

Governance and socio-political issues in management of acid mine drainage in South Africa

Charles Mpofu^a, Thabiso John Morodi^b and Johan Petrus Hattingh^c

^a*Corresponding author. Auckland University of Technology, Auckland, New Zealand. E-mail: charlesmpofu@hotmail.com*

^b*Tshwane University of Technology, Pretoria, South Africa*

^c*Stellenbosch University, Stellenbosch, South Africa*

Abstract

The water resources in South Africa are threatened by current and past mining practices such as abandoned and closed mines. While mining is considered valuable for its contribution to this country's gross domestic product, its polluting effects on water and land resources have been criticised as unsustainable. Acid mine drainage (AMD) is one specific public health and ecological issue that has stirred debates in political and social circles in this country. This paper examines the scalar politics and other related dimensions of water and AMD governance, thereby revealing evidence of deep-rooted challenges regarding the governance of water and mineral resources. The specific focus is on the socio-political context of labour laws and Black Economic Empowerment and the decision-making processes adopted by government. Thus, this paper has implications for the improvement of environmental governance and decision-making strategies and the adoption of a national strategy for adequately addressing AMD and related policy issues.

Keywords: Acid mine drainage; Decision-making; Environment; Governance; Management; South Africa

Introduction

The water resources in South Africa are threatened by current and past mining practices such as abandoned and closed mines. While mining is considered valuable for its contribution to this country's gross domestic product, its polluting effects on water and land resources have been criticised as unsustainable. Acid mine drainage (AMD) is one specific public health and ecological issue that has stirred debates in political and social circles in South Africa (Feris & Kotzé, 2014). This AMD problem, currently experienced by the government and society in South Africa, is, to a large extent, the result of the governance, the administration and the socio-political landscape in the country. This paper argues that the deeper dimensions of the AMD problem are particularly the result of inadequate legislation, socio-political policies such as Black Economic Empowerment (BEE),

doi: 10.2166/wp.2017.068

© IWA Publishing 2018

corruption and the decision-making processes adopted by the government. Thus, a closer examination of the administrative structures that characterise most instances of environmental governance and of the scalar politics and other related dimensions with which water and AMD governance are organised may yield valuable insights. This work will demonstrate that both water and mineral governance are politicised in South Africa (Swyngedouw, 1999; Zeelie, 2010). Since these contextual dimensions also affect any conventional or alternative efforts in addressing the AMD problem, it is important that they are highlighted.

Background

Fresh water in South Africa is scarce, unevenly distributed and the supply is in the international threshold of freshwater stress (Feris & Kotzé, 2014). Much of the country is semi-arid, and only 14% of its surface is available for arable farming (Flynn & Chirwa, 2005). Cities tend to experience water stress and, in certain drought situations, municipalities have had to recycle sewage or initiate expensive desalination projects (Flynn & Chirwa, 2005). Concerns regarding water issues and AMD have been raised by institutions such as the International Water Security Network, which indicated that although South Africa is a water-scarce country and the AMD issue impacts on water security, research on the socio-political aspect of it and its mitigation has not yet received sufficient attention. In terms of specific quantities of AMD, it has been estimated that Witwatersrand goldfield (the biggest goldfield in Gauteng) alone produces about 350 ML/day (1 ML = 1,000 m³) of AMD representing about 10% of the total water supplied by a major regional bulk water-supplying company in that region (Chiluwe, 2015). Concerns raised by the AMD issue need attention as the AMD issue is not only exacerbating the existing burdens of water crises but also adding to the specific issues faced by South Africa such as being in a drought-prone region and the wide gaps between levels of availability of resources for different sections of society. High population density, poverty and the wide gaps between the rich and the poor in South Africa are notable in large cities around Gauteng¹ region where most of gold, coal and copper mining is done. For example, it was once found that the affected people live in informal settlements called shacks, which are densely populated and impoverished shacks without running water for drinking, cooking, bathing or laundry (International Human Rights Clinic Harvard Law School, 2016). This demonstrates that the AMD consequences extend beyond poor access to fresh water resources to basic human rights and wider public health issues. Hence, this issue needs not only a technical solution but also socio-political ones.

AMD has been described as the production of highly acidic water caused when rock containing sulphide minerals is exposed to air and water, either as a result of mining activities or from residue disposal areas. The characteristics of the released AMD include low pH, high electrical conductivity, increased concentrations of iron, aluminium and manganese and higher concentrations of toxic heavy metals. The acid so produced dissolves salts and mobilises heavy metals from mine workings (Matsumoto *et al.*, 2016). This results in dark, reddish-brown water, with pH values as low as 2.5 persisting at many sites, which not only affects the availability of freshwater resources but is also detrimental to ecological

¹ Gauteng is a local word meaning 'the city of gold'.

