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Overcoming environmental problems in the gold panning sector through legislation and education: the Zimbabwean experience

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Abstract

Although small-scale mining is often associated with ruinous effects on the natural environment, Zimbabwe's experience in gold panning demonstrates that though that may be true, the sector, can, through appropriate measures, be encouraged or enticed to develop environmentally friendly methods for gold mining and recovery. A combination of legislation, education, and the promotion of appropriate technology has enhanced the environmental management within the ever-growing gold panning community in Zimbabwe. This paper evaluates the success of attempts to minimise the environmental impacts of gold panning in Zimbabwe through legislation, education and the promotion of appropriate technology.

Keywords: Small-scale mining; Environmental issues; Mercury; Legislation; Zimbabwe; Gold panning

1. Introduction

The history of small-scale mining in Zimbabwe dates back to the period well before colonisation in the late-1890s. As late as 1908, over 70% of the country's mines were still classified as 'small workings' [1]. As in other African countries, gold mining was the basis for the wealth and power of many empires and kingdoms in Zimbabwe and this fuelled growth of small-scale mining on the continent [2]. Despite the immense growth of small-scale mining over the years, especially since independence in 1980, the sector has essentially remained subsistence and a significant complimentary activity to communal and small-scale resettlement agriculture. As a whole, small-scale mining is an important sector in the mineral production system in Zimbabwe, as miners work on economic deposits often below the threshold levels of the larger operators. Furthermore, the sector is well suited for Zimbabwe as it utilises an abundant resource, labour, and employs a relatively small proportion of the scarce resource, capital. The mining systems used in the sector are labour-intensive and feature manual procedures using homemade tools such as hoes and panning dishes. There are 20,000 registered claims owned by small-scale operators of which less than 10% are active.

While today, the sector has expanded to include minerals such as chromite and tantalite, early small-scale mining was concentrated on the extraction of gold, copper, iron ore and tin. The definition of small-scale mining in Zimbabwe includes both legal and illegal operators, mechanised and semi-mechanised miners of varying sizes in terms of output, employment and capitalisation. Broadly, Zimbabwean mines are classified into four categories—mines operated by experienced individuals, those operated by unsophisticated groups, registered gold panners, and cooperative miners [3]. This classification, though covering a significant section of the sector, fails to take cognisance of the important role played by illegal operators, many of them gold panners. Tantalite panning has also emerged as a significant activity during the last two years, fuelled by improved tantalum prices during this period.

Although the debate over what constitutes a small-scale mine is beyond the scope of this paper, the general definitions provided in [4–6], among others, are sufficient for the present discussion. A classification of Zimbabwean mines using labour and tonnage based on 1988 data showed that 10% of the country's mines were

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'small' and employed between one and 50 workers [3]. Twenty per cent of the country's gold mines and 75% of chromite mines were classified as small, based on tonnage of ore. These categories of mines produced between 0 and 50 thousand tonnes of ore per year. Other commentators have estimated the small-scale gold sector to account for 20% of gold production in Zimbabwe [1]. Without a proper study on the actual size of the sector, estimations from analysts remain the source of credible information about the actual size of the sector.

The sector occupies an important niche in mineral production through the exploitation of small economic deposits and providing alternative sources of livelihood for impoverished masses mostly in rural areas. Small-scale mining increases economic power to rural communities, and in that way, contributes positively to social development. However, small-scale miners face a host of technical, financial and socio-economic problems that adversely affect productive capacity, capability and compliance with mining, safety and environmental regulations. The vicious cycle of poverty explains the problems faced by the sector [7]. More importantly, it is the sector's purported disregard of environmental management issues, which is seen by commentators as a threat to environmental harmony. Small-scale producers are often labelled as insensitive to ecological issues, wasteful of mineral resources through 'high grading', and, in some cases, also impinge on tenements of larger producers.

It is in the background of these observations that this paper outlines environmental effects from small-scale gold panning in Zimbabwe and evaluates how legislative, technical and educational approaches, and pilot projects have assisted in reducing the adverse effects of the sector on the environment. This paper is divided into two sections following this introduction. The first section briefly outlines the environmental problems associated with gold panning activities. In the second section, the paper describes and critiques the three broad approaches to minimising environmental damage and discusses possible approaches to improve the current system. Concluding remarks are then offered from the Zimbabwean experience.

