

An Examination of the Sustainability of Pozzolana Mining Processes in Uganda

Eunice Naigaga

Abstract—Uganda is endowed with vast deposits of Pozzolana, which is a key additive in the manufacture of Portland Pozzolana Cement. Cement manufacture is a key component in the country's construction sector growth which is at a rate of 12% according to recent reports. Pozzolana is mined on both large and small scale, using unsound mining processes which have resulted in post mine areas that are unfit for use by future generations. The activities in Pozzolana mining were examined to observe how they affect the mining communities and to ascertain if they are geared towards sustainable socio-economic growth of the mining communities. A comparative and explanatory study of the two main cement producing factories that use Pozzolana in the country was done. Data was collected using structured observations, close-ended questionnaires, focus group discussions and literature. Analysis was done using content, trend and Contingency table analysis. The key study findings are that the tools used during small scale mining are archaic leading to deaths and environmental degradation. On the other hand large scale mining is done using indiscriminate methods that result in severe environmental degradation. The mining regulation and enforcement is weak and therefore the mining processes in both cases are not sustainable. It was recommended that co-learning, co-production and co-evolution be adopted in the Pozzolana mining industry in Uganda. A framework through which these can be enforced was formulated as part of this research.

Keywords—Co-evolution, Co-learning, Co-production, Environment, Pozzolana, Sustainability.

I. INTRODUCTION

POZZOLANA is a material containing reactive silica and/or alumina. Pozzolana has little or no binding property but it will set and harden when mixed with lime and/ or cement in the presence of water [4]. It can be used in combination with lime and/or ordinary Portland cement (OPC). When Pozzolana is mixed with lime, it improves the properties of lime-based mortars and concretes for use in a wide range of building applications [6], [7]. Alternatively Pozzolana can be blended with OPC to improve the durability of concrete and its workability which can reduce its cost considerably. In such a case, Pozzolana serves as a partial cement replacement material in ratios of 5-25%.

Pozzolana mainly exists in the form of volcanic ash. It was first used as a Pozzolana by the Romans from deposits close to the village of Pozzuoli near Naples, hence the name. Pozzolana can be in the form of clays or shales which are very

widespread and are readily available in almost all regions of the world. Pozzolana has been used as a cement supplement on large-scale construction projects in a number of countries, particularly the United States, Brazil, Egypt and India [5]. In Egypt for example, a lime-calcined clay mortar was used in the core of the first Aswan dam built in 1902.

There exists a variety of Pozzolana from natural sources and also from various wastes like agro-wastes, mine wastes and industrial wastes in East Africa especially from Kenya and Uganda both of which are primarily agricultural economies. Potential artificial Pozzolana also include burnt clays and reject bricks, blast-furnace slag from steel production and the ash of burnt rice husks [9], [10]. There are Pozzolana deposits of volcanic origin within Uganda with Hima and Tororo cement companies currently mining the material and using it as cementitious mineral admixtures in their products marketed as Portland-Pozzolana cement [5]. Although none of these or any other studies state specific statistical details, they acknowledge that the deposits are substantial. These studies state further that the East African region is endowed with vast construction clays and deposits of volcanic rocks due to volcanic activity in the recent past leaving deposits of volcanic ashes with Pozzolana properties.

In Uganda, volcanic ash deposits are found in the west and south western areas of Bushenyi, Kabarole, Kasese, Bundibugyo, Kabale and Kisoro. Pozzolana deposits also occur in the eastern parts of the country on the slopes of Mt. Elgon and in Karamoja [1], [2], [3].

Although there are no accessible records of the numerical volumes of Pozzolana deposits in Uganda, it can be inferred from the records of the mineral production quantities of Pozzolana that the deposits in Uganda are substantial [8]. This report shows that between January and March 120,186.24 tonnes of Pozzolana were produced in 2010, 71,701.77 tonnes were produced between April and June, 94,065.31 were produced between July and September of the same year while 160,362.58 tonnes were produced between October and December of the same year. These huge production volumes albeit from only two cement producing companies are an indicator that the Pozzolana deposits in Uganda are sizeable. Pozzolana mining in Uganda is done on both large and small scale. In the case of large scale mining, mechanized earth moving equipment is used.

Conversely, hand tools like hand hoes and pick axes are engaged during small scale mining.

II. PROBLEM STATEMENT

The activities within the Pozzolana mining industry in Uganda are not well streamlined, defined nor regulated. This has resulted into wasteful exploitation procedures which are confirmed through the resultant chaos and untidiness. The photographs in appendix A, B, C and D visibly highlight these issues.

Mining of Pozzolana in the current manner is not sustainable as it leads to environmental degradation with little or no regeneration. Since reduction in the Pozzolana mined is not a foreseeable option, there is a need for critical examination of these activities with the aim of providing sustainable mining solutions within the industry.

