

Untying the Gordian Knot: Unintended Consequences of Environmental and Water Policy for the Gold Mining Industry in South Africa

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Abstract

South Africa was once the largest producer of gold in the world. Gold was central to the creation of the South African state, with revenues sustaining the pariah Apartheid state in the face of comprehensive economic sanctions and massive spending on military activities deemed necessary by the ruling party. Perceptions of state survival between 1961 and 1994 created a regulatory regime in which the state and the industry became partners, blurring the distance needed between regulator and regulatee. Policy allowed for the nationalization of environmental (specifically water) liabilities, which has passed a burden onto the current Government. Legal reform after the transition to democracy in 1994 has sought to internalize those historic externalities, through the application of Greenfields logic evident in global best practice. When applied to the Brownfields logic inherent to the gold mining sector, the unintended consequence of this policy is disinvestment, thereby hastening the nationalizing of all remaining liability. Policy reform is needed if environmental rehabilitation is to be viable, specifically in the face of uranium contamination arising from the significant flow of Acid Mine Drainage (AMD) from the now flooded voids and abandoned surface tailings dams.

Key Words

Acid Mine Drainage (AMD); National Environmental Movement Act (NEMA), Water Act, Policy Paradigm, Policy Monopoly, South Africa, Gold Mining, Polluter Pays Principle

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Untying the Gordian Knot: Policy Drivers and the Demise of Gold Mining in South Africa

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Introduction

Policy and legislation tends to follow progress in industry and the economy. This is particularly true in an emerging market, where diversification has not yet taken place to the point where a post-extractive beneficiation economy emerges after the depletion of the ore bodies that originally sustained mining. Seen in this light, policy and legislation is based on a certain set of assumptions, fleshed out during the life of mining in a given jurisdiction. What happens when the core assumptions change? Can policy and legislation guide a transition from a mining-based economy to a post-mining beneficiation economy? What role does water policy - specifically the retrospective application of the Polluter Pays Principle - play in investment decisions into the mining industry? What are the consequences of this in terms of long-term rehabilitation of mine-impacted aquatic ecosystems? This set of issues is currently at the heart of the gold mining industry in South Africa. Once the richest gold producer in the world, supplying a staggering 40% of all gold ever produced in recorded history (Hart, 2013), the Witwatersrand Goldfields are now in rapid decline. Johannesburg is one of the few cities in the world that is not on a river, a lake or a seafront – it straddles the continental divide between two major transboundary rivers in southern Africa – the Orange (discharging into the Atlantic Ocean) and the Limpopo (discharging into the Indian Ocean). Its very existence is rooted in gold mining and it has grown to become the financial hub of continental Africa (Turton *et al.*, 2006). All of this is changing rapidly however. The majority of the resource is mined out and three of the four major groundwater basins are flooded, or are in an advanced stage of flooding (Coetzee *et al.*, 2010). Acid mine drainage (AMD) is a highly acidic and heavy metal-laden water that has been decanting unabated from the Western Basin since 2002. A major engineering race is currently underway to prevent a similar environmental catastrophe happening in the Central and Eastern Basins of the Witwatersrand Gold Mining Complex. The city of Johannesburg is famous for its mine dumps, often featuring on post-cards sent by tourists back home. Yet lurking within those dumps is a staggering 600,000 tonnes of uranium, discarded as waste over the last 135 years of mining (Winde, 2006). This uranium is now being mobilized into the headwaters of these two transboundary river basins by rainfall (Coetzee, 1995; Coetzee *et al.*, 2002a; 2002b; 2005; Camden-Smith *et al.*, 2015), and distributed over a wide area of land by means of dust storms. There is little known about what the consequences of this will be for all stakeholders at different levels of scale (Turton, 2014) and water policy-makers are confused.

This begs the question – what can be done to avert an economic and social catastrophe in which environmental policy in general, and water resource policy in particular (both surface and underground) play a major role? This paper gives a closer insight into the complexity associated with policy formulation under conditions of contestation, data uncertainty and high levels of risk. The first part gives a historic overview of the evolution of water policy and mining in South Africa to serve as a contextual background to the analysis. The second part presents data on the current state of the gold mining industry in South Africa. The third part provides an analysis of the current policy approach. The analysis concludes that the failure to distinguish between environmental management in Greenfields and Brownfields developments destroys the business case for the latter, hastening the demise of the industry preventing rehabilitation initiatives in mine-impacted aquatic ecosystems from being funded.

Historic Overview of Mining in South Africa

“It’s no secret that South Africa’s once-massive gold mining industry has been shrinking for years, leaving billions of dollars in processing plants, worker housing, and pipelines at risk of demolition and the scrap yard. Seemingly keen to stave off this scenario, the government wants mining companies to find alternative uses for idled facilities to support communities and even continue to provide jobs. **“When we talk about mine rehabilitation we are not talking about just putting back the sand, but actually rebuilding those communities,”** Mines Minister Ngoako Ramatlhodi told Reuters. [This] ... presents a rosy picture of Harmony Gold ... transforming one of its disused leaching facilities into a biofuel-producing plant, but we can’t help but feel a little uneasy as to what the above statement will mean for the industry as a whole. Environmental rehabilitation is a good thing, but tough enough - community rehabilitation is a tall order. SA’s mining problems are far-reaching and difficult to surmount. In our view, the government should take every care not to burden the already overburdened industry - risking its very survival” (International Spectator November 2014, Casey Research, a confidential newsletter subscribed to by investors).

This quotation serves as a point of departure into a historic assessment of the evolution of water and environmental policy in South Africa as it pertains to the gold mining industry. The Second Anglo-Boer War was driven by Great Britain’s desire to gain control over the largest resource of gold in the known world (Pakenham, 1992). Due to the dogged persistence of the fighters in the two Boer republics, refusing to capitulate once their capital cities had been taken, a scorched earth policy was introduced (Pretorius, 2001) that involved the use of concentration camps for wives and children of the combatants (Fawcett, 1901; Krebs, 1992). The modern state of South Africa created by the Act of Union in 1910 was thus an amalgam of two vanquished Boer republics (Transvaal and Orange Free State) and two former British colonies (Cape and Natal) with a deeply entrenched collective memory of violence and inequality (Meredith, 2007).

In this context there have been five distinct phases of policy evolution (mineral, water and environmental), with three clear policy monopolies interspersed by periods of intense policy instability. This is presented graphically in **Figure 1**.

On the horizontal axis of **Figure 1** time is represented, with distinct periods of historic significance recorded as pivotal moments in the evolution of policy. There have been five pivotal events that have triggered five distinct policy paradigms (Turton, 2009). These are summarized briefly as follows:

Policy Paradigm I commenced with the formation of South Africa as a single sovereign state rising from the ashes of war (Meredith, 2007; Morris, 1971). It spans the period 1910 (Act of Union) to 1948, which was the first general election post-World War II. The key defining characteristic was British hegemony focussed on the extraction of gold and repatriation of the wealth so created back to the United Kingdom. This created all of the original legislation that gave rise to the various government departments that played a role in the regulatory aspects of mining from that date forth. There was no emphasis on water or environmental management at this time, creating **Policy Monopoly I** based on simple extraction.

Underpinning this period of time was the growing discontent by certain Afrikaner political elites, all of whom had living memory of the British concentration camps, collectively wanting to regain the freedom lost during the Anglo Boer War (Liebenberg, 1987a). Running parallel to this process was a growing political consciousness among the disenfranchised Black majority (Karis & Carter, 1972; Liebenberg, 1994; Mbeki, 1984).

