700,000 tonnes of copper in the 1970s and dropped to 255,000 tonnes in the late 1990s due to lack of recapitalisation in mining, assets nationalization of the mines as the Zambian government at the time felt it needed an increased level of participation in the mining sector ([23], [27]).

Privatisation of the mines in the 2000s led to a revival of the industry due to an increase in investments in the mining industry by foreign investors [27]. It was reported that 715,000 tonnes of copper was produced equivalent to 4.4% of global output in 2011 making Zambia the sixth world largest copper producer [14]. Due to a number of expected expansion plans, Zambia was seen as a major growth area for copper production and was anticipated to rank under the top five copper producers globally going forward [14]. It has not quite made the top five yet, but has steadily increased its copper output, producing 799,329 and 861,946 in 2017 and 2018 respectively [30].

Copper mining in Zambia is currently focused in the rural areas of North Western province as it can be seen from the copper production of 2018 where the province produced 575,077 tonnes out of total production of 861,946 representing 67% of the country's annual production [30]. Three of the largest open pit copper mines in Zambia namely, Sentinel, Lumwana and Kansanshi operate in rural areas of the North-Western Province. Sentinel and Lumwana are both located in Kalumbila District (Fig 1) while Kansanshi mine is located in Solwezi District (Fig 2). These mines are major providers of income, employment and services such as education and health [5]. The closure of any of these mines would therefore, have a significant impact on the well-being of the community and the nation at large. It has to be noted that mines usually close for two main reasons i.e., either the reserves are depleted or they become unprofitable.

Fig. 1. Kalumbila Mine located in rural area of North-Western province

Fig. 2. Kansanshi Mine located in rural area of North-Western province

When mine closure occurs, various stakeholders raise post-mining environmental concerns in relation to the rehabilitation of the affected areas. Usually, minimal attention is paid to the socio-economic impacts of mine closure on the local communities [12]. Mine closure has a massive impact on a country's economy, however, for those people in the local communities the impact is traumatic [19]. The social services that the mines provide to the communities become unsustainable after mine closure. Local municipalities and the government do not usually have the ability to create alternative economic initiatives and hence cannot continue

providing the services that were initially provided by the mines [26]. These issues lead to the economic, emotional and spiritual collapse of the communities which are usually then characterised by poverty, substance abuse, crime and violence [19]. This paper proposes a community exit strategy as a partial solution to the socio-economic impacts of mine closure on the local community whose principle objectives would be:

(iii) To re-establish communication among the three key stakeholders (government, investor and local community) in order to provide a basis for the key stakeholders to have a common and clear understanding of their objectives and expectations;

(iv) To carry out an assessment of the livelihood of the local community;

(v) To investigate the potential socio-economic activities that can be undertaken in the area after mine closure in line with pre-mining land uses; and

(vi) To establish the roles and responsibilities of all the stakeholders in the implementation process.

2 Mine closure

Mine closure is the process of terminating mining operations either temporarily or permanently. [4] describe it as process that marks an important moment at the end of the mine life that involves more than closing down the metallurgical and mine site. It is more than a managerial-technical-aspect within the mine life cycle but also a social incident in the lives, of individuals, households, families, communities and local government [18]. Mine closure plans often focus only on environmental and physical aspects, such as land rehabilitation and asset removal, rather than social, cultural and economic aspects [12]. The intensified attention on sustainable development and its use in mining in the modern era has assisted in putting into context the necessity of addressing the similarly significant social aspects of mine closure [15]. Closure Plans must be developed in such a way that they comply with rules that support sustainable development. Scheduling for closing a mine must therefore, also concentrate on the various socio-economic aspects of closure and not just on rehabilitating the environment [1].

There is insufficient literature regarding mine closure in Zambia. This is attributed to the fact that most of the mines that have been closed have been reopened such a Maamba Collieries

Limited. Other mining companies have shut down certain mines but opened new ones within the same locality. In Luanshya for example, Baluba mine was shut down due to plummeting copper prices and energy shortages while Muliashi mine remained operational despite being in the same area and owned by the same company [31]. Most of the available literature addresses the health issues related to the closure of Kabwe [29] and impact of privatisation of Zambia Consolidated Copper Mines (ZCCM). It was noted that there was insufficient information regarding the impact of mine closure in both developed and developing countries. Several years later [4] equally explained that compared with the substantial body of literature detailing the socioeconomic, cultural, and political impacts of mining, there are relatively few publications that specifically address the social aspects of mine closure and associated issues of planning and managing the social domain towards the end of the project life-cycle.

3 Social impacts of mine closure

Social impacts of mine closure are often neglected despite being as serious as the environmental and economic ones

[18]. The community challenges resulting due to poorly carried out mine closure may cause serious problems for mining corporations [17]. For communities on the other hand it may cause a lot of stress due to the risk of economic and social meltdown [17]. Constructing and commissioning a mining project pulls local people, businesses, and government agencies into an economic process. Each of these parties will, to different degrees, become dependent on the mine [21]. Some of these dependencies are mutual, whereas others are at the convenience of one or the other party

57. Some mining companies add value to nearby communities through building or funding schools, clinics, hospitals, social centres, self-help schemes, roads, houses or sports facilities [8]. The people living in an area where mining is undertaken are given the chance to work with the mine to guarantee sustainable benefits from its operations. However; the employees and the communities at large are usually not ready for the impacts of mine closure [15].

Mine closures can have severe impacts on local economies, add to impoverishment, prompt the loss of crucial services such as health and education, and cause out-migration which may consequently affect labour markets, employment, and housing prices ([4], [12]). Ineffective mine closure activities in reality leads to interruption of community cohesiveness and it can also cause displacement of communities [13]. In developing nations, schools and clinics run by

mining companies end up in the hands of the municipalities and that is usually a problem [15]. [10] states that accommodation and public services are also negatively impacted by mine closure. For example mine workers lose their right to housing, hence, the houses are abandoned and then inhabited by illegal occupants. In addition the structures and facilities previously owned by closed mines are usually vandalized hence compromising safety of the mining communities [10].

Mine closure leads to social transformations in local communities associated with job loss such as escalation in poverty

[24]. For instance, the closure of the Kabwe Lead Mines in Zambia in 1994 resulted in nearly 1,200 direct job losses and an additional 5,000 jobs by contractors [20]. The mine closure of Kabwe mine led to rapid decline of the local economy with minimal diversification being developed [6]. Luanshya Copper mine in Zambia dismissed 1,600 employees when it closed its Baluba mine due to plummeting copper prices and energy shortages [31]. The closure of Zambia's Bwana Mkubwa mine in 2008 led to 400 employees losing their jobs [3]. Job losses raises the need to search alternate forms of livelihood and employment putting former mine workers to difficulties of relocation and they may be unable to find employment with their skills as they may not be useful in the new environment ([15], [16], [18]). It is even more challenging for retrenched miners to get other jobs in rural areas [3]. [10] discovered that mining communities in Romania, Russia and Ukraine not only have a similar challenge of the number of jobs but the quality as well as long-term stable jobs offering reasonable salaries are rare. [10] further explained that the basic situation on local labour markets led to a worsening of living standards for many due to qualitative transformation in the type of jobs, with the development of informal, insecure types of jobs offering lower salaries with less legal and social amenities. It also caused the development of individuals that are typically vulnerable in these extremely competitive employment markets. In most cases mining communities are not prepared beforehand for the loss of employment and the ensuing poverty due to closure and hence suffer from shock [25]. Post mine closure, mining communities appear to be fragile or vulnerable and their capacity to respond adequately to social instability, alienation and apathy on a community platform weakens [10].

Mine closure also affects local and regional governments which in turns affects local communities. [12] notes that payment of taxes and royalties usually cease or are significantly reduced upon mine closure, which can further reduce local expenditure of governments and

other beneficiaries. Governments that benefit from taxes, royalties and infrastructure provided by mines would equally have to adjust [15]. Municipal budgets experience a double impact due to mine closure as they lose tax revenues and at the same time cost obligations increase [10].

4 Proposed community exit strategy (CES) for Kalumbila Community

The closure of a mine in any jurisdiction ideally requires a community exit strategy that addresses the anticipated impact of closure on the local community. There are three key stakeholders in such a strategy each with very specific expectations, and for a successful closure, the impact on all three stakeholders must be fully taken into account. These stakeholders are:

- The government who lose tax revenues and at the same time cost obligations increase;
- The investor who incurs the mine closure costs; and
- The local community who lose employment, crucial services such as health and education and risk local economic meltdown.

In support, [17] states that in order to properly close a mine, a trilateral discussion aimed at finding solutions is needed among mines, governments and communities. Despite closure concerns being different for each mine, it is feasible to create a number of principles to help the mine, municipality and community taking part in the closure process to guarantee full value for everyone involved [15]. Therefore, the proposed community exit strategy is carried out in a series of steps that aim at meeting the expectations of all the three stakeholders. It is developed based on the landscape approach proposed by [22]. In that proposal, [22] provides ten principles to support implementation of a landscape approach placing emphasis on adaptive management, stakeholder involvement and multiple objectives. In some of the steps of the proposed community exit strategy, one or two of the ten principles are utilized to support the strategy.

The first step of the proposed community exit strategy is to re-establish communication among the three key stakeholders i.e. the government of Zambia, mine owners and community in Kalumbila district. The purpose is to revisit the contractual agreement that was made among them prior to granting mining rights to the Kalumbila mining company. This is intended to bring out the obligations and expectations of all the stakeholders in relation to mine closure. [18] states that one of the problems faced during the mine closure process is miscommunication among the various stakeholders over concerns such as what the local community expects and

if the mining company can meet those expectations. In that case, [18] claims that mitigating the socio-economic impacts of mine closure is not more about preparing for the inevitable end of the life of mine but more about the government making sure that the mining company does not avoid meeting its obligations. On the contrary, [21] suggest that mining companies should be ready to labour as the intermediary between government and local communities as they are well situated in the direct impact zones. Both authors understand the necessity of communication during the mine closure process but contradict each other on who should be the mediator. However, emphasis should be placed on the purpose of the communication and not who meditates it. Therefore, [22] provides a couple of principles that enables effective communication among the stakeholders. In principle number two, [22] states that difficulties of implementation of a landscape approach can be solved through negotiations based on trust which in turn is achieved if objectives and values are shared. In other words, a common problem has to be identified as each stakeholder would only participate if it is in their best interest. [22] further states that initially, reaching an agreement on the primary objectives may not be easy but concentrating on easy-to-reach intermediate goals may encourage stakeholders to work together. Principle number five emphasizes that a landscape approach needs to identify its stakeholders and understand their concerns and aspirations. All stakeholders should be acknowledged even if negotiations may not include all of them but the solutions should be fairly beneficial to all. The proposed community exit strategy in Kalumbila area recognizes its stakeholders from the onset and prioritizes initiating communication as the first step to achieving its purpose.

The second step is to carry out an assessment of the livelihood of the local community in Kalumbila area. This is intended to get an understanding of what people in Kalumbila area surrounding the mine do other than working in the mine. It will also provide a background on what socio-economic activities they were engaged in before the mining operations began in the area. This is important because any landscape approach that will be adopted post mine closure will have to be in line with what the local community are familiar with or are currently engaged in. For example if pineapple farming is the norm in the area then it would difficult for the local community to adopt sunflower farming even though it might be more lucrative. As part of the assessment, a demographic study of the Kalumbila area will be conducted to determine the socio-economic characteristics of the population. This will give an insight of the socio-economic impact of mine closure on the local community and possible mitigation measures that can be put in place.

29. acknowledges that optimising mine closure activities on a social point of view would improve instead of reducing local capital to develop the platform for a more sustainable post-mining future. In other words, investment in improving social livelihood of the Kalumbila community after mine closure would not necessarily result in loss of capital for the mine but minimize the dependency on the mine by the community. This would be done through execution of activities that meet social requirements, build local capacity for self-development and foster resilience to change [12].

The third step involves conducting an investigation of the potential socio-economic activities that can be undertaken in Kalumbila area after mine closure in line with pre-mining land uses. [22] in principle number four explains that landscapes and their constituents have several uses providing a variety goods and services that are of value to stakeholders differently. Hence the investigation has to be carried out in line with the second step discussed above in terms of a landscape approach that the local community is familiar with. However, the third step is carried out to explore other socio-economic activities that are still within the comfort zone of the local community but have not been fully exploited. This is also intended to determine what alternative economic activities other than mining can be carried out in the area in the wider perspective of local economic development. [17] in support states that linking local economic development and mine closures plans can guarantee that land uses after mine closure are in sync with surrounding development projects. Effective management and resourcing of those activities in an integrated way is likely to build the basis for long-term development [4]. The third step of the proposed Kalumbila community exit strategy is crucial as it would provide useful information that would prevent economic meltdown of the area in question.

Lastly, the outcomes of the three steps discussed earlier will form the basis upon which the proposed community exit strategy will be implemented. This will also require establishing the roles and responsibilities of all the stakeholders in the implementation process. In this case principle number seven by [22] is particularly useful as it points out that resource access and land use determines the social and preservation outcomes, therefore, the rights and responsibilities of different stakeholders have to be clear and acceptable by all. A legitimate system for conflict resolution is required when conflicting claims are made among the stakeholders. In principle number ten, [22] states that the complicated and evolving nature of landscape approaches needs experienced and effective representation and institutions that are capable of solving all problems raised by the approach. In other words, stakeholders have to possess certain skills in order to effectively participate in various roles and responsibilities. The proposed community exit strategy will take into account the skills of the stakeholders in the

various roles they will hold during the implementation process. Fig 3 summarises the steps that have to be taken to develop the proposed community exit strategy for Kalumbila area.

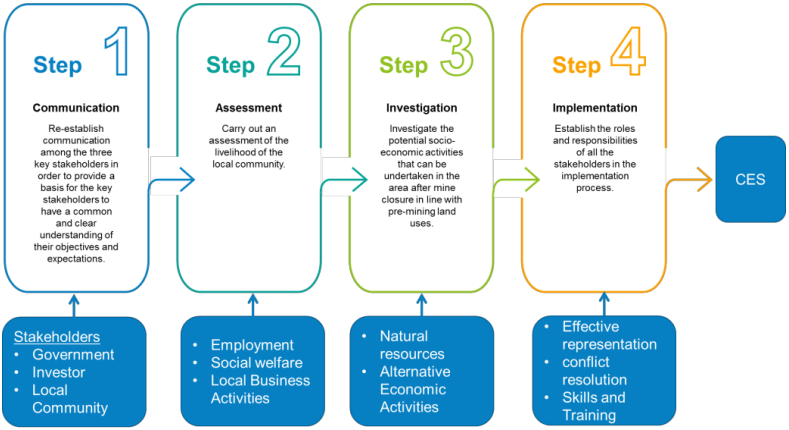


Fig. 3. Community Exit Strategy (CES) Flow Chart.

5 Key considerations of the proposed community exit strategy

The following are the key considerations of the proposed community exit strategy in Kalumbila area;

(v) The strategy needs validation with good quality empirical data. A case study research will be carried out on Kalumbila District as it hosts two of Zambia's major copper mines that are both currently in operation and will be due for closure over the next 10 to 20 years.

(vi) The strategy will be used as a tool for mine closure planning across the mining industry with respect to the socio-economic aspect of the closure plan; and

(vii) The strategy will have quite wide applications, across different jurisdictions. This means that the collection of data from different jurisdictions will be in order.

6 Conclusion

This paper has proposed a community exit strategy for Kalumbila mine that incorporates the expectations of the three stakeholders, government, investor and local community during the mine closure process. However, the research is still going on and will require good quality empirical data to validate it and establish its usefulness through a case study of Kalumbila district.

References

1 Ackerman, M., Van der Waldt, G. and Botha, D. 2018. Mitigating the socio-economic consequences of mine closure. SAIMM: Journal of the Southern African Institute of Mining and Metallurgy. 118(4):439-447.

2 Africa Development Bank. 2019. Zambia Economic Outlook. Africa Development Bank Group. https://www.afdb.org/en/countries/southern-africa/zambia/zambia-economic-outlook/

3 Allafrica. 2010. Zambia: Bwana Mkubwa Mine Resumes Operations https://allafrica.com/stories/201001110091.html

4 Bainton and Holcombe. 2018. A critical review of the social aspects of mine closure. Resources Policy: Elsevier Ltd. 1-11.

