The Social and Environmental Consequences of Coal Mining in South Africa

A CASE STUDY

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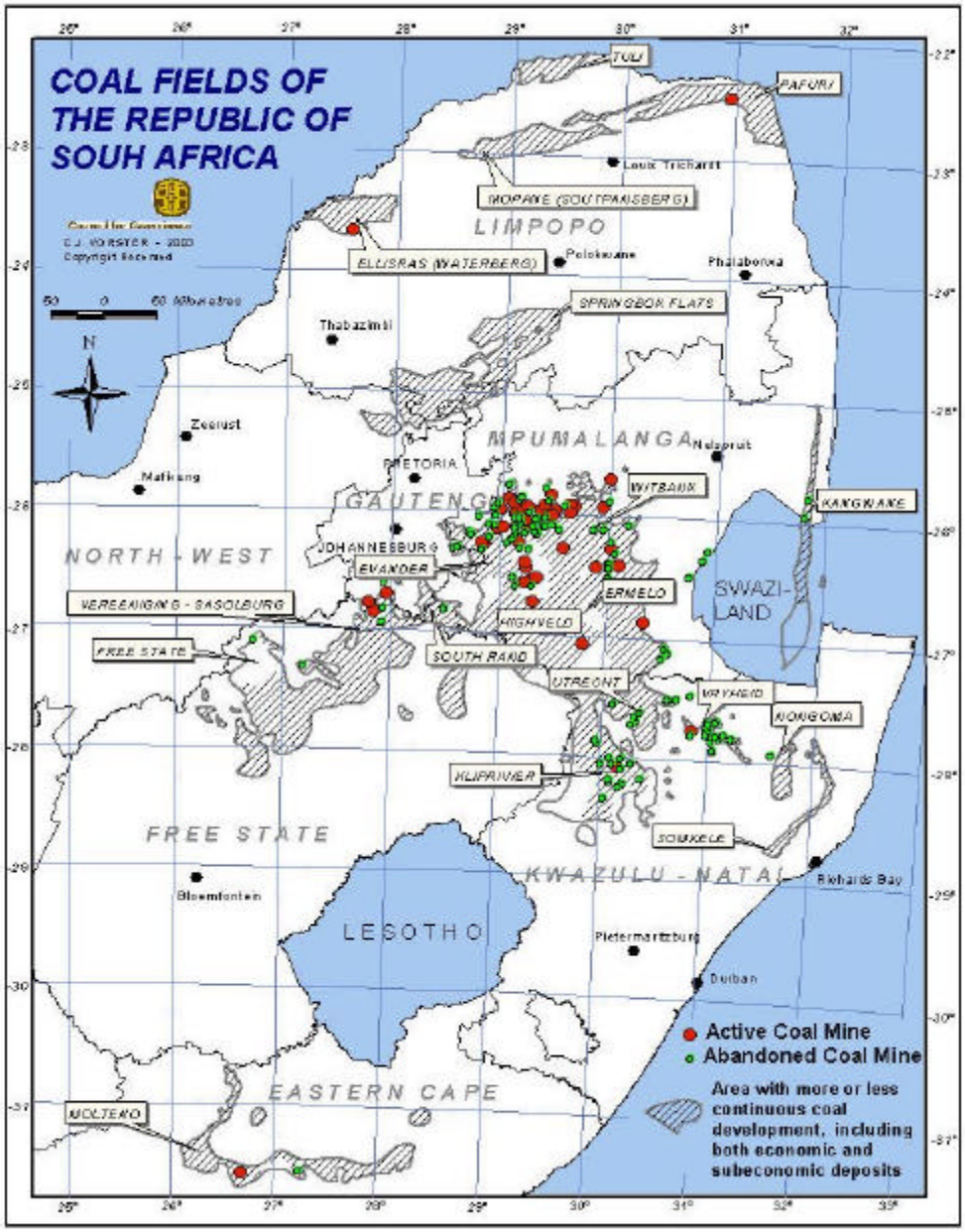
Acronyms