The significance of **Policy Paradigm I** from a water resource perspective is that the main focus was on the building of hydraulic infrastructure to act as a foundation for the growing economy, with no emphasis on water quality.

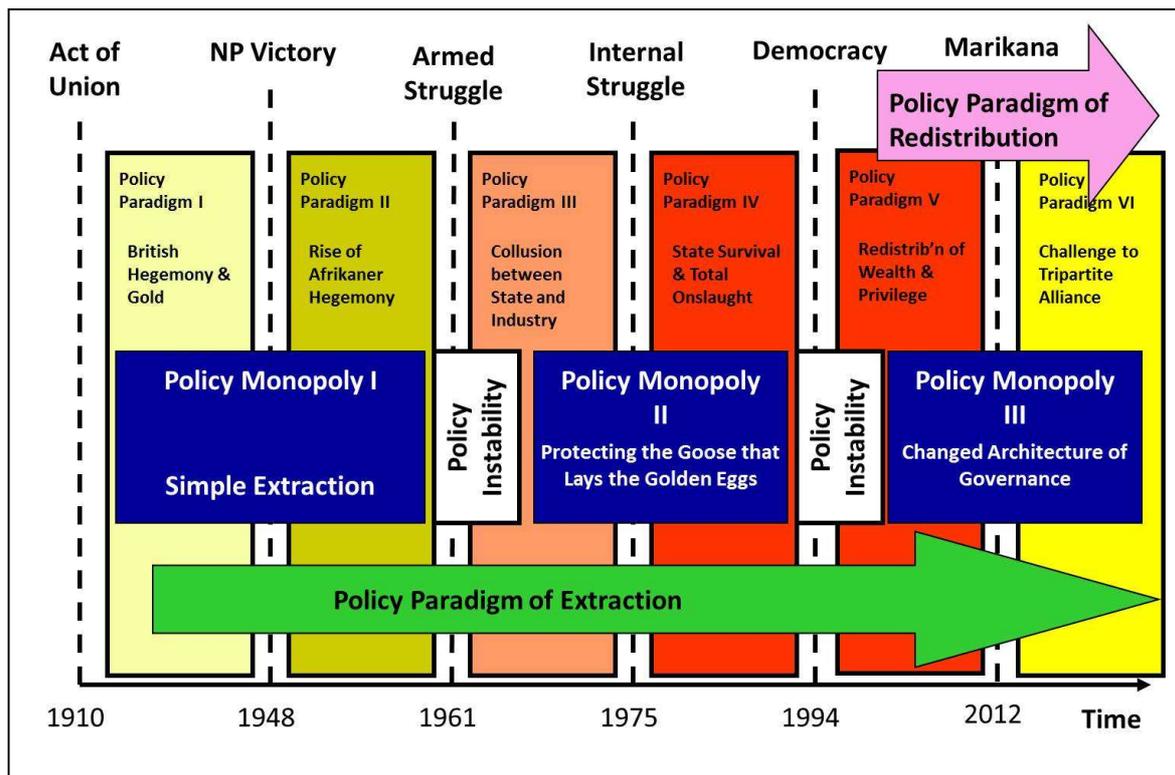


Figure 1. The evolution of policy as it relates to water and environmental management in the mining sector over time (Turton, 2009).

Policy Paradigm II occurred from 1948 to 1961 after the Nationalist Party (NP) won the first election victory in the post Boer War era (Meredith, 2007; Turton, 2009). This did not change the policy focus in any way, merely rearranging the locus of political power away from British hegemony back into Afrikaner (Boer) hands once again. Water policy was encapsulated by the Water Act (1956) that was essentially focussed on building infrastructure for irrigated agriculture and the needs of a newly industrializing economy (Turton *et al.*, 2004). While this did require mining companies to take measures to prevent pollution arising from their activities, the impact of that pollution on water resources was not yet quantified.

These first two policy paradigms were about simple extraction without any regard to environmental or social issues, creating **Policy Monopoly I** – simple extraction. Where water was relevant to policy it was primarily driven by the need to build infrastructure, with a secondary objective being the management of water quality, which at that time was still of a relatively high standard.

In 1961 a period of intense policy instability was experienced when the Armed Struggle was born out of an event that came to be known as the Sharpeville Massacre² when protesting black citizens were shot by police (Tyler, 1995). South Africa became a Republic and was expelled from the British Commonwealth after the policy of racial segregation (apartheid) was legislated (Geldenhuys, 1990). Thus began its slow passage to subsequent international isolation as a pariah state under comprehensive economic sanctions (Liebenberg, 1987b) that played a significant role in the evolution of subsequent policy.

Policy Paradigm III thus emerged from a period of intense policy instability underpinned by a major loss of investor confidence and the withdrawal of foreign investment on a significant scale (Meredith, 2007). Central to this was the restoration of investor confidence by means of the **Jordaan Commission of Enquiry** (Turton *et al.*, 2004) that opened up the deep level reef too dangerous to mine because of the perched dolomitic aquifer located in the Far Western Basin (Jordaan, *et al.*, 1960). In effect between 1961 and 1975 the state ceased to be an independent regulator of the mining industry, with growing collusion between both parties with a shared objective of maximizing profits – and thus taxes to the State – by externalizing liabilities as far as possible. This gave rise to **Policy Monopoly II** that was about protecting the goose that laid the golden eggs.

The significance of **Policy Paradigm III** from a water resource perspective is that it was during this period of time that the aggressive phase of the national Hydraulic Mission occurred (Blanchon, 2001; Turton, 2000; Turton *et al.*, 2004). This was manifest as major investment into water infrastructure, with a view to developing the economy in the face of international isolation, by developing the coal and energy sectors while using the revenue from gold to sustain the embattled state. It was during this time that the oil from coal technology was pioneered as a strategic initiative under the brand name of SASOL; and it was also during this time that ESKOM (national electricity producer) underwent a massive period of growth underpinned by the inter-basin transfer of water as a matter of national priority but impacting other countries in the region (Basson, 1995; Basson *et al.*, 1997; Blanchon & Turton, 2005; Heyns, 2002).

In 1975 the regional balance of power changed when Portugal announced its withdrawal from the various wars of liberation in Lusophone Africa. This made the Rhodesian Bush War unwinnable with a second front opening up in Mozambique (Martin & Johnson, 1981), triggering a ripple effect in Angola (Venter, 1975). South Africa became embroiled in various local wars of liberation (Turner, 1998), draining massive sums of money from the fiscus. Significantly South African military involvement in Angola was triggered when engineers working on the Calueque Hydroelectric project (part of the national hydraulic mission) were taken hostage. This triggered a policy response from the South Africa government based on the concept of a “Total Onslaught” and focussed on the need for state survival, underpinned by military intervention, in a perceived Cold War theatre of operations (Gutteridge, 1983). Manifesting as the need for a “Total Strategy” based the writing of a French strategist at that time (Beaufre, 1965; Brodie, 1965), this became embedded in the water sector as part of the Lesotho Highlands Water Project (Blanchon & Turton, 2005; James, 1980). **Policy Paradigm IV** was thus about state survival in the face of a perceived total onslaught as a localized theatre of the Cold War (Geldenhuys, 1984).