resources. Although not widely reported in South Africa, elsewhere in the United States high acidity in rivers has in the past resulted in the death of fish in the Appalachian area and California. Further investigations in the 1980s revealed that 10% of streams in the Appalachian region were indeed polluted by AMD (Matsumoto *et al.*, 2016). In terms of land resources, in South Africa it was once reported that the flooding of an abandoned mine in Randfontein, near Johannesburg, the biggest city in Gauteng, created a number of AMD hotspots leading to farmers failing to grow crops in the affected areas (Chiluwe, 2015). Furthermore, residents of the region were then affected through ingesting contaminated food, doing laundry, and swimming or bathing in water contaminated with AMD (International Human Rights Clinic Harvard Law School, 2016). It is the two-pronged (water safety and ecology) consequence of AMD production that leads to our pursuit of the argument that governance and socio-political solutions are needed to tackle this issue.

Current solutions by the government include the establishment of a state-owned treatment plant in 2012 which had up to 2016 stopped the decant in the West Rand. The government also introduced a plant in 2014 that pre-empted decant in the Central Rand (International Human Rights Clinic Harvard Law School, 2016).

Socio-political issues

The challenges confronting the governance of water resources and particularly AMD are associated with how AMD is linked with socio-political issues. This includes how conflicts and tensions occur between government and scientists on the one hand and between communities and non-scientists on the other hand. In South Africa, AMD and water resources have been politicised to a point of undermining public confidence in both governance and management (Swyngedouw & Swyngedouw, 2004; Linton, 2010).

Mining in South Africa can, therefore, not be discussed without mentioning its inherent political dimensions that are deeply intertwined with a colonial history of more than a century. Indeed, these political dimensions have directly or indirectly contributed towards the magnitude and the potential consequences of AMD. During the years of apartheid (policies that discriminated against people in South Africa based on colour), it is argued that the state wilfully ignored the industry's damaging impact on the environment (Van Eeden, 2007; Turton, 2009). In addition, it needs to be made clear that responsibility also lies with the major mining houses that profited from South African gold and uranium during the prosperous years. Key gold-mining companies, such as Anglo American Corporation, Gencor, Goldfields and Johannesburg Consolidated Investments, have largely been transmuted into new legal structures, but closer corporate forensics would establish the extent to which they were beneficiaries over the lifetime of their mining operations.

Furthermore, in terms of ownership, South African mines were previously operated by a cohort of conglomerates known as the Big Six, which comprised Anglo American/De Beers, Gencor/Billiton, Goldfields, JCI, Anglovaal, and Rand Mines. Together, they controlled more than one half of the country's economy. Their dominance waned, however, as South Africa gained independence; the focus shifted towards BEE, ushering in new players that critics claim were comfortably connected to both the business and the political elite (Zeelie, 2010). The importance of noting this change is that the second cohort could have imposed much-needed worker and environmental protection, neutralising errors caused by their predecessors. However, it is claimed that, instead, they used their political

connectedness to amass personal wealth, frustrating the legitimate expectations of the country's electorate concerning accountability, transparency and governance (Zeelie, 2010).

In his seminal work, Turton (2009) determined that throughout the history of mining in South Africa the focus has been on the generation of profits and the reduction of operating costs. Thus, all liabilities were avoided, and costs were externalised. This policy of extraction has continued through to the present-day government. The environmental legacy of past mining operations frequently poses major problems (Danielson & Lagos, 2001) that are similar to the potential impacts of existing mines but pose the problem of liability for clean-up and its costs. The largest liability in this field is AMD, which may become a long-term problem as has occurred in the Rio Tinto region of Spain, a source of AMD for at least 200 years (Balkau & Parsons, 1999).

Furthermore, especially in the sub-Saharan region, the mining industry has traditionally been an important foreign exchange earner through major direct foreign investment. Thus, mining in South Africa, as in the rest of the region, has become a dependable source of steady income. Sadly, profit margins in South Africa appear to have taken precedence over environmental protection. It is the contention that while government and businesses fail to respond positively in terms of how they will implement smart, anti-pollution strategies stemming from AMD, the two parties (government and mining houses) are likely to prolong and accelerate the devastation of water quality in the country, thus negatively affecting water governance. It may appear that, in the context of the AMD issue, government and mining houses are not acting in the best interests of the environment and, thus, they should not be seen as separate entities working solely for their own interests but as partners.

Public opinion also points to the need for political intervention into the AMD issue. For example, a Harvard University report based on more than 200 interviews acknowledged that although the government has acted on AMD there are still some gaps that were not filled (International Human Rights Clinic Harvard Law School, 2016). Similarly, a report commissioned by the local authority of one of the most affected regions, Gauteng, pointed to the need for a concerted effort by the government (Bobbins, 2015). Furthermore, a resident of Gauteng's East Rand (another region experiencing AMD) made a claim that increased governmental leadership is essential to remediating polluted water (Matthew Hanvinga, personal communication, 9 September 2013). Among political parties, an opposition politician (Gareth Morgan²) speaking at a meeting of the Parliament of South Africa stated, 'political will is what's required to fix the problem of AMD, and it's lacking' (Kardas-Nelson, 2010).