5 Barrick. 2017. Sustainability report summary. Barrick Gold https://barrick.q4cdn.com/788666289/files/sustainability/2017-Sustainability-Report-Summary.pdf

6 BMR. 2016. The Kabwe Mine. BMR Group PLC. http://www.bmrplc.com/kabwe_mine.php

7 Choshi, S. 2001. Mining and society – local development, MMSD Southern Africa Report on Research Topic 3. African Institute of Corporate Citizenship. 59

8 Cooke, J.A. and Limpitlaw, D. 2003. Post-mining site regeneration: Review of good practice in South Africa. Unpublished report for the Global Mining Consortium, Global Centre for Post-Mining Regeneration. Cornwall, UK.

9 First Quantum Minerals. 2016. Sustainability report. First Quantum Minerals Ltd. https://s1.q4cdn.com/857957299/files/doc_downloads/Reports/2016-Sustainability/2016-Sustainability-Report.pdf

10 Haney, M. and Shkaratan, M .2003. Mine closure and its impact on the community: five years after mine closure in Romania, Russia and Ukraine. Social Development Department, World Bank. 42: 1-77

11 https://siteresources.worldbank.org/INTZAMBIA/Resources/copper-mining-summary-note(online-copy).pdf

12 Kemp, D., Clark, P. and Zhang, T. 2008. Estimating Socio-Economic Impacts of Mine Closure. Research Paper. Centre for Social Responsibility in Mining, the University of Queensland, Australia. 8:1-19

13 Khanna, T. 2000. Mine closure and sustainable development: Results of the workshop organized by the World Bank Group Mining Department and Metal Mining Agency of Japan. Mining Journal Books, London.

14 KPMG. Zambia mining guide. 2013. KPMG International Cooperative. https://assets.kpmg/content/dam/kpmg/pdf/2013/08/zambian-country-guide.pdfLaurence, D. 2005. Optimisation of the mine closure process. Journal of Cleaner Production, Elsevier Ltd. 14:285-298Leteinturier, B., Laroche, J., Matera, J. and Malaisse, F. 2001. South African Journal of Science. 97:624-627

15 Limpitlaw, D. 2004. Mine closure as a framework for sustainable development. School of Mining Engineering, University of the Witwatersrand, Johannesburg. https://www.researchgate.net/publication/242116913

16 Manjunath, A., Partha, S.A. and Biswajit, P. 2014. Environmental and socio-economic impacts due to mine closure. ResearchGate. Conference Paper.

17 Marais, L. 2013a. The Impact of Mine Downscaling on the Free State Goldfields. Urban Forum. 24(4): 503.

18 MMMD. 2016. Environmental and Social Management Framework: Zambia Mining Environment Remediation and Improvement Project. Ministry of Mines and Mineral Development. 12-15.

19 Owen, J. and Kemp, D. 2018. Mine closure and social performance: an industry discussion paper. Centre for Social Responsibility in Mining, Sustainable Minerals Institute, the University of Queensland: Brisbane.

20 Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A. K. et al. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. PNAS. 110(21): 8349–8356

21 Sikamo, J., Mwanza, A. and Mweemba, C. 2016. Copper mining in Zambia - history and future. The Southern African Institute of Mining and Metallurgy. 116:491-496

22 Stacey, J., Naudé. A., Hermanus, M., and Frankel, P. 2010. The economic aspects of mine closure and sustainable development. Literature overview of lessons for the socio-economic aspects of closure. The Coaltech Research Association. CSMI: WITS. 1:1-32.

23 Van Eeden, E.S., Lieffering, M. and Du Rand, J.F. 2009. Legal issues concerning mine closure and social responsibility on the West Rand. The Journal for Transdisciplinary Research in Southern Africa. 5(1):51-71.

24 World Bank. 2002. It's Note Over When It's Over: Mine Closure Around the World, Mining and Development Series. World Bank and International Finance Corporation. 4:1

25 World Bank. 2011. What would it take for Zambia's copper mining industry to achieve its potential? The World Bank Group.

26 World Bank. 2016. How Can Zambia Benefit More from Mining? The World Bank Group. http://www.worldbank.org/en/news/feature/2016/07/18/how-can-zambia-benefit-more-from-mining

27 Yabe, J., Nakayama, S.M.M., Ikenaka, Y., Yohannes, Y.B., Bortey-Sam, N., Oroszlany, B., Muzandu, K., Choongo, K., et al. 2014. Lead poisoning in children from townships in the vicinity of a lead–zinc mine in Kabwe, Zambia. Chemosphere, Elsevier Ltd. 119:941–947

28 Zambia Chamber of Mines. 2019. http://mines.org.zm/the-2018-copper-production-hits-861946-tonnes/ ZCCM-IH. 2015. China's CNMC says followed the law in closing Luanshya Copper Mines. http://www.zccm-ih.com.zm/chinas-cnmc-says-followed-the-law-in-closing-luanshya-copper-mines/ ZCCM-IH. 2018. Mining sector GDP input low. http://www.zccm-ih.com.zm/mining-sector-gdp-input-low/

Socio-economic contributions of small-scale scrap metal sector to household economies – a case study of Lusaka district

(2nd Zambia Conference on Mining, Metallurgy and Groundwater Resources)

Ethel Lungu[1] and Edward Siame[1]

[1]Department of Metallurgy and Mineral Processing, School of Mines, The University of Zambia, P.O. Box 32379, Lusaka Zambia
Email:ethellungu@gmail.com

ABSTRACT

In Lusaka today, importation of metal based goods has risen leading to accumulation of scrap metal in the district. During daytime, scrap metal loaded in wheel barrows and vans are seen being delivered to scrap metal buyers by small-holder scrap metal dealers. However, the quantities collected, jobs created and income generated from the business were unknown. Hence, the study aimed at investigating the potential of small-scale scrap metal industry in creating jobs, improving livelihoods and providing recycled goods in Lusaka District. In addition to this, the aid of Statutory Instrument 102 of 2011 in retention of scrap metal in the district. In this study, fifty (50) questionnaires were administered to small-scale scrap metal dealers in Kalingalinga, Bauleni, Chaisa, Garden, Mutendere, Misisi, Chainda, Chinika area, along Mumbwa Road, Kamanga, Mandevu and Kaunda Square. Additionally, Two (2) questionnaires to Kafue Steel Company and Heroes Foundry and Engineering Company and one (1) to Zambia Revenue Authority Chirundu Boarder Branch. The results showed that an average of nine (9) workers were employed per business who earned between K10 and K45 per day and K250 and K5000 per month. Additionally, 74% claimed that Statutory Instrument 102 of 2011 was helping in retaining of scrap metal while 26% claimed that it is not. Products made from recycled scrap metal include bars, window section, deformed angle lines, billet, man-hole covers and crasher plates. Ultimately, small-scale scrap metal dealers benefited from the study by being aware of different products they can manufacture from recycled scrap metal. Similarly, policy makers have known the effect of Statutory Instrument 102 of 2011 in retention of scrap metal in Lusaka District.

Key words: *scrap metal, small-scale scrap metal dealers, metal reuse*

INTRODUCTION

Background

In the world today, metals play a significant role more so in the manufacturing industry sector to manufacture various metal products such as motor vehicles. This has led to their high demand especially due to the increase in people leading modernized lifestyles. Conversely, in Lusaka District, population increase coupled with increased importation of second-hand motor vehicles, household appliances and electronic components that usually have short life spans (Kayoba and Chanda, 2010) have resulted in accumulation of large quantities of scrap metal in the district. For example, about 50, 000 motor vehicles are imported annually in Zambia of which nearly 75 % are second hand whose roadworthy lifespan is estimated slightly below four (4) years (ZIPAR, 2014; Nyati, 2015). Consequently, this has led to environmental pollution from dumping waste metal resources especially in high density areas of Lusaka. However, the Small-Scale Scrap Metal Dealers (SSSMD) took advantage of the opportunity by engaging in scrap metal collection, reuse and recycling business to generate income. Moreover, during daytime in Lusaka District, wheel barrows and vans loaded with scrap metal from various sources are seen being transported to various locations by small-holder scrap metal dealers. From there, they are collected and sold to various buyers such as metal recyclers, car breakers and foundries. However, quantities collected, jobs created and income generated in the business were poorly studied as Sakala and Moyo (2017) researched only on Aluminum and Bronze which accounted for 13% of job creation in Zambia. These questions needed answers as job creation is imperative in this nation as well as the socio-economic impact of the business on dealers and the environmental impact of scrap metal reuse and recycling business. A report by Sakala and Moyo (2017) indicated that waste management and recycling can make a substantial contribution to economic growth and job creation. Above all, the aim of the study was to investigate the potential of the small-scale scrap metal industry in creating jobs, improving livelihoods and providing needed recycled goods to the population in Lusaka District.

Along the same lines, the Zambian government enacted Statutory Instrument 102 in 2011 banning the exportation of scrap metal out of the country. Research however, showed no evidence of a study being conducted in this area in order to access how that law was fairing in retention of scrap metal in the business sector. Therefore, the study also endeavored to assess the impact that law was having on the retention of metal waste in Lusaka District.

The proposed solutions to the above mentioned problems were conducting a research using a case study in order to determine jobs created, income generated, environmental impact of the business and provision of needed recycled goods to people in the district.

MATERIALS AND METHODS

The study was conducted in Lusaka District using a Case study, interviews and questionnaires to gather primary data. Fifty (50) questionnaires were administered to small-scale scrap metal dealers in Kalingalinga, Bauleni, Chaisa, Garden, Mutendere, Misisi, Chainda, Chinika area, along Mumbwa Road, Kamanga, Mandevu and Kaunda Square. Additionally, Two (2) questionnaires to Kafue Steel Company (Universal Mining and Chemical Industries Limited, P.O. BOX 30824, Lusaka, Zambia) and Heroes Foundry and Engineering Company (Plot 183/1 Mzilikazi, Lusaka) and one (1) to Zambia Revenue Authority Chirundu Boarder Branch.

Small-scale scrap metal dealers were asked questions such as how many employees they have; how much those employees earned and whether Statutory Instrument 102 of 2011 was helping in retention of scrap metal in the district. Additionally, Kafue Steel Company and Heroes Foundry and Engineering Company were asked on products they manufacture from recycled scrap metal. Furthermore, Zambia Revenue Authority Chirundu Boarder Branch was asked if it has impounded any trucks carrying scrap metal since 2011. Conversely, this data was analyzed using Descriptive Analysis.

RESULTS AND DISCUSSION

Income Generation

The results showed that an average of nine (9) workers are employed per small-scale scrap metal business. This entails that an average of 450 people are employed altogether in the 50 small-scale scrap metal business sampled. This number is quite low for a business that is mushrooming in the district. However, about 1066 people add to this number by holding odd jobs of collecting and supplying scrap metal to SSSMD in the district. These people play a vital role in sustenance of the sector as they feed small-scale scrap metal dealers with metal waste. Similarly, these workers (1066) earn between K10 and K45 a day for odd jobs such as packing a truck. By extension, such jobs are available nearly only once a month when metal waste has reached a desirable amount such that it can be packed in a truck. Hence, this may be the only finances that they earn in a month. Along the same lines, workers (450) also earn between K250

and K5000 per month as a salary. Ultimately, 86% workers earn below the Zambia minimum wage of have K1, 698.60. This however, shows that majority of people in this industry earn below the minimum wage.

Environmental Impact of Scrap Metal Collection

Table 1: Kilograms of scrap metal collected per day

KILOGRAM	# OF SSSMD WHO COLLECT IT	PERCENTAGE
1kg – 100kg	25	50%
101kg -500kg	12	24%
501kg- 1tone	6	12%
1001 tones – 3tones	6	12%
3001kg– 10tones	1	2%

Table 1 shows the amount of scrap metal collected per day. It could also be deduced that scrap metal business has a positive effect on the environment as an average of 1000kg garbage is recovered from it. Furthermore, the Circular Economy Model was being utilized to manage the subsector using reuse and recycling principles.

Provision of Recycled Products

The industry is providing products made from recycled scrap metal. For instance, Heroes Foundry and Engineering Company produces billet, man-hole cover, crasher plates and many others that customers request. While Kafue Steel Company produces bars, window section and deformed angle lines.

Statutory Instrument 102 of 2011's Aid of Scrap Metal Retention in Lusaka District

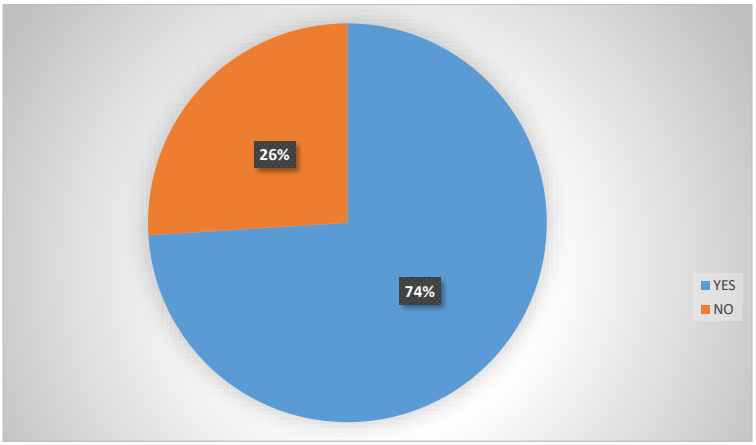


Figure 1 shows SSSMD's response of Statutory Instrument 102 of 2011 in retention of scrap metal in Lusaka District.

As could be seen from the Figure, 74% claimed that Statutory Instrument 102 of 2011 is helping in retention of scrap metal while 26% claimed that it is not. A deduction that the law is adding in retention of scrap metal in the district was then realized. Moreover, Zambia Revenue Authority Chirundu Boarder Branch claimed asserted that they have not impounded any truck carrying metal waste with the intention of smuggling.

CONCLUSION

- The industry is creating jobs thus contributing to the socio-economic wellbeing of SSSMD in Lusaka District.
- Statutory Instrument 102 of 2011 is contributing to the sustenance of the industry by making sure that scrap metal is readily available to local scrap metal recycling industries in the district.
- Waste metal is turned into recycled valuable goods hence cleaning the environment.

ACKNOWLEDGEMENTS

Special thanks to God for this opportunity to study Master's Degree in Sustainable Mineral Resource Development and ESDA for funding my research. I also express my gratitude to my supervisor Dr. E. Siame for his timely guidance throughout my research work and lastly but not the least my husband for being by my side.

REFERENCES

Kayoba S and Chanda O 2010 Aluminum project report. National Technology Business Centre. Lusaka: Zambia.

Nyati k 2015 State To Introduce Used Vehicle Age Limit. Zambia Daily Mail. May 28th, 2015.

Sakala W and Moyo S 2017 Solid waste recycling and job market in Zambia. Sustainable Resources Management journal, 2(6)01-09.

ZIPAR 2014 Second-hand Motor Vehicle Imports in Zambia: Juicing from Lemons? http://www.newworldencyclopedia.org/entry/Lusaka.

Socio-economic impacts of mining on local communities - the case of the Kansanshi Mine in Zambia

(10th Annual Ibadan Sustainable Development Summit (ISDS), with the theme "Building and Sustaining Strategic Partnerships for the Achievement of the Sustainable Development Goals")

Peter Mhone[1], Jewette H. Masinja[2] and Orleans Mfune[3]
[1-2]University of Zambia, School of Mines, Department of Metallurgy and Mineral Processing
[3]Manager Research and Institutional Audits at the Higher Education Authority, Lusaka.
Email: petermhone04@gmail.com

Abstract

Mining activities can bring about investment to a previously rural area and thereby promote rural-urban connections, employment opportunities for the host community and improvements in education facilities, among others. The aim of the study was to assess the socio-economic impacts of mining on people's livelihoods in communities surrounding the Kansanshi mine and the role of Corporate Social Responsibility (CSR) in mitigating the effects. The objectives were to establish how mining activities impact (socially and economically) on people's livelihoods, examine the (CSR) strategies used by the mining firm to improve local people's welfare and to establish the extent to which CSR strategies are contributing towards the improvement of people's livelihoods. The results of the study revealed that the Kansanshi mine, through its CSR initiatives, has built and renovated some schools, clinics, the main district hospital and some township roads. Despite this, health and educational facilities are far apart resulting in pregnant women and school going children walking long distances to access these services. Some roads are in very bad condition rendering them impassable during the rainy season. As a result of this, the communities surrounding the mine feel neglected by both the mine and the government. There is need for a law which can distinctively stipulate the roles of the government and those of the investor in community project implementations. Additionally, the government need not abandon social provisioning to mining companies, but rather, pursue a programme of being a partner with the mining companies. This can be done by involving the mining companies and the host communities so as to establish responsibilities, costs and benefits and also to sign tripartite (the investor, government and the host community) community development agreements.

