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Attractive nuisances and wicked solutions

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Abstract

Mine closure plans generally include the objective of creating sustainable conditions that provide for public health and safety and protect the environment. The mining industry has developed and implemented approaches and technologies to achieve this objective in a variety of contexts. However, some activities will inevitably result in post-mining conditions that become attractive nuisances — conditions that appeal to trespassers who may not understand or appreciate the safety risks to themselves and others.

During operations, controls can be implemented and monitored to reduce the risk of exposure to attractive nuisances, but after closure this becomes more difficult. Proactive stakeholder engagement can identify likely post-mining land uses and sustainable livelihoods. However, what happens when these are in conflict with mine closure goals? It is critical to understand the drivers for and context of future land use and livelihood development to mitigate and/or influence the potential impacts of both.

In addition, throughout the mine lifecycle (exploration through closure), the operation should support sustainable and responsible development at a community level. Yet, in some instances the social context can severely limit the options for and effectiveness of standard technical closure approaches. In extreme cases, the social context of a project may not lend itself to any solution that achieves the technical and socio-economic objectives of closure because of uncontrollable future use of the site. These challenges, along with the consequences of economic disturbance, and population displacement, inequality, and poverty — issues often referred to as a 'wicked problem' — are often inadequately addressed.

Within the context of closure, this paper compares the complex and multi-dimensional aspects of poverty with the constraints and opportunities posed by mining as a dominant single sector economy. Examples of integrated closure planning, stakeholder engagement, and land use and livelihood development are presented to illustrate successful approaches to avoiding or mitigating attractive nuisances after closure. These successes are contrasted with situations where future land use and livelihood development are less controllable, potentially limiting the effectiveness of industry standard closure practices. In doing so, the authors propose an overarching wicked solution for social closure through livelihood restoration and socially and ecologically sustainable community development practices.

1 Introduction

The notion of a positive social legacy is gaining ground in a way similar to a social licence to operate. Many social problems and risks associated with closure of mining operations can be linked to the poverty that has challenged the social licence to operate across the life of mines. This suggests that addressing the challenges of the attractive nuisances cannot be effective if dealt with only in the immediate pre-closure period. Furthermore, solutions must consider the time frame for closure, which is forever. If surrounding poverty is not understood and addressed from the outset of a mining operation, problems accumulate and become increasingly complex and 'wicked'.

The notion of a 'wicked problem' was first coined in 1973 by Rittel and Webber. They used the term wicked to denote complex and multi-dimensional issues. Relating this to mine closure, while successful environmental rehabilitation of sites has been well documented, effective social closure still poses a wicked and complex problem. It becomes even more wicked when the ore being extracted is of interest to artisanal and small-scale miners. Despite carrying out extensive rehabilitation to sites and redundant assets, if a

perception of retrievable mineral resource exists and local livelihoods depend on its extraction, rehabilitated sites become attractive nuisances. While attractive nuisance doctrine applies to the law of torts, in the United States, it is also relevant in this scenario: mining companies carry the ultimate responsibility of ensuring no harm occurs as a result of mine closure. Addressing issues associated with attractive nuisances is not a simple or linear process and requires a solution that is as wicked as the nuisance is attractive.

2 Attractive nuisances

An attractive nuisance is a doctrine (in United States tort law) under which a landowner may be liable for injuries to children who trespass on land if the injury results from a hazardous object or condition on the land that is likely to attract children who are unable to appreciate the risk posed by the object or condition (Cornell University Law School 2015). This doctrine has been applied to the development of commercial and residential properties where conditions have been created that pose a risk to a trespasser who would not understand the risk and could be harmed. For example, the installation of a swimming pool without adequate fencing could attract children who would not be fully aware of the risks apparent to most adults.

Mining industry professionals understand that mine sites are inherently dangerous places, and some risks often remain regardless of the effort made during closure. However, the general public would be unaware of the magnitude of some risks, such as those associated with highwalls or steep slopes. Others, such as the water quality of a pit lake (Figure 1) or the chemical dangers of mine wastes hidden below an engineered cover, would also not be obvious to the general public. If these conditions present an inviting opportunity, they could be considered an attractive nuisance that invites trespass and puts the trespasser at risk.

