Water and Mine Closure in South Africa: Development that is sustainable?

ANTHONY R. TURTON
E-mail: ATurton@csir.co.za; atyurton@csir.co.za
Words: 5.368

ABSTRACT Of the various impacts of mining on the environment, the depletion in the availability and deterioration in quality are the two most serious problems. In an economy dependent on mining such as that in South Africa, maintaining the quality and quantity of waters can become a major problem as abandoned mines can decant into rivers and aquifers. Anthony R. Turton argues that in water–constrained situation, this may have long-term impacts on human well-being, and can trigger political and civil unrest.

Introduction
South Africa has an extractive economy based on mining. It also has a troubled history in which human rights violations have played a major role in forging a political conscience (Davenport, 1977; Spitz and Chaskalson, 2000; Welsh, 2000). This paper explores the nexus between these two aspects – mining and human rights – by presenting a case study in development that was never intended to be sustainable, now being challenged by a Constitution (1996) that mandates sustainability, without defining exactly what that means. The core argument is that the mining industry was driven in two distinct phases by a strong political culture that never had a core ethic of human rights, first in the post Anglo-Boer War era and later in the Apartheid era, which has resulted in a structural fault line that is deeply embedded in the contemporary South African political economy. The significance of this factor becomes apparent in the post-Apartheid era in which a vibrant fledgling democracy, based on a Bill of Rights and underpinned by a deeply-entrenched culture of confrontation, is now being challenged by the perceived victims of an accumulated impact of a century of mining. Central to this is the issue of accountability and who knew what, when and where? The big question is how Government will deal with this challenge? Will it respect the Bill of Rights by regulating mining to the satisfaction of the perceived victims, or will it adopt the bad habits of the former regime by ignoring human rights in the quest for wealth and the power associated with it? Embedded in this is the role of science and scientists, now liberated from political oppression themselves (Turton, 2007) and driven by a social conscience in what is being called a Trialogue of Governance in which interfaces between Government, society and science are critical because it is here that feedback loops occur, allowing adaptive actions to be developed and implemented (Turton et al., 2007).

How it all began
To understand the significance of the nexus between mining and human rights in the context of a discourse on sustainable development, one needs to travel back in time to the late 1800’s. At that time there were two Westphalian states in Southern Africa, both Boer Republics
called the Orange Free State (OFS) and the South African Republic (ZAR), also known as the Transvaal (Welsh, 2000; Turton et al., 2004; 2006). These two republics had been established largely as the result of the massive depopulation in the hinterland by the Zulu impi’s under the ruthless command of King Shaka. Known as the Mfecane, which started in 1816, this human tragedy swept across the southern portion of Africa in great tidal waves of misery as men were slaughtered, cattle captured and woman taken as incubators of future Zulu warriors. The word ‘mfecane’ means to be ‘crushed in total war’ in the language of the perpetrator (isiZulu), with a variant being ‘difaqane’ meaning ‘forced migration’ or ‘to be crushed’ in the language of the victim (seSotho) (Welsh, 2000). One commentator describes this event as leaving,

’a generation of homeless refugees … doomed to wander about South Africa seeking temporary refuge and food, but being driven to cannibalism and starvation. The passage of such armies led to widespread devastation. European writers spoke of travelling for days through a deserted countryside past the scattered bones of the dead. Into the geographical void left by the killing and dispossession moved the [Trekboers], the pioneers of what became the Afrikaner Republic’s’ (Welsh, 2000: 140).

So in essence the people were deeply traumatized by this cataclysmic event, which resulted in the establishment of two sovereign states, recognized by the British and populated by the Boer people who were discontent to live under English hegemony in the Cape Colony. Then things began to change as minerals were discovered (Turton et al., 2004). When gold was discovered in the Transvaal in 1886, the British wanted it and set in place a plan to overthrow the Kruger regime by means of a mercenary force under the leadership of a man called Dr. Leander Starr Jamieson (Seymour Fort, 1908; Longford, 1982). This ended in a debacle, failing to unseat the government, so another plan was devised. Through a complex series of events the Anglo-Boer War happened as a result. Considered by commentators to have been a resource war triggered by the British desire to control gold (Barber, 1999; Porch, 2000) this was a brutal affair (Farwell, 1999; Nasson, 1999; Lee, 2002). Due to the asymmetry in military power, the British forces were unable to defeat the Boer’s on the field of battle, so they turned to a scorched earth policy that involved the capture and imprisonment of women and children in concentration camps (Hobhouse, 1901; 1907; Spies, 1977; van Rensburg, 1980; Krebs, 1992; Evans, 1999; Raath, 1999; van Reenen, 2000; Hasian, 2003; Turton et al., 2006). Tragically more people died in the British Concentration Camps than on the field of battle on both sides. This was a cataclysmic event that traumatized the Boer society for decades to come, laying the foundation for the subsequent brutality known as Apartheid, as victim became perpetrator and compassion was seen as weakness.

