

# Small-scale mining and cleaner production issues in Zambia

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## Abstract

Small-scale mining (SSM) has had unprecedented growth in Zambia during the past decade. The sector now produces a variety of commodities, especially gemstones, building and industrial minerals. From a structural and technical perspective, SSM is conducted on a very rudimentary level using basic tools such as picks and shovel, and occasionally, mechanized equipment. The environmental degradation caused by SSM is also growing with the intensification of activities in the country. Meanwhile, institutions responsible for managing the environment are unable to effectively carry out regulatory and monitoring mandates due to inadequate resources. Although current legislation appears to be adequate in many respects, time has now come to amend the Mines and Minerals Act (1995) so that it becomes mandatory for all mining activities, including small-scale mines, to submit environmental impact assessment reports before a license to mine or explore can be granted. Strategies to eliminate illegal mining, enhancement of miners' technical skills, and mine responsibly must also be placed high on the agenda. This paper focuses on the major issues affecting cleaner production in the Zambian SSM sector including, environmental complications, pertinent mining environmental legislation, and the institutions involved. It concludes by suggesting possible interventions to minimize environmental impacts in the sector.

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## 1. Introduction

Small-scale mining (SSM) is defined in various ways in different countries. However, in Zambia, according to the Mines and Minerals Act of 1995, four types of mineral rights are issued for SSM. As Table 1 indicates, the types of minerals mined and size of an area determines the definition of SSM. A holder of a gemstone license or SSM license may be compelled to obtain a large-scale

mining license if the operations are determined to be large.

The SSM sector in Zambia has finally come of age, producing many different types of minerals, with operations conducted at different levels. Small mines are found in all parts of the country with some areas having a large concentration of mines. Most research on this sector has concentrated on issues not directly related to cleaner production. However, some preliminary investi-

Table 1  
Defining factors for SSM in Zambia

Type of mining right	Minerals	Area
Prospecting license	All minerals except gemstones	Less than or equal to 10 km <sup>2</sup>
Artisanal license	All minerals except gemstones	Not exceeding 5 ha
SSM license	All minerals except gemstones	Not exceeding 400 ha
Gemstone license	Gemstones	Not exceeding 400 ha

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gations on environmental impacts of SSM in the Southern African Development Countries (SADC) were undertaken by the SADC Mining Sector Coordination Unit (MCU) [1] and more recently and specifically to Zambia, by Masialeli [2]. Essentially, there has been no detailed research work on the environmental impacts of SSM in Zambia.

This paper discusses SSM in relation to cleaner production. It constitutes part of the efforts undertaken by the University of Zambia School of Mines to assess in detail the environmental impacts of SSM in Zambia. The justification for this work lies in the fact that the sector, which was originally small, has, in the last decade, experienced an unprecedented rapid growth whose collective environmental impacts can no longer be ignored.

## 2. Institutional framework

Cleaner production from mining and SSM operations in particular is an issue that has not been tackled seriously by the governmental institutions managing the environment in Zambia: the Ministry of Mines, and the Environmental Council of Zambia (ECZ).

The Ministry of Mines is responsible for the administration of the Mines and Minerals Act (1995) [3]. One of the Ministry's principal functions is to issue mineral rights (licenses) and ensure that the licensees adhere to the provisions of the Act. Equally important, the Ministry is also expected to carry out regular inspection of mines to ensure that appropriate mining methods are being used and adherence to health and safety standards. Usually, these visits are confined to large-scale mines because SSM operations are considered too 'small' and thus less significant. Furthermore, small-scale mines are scattered countrywide and a significant number of them operate illegally, making effective monitoring or provision of assistance difficult.

Poverty is a major social-economic problem now afflicting over 80% of the population [4,5]. The concurrence of rising levels of poverty and unemployment in the past decade due to poor economic policies and the opening up of the mining industry to the private sector after the introduction of economic reforms in 1991, created opportunities in SSM. Available evidence indicates that the SSM sector has become an important source of livelihood for many thousands of people.

It is therefore imperative that improvements be made to the monitoring and technical assistance programs conducted by the Ministry of Mines.

The ECZ, which falls under the Ministry of Environment and Natural resources, is responsible for the dispersion of the Environmental Protection and Pollution Control Act (1990) [6] and accompanying regulations. The functions of the Council and key elements of the Act and regulations are discussed in subsequent sections.

## 3. Pertinent mining environmental legislation in Zambia

In Zambia, the Ministry of Mines and Minerals, in conjunction with the ECZ, administers environmental legislation for the mining industry. The relevant legislation includes the Mines and Minerals Act and associated regulations. These are briefly examined in this section of the paper.