Figure 1 Artisanal and small-scale miners in West Africa

For example, a pit lake in an arid area would appear to be a viable source of water for people and animals. However, if the chemistry of that water was dangerous to those users, they could unknowingly expose themselves to a health hazard. Education, signage, backfilling, and/or in-pit treatment could mitigate the risk, but during drought conditions the attraction may overcome concern about the risk and result in a public health issue.

In an area where flat, arable land is scarce, a large tailings facility covered with topsoil could appear to be an ideal place to plant crops or graze animals. Yet the chemistry of the tailings beneath the surface could pose a health risk to consumers of the crops. Furthermore, disturbance of the surface could reduce the

effectiveness of the cover and result in environmental degradation. Creating a cover design that did not leave a flat surface suitable for agriculture would limit the attraction of the site.

In some instances, these unforeseen and undesirable post-mining land uses can be predicted based on current land uses and the social context of the area before and during operations, but in many instances they may not be desirable or consistent with the planned closure activities. In situations where illegal activities are occurring during operations, these can be expected to continue after closure. Likewise, some pre-existing or surrounding land uses may be anticipated on the mine site after closure. This is highly likely to occur where there is active small-scale agriculture or an artisanal or small-scale mining (ASM) community near the mine (Parshley et al. 2014). If conditions and risks are identified early, the approach to closure can be altered to eliminate the attraction or minimise the risk. Education of the local community can also limit the risk, but the capacity to understand and manage the risks must exist at the time of closure (IIED 2003a) and beyond.

3 Mine Closure, a summary of the bad and good

The modern mining industry, regulators, and the public began thinking seriously about mine closure due to a number of legacies left from centuries of mining. Legacies like the Berkeley Pit in Montana, the Giant Mine in Northern Canada, the Wismut uranium mine in former East Germany, the town of Leadville, Colorado, and abandoned sites around the world (Figure 2) are mining's 'dirty pictures'. Disasters such as Aberfan, Wales, United Kingdom, where in 1966 a waste rock dump slid down a mountainside into this coal mining village killing 144 people of whom more than 100 were school children have also contributed to this legacy dialogue. In North America, the passage of the United States Surface Mining Control and Regulation Act (SMCRA) in 1977 (Hockley & Hockley 2015) was an acknowledgement of the historical bad practices within the mining industry. Due to of these types of incidents and recognition of the risks and liabilities associated with mine closure planning and management, closure has become an integral part of the industry's culture over the past two to three decades. Fundamentally, mine closure is about acting in a manner that avoids creating more of these bad examples and hopefully creates a new legacy of which the industry can be proud.

Figure 2 Abandoned copper plant, Central Africa

Unfortunately, the mining industry has not avoided creating more dirty pictures in the last 25 years, which has cost the industry. The legacy of the Berkeley Pit has become an example of what happens when post-closure conditions are not considered. It does not matter that the mine was developed with out-of-date technology in a time when environmental regulations did not exist. The result is all that is considered. This one dirty picture is a significant part of the reason that non-governmental organisations (NGOs) and the public have been effective at stalling the development of other mines even in countries that could use the benefits of economic development that come with responsible mining. More recently, the impact on the environment and the industry was seen from the Mount Polley tailings failure in 2014. The outcome of that failure will reach far beyond British Columbia and Canada (Province of British Columbia 2015) including improvements for safety of all tailings facilities in all phases of the mining lifecycle.

Good international industry practice and some national regulations now stipulate that environmental and social closure be considered from the outset of project planning. Indeed, there have been some remarkable successes. The successful closure and redevelopment of large areas of the former East German coal mining regions is particularly noteworthy (Figure 3).

Figure 3 Senftenberger See, Germany

Technological advances and regulatory changes in mine closure can also be linked to trends in commodity prices. For example, the economics of the turn of the last century and the low price of gold (Figure 4) resulted in numerous mine closures. Numerous closures occurred as a result of operational economics. Some of these mines were closed in an orderly manner in accordance with an approved closure plan. Unfortunately, other sites were simply abandoned by a bankrupt company resulting in scenarios similar to the abandoned copper mine illustrated in Figure 2. The metals “super cycle” of the 2000s saw a period with fewer closures and some abandoned and closed sites being reopened.