² See http://en.wikipedia.org/wiki/Sharpeville_massacre for more information.

The significance of **Policy Paradigm IV** from a water resource perspective was that yet again, there was no significant place in this policy framework for environmental and social concerns that were starting to manifest in the mining sector. Water was increasingly seen as a strategic issue with major interventions in the form of supply-sided engineering, often in transboundary rivers in which inter-basin transfers played a key role (Basson, 1995; Basson *et al.*, 1997; Turton, 2000; Turton *et al.*, 2004). There was one notable new development in water policy at this time. As a direct response to the deteriorating national security situation in 1975, attention was again drawn to the mining industry as a key element of state survival during the Cold War. A significant policy reform took place in late 1975 when the Fanie Botha Accord³ - named after the then Minister of Water Affairs - was negotiated between the gold mining industry and the government regulatory authority. In terms of this the following became key elements of water policy for the mining sector:

- Pollution control measures abandoned by mining companies prior to 1975 would become the responsibility of the State.
- Where mines own the land on which such pollution had occurred, they would facilitate the transfer to the State, effectively nationalizing the liability accrued prior to 1975.
- Where the mining company only owned the mineral rights but not the land, then they would be required to assist the State in acquiring that land for purposes of consolidating the liability, effectively taking it off balance sheet and nationalizing it.
- Where mining had ceased before the promulgation of the **1956 Water Act**, but had disposed of its mineral rights, then the company was not required to assist the State in acquiring land for pollution control structures.
- Provided that mining companies had taken steps to control pollution based on the **1956 Water Act**, the State would assume management of all pollution control works after mining had ceased.
- When mining ceased on specific land, the mining company had the right to develop that land for other purposes, with the management of pollution control arising from mining reverting to the State, provided that such measures had been approved by the State during operations. Pollution control measures arising from the non-mining activities would then become the sole responsibility of the mining company, the State assuming full liability for the mining-related pollution.
- Should a mining company wish to return to old mining operations for whatever reason after the State had assumed liability, then such company would only be held liable for pollution control measures arising from the new activities.

In effect then, the **Fanie Botha Accord** nationalised all liabilities prior to 1975, on the condition that pollution control devices had been installed and approved in terms of the **1956 Water Act**. This enabled revenue to the embattled State to be maximized by removing significant liabilities off the collective balance sheet of the mining companies (see **Figure 2**). **Policy Monopoly II** thus consolidated **Policy Paradigms III & IV**, centred solely on the protection of the gold mining industry, by externalizing and nationalizing all environmental liabilities as a perceived means of state survival. This gave rise to the period known as the “Midas Touch” in which South Africa was able to counter growing internal insurgency while fighting a series of external wars (Geldenhuys, 1983; 1984) using the minerals complex as a core revenue source (Gutteridge, 1984). In effect the state ceased to regulate the gold mining

³ Summarized here from correspondence between the Chamber of Mines and the Department of Water Affairs between 4 November 1975 and 19 January 1976.

industry, allowing instead for self-regulation in the absence of democratic oversight in exchange for a greater flow of funding to meet the State's increasing dire financial requirements.

Policy Paradigm V was triggered by an intense period of policy instability associated with the final days of the Armed Struggle in which South Africa nudged close to a fully-fledged civil war. The pivotal moment came when South Africa adopted a democratic constitution in 1994. This triggered a new paradigm of redistribution of wealth and privilege under **Policy Monopoly III**, which was all about a changed architecture of governance. Tension now exists between the old policy paradigm of extraction and the new policy paradigm of redistribution. *More importantly emphasis is now placed on State capacity as a regulator, without the institutional memory needed to underpin that process.* The Marikana crisis in August 2012⁴, resembles the policy instability triggered by the Sharpeville Massacre in 1961, potentially giving rise to an as yet ill-defined **Policy Paradigm VI**, which for the purposes of this paper will be called "Challenge to the Tripartite Alliance" because of the emergence of a new trade union and the implosion of the Confederation of South African Trades Union (COSATU) that had played such a pivotal role in the democratic transition (COSATU, 2014). *In the absence of robust State capacity to effectively apply the laws and policies, as well as provide strategic leadership in an environment where critical decision-making occurs at the company level, underpinned by the inability to make adaptive responses in the form of policy reform, this is now accelerating the demise of the industry.*

The significance of **Policy Paradigm V** from a water resource perspective was the nationalization of all water-related liabilities in return for increased revenue flows to the fiscus. The unintended consequence of this relates to the application of the Polluter Pays Principle, along with other environmental management principles, in a retrospective manner that now manifests as a constraint to investment in highly impacted aquatic ecosystems draining Brownfields sites in critical need of rehabilitation.

Understanding Policy Monopoly II – The Externalization of Costs Model

An analysis of these policy dynamics was done by the principal author and his team at the Council for Scientific and Industrial Research (CSIR) in 2006-2007 (Adler *et al.*, 2007a) as part of the Mining, Minerals and Sustainable Development (MMSD) Program. From this a model was developed (**Figure 2**) to illustrate the economics of gold mining in South Africa (Adler *et al.*, 2007b).

On the vertical axis we have value with time represented on the horizontal axis. The **Development Cost Curve (DCC)** represents the cost of developing a given mine, peaking at value **V1**. The **Revenue Curve (RC)** is out of phase with the **DCC**, representing the flow of cash after the mining infrastructure (shafts, processing plant etc) has been developed, peaking at value **V2**. The profit of the given mining operation represents the area beneath the **RC** minus the area beneath the **DCC** (refer to **Figure 4**). The revenues arising from mining in the form of job creation are shown as the **Mining Livelihoods Curve (MLC)**. This includes the wages accrued from all mining-related activities, both on and off the site. At a moment in time the **RC** and **DCC** reach a nil value (**T1**) when mining ceases to be economically viable. This is called mine closure and is characterized by a dramatic fall in wage remittance (**MLC**) arising from the cumulative effect of the collapse of mining-related employment. This causes

⁴ See <http://marikana.mg.co.za/> and http://en.wikipedia.org/wiki/Marikana_miners'_strike.

catastrophic social collapse in an area around the mine concerned, often associated with the decline in the economic viability of many small towns, accompanied by an increase in crime as alternative livelihoods are sought. These Brownfield sites almost always manifest with severely degraded aquatic ecosystems in critical need of rehabilitation.