Keywords: Mining, Corporate Social Responsibility, Socio – economic impacts, local communities

Introduction

Kansanshi Mine is a subsidiary company of First Quantum Minerals Limited and Zambia Consolidated Copper Mines (ZCCM) which owns 80 per cent and 20 per cent of the shares respectively. This study was focused on the host community around the Kansanshi Mine in Solwezi in the North Western Province of Zambia. Mining comes with a lot of impacts (positive and negative) to a particular area (local community) where operations are taking place. Most often, mines are located in rural areas – locations where such operations would be taking place for the very first time. Some of the negative impacts of mining on rural areas are water pollution (surface and underground), land degradation, air pollution and displacement of people. Despite the above stated negative impacts, mining activities are critical in linking rural and urban areas. Mining activities may bring about technology which promotes rural-urban connections, employment opportunities for the local community and improvements in education facilities, among others. These impacts are often under researched by scholars. In the case of North-western province (Zambia), for example, there has been little research on the extent to which the new mines are impacting on local communities. For example, it is not clear how Kansanshi mine, through its' Corporate Social Responsibility (CSR) initiatives has contributed to the socio-economic wellbeing of their local communities. This study sought to examine the socio-economic impacts of mining on local communities and the role of CSR.

The objectives of the study were: 1) to establish how mining activities impact (socially and economically) on people's livelihoods; 2) examine the Corporate Social Responsibility (CSR) strategies used by the mining firm to improve local people's welfare; and 3) establish the extent to which CSR strategies are contributing towards the improvement of people's livelihoods. Bearing in mind these objectives, the research questions were: 1) how do mining activities impact (socially and economically) on people's livelihoods? 2) What CSR strategies does the Kansanshi mine use to improve the local people's welfare? 3) To what extent are the CSR strategies being used by the mining firm to contribute towards the improvement of the local people's livelihoods?

This study was (is) significant in that it seeks to contribute towards the development of laws which can see to it that communities which host local mines benefit socially and economically during and after the lifespan of a mine operation. Further, the study can assist policy makers to review some of the agreements which governments enter into with mining companies so that at the end of the day, benefits can demonstrably accrue to host communities. Additionally, the

findings of the study seek to further strength the need for a widely accepted definition of CSR. A CSR definition which can distinctively stipulate the role of governments and those of investors in community project implementations in order to have a win – win situation for all stakeholders (local communities, governments and mining companies).

When mining activities begin to take place in a locality, infrastructure, business services, public and personal services sectors also grow, with particularly noticeable employment gains in the public and personal services sector (Mcfarlane *et al.*, 2016). An investment in a key sector such as mining tends to enhance a country's economic development because such a sector causes an expansion of other sectors due to it being a user of inputs from other sectors and as a supplier of inputs to other sectors (Ivanova, 2014). Mining districts have larger average consumption per capita and lower poverty rates than otherwise similar districts (Loayza and Rigolini, 2016). These positive impacts, however, decrease drastically with administrative and geographic distance from mining centers.

The province of Tete in Mozambique was once a remote "rural" area but is now a hub of power generation for the southern African region and an emerging centre of global investment in coal extraction (Kirshner and Power, 2015). The development of an entirely new town by the Lumwana company in what was until very recently "bush" has led to new "expectations of modernity" in the region, now commonly referred to as the "New Copperbelt (Fraser, 2010). Another example is Kalumbila town where FQM built around 3000 houses for rent and purchase, with all the modern amenities to 'stabilize' its workers and families in this remote area of Zambia which was initially a "bush" (Rubbers, 2019).

Our Common Future report (also known as the Brundtland Report) holds a key statement of sustainable development, which defined it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Mebratu, 1998).

The fact that mineral resources are non-renewable has rendered the concept of sustainable development to be debatable within the mining sector (Ololade and Annegarn, 2013). Despite this, be it in the mining sector or any other sector, according to Parkin et al., (2003), there are common grounds on which development can be practiced as shown in figure 1 below. Any kind of development needs to have a balance of the three aspects; which are, the environment, economy and society at large. As the extraction of the natural resources takes place in order to improve the livelihoods of people in a certain locality, there is need to conserve the natural

environment, as such. A situation can be said to be sustainable if the next generation inherits from its predecessors at least as much capital as they themselves inherited. Among many other things to be sustained are natural resources and human life. Additionally, mining companies have also stated that sustainable development principles are taken into consideration in their operations.

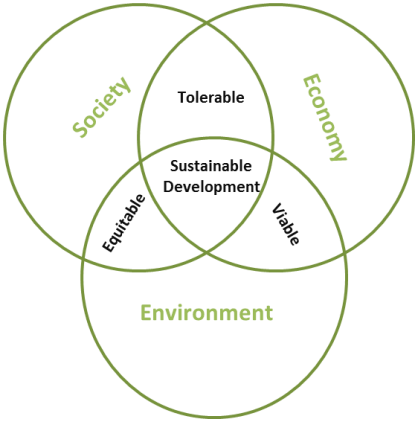


Figure 1: The concept of sustainable development (Parkin et al., 2003)

In light of this, as a contribution to sustainable development, it has been suggested that a state's resource endowments should provide a solid platform for economic and industrial growth (Black and Mckinnish, 2004).

Strong sustainability maintains that natural capital cannot be substituted for manufactured capital and that environmental, economic and human capital must be sustained independently of each other across generations (Essah and Andrews, 2016). On the other hand, weak sustainability is inherent in the view that manufactured capital can replace natural capital and that transfers of capital will lead to the maintenance of intergenerational equity.

There is now a burgeoning literature that examines sustainable development in the context of minerals and mining, most of which is concerned with sustainability at global and national scales (Hilson and Murck, 2001). What is often challenging to ascertain, however, from these numerous perspectives on sustainable mineral extraction, minerals and metals recycling, environmental management, and social performance, is how sustainable development applies to mining companies themselves, and what steps a mine must take in order to improve the sustainability of operations (Yirenkyi, 2008). Since mining processes have the potential to

impact a diverse group of environmental entities, and are of interest to a wide range of stakeholder groups, there is ample opportunity for the industry to operate more sustainably (Shields, 2004; Maf *et al.*, 2014). Specifically, with improved planning, implementation of sound environmental management tools and cleaner technologies, extended social responsibility to stakeholder groups, the formation of sustainability partnerships (Bond, 2014; Caron, Durand and Asselin, 2016) and improved training, a mine can improve performance in both the environmental and socioeconomic arenas, and thus contribute enormously to sustainable development at the local level (Giurco and Cooper, 2012; Yakovleva et al., 2017).

Although there is notable growth of scholarly literature on mining impacts on communities in Africa and beyond, there is limited focus on the micro-level social dynamics that arise when mining expands into rural communities (Mnwana, 2015). The environmental impacts of natural resource exploitation such as loss of biodiversity, water shortage and pollution and the production of large quantities of waste have been discussed extensively (Kitula, 2006; Yeboah, 2008; Case *et al.*, 2010; Mensah *et al.*, 2015; Damigos *et al.*, 2016; Northey *et al.*, 2016; Schoenberger, 2016; Chimonyo and Mupfumi, 2017). Al, Campbell and Titi (2016) argue that air emissions, discharges of liquid effluents and large volumes of solid waste are responsible for the most important negative environmental impacts of the mining and minerals industry. However, the discussion on the sector's environmental performance should not only pay attention to direct, site-specific impacts but also take into account cumulative impacts and indirect effects that pose environmental and social challenges in the state and beyond (Black and Mckinnish, 2004).

Mining projects related impacts can include the displacement of a whole community to a new location, posing high risks for the livelihoods, health and social ties of its members (Yirenkyi, 2008; Owen and Kemp, 2015; Owen and Kemp, 2016). It also generates stress, insecurity and feelings of inequality both within the most directly affected community and others in the broader area, notably as a result of resettlement and uneven compensation (Conde and Le, 2017). As a result of this, some analysts have observed that despite the discourse around social sustainability, mining policy and governance prioritize economic aspects, giving environmental and social considerations a lower priority (Tiainen, 2016).

A key strategy adopted by mining companies to manage social impacts are programs to support community development (Franks, 2010). Social impacts refer to a multifaceted group of matters, influencing the everyday lives of people (Tiainen, 2012). This may include health and education programs, or support of organizations such as schools, clubs, and societies. Moomen

et al., (2016) state that as relocations of communities are carried out, there is need to have a foresight of mine expansion hence communities need to be beyond a 2km buffer. The mining industry tend to follow the World Bank Group's social safeguards for involuntary resettlement, which emphasize that resettled communities should at least be as well off as before in terms of local production systems and income opportunities (Conde and Le, 2017).

Some towns which had a 'boom' of mining activities on the Copperbelt in the past have practically little to point at in terms of the benefits the local communities have been left with after mining activities ceased. For example, subsistence farmers displaced by mining activities became particularly economically vulnerable since their land – their only source of financial capital and income generation – is no longer accessible to them and they have no welfare safety net to draw on (Mwitwa et al., 2012; Mususa, 2012; Horsley *et al.*, 2015).

In Zambia, the principal legislation governing environmental management is the Environmental Management Act, Number 12 of 2011. The Act is an umbrella law which stands over all other environmental legislation in Zambia (Lindahl, 2014). Through the Act, the Environmental Council of Zambia was renamed to Zambia Environmental Management Agency (ZEMA), which now is mandated to ensure the sustainable management of natural resources and protection of the environment in the country. Projects such as the Copperbelt Environment Project (CEP) (Lindahl, 2014) and the Zambia Mining and Environmental and Remediation Project (ZMERIP)[1] which were[2] and are[3] respectively, aimed firstly at addressing the environmental liabilities associated with the mining industry, and secondly to improve future compliance of the mining sector in environmental and social regulations respond to.

Corporate-community relations are concerned with the policies and processes of participation and engagement with local communities and with practices aimed at maximizing local economic development (Raufflet, Cruz and Bres 2014; Lin, Li and Bu, 2015; Litmanen, Jartti and Rantala 2016). The results for the CSR practices related to community relations are rather mixed (Hilson, 2012). According to Owen and Kemp (2014) and Govindan, Kannan and Shankar (2014), five drivers of CSR which are considered by most companies in the mining sector are: 1) the participation or involvement of communities; 2) access to information; 3) the protection of cultural heritage; 4) economic development assistance; and 5) the health and quality of community life. Another aspect is environmental management which relates to policies, commitments, and mechanisms for following up on greenhouse gas (GHG) emissions,

water use, the protection of the environment, and biodiversity (Garvin *et al.*, 2009; Liew, Adhitya and Srinivasan, 2014; Burchart-Korol *et al.*, 2016). The large majority of companies integrate environmental management practices and activity impact reductions as part of their CSR initiatives (Tan *et al.*, 2017). Wilson (2015) notes that with the exceptions of establishments such as Kimbadu[4], implementation of CSR initiatives facilitate minimal, and at times, unsustainable, community development. It has been argued that such 'developmental' outcomes are primarily due to asymmetrical power relations between (Transnational Mining Companies) TNMCs (i.e. Octea Mining and Sierra Rutile Limited) and the mining communities in which these companies engage in pre-defined development projects that are, in many instances, at variance with community needs.

The CSR practices of mining companies are relatively well developed in terms of social issues and the health and safety of operations and employees (Zhu and Zhang, 2015). Most companies have implemented preventative mechanisms with regard to health, safety, and accident prevention (Raufflet, Cruz and Bres, 2014). Mining companies are increasingly choosing to avoid negative publicity and protests by tolerating, and in some cases supporting and assisting in whatever way possible, the local communities (Andrew, 2003). These firms realize that their long term sustainability and ability to continue to operate in certain areas depends on the health of the local environment (Velicu and Kaika, 2017), as well as the stability and safety of the area. These in turn depend largely on co-existing peacefully with the small-scale miners that preceded them (Bebbington, 2014).

Since the mid-1980s, countries around the world have adopted community development requirements into their mining laws to ensure that mining translates into real, positive social and economic gains for mining-affected communities, thereby redressing the inequitable distribution of mining's costs and benefits (Imbun, 2013; Dupuy, 2014). Providing access to knowledge is another practice undertaken by the majority of the companies (Wirth *et al.*, 2016). Mining companies promote education and the dissemination of information to the general public and local government through their programs (Jenkins and Yakovleva, 2006) such as sustainability reports based on the Global Reporting Initiative (GRI) Framework (Fonseca, McAllister and Fitzpatrick, 2012). They often organize activities to raise awareness about aspects in the communication of companies' CSR practices related to labor laws and employee relations (Viveros, 2017).

Materials and Methods

The research applied in this study employed a qualitative approach. The qualitative approach enabled the researcher to conduct observations, undertake semi-structured interviews, review public documents and carry out audio-visual recordings of the host community.

The researcher went into the research site, around Kansanshi mine, interacted with the participants, took field notes on the behaviour and activities of individuals within the host community. Face-to-face interviews were conducted with participants and some participants were interviewed by telephone. These interviews involved semi-structured questions which were intended to elicit views and opinions from the participants. This method enabled the researcher have control over the line of questioning and the participants provided historical information which enabled the researcher to probe further, as appropriate.

During the process of research, public documents (newspapers, minutes of meetings, official reports) were collected. The relevant documents which addressed the objectives of the study were read thoroughly, and analysed. These documents helped to provide a comparison with what was on the ground, and they were useful in the sense that the "participants" had given attention to compile them and they were a useful resources for reference purposes during the time of data analysis. Additionally, photographs, audio recordings and short video clips were made. This approach provided an opportunity for participants to directly share the reality because it captured the 'situations' as they were on the ground at the time when the research was being conducted.

From the information which was obtained before going into the field, there are two Council Wards in the vicinity of Kansanshi mine namely; Kapijimpanga and Kamalamba whose total number of households per ward are 3353 and 3877 respectively (Central Statistical Office Zambia, 2013). According to Franklin and Isip (2017), Slovin's formula is one of the suitable way of determining the sample size from a given population, in such a study. The stated formula is as follows;

$$n = \frac{N}{[1+Ne^2]},$$

where n = sample size, N =population size, e = desired margin of error.

For this study, the target confidence level is 95%, meaning that the margin of error will be 5%. An addition, the sum of the households of the two Wards is 7230, and therefore, representative sample size is 379 households as shown below.

Representative sample size $=\frac{7230}{[1+(7230\times0.05^2)]}=379$

For the two Wards, the samples were calculated firstly by finding the percentage for each ward using the total number of households for the two wards. The percentages were 46.38% for Kapijimpanga Ward and 53.62% for Kamalamba Ward. Using these percentages, the sample sizes for each Ward were determined to 175 and 203 for Kapijimpanga and Kamalamba respectively.

However, even though 379 interviews were planned, only 196 were undertaken. This represents 51.7% of what was planned. This was as a result of reaching a point of saturation, that is, the repetition of information which had already been obtained. Of the 196 samples, 93 were from Kapijimpanga ward while 103 from Kamalamba ward. This was arrived at after considering the initial total number of households in each ward.

The filled in semi-structured questionnaires were all read through taking note of the words and phrases which were frequently used. Likewise, the recorded audio-visual was transcribed taking note of the frequently used words and phrases. The collected documents were consulted to verify and triangulate what came out of the semi-structured questionnaires, recorded audio-visuals and the photographs.

The generated data was then grouped into themes such as employment and income generation which enabled the researcher to elaborate what was on the ground under each theme. Thereafter, a comparison was made with what is stated in the literature from other similar studies. The findings from most of these studies confirmed what came out in this study.
Pie charts, bar graphs, tables and images have been used to display the data. Pie charts have been used to display the community's source of livelihoods while bar graphs for what the local community considered that they need. Additionally, tables have been used to display direct responses from the respondents. Images are another method which has been used to show some of the projects the Kansanshi mine has carried out in the local community.

Results and discussion

Displacements of people

Kabwela, Muzabula and New Israel communities were 'created' as a result of displacements. According to the views from the affected communities, those who reside in these three communities were previously living right in the current "heart" of the mine. In 2005, 42 households were displaced from the Kansanshi mine site to New Israel and most (not all) households were persuaded to move and were compensated between K700 and K1, 500 (rebased). From community views, it has been stated that mining development and exploration has had some costs and benefits, but the costs outweigh the benefits in that what was given to them after relocations was little compared to what they had before relocations. Before relocations, the people in these communities were able to plough their fertile fields, sell their merchandise and take their children to school. At the time these communities were relocated, a number of promises were made to them concerning compensation and what the mine was going to do for them in their 'new' communities. One community member in Kabwela stated:

> "They promised to build houses for us, connect electricity and give us some money, but to this day, nothing has been done."