The first order of business after the signing of the Treaty of Vereeniging that ended the Anglo-Boer War was the rapid development of the gold industry in order to pay war reparations back to Britain. This was a favoured British instrument – the payment of war reparations designed to totally subjugate the vanquished, preventing them from ever rising again – which was used to the same effect after the Sixth Xhosa War, triggered in part by the Mfecane noted above; and later after the War of the Axe (Welsh, 2000). After the War of the Axe the British seized 40,000 cattle, pushing the amaXhosa to the brink of starvation, the threshold of which was crossed as a result of what is known in Xhosa history as the Great Cattle Killing between April 1856 and February 1857 (Meer, 1990; Welsh, 2000; Peires, 2003). So in essence the same strategy was used to totally subjugate the vanquished Boers in the form of war reparations, this time to be paid in gold bullion, sowing the seeds for a brutalized society, living off an extractive economy, with a declining stock of natural capital.

The outcome of this set of events was essentially twofold in the context of mining and human rights. Firstly, it set mining up as an industry with all the government policies and

ministries designed to deliberately facilitate this extraction in a one-way payment stream that saw a net reduction in South African natural capital over time. Secondly, there was no culture of human rights that could ever be used to mitigate against the impacts of this extraction, because the main political actors in South Africa – the amaZulu, the amaXhosa and the Boer nations – had all been vanquished by the British who were now in control of the richest goldfields in the then known world. The core logic is that if the victor could allow the wholesale starvation of the amaXhosa by taking their cattle, and the extermination of the Boer people in Concentration Camps, why would they have any concern for the human rights of future generations potentially impacted by the results of mining?

And this is the core problem because as Tenner (1996) so eloquently tells us, ‘things bite back’ when unintended consequences arise.

**The current situation**

After a protracted conflict dating back to the 1913 Native Land Act, but becoming violent after the Sharpeville Massacre in 1961 that gave birth to what is known as the ‘Armed Struggle’, South Africa negotiated a reasonably peaceful transition to democracy in 1994 (Spitz and Chaskalson, 2000). With all of the attention being focused on the political liberation of the previously oppressed, a silent revolution occurred without anyone paying attention. That silent revolution was within the scientific community. South Africa is unique in this regard. Blessed with no less than six National Science Councils, it has a critical mass of scientists that have long had a collective capacity to drive technology development to the point where the economy had become the strongest and most diversified on the continent by the time that democracy arrived in 1994. So it comes as no surprise that the scientists were liberated too. Freed from the shackles of the past, they began to apply their minds to the issue of development, which in terms of the democratic Constitution (1996), had to be sustainable.

The literature on mining and development has a unique characteristic invisible to the uninformed. Almost all of the scientific literature generated before 1994 – at least when it came to critical technologies – was classified and thus out of the public domain. Much of the scientific literature generated after 1994 is unclassified and thus firmly in the public domain. It is this new generation of public domain literature that has given rise to the dilemma now confronting Government, because in essence, what it has shown is that there is a massive pollution plume downstream of gold-mining activities, consisting of a cocktail of heavy metals, sulphates and radionuclides (Coetzee, 1995; IWQS, 1999; Wade et al., 2002; Coetzee et al., 2002; 2005; 2006; Holtzhauzen, 2004; Winde, 2005; Adler et al., 2007a; 2007b; Hobbs and Cobbing, 2007; Oelofse et al., 2007; Turton, 2007).