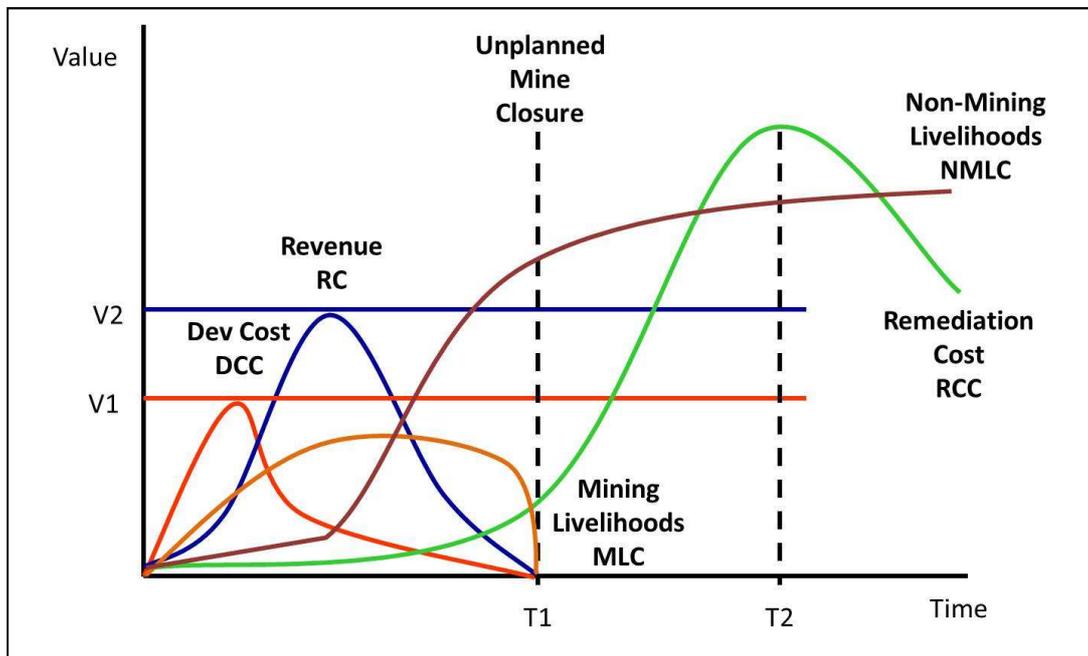


Figure 2. Economic model showing the flow of money over time from a given mining site, by specific source of cost or revenue. Policy Monopoly II (see Figure 1) saw the removal of all significant environmental liabilities from the balance sheet in order to ensure state survival by maximizing taxable revenues. This means there is insufficient money set aside to fund post-closure rehabilitation of mine-impacted aquatic ecosystems.

When mine closure occurs (**T1**) *it does not necessarily mean that the resource is totally depleted, merely that the cost of extraction exceeds the potential value under the prevailing set of regulatory conditions*⁵. At this time the environmental liabilities, shown here as the **Remediation Cost Curve (RCC)** are not yet fully manifest. These increase rapidly after mining stops and the pollution control devices reverted to the State (in terms of the 1975 **Fanie Botha Accord**), peaking at an unknown value $>V2$ at an unknown time in the future (**T2**). In essence then, the externalization of costs model was deliberately introduced by an embattled pariah state between 1975 and 1994 (**Figure 1**), enabling mining companies to show substantial profits by removing all environmental (and thus social and economic) liabilities off their balance sheets, but now manifesting as a constraint to future economic development post-mining. The **Non-Mining Livelihood Curve (NMLC)** was never considered by the regulator at the time and will be dealt with later in this paper.

The water and environmental policy challenge inherent to **Policy Paradigm VI** is thus centred on the need to transition from an extractive to a post-mining beneficiation type of national economy in which externalized environmental liabilities now manifest as constraints

⁵ The current regulations mean that new investors into old sites are expected to pay a deposit in cash calculated to be equal to the cumulative liability associated with the site. This is a regulatory issue that could be changed to incentivize investment into such sites with a view to extract the remaining resource to fund rehabilitation.

to investment and job creation. *More importantly insufficient capital has been accrued to fund rehabilitation, so attempts by the State to re-internalise those liabilities in order to make up this financial shortfall, act as a disincentive to new investment by destroying the business case for Brownfields operations. The retrospective application of the Polluter Pays Principle is thus inappropriate as a policy instrument if the rehabilitation of mine-impacted aquatic ecosystems is to be viable.*

Demise of the Gold Mining Industry in South Africa

Noting the evolution of policy over time, it now becomes instructive to analyse the performance of the gold mining industry with a view to assessing its remaining useful life. More importantly it is necessary to determine when gold mining will cease in order to better understand the water and other policy reform needed to ensure a soft landing as we transition from an extractive economy into a post-mining economy in which historic environmental externalities now manifest as constraints to investment, aquatic ecosystem rehabilitation and job-creation.

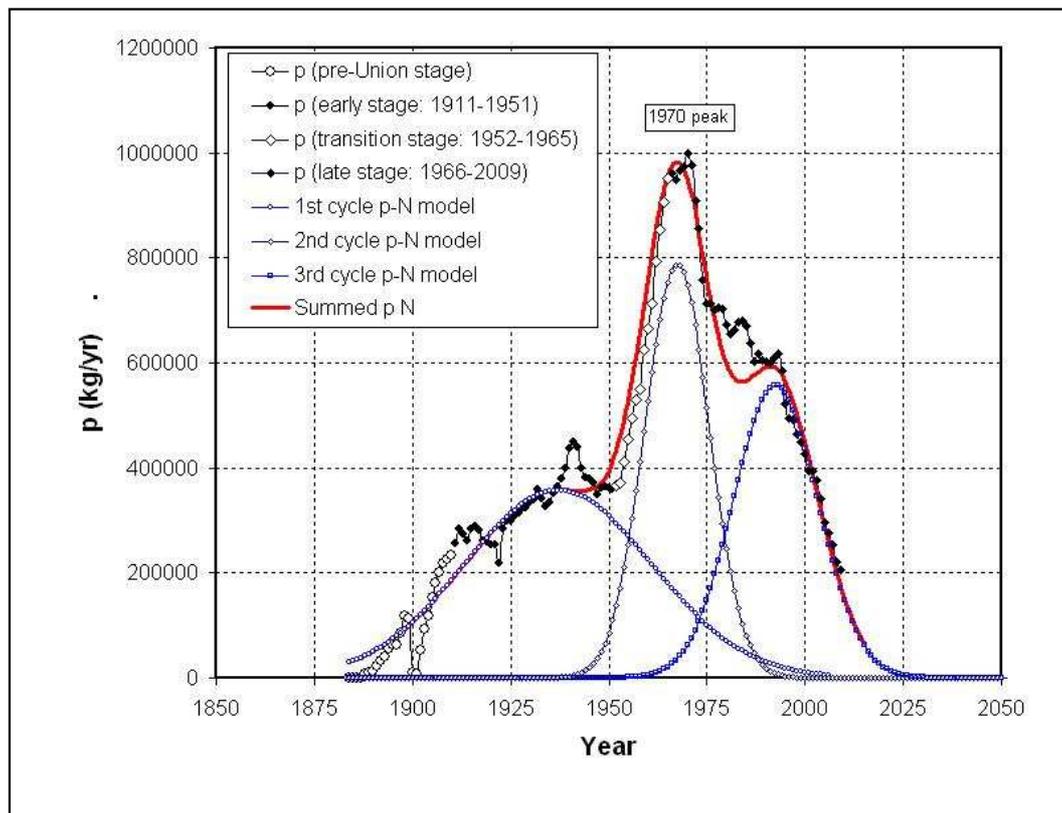


Figure 3. A statistical analysis of production from the Witwatersrand Goldfields reveals three discrete sub-cycles (Hartnady, 2009; GDARD, 2011). The third sub-cycle could create a soft landing by extending the life of marginal mines provided that policy reforms are implemented.

A statistical analysis of the Witwatersrand Goldfields production (Hartnady, 2009), based on Hubbert Theory⁶ as used by Campbell and Laherrère (1998), was used to inform the Gauteng

⁶ See http://en.wikipedia.org/wiki/Hubbert_peak_theory

Department of Agriculture and Rural Development (GDARD) assessment of the policy implications arising from the many mine residue areas (MRA's) around Johannesburg (GDARD, 2011). These MRA's are home to around 1.6 million people mostly living in informal settlements on the 5,445 ha of hazardous mine residues that could be rehabilitated (Tang & Watkins, 2011). This analysis is presented as Figure 3.