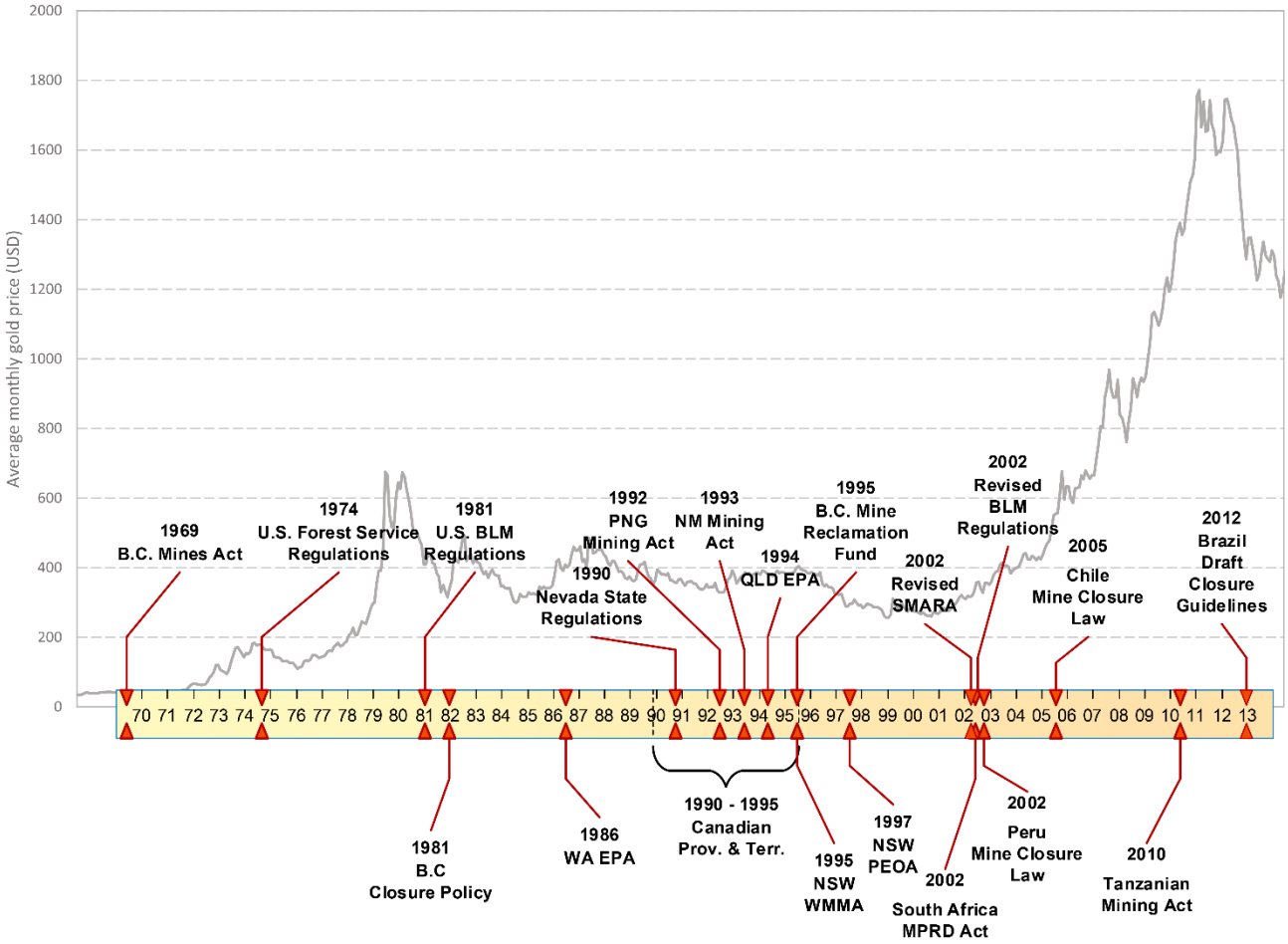

Figure 4 Gold price and mine closure regulations

As the sector returns to a time of low commodity prices, unprecedented numbers of mining projects are being stalled, reducing their footprints, being placed in care and maintenance status, or closing. However, this time around corporate philosophies have changed, regulations have been modified, and new laws have been enacted. While such legislation has been regarded as a painful burden by some, the effect and impact of previous bad practice became a catalyst for the industry's current approach to mine closure.