This issue is coming to a political head in the various catchments that drain the Far West Rand, with two being the most notable in the short-term – the Wonderfontein Spruit and the Tweeloop Spruit – draining into the Orange and Limpopo River Basins respectively – as represented in Figures 1 and 2. The Wonderfontein Spruit is a small stream rising in Krugersdorp, ironically at the base of a massive mine waste dump and municipal landfill, flowing past Carletonville and Potchefstroom, draining into the Vaal and ultimately the Orange River system (see Figures 1 and 2). The Tweeloop Spruit starts on mine property in Krugersdorp and flows through a game reserve and into the Limpopo Basin via the Cradle of Humankind with elevated levels of Uranium coinciding 100 percent with active mine decant from a variety of point and diffuse sources (Figure 1).
Figures 1 and 2 are based on a Tier 1 Risk Assessment methodology (Coetzee et al., 2005), which plots sampling points using a risk quotient where a value of 1 indicates either existing national or internationally accepted safety standards for a given metal. A risk quotient of 1 thus implies a sampled value equal to an accepted safety standard, with any value greater than that being above international safety standards.

Figure 1: Tier 1 Risk Classes for Uranium (after Coetzee et al., 2005). Note the high concentrations at sampling points along the Wonderfontein Spruit, the upper Klip River flowing past Soweto and the Blesbok Spruit draining Benoni and Springs.

Figure 2: Tier 1 Risk Quotients for the maximum Arsenic concentrations for each wetland sampling site (after Coetzee et al., 2005). Note the high concentrations at sampling points along the Wonderfontein Spruit and the upper Klip River flowing past Soweto.
These two drainage basins are spawning active public protests, gaining in their level of concern for human health (Brown, 2007; Crotty, 2007; Groenewald, 2007; Marshall, 2007; Newmarch, 2007; Tempelhoff, 2007a; 2007b; 2007c.). Central to this growing public concern are fears of human health impacts arising from: toxicological properties of heavy metals; carcinogenic properties of both heavy metals and radionuclides; use of potentially contaminated mine waste in building materials; and fears that heavy metals and radionuclides might have entered the food chain. Underpinning this is the whole issue of: accountability of mine management that should have known better than to allow human beings to be exposed to potentially hazardous substances; and the accountability of governmental regulatory agencies whose core function it is to protect humans for possible exposure to such harmful substances.

Against this background the Department of Minerals and Energy has introduced what is being called the Government Task Team for Mine Closure and Water Management, ostensibly to deal with the impacts of mining after the mine is no longer a viable economic operation (DME, 2005).

Some possible explanatory theory

Mine closure is a concept that needs to be understood in order to better appreciate the argument being presented in this paper. Any mine has a finite lifespan, because of two critical factors. Firstly, there is a given stock of minerals which, once extracted, no longer exist in a form that can be mined. Secondly, there are physical limitations to the depths that mining can occur in safety, so as engineering technology improves, new reserves are potentially viable. Both of these conditions exist in South Africa at present. The gold industry is a mature one, with most of the known reserves having been located and in many cases actively mined. This means that there are a large number of mines that have reached the end of their productive lives and are now left, often in a derelict and abandoned condition. This has prompted Ms. Elize Swart, in her official capacity as Director of Environmental Policy at the Department of Mines and Energy (DME) to declare that at present there are around 8,000 derelict and ownerless mines on record, which at current rates would take 800 years to rehabilitate at a current cost of 100 billion South African rand (approximately US$ 14 billion) (Brown, 2007).