From this assessment it is evident that production peaked in 1970 with a rapid near linear decline subsequent to that. There are three discreet sub-cycles. The first peaking in about 1930 was driven by shallow mining in the Eastern, Central and Western Basins (Davenport, 2013). The second peak was driven by deep level mining, most notably in the Far Western Basin, after the decision was made by government to dewater the massive dolomitic aquifer that was perched above the reef (Jordaan *et al.*, 1960) in order to accelerate economic growth during **Policy Paradigm III (Figure 1)**. *The third peak is not well defined, being driven by improvements in metallurgy that enables gold to be extracted from old tailings dams, along with improvements to engineering processes that allow safe pillar extraction (Grice, 1998), manifesting as a brief interruption to the otherwise linear decline. This could become significant if the necessary policy reform takes place as suggested later in this paper.* A central characteristic of this analysis is the sharp decline in production during **Policy Monopoly III (see Figure 1)**.

In this regard the senior gold analyst working for the Old Mutual Gold Fund Manager stated the following on 17 June 2014:

“Predicting the future of gold mining in South Africa has become easy. ... Having peaked in 1970, it has fallen to a 109-year low of 167 tons in 2012 *For exactly 20 years now [i.e. coinciding 100% with Policy Monopoly III], SA's declining output has followed a distinct linear pattern* (if we disregard the effect of the 2012 strike). In itself, this is highly remarkable *since it has completely disregarded the law of price elasticity: no supply response at all following bullion's spectacular price increase after 2001*... After more than 135 years ... SA is likely to hoist its last skip of gold-bearing ore from the once giant Witwatersrand deposit in 2019... Some 130 000 direct jobs will be lost, with many more disappearing on the periphery in goods and services. By 2020, some R25bn of earnings annually will have stopped flowing to employees. Sadly, the poor will be particularly hard hit in the labour-supplying areas, where mineworkers tend to have many dependants” (Schroder, 2014.)

This problem has been exacerbated by five significant drivers that need to be understood, because they act as significant constraints to water policy implementation:

Firstly, mine workers are extremely well organized, having been a central feature of the struggle for democracy in South Africa. They have successfully managed to negotiate wages significantly higher than peer cohorts in other jurisdictions. The living wage demanded for rock drill operators by the militant union AMCU⁷ (Association of Mineworkers and Construction Union) during the 2012 Marikana strike of ZAR 12,500.00 per month (ZAR 10.00 = US\$ 1 approximately), which broke the Tripartite Alliance (**Policy Paradigm VI**), compares favourably against a similar cohort in Russia (ZAR 1,666.00), China (ZAR 2,184.00), Zimbabwe (ZAR 2,406.00) and Peru (ZAR 2,839.00) (Schroder, 2014). This

⁷ See http://en.wikipedia.org/wiki/Association_of_Mineworkers_and_Construction_Union

statistical fact becomes starkly relevant when one considers that in 2012 a South African mine worker produced 39% less gold per worker than he did in 2002 (Schroder, 2014). Union demands have been systematically decoupled from productivity (see the **MPC 2** trajectory in **Figure 5**) and this is now acting as a significant disincentive to foreign direct investment. This is directly reflected in the Fraser Institute survey of mining jurisdictions (**Table 1**), where *South Africa now ranks 109 out of the 112 jurisdictions listed on labour relations, with an astonishing 17% of respondents saying they would not invest in South African mining due to the current state of labour relations* (Wilson & Cervantes, 2013).

Secondly, policy reform in the environmental field has been radical in the post 1994 transition to democracy. In effect, the historic legacy of mining, centred on the deliberate regulatory approval of the externalization of environmental and other liabilities during **Policy Monopoly II** (1961 – 1994) (see **Figure 2**), has been reversed. All mining operations are now expected to internalize historic externalities by paying a significant cash deposit up front (NEMA, 2014). The Polluter Pays Principle, enshrined in the National Water Act and accepted as international best practice, is increasingly the focal point of anti-mining activists, relentlessly applying pressure on old and marginal mining operations that are simply incapable of reversing the legacy of **Policy Monopoly II**. This has become an additional disincentive to foreign direct investment by failing to distinguish between Greenfields (with 100% of the mineral resource available to fund rehabilitation) and Brownfields operations (with insufficient economically viable mineral resource left under prevailing regulatory conditions).

Thirdly, the acid mine drainage (AMD) issue that burst into the public arena when decant to surface was reported by the media in the Western Basin in 2002 has given rise to a growing narrative of blame-seeking (Coetzer, 2008; Noseweek, 2009; Segar, 2013) that has an inherently high conflict potential (Botha, 2013). An increasingly angry public opinion, moulded by anti-mining activists, makes no attempt to understand that the current situation is a manifestation of a policy failure between 1961 and 1994 (**Policy Monopoly II (Figure 1)**) and not the deliberate intention of a seemingly reckless mining industry. Of even greater concern is the growing evidence that points towards uranium contamination as being a largely unquantified but significant risk that is just beginning to be recognized (Camden-Smith *et al.*, 2015; Coetzee, 1995; Coetzee *et al.*, 2006; Toffa, 2012; Turton, 2014; Wade *et al.*, 2002; Winde & van der Walt, 2004; Winde, 2010).

Fourthly, the only significant land left to develop in and around the city of Johannesburg is located on MRA's (GDARD, 2011). The uncontrolled settlement of around 1.6 million people is a growing risk, given the toxic nature of the mine tailings and the geotechnical instability caused by shallow undermining from illegal artisanal miners (Tang & Watkins, 2011; Toffa, 2012). This means that government has a tough decision to make: either move the hazard from the people; or move the people from the hazard (GDARD, 2011). The latter is unlikely given South Africa's experience with forced removals, leaving the rehabilitation of MRA land the only viable option, unless the State is willing to assume this responsibility as mining companies inevitably become insolvent. Given the experience of the Tudor Shaft case (SERI, 2013), a small uranium-rich dump on the West Rand that has seen environmental activists oppose all attempts at implementing both options (Bega, 2012; Segar, 2013), the prognosis for rehabilitation of mine-impacted aquatic ecosystems seems bleak as the overall policy framework currently stands.

Finally, the collapse of the formal mining sector has given rise to a burgeoning illegal artisanal mining community, currently accounting for the loss of a staggering ZAR 5 billion per annum (Hart, 2013; Wolmarans, 2013). This is also closely associated with sophisticated criminal syndicates that use the gold bullion for money laundering on an international scale. As mines become insolvent, they are stripped out by gangs that attack the remaining mineral resource, which is enough to sustain informal mining for more than a century. The unintended consequences of this have been revealed from the Grootvlei⁸ and Blyvooruitzig⁹ cases, both of which have resulted in a sharp increase in criminal activity once formal mining ceased to be economically viable and the failure of the mining company caused unplanned closure to occur (**T1** on **Figure 2**).