2. The gold panning environment

An estimated 300,000 people are directly involved in gold panning activities along 5000 km of Zimbabwe's major rivers including Mazowe, Angwa, Insiza, Runde and Bubi. Fig. 1, adapted from a recent Southern African Development Community report, and produced as part of a Minerals, Mining and Sustainable Development (MMSD) study, shows the locations of panning sites along Zimbabwe's rivers, and provides an estimate of the panning density per area. This map shows that panning is indeed a widespread activity in Zimbabwe and can no longer be treated as an isolated activity.

Fig. 1. Map showing prospective panning regions in Zimbabwe.

An estimated additional 150,000 people are indirectly dependent on gold panning for subsistence in some areas [8]. Overall, artisanal mining is believed to sustain the livelihood of at least two million people in Zimbabwe, directly and indirectly through ancillary services and secondary economic activities [9]. The sector has grown in leaps and bounds during the last 20 years, fuelled by many factors including the economic decline that led to high unemployment as a result of retrenchments and drought during the 1980s. Prior to the droughts of the 1980s and that of the early 1990s, panning was primarily a dry-season activity. The upsurge in gold panning during the 1982, 1992 and 1994 agricultural seasons is directly attributable to drought [1]. During periods of drought, panning provides an alternative source of livelihood. However, in recent years, panning has evolved into a year-round activity and has become a primary source of livelihood in many rural communities. The complementary relationship between panning and sub-

sistence agriculture also accounts for the increased popularity of the activity among rural communities and its exponential growth from the 1990s [8]. Proceeds from gold sales lubricate agricultural activities for communal and resettlement farmers as they are able to procure some inputs. In many ways, small-scale mining has become an integral part of the rural economy and lubricates regional economic development through employment and income multipliers. Panning is no longer restricted to the banks and beds of rivers, but also takes place away from riverbanks, where miners work reef deposits to recover gold. Activities away from rivers are also described as panning since gravity separation is the final recovery method. Thus, environmental problems of panning in Greenstone Belt areas extend beyond the riverbanks.

Many studies have been undertaken during the last 15 years to highlight the principal environmental problems emanating from small-scale gold mining and panning in Zimbabwe [3,8,9]. From these studies, environmental problems from both the formal and informal sections of the sector are classified into two broad categories—physical effects (vegetation destruction, wastage of resources, and river siltation) and chemical effects (mainly pollution from mercury). The nature and extent of these adverse effects depends on many factors including the location of mineral extraction operations, the mining and processing methods used, and the nature of material mined and processed (whether ore or reef). The concentration of panners (miners) within an area also affects the extent of the adverse environmental effects.

Physical environmental effects are related to gold exploration and mining and social reproductive activities, while chemical pollution results from processing of ore. Figs. 2 and 3 show the typical physical effects of panning where a reef is the source of ore.

Remnants of gold panning include large amounts of sand, and numerous pits, both away from and along riverbeds. On average, panners move an estimated 8 million tonnes of material annually and in the process destroy significant portions of riverbanks on either side of rivers. The panned waste chokes river channels and may result in flooding during the rainy season. The destruction of vegetation is another common occurrence on mining sites, especially in reef mining, as miners follow rich gold belts. Increased population density in panning villages results in accelerated timber harvesting for construction purposes and for use as fuel.

The primary gold recovery method used by panners involves crushing of ore followed by amalgamation with mercury. A recent study conducted along one of Zimbabwe's major rivers, Mazowe, identified the widespread use of mercury to recover gold as a major environmental hazard [8]. Mercury is popular because of its ability to simplify the process of gold recovery, low investment and its high recovery rates. An estimated

Fig. 2. A trench abandoned after reef mining.

6 tonnes of mercury is used annually by illegal panners in Zimbabwe [7]. However, about 50% of the mercury (3 tonnes) is lost on amalgam plates, barrels, to the atmosphere, and during retorting, and is thus a direct threat to the environment.

It is instructive to briefly review the gold recovery process used by panners in order to highlight the environmental problems from use of mercury. Amalgamation recovers gold in its native or 'free' form from the gold–mercury amalgam. The process is suitable for already-liberated elementary gold and has grain size ranging between 20–50 μm and 2 mm.

The application of mercury for amalgamation is done at different stages of gold recovery depending on the treated ore type, equipment used, and the experience of miners [10]. Similar experiences in the use of mercury have been reported in many African countries, including Tanzania [11].