During the construction of the tailings dam in the eastern part of the mine for example, some families were compensated, while others were given fields in other locations. Unfortunately, they were given fields where the soils are unfertile. Field observations revealed that most crops – especially maize – do not grow to maturity anymore if chemical fertilizers are not applied. During the first two to three years, farmers were assisted with farming inputs (seed and fertilizers) and the assistance did not continue beyond that. The displaced communities expected perpetual assistance from the mine in terms of farming inputs. Further, some of these fields are a distant (about 5kms) from where the owners reside, making it difficult for them to access them. Additionally, they were also promised boreholes in their 'new' fields but the promise did not come to fruition as one respondent noted:

> "Those given fields were promised boreholes but to this day, nothing has been done."

A Kansanshi member of staff who participated in this study noted that the assistance with farming inputs was to help the people who were relocated settle down. He further added that the assistance was not for as long as the mine operated. The mine envisaged that during those three years, the people were going to use the resources given to them and grow their businesses and no longer depend upon the mine to provide them with farming inputs – self-sufficient. The member of staff pointed out that:

> "Communities need to reach a sustainable level. We couldn't continue 'breastfeeding' them beyond that time."

This view by the Kansanshi member of staff contradicts with Cernea (2003) who states that once inhabitants of a certain locality have been moved for the reason of setting up a public-sector project, there is need for continual help and empowering them. They need to be assisted with aspects such as farming inputs and until they are deemed to have fully settled and self-reliant. After being relocated, a community might take a longer period of time to reach a "self – sustainable level" than what would have been focussed by those who displaced them.

In the South-West part of the mine (Muzabula), twenty-three families were asked to choose where they wanted to go and they chose chief Mulonga's area. Upon relocation, they were supported with bricks for their houses, roofing sheets, five protected wells, two boreholes, a school, staff house, clinic and a bicycle for each household.

In the New Israel area, complaints were mainly on scarce and costly public transportation, following the relocation of the community a distance of 40 km north of its previous location. Residents in particular were critical of the fact that since moving to the new site, the high bus transport cost to Solwezi had consumed a substantial share of the resettlement allowance provided by Kansanshi. The road leading to Solwezi Central Business District (CBD) too is in a bad state. Despite this, the mine has built a school, a house for the school headmaster, a clinic and another house for the clinical personnel. The company states that these are some of Kansanshi mine's CSR initiatives which have helped to improve the community's quality of life in New Israel. Children have access to education within their community, the headmaster is motivated to live within the vicinity of the school, healthcare is within reach and the medical personnel also lives in the community unlike a situation where due to lack or poor accommodation, the medical staff might be living a distance from the health facility. This view was confirmed by members of the community.

Employment and income generation

Respondents from Kimasala, Mushtala and Kabwela communities noted that they work or knew of colleagues and/relatives who work at the mine as field officers (under conservation farming), miners, environmentalists and drivers. The Kansanshi staff stated that they don't have any casual workers apart from those they had engaged at construction stages. This sentiment was also acknowledged by some of the members in the communities of interest. Some of those who no longer worked for the mine are into farming activities and charcoal production and selling of the same.

In Kabwela, Mushitala, Kimasala and Muzabula communities, 54% of the respondents are involved in farming in addition to other economic activities they do like charcoal 'burning' and selling, gardening, among others. Of those interviewed, Figure 2 shows that 40% are involved in farming, 12% in charcoal burning, 8% in part time as workers in other people's houses, while another 8% run their own small businesses. Further, 5% work for Kansanshi mine and 27% are involved in other income generating activities such as welding, as maids, and cleaners in the shopping malls, among others. It needs to be noted that 40% of those who were interviewed are involved in farming in addition to being involved in other income generating activities.

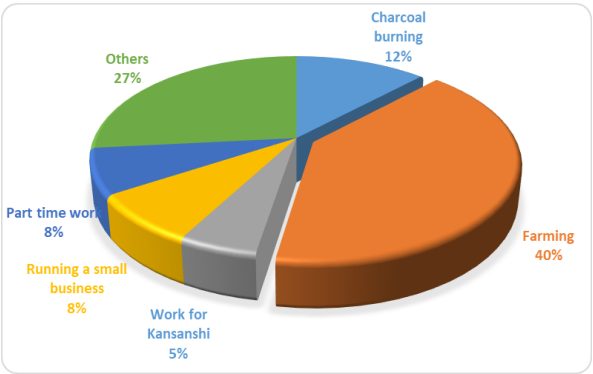


Figure 2: Respondents' sources of livelihoods

Mixed responses were expressed in the communities with regards to employment, in so far as the impact of the company is concerned. Positive impacts in the form of some new job opportunities were identified, but community representatives felt these were largely limited. In all the communities, employment was highlighted as the main concern, with corruption, in-migration and lack of necessary skills to gain employment at the mine being noted as major barriers. The vast majority of skilled labour working for the company is sourced from outside the Northwestern Province – mostly from the Copperbelt Province, and if locals do succeed in getting the low-skilled jobs that seem to be available, such as cleaners, and manual laborers, they are often paid low salaries working for contractors. They claim that their wages rage between K1500 to K3000. It was also noted that there were remuneration disparities among workers despite them doing the same work. One would be remunerated K2500 while another is remunerated K4500 despite both doing the same work and even working together in the same section. This was as a result of people being engaged by different contractors. It was felt that there is need for a policy which can address the issue of 'equal pay for equal work at the mine.'

Those respondents who had a member of their household working at Kansanshi had something positive to say. For example, some noted that they manage to take their children to school and helped their relatives to start businesses from their wages.

Local economic spillovers

The study established that the Kansanshi mine, in addition to paying taxes, royalties and contributing to the Zambian economy, also developed a Local Business Development Plan (LBDP) in 2011. Under this programme, they contract local suppliers, hold workshops with the North West Chamber of Commerce (NWCC) to assisting the attendees in meeting the mine's procurement and contract requirements. In the process the company also trains NWCC members on the Zambian labor law, equator principals and the mine's safety standards. A total number of 108 participants attended workshops as at the end of the year 2010. The company has also built capacity among the micro, small and medium enterprises in the Province through local business development workshops which have had about 1, 797 participants. These have been equipped with knowledge in areas such as writing of business plans, managing money, business choices, and customer relations. A number of those who have attended these workshops were happy about their experience, and one of them stated:

> *"The course taught me to set aside some of my profits and use the remaining money for my home needs. This has really helped me as I have been able to build up a small capital amount."*

Following the establishment of mining activities in Solwezi, there have been a number of other indirect benefits for the people such as installation of communication towers, makeshift grocery 'shops', shopping malls, among others.

With the increase in the number of people coming to work in the mine, the demand for goods such as food and services (transport, accommodation), has also increased. As a result of this, those who are into agriculture have a "ready" market for their produce. A Non-governmental Organization (NGO) representative stated:

> *"A marketeer knows that his or her merchandise are going to be sold. Malls have also come into the district – Foreign Direct Investment (FDI). People now have disposable income, not like those days."*

In Kabwela, there is now a network tower which was not there before the mine was set up.

Apart from Mulenga community, the rest of the communities did not report having any serious problems as far as connectivity is concerned. They are able to communicate with their loved ones. It was also noted that MTN had a wide coverage in most of these communities.

Additionally, there is also a demand for accommodation due to the influx of people. This has led to more accommodation facilities being built which has led to some people earning a source of living from the same.

Even though people are constructing houses and generating an income, the influx of people had resulted in accommodation becoming quite expensive, plus it had increased pressure on infrastructure such as schools.

The local authority acknowledged the revenue it receives from the mine although they did not state the actual amount. Just like the local community, they also stated that the presence of the mine had a positive economic impact on the locals. Small and medium-sized business enterprises, as well as farmers were benefiting due to the population increase which has in turn broaden their market. Residents of Mushitala and Zambia compound talked of mineworkers being able to acquire assets such as houses, vehicles and farm lands. Considering most of the miners' low wages, those acquiring such assets are those with qualifications such as degrees and are involved in skilled labour like accounts, geologists, and metallurgists, among others. A grocery store owner (a respondent) noted:

> "The majority of our customers work for the mine."

Corporate Social Responsibility (CSR)

First Quantum Minerals Limited (FQML) has a globalized CSR agenda. The Company believes that it makes sound, strategic business sense to involve local communities and other relevant stakeholders in their business. They engage with them to build and maintain effective, long-term and mutually beneficial relationships, and conduct business in a way that provides long term economic opportunity and supports social well-being. The company's commitment is based on the following principles:

Respect: First Quantum strives for relationships that are based on transparency, mutual trust and respect. They recognize that their activities affect or could affect stakeholders, local communities, their culture and traditional and current uses of lands and resources.

Engagement: First Quantum commits to listening and communicating with stakeholders and local communities directly and openly about events, issues and ideas. They seek to consult and resolve grievances in a timely, interactive and culturally appropriate manner.
Benefit: They recognize that people and communities affected by their business should benefit through opportunities such as employment, business development, education, training or community investment over the long term.

It is through these commitments that they assist communities in various ways such as employment opportunities, engaging local contractors, provision of clean and safe water, among others. The views of the communities attested to the fact that the company had strived to implement some of the commitments stated in their CSR policy.

A respondent working for Kansanshi mine noted that even though the company has a global CSR agenda, they endeavor to localize it in the areas where they operate. The company states in its 2010 and 2012 CSR reports that in 2009 and 2011, they contributed almost 4.4% and 8.6% to the Zambian Gross Domestic Product respectively. This reflects the company's direct impacts in addition to considerable indirect impacts through downstream enterprise developments and procurement. The CSR team is composed of the manager, who is assisted by the CSR superintendent in addition to several field officers. The immediate beneficiaries are communities which are within the vicinity of the mine (10 kilometres radius) although there are usually other considerations made when need arise. Kansanshi considers community's situation in terms of the risk they could be exposed to as a result of mining activities and their economy in addition to safeguarding the environment.

In implementing CSR initiatives, the mine works with the government through the community development and social welfare to identify what the communities need apart from directly engaging with the community.

Conservation farming

One CSR strategy being implemented by the Kansanshi mine is conservation farming. The Kansanshi mine initiated conservation farming in 2010. Funded by First Quantum through their non-profit Kansanshi Foundation and developed in partnership with Zambia's Ministry of Agriculture and Cooperatives, the conservation farming program teaches community members how to grow their crops sustainably, averaging four times the yield of traditional cultivation methods. Under this programme, Kansanshi were providing the local community farmers with

fertilizers, village chickens, pigs and goats in addition to training them in better farming methods. The local people have appreciated this initiative evidenced by those who have been trained and employed as field officers and the improvements in yields for those who have embraced the initiative.. The FQML 2012 CSR report affirms that this initiative has contributed to an average fourfold increase in maize crop yields. A senior Kansanshi employee stated:

> "We have trained more than 30 000 farmers in conservation farming."

The aim of this initiative was to enable farmers be self-sufficient from their initial subsistence kind of farming they were practicing. The company uses simple farming methods which are easily being understood by the community members. According to a representative from the conservation farming team, this program is being seen as a model for sustainable agriculture in Zambia due to the improvements in yields for those who are using it. A respondent who works for Kansanshi mine noted that:

> "Participants have learned to apply the simple techniques of conservation farming as they feed their families, earn extra income and gain newfound pride."

Through respondents, the study established that some of the target populace are those who grew up with limited education, coupled with few prospects for employment. Those who have benefited from this initiative have a positive view of it as noted by a respondent:

> "For the first time, my daughter and son appreciated me as a providing father when the conservation farming initiative begun."

This initiative was widely appreciated by the communities in that they felt considered and thought of by the mine. For those who were displaced from their initial locations, this initiative helped them have improved harvests in that they were provided with fertilizers. The downside of it is that the programme ran for only three years to the disappointment of the communities especially those in Kabwela. They expected it to be a continual assistance as long as the mine operated. One resident stated:

> "We need fertilizer, our yields are very bad. Without fertilizer, our maize crops only reach one meter."

The views of most Kabwela residents on their agricultural outputs were negative. To them, the mine has made them be worse than they were before. These people's predominant activity was agriculture in the fertile soils where they were before being relocated 'upstream.' To make matters worse, they have not benefited in terms of employment. This has greatly contributed to

engaging themselves in charcoal burning which in the long run may lead to deforestation. From field observations, almost every 20 – 30 minutes, someone would be seen ferrying charcoal for sale along the road which connects Kabwela and Mushtala leading to the Solwezi central business district. This was also noticed along the road from Muzabula to Kimasala.

Health and sanitation

The Kansanshi mine has undertaken a number of relevant initiatives and projects in communities surrounding the mine. The company has undertaken edutainment Health Road Shows since April 2009 with a view of sensitising communities on HIV/AIDS and other ailments such as malaria, cholera and sexually transmitted diseases. Door to door health checks is another initiative which the company has carried out with a team which includes peer educators, community nurses and nurse counsellors. These people who are carrying out this initiative have been trained by the Kansanshi mine. Some of the services under this initiative are voluntary counselling and testing, malaria tests and blood sugar tests. Those who need further assistance are referred to the Solwezi General Hospital. The mine has also sponsored equipment for Mary Begg clinic to support the delivery of health related courses.

On the spot checks in the field revealed that the Kansanshi mine has drilled a number of water wells in order for communities to have access to clean water. They have also spearheaded an anti-malaria water purification campaign and a malaria prevention programme. They have also provided and facilitated the distribution of bed nets for every bed space especially for families who wear relocated to pave way for mine construction, renovated the high cost section at the Solwezi General Hospital.

There were mixed community views regarding healthcare. In Kabwela and Mulenga communities for instance, the clinics were understaffed – each only had one health attendant and were not operating on a daily basis. For this reason, Kabwela community members have to walk a five-kilometer distance to Mushtala to seek medical services. For Kimasala, according to a respondent who works at the clinic, the clinic had 18 health personnel, who were overwhelmed because on daily basis, especially on busy days, they have to attend to more than 200 patients. Some of the most common illnesses being attended to in Kimasala are Respiratory Tract Infections (RTI), malaria and diarrhea. There was also a plea to expand the clinic block so that each department could have its own room and professional development of the health attendants in order to improve service delivery. Muzabula community has no clinic. The nearest health centers are Kimasala and Mashimpi. Apart from Mulenga community, the rest of the communities are sharing the boundary with the Kansanshi mine.

Kansanshi mine conducts regular environmental monitoring to measure ambient air, dust and noise levels on and in close proximity to the mine. Additionally, the company also gives high priority to water management issues given that the mine's location is upstream of Solwezi town. This has helped in dealing with any toxins which could have adverse effects on the environment and on people's health.

Education

First Quantum's corporate social responsibility initiatives take many forms, but the vital thread connecting all of them is education. When sustainability efforts provide opportunities to acquire new knowledge and skills, people gain the power to shape their own futures. FQML has undertaken a number of initiatives in this sector. First Quantum's support for public education is particularly important in Zambia, where literacy rates are among the lowest in Africa. The aspect of having low literacy rates is also elaborated in a Central Statistical Office (CSO) 2013 report which states that the North-Western Province had an overall literacy rate of 63%. The adult literacy rate (i.e., for ages 15+) was just over 50%, while the figure for Solwezi, was still lower at 43%. The company has operated a scholarship programme since 2006 to enable students to attend degree courses mainly in mining – related disciplines at Universities in Zambia, South Africa and Mauritania. A respondent who deals with CSR matters stated that as of 2012, the company had spent about US$ 319,950 in Zambia on the scholarship programme. A young metallurgist on the scholarship programme noted:

> *"My experience here has expanded my outlook. I have learned about different cultures and ways of doing business. The First Quantum Way allows for a flexible approach to the complexity of the mining process and I have decided to adopt 'Bolder, Smarter, Driven' as my personal credo."*

FQML has also committed itself to a programme called Kwambula Leadership Programme. To drive this commitment to skills development, the Company entered into an agreement with the Solwezi Trades Training Institute (SOTTI) in 2011 with the intention of establishing a learnership programme aimed at providing people with the opportunity to get a valid craft qualification. A visit to SOTTI established that US$1.4 million investment at the institution led to the upgrading of infrastructure increased training resources and additional facilities to expand the institute. The programme was christened "Kwambula" which means "igniting" in Kaonde, an apt name for an initiative that aims to ignite hope in people and set the course in motion for a prosperous Zambia. Kwambula provides practical and theoretical training in

various mining trades including mining electrical, metal fabrication, welding and machining, which is being conducted under the auspices of the Ministry of Higher Education at SOTTI. The qualifications received by course participants are being recognized across the country. Students are also undertaking work experience at Kansanshi and Sentinel mines. The creation of Kwambula is consistent with the First Quantum's CSR philosophy, which is aimed at building sustainable communities that are able to outlive mining activities, thus providing Zambia with the benefit of skilled people, who will grow the economy and promote sustainable living.