Unintended Consequences of the Current Policy Approach

The outcome of these five significant drivers presents as a classic dilemma confronting the government as well as invested mining companies. The policy response thus far is not informed in any way by the historic legacy of mining, or the unintended consequences arising from **Policy Monopoly II** (Naidoo, 2014). *In the absence of evidence-based policy reform, attempts by the State to accrue the capital needed for post-closure rehabilitation, have incentivized the acceleration of the nationalization of remaining liability, by discouraging investment into Brownfields operations.* The aggressive application of the Polluter Pays Principle, without taking cognizance of this complex legacy, amounts to the retrospective implementation of policy that is simply unworkable if the rehabilitation of mine-impacted aquatic ecosystems is to attract the magnitude of investment needed.

An economic model capable of asking what/if questions needed for policy analysis is shown in **Figure 4**. On the vertical axis two monetary values are represented. On the left hand axis the comparative value at any given time is shown as both a positive and negative quantum, with 10 arbitrarily selected as being the peak, equivalent to **V2** in **Figure 2**. On the right hand axis the cumulative value is expressed as a percentage of the total cost of remediation, representing the **RCC** in **Figure 2**. Value **CV1** represents the legally required cash deposit to cover the cumulative environmental liability that was nationalized during **Policy Monopoly II** should a company wish to invest into the Brownfields site today. At zero cumulative value there is 100% of the mineral resource in the ground and no pre-mining work has been undertaken, with no liability at the start of mining. At 100% cumulative value, there is zero mineral resource that can be viably extracted from the ground from which to fund rehabilitation, thereby representing the full cost of remediation required at that point. The important point to note is that when **T1** occurs, for illustrative purposes there is still some of the mineral resource left in the form of crown, shaft and stope pillars, as well as residual gold left in tailings from older, less efficient metallurgical processes. Unplanned closure occurs only when the commercial viability ceases, based on current regulatory assumptions and the social cost structure. The **Cumulative Rehabilitation Requirement Curve (CRRC)** is the quantum of funds required to rehabilitate the impacted land and water resources at that particular time in the mining project. Thinking about it as vertical lines, the rehabilitation is 100 (as it is accumulative) where the revenue bell curve is cut into each unit of time; and the vertical lines bisecting the bell curve summed to give this value. It is thus a multiple of the total rehabilitation amount and the revenue needs to cover CAPEX, OPEX, rehabilitation costs and profit for there to be a viable project.

⁸ See <http://www.iol.co.za/business/companies/grootvlei-mine-now-stands-in-ruins-1.1075667#.VGMmhfaLIU>

⁹ See <http://www.moneyweb.co.za/moneyweb-mining/blyvooruitzicht-the-fallout-from-a-gold-mines-clos>

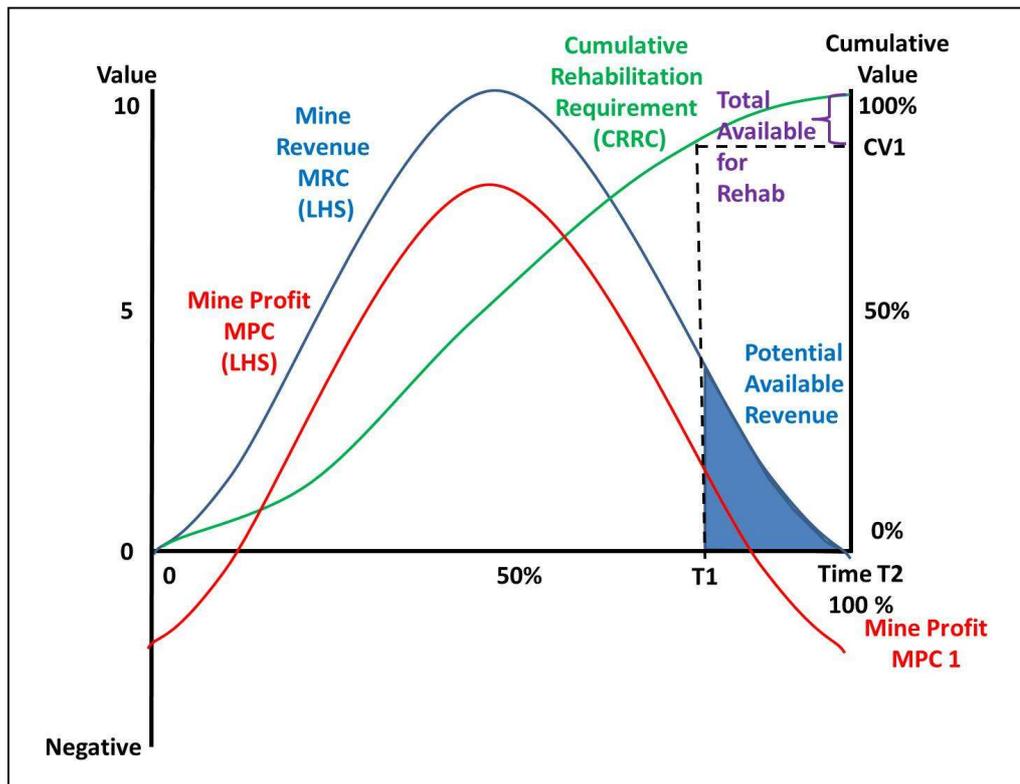


Figure 4. Model showing the unintended consequences of Policy Monopoly II.

Once again the significance being that *when T1 occurs, the majority of the resource has been extracted, but there is still some remaining on which future rehabilitation can be based, provided that the policy response accepts that the remaining resource is insufficient to carry the accrued liability of all past mining.*

On the horizontal axis time is expressed as a percentage needed to totally deplete the mineral resource as a viable mining operation from an original pristine pre-mining value. The time value shown as **T1** represents the day that the regulatory regime changes the economic viability by materially altering the cost structure. In the case of the Witwatersrand Goldfields, this happened at the start of **Policy Monopoly III** in an attempt to overcome the shortcomings of **Policy Monopoly II**. *Importantly this does not represent the total depletion of the mineral resource.* The **Mine Revenue Curve (MRC)** in **Figure 4** is identical to the **RC** for a specific mine (**Figure 2**) or the bell curve shown for the entire industry in **Figure 3**. The **Mine Profit Curve (MPC 1)** represents the difference between the area under the **RC** and **DCC** shown in **Figure 2**.

Seen in the context of the historic evolution of mining policy shown in **Figure 1**, most notably in light of the **Fanie Botha Accord** that was a feature of **Policy Paradigm IV** and **Policy Monopoly II**, there has been insufficient capital set aside to fund post-mining rehabilitation of the magnitude defined by the value of the **CRRC**. If one applies that retrospectively, at the time of mine closure (**T1**) when the majority of the mineral resource has been depleted, with the remaining being marginal at best – as required by the NEMA (2014) amendment – in order to fund 100% of the accumulated liability (**CRRC**), then it simply destroys the business case by making such a venture unattractive to any investor. This

drives the inevitable outcome of insolvency for all remaining marginal mines, consistent with the non-elasticity of the supply curve in **Figure 3** highlighted by Schroder (2014). The unintended consequence of this is that the rehabilitation of mine-impacted aquatic ecosystems and landscapes naturally reverts to the State, with limited technical capacity and insufficient funds with which to accomplish this complex task.

This need not be the case however, given that at **T1** there is still some of the mineral resource left in the ground. If policy reform is initiated, then the case shown in **Figure 5** is possible.