In addition, politicians could potentially make provision for appropriate measures for restitution that could include addressing the AMD problem where relevant. Clearly, this would require a good deal of political will, which is unlikely to be forthcoming. For example, the state has not supported the efforts by civil society organisations to obtain restitution from the key transnational corporations that benefited from apartheid (Zeelie, 2010). The same reluctance to confront the mining industry also applies. Instead, the state and its taxpayers are likely to be burdened with the remaining costs for mining pollution.

² Gareth Morgan is a member of parliament representing the Democratic Alliance (DP) in South Africa. He is a shadow Minister of the Portfolio Committee on Mineral Resources.

Labour laws and BEE

The other serious challenge that tends to frustrate efforts to address the problem of AMD is perceived to be interference by BEE. As explained below, BEE is an attempt to marry redistributive and neo-liberal economic policies. The beneficiaries of BEE are criticised for contributing nothing but confusion since their focus seems to be on profiteering at the expense of finding a long-lasting solution to AMD. The means by which labour laws such as the BEE have been implemented in the mining sector in South Africa have also contributed substantively to delays in effectively responding to the challenges of AMD. In regard to BEE, the South African State has differing degrees of power to force redistribution on different sectors of the economy. Mining is one of the sectors in which state allocation of licences and exploitation rights makes the prospects for BEE promising. In this context, BEE is perceived as a catalyst for the redistributive processes in the mining industry. Despite its redistributive intentions, BEE has been seen as doubly conducive to the interests of large-scale South African capital (Ponte & Van Sittert, 2007). Firstly, it has mainly confirmed the historical share of mining rights to incumbent and largely white-controlled operators. Secondly, it has created a layer of ‘black captains of industry’ to whom the incumbents are increasingly outsourcing primary production in a volatile, high-risk and currently loss-leading sector.

The move by government to apply the BEE policy is also suspected to be a guise by the ruling elite to enrich a selected few connected individuals. This assertion was once confirmed by a mining expert who posited that BEE would not resolve the issue of AMD but a collective would (Professor Maree, personal communication, 6 June 2011). A search in Google Scholar indicated that there is recent literature alluding to the issues of little success of BEE business leaders (Nattrass, 2014; Southall, 2014; Mattes, 2015). Another point in this regard stems from the fact that some of the proprietors of the mines that originally caused the AMD problem sold their mines to new companies, including companies established within the context of the BEE framework of government. In doing so, they have tried to evade their liabilities. This was illustrated in the case of Harmony Gold, which was ordered by the High Court in 2005 to comply with a directive issued by the Department of Water Affairs (DWA) to pump underground water containing AMD in an effort to avoid water pollution. The company sold the mine in 2007 to Pamodzi Gold Orkney (Pamodzi), a BEE company. After the land on which mining took place was transferred to Pamodzi, the company assumed that the directive was no longer applicable.

A further connection between BEE and the failure to address the AMD problem is the preferential treatment bestowed upon those who are politically connected to the ruling party. It appears that they tend to receive both substantial and lenient consideration. Many high-ranking, prominent appointments in BEE companies proved to be of a political and not of a managerial nature. For instance, Zondwa Mandela and Khulobose Zuma (both beneficiaries of the government empowerment policy) are a grandchild of former president, Nelson Mandela, and a niece of President Jacob Zuma, respectively. However, both beneficiaries never had any formal training in mining and do not possess the necessary skills and expertise. Their lack of experience in mining management has been linked to the proliferation of AMD and the devastation demonstrated in the Central and Western Basins in Gauteng. For instance, the political rather than the managerial appointments mentioned above may be suspected to have resulted in the issues surrounding the mines managed by the BEE, especially at the Aurora mines in the East Rand, and the proliferation of AMD. The impact of the issues was also experienced in the Witwatersrand due to AMD reaching the fresh water of Gauteng and leaving millions of people at the mercy of mining houses and government. Hence, it is the view of the authors that BEE should be monitored, and priority should

be given to appointing those with the necessary ‘expertise’ and predetermined relevant skills in mining, without consideration of partisanship that is guided and informed by political connectedness to a ruling party.

Following the above examples of the issues relating to BEE, the debate circulating in political discourse is whether BEE has become the cause of its own problems since it benefits only those who are politically connected (Zeelie, 2010). BEE is also seen in some quarters as something that may have failed to deliver the humanism it purported. Labour organisations, including National Union of Metalworkers of South Africa (NUMSA), a trade union federation in South Africa, and those within Congress of South African Trade Unions (COSATU), see BEE as favouring spending power over humanitarian considerations partly because BEE merely discards those without spending power. There is also a narrative in social and political spheres that suggests that the poor are becoming poorer and the rich richer, thereby failing the marginalised groups (Zeelie, 2010). Another argument is that while mining operations are being outsourced under the banner of redistribution, the mining trade remains under the effective control of white capital. However, the white capital monopoly has been frantically replaced by a black capital monopoly, albeit with challenges.