Technologically there have been numerous significant advances in terms of bio-physical mine closure. Methods of characterising the chemical behaviour of mine waste and predicting long-term geochemical behaviour is one example. The development of the Mine Environment Neutral Drainage (MEND) program in Canada and creation of the Global Acid Rock Drainage (GARD) Guide (INAP 2009) are also excellent examples. The industry has taken great strides in understanding the design and performance of closure covers and numerous related papers and guidelines (MEND 2004) have been published since 1990. More recently, landform design has evolved from early work done in the southeastern coalfields in the United States to the creation of complex slopes to limit erosion, manage stormwater and mitigate visual impacts by creating final rehabilitation surfaces that mimic natural landforms (Tiemann & Wealleans 2015). However, innovative approaches to the social legacy have not been as forthcoming, resulting in beautifully engineered, technologically sophisticated mine site reclamation that becomes an attractive nuisance requiring complex and wicked solutions.

4 Mine closure guidance and social considerations

Since 1990 numerous publications have presented guidelines for the role of mine closure in responsible mining. Guidelines like the Australian government's mine closure handbook (Australian Government 2015),

the International Council on Mining and Metals (ICMM) toolkit for mine closure (ICMM 2008), the Mining Association of Canada's Toward Sustainable Mining protocols and frameworks, and the Brazilian Mining Association's (IBRAM) Guide for Mine Closure Planning (Sánchez et al. 2014) have all been published to provide guidance on general planning approaches and specific biophysical aspects of mine closure.

Since the National Environmental Policy Act (NEPA) was enacted in 1969, the United States and, more recently, the International Finance Corporation (IFC) of the World Bank have required an assessment of lifecycle socio-economic and cultural impacts and stakeholder engagement as part of the project approval process for all development projects. Such international industry practice is good and has resulted in many mining companies aligning their community relations and community development efforts in response to the social impact assessments identified during their permitting processes. While positive community relations are considered a foundation of community development projects and constructive partnerships with stakeholders, such relations tend to create and nurture a culture of dependency that in turn becomes an increasing burden on the mine operation, especially as it seeks to reduce its capital expenditure and/or move towards closure.

Mining in rural areas, from exploration through to closure, can impact positively and/or negatively on local and regional poverty. At the same time, the range of corporate and management obligations to engage in community development initiatives tends to be translated into corporate social responsibility and philanthropy rather than a core business activity. Securing a social licence to operate is increasingly seen as risk mitigation (Callan 2012) through reducing opposition from local communities that could potentially disrupt operations and result in higher costs. However, as the sector is perpetually affected by global commodity prices that constrain such initiatives, community expectations are not.

Many of the social issues and risks posed to mining operations are a direct result of poverty. Understanding the context and complexities in which an impoverished community exists should be part of the required impact assessment process undertaken during project development. This presents an opportunity to understand and analyse the local situation and economic drivers, so potential mitigation strategies can be aligned with the community development agendas. Adopting such practice as a standard would enable effective integration of social considerations and aspects of mine closure throughout the life-of-mine plan. Such rhetoric has gained credence since 2000 when the Mining Minerals and Sustainable Development (MMSD) project began.

The broader implications of sustainable development in mining, beyond just environmental considerations, has been increasingly recognised by the industry with initiatives such as the ICMM toolkit (ICMM 2009) emphasising the importance of involving stakeholders in the mine closure decision-making process during the entire mining lifecycle. In Africa, where international standards preceded national ones, several countries such as South Africa, Ghana, Ethiopia, and Tanzania have national legal requirements that social closure be included as part of the closure planning process for all mines. This is, in part, acknowledgement of the economic dependency a mine creates with its host community.