Along Zimbabwean rivers, mercury is mixed with finely crushed ore and water in small dishes, which are then shaken so as to allow both mercury and gold to settle to the bottom. After stirring the material momentarily, the wet ore at the top is washed off slowly into a second dish. This is repeated until all the fine material is separated from the mercury. Stirring is done by hand

Fig. 3. Remnants of reef mining near Angwa River, Zimbabwe.

and thus there is direct contact with mercury. Some mercury is lost into the tailings and eventually washed away into rivers.

The gold–mercury mixture is wrapped into a piece of strong cloth, which is then twisted by hand to separate the amalgam into liquid mercury and a viscous amalgam. A container to collect excess liquid mercury is needed at the bottom. The silver-grey mixture of mercury and gold produced is then heated on an open flame either indoors or outdoors to separate the gold from the mercury.

In either case, mercury vapour escapes into the atmosphere and is inhaled by miners; this defines the nature of chemical contamination from gold processing through amalgamation. Environmental and occupational effects of mercury emanate from handling, mercury vapour and disposal. A recent study of mercury poisoning in Insiza Mining District, an area rife with panning and the use of mercury for gold recovery, identified symptoms characteristic of occupational mercury poisoning. Sixty per cent of sampled miners had general body weakness, 55% had nausea symptoms, 50% had lost teeth, 45% had a history of respiratory distress and 40% had high mercury levels in their hair. Given the careless handling of mercury during amalgamation these results are not at all surprising.

Water-quality problems are common, as runoff from processing areas close to rivers results in serious consequences for aquatic fauna and flora. A vicious poverty cycle within the sector aggravates water pollution, deforestation, and destruction of agricultural land problems. Poverty may not be a direct cause of environmental degradation but instead operates as a constraining factor as miners do not have the resources to commit to environmental management or mitigation programmes.

3. Dealing with environmental contamination from panning in Zimbabwe

Although the adverse environmental effects from gold panning still persist along Zimbabwe's rivers, deliberate government policy has certainly helped curtail both the impact and extent. Legislative, technical and educational approaches have helped contain contamination from the sector. NGOs and the private sector have also been an integral part of environmental stewardship programmes in the sector. We will deal with each approach in turn.

3.1. Legislation

The use of command and control instruments in environmental management is easier for government to administer compared with other approaches such as the use of economic incentives [12]. Although at times limited by a poor administrative base, this approach provides a basis for enforcement through the prosecution of violators of regulations. The promulgation of the *Mining (Alluvial Gold) (Public Streams) Regulations* in 1991 represented a bold step by the Zimbabwean Government to recognise and regulate a sector that had become too significant to ignore in terms of size, socio-economic and environmental effects, and general regional importance. Promulgation of these regulations removed an important structural constraint to the growth of the sector by according it legal status [13]. These regulations have incorporated the sector into national development policies, and, in the process, created conditions for sustainable resource utilisation at the local level. Applying the three facets to sustainability[1]—ecological

[1] The term is used within the broad context of living within self-perpetuating limits of one's environment and satisfying human needs

(environmental), economic and social—these regulations have gone a long way towards setting the conditions for achieving sustainable resource utilisation. Legalising panning and setting environmental standards managed at a local level improves environmental management in the sector, and is a significant stride towards ecological sustainability as investment in other forms of replacement capital becomes possible. Yet, as argued elsewhere in this paper, enforcement of the regulations is the ultimate determinant of their effectiveness, the attainment of minimum acceptable environmental rehabilitation conditions, and the promotion of positive regional benefits. As legal entities, panners are empowered economically, as they can seek the best price for their output. This enables panners to accumulate surplus income for other uses, and thus raises the standard of living. Socially, better prices for gold ensure that panners can participate fully in the rest of the economy; this enhances the overall multiplier effects on the regional economy [14]. Other ancillary services could develop once the region's income levels have increased, as disposable income will be higher within panning areas. Once this happens, one of the objectives of the regulations, which is to promote regional development, would have been realised.