This has prompted the Council for Scientific and Industrial Research (CSIR) in South Africa to start thinking about ways to model this phenomenon in order to understand where policy interventions could make a difference (Adler et al., 2007a; 2007b). The current CSIR thinking is presented in Figure 3. On the vertical axis we represent value expressed as a monetary currency, including actual revenues generated, costs incurred and importantly, the cost (either financial or other) for environmental remediation and health care for persons potentially harmed by exposure to effluent streams. On the horizontal axis we represent time. Three curves can be generated. The Development and Operational Cost Curve (DOCC) reflects the actual cost of prospecting, sinking shafts and ongoing operational and maintenance costs of a given mine. The Revenue Curve (RC) refers to the actual revenue streams generated on a given mine, representing company or industry-level figures. Both the DOCC and RC are balance-sheet items and are reported to shareholders and regulators. At a point in time the DOCC and RC curves cross, which represents the time when the mine ceases to be economically viable (T1). Typically this is where mine closure becomes relevant. This point can be staved off if commodity prices lift the RC, if the DOCC can be reduced by means of cheaper production methods, or by means of the introduction of new technologies to mine deeper reserves, or to reduce the underground pillars needed to keep the roof from collapsing under pressure of the rock above. Thus T1 can be moved around within certain limits, introducing the element of scientific research and technology development as a critical variable. The third plot is the Environmental and Social Remediation Curve (ERSC),
which typically starts to manifest itself some time after mining commences, but which grows rapidly in amplitude once mine closure is reached (T1) and no further cash is available for remediation. Typically the ESRC is not a balance sheet item, being kept away from investors, effectively representing the cost of production that is externalized onto society. It is this cost that Ms. Elize Swart currently values at 100 billion South African Rand (Brown, 2007), a figure that is at best a rough estimate and certainly excludes the cost implications of human health such as treatment for cancers, loss of earnings and social disruption. It is this curve that could potentially take hundreds of years to reach maximum amplitude (Ms. Swart mentions 800 years) (Brown, 2007). In truth, these values are simply unknown because no high confidence epidemiological study has ever been conducted among off-mine populations, so the exact extent of health impacts is unknown. It is only since political emancipation occurred in 1994 that public domain funding has been spent on research into this field, so the exact extent of the problem is also largely unknown.

Using the same logic, this theoretical model can be developed a little further. The same axes apply to Figure 4 as applied to Figure 3 above. The RC is also the same, but this time a separate plot is possible. The Household Revenue Curve (HRC) represents the flow of money into a given household or community as a direct result of the mining operation. This could be from wages earned by an individual mine-worker, or it could be revenues generated by off-mine but mine-dependent enterprises like goods and services suppliers such as engineering works, supermarkets, gas stations, motorcar sales, etc. The HRC lags behind the RC and crashes dramatically after mine closure at T1. It is this crash that leaves behind destitute communities, now living on denuded landscapes, often relying on polluted water resources such as we are finding in the Wonderfontein Spruit case. It is this impact of mine closure that is not yet being considered by the Government Task Team for Mine Closure and Water Management, which is focusing instead on the narrow aspects of groundwater management as a function of mine safety, largely ignoring off-mine consequences such as the fate and pathway of heavy metals and radionuclides into environmental sinks.

**Figure 3.** Theoretical model showing the externalized costs associated with mining (redrawn from Adler *et al.*, 2007b).
Policy aspects associated with mine closure

From the case study presented above, it is evident that the South African gold mining industry poses a number of severe policy challenges. Within this basket of challenges, three are highlighted further. These are:

- Mining and human rights.
- The role of technology in extending the viable life-span of a mine.
- The issue of externalized costs and how to deal with accumulated impacts.

Mining and human rights

Article 24 of Chapter 2 of the Bill of Rights in the South African Constitution states simply that, ‘everyone has the right to an environment that is not harmful to their health or wellbeing’. It goes on to stipulate that, ‘… [this right includes an] environment [that is] protected, for the benefit of present and future generations, through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development’.

The Wonderfontein Spruit catchment is now spawning a series of political challenges that is likely to result in the very first test case to be brought before the Constitutional Court. The recent establishment of an NGO called the Randfontein Environmental Action Group (REAG), which has attracted the overt support of Advocate George Bizos (Marshall, 2007) and is now being forged into a new federation of NGO’s with the stated intention of determining the viability of a legal challenge in the Constitutional (or other) Court(s). Advocate Bizos is highly respected, having made a name for himself defending many of the victims of Apartheid, including Mr. Nelson Mandela. The nature of this court action will be to test the constitutional ruling on what is actually meant by the Bill of Rights, which will also grapple with the complex issue of inter-generational equity and the balance between, ‘ecologically sustainable development and use of natural resources while promoting justifiable economic and social development’ as stipulated in the Bill of Rights. A significant sub-component of this general thrust could conceivably be the accountability of mine...
management, if it is discovered that they were aware of possible toxic discharges and were negligent in failing to institute reasonable remedial measures. Lessons learned from the Enron case (centred on corporate governance and accountability to shareholders), and other environmental catastrophes in America, could be relevant in this regard.