The majority of these industry guidelines and legal requirements recognise the need to build capacity in the local communities and to employ safer and more environmentally responsible mining methods. They also acknowledge that livelihood restoration requires a broad and diverse economy during the life of the mine and post-closure for sustainable development and sustainable change to be realised. The interconnections between local livelihoods, the mine operation, and what happens post-closure to enable sustainable development is incredibly complex, especially within the context of developing countries. For example, Sub-Saharan Africa's dependency on the mining sector continues to increase with ore and metal exports accounting for approximately 20% of the regions total merchandise exports (IIED 2003b), yet the economic growth and good governance of many of these countries is not associated with being resource rich.

Initiatives such as the Extractives Industry Transparency Initiative (EITI 2015) have spearheaded a responsible relationship between the mining companies and the governments that host their operations. However, the disconnect between the governments, the communities, and the mining companies requires a coherent and effective dialogue and effective engagement between the mining company and the respective stakeholder

groups. This is essential if the risks associated with these wicked problems are to be minimised, the efficiency of the mine operation improved, and post-closure liability reduced. While the current focus on new global sustainable development goals identifies what our goals should be, how to achieve or create viable sustainable mechanisms for change still presents a conundrum to the mining sector.

5 Post-mining land use

In most instances today, mine closure plans are developed with the goals of limiting long-term risks, and returning the land to a stable and safe condition that supports productive post-mining land use. This goal is consistent with the definition of sustainable development as described in the 1987 Brundtland report which states development should meet "…the needs of the present without compromising the ability of future generations to meet their own needs" (UNWCED 1987). To achieve this, a closure plan must consider how the land will be used following closure and relinquishment of the site.

Post-mining land uses are typically defined based on a combination of parameters including surrounding land uses, water quality, socio-economics, soil, geotechnical conditions, and biodiversity. Ideally, these factors are assessed to determine appropriate post-closure land uses through a collaborative process that includes key stakeholders. However, this approach presumes that all of the stakeholders who will use the land after the mine closes are part of the stakeholder engagement process. Informal or illegal land users are unlikely to be represented in this process, as are future land users who migrate to the area after closure (Parshley et al. 2014). If all of the future stakeholders are not represented or some are under-represented, a collaborative closure planning process may not identify all of the future land uses. In countries with a well-developed legal system, regulatory processes or the application of administrative controls such as deed or land use restrictions can be used to control unwanted land uses. Societies with limited legal frameworks or enforcement capacity may not be able to effectively control post mining land use, particularly use by informal or illegal tenants.

The actual uses of a mine site after closure could have unintended consequences and be detrimental to the efficacy of the closure measures implemented to achieve the defined closure goals. This could result in damage to the environment and increased risks to humans and animals. Furthermore, ignorance of the residual dangers associated with a closed mine could place future land users at risk. Education can mitigate this risk somewhat, but there is no guarantee the information will be passed on to future generations. Furthermore, the reality in many parts of the world is that in the face of extreme poverty the potential rewards from using the land for unintended post-closure uses or from exploiting the value of remanent resources in the ground or mine waste facilities are so large that uncontrolled use of the post-closure land is nearly certain.

5.1 Artisanal and small-scale mining

Perhaps the most wicked problem requiring an equally wicked solution is the attractive nuisance of residual mineral resources at closed mine sites resulting in the presence of ASM. In spite of the small size of most ASM operations, ASM contributes significantly to global mineral production: approximately 15 to 20 per cent of the world's non-fuel mineral production (IIED 2003b). In many countries, gold is the primary commodity of ASM, but other minerals include bauxite, gemstones, iron ore, copper, silver, tin, and zinc. In many countries ASM constitutes an important component of rural livelihoods.

According to the South African Institute of international Affairs (SAIIA), there is a negative correlation between this growth and a country's general economic situation: artisanal mining increases as economic conditions deteriorate. This is particularly relevant to the current economic downturn where mine footprints are being reduced and operations are being put into care and maintenance, leaving the mine operator responsible for the site including impacts and risks from unlicenced activities resulting from the creation of attractive nuisances.