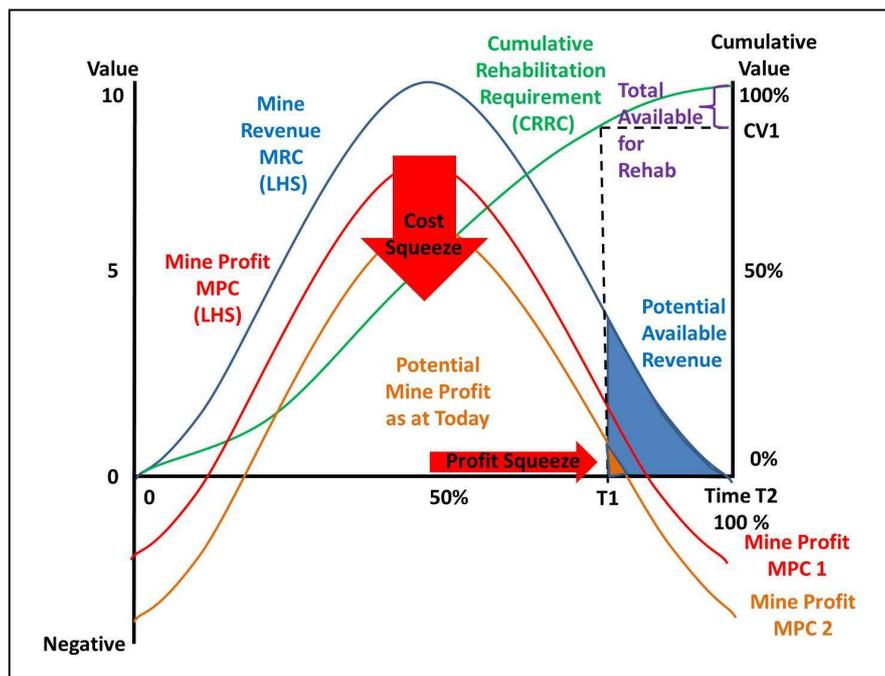


Figure 5. Model showing that sufficient profit can attract direct investment into Brownfields sites, provided that policy reform differentiates this reality from Greenfields logic.

If one accepts that when unplanned closure occurs (**T1**) there is still a quantum of the mineral resource remaining, then the potential available revenue to fund the shortfall arising from the **Fanie Botha Accord** is represented by the area beneath the **MRC** between **T1** and **T2** and above **CV1**. The revenues available to rehabilitate Brownfields sites is reflected in the triangle shown as **Potential Revenue** beneath the **MRC**. There is no relationship between the area under this portion of the curve and the revenues needed for full rehabilitation. The revenues needed are the value of the **CRRC** at any given point in time and are naturally small under such circumstances, reflected as the small red triangle beneath **MPC 2**. While the total available for rehabilitation is small, it not insignificant when one considers the harsh consequences of the alternative - a nationalized liability with limited state capacity to rehabilitate (Turton, 2014). Profits are going to be materially smaller as the differential between the **MRC** and **MPC** is **OPEX** and any further required **CAPEX** (**Note**: the curves are not to scale for illustrative purposes). This is where the Minister's comment noted above becomes relevant. If mining is to effectively become part of the solution by rebuilding communities (International Spectator November 2014, Casey Research), then the only possible way is to unlock the potential found in non-mining livelihoods (**NMLC** shown in

Figure 2). The way that this can be accomplished is to incentivize the following through policy reform:

- Distinguish Greenfields logic from Brownfields circumstances where 100% of the liability has been accrued, but only a limited amount of the mineral resource is left to fund possible environmental and social rehabilitation.
- Create a relatively uncontested vision for a post-closure landscape and environment for use as a blueprint for potential rehabilitation (Juwet & Lyssens, 2014).
- Quantify the cumulative impacts of mining in a given hydrological management unit that need to be mitigated by an integrated closure strategy (Mudd, 2007; van Tonder & Coetzee, 2008).
- Encourage investment into Brownfields sites by allowing for the quantification of benefits arising from the removal of hazards such as surface tailings dams, unmitigated AMD flows, geotechnical instability caused by shallow undermining and accumulation of uranium and other metals in wetlands as defined by the vision.
- Once these potential benefits have been quantified, bring them onto the balance sheet in a transparent way in order to offset the liabilities currently acting as a disincentive to investment into Brownfields sites.
- Quantify the potential for cumulative positive downstream impacts arising from wetland and other rehabilitation upstream in rivers, enabling this to become a multiplier of sufficient magnitude to further incentivize investment into Brownfields rehabilitation.
- Create the necessary regulatory oversight that measures performance in achieving rehabilitation targets, thereby allowing them to be offset against existing liabilities, rather than expect a hefty cash deposit to be made as required by NEMA (2014).

The **NMLC** shown in **Figure 2** needs to be better understood, because only by stimulating off-mine jobs can the impact of the **RCC** be negated. In Brownfields sites, this is constrained by the small value of the potential revenue shown in **Figure 5**. This suggests the need for the quantification of benefits that can be used to offset liabilities that will inevitably fall to the State when the last few mining companies become insolvent by 2019 (Schroder, 2014). In Greenfields sites this is not a constraint, so increased attention should be given to stimulating off-mine livelihoods over the life-span of the mine concerned. In both of these scenarios the social licence to mine, triggered by the Marikana tragedy, will become increasingly relevant, even if it has not yet been captured by policy or codified into law.

A Bite of the Reality Sandwich – Harsh Lessons to be Learned

The unintended consequences of current environmental and water policy are that the Marikana Massacre¹⁰ has become to the African National Congress (ANC) in 2012, what the Sharpeville Massacre became for the Nationalist Party government in 1961. Both were watershed events in which policy instability became a predictable outcome. The handling of both by the State was a determinant of investor confidence going forward. Both defined the capacity of the State to survive under conditions of high risk and inherent social instability. The first triggered an internal uprising based on an armed insurrection, whereas the second has spawned the polarization of the trade union movement accompanied by the emergence of fascist style politics and vigilante action underpinned by a significant loss of investor confidence (Wilson & Cervantes, 2013)(**Table 1**). **Policy Paradigm VI** arose in 2012 when

¹⁰ See <http://www.enca.com/marikana> for more details.

events at Marikana revealed the magnitude of the unresolved social tension between the **Policy Paradigm of Extraction** and the **Policy Paradigm of Redistribution (Figure 1)**. Seen as a sub-set of the complex whole, water policy plays a small but significant role. Without policy reform, the Gordian Knot inherent to **Policy Paradigm VI** cannot be undone. Central to this impasse is the increased confusion and complexity with the Department of Environmental Affairs (DEA) seeming to cut across into the Department of Mineral Resource (DMR) and the Department of Water and Sanitation (DWS) territory. There are also different regulatory bodies where the radioactivity component of uranium is a factor.

A global survey of mining companies (Wilson & Cervantes, 2013) summarized in **Table 1** has shown that *South Africa is currently ranked as one of the worst mining jurisdictions for the categories Regulatory Duplication and Inconsistency*. Significantly political instability is also listed as a major perceived risk and thus constraint to investment. If political violence and vigilantism becomes a key element of **Policy Paradigm VI**, then self-imposed economic sanctions will continue to cripple the economy exactly as externally imposed economic sanctions did during **Policy Monopoly II**.