### 3.1. Mines and Minerals Act, No. 31 1995

Issues relating to environmental protection from mining activities are covered in Part IX of the Mines and Minerals Act for eliminating or minimizing impacts on air, water, soil, flora, fauna and the conservation of scenic attractions and other features of cultural, architectural, archaeological, historical interests.

In general, the Act may require that environmental impact studies and other relevant research be carried out before a mining right can be granted. Although this is a general statement applicable to all forms of mining, in practice, only LSM has been subjected to this rule. The Act regrettably exempts the SSM sector. This is a major flaw in the Act, which needs amendment if increasing environmental degradation from SSM is to be addressed.

### 3.2. Mines and Minerals (Environmental) Regulations (1997)

These are the most comprehensive environmental regulations pertinent to mining activity in Zambia. They provide information on project briefs, environmental impact assessment (EIA), mine closure, and also cover such aspects as mine dumps, air quality, emission standards, water standards, and the storage, handling and processing of hazardous substances.

### 3.3. Mining Regulations (1971)

Some important aspects of these Regulations are covered in Parts VI, VII and IX of the Mines and Minerals Act. Hazards arising from unsafe surface excavations such as large cracks, subsidence, and pits, and the protection of surface features like infrastructure or water rights are covered under Part VI. With regard to the protection of humans in working areas, this is detailed in Part VII. Part IX addresses the issue of ventilation and air pollution arising from dust, fumes and other toxic gases. It details the determination of concentration of these pollutants in ambient air, set air quality standards, and measures to minimize or prevent generation of air pollutants from drilling and other operations likely to release dust (e.g. transportation by dump trucks or crushing and grinding), toxic gases or fumes.

#### 4. Characteristics of the Zambian SSM sector

From a structural and technical perspective, SSM in Zambia can be divided into the following three categories [7]:

- artisanal mining;
- traditional SSM;
- advanced SSM.

The lowest level is the artisanal mining category, which encompasses the smallest and simplest operations. One of the principal characteristics of this sub-sector is the widespread use of simple tools and the absence of a formal business enterprise, although its activities include both informal, spontaneous operations without legal title to the property worked, and formal operations on registered claims. The majority of illegal miners are involved in gemstone mining, and is very mobile and will migrate quickly to a reported new find.

However, a new form of illegal artisanal mining has developed. This involves illegal quarrying of stone aggregates, flat stones, gravel and building sand used in home construction. Usually, the activity is conducted as a family business and is therefore located near homesteads. As expected, this activity has serious environmental consequences, which will be examined later.

The next category is the traditional SSM. The prospect is often registered and rarely licensed due to financial inability to pay the statutory annual mining license fees. Mining operations can be described as non-mechanized or semi-mechanized. Typically mining equipment is antiquated.

The third category is the advanced SSM. It is a legally constituted enterprise, highly mechanized, and features technical and managerial skills. The majority of mines included in this category are engaged in the extraction of gemstones.

#### 5. Environmental impacts of SSM operations

In this discussion of environmental impacts from SSM operations, it has been found convenient to discuss them under the type of mineral commodity category. Table 2 presents the distribution of mining licenses by type of mineral commodity. It is quite evident from the table that emerald mining is by far the most important.

##### 5.1. Gemstone mining

Attracted by the high unit value, the largest number of SSM operations fall under this broad mineral commodity. In terms of geographical distribution, gemstone mining takes place in all provinces. Currently, the most important mining areas featuring the highest concentrations of mines as shown in Table 2 are:

- Ndola Rural — for emerald;
- Kalomo — for amethyst;
- Lundazi — for aquamarine and tourmaline.

Ndola Rural Emerald Mining Area is the most significant mining district in Zambia with about 350 mining licenses covering an area exceeding 200 000 ha. Most deposits lying close to the surface have been exhausted. Pit depths now average 30–35 m, with the deepest having reached 55–60 m. Despite such depths and without exception, gemstone mining is conducted entirely by open pit mining methods.

In this commodity sub-sector, all classes of mines are found, ranging from those using manual methods (essentially artisanal) to highly mechanized operations (advanced SSM to LSM). As can be expected, the damage to the environment follows the intensity of mining with large mechanized operations causing the most damage (Fig. 1).