Commonly, ASM is conducted informally or illegally outside of any legal structure, so managing ASM through normal mine permitting processes is generally difficult, if not impossible. In many countries, gold mining is

seen as a birthright, yet there is an unclear distinction between unlicenced and illegal artisanal activity. Depending on the state concerned, illegality can vary from not being registered to breaking into a mining company's underground workings.

The damage inflicted on the natural environment is often compounded by human health risks, conflicts, smuggling, child labour, and other human rights issues associated with the sector (Figure 5). Government's attempts to regulate the sector tend to focus on small and medium scale miners and neglects artisanal miners. This results in the smallest scale operators remaining illegal and unregulated, engaged in criminal activities that are damaging to the health and well-being of the environment and the local populations who have the intention of securing a livelihood.

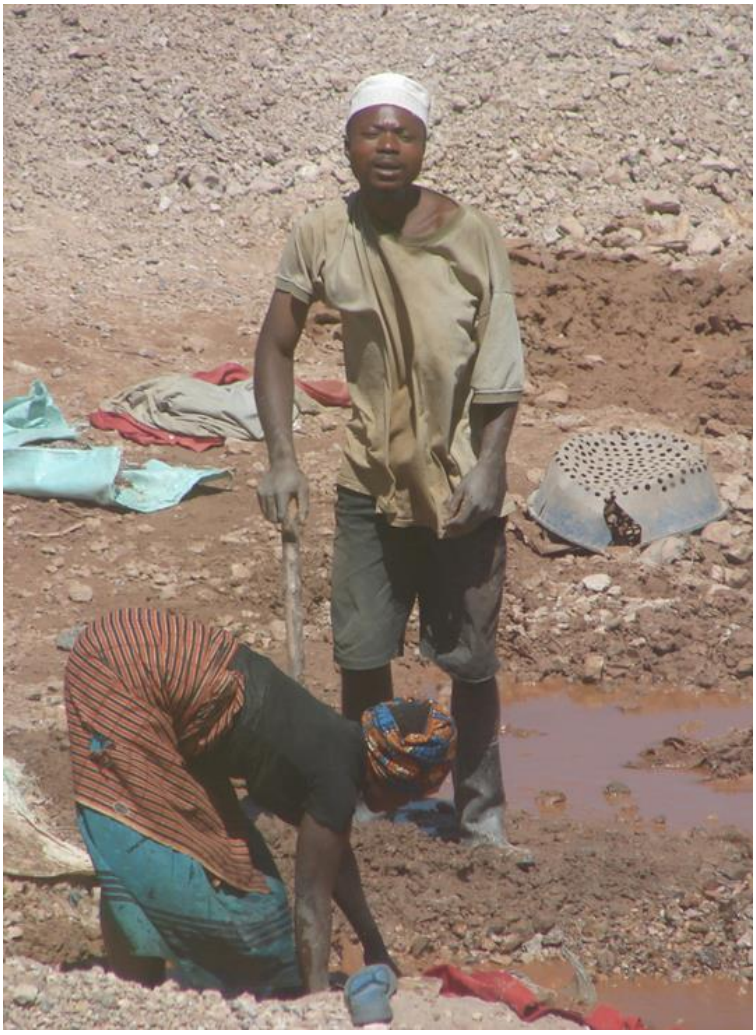

Figure 5 Artisanal miner

Globally, there are more than 10 million artisanal and small scale miners. In addition to the ASM miners, more than 100 million people are indirectly dependent on the sector (IIED 2003b), (Table 1). The 2003 IIED/MMSD report on 18 ASM countries concluded that the impacts of ASM on the environment can be extreme and could result in serious health and safety consequences for ASM mining communities (IIED 2003b). In addition to the direct impacts of ASM, there are also the attendant issues associated with mining where significant ASM communities exist. These include exposure of vulnerable groups (women and children) to dangerous conditions, communicable diseases, corruption, and other social ills.