Two important attributes of these regulations are critical in controlling or minimising environmental damage from panning. First, the sector empowers local authorities (Rural District Councils, RDCs) to issue panning permits to 'approved' local persons, cooperatives and partnerships. By empowering local authorities, the regulations have the potential to easily ensure compliance with regulations as officials scrutinise and approve deserving applicants using clearly defined criteria, especially previous records. Second, the regulations outline and specify where panning is legally permitted, and prohibit panners from mining river banks, pitting in riverbeds to depths of more than one and a half metres, and limit undercutting of river banks to reduce the prospect of flooding during the rains. The regulations encourage miners to restore areas to their original setting through filling of pits on riverbeds.

Yet, RDCs have shown 'limited' enthusiasm to adopt this approach. The reluctance to enforce regulations on the part of RDCs may partly be due to the lack of knowledge about long-term benefits of monitoring panning activities. Implementation is thus the major problem. For example, there are presently about 30 RDCs in which intense gold panning occurs for which there should be special grants, however only nine have been issued. Many point to limited implementation capacity as the major constraint. Further, the restrictions on panning depth along rivers are seen as impossible to police even where permits have been issued.

The introduction of the *Environmental Management Bill* in 1998 will certainly close some of the loopholes in the existing regulations. Presently, there are over 18 pieces of legislation governing the management of natural resources administered by seven different ministries. This makes management of compliance almost impossible. The Bill, currently under review, proposes to streamline all environmental management, monitoring and compliance issues, and to tighten regulations regarding Environmental Impact Assessments (EIAs) for all old and new projects. These developments, coupled with strengthening the capacity of local authorities to monitor compliance with panning regulations, would certainly improve environmental performance in the sector.

Although legislation has certainly improved the situation in panning areas where local authorities have policed operations, the weak implementation capacity of local authorities compromises the effectiveness of these regulations. For instance, panning continues to occur in restricted areas, and panners continue to leave a trail of unfilled trenches; all this is due to a lack of adequate monitoring capacity by local authorities. All the same, the legislation has enabled government to police panners and prosecute illegal operators.

The other positive effects from panning regulations relate to increased marketing of gold from panning through official channels. Although some gold is still lost to the unofficial market, there is anecdotal evidence to suggest that legalising panning has certainly reduced parallel market gold losses and thus enhanced national benefits. Moreover, as legally registered operators, panners now spend more time working on issues related to operational, environmental, economic and marketing efficiency, rather than trying to evade the police. Yet, the price difference between the parallel market and the official market continues to fuel illegal trading.

3.2. Appropriate gold processing technology

One of the major constraints faced by panners relates to appropriate, economic and environmentally friendly technology. As noted earlier, the processing methods used in the sector include panning, washing with sluice boxes and amalgamation. National efforts have been focussed on the need for mass training on proper, safer and environmentally friendly use of mercury, the principal processing chemical. Major concerns relate to amalgamation, which involves direct contact with mercury and inhalation of fumes.

Technological constraints impinge on operational and environmental efficiency and safety of the sector. Improvements in panning technology especially the design of panning dishes, impacts on the environmental effects of the sector by enhancing gold recovery and

and improving quality of life. In other words, sustainability deals with the long-run preservation of an economy, which is essentially dependent on the use of natural resources and the environment. Intergenerational fairness is a key component.

minimising the rate at which panning progress as output per panned area increases. Wooden dishes are the most commonly used pieces of equipment for panning along Zimbabwe's rivers. Since the dishes are made from some of the largest trees in the areas, and given the open access to timber in most rural areas, vegetation destruction to harvest timber for making panning dishes is a real threat to the environment. Given the extent of panning, an industry to produce dishes has emerged in Zimbabwe. To improve gold recovery and thus reduce wastage of resources and minimise the extent of panning, some gold panners along Zimbabwean rivers and those working on reef deposits have adopted striated panning dishes. The striation of dishes improves the recovery of gold in that gold is trapped in the furrows of the dishes.

Metallic dishes made from scrap metal have replaced wooden dishes among some communities as panners seek to enhance efficiency and reduce the need for wooden dishes. Although much smoother compared with wooden dishes, metal panning dishes are designed with a depressed base, which traps gold during panning. The base can be replaced when it wears off. Fig. 4 shows an example of a metallic panning dish used on Zimbabwe's rivers.

Panners have also improvised portable 'James Tables' for use on panning sites along the rivers. The 'James Tables' are made from scrap metal and old rugs/blankets (Fig. 5). These improve recovery of free gold and can be moved from one site to another and thus are appropriate for the nomadic nature of panning.