In addition to the Kwambula initiative, the company has also built a classroom block in Kabwela and helped complete a teacher's house in Kyafukuma. The teacher's house in Kyafukuma was started by the local community after they noticed that teachers lacked accommodation. It was during the building process that the community ran out of materials to complete the said house that the mine came in and assisted. This has contributed having teachers stay within the community unlike in the past when they used to shun the area due to lack of accommodation.

The company has also conducted surveys on over 1500 households on a range of topics including education. This has been done so that they can analyze the changes which have taken place over the period of time they have been operating so as to ensure that opportunities for contributing to economic and social development are well targeted and account for local complexities relating to poverty and inequality.

Community needs

Thus far, the study has looked at what the Kansanshi mine has done in the local communities. Despite the fact that the company has claimed to have built and renovated schools, clinics, accommodation for teachers and health personnel, some communities noted that there is more which the mine needs to do for them. When the respondents were asked what their priorities were in their communities, road network, educational and health facilities stood out while aspects such as electricity were the least. Figure 3 below shows what the community needs are.

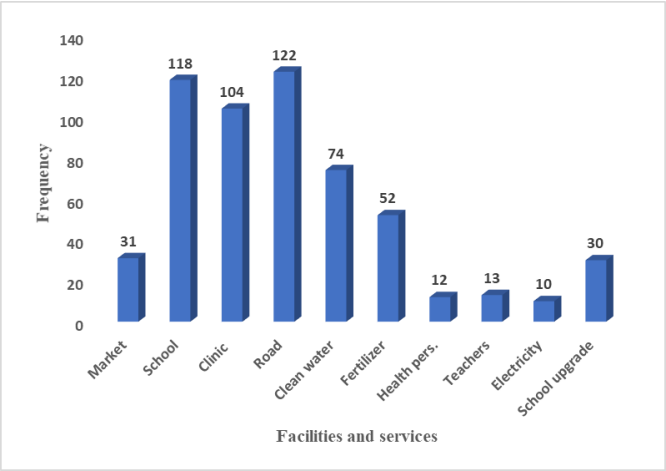


Figure 3: Current local community needs

Conclusion

It needs to be noted that mining has a direct effect on the socio – economy of the local people in that mining activities offer employment opportunities to the local communities and other economic "spillovers" for income generation. The study has illustrated that the Kansanshi mine has employed people, helped farmers, improved the road network, constructed and rehabilitated some schools and health facilities, engages local suppliers of goods and services in addition to paying taxes to the government.

The findings highlight the fact that locals, believing themselves to be the victims, have a natural tendency to expect tangible projects and services from mine developers. This feeling is particularly intense among local communities given what they lost out during displacements cannot be measured in monetary terms. Additionally, communities become dissatisfied when mining companies fail to implement, or fail to complete, within the specified timelines, the various CSR programmes that they had promised.

Despite having done all that has been stated above, there are mixed views from most stakeholders – the government, the local communities, NGOs and the Kansanshi mine themselves – on what FQML ought to do for the local community. There is need for the

Kansanshi mine, the government and the local communities to harmonize these expectations in order to have a win-win situation.

Recommendations

i. The fact that corporate social responsibility is not well defined, there is need for clearly stated legal frameworks which should give clear guidelines on what mining companies ought to do for local communities apart from job creation.
ii. Upon paying taxes, mining companies take it that the government needs to provide services such as health and educational facilities to communities. On the other hand, the government expects the mining companies to do the same. For this reason, there is need for a law which can distinctively stipulate the roles of the government and those of the investor in community project implementations.
iii. The government need not abandon social provisioning to mining companies, but rather, as findings in this study indicate, they should pursue a programme of being a partner with the mining companies. This can be done by involving the mining companies and the local communities so as to establish responsibilities, costs and benefits and also to sign tripartite community development agreements.

References

Al, R., Campbell, G. and Titi, A. (2016) 'The Extractive Industries and Society The socio-economic impacts of mining on local communities : The case of Jordan', The Extractive Industries and Society. Elsevier Ltd., 3(2), pp. 494–507. doi: 10.1016/j.exis.2016.02.001.

Andrew, J. S. (2003) 'Potential application of mediation to land use conflicts in small- scale mining', 11, pp. 117–130.

Bebbington, A. J. (2014) 'Socio-environmental conflict: An opportunity for mining companies', Journal of Cleaner Production. Elsevier Ltd, 84(1), p. 34. doi: 10.1016/j.jclepro.2014.08.108.

Black, D. and Mckinnish, T. (2004) 'The Economic Impact of the Coal Boom and Bust * by', (March 2004).

Bond, C. J. (2014) 'Positive peace and sustainability in the mining context: Beyond the triple bottom line', Journal of Cleaner Production. Elsevier Ltd, 84(1), pp. 164–173. doi: 10.1016/j.jclepro.2014.01.033.

Burchart-Korol, D. et al. (2016) 'Model of environmental life cycle assessment for coal mining operations', Science of the Total Environment. Elsevier B.V., 562, pp. 61–72. doi: 10.1016/j.scitotenv.2016.03.202.

Caron, J., Durand, S. and Asselin, H. (2016) 'Principles and criteria of sustainable development for the mineral exploration industry', Journal of Cleaner Production. Elsevier Ltd, 119, pp. 215–222. doi: 10.1016/j.jclepro.2016.01.073.

Case, T. H. E. et al. (2010) 'THE SOCIAL AND ENVIRONMENTAL IMPACTS OF MINING ACTIVITIES ON INDIGENIOUS COMMUNITIES'.

Central Statistical Office (CSO) [Zambia] (2013) '2010 CENSUS OF POPULATION AND HOUSING DESCRIPTIVE TABLES Series A - Population Size Tables Series B - Social Series C - Fertility Series D - Education Tables', 5, p. 543.

Chimonyo, G. . and Mupfumi, J. . (2017) 'ENVIRONMENTAL IMPACTS OF GOLD MINING IN PENHALONGA', pp. 1–14.

Conde, M. and Le, P. (2017) 'The Extractive Industries and Society Why do some communities resist mining projects while others do not ?', The Extractive Industries and Society. Elsevier Ltd., 4(3), pp. 681–697. doi: 10.1016/j.exis.2017.04.009.

Damigos, D., Menegaki, M. and Kaliampakos, D. (2016) 'Monetizing the social benefits of landfill mining : Evidence from a Contingent Valuation survey in a rural area in Greece', Waste Management. Elsevier Ltd, 51, pp. 119–129. doi: 10.1016/j.wasman.2015.12.012.

Dupuy, K. E. (2014) 'The Extractive Industries and Society Community development requirements in mining laws', Biochemical Pharmacology. Elsevier Ltd, 1(2), pp. 200–215. doi: 10.1016/j.exis.2014.04.007.

Essah, M. and Andrews, N. (2016) 'Linking or de-linking sustainable mining practices and corporate social responsibility? Insights from Ghana', Resources Policy. Elsevier, 50, pp. 75–85. doi: 10.1016/j.resourpol.2016.08.008.

Fonseca, A., McAllister, M. L. and Fitzpatrick, P. (2012) 'Sustainability reporting among mining corporations: A constructive critique of the GRI approach', Journal of Cleaner Production. Elsevier Ltd, 84(1), pp. 70–83. doi: 10.1016/j.jclepro.2012.11.050.

Franks, D. (2010) 'Management of the Social Impacts of Mining'.

Fraser, L. (2010) ‘Zambia, mining and neoliberalism: Boom and Bust on the Globalized Copperbelt’.

Garvin, T. et al. (2009) ‘Community e company relations in gold mining in Ghana’, Journal of Environmental Management. Elsevier Ltd, 90(1), pp. 571–586. doi: 10.1016/j.jenvman.2007.12.014.

Giurco, D. and Cooper, C. (2012) ‘Mining and sustainability: Asking the right questions’, Minerals Engineering. Elsevier Ltd, 29, pp. 3–12. doi: 10.1016/j.mineng.2012.01.006.

Govindan, K., Kannan, D. and Shankar, K. M. (2014) ‘Evaluating the drivers of corporate social responsibility in the mining industry with multi-criteria approach: A multi-stakeholder perspective’, Journal of Cleaner Production. Elsevier Ltd, 84, pp. 214–232. doi: 10.1016/j.jclepro.2013.12.065.

Hilson, G. (2012) ‘Corporate Social Responsibility in the extractive industries: Experiences from developing countries’, Resources Policy. Elsevier, 37(2), pp. 131–137. doi: 10.1016/j.resourpol.2012.01.002.

Hilson, G. and Murck, B. (2001) ‘Sustainable development in the mining industry : clarifying the corporate perspective’, 26(2000), pp. 227–238.

Horsley, J. et al. (2015) ‘Sustainable livelihoods and indicators for regional development in mining economies’, The Extractive Industries and Society. Elsevier Ltd, 2(2), pp. 368–380. doi: 10.1016/j.exis.2014.12.001.

Imbun, B. Y. (2013) ‘Maintaining land use agreements in Papua New Guinea Mining : “ Business as usual ” ?’, Resources Policy. Elsevier, 38(3), pp. 310–319. doi: 10.1016/j.resourpol.2013.04.003.

Ivanova, G. (2014) ‘The mining industry in Queensland, Australia: Some regional development issues’, Resources Policy. Elsevier, 39(1), pp. 101–114. doi: 10.1016/j.resourpol.2014.01.005.

Jenkins, H. and Yakovleva, N. (2006) ‘Corporate social responsibility in the mining industry : Exploring trends in social and environmental disclosure’, 14, pp. 271–284. doi: 10.1016/j.jclepro.2004.10.004.

Kirshner, J. and Power, M. (2015) ‘Mining and extractive urbanism: Postdevelopment in a Mozambican boomtown’, Geoforum. Elsevier Ltd, 61, pp. 67–78. doi: 10.1016/j.geoforum.2015.02.019.

Kitula, A. G. N. (2006) 'The environmental and socio-economic impacts of mining on local livelihoods in Tanzania : A case study of Geita District', 14. doi: 10.1016/j.jclepro.2004.01.012.

Liew, W. Te, Adhitya, A. and Srinivasan, R. (2014) 'Sustainability trends in the process industries: A text mining-based analysis', Computers in Industry. Elsevier B.V., 65(3), pp. 393–400. doi: 10.1016/j.compind.2014.01.004.

Lin, P. T., Li, B. and Bu, D. (2015) 'The relationship between corporate governance and community engagement: Evidence from the Australian mining companies', Resources Policy. Elsevier, 43(January 2014), pp. 28–39. doi: 10.1016/j.resourpol.2014.11.004.

Lindahl, J. (2014) 'ENVIRONMENTAL IMPACTS OF MINING IN ZAMBIA'.

Litmanen, T., Jartti, T. and Rantala, E. (2016) 'The Extractive Industries and Society Re fi ning the preconditions of a social licence to operate (SLO): re fl ections on citizens ' attitudes towards mining in two Finnish regions', 3, pp. 782–792. doi: 10.1016/j.exis.2016.04.003.

Loayza, N. and Rigolini, J. (2016) 'The Local Impact of Mining on Poverty and Inequality: Evidence from the Commodity Boom in Peru', World Development. Elsevier Ltd, 84, pp. 219–234. doi: 10.1016/j.worlddev.2016.03.005.

Maf, C. et al. (2014) 'Management for sustainability in companies of the mining sector : an analysis of the main factors related with the business performance', 84, pp. 84–93. doi: 10.1016/j.jclepro.2013.08.030.

McAllister, M. L., Fitzpatrick, P. and Fonseca, A. (2014) 'Challenges of space and place for corporate "citizens" and healthy mining communities: The case of Logan Lake, BC and Highland Valley Copper', The Extractive Industries and Society. Elsevier Ltd, 1(2), pp. 312–320. doi: 10.1016/j.exis.2014.04.005.

Mebratu, D. (1998) 'Sustainability and sustainable development', Environmental Impact Assessment Review, 18(6), pp. 493–520. doi: 10.1016/S0195-9255(98)00019-5.

Mensah, A. K. et al. (2015) 'Environmental Impacts of Mining : A Study of Mining Communities in Ghana', 3(3), pp. 81–94. doi: 10.12691/aees-3-3-3.

Mnwana, S. (2015) 'The Extractive Industries and Society Mining and " community " struggles on the platinum belt : A case of Se fi kile village in the North West Province , South Africa', 2, pp. 500–508. doi: 10.1016/j.exis.2015.05.003.

Moomen, A., Dewan, A. and Corner, R. (2016) 'Landscape assessment for sustainable resettlement of potentially displaced communities in Ghana ' s emerging northwest gold province', Journal of Cleaner Production. Elsevier Ltd, 133, pp. 701–711. doi: 10.1016/j.jclepro.2016.06.004.

Northey, S. A. et al. (2016) 'Water footprinting and mining: Where are the limitations and opportunities?', Journal of Cleaner Production, 135, pp. 1098–1116. doi: 10.1016/j.jclepro.2016.07.024.

Ololade, O. O. and Annegarn, H. J. (2013) 'Contrasting community and corporate perceptions of sustainability : A case study within the platinum mining region of South Africa', Resources Policy. Elsevier, 38(4), pp. 568–576. doi: 10.1016/j.resourpol.2013.09.005.

Owen, J. R. and Kemp, D. (2015) 'Mining-induced displacement and resettlement : a critical appraisal', Journal of Cleaner Production. Elsevier Ltd, 87, pp. 478–488. doi: 10.1016/j.jclepro.2014.09.087.

Owen, J. R. and Kemp, D. (2016) 'Can planning safeguard against mining and resettlement risks ?', Journal of Cleaner Production. Elsevier Ltd, 133, pp. 1227–1234. doi: 10.1016/j.jclepro.2016.05.165.

Parkin, S., Sommer, F. and Uren, S. (2003) 'Sustainable development : understanding the concept and practical challenge *', 138(March), pp. 19–26.

Raufflet, E., Cruz, L. B. and Bres, L. (2014) 'An assessment of corporate social responsibility practices in the mining and oil and gas industries', Journal of Cleaner Production, 84(1), pp. 256–270. doi: 10.1016/j.jclepro.2014.01.077.

Rubbers, B. (2019) 'Geoforum Mining towns , enclaves and spaces : A genealogy of worker camps in the Congolese copperbelt', Geoforum. Elsevier, 98(September 2018), pp. 88–96. doi: 10.1016/j.geoforum.2018.10.005.

Schoenberger, E. (2016) 'Environmentally sustainable mining: The case of tailings storage facilities', Resources Policy. Elsevier, 49, pp. 119–128. doi: 10.1016/j.resourpol.2016.04.009.

Shields, D. J. (2004) Sustainable mineral resource management and indicators: case study slovenia.

Tan, Y. et al. (2017) ‘A study of best practices in promoting sustainable urbanization in China’, Journal of Environmental Management. Elsevier Ltd, 193, pp. 8–18. doi: 10.1016/j.jenvman.2017.01.058.

Tiainen, H. (2012) ‘A case study on social sustainability in the Kyrgyz mining industry’, (January).

Tiainen, H. (2016) ‘Contemplating governance for social sustainability in mining in’, Resources Policy. Elsevier, 49, pp. 282–289. doi: 10.1016/j.resourpol.2016.06.009.

Velicu, I. and Kaika, M. (2017) ‘Undoing environmental justice: Re-imagining equality in the Rosia Montana anti-mining movement’, Geoforum. Elsevier Ltd, 84, pp. 305–315. doi: 10.1016/j.geoforum.2015.10.012.

Viveros, H. (2017) ‘Unpacking stakeholder mechanisms to influence corporate social responsibility in the mining sector’, Resources Policy. Elsevier, 51(October 2016), pp. 1–12. doi: 10.1016/j.resourpol.2016.10.014.

Wilson, S. A. (2015) ‘Corporate social responsibility and power relations: Impediments to community development in post-war Sierra Leone diamond and rutile mining areas’, Extractive Industries and Society. Elsevier Ltd., 2(4), pp. 704–713. doi: 10.1016/j.exis.2015.09.002.

Wirth, H. et al. (2016) ‘Corporate Social Responsibility : Communication about social and environmental disclosure by large and small copper mining companies’, 49, pp. 53–60. doi: 10.1016/j.resourpol.2016.04.007.

Yakovleva, N., Kotilainen, J. and Toivakka, M. (2017) ‘Reflections on the opportunities for mining companies to contribute to the United Nations Sustainable Development Goals in sub – Saharan Africa’, Extractive Industries and Society. Elsevier Ltd., 4(3), pp. 426–433. doi: 10.1016/j.exis.2017.06.010.

Yeboah, J. Y. (2008) ‘ENVIRONMENTAL AND HEALTH IMPACT OF MINING ON SURROUNDING COMMUNITIES: A CASE STUDY OF ANGLOGOLD ASHANTI IN OBUASI’, (August).