Table 1 Employment in the ASM sector

Country	Number of workers (in 000s)
Bolivia	72
Brazil	10
Burkina Faso	100 to 200
China	3,000 to 15,000
Ecuador	92
Ghana	200
India	500
Indonesia	109
Malawi	40
Mali	200
Mozambique	60
Peru	30
Philippines	185
PNG	50 to 60
South Africa	10
Tanzania	550
Zambia	30
Zimbabwe	350

The danger of ASM at closed mine sites is illustrated by the increasing incidents of illegal miners becoming trapped, injured, or killed in ASM mines. Recently, dozens of illegal miners were trapped underground when part of a ventilation shaft collapsed in Benoni, South Africa. More than 10 people were killed, a number were rescued, but many refused rescue due to fear of arrest. Although this mine is abandoned rather than closed, the incident — and many like it — demonstrate the extent to which people will go to extract actual or perceived values from mines that are no longer operational. Similar examples exist in the Democratic Republic of Congo, Ghana, Zambia and Tanzania, where abandoned or closed waste rock dumps and tailings dams are seen as an opportunity for artisanal miners. Even when mines are closed using acceptable closure practices, the lure of wealth from closed mines may drive illegal miners to actions that could compromise their own safety and increase post-closure liabilities of the mines.

In Ghana, mining companies, in response to repeated incursions into their mine workings, have involved the National Guard in the removal of large numbers of illegal miners from their concessions. In most countries where there is gold, unregulated artisanal and small scale mining operations contribute to the pollution of the rivers in the area with arsenic and mercury compounds as by-products of ore extraction processes, and the silting of waterways through physical extraction. Methyl mercury and other pollutants associated with artisanal mining contaminate land and water, poison fish stocks, crops and ultimately the local population.

If there is even the perception that value can be obtained from a closed mine site, ASM miners are likely to occupy the site after the mine is closed. In doing so, they may expose themselves to physical or health hazards and their mining activities may compromise measures implemented during closure that were designed to protect the environment and human health.

6 Wicked solutions

The mining sector makes significant investments in human resources and infrastructure to support its operations. In many instances, this contributes to expansion of economic sectors and activities to service the employees, if not the mine operation directly. There is a challenge, however, to understanding how traditional economic bases can be strengthened and less dependent on the boom and bust cycles associated with commodity price fluctuations.

In most developing country contexts, these expectations do not consider closure or the attractive nuisance legacies associated with many gold mining operations. These are often regarded as assets to be exploited, as described in the previous section, and result in a plethora of liability issues for mining companies and serious environmental and health issues for communities. Studies have shown that poor people are acutely aware of their lack of voice, power, and independence. This renders them vulnerable to exploitation, humiliation, and inhumane treatment by those they approach for help. Displacement and the shift from a traditional subsistence economy to a cash-based economy can also lead to the loss of traditional values and way of life (MacCallum 2014). This suggests philanthropic approaches to establishing a social licence to operate and close a mine are not sufficient.

To be viable, and to reduce risks to a mining operation, the vulnerability of a host community and its dependency on the mine's economic growth and ultimate closure requires an understanding of the perceptions and drivers of poverty from the community's perspective. This can provide an opportunity to re-orientate social obligations and responsibilities towards a positive legacy and ultimately a wicked solution. Again, such a solution is not straight forward or linear, but complex and involves an understanding of the multi-dimensional nature of poverty within a host community. This understanding, from a range of different stakeholder perspectives, should focus on the drivers and motivators of change from the outset through to long-term post-closure. For example, in the case of artisanal mining, providing alternative income generating opportunities may contribute towards dissuading mining of a reclaimed and rehabilitated site; however, unless the benefits of not encroaching on such sites outweigh the risks and benefits, to be gained from such artisanal activity, it will continue. Benefits could range from supporting regulated practice to increasing environmental awareness and stewardship to creating alternative livelihood opportunities that are culturally appropriate and viable in the long-term. However, even under the best of circumstances, uncontrolled ASM activity may continue and ultimately compromise the effective closure of the site.

7 Effective engagement

A comprehensive understanding of the factors driving post-closure land use is essential if a relation is to be fostered that assumes a shared responsibility for the environment during the operation and resultant closure. The rhetoric of stakeholder engagement is focussed on building trust, creating shared value, creating a social licence to operate, and establishing a positive legacy for the mining operations. It is a mine field of terminology that is rarely understood and more rarely implemented.