III. OVERALL RESEARCH OBJECTIVE

The main objective of the research was to examine the Sustainability of Pozzolana Mining Processes in Uganda

IV. SPECIFIC OBJECTIVES

The specific objectives of the research include:

- i. Ascertaining the activities and processes in Pozzolana mining
- ii. Ascertaining the effect of these activities on the mining communities
- iii. Examining how the mining activities are geared towards sustainable socio-economic growth of the communities

V. RESEARCH QUESTIONS

- What are the activities involved in Pozzolana Mining in Uganda?
- How are these activities carried out?
- What is the effect of these activities on the mining communities?
- Are the activities geared towards sustainable socio-economic growth of the communities?

VI. METHODOLOGY

Data Collection methods included Close ended questionnaires, structured observations, Focus group discussions with Ishikawa analysis and review of Literature. Analysis was then done using content analysis and Trend analysis. Results are presented in graphs, literature and photographs

VII. RESULTS

TABLE I: POZZOLANA MINING ACTIVITIES AND PROCESSES

Mining Scale	Large	Small
Location	Eastern Uganda, Kaserem, Kapchorwa Road	Western Uganda, Harugongo, Kabarole
Mining Tools Used	Backhoe excavators, wheel loaders, crushers, grinding mills and conveyor loading equipment	Hand hoes, old car springs, shovels, pick axes, wheel barrows, crow and iron bars
Mining Process followed	The process followed during large scale mining is as follows: Identification of deposits → removal of overburden → blasting and crushing of rock → site storage → transportation to factory storage site → weighing, drying and factory storage.	The process followed during small scale mining is as follows: Identification of deposits → removal of overburden → extraction of Pozzolana → transportation to Hima town council for open storage at various locations → sale to Hima cement

VIII. EFFECTS OF THE ACTIVITIES ON THE MINING COMMUNITIES

Some of the effects of the activities on the mining communities include:

- Improved living standards due to income after sale of Pozzolana
- Deaths during mining operations
- Increased disease outbreaks
- Dangerous post mine areas
- Loss of vegetation and resultant severe climate change
- Accidents during transportation
- Displacement of people during mine creation
- Destruction of the road network
- High levels of illiteracy and school drop outs
- Increased conflict
- Poor water and sanitation, extra.

IX. HOW THE ACTIVITIES CONTRIBUTE TO SOCIAL ECONOMIC GROWTH OF THE COMMUNITIES

Some of the ways in which Pozzolana mining has contributed to social economic growth of the surrounding communities include:

- Provision of jobs
- Provision of social services in some areas
- Provision of building materials

X. DISCUSSION

TABLE II
SUMMARY OF DISCUSSION OF RESULTS

Issue	Eastern Uganda	Western Uganda
Summary thoughts on the Mining process	-The mining process in eastern Uganda is unclear, not documented and inconsistent. With the mining agreement between two investors who are each painting a different picture, it has proven very hard to follow one mining process, and thus regulation and enforcement of mining laws would be hard. -The Pozzolana mining process in this area has been the same and no review has been carried out and therefore there is no continuous improvement.	- The mining process in this area is unclear, not documented and is further marred by a lack of accountability by the parties involved in the mining. - No review of the process has been done, especially given that it is hard to pin point responsible parties.
Tools and Equipment	-The tools and methods of mining are quick and efficient for the miner, but are indiscriminate and have created negative impacts on the people and the physical environment. -The method of rock blasting, especially since it is done haphazardly creates shock and other problems which if not checked could result into severe illnesses and deaths.	- The tools and methods used are very crude and have resulted in deaths of miners although they have not created big negative impacts on the environment.
Possibility of mine area restoration	The mining depths and breadths are very big and thus would require proper planning for restoration. The present restoration plans may prove hard to follow because it would mean creating a land management crisis in another area in order to solve one in the post mine.	The depths and breadths of mining are not big, especially because of how the Pozzolana appears naturally in the area.
Relationship between locals and mining company	The relationship between the locals and the mining company is not healthy especially because the former feel cheated by the mining company due to the low rates paid to them during land acquisition and the general lack of corporate social responsibility especially in solving the various issues created by the company activities in the area.	-There is no direct relationship between the locals in the mining community and Hima Cement factory. -Although the factory has corporate social responsibility efforts, these have been towards residents of Hima town council, not the actual mining communities
Safety and Health	Safety equipment is provided by the mining company to its workers, but no efforts are made for the locals' safety.	There is no safety equipment for the miners, transporters or the local community.
CSR	There is not much done by the mining to address social economic issues of the local community	Hima Cement is thin on the ground in the Pozzolana mining areas because of the nature of Pozzolana acquisition.

XI. CONCLUSIONS AND RECOMMENDATIONS

The key study findings are that the tools used during small scale mining are archaic leading to deaths and environmental degradation. On the other hand large scale mining is done using indiscriminate methods that result in severe environmental degradation. The mining regulation and enforcement is weak and therefore the mining processes in both cases are not sustainable. It is recommended that co-learning, co-production and co-evolution be adopted in the Pozzolana mining industry in Uganda.

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