Yirenkyi, S. (2008) ‘SURFACE MINING AND ITS SOCIO-ECONOMIC IMPACTS AND CHALLENGES Stephen Yirenkyi’, pp. 181–202.

Zhu, Q. and Zhang, Q. (2015) ‘Evaluating Practices and Drivers of Corporate Social Responsibility: The Chinese Context’, Journal of Cleaner Production. Elsevier Ltd, 100, pp. 315–324. doi: 10.1016/j.jclepro.2015.03.053.

Land use and land cover change detection of Chingola and Chililabombwe districts using GIS and remote sensing techniques

(Paper was submitted to Journal of Ecology and the Natural Environment and it is still under review)

Joyce Masinja[1, *] and Lordwell K. Witika[2]
Department of Metallurgy and Mineral Processing, University of Zambia, Lusaka, Zambia
** Contact Details: University of Zambia, Department of Metallurgical and Mineral Processing, Box 32379 Lusaka, Zambia*
Email: masinjajoyce@gmail.com

Abstract

Land use and land cover change is occurring at unprecedented rates worldwide and is believed to contribute to environmental concerns including GHG emissions. The study focused on land use and land cover change in Chingola and Chililabombwe districts between 2000 and 2015. It examined the land use pattern for the past 15 years and identified the responsible factors for the changes in the area. GIS and Remote Sensing techniques were applied in mapping the landuse/landcover of Chingola and Chililabombwe districts to detect changes that took place in the last 15 years. Landsat images of 2000, 2005, 2010 and 2015 was used for the study. Arc GIS 10.0 was used for map georeferencing and image classification, while ENVI 5.0 was used for area calculation and map analysis, ERDAS 10.0 was used for accuracy assessment. The results showed that built-up land had the greatest negative impact on vegetation cover in Chingola and Chililabombwe districts. Built-up land covered the largest area in 2000 with 33,752.68 ha (12.4%) of the total land mass which increased to 35,113.67 ha (12.9%) in 2005. In 2015, built-up land increased to 35,658.07 ha (13.1%) due to mining expansion and increased and rapid in- migration in the area. The study further revealed that agriculture and accompanying settlements had the second largest impact on vegetation cover in 2015. The forest area that was 181,556.73ha (66.7%) in 2000 decreased to 178,018.15 ha (65.4%) in 2015. The projected results for 2020 revealed that forest land will reduce to 168,278 ha representing a decrease of 5% while built-up land and agriculture will increase to 48,875 ha and 37,894 representing a percentage of 4.9 and 1.9 respectively. Therefore, it is recommended that control measures be put in place to prevent further forest conversion from built-up land, agriculture and settlements. The study further recommends the need to promote public awareness on the benefits of sustainable land management and forest conservation.

Key Words: Land use/landcover, change detection, Chingola and Chililabombwe

INTRODUCTION

Viewing the Earth from space is important to understanding of the influence of man's activities on his natural resource base over time. Land use and land cover change is a key driver of global change **(Vitousek, 1992)** and has significant implications for many international policy issues **(Nunes and Auge, 1999).** To understand how (LULC) change affects and interacts with global earth systems, information is needed on what changes occur, where and when they occur. The information needs for such a synthesis are diverse. Remote sensing has had an important contribution to make in documenting the actual change in land use/land cover on regional and global scales since the mid-1970s **(Lambin *et al*., 2003)**.

Several studies have been conducted with the integration of remote sensing and geographic information systems to analyze and monitor land cover changes. Land use/cover change detection is very essential for better understanding of landscape dynamics within a known period of time for sustainable environmental management. Land use and land cover change has been recognized as an important driver of environmental change on all spatial and temporal scales **(Tansey and Millington, 2006)**, as well as emerging as a key environmental issue on a regional scale. Changes may involve the nature or intensity of change but may also include spatial (forest abatement at village level, or for a large-scale agro industrial plant), and time aspects. Land use/land cover changes also involve the modification, either directly, or indirectly, of natural habitats and their impact on the ecology of an area **(Rogan, 2004).**

Sustainable land management is therefore a central challenge in the sustainable management of earth systems and resources. Monitoring and mediating the negative consequences of LULCC while sustaining the production of essential resources has therefore become a major priority of researchers and policymakers around the world. Moreover, local alteration of land use and land cover can have global consequences, requiring local and regional solutions to global problems and the cooperation of the world's policymakers, land managers, and other stakeholders in land management at local, regional and global scales **(Lambin *et al*., 2003)**. Protection of productive agricultural land has thus become a major priority in many regions of the world. Land degradation by overgrazing and intensive agriculture on marginal lands are major drivers of land loss; a number of national and international programs have responded

with land reforms and incentive programs to avoid this outcome. Landcover is therefore an important indicator of environmental change and plays a role in the process of change **(Lambin *et al*., 2006)**. In Zambia, land cover data for natural resources management is lacking and where they do exist they are not up to date. Thus, because of lack of such data, professionals such as town planners and resource managers often make decisions based on false assumptions. Presently remote sensing methodologies provide the most current and viable means of obtaining land cover data **(Kutty *et al.*, 2006)**.

Chingola and Chililabombwe districts having been miming areas from time immemorial attract agricultural activities and settlements. The two towns have grown to be the country's economic zones with high population contribution to the Copperbelt Province .The problem associated with land use and land cover change is expressed in terms of Built -up land use development and weak implementation of district development plans. This perhaps led to distortion of the original layout plan and conversion of reserved forest lands to uses. Today, there are little or no marked boundaries between what is a high, medium and low density settlement area because of incessant changes and uncontrolled landuse development and management of residential land in Chingola and Chililabombwe districts. Within the last decade most land has been converted to either built land (mining and residential), agricultural and settlements. The increase in economic activities driven by the mining industry has resulted in increased the human population in the two districts due to employment opportunities offered by the industry ultimately leading to, accelerated land use and land cover change. The population increase has resulted in high demand for land leading to the alteration in the land use pattern. Due to the increase in commercial activities and population growth there is increase in LULCC. This paper therefore examined the land use and land cover change detection in Chingola and Chililabombwe districts of the Copperbelt Province of Zambia between 2000 and 2015 with a view to detecting the land conversion rate and the changes that has taken place in this aspect particularly with regard to built-up land using Geographic Information System (GIS) and Remote Sensing (RS) data.

Remote Sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management. **(Wilkie and Finn, 1996)**. Therefore, an attempt was made in this study to map out the status of land use land cover of Chingola and Chililabombwe districts between 2000 and 2015 with a view to detecting the land conversion rate and the

changes that have taken place particularly with regards to the built-up land using Remote Sensing data.

STUDY OBJECTIVES

The aim of this paper is to use remotely sensed data with GIS techniques to detect changes that have taken place in the land use and land cover in Chingola and Chililabombwe Districts. The specific objectives include:

1. Produce land use and land cover maps for Chingola and Chililabombwe districts.
2. Determining the location and magnitude of land use and land cover changes of the study area.
3. Produce a prediction Map for 2020.

STUDY SITE LOCATION AND DESCRIPTION – CHINGOLA AND CHILILABOMBWE DISTRICTS

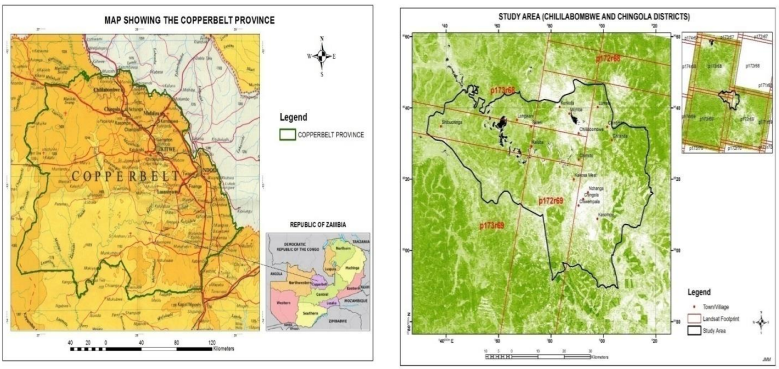


Figure 1: Location map for study area (Survey Department 2015).

The study area covers Chingola and Chililabombwe district of the Copperbelt province of Zambia. Chingola and Chililabombwe district is situated at latitude 12° 53'S and latitude 12°22'S and between longitude 27° 85'E and 27°49'E (www.daily-mail.co.za and mapstreetview.com 2018).According to the Central Statistical Office (CSO) report of 2015, Chingola and Chililabombwe districts had 216,626 and 91, 833 inhabitants, respectively. The two towns have mining as a major economic activity, coupled with other income

generation activities such as farming cross boarder trading and vending. Just like the rest of Zambia, Chingola and Chililabombwe have three seasons: hot and wet-rainy (November – March), cool and dry (April – July), hot and dry (August – October). The districts lie in the high rainfall belt of Zambia with an average annual rainfall of 1,341 millimetres. The highest temperature is recorded in October when it rises to above 27^0 C. The lowest temperatures are recorded in July. The land is generally undulating with most of the areas having deeply weathered red lateritic soils. Top soils are generally sandy with heavy textured sub-soils. Most of the underlying rock is rich in minerals such as copper, cobalt, and gold, and has attracted heavy mining activities since the 1900s. The two towns have both open forests and woodlands with Miombo being the common vegetation type.

METHODS AND MATERIALS

The research design adopted for this study area was the use of satellite images and other methods to generate data for the study. The Data was obtained from satellite images, academic journals, official publications and internet sources. Data was also collected from Landsat Thematic Mapper (TM), Enhanced Thematic Mapper (ETM), and Earth Science Data Interface Landsat MSS: 2000, 2005, 2010 and 2015 (Figure 2, 3, 4 and 5). Maps and measurements of land cover were derived directly from remotely sensed data by a variety of analytical procedures, including statistical methods and human interpretation. Maps of land use and land cover (LULC) were produced from remotely sensed data by inferring land use from land cover.

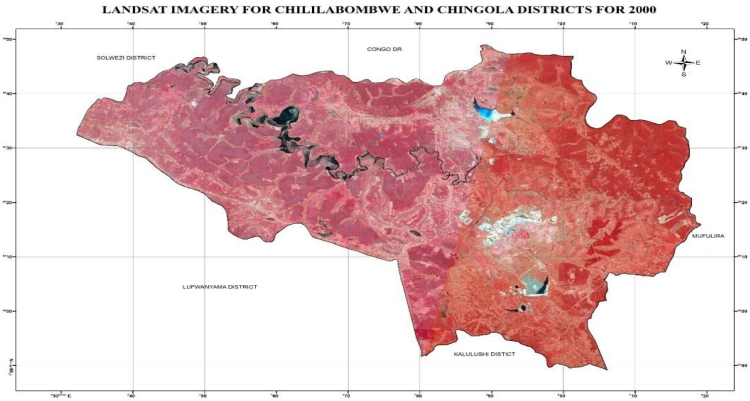


Figure2: 2000 Landsat Imagery of Chingola and Chililabombwe Districts

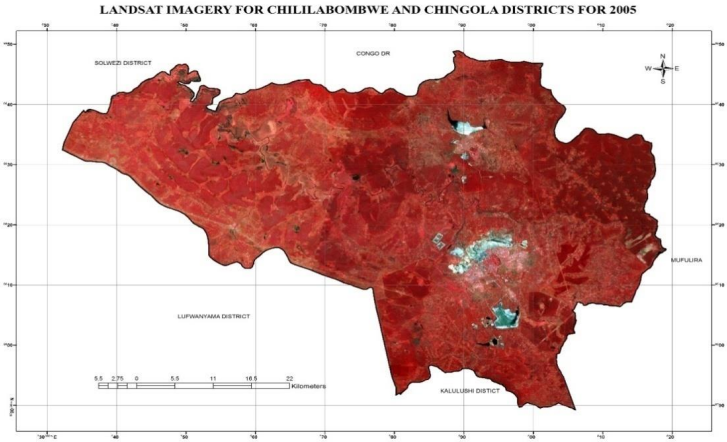


Figure3: 2005 Landsat Imagery of Chingola and Chililabombwe Districts

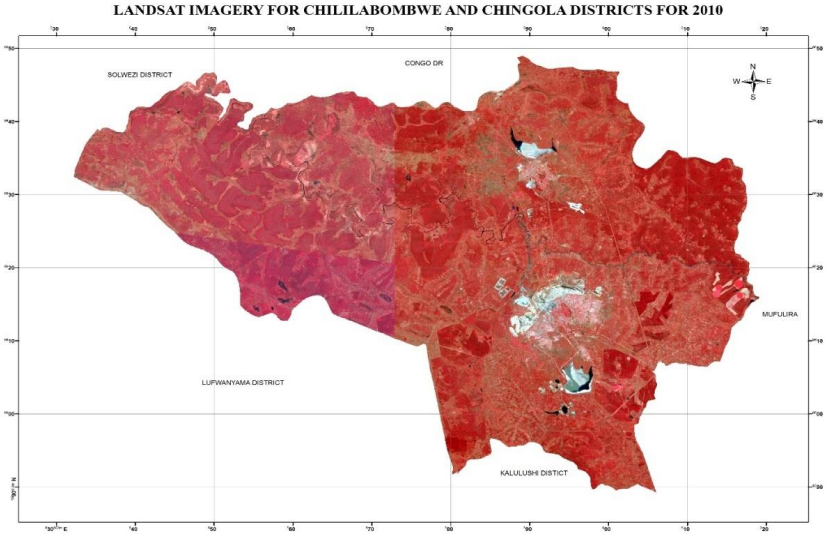


Figure4: 2010 Landsat Imagery of Chingola and Chililabombwe Districts

LANDSAT IMAGERY FOR CHINGOLA AND CHILILABOMBWE DISTRICT 2015

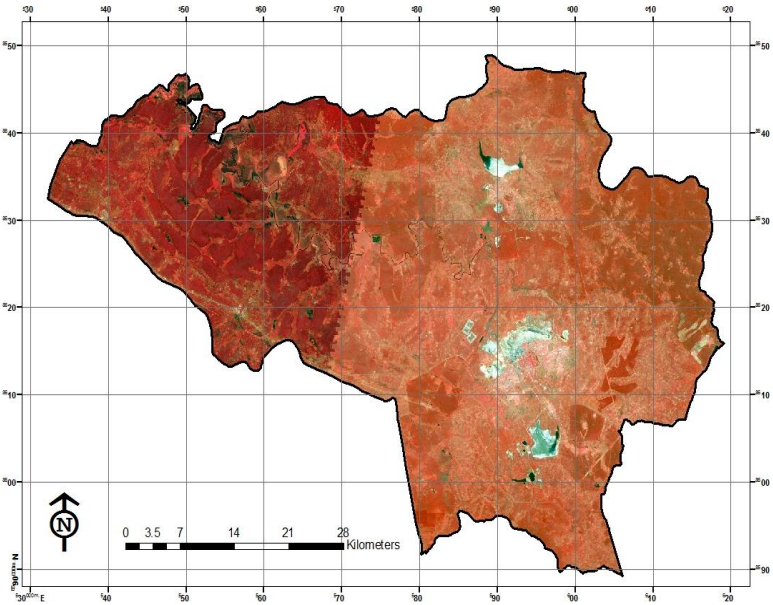


Figure5: 2015 Landsat Imagery of Chingola and Chililabombwe Districts

`

TOOLS AND SOFTWARE ACQUIRED

The software used for digital image processing were ERDAS IMAGINE 16 and ENVI 5.0. They were used individually in spefic functions and also in combination to optimize processing. For instance, edge corrections for land cover classes was done by ENVI, while ERDAS IMAGINE was used mainly for all supervized classification steps including the accuracy assessment. Complimentary tools used were the GIS softwares: ArcMap 10.5 used mainly for extrating zonal statistics and QGIS for geo-visualization of the 4 land cover maps. Finally, the land cover products were saved as an ArcMap document and anchored in a single geodatabase in ArcMap 10.5.

IMAGE CLASSIFICATION

Image classification was implemented using ENVI 5.0 after the preceding steps were successfully done. Image classification was done by extracting signatures or regions of interest (ROI) which are unique for each class. This is what was used to create statistical

characterization information about the land cover classes. The process involves supervising the selection of representative samples of each feature class using on-screen interpretation and digitizing. Each sample was as much as possible uniquely selected to meet some level of pixel hygiene. Samples with highly mixed pixels were avoided. A good number of samples for each class were digitized and well distributed across the study area to capture observable variations in reflectance properties. Appropriate domain names and values corresponding to the accuracy assessment sample set were entered. A number of iterations were run and the best case scenario was upheld for the accuracy assessment.