To avoid the astronomical costs that are manifested socially (unemployment resulting from closure of mines) and ecologically (demonstrated by the challenge of AMD), it is therefore important to review all applications of those who wish to enter the business of mining in order to obviate similar challenges being presented again. This is not to suggest that BEE be dismissed but rather should it be implemented fairly and equitably. Thus, the onus lies with the government as the custodian of the mineral resources of the country to ensure that problems of water quality, such as AMD, are dealt with effectively without jeopardising the health and well-being of the citizens and the environment. These two are intertwined. With reference to Section 27 of the Constitution, the national, provincial and local governments have a duty to realise the right of access to water (Flynn & Chirwa, 2005). Therefore, the lesson learnt with BEE is that if consideration is not given to the empowerment of groups that are qualified to take charge, there is likely to be a proliferation of more AMD issues.

Regulation of environmental affairs

The current environmental legislation relevant to AMD in South Africa includes the National Environmental Management Act, No. 107 of 1998 (referred to below as the NEMA) and the National Water Act, No. 36 of 1998 (referred to below as the NWA) (Flynn & Chirwa, 2005). Prior to the promulgation of the NEMA and the NWA, mining companies were bound only by the Water Act of 1956, which was insufficient in dealing with mine closures (Naidoo, 2017). Thus, historically, it was legally possible for mines that were no longer profitable to be boarded up and abandoned and the land transferred to the government. Confirmation of this is the Fanie Botha Accord of 1975 (Chamber of Mines). An agreement was reached between the Chamber of Mines and government, which stated that government would take over ownership of abandoned mines that existed before 1976 (Flynn & Chirwa, 2005).

However, even within the framework of the latest environmental legislation, there is very limited regulation by government in real terms. While both the NEMA and the NWA stipulate that ‘a party has to take all reasonable measures to prevent pollution or degradation from occurring, continuing, or recurring as a result of mining operations for which it is responsible’ (Durand *et al.*, 2009), this was never effectively enforced by government. In fact, according to current legislation, mining

companies are required to comply only with the environmental legislation reflected under the Department of Mineral Resources (DMR) as covered in the Mineral and Petroleum Resources Development Act, No. 28 of 2002 (MPRDA) and thus are able to avoid the more stringent environmental legislation of the Department of Environmental Affairs (Naidoo, 2017).

In South Africa, mining activities are regulated by legislation from the mining, water and environmental divisions. In terms of the MPRDA, the principles set out in Section 2 of the National Environmental Management Act (No. 107 of 1998) (NEMA) apply to all prospecting and mining operations. In essence, this means that any prospecting or mining operation must comply with generally accepted principles geared towards sustainable development by incorporating social, economic and environmental factors into the planning and implementation of such operations. The National Environmental Management Amendment Act (No. 62 of 2008) (NEMA) and the NWA stipulate that a person(s) or party answerable or responsible for any mining operation shall take all reasonable steps to prevent pollution or degradation from taking place. Accordingly, the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) requires that the holder of a mining right or permit is responsible for any environmental damage and pollution, including rehabilitation of the environment affected by mining to its natural state until a closure certificate has been issued.

However, amid all these stringent legal provisions, implementing them has proved to be a debatable and cumbersome task. This is evidenced by the observation that the role of NWA was considerably complicated by an unclear description of the fundamental issue of how high AMD levels are allowed to rise below the surface. For instance, abandoned mine drainage, if allowed to rise, may run off from its original location and contaminate nearby water bodies, thus affecting water quality negatively and rendering it unfit for use. In addition, heavy metals can be leached from rocks that come in contact with the acid, a process that may be substantially enhanced by bacterial action (McCarthy *et al.*, 2010). The resulting fluids may be highly toxic and, when mixed with groundwater, surface water and soil, may have harmful effects on humans, animals and plants (McCarthy *et al.*, 2010).

It also appears that failure to implement environmental legislation robustly in order to remedy the AMD problem and ensure sound water quality management is biased in most instances by economic interests and concerns rather than by environmental concerns. This, according to the authors, is a travesty. Turton (2009) posited that the evolution of South Africa's mining industry was one where 'powerful financial interests coincided with the interests of a racially defined elite, which saw government becoming a collaborator rather than a regulator of the mining industry', which for the last century has manifested itself as a policy and practice of extraction. This view is supported by Durand *et al.* (2009) who postulated that 'both parties benefitted economically from this relationship, while government turned a blind eye to environmentally and socially harmful practices of mines'.