Gemstones have very high stripping ratios. That is,

Table 2  
Distribution of mining licenses by type of mineral commodity [8]

Number of licenses	Mineral type	Location and distribution
350	Emeralds	Ndola Rural (343), Mpika (1), Mwinilunga (2), Chinsali (1), Mkushi (2), Serenje (1)
72	Amethyst	Kalomo (55), Mumbwa (4), Kafue (1), Mpika (1), Namwala (2), Solwezi (6), Petauke (1), Gwembe (2)
10	Aquamarine	Lundazi (5), Namwala (3), Mumbwa (1), Solwezi (1)
22	Tourmaline	Lundazi (9), Nyimba (4), Mumbwa (2), Mazabuka (2), Serenje (2), Mkushi (3)
1	Clay	Kapiri-Mposhi
7	Garnet	Chama (3), Sesheke (1), Kapiri-Mposhi (1), Nyimba (2)
1	Diamond	Mwinilunga
3	Dimension stone	Mostly marble in Lusaka and some sodalite in Solwezi
93	Industrial minerals (talc, gypsum )	Dominated by minerals related to construction industry (lime, aggregates, cement, etc). Licenses distributed throughout the country



Fig. 1. Highly mechanized mining at Kagem Mines Ltd, Ndola rural.

the waste removed compared to very small quantities of gemstones extracted is very high when compared to other bulk or massive mineral commodities such as iron ore, copper, industrial or building materials. Therefore, large volumes of waste piles are left after mining since no back-filling or land restoration is undertaken. The situation is worsening with mining occurring at greater depths. In a bid to minimize stripping ratios, pits are left with steep walls that have resulted in frequent slope failures, commonly injuring personnel.

Only illegal miners practice underground mining, although in crude form. These comprise a vertical shaft, which acts as entry to tunnels below. Usually the shaft does not exceed 1.5 m in diameter and is meant during the day to be easily concealed. Ventilation, lighting and ground support is virtually non-existent. These structures pose a great danger to miners themselves and other unsuspecting people.

### 5.2. Building materials

Both the artisanal and advanced small-scale miners carry out quarrying for hard rock respectively. Hard rock quarrying by advanced small-scale miners involves drilling and blasting. Being bulk materials, the operations are located near the markets in built up areas. Blasting vibrations are known to have caused damage to structures. For example, the crushed stone quarry located about 1.2 km near the Lusaka town center has since been closed due to injunctions from blasting damage. In addition, dust is generated from blasting, crushing and movement of dump trucks.

For a mine like the United Quarries Ltd in Lusaka that is located among the farmers, blasting has damaged some farm structures and dust has stunted the growth of the surrounding vegetation and plants. In addition, noise from blasting and machinery is a source of concern for residents near the mine. With the growing demand for building materials due to the rising population, environmental impacts from quarrying — particularly illegal operations — will intensify if uncontrolled by the authorities.

As previously mentioned, artisanal miners are also



Fig. 2. Exposed rock ready for heat treatment, Chilenje South, Lusaka.

involved in quarrying. The desired rock is exposed using simple tools like picks and shovels. Once exposed, the rock is heat treated by burning with used auto tyres or fuel-wood, and is then quenched with water to induce cracking. The rest of the job is accomplished with hammers and chisels (Fig. 2).

A primary impact resulting from this form of mining is the creation of dangerous pits and trenches near homesteads, which also destroy the scenery and prime land for future development. Furthermore, the abandoned trenches and ditches collect water during the rainy season and become breeding grounds for mosquitoes and thus contribute to the malaria infestation. An example of this extensive damage is the land where the city airport is located in the capital Lusaka. This area is in excess of 80 hectares of prime land. Furthermore, the smoke from burning tyres is a source of concern for nearby residents (Fig. 3).

The finished product (i.e. crushed stone) is piled along roadsides for sale, which pose a serious hazard to motorists (Fig. 4).

The majority of artisanal mining licenses are obtained mainly for the mining of building sand and gravel, and in some cases, stone aggregates. However, most activities are carried out as unlicensed operations near emerging townships. The major pieces of equipment used are picks, shovels and wheelbarrows. As can be expected, the creation of trenches near homesteads poses both an environmental and health threat to human beings.



Fig. 3. Part of the Lusaka City Airport degraded land.

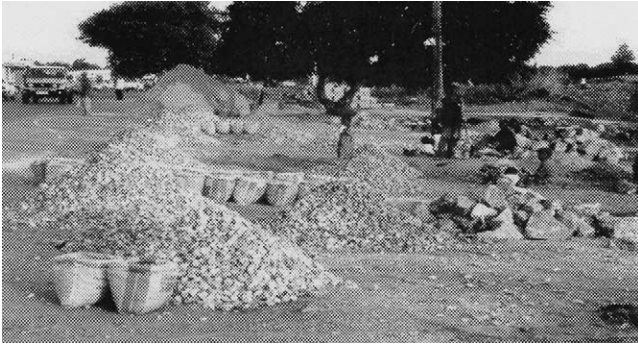


Fig. 4. Roadside Stone crushers in Lusaka near city airport.