Among the 'new' technologies being promoted among panners are inexpensive closed retorts that can be used to distil mercury without releasing it into the atmosphere. These also allow miners to recycle mercury for future use. Although use of these retorts is still limited by cost and availability, the benefits of the technology are immense as has been shown in other countries and has been demonstrated in pilot projects locally. At Z$6000, retorts are an expensive initial outlay for the subsistence miners. The fear of losing gold in the retorts is another contributory factor to limited use of retorts in Zimbabwe.

Generally, since the enactment of panning regulations, small-scale mining equipment manufacturers and individuals have attempted to serve the market by producing appropriate gravity separation equipment. An example is the 'Bambazonke' machine developed in the early 1990s for use by panners. However, the machine failed to increase throughput levels and was abandoned, as panners saw no benefit in using the equipment. Another recent innovation has been a wind-sifting gravity gold separator that does not require water for recovery. The new product, developed by an individual, is still at the trial stage.

Organisations such as the Intermediate Technology Development Group (ITDG) and the National Miners Association of Zimbabwe (NAMZ) have contributed immensely in advertising appropriate technology and educating miners on environmental risks and appropriate mitigating measures.

The legalisation of gold panning has resulted in many flow-on benefits in terms of cooperation between the panners and large mining companies. Some large mining houses have also realised the need for the integration of panners into their programmes so as to minimise environmental damage. Education programmes funded and conducted by some large producers to conscientise panners on better gold recovery methods and good environmental management are also in progress at some mines. For example, at Dalny Mine, one of Zimbabwe's

Fig. 4. Appropriate processing technology—metallic gold panning dish.

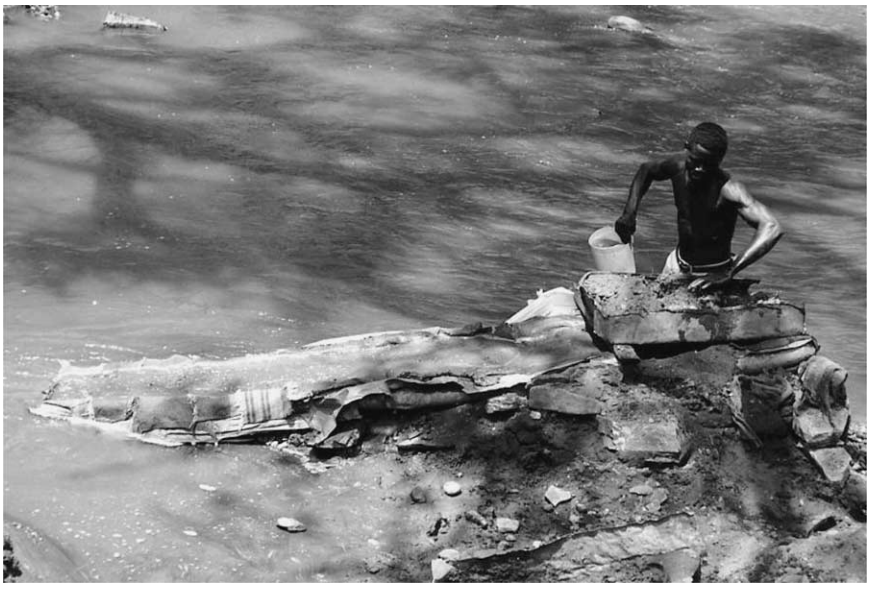

Fig. 5. A portable James Table in use on Angwa River, Zimbabwe.

largest gold mines, panners have signed an agreement with mine management allowing them to access water for panning from the mine's pipeline, thus improving productivity and ensuring that panning occurs at specific sites. The scheme demonstrates that panners and miners can co-exist since the panners work on claims owned by Dalny. At another mine, Redwing, panners have been given permission to rework old dumps with the mine processing their concentrates to recover gold. This eliminates the need for mercury as the mine takes responsibility for the marketing of the recovered gold and then deducts processing charges and pays the remainder to panners. At both mines, management has invested in ongoing programmes for educating the panners on the dangers of using mercury.

Panners appreciate the adverse impacts of gravel washing on the water table and on drinking water, and have devised new approaches to panning through the construction of special ponds away from rivers. The ponds are manually filled with water, and gold is processed further away from rivers, which helps to minimize direct river siltation. From these ponds, free gold is recovered as in a normal river-panning scenario. An example of a typical gold panning pond is shown in Fig. 6. Another advantage of the water ponds is their safety during the rainy season.