Furthermore, the regulation of mines is fragmented, and the enforcement of environmental legislation is generally poor. Regarding the general issue of fragmented environmental governance in South Africa, there is also considerable overlap and conflict between ministries because of their different mandates (Naidoo, 2017). Although overlapping governmental roles and responsibilities make it easy for one department to pass the problem of AMD to another, this may lead to inaction and duplication of roles. It has been specifically acknowledged that in respect of the governance of mining and AMD '[...] the delegation of powers between various government departments at the national, provincial and municipal levels is unclear. Institutional roles and responsibilities are fragmented, overlapping or

vaguely defined. There is a need to rationalise and align national legislation to remove ambiguity' (Manders *et al.*, 2009).

Inaction, rhetoric and lack of comprehensive strategy among government departments

Government departments, private institutions, mining houses and scholars have attempted to find solutions to the AMD issue. However, scholarly opinion (Ewart, 2011) reveals that solutions based on research (Hobbs & Cobbing, 2007) have adopted a reductionist approach regarding AMD, with studies that have typically revolved around isolated solutions to individual elements of the process such as sulphate reduction, the treatment of heavy metals and cost savings through the use of alternative reagents (Poinapen *et al.*, n.d.).

Regardless of the numerous solutions that have been researched and proposed, the immediate AMD threat posed by the abandoned mines, of which there are approximately 8,000 reported in South Africa (Turton, 2009), is still awaiting urgent intervention. In this section, the authors argue that delays in conclusive actions may have resulted from debates as to who is to take action and, therefore, who should be responsible for the costs when addressing AMD – government or the mining companies. However, there is a great deal more that can explain the failure to address the AMD problem effectively in South Africa. An example is the DWA's commissioning of a task team as announced in February 2010. In this instance, it was revealed that an agreement had been reached in a joint collaboration with the mining houses regarding a model to deal with AMD (McCarthy, 2010). While the announcement made mention of the establishment of a public–private partnership that would assume technical and operational responsibility for the model, it made very little mention of the exact treatment approach that would be followed. Reference was given only to the refurbishment and development of the infrastructure for the collection, conveyance and treatment of mine water at a central point.

Richard Doyle of Earth Metallurgical Solutions suggested that there may be various other reasons for the delay in implementing a solution, including 'technical complexity, responsibility, cost, changes in government and the state's shortage of skills' (personal communication, 13 November 2011). McCarthy (2010) questioned whether the inaction was 'due to the nature of government or the proximity of government to mining companies and their revenue, or the impact of of [sic] BEE (affectionately called BEEllionnaires to connote their financial strength) in the mining sector'.

However, in the latter half of 2010, prompted by what some describe as sensationalism by environmental activists and the media, it appeared that action would finally commence when the South African Government announced a reappraisal of the threat of AMD by a special team of experts commissioned by the Minister of Water Affairs. The assembled team of experts were tasked with reappraising the research and the risks associated with AMD, assessing viable, short-term solutions and exploring medium- to long-term sustainable options in partnership with the private sector (McCarthy *et al.*, 2010). The findings of the team were compiled into a report in December 2010 that was submitted to the DWA. The report (McCarthy *et al.*, 2010) believed that a lack of synergy between the DWA and the DMR contributed to the government's delayed response to the AMD threat. The DWA was mandated to manage AMD at an environmentally critical level (believed to be approximately 150 m below ground level), which would result in the flooding of the country's mineral assets. Where the responsibility for the protection of such resources falls with the DMR, it was expected that the DMR would have acted first; to date, a solution is still to be found. Consequently, the credibility of the proposed solution

was questionable. Of the solutions that have been proposed, most have been reductionist in approach and have focused only on dealing with the surface decant of contaminated water from predominately non-functioning mines. The health risks associated with radioactive and highly toxic waste have been minimised or simply ignored (Ewart, 2011). This, therefore, leads to the argument that the absence of a comprehensive solution also raises questions regarding the assessment and decision-making process utilised by the DWA (Ewart, 2011).

Marius Keet, the water-quality management senior manager of the DWA, reflects the absence of a comprehensive solution in the assertion that the gain ‘in the western basin is that, we have managed to stop the decant and draw the water down to one metre below surface level. However, this was before the rains started, which will cause the water to rise again’ (personal communication, 12 September 2010). Keet further argued that if the DWA had enough pumps and treatment facilities, it would be able to draw the water down to the environmental critical level, which is 150 m below the surface, and this would create a buffer capacity if it rained. Therefore, in terms of understanding the Central Basin, the DWA could implement the construction of the treatment plant only if the budget were made available for that purpose (McCarthy et al., 2010). Furthermore, this may suggest that solutions to remedy AMD can be informed only by availability of funds. These views point to the fact that failure to resolve the South African AMD threat is not the result of a lack of funds, ideas or knowledge among experts in regard to possible solutions. Evidence further shows that the issue seems to be about inaction and lack of coordination among various government departments (Kidd et al., 2009; Ewart, 2011).