POST CLASSIFICATION.

After the images were successfully classified, some post classification processes that involved assigning of unique land cover class codes, edge matching, and chain classification were done in order to generate the correct classification results. Coding and colour matching of the classified images was done using the decision tree that contains a series of binary decisions that are used to determine the correct category for each pixel. The decision tree is the classifier that enabled the correction of classification results. The classifier was used to delineate between the classes and features that had similar spectral signature where maximum likelihood classification (MLC) identified them as one class **(Siampale, 2008)**.

Edge matching procedure was done using feathering distance to reduce edges along the overlap areas between two classes. The feathering distance was determined by measuring the overlap area between the two classifications of different images. Once this was done, the feathering distance was applied during mosaicking in order to remove edges. Chain classification involves selecting common regions of interest (ROI) in ENVI 5.0 on two overlapping scenes for classification to reduce edge difference between them **(Brown, 1997)**.

ACCURACY ASSESSMENT

The procedure for accuracy assessment was as follows, the classes to be assessed were defined, namely forest, settlements, agriculture, wetlands, grass land and other land though in the actual sample set, other land was not included because there were no points generated by the software because the spectral signature (reflectance values) are similar to settlements. Collection of ground truthing data sets (both training and accuracy assessment) was carried out using GPS. What followed next was creating a sample set and choosing a classifier /decision rule (algorithm). The actual classification and lastly assessing the accuracy of the actual classification was conducted using ERDAS 10.0. Therefore the created sample set collected

from ground truthing had two separate subsets that is training data set used in supervising the digital image classification and the sample set for training the accuracy assessment for each year.

RESULTS AND DISCUSSION

LAND USE AND LAND COVER DISTRIBUTION FOR CHINGOLA AND CHILILABOMBWE DISTRICT (2000-2015).

All the images used for the land cover mapping were converted to the geographical coordinate system to match the 2015 set of images. Change detection analysis using the district mosaics was performed for the years between 2000 and 2005; between 2005 and 2010; and 2010 and 2015 finally between 2000 and 2015. The total length of period for change detection analysis was 15 years. The classes for the land use and land cover distribution for each study year as derived from the maps are represented in Table 1. This was achieved with the aid of statistical module of area calculation in Arc GIS. The results presented represent the area of each land use land cover category for each study year.

Table 1: Land Use and Land Cover Distribution (2000, 2005, 2010 and 2015).

	2000		**2005**		**2010**		**2015**	
LU/LC Category	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
Forestland	181,556.73	66.7	179,106.94	65.8	179,379.14	65.9	178,018.15	65.4
Built land	33,752.68	12.4	35,113.67	12.9	35,113.67	12.9	35,658.07	13.1
Agricultural land	29,125.29	10.7	30,758.49	11.3	31,030.69	11.4	32,663.88	12.0
Water bodies	9,254.77	3.4	9,254.77	3.4	9,799.16	3.6	8,438.17	3.1
Grassland	16,059.74	5.9	14,698.75	5.4	13,882.15	5.1	12,793.35	4.7
Bare land	2,449.79	0.9	3,266.38	1.2	2,994.19	1.1	4,627.38	1.7
Total	**272,199.00**	**100**	**272,199.00**	**100**	**272,199.00**	**100**	**272,199.00**	**100**

Analysis of the 2000 image in figure 6 revealed forest land had the largest area followed by built –up land and agriculture. In 2000 forest land occupied the highest area 66.7% of the total

land. This might have been due to the fact that the town was in its traditional setting, where farming seemed to form the basis for living. Mining was probably done on a small scale, Built-up land occupied 12.4% of the total area, with farming at 10.7%.

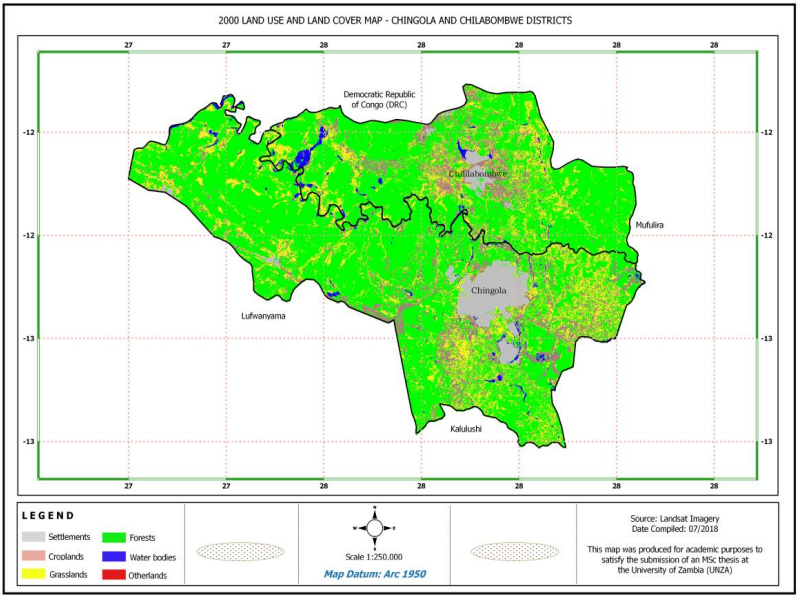


Figure 6: Classified Land Use and Land Cover Map 2000-Chingola and Chililabombwe Districts.

In 2005, forest land occupied 65.8% of the total land this could have been as a result of increase in the population. Farming activities took up 11.3% of land in this year and seemed to have increased compared to 2000 which was 10.7 %. Built land on the other hand increased from 12.4% in 2000 to 12.9% in 2005, this may be attributed to urban growth as more land was used for building of houses, road construction and commercial activities thereby occupying 12.9% of the total area of classes (Table 1) The other land (rock-outcrop) occupied 1.2% which may be due to mining expansion and other land covered 1.2% compared to 0.9% in 2000 possibly as a result of clearing of some vegetation and people buying lands for development. Forest land reduced to 65.8% as seen in (Figure 7) as compared to 66.7% less than 2000 this could have been due to the fact that charcoal production and farming was becoming a preferred or

prominent source of livelihood .The other reasons for the decrease could be mainly based on anthropogenic activities such as farming, and expansion of built-up area.

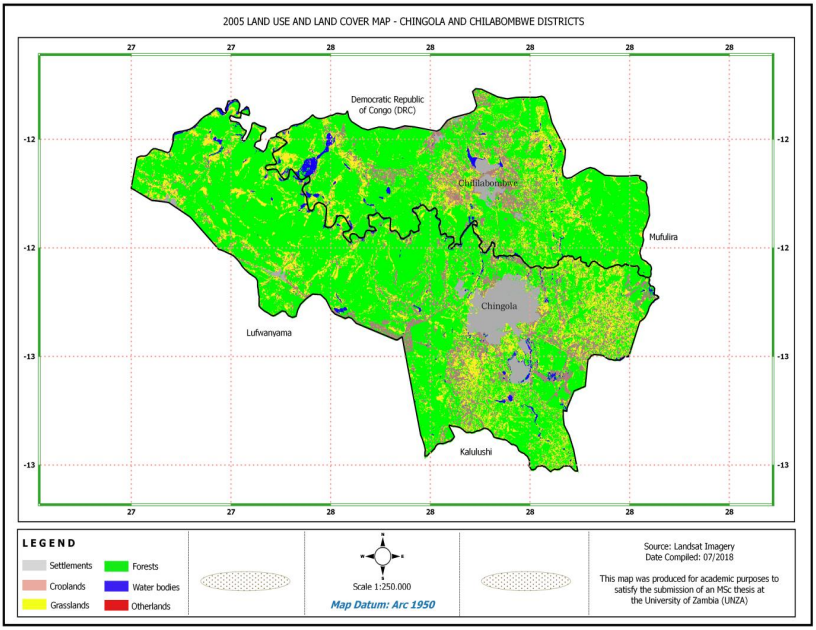


Figure 7: Classified Land use and Land cover map 2005 - Chingola and Chililabombwe Districts

As can be seen in (Figure 8) for the 2010 image of Chingola and Chililabombwe, the Proportion of forest and agriculture land increased. In 2010, forest land area increased to 65.9% from 65.8% in 2005. This was probably based on many factors such as the Zambia Forest and Forestry Industry Corporation Company (ZAFFICCO) plantation expansion project which led to an improvement in vegetation cover. Settlement area remained at 12.9% as previously in 2005. Agricultural lands increased to11.4% from 11.3% as shown in (Table 1) the main reason for that could be stability of mining operations which led to people having stable income therefore farming activities increased as people were able to afford farming inputs. Water bodies had increased to 3.6 % more than in 2005.Related to vegetation increment, water retention and flow likely improved; this could be the reason for the increase in the water bodies. Other land (Rock outcrop) reduced to 1.1% as a result of an increase in forest activities such as reforestation of vegetation that had covered it.

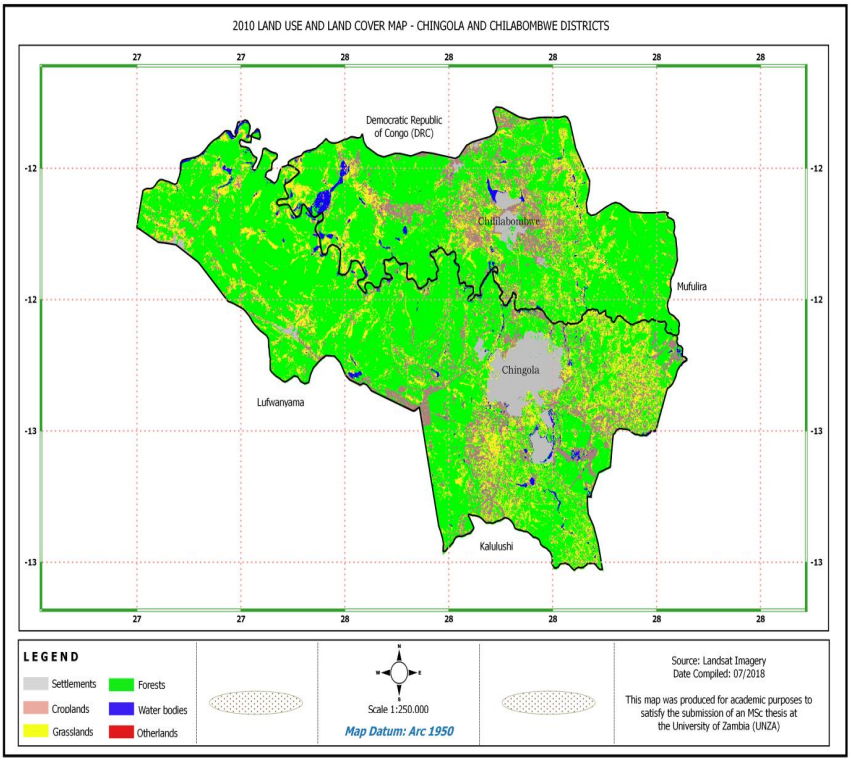


Figure 8: Classified Land Use and Land Cover Map 2010-Chingola and Chililabombwe Districts.

In accordance with the trends from the past, built-up land expanded again from 2005 to 2015 (Figure 9) that built-up land was again the major land use class covering more of the landscape. The Landsat image of 2015 revealed that built-up land (settlement) increased to 13.1% from12.9% in 2010. This was due to many factors such as increased mining activities, concentration of schools, availability of social amenities and population increase. Cropland also increased to 12.0%, the main reason for that could be due to the increase in settlement development associated with urbanization. Grass land surfaces had decreased to 4.71% compared to 5.1 % in 2010 due to the fact that it had been converted to other land uses such as built-up land. Water bodies' coverage also reduced to3.1% compared to 3.6% in 2010. This may be attributed to tempering of important water sources in establishing settlements and

clearing trees for charcoal production and settlements. Other land (quarries, rock -outcrop) increased to 1.7% from 1.1% in 2010 as a result of clearing of vegetation that had covered it. Vegetation decreased to 65.4%, which can be attributed mainly to anthropogenic activities such as charcoal production, farming, and expansion of built-up land as shown in table 1.

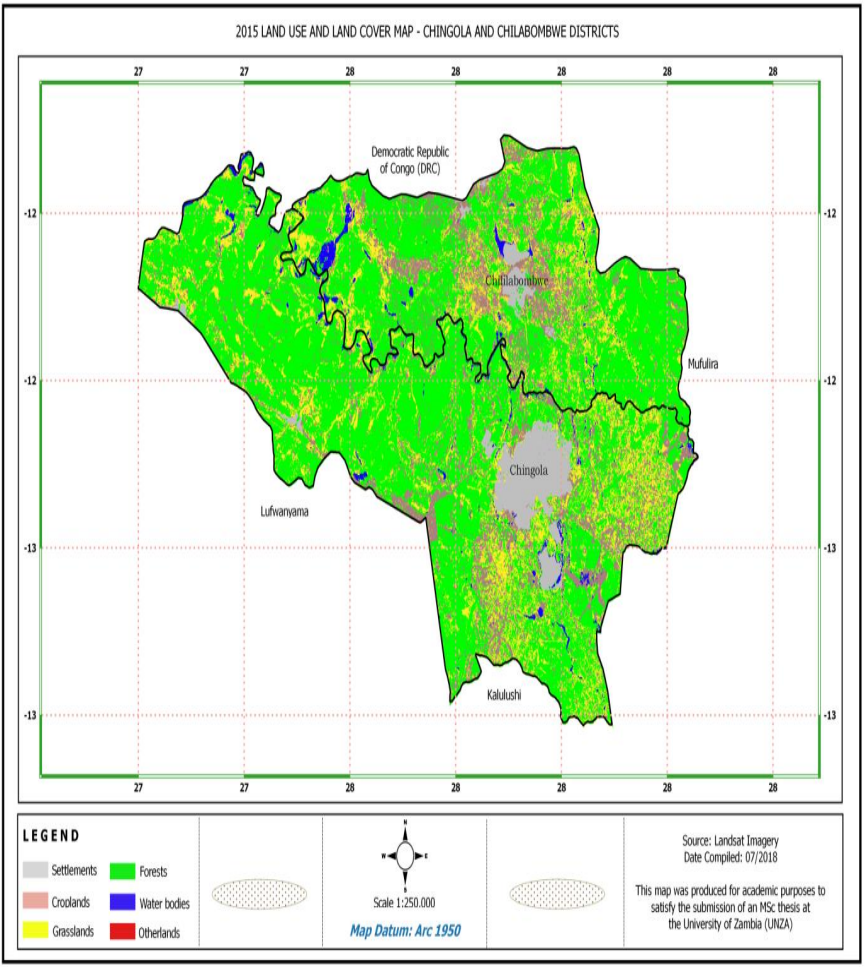


Figure 9: Classified Land Use and Land Cover Map 2015-Chingola and Chililabombwe Districts.

ACCURACY ASSESSMENT RESULTS

The most common and typical method used by researchers to assess classification accuracy is the use of an error matrix (Sherefa, 2006). The error matrix for each classification was created and then overall accuracy, user accuracy producer accuracy and Kappa coefficient were calculated and evaluated. Therefore, Tables 2,3,4,5 shows details of the accuracy assessment results conducted for the study area.