3.3. Pilot environmental rehabilitation projects

A GTZ-funded rehabilitation pilot project supervised by the Department of Mining Engineering at the University of Zimbabwe has demonstrated the benefits of rehabilitating mined areas in small-scale gold mining regions. The work undertaken on two sites in Zimbabwe, along the Manyuchi and Insiza rivers, has demonstrated that riverbank mining can be undertaken economically in an environmentally responsible and successful way. Although the economics of one of the projects, the Manyuchi scheme, were hampered by water shortage and the lack of a flood plain to provide good segregation of gold into the rubble horizon, the Insiza scheme was economic and a fairly high productivity of 4 tonnes per man-shift was achieved. The concern is the high economic cut-off grade of 0.25 g/tonne, which is wasteful as panners normally work on material lower grades. Thus, the tailings left by the panners can be revisited by other miners and this results in further environmental damage.

The strategy employed at these schemes involves using mined-out material from one section of the bank to backfill another section. The process involves first removing gold-free topsoil and subsoil and then treating the ~10 mm fraction of the rubble horizon through sluice boxes. Large rocks are left behind, or used to create a dyke between the excavation and the river. The plus 10 mm material is returned to the base of the old pit, followed by surface tailings, and then the subsoil and topsoil are replaced. Overall, the scheme showed that revegetation could naturally occur with the advent of the rains.

The damaged riverbank was rebuilt successfully and the project showed that such 'rehabilitation mining' might be used to repair riverbank damage at a cost covered by the value of the gold produced by panners.

Thus, the sluice boxes technology enables the miners to recover gold and rehabilitate effectively. The experience from the pilot schemes described in this paper could be extended to full-scale mining and rehabilitation operations to facilitate recovery of resources located away from the river banks to be exploited in an environmentally friendly manner. The huge labour input requirement results in immense regional economic multiplier effects,

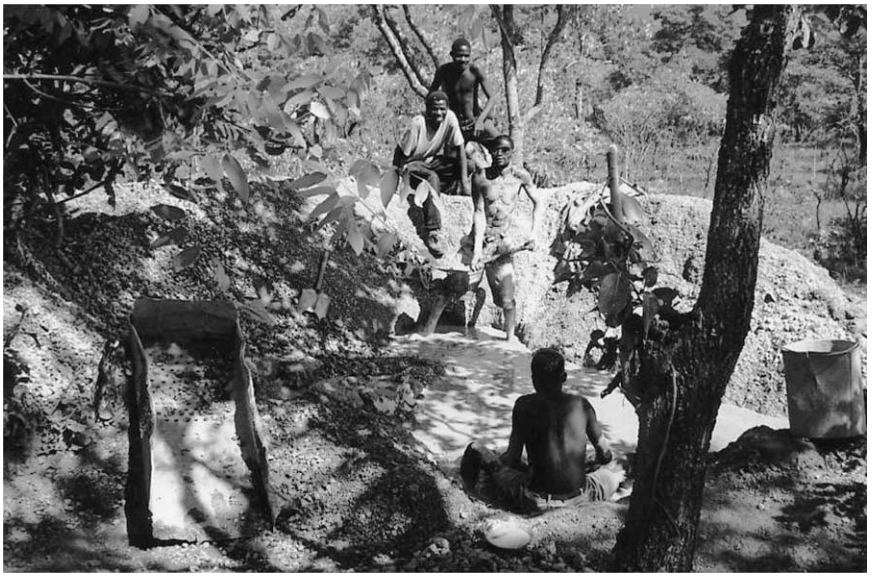

Fig. 6. Gold panning ponds to recover gold from reef mining.

which augment income flows from gold sales. Despite the high capital investment of about US$10,000–15,000 per panning site, the economies of scale and regional benefits far outweigh the initial investment.

The success of the rehabilitation pilot project showed that legally registered panners, when supplied (provided) with the necessary capital, could rehabilitate mined areas and recover gold economically. The capital input is critical and, thus, support for the procurement of the needed equipment is the crux of the success of the programme. The challenge is for government, NGOs and the private sector to support the acquisition of equipment so that the benefits of this approach are realised nationally.

Development of small-scale mining in Zimbabwe has also benefited from the efforts of NGOs and the private sector. Although not directly related to panning, these activities have indirectly served the needs of the panning community.