Moreover, the Independent Monitoring Committee (IMC) report of 2010, prepared by a team of experts working in a wide spectrum of disciplines relevant to understanding the nature and implications of AMD, serves as a vital and crucial example to consider in this work. A team of experts that included directors general of Mineral Resources and Water Affairs, Ministers of Mineral Resources, Water Affairs and Science and Technology, the Minister in the Presidency and the National Planning Commission were selected to advise the IMC. Their focus was on AMD in the Witwatersrand goldfields (Coetzee et al., 2010). In this respect, the Minister of Mineral Resources who had the mandate of promoting mining and mineral resource development had the power to approve the environmental management programme of a mine in terms of the MPRDA, with approval subject to consultation with the Minister of Water Affairs. In terms of the National Water Act (No. 36 of 1998) (NWA), the Minister of Water Affairs had the power to license the use of water by a mine, which included dewatering for the purposes of excavation and the disposal of contaminated water and residue resulting from the mining activities. In addition, certain activities associated with mining such as road construction and the construction of diesel-storage tanks that could affect the environment were governed by the Ministry responsible for water resources. The inevitable result was that the governance of mines in South Africa was primarily driven by a fragmented and, in the case of the DMR, more economically ambitious agenda that followed a distinctly separate track from environmental governance efforts, which should focus on environmental issues.

The way forward

Finally, all these issues demonstrate that failure to resolve the South African AMD threat is not the result of a lack of ideas or knowledge about possible solutions among experts (Kidd et al., 2009; Ewart, 2011). This failure is the result of complex interplay between socio-political and historical contexts

coupled with the divergent responsibilities and implementation strategies of the various government departments charged with the management of AMD.

Thus, the discussion indicates that if a long-lasting solution for AMD is to be found, it should embrace the rethinking of issues around governance. These include the enforcement of environmental regulation and community engagement as a decision-making strategy in the governance of mines. Such approaches and strategies are outlined below.

Environmental regulation and community engagement

In terms of environmental regulation, the mining industry should be subject to stringent environmental mining guidelines in the formulation, monitoring and revision of its activities, in which communities should have a say. A mining licence should have a term of no longer than five years, and renewal should be subject to compliance. The authors further recommend that government in its regulatory function should stipulate and ensure that the management plans of companies in general, and mining houses in particular, should include specific elements regarding communities. These elements should involve enhancing individual and community well-being and welfare by following a path of economic development, thus safeguarding the welfare of future persons, providing for equity within and between generations, protecting biological diversity and maintaining essential ecological processes.

Decommissioning and post-closure of mines

Since the challenge of AMD manifests itself during the decommissioning and post-closure of a mine, government, mining houses and those who have an interest in the project should ensure that the details of the closure and post-closure are made available to those affected by the activity. Initially, a detailed report regarding the reclamation and restoration of the mining site should be drawn up by a team of specialists, particularly encompassing those who have first-hand experience of the AMD issue. Against the background of the argument articulated above, a multi-stakeholder approach is required, involving all role players and including the lay communities affected by the closure of the mine. Lay communities should be part of the plenary meetings when decommissioning is planned and implemented. A critical purpose of such meetings is to draft reports and detailed plans for post-closure monitoring and maintenance of all mine facilities, including, as clearly revealed in the case of AMD, surface and underground water. For instance, post-closure tailing dams should be monitored for overflow and be subject to periodical ‘flushing’, and the general waste that could affect the functioning and health of the systems and communities surrounding the closed mine should be dealt with. In addition, the plan should periodically be revisited to ensure that the newest technology and best practices are applied to monitor and manage the effects of the closed mine.

Dealing with bias and corruption in governance by using international standards

In terms of governance, those in national leadership should enforce robust management strategies for the environment that are free from political interference. To deal with the issue of corruption and bias in

government, the issuing of mining permits and licences should be transparent to obviate the resurrection of AMD. As an important strategy, government could use international standards as frameworks for measuring and monitoring its environmental performance. For example, government could measure and monitor its environmental performance in terms of the United Nations Environment Programme (UNEP), thus highlighting the gaps that exist regarding sustainable development (Singh *et al.*, 2012). The government should also embrace the guidelines of the Coalition for Environmentally Responsible Economies (CERES), demonstrating its compliance in terms of its reporting. Further strategies for dealing with bias could include escalating the AMD challenge to Cabinet level to seek more voices for addressing this scourge. Independent scientists should also be engaged, together with the affected and interested communities to ensure a collective and non-biased approach.

The role of science in the context of corruption in government

In this work, the authors argue that the government may be suspected to have an influence on the role of contracted scientists commissioned by government to perform tasks on their behalf. Being a shareholder, government has an interest in mining and thus is not in a position to enforce mining and water legislation seriously and effectively. The notion of independent scientists is informed by the argument that individuals tend to be biased and have personal motives. As alluded to earlier, the services of certain scientists are compromised by corruption in South Africa and the subsequent personal motives for financial gain and political legitimacy of appeasing those in power. These biases can be addressed by introducing measures that will ensure that scientific advisers act purely in their capacity as professional scientists and that all extraneous influences of which they are aware are excluded or at least openly acknowledged and managed.