Empowering the voice of the host community and their ability to build on and expand their coping and adaptive strategies in a sustainable way is a challenging key to a wicked solution (Conklin 2006; Cornwall 2003). Ultimately, only when a host community associates environmental degradation and short-term development with unregulated mining practices will closure and attractive nuisances become regarded as a shared obligation and responsibility. This requires effective engagement with stakeholders, including investors, government agencies, community representatives and others. Ultimately, engagement is a two-way process of exchange of information. It can vary from provision of information at one end of the spectrum through to a participatory planning process at the other. However, experience suggests that the more substantive and inclusive the dialogue is, the better the relationship between stakeholders and the mine operators and the better the resultant closure process.

8 Adaptive capabilities

The mining industry makes significant investments in human resources and infrastructure to support its operations. The industry is challenged to understand how traditional economic bases can be strengthened to become less dependent on the boom-and-bust cycles associated with commodity price fluctuations and the reduced dependency does not become a post-closure liability.

Drawing on international development practice, social specialists widely acknowledge that putting people at the centre of their livelihoods, rather than the resources they use, facilitates a process of evidence-gathering to understand the context — the what, how, why, and who — involved in bringing about meaningful change (Alkire & Sumner 2013; Sen 1999; Bebbington 1999). Involvement of the people at the centre of the intervention provides community-based learning opportunities within communities and with outsiders (Breinard & LaFleur 2005). Ultimately, a mine operation is an outsider. Identity is a central issue to this relationship; in particular, the multiple identities an individual, a culture, a civilisation, or a corporation can assume. Understanding these different perspectives and their plurality is an integral part of the development process (MacCallum 2014). It is also an important consideration in managing attractive nuisances post-closure.

A longitudinal research project involving 10 countries across Europe, Africa, and South America showed that a critical understanding from a range of perspectives is essential in shaping the values that determine what an individual chooses to become and do. This reflects Sen's (1999) thinking on capabilities and development as freedom to be and choose what you value. This is a very important consideration when related to engaging with the wide array of stakeholders in a cohesive and constructive manner. Local capabilities to be active and productive are strengthened by focussing on strengths and the 'can do' rather than 'what is needed' approach (MacCallum 2014). Informed choice and decision-making or the ability to be and do what one values ultimately shapes social change. Furthermore, social change towards sustainable livelihoods is dependent on a deliberative dialogue in which all voices and perspectives are considered. Adaptive capabilities are then determined by the willingness for collaboration within and between different sectors of society that build on existing assets and strengths.

9 Conclusion

Adopting an effective and inclusive stakeholder engagement process as part of mine closure planning can, in many cases, provide effective long-term solutions that promote sustainable communities and expand future opportunities for economic development. Technological advances and industry experience continue to improve the prospects for successful biophysical mine closure. However, there are a number of circumstances that could be combined to disrupt an orderly mine closure.

As the timeline for mine closure persists in perpetuity, actions occurring on the land after mine closure have the potential to significantly impact the efficacy of actions taken during closure. Collaborating with a community in the mine closure process encourages a shared responsibility for post-closure hazards rather than a 'brick wall' or 'cliff edge' approach — even when mining activity stops with limited advance notice. However, the in perpetuity nature of mine closure and local socio-economic pressures may create a context in which successful closure may not be realistically achievable.

Attractive nuisances may entice future land users to implement land uses that are not consistent with the objectives or actions of the mine closure plan and could ultimately result in failure to the closure objectives. The primary example examined in this paper, i.e. ASM, will likely continue to be an uncontrolled and uncontrollable post-closure land use that will also likely continue to compromise closure measures. Such uncontrolled land use and the damage it could cause may be partially mitigated through effective comprehensive stakeholder cooperation processes that honestly recognise and address the technical and social context, acknowledge the attendant risks, and cultivate wicked solutions. Critical to this process is space for engaging stakeholders in periodic reflection and review of the situation. Factoring this in enables acknowledgement of achievements, challenges, and recommendations for change.

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