3.4. The role of NGOs and the private sector

The ITDG has been at the forefront in the provision of a range of financial and technical support services to the small-scale mining sector in Zimbabwe. A custom milling facility, the Shamva Mining Centre, was established through ITDG initiatives for artisanal miners to use. Gold panners working on reef deposits are able to access the centre for milling of ore and recovery of gold. Other NGOs that have assisted small-scale miners in Zimbabwe include COMIC Relief, which provided capacity building training for the NMAZ, GTZ (Germany, Insiza project), TDH, SNV of the Netherlands (assisted in establishing Shamva Training School for women miners) and AFSM from Austria, which provided financial and technical assistance initially to chromite miners and later to gold producers. Support for aspects related to gold panners still remains scanty due to the way in which the formal mining community views panning. Despite legalisation of the sector in 1991, panning has not been fully incorporated into recognised formal activities, which deserve support from structures within the country.

The National Miners Association of Zimbabwe could potentially be playing an important role in improving environmental stewardship in the sector if it could expand its membership. Currently, an estimated 8000 small-scale miners are members of the association in a sector with over 800,000 miners. Thus, whatever influence the association could have on the sector is limited mostly to 1% of its potential constituents. Collaboration between NMAZ and the Explorers and Developers Association and the Zimbabwean Women Miners Association would improve the sector's environmental rehabilitation approach as sharing of information becomes easier.

Government schemes such as loans and plant hire facilities are theoretically available to the sector. Training programmes demonstrating the benefits of prudent environmental management mounted by the government, NGOs and private companies have demonstrated significant positive effects, with the potential to improve the sector's overall performance. However, incentives could be used to entice miners to rehabilitate panned areas.

Despite the existence of elaborate systems to improve environmental stewardship within the sector, challenges still remain. We will briefly examine other complimentary and supplementary approaches, which could be used to improve the current system.

4. Recommendations for improvement

4.1. Empowerment of local authorities

As argued elsewhere in this paper, panners are generally aware of the existence of regulations and their requirements but deliberately violate them. The major weakness in the regulatory system relates to monitoring of activities through enforcement of the regulations. The empowerment of local authorities to enable them to monitor panning activities and prosecute violators of regulations is required. Questions that have to be answered in this approach relate to financial and human resources to undertake the task as prescribed in the regulations. To overcome financial constraints, a system of levies collected by local authorities could be introduced and enforced. Local authorities have a lot to gain from collecting levies as these form a reserve fund which they can tap on for other uses. For example, human resource constraints could then be overcome through use of the financial resources to train 'environmental monitors' who visit panning sites regularly.

The effectiveness of a locally based monitoring system could be enhanced by the creation of a national or regional database of all permit holders. Information on the inter-linked database could be shared through a national office, like the Geological Survey. Such a centralised system allows for traceability and effective blacklisting of those who do not comply with regulations.

4.2. Reduction in poverty

Studies on small-scale mining have identified poverty as a major cause of environmental neglect in the sector [3]. Problems in the sector demonstrate the link between poverty and natural resource degradation. Poverty is a constraining factor on the ability to invest in mitigating strategies. Poor miners with limited access to capital extract short-term rents through intensive panning and hence degradation continues as long as there is open access to resources. Thus, breaking the poverty–resource degradation linkage will enhance compliance with existing regulations and may even enable the sector to move from a command and control approach to one where economic instruments are used.

Poverty emanates from many factors but mainly from ignorance of better prices offered elsewhere for output. The poverty sustains environmental damage in the sector as it constrains the ability of the poor miners to invest in mitigating strategies. Because of lack of financial resources, miners have shorter planning horizons and thus do not regard environmental issues as important, as theirs is a subsistence existence.

The ability of middlemen to prosper within mining communities has to be understood within the context of the nature of panning. Panning is mostly a poverty-driven activity and thus quick returns, no matter how low, are preferred to higher returns that take longer to materialise. Easily accessible selling points offering cash on the spot are much suited to the panning communities. Thus, to enhance adherence to regulations, marketing systems that ensure the best prices for producers are needed. The government has to invest in mobile gold buying units that can visit producing areas regularly. With regulations in place, the location of formal panners is known and thus a calendar of buying days can be established. In fact, at the moment the middlemen have established informal gold buying days within the panning areas. What the idea of buying days does is that income flows become more consistent and producers are able to develop long-term plans including rehabilitation programmes.