Table 1						
Summary of a Survey of Mining Jurisdictions as rated by Industry Executives						
Top Four Categories						
(see Note 1 below for interpretation)						
	% score	of 112		Quartile		
Policy Perception Index	39.8	64		1 to 28		
Best Practice Mineral Perception	65	37		29 to 56		
Investment Attractiveness	54.7	53		57 to 84		
Current Practice Mineral Potential	37	55		85 to 112		
Room for Improvement	30					
Fifteen Questions asked of Mining Executives Around the World						
(see Note 2 below for interpretation)						
	A	B	C		D	Best Jurisdiction
Uncertainty Concerning the Administration, Interpretation and Enforcement of Existing Regulations	72	85	4		58	Western Australia
Uncertainty Concerning Environmental Regulations	53	69	8		30	Namibia, Wyoming USA
Regulatory Duplication and Inconsistencies (including federal/provincial & interdepartmental overlap)	69	83	2		33	Eritrea
Legal System (fairness, transparent, non-corrupt, timely, efficiently administered, etc.)	64	63	6		50	New Brunswick Canada
Taxation Regime (includes personal, corporate, payroll, capital and other taxes and complexity of tax compliance)	53	72	6		38	Alberta Canada
Uncertainty Concerning Disputed Land	70	97	2		38	Ireland

Claims						
Uncertainty About Which Areas Will Be Protected as Wilderness, Parks or Archaeological Sites	45	57	10		25	Burkina Faso
Quality of Infrastructure (including access to roads, power availability, etc.)	26	32	22		60	Finland
Socioeconomic Agreements/Community Development Conditions (includes local purchasing, processing requirements, supplying social infrastructure)	53	73	6		47	France
Trade Barriers -Tariff and Non-tariff Barriers (restrictions on profit repatriation, currency restrictions, etc.)	43	63	17		51	Sweden
Political Stability	72	85	8		75	Alberta Canada
Labour Regulations, Employment Agreements and Labour Militancy/Work Disputes	81	109	0		45	Sweden
Quality of Geological Database (includes quality and scale of maps, ease of access to information, etc.)	23	42	23		78	Ireland
Security Situation (including physical security due to threat of attacks by terrorists, criminals, guerrillas etc.)	59	83	4		85	Minnesota USA
Availability of Labour and Skills	45	66	24		63	Ireland
Note 1: The Top 4 Categories are general perceptions, being an overall view on policy, attractiveness of minerals applying best policies and overall investment attractiveness (weighted 40% policy perception and 60% mineral resource).						
Note 2: The Fifteen Questions asked of mining executives around the world. They rated on 1 - 5, factor encourages investment to would not invest. Column A - % of respondents answering 3 (mildly deters investment), 4 (strongly deters investment) or 5 (would not invest due to this factor). Column B - Ranking out of 122 jurisdictions for this factor. Column C - % of respondents answering 1 - this factor encourages investment. Column D - % of respondents in the top rated jurisdiction for this factor answering 1 - this factor encourages investment.						
Source: Wilson & Cervantes (2013).						

Clearly the global mining industry is not opposed to environmental regulations, as jurisdictions like Sweden and Finland rank well in that category, so what is needed is coherent policy reform to generate a coherent set of laws and policies that are fair, unambiguous and consistently applied by all regulatory authorities at all levels of the state (national, provincial and municipal). This reform needs to take full cognizance of the historic context and resultant legacy if positive progress is to be made.

The unintended consequences of South African mining policy, when interpreted through the survey conducted by Wilson & Cervantes (2013), in the context of water resource management and the rehabilitation of mine-impacted aquatic ecosystems are the following:

- 1) Current legislation is written with the purpose of ensuring rehabilitation of Greenfield sites are catered for, so as to not repeat the mistakes of **Policy Paradigms III & IV**. However, when applied to existing legacy Brownfield sites, particularly regarding water, it has the unintended consequence of reducing or eliminating the viability of projects, by matching current liabilities to historical assets long ago realised and thus unavailable to support these rehabilitation aspirations. This accelerates the collapse of the commercial viability thereby hastening the return of an increased quantum of overall liability to the State as a predictable outcome.
- 2) Current policy provides that liabilities created during mining fall to the creator of that liability, so the strategy for the overall rehabilitation remains with the company. This works with Greenfield sites where there is no initial liability and the full resource is available to support any liabilities created. However, when applied to legacy Brownfield sites, the logical action of executives will necessarily be to collapse the company prior to the remediation of accrued liabilities, thus shifting the liabilities to the State. In such a scenario, the State needs to provide greater strategic direction in the application of limited current assets to support much greater historic liabilities, in order to assure that the limited resources are applied in a manner not to accelerate the reversion of such liabilities to the State; and to apply such resources in a structured way to maximise the overall impact of the available resources for the benefit of the State, environmental rehabilitation and the restoration of social functionality for impacted communities.
- 3) The State should seriously consider amending current policy and legislation to allow the regulatory regime the required flexibility to oversee the application of the limited current resources to mitigate the greater historic liabilities. Additionally, in reforming such policy, care should be taken to reduce or eliminate costly and confusing contradictory regulatory regimes.

Conclusion

Stated simplistically, the current suite of policy being applied during **Policy Monopoly III** to the gold mining sector in South Africa – water, environmental and financial – based on the desire to internalize the historic externalities dictated by the perception of the need for state survival that underpinned **Policy Monopoly II**, is simply hastening the demise of the mining sector by destroying the business case for investment into Brownfield sites. This is exacerbated by the squeeze on profitability arising from the fact that the cost of labour has been decoupled from the productivity of labour through militant union actions (Schroder, 2014). Combined this is the reason why the linear collapse shown in **Figure 3** is occurring. With the best of intentions, the rigorous application of policy based on international best practice, *inter alia* the Polluter Pays Principle, does not work when done so retrospectively and without consideration of the historic context and appreciation of the unintended consequences. If policy reform distinguishes Greenfield logic from Brownfields realities in a coherent manner, then this trend can be reversed and capital can be attracted to the rehabilitation of mine-impacted aquatic ecosystems and industrial landscapes. In fact, the value of gold left in the hundreds of remaining tailings dams is of such a magnitude, that recent improvements in metallurgical engineering make it commercially viable to reprocess. Being a marginal operation this can only be achieved if new investors are attracted into the industry, willing to bring old mining companies out of liquidation. This in turn is only going to be possible if a new regulatory regime is capable of quantifying the benefits arising from

the consolidation of the many old dumps into a few mega dumps engineered to 21st Century standards, thus allowing that historic liability to be offset against the benefits arising from removal. The capacity of the State, specifically insofar as policy reform and regulatory oversight is concerned, will increasingly be the determining variable if the current trend is to be reversed. South Africa has the potential to succumb once more to festering social unrest if the constraints created by the ruthless application of the externalization of costs model inherent to **Policy Monopoly II** are not effectively countered in a way that incentivizes investment into Brownfields operations. Only through evidence-based policy reform can the South African government unravel the Gordian Knot created by the Apartheid State in its self-imposed battle for survival during the Cold War.

Water policy thus plays a critical but often invisible role in attracting the level of investment needed to rehabilitate mine-impacted aquatic ecosystems and landscapes. Of greater importance, the potential for public-private partnerships as a vehicle for rehabilitation is squarely based on the ability of projects arising under such circumstances, to attract the level and type of funding needed to make rehabilitation viable. Failing in this crucial area will automatically result in the unintended consequence of nationalizing all remaining environmental liabilities that will increasingly manifest as constraints to future job creation and economic development in a highly impacted aquatic ecosystem and landscape.

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