The fundamental approach to enhance public trust in scientists who are perceived to be biased towards the government's project should ensure that scientists do not hide behind uncertainty or apply hidden 'safety margins' since this would be deviating into policy-making and the unfair, biased judging of societal values. Furthermore, it would be poor judgement if advisers sought closure on issues comprising genuine and different perspectives. Advisers should, therefore, faithfully record and present to policy-makers the alternative views and the evidence to support them.

Since science also creates uncertainty, the companies have a moral duty to avoid ambiguous responses because these create more uncertainty and mistrust. The relationship between the mining industry, the 'scientific' community and government should be revisited so that it is no longer easy for mining companies to exploit and abuse ecosystems.

Conclusion

The above argument demonstrates that AMD is a mismanaged crisis in the contemporary history of South Africa. It has proved to be a burden for policy-makers whose response to this issue has been slow. The government's efforts to finally manage this problem are compromised by numerous issues that tend to shift the focus away from it. Environmental legislation that enables action to address the AMD problem has been found to be inadequate in terms of enforcement. Policies that govern mining and water usage are inadequate and appear to be subject to abuse by those who are politically connected. There is

also the question of governance regarding enforcement where there appear to be issues of compromised management, with government colluding with mining houses in terms of being seen as shareholders in the mines by proxy instead of governors. Economic gains seem to have been placed above the interests of the environment, as seen by the prolonged proliferation of AMD while mines were flourishing. Furthermore, the BEE seem to be worsening the situation through abuse by the beneficiaries that government has appointed, with declarations of cronyism from among the general public. The focus seems to be on making a profit and promoting individual and political interests rather than resolving this pertinent issue. It is, therefore, concluded that failure to resolve the South African AMD threat is not the result of a lack of ideas, expertise or financial resources but the result of a complex interplay between the socio-political and the historical contexts coupled with failure of the management strategies adopted by both government and other concerned parties.

Acknowledgements

The authors are grateful for the funding from Tshwane University of Technology and Stellenbosch University that supported the writing of this article.

References

- Balkau, F. & Parsons, A. (1999). *Emerging Environmental Issues for Mining in the PECC Region*. United Nations Environment Programme, Nairobi, Kenya.
- Bobbins, K. (2015). *Acid Mine Drainage and its Governance in the Gauteng City-Region*. Available at: http://www.gcro.ac.za/media/reports/amd_occasional_paper_final_web.pdf (accessed 15 May 2017).
- Chiluwe, Q. W. (2015). *Acid Mine Drainage: A Threat to Water Security in South Africa*. Available at: <http://www.watersecuritynetwork.org/acid-mine-drainage-a-threat-to-water-security-in-south-africa/> (accessed 5 July 2017).
- Coetzee, H., Hobbs, P. J., Burgess, J. E., Thomas, A., Keet, M., Yibas, B., Van Tonder, D., Netil, F., Rust, V., Wade, P. & Maree, J. (2010). Mine water management in the Witwatersrand Goldfields with special emphasis on acid mine drainage: Report to the Inter-Ministerial Committee on Acid Mine Drainage, South Africa.
- Danielson, L. & Lagos, G. (2001). The role of the minerals sector in the transition to sustainable development. *International Mining and Minerals*, 20, International Institute for Environment and Development, London. Available at: http://www.environmental-mainstreaming.org/nssd/pdf/wssd_14_mining.pdf (accessed 2 June 2017).
- Durand, F., Liefferink, M. & Van Eeden, E. S. (2009). *Legal issues concerning mine closure and social responsibility on the West Rand*. *The Journal for Transdisciplinary Research in Southern Africa* 5(1), 21.
- Ewart, T. I. (2011). *Acid Mine Drainage in the Gauteng Province of South Africa: A Phenomenological Study on the Degree of Alignment Between Stakeholders Concerning a Sustainable Solution to Acid Mine Drainage*. PhD Thesis, Stellenbosch University, Stellenbosch, South Africa.
- Feris, L. & Kotzé, L. J. (2014). The regulation of acid mine drainage in South Africa: law and governance perspectives. *PER: Potchefstroomse Elektroniese Regsblad* 17(5), 2105–2163.
- Flynn, S. & Chirwa, D. M. (2005). The constitutional implications of commercializing water in South Africa. *The age of commodity: water privatization in Southern Africa* 59, 46.
- Hobbs, P. & Cobbing, J. (2007). *Hydrogeological Assessment of Acid Mine Drainage Impacts in the West Rand Basin, Gauteng Province*, Report No. CSIR/NRE/WR/ER/2007/0097/C, CSIR/THRIP, Pretoria, South Africa, p. 48.
- International Human Rights Clinic Harvard Law School (2016). *The Cost of Gold: Environmental, Health, and Human Rights Consequences of Gold Mining in South Africa's West and Central Rand*, Harvard Law School International Human Rights Clinic. President and Fellows of Harvard College, USA.