The role of technology in extending the viable life-span of a mine.

While the South African goldfields are largely depleted, there are two significant known reserves as yet unexploited. The first is at great depth, where it is dangerous to mine, with costs of extraction currently exceeding the market price for refined bullion. Technologies are being developed to mine at depth, spearheaded mainly by the platinum deposits of the Bushveld Igneous Complex, which lie at great depth below complex geological stata. It is conceivable that technological breakthroughs in this area would immediately spill-over into the gold industry, effectively extending the viable life-span of current deep mines such as those found in the Wonderfontein Spruit. The second relates to the known reserves left in underground pillars in relatively shallow mines, mostly in and around Johannesburg. Conventional mining techniques dictate that pillars needed to be left in stopes in order to support the roof. This is particularly relevant in the context of Johannesburg, given that a major urban metropolis has now been developed above these mine voids, so ground stability is an important concern. New engineering technologies could see the need for these pillars becoming irrelevant, which could yield a significant volume of known gold reserves.

These two aspects make gold mining relevant in the foreseeable future, even if the industry is mature. Significantly, these technological breakthroughs would only be viable if public confidence is restored in the industry, currently battling with a tarnished reputation and a general loss of public confidence, including the simmering and as yet unresolved Brett Kebble Affair, with indictments imminent.

The issue of externalized costs and how to deal with accumulated impacts

At present there is a significant loss in public confidence, in both the mining industry, and in Government as a neutral regulating authority. This can have a potential negative impact on the national economy if left unmanaged, given that most of the shares in the mining houses are traded freely on international stock exchanges. It is possible that fickle investors could dump shares once they become aware of impending litigation. This can be potentially accelerated when a current known case of an infant having been born with significant defects, allegedly as the result of exposure to heavy metals, becomes public knowledge. It is known that this story was scheduled to be broken in early September 2007, but was pushed off the front page of a major national newspaper by a sports story, so the text has already been written and is waiting for the chance to make it past the editors red pen. (Note: It is probable that this story will have broken by the time this paper is reviewed, in which case reference will be made to that article).

There is a growing demand for a high confidence epidemiological study of off-mine populations, with known interest being shown by the Cancer Association of South Africa (CANSA) (e-mail communication dated 14/9/07). It is also known that no such public-domain studies have been done. This is likely to place considerable pressure on Government to do such studies in order to satisfy a growing public demand, but also to end speculation that existing health problems potentially arising from exposure to endocrine disruptors (agro-chemicals and birth-control hormones not effectively removed from waste water before being discharged back into rivers) is not falsely blamed on heavy metal and radionuclide exposure. In this regard a high confidence study will serve as a valuable baseline for future policy, and will enable satisfactory interventions to be developed to satisfy constitutional requirements.
and the reasonable aspirations of a public that is weary of being pushed around by a non-responsive government.

Conclusion

The nexus between mining and human rights is an important issue in contemporary South Africa. With a mining-based economy and a century of mining history, mostly in the absence of a corporate culture of accountability and a political culture of respect for human rights, the whole issue of sustainability is being examined. We know from the mining of asbestos that the externalized costs of remediation exceed the value of mineral extracted in the first place. The gold case in South Africa could give us an insight into the true cost of mining, as well as the exact magnitude of the loss of wealth as the national resource-base has been depleted in a reasonably one-way flow of money out of the country. There are two possible outcomes from this set of dynamics. The one is an erosion of confidence in Government accompanied by a simmering discontent, driven by impoverished communities directly impacted by mining. In this regard the ongoing Khutsong crisis, now in the Constitutional Court, will become a powerful barometer. The other is a reinvigoration of the core values that underpinned the Armed Struggle for emancipation from the yoke of Apartheid, and a reemphasis of the so-called miracle that accompanied South Africa’s negotiated transition to democracy via the process known as the Convention for a Democratic South Africa (CODESA). At the time of writing it is too early to predict which of these two alternatives will prevail, even as various analysts try (Groenewald, 2007). Underpinning this whole set of events is the question of how to transform mining-based development in a way that makes it sustainable in terms of inter-generational equity.

References


**Anthony R. Turton**

*Contact details:*

Unit Fellow: Natural Resources and the Environment (NRE) Council for Scientific and Industrial research (CSIR) South Africa