Table 3 summarizes the environmental impacts of small-scale and artisanal mining in Zambia.

## 6. Interventions to eradicate or minimize impacts

Cleaner production at SSM operations should be a concern of all stakeholders. Government must have the political will to implement environmental provisions of the Act, which it enacted. In terms of the Minerals Act, a mining company is expected upon closure, to rehabilitate the disturbed land, to the satisfaction of the Minister of Mines. Under Part IX, Section 82 of the Act, government should by now have established the 'Environmental Protection Fund'. Basically, this is a fund into which miners must contribute for future environmental cleanup. This has not been effective 6 years after enactment because a mechanism for its operation has not been worked out.

A new South African approach for funding future rehabilitation/closure costs, may lend an invaluable experience. The driving motivation under this new funding option is that investments/savings can be made toward future rehabilitation costs of land or the environment, with the mining company receiving tax concessions as 'expenditure' against income provided that such savings are affected through a registered environmental trust [9].

Weak institutional capacity has been identified as one of the limiting factors inhibiting cleaner production in the sector. Cleaner production does not end with the submission of excellent EIA reports. To effectively monitor the activities of SSM operations including artisanal countrywide, mining authorities must be properly equipped in terms of adequate technical personnel and operational budgets for mine inspections. This will also help to curb undesirable illegal mining activities.

Furthermore, the current regulatory framework is highly inappropriate. The Act does not explicitly state that an applicant of a SSM or artisanal license should submit an EIA report as required in the case of LSM. It is recommended that without discrimination, all mining activities that have an impact on the environment should comply with this legislation.

Equally important, recognizing the lack of technical skills by small-scale and artisanal miners, a deliberate well-designed program in mining skills and environmental management, should be implemented. Previous efforts to impart technical knowledge to miners through programs such as road shows by the World Bank appear not to have succeeded. Miners have complained that the courses were inappropriate (very technical). It may be necessary to initially undertake a needs assessment study to establish appropriate training programs for small-scale miners.

One of the major bottlenecks in the successful implementation of promotional strategies in practice is the large numbers of miners involved, their mobility and their remote locations. Therefore, reaching the target group with assistance programs requires special organizational arrangements. In this approach, first the individual informal artisanal and small miners must be encouraged to form single proprietorship firms or other forms of partnerships. Secondly, the objective is to have these formalized firms or proprietorships encouraged to form associations representing their interests. Largely, this has been achieved although weak. Prominent ones are the Emerald and semi-precious stones Mining Association of Zambia, which represents gemstone miners; the Kal-

Table 3  
Environmental impacts from SSM and artisanal mining

Type of impact	Comment
Destruction of vegetation and scenery that existed prior to mining	Done mostly by advanced SSM
Generation of stockpiles of overburden rock, topsoil and sub-soil	Especially by highly mechanised gemstone mining
Creation of unsightly pits, trenches/ditches that may also pose danger to human and livestock	Open-pits left mostly by quarrying and gemstone mining while ditches/trenches are by artisanal miners
Production of dust, noise and damage to structures by blasting operations	Nuisance especially quarries near settlements
Disturbance to natural streams	Observed in Ndola rural emerald mining area at Kagem Mines Ltd and Kuber Minerals where natural streams have been diverted and blocked, respectively

omo Amethyst Miners Association; and the Women Miners Association. The latter promotes the interests of women miners in Zambia [10].

Associations can be instrumental in reducing illegal mining, organizing training and channeling other technical and financial assistance programs. The need to strengthen associations in Zambia has been recognized by European Union, which is developing a five-year support program for Zambian SSM (EU-Sysmin project). The EU-Sysmin project is scheduled to take off in 2002, with proposed funding of EU 30 million.

With regard to illegal roadside artisanal miners, an orderly relocation from present locations to suitable sites is a matter of urgency. Some initiatives targeted at women by the Association of Zambian Women in Mining to help them move to suitable sites where they can be provided with gender friendly tools and other forms of assistance is already underway. The Association has with great success held a number of training workshops to upgrade the skills and profile of women miners [10].

## 7. Conclusions

In the foregoing discussion, it was established that due to the increasing intensity of SSM operations, including artisanal mining, their impact on environment can no longer be ignored. Consequently, a review of the regulatory framework is required to make it mandatory that all classes of mining activities be subjected to the same rules.

With regard to the institutional framework support,

although the Ministry of Mines and the ECZ are mandated to do different things, the two institutions ought to work closely because of their expected close interaction with the sector.

In order to achieve cleaner production in the sector, improving the technical capacity of miners in mining skills and environmental management is important. Furthermore, the provision of adequate resources to monitoring institutions will be a key to the success of the process.

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