- Kardas-nelson, M. (2010). *The Acid Mine Drainage Solution Bandwagon*. Available at: <https://mg.co.za/article/2010-12-10-the-acid-mine-drainage-solution-bandwagon> (accessed 20 April 2017).
- Kidd, M., Paterson, A. & Kotzé, L. (2009). Criminal measures. In: *Environmental Compliance and Enforcement in South Africa: Legal Perspectives*. Sachs, A., Paterson, A. & Kotzé, L. J. (eds). Juta and Company Ltd, London, pp. 240–265.
- Linton, J. (2010). *What is Water? The History of a Modern Abstraction*. UBC Press, London.
- Manders, P., Godfrey, L. & Hobbs, P. (2009). *Briefing Note: Acid Mine Drainage in South Africa*. CSIR, Pretoria. Available at: <http://www.csir.co.za> (accessed 6 January 2017).
- Matsumoto, S., Shimada, H. & Sasaoka, T. (2016). The key factor of acid mine drainage (AMD) in the history of the contribution of mining industry to the prosperity of the United States and South Africa: a review. *Natural Resources* 7(7), 445–460.
- Mattes, R. (2015). South Africa's emerging black middle class: a harbinger of political change? *Journal of International Development* 27, 665–692.
- McCarthy, T. (2010). The decanting of acid mine water in the Gauteng City-Region: Analysis, prognosis and solutions. *Provocations Series, Johannesburg, Gauteng City-Region Observatory*.
- McCarthy, T. S., Steyl, G., Maree, J. & Zhao, B. (2010). *Expert Team of the Inter-Ministerial Committee Under the Coordination of the Council for Geoscience Report to the Inter-Ministerial Committee on Acid Mine Drainage: Mine Water Management in the Witwatersrand Goldfields with Special Emphasis on Acid Mine Drainage*. Pretoria. Available at: <http://earthlife.org.za/www/wp-content/uploads/2011/04/Team-of-Experts-Report-to-the-IMC-on-AMD-Dec-2010.pdf> (accessed 21 April 2017).
- Naidoo, S. (2017). *The Policy Response to Acid Mine Drainage in the Gold-Mining Sector*. In: *Acid Mine Drainage in South Africa*, Springer, Cham, Switzerland, pp. 75–106.
- Natras, N. (2014). A South African variety of capitalism? *New Political Economy* 19, 56–78.
- Poinapen, J., Ristow, N., Wentzel, M., Rose, P. & Ekama, G. (n.d.). *Biological Sulphate Reduction of Acid Mine Drainage Using Primary Sewage Sludge in an Upflow Anaerobic Sludge Bed (UASB) Reactor*. Water Research Group, Department of Civil Engineering, University of Cape Town, Rondebosch, South Africa and Environmental Biotechnology Group, Rhodes University, Grahamstown, South Africa.
- Ponte, S. & Van Sittert, L. (2007). The chimera of redistribution in post-apartheid South Africa: 'Black Economic Empowerment' (BEE) in industrial fisheries. *African Affairs* 106(424), 437–462.
- Singh, R. K., Murty, H., Gupta, S. & Dikshit, A. (2012). An overview of sustainability assessment methodologies. *Ecological Indicators* 15, 281–299.
- Southall, R. (2014). The black middle class and democracy in South Africa. *The Journal of Modern African Studies* 52, 647–670.
- Swyngedouw, E. (1999). Modernity and hybridity: nature, regeneracionismo, and the production of the Spanish waterscape, 1890–1930. *Annals of the Association of American Geographers* 89(3), 443–465.
- Swyngedouw, E. & Swyngedouw, E. (2004). *Social Power and the Urbanization of Water: Flows of Power*. Oxford University Press, Oxford.
- Turton, A. R. (2009). South African water and mining policy: a study of strategies for transition management. In: *Water Policy Entrepreneurs: A Research Companion to Water Transitions Around the Globe*. Huitema, D. & Meijerink, S. (eds). Edward Elgar Publishing, Cheltenham, pp. 195–214.
- Van Eeden, E. (2007). Past and present actions of environmental heritage by NGOs in the controversial Wonderfontein Catchment, Gauteng – a critical assessment. *New Contree* 53, 55–80.
- Zeelie, A. (2010). *Acid Mine Outrage: How South Africa Communities are Affected by Government and Industry Neglect*. New Solutions, Johannesburg, South Africa. Available at: <http://scienceblogs.com/thepumphandle/2010/05/31/acid-mine-outrage-how-south-af-1/> (accessed 1 June 2017).

Received 3 May 2017; accepted in revised form 23 July 2017. Available online 31 August 2017