Table 2: Accuracy Assessment Results for 2000 LCM

Total GCPs for 2000 image 115						Diagonals (Chances Agreed) = 99 GCPs			
2000 Scheme I		Class types determined from reference source							USER ACC % (88.7)
Class	# OF POINT	Forestland	Grassland	Cropland	Wetland	Settlement	Other	TOTAL	
	Forestland	47	3	2	1	0	0	53	88.7
	Grassland	3	20	1	1	0	0	25	80.0
	Cropland	3	2	15	0	0	0	20	75.0
	Wetland	0	0	0	15	0	0	15	100.0
	Settlement	0	0	0	0	2	0	2	100.0
	Other	0	0	0	0	0	0	0	-
	TOTAL	53	25	18	17	2	0	115	100
PRODUCER ACC % (88.0)		88.7	80.0	83.3	88.2	100.0	-	100	86.1

Overall accuracy = 86.1%, User accuracy = 88.7%, Producer accuracy= 88.0% Kappa coefficient = 0.79

Table 3: Accuracy Assessment Results for 2005 LCM

Total GCPs Used for 2005 Image 156						Diagonals (Chances Agreed) = 135 GCPs			
2005 Scheme I		Class types determined from reference source							USER ACC % (87.1)
Class	# OF POINT	Forestland	Grassland	Cropland	Wetland	Settlement	Other	TOTAL	
	Forestland	53	5	3	2	1	0	64	82.8
	Grassland	4	34	1	1	0	0	40	85.0
	Cropland	3	2	24	0	0	0	29	82.8
	Wetland	2	1	0	17	0	0	20	85.0
	Settlement	0	0	0	0	3	0	3	100.0
	Other	0	0	0	0	0	0	0	0.0
	TOTAL	62	42	28	20	4	0	156	-
PRODUCER ACC % (82.4)		85.5	81.0	85.7	85.0	75.0	-	100	86.5

Overall accuracy = 85.5%, User accuracy = 87.1%, Producer accuracy= 82.4% Kappa coefficient = 0.78

Table 4: Accuracy Assessment Results for 2010 LCM

Total GCPs Used for 2010 Image 125								Diagonals (Chances Agreed) = 107 GCPs	
2010 Scheme I		Class types determined from reference source							USER ACC % (87.5)
Class	# OF POINT	Forestland	Grassland	Crop land	Wetland	Settlement	Other	TOTAL	
	Forestland	51	3	-2	1	0	0	57	89.5
	Grassland	3	22	2	1	0	0	28	78.6
	Cropland	3	2	16	0	0	0	21	76.2
	Wetland	0	0	0	15	0	0	15	100.0
	Settlement	0	0	0	0	4	0	4	100.0
	Other	0	0	0	0	0	0	0	-
	TOTAL	57	27	20	17	4	0	125	100
PRODUCER ACC % (86.6)		89.5	81.5	80.0	88.2	100.0	-	100	85.6

Overall accuracy = 85.6%, User accuracy = 87.7%, Producer accuracy= 86.6%
Kappa coefficient = 0.79

Table 5: Accuracy Assessment Results for 2015 LCM

Total GCPs Used for 2015 Image 136								Diagonals (Chances Agreed) = 116 GCPs	
2015 Scheme I		Class types determined from reference source							USER ACC % (87.33)
Class	# OF POINT	Forestland	Grassland	Cropland	Wetland	Settlement	Other	TOTAL	
	Forestland	55	4	3	1	0	0	63	87.3
	Grassland	3	24	2	1	0	0	30	80.0
	Cropland	3	2	17	0	0	0	22	77.3
	Wetland	0	0	0	16	0	0	16	100.0
	Settlement	0	0	0	0	4	0	4	100.0
	Other	0	0	0	0	0	0	0	-
	TOTAL	61	30	22	18	4	0	136	100
PRODUCER ACC % (86.2)		90.2	80.0	77.3	88.9	100.0	-	100	85.3

Overall accuracy = 85.3%, User accuracy = 87.3%, Producer accuracy= 86.3% Kappa coefficient = 0.85

Overall (summary) accuracy and kappa coefficient

- User's accuracy – errors of commission (inclusion)
- Producer's accuracy – errors of omission (exclusion)
- Summary accuracy (i.e. 99/115*100 = 86.1% for 2000)
- Kappa coefficient = 0.7927 (2000); 0.7829 (2005); 0.7991 (2010) and 0.8492 (2015)

The accuracy statistics for the years 2000, 2005, 2010 and 2015 were all high and exceeded the acceptable limit, therefore, the classified maps from supervised classification were acceptable and used for the research.

MAGNITUDE AND PERCENTAGE OF CHANGE

Table 6: Magnitude and Percentage of change in land use and land 2000 and 2015.

Class Name	2000 (Ha)	2015 (Ha)	Change (Ha)	Change (%)	Description
Forest land	181,556.73	178,018.15	-3,538.59	1.95	Decrease
Built-up land	33,752.68	35,658.07	1,905.39	-5.65	Increase
Agricultural land	29,125.29	32,663.88	3,538.59	12.15	Increase
Water bodies	9,254.77	8,438.17	-816.60	8.01	Decrease
Grassland	16,059.74	12,793.35	-3,266.39	-21.9	Decrease
Other land	2,449.79	4,627.38	2,177.59	-79.52	Increase

The results in Table 8 show that the rate of change of forest land in the study area had been reduced by 1.95% during the period15 year's period. It may be due to the increase in the mining activities; population increase which has resulted in demand for new settlements. **Mwitwa et al (2011)** stated that urban pressure on forests was as a result of the growth of mining towns and is most evident in case of Chingola and Chililabombwe where KCM is located. Here the pull factor of the mine is apparent and the development (and degradation) of land extends well beyond the concession itself. As a result of this transformation of forest land to urban development (for example) and due to the increased population density in the area, remaining customary forest was under increasing pressure.

The pressure on resources stems from the consumption demand by the mines, mines employees and residents of the town that are indirectly connected with the mine. This had resulted in forest degradation and the need for customary rights holders to move further to access forest resources. Furthermore, the markets provided by the mines and the two towns had shifted the nature of consumption from subsistence to commercial. The rate of change indicates that other land experienced 88.9% increase for the period of fifteen (15) years, while the percentage of

change of water body and grass land stood between 8.82% and 20.34%. However, agricultural land (crop land) recorded increase between 2000 and 2015 but woodland recorded decrease. Water bodies and forest land have negative changes of 8.01% and 1.95% reduction respectively which might be as a result of conversion to agriculture land, built-up and other land, as a result of mainly human activities. The land use and land cover change for the past fifteen years is tabulated in (table 6).

ANNUAL CHANGE AND PERCENTAGE

Table 7: Annual rate of change and percentage of Chingola and Chililabombwe Districts

Class Name	2000 (Ha)	2005 (Ha)	2010 (Ha)	2015 (Ha)	Average Change per year (Ha)	Description of change	% Annual Change.
Forest land	181,556.73	179,106.94	179,379.14	178,018.15	236	Decrease	0.13
Built-up land	33,752.68	35,113.67	35,113.67	35,658.07	127	Increase	0.38
Agriculture	29,125.29	30,758.49	31,030.69	32,663.88	236	Increase	0.81
Water bodies	9,254.77	9,254.77	9,799.16	8,438.17	54	Decrease	0.59
Grassland	16,059.74	14,698.75	13,882.15	12,793.35	218	Decrease	1.36
Other land	2,449.79	3,266.39	2,994.19	4,627.38	145	Increase	5.93

Forest land has been steady in reduction between 2000 and 2015. It will be in the good side of Chingola and Chililabombwe Districts and indeed the nation as a whole if the moderate reduction in woodland observed in between 2000 and 2015 is sustained or maintained. It was observed that man has been playing major roles in the use of land resources of within the study years. The increasing human activities such as settlement development, agriculture (farming) and others have exerted so much stress on the ecosystems and resulted to the loss of great proportion of the land forest. Forest which had a total land mass of 181,556.73 Ha in 2000 had decreased to 178,018.15 Ha in 2015. This showed that forest land has a decrease annual rate of 236 hectares (0.13%). This means that woodland is changing annually at rate of 236 (0.13%) in Chililabombwe and Chingola districts. A land cover change for the entire Copperbelt was conducted by Limpatlaw in 2001 and the results showed that in 2000, Miombo woodlands accounted for 31% with patches increasingly broken up and only occurring in the peripheral areas of the area of interest which included the study area. He added that it was impossible to

attribute these changes to one economic activity as there was a link between agriculture and woodland clearing to supply wood to the mines. It is apparent, however, that a remarkable increase in informal agriculture had occurred and that this has implications on the woodland ecosystem Over the period of investigation there has been a 127Ha (0.38%) annual increase in the area occupied by built land settlements.

IMPLICATIONS OF LAND USE AND LAND COVER CHANGE

From the results shown in the LULC pattern agriculture and built-up land are increasing at the expanse of forest land. There is needed to critically look at the land allocation system in the study area. The forest land is under pressure and if no measures are put in place more of the forest land will be converted to other land use and this may have implications on vegetation cover leading to serious climate change. The results have further indicated that most forest land is increasingly fragmented and exploited for economic purposes. This has also affected the water bodies as they have been seen to be reducing due to increased anthropogenic activities in the study area. These calls for further studies to better understand current changes and evaluate the impacts so as to make immediate corrections and draw important lessons to further scale up the experience to other areas. Currently the revised land policy is still in draft form and hoping that it will be finalised soon so that certain measures can be put in place such as building and farming in designated areas so as to avoid unnecessary conversation of land to undesirable state.

The increase in agriculture has important implications for the sustainability of agricultural production and is likely to result in increasing levels of environmental degradation. The permanent conversion of forest land may affect water availability downstream, as clearing reduces the amount of water infiltrating the soil and lowers the water table. This progressive deforestation has also resulted into the development of large exotic softwood plantations that are owned by ZAFFICCO. The results have shown that humans generally increase landscape heterogeneity by modifying landscapes there by leading to natural disturbance, leading to distinctive patterns of change.

PREDICTION FOR LAND USE AND LAND COVER FOR THE YEAR 2020.

The future prediction of land use and land cover for the year 2020 indicated that substantial changes will occur (Table 8 and Figure 10). Forest loss and fragmentation due to expansion of agriculture and built-up land is expected to increase. In 2020 the area of forest is estimated (predicted) to be at 168,278 Ha representing a decrease of 5%, while built-up land is expected

to increase to 4.9 % (48,875) Ha and agriculture will be at 37,894 Ha. Other noticeable changes in land will occur in the category of other land which includes quarries. Other land is predicted to decrease in favour of other land categories such as built-up land and agriculture land. However the conversion from forest to built-up and agriculture can be kept stable with the gradual increase of awareness of sustainable environmental protection and management and government support. The future land use and land cover map for Chingola and Chililabombwe is shown in figure 11.

Table 8: Future land use and land cover prediction 2020

Land use and land cover	2015	Predicted 2020	Change%
Forest	178,018.15	164,278.73	-5.0
Grassland	12,793.35	15,142.8	0.9
Agriculture	32,663.88	37,894	1.9
Wetland	8,434.17	5,617.5	-1.0
Built-up land	35,658.07	48,875.97	4.9
Other land	4,627.38	390	-1.6
Total	**272,199**	**272,199**	**-**

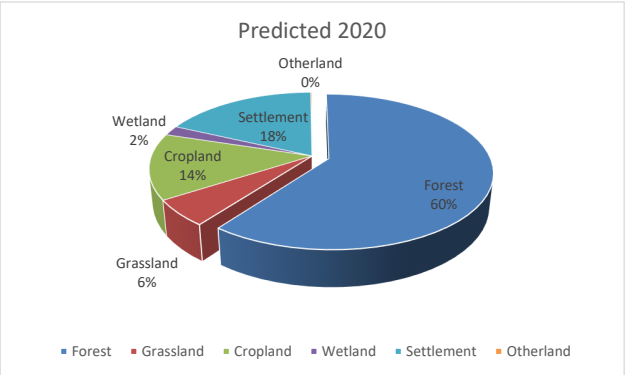


Figure 10: Future land use and land cover distribution for 2020.

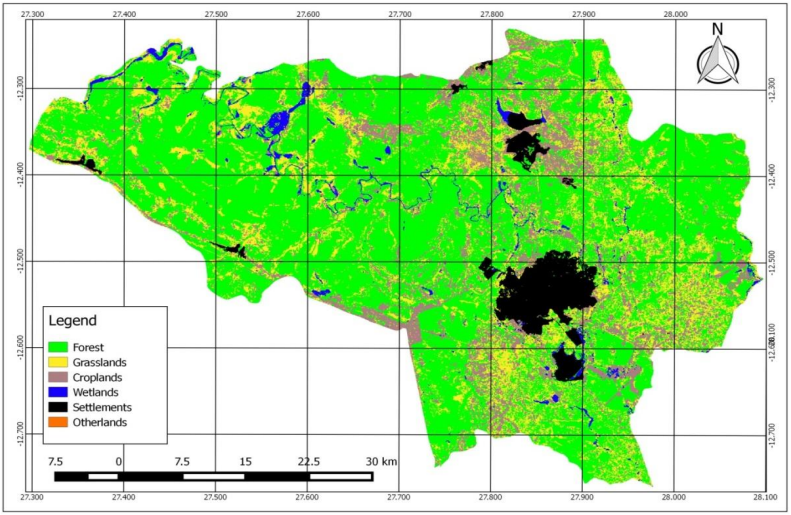


Figure 11: The Map of future land use and land cover of Chingola and Chililabombwe Districts 2020.

.CONCLUSION

It can be seen that the Districts of Chingola and Chililabombwe have under gone changes in land use and land cover during 15 years period. Some undesirable changes such as decrease on forest land, water bodies and grass lands happened and an attempt was made to capture as accurate as possible six land use and land cover classes as they change through time. The six classes were distinctly produced for each study year with more emphasis on built-up land which combines anthropogenic activities that make up these classes; and indeed, it is one that affects the other classes. However, the result of the work shows a rapid growth in built-up area between 2000 – 2005 and 2010-2015. It is also believed that land use and land cover change by 2020 is likely to follow the trend all things being equal. The results of this study show that a lot of forest and grass lands was converted into built-up land (settlements) agricultural land, and other land (quarries, rock out-crop) and the rivers were also reduced .This showed that the human activities such as the increase of population, development of the economy can change the land use and land cover in a very short process. Results from this study will benefit land use and land cover mapping efforts as scientists and researchers continue to investigate these changes. There are numerous opportunities for future research related to this project.

RECOMMENDATIONS

The study recommends the following:

1. Remote Sensing and GIS techniques should be applied by organizations, legislators and government for environmental planning, management, monitoring and formulation of land use policies. This is because it is a superior tool that gives accurate and reliable information in time and space.
2. Government should enhance the national Remote Sensing centre in order to increase its capacity for mapping and evaluating land use and land cover change in Zambia. The service of the centre must be affordable for national development at all levels.
3. There is need for public and community awareness on responsible and sustainable management and use of land in the study area. Land is a limited resource therefore communities must learn to appreciate and practice the best landuse forms that enhance their livelihoods on the same parcel of land available to them over time. It is government's responsibility to facilitate and execute such programmes.
4. Government must undertake land use audit periodically for purposes of having current land inventory and conditions, generating land use plans and for responsible management of land

REFERENCES

Brown, S., (1997). "Estimating Biomass and Biomass Change of Tropical Forest". A Primer - Food and Agriculture Organization of the United Nations (FAO), Rome. Italy.

CSO (2015) Central statistics office- Lusaka Zambia

GRZ (2015). Survey Department, Ministry of lands Natural Resources and Environmental protection, Lusaka Zambia.

Lambin E.F (1997). Modelling and monitoring land-cover change processes in tropical regions. Progress in Physical Geography. 21:375–393.

Lambin E.F, Geist H, and Lepers .E (2003). Dynamics of land use and cover change in tropical regions. Annual Rev. Environ. Resource. 28: 205 – 241.

Lambin, E.F., Geist, H. and Rindfuss, R.R. (2006).Introduction: Local Process with Global Impact (1st Edition) Berlin, Heidelberg: Springer.

Mwitwa J. Paumgarten and. German L. (2011) Evaluating the Impacts of Expanded Trade and Investment in Mining on Forests: Customary Rights and Societal Stakes in the Copper Belt of Zambia. Canter for International Forestry Research (CIFOR). Forestry Department Nursery, Woodlands, Lusaka, Zambia.

Narangarel, Z. de Lamo, X., Hicks, C. and Guth, M. (2016) Spatial analysis to support REDD+ planning in Mongolia: Joint working sessions report. Working sessions convened as part of Mongolia's National UN-REDD Programme, October 2015 and March 2016, UNEP World Conservation Monitoring Centre, Cambridge, UK.

Nunes and Auge J.I (1999). Land-Use and Land-Cover Implementation Strategy (Stockholm: IGBP).

Rogan J (2004). Remote Sensing Technology for mapping and monitoring land-cover and land-use change, progress in planning, 61: 301–325.

Sherefa, B., (2006), Remote Sensing & GIS for Land Cover/ Land Use Change Detection and Analysis in the Semi-Natural Ecosystems and Agriculture Landscapes of the Central Ethiopian Rift Valley. PhD thesis, Institute of Photogrammetry and Remote Sensing, Technology University of Dresden, Germany.

Siampale, A. M. (2008)**.** Land use and forest cover change (LUFCC) detection analysis 1990, 2000 and 2005". Determining the Deforestation Rate for Zambia based on Remote Sensing data. Ministry of Tourism Environment and Natural Resources, Forestry Department. Lusaka. Zambia

Tansey K.T, and Millington A.C (2006). Land use/land cover change detection in Metropolitan Lagos (Nigeria): 1984-2000. ASPRS 2006 Annual Conference Reno, Nevada, May 1-5, 2006.

Wilkie, D.S., and Finn, J.T. 1996. Remote Sensing Imagery for Natural Resources Monitoring, Columbia University Press, New York. p. 295.

Vitousek PM (1992). Global environmental change: an introduction. Ann. Rev. Ecol. Syst. 23: 1–14.