Middlemen who offer quick cash for panners perpetuate exploitation as they take advantage of lack of knowledge among miners. Zimbabwe's centralised gold marketing system controlled by the Reserve Bank through Fidelity Printers is unsuitable for 'subsistence panners', due, for example, to bureaucratic delays in getting payment for gold sold to the official buyers. Also, official prices are often lower than those offered on the parallel market. The lack of information about parallel market gold prices enables middlemen to buy gold from panners at lower prices and to sell to a second tier of buyers at a profit. Thus, the convenience of having buyers at their 'doorstep' comes at a cost of low prices for producers when they could potential obtain much better returns.

Although higher prices may result in better environmental management, these prices will invariably attract more panners onto the country's rivers and thus environmental problems increase. However, low prices put more pressure on panners to increase volumes of output which results in environmental issues being relegated to very low levels in the pecking order. A rich society appreciates the value of environmental resources compared with a poor one and they are more likely to respect regulations and invest in mitigating measures.

4.3. Access to financial resources and information

Government and the private sector should facilitate development of programmes enabling officially registered panners to access development finance. In addition to reducing poverty, loans enable miners to invest in the best possible technology. Also, a commercially healthy sector is able to negotiate much more favourably with buyers of gold. Improved access to information on prices and environmental rehabilitation approaches will enhance compliance with the sector. Encouraging financial institutions to support gold panners by providing resources to purchase equipment and payment could be through guarantees to supply output to the banks at

agreed prices, a variant of gold loans. The government has a role to play in raising awareness of the banks of the benefits of gold panning to the local economy, as this creates financial confidence and enables banks to support the sector.

The government, through a close monitoring strategy, should avoid subsidising environmental damage by providing finance to improve productivity. A monitoring regime which ensures financial resources are not misused and miners rehabilitate panning sites would be needed.

4.4. Education

Although studies have shown that gold panners are generally knowledgeable about existing regulations, continuous education programmes are needed on new technology and approaches to ensure the appreciation of the long-term benefits of good environmental stewardship. Regional training centres and demonstration courses sponsored by the government and the private sector would also enhance compliance.

In conclusion, it is important to emphasise that it is a combination of education, improved access to finance, reduction in poverty and the enhanced empowerment of local authorities which will determine the positive impact of the panning regulations. A national database of panners would greatly assist in monitoring activities on a national scale.

5. Concluding remarks

The environmental problems of the panning sector in Zimbabwe can be overcome or at least compliance improved through empowerment of local authorities that enforce regulations, reduction in poverty among miners through improved gold marketing methods and through continuous education programmes. Although the promulgation of panning regulations in 1991 was a significant step in the process of trying to reduce contamination from the sector, overcoming the current legislative constraints related mainly to the inability of RDCs to enforce these regulations can help improve the environmental management in the gold panning sector. Though not a panacea, the regulations are a proactive approach to dealing with a sector, which, for many years, was regarded as illegal. The positive impacts of pilot rehabilitation projects need to be publicised and carried to a national platform through the provision of the necessary supporting infrastructure. As argued in this paper, the government has a role to play in promoting a legal economic activity to finance houses by providing collateral for registered panners. Efforts by formal large scale mines to integrate panners into their own activities through material and professional assistance is an illustration that the industry has come of age and now considers panners as colleagues and not as a nuisance. It is my belief that if more mines did this, panners would recognise the need for ensuring good environmental measures are in place.

The Zimbabwean experience since the promulgation of regulations in 1991 demonstrates that regulations are not an event but a process of continuous challenges. A strict monitoring regime is needed for the regulations to have a meaningful impact. Policy makers should realise that as long as there is poverty in rural areas, regulations will not achieve much. In fact policies designed to alleviate poverty will enhance effectiveness of regulations. Furthermore, the use of economic instruments to improve compliance becomes technically feasible in an affluent society compared with one where there is poverty. For instance, panners could then auction panning sites, capture economic rent and generate revenues for rehabilitation.

Since panning frontiers continue to expand due to the positive demonstration effects from fore-runners, challenges to the current legislation will continue to emerge and thus a dynamic legal framework is needed to deal with problems in the sector. For example, the decentralisation of registration functions to RDCs should be accompanied by the authority to recruit the necessary monitoring staff at a local level.

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