AMD	Acid mine drainage
ANC	African National Congress
BEE	Black Economic Empowerment
D&O Mines	Derelict and Abandoned Mines
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
EMP	Environmental Management Programmes
EMPR	Environmental Management Programme Report
HIV/Aids	Human immunodeficiency virus/Acquired immune deficiency syndrome
LTMS	Long Term Mitigation Scenarios
MMSD,	Mining, Minerals and Sustainable Development
MPRDA	Minerals and Petroleum Resources Development Act
Mt/a	million tons per year
MW	Megawatt
NEDLAC	National Economic Development and Labour Council
NEMA	National Environmental Management Act
NGO	Non government organisation
NWA	National Water Act
pH	a measure of the acidity (low pH) or basicity (high pH) of a solution
PM	particulate matter (breathable)
RBCT	Richards Bay Coal Terminal
SA	South Africa
WESSA	Wildlife and Environment Society of SA



Introduction

This case study focuses on the costs of the environmental and social effects of coal mining in South Africa, undertaken for export to the Netherlands. Coal mining imposes many external costs on its surroundings and the people who live in it. Some of these can be quantified by estimates, others are difficult to estimate. Coal mining is by nature disturbing and destructive of the environment. Open cast mining removes large volumes of soil and rock overburden to get to the workable coal seams, and destroys regional aquifers. Mining produces large mountains of solid waste. Coal heaps are prone to spontaneous combustion. Leachate from waste heaps are often acidic, adding to the general and large scale acid mine drainage impact and interferes with underground and surface water. Mining also has serious social consequences: on the movement of people, on people's health and the environments they live in.

The case study looks at air pollution, water quality issues, biodiversity effects, climate change effects, community responses, mine companies' engagement with these responses, and the issues of coal miners. It is based on desk top research, interviews, and interactions with affected communities and activists in the Witbank-Middelburg-Ermelo area, South Africa's most intensely worked coalfield. A number of coal mine managers, coal companies and the Chamber of Mines were approached, but chose not to respond.

Mine publicists generally point to the positive impacts of mining, like job creation and spin-off businesses. It is a sobering thought that only 41% of the income from economic activities in the area, chief of which is coal mining, remains in the area[1]. What remains behind is land that is mostly not rehabilitated for agricultural use, although some is, rivers like the Olifants polluted with acid mine drainage, areas of soil subsidence and underground fires, air pollution from dust and the associated effects of coal fired power stations with inadequate pollution control, and coal miners suffering the effects of silicosis, tuberculosis and other occupational diseases.

Coal mining in South Africa

It was mining that gave South Africa its current shape through processes from the 1880s to 1910. Gold mining took centre stage early, both because of its importance for the British and thus global monetary system and the profits to be made. Cheap black labour, achieved via the migrant labour system (in which mineworkers left their families behind and lived in all male, strictly controlled compounds), required political control. Early conflict between gold companies and Paul Kruger's Transvaal Republic about access to water, railroad transport and dynamite concessions, led to the Anglo Boer War and the consolidation of four independent provinces into a single South African state in 1910. At the core of this state is a minerals energy complex[2], centred on the South African Chamber of Mines, which was formed in 1887, with its object "the promotion and protection of the mining interest"[3]. In 1980, the Department of Minerals and Energy (DME) was formed with the express mandate to promote mining.

Gold mining had to deal with deep, low grade ore requiring large capital and cheap labour to keep costs down. The concentration of capital in gold mining gave the South African economy its basic structure organized around six dominant groupings of capital which extend into manufacture, banking and retail, but have at their basis a historic investment in mining.

Coal mining played a supportive role as provider of energy to the growing gold mining industry and indeed, many collieries were historically and are today owned by gold mining companies. To these coal mine owners it was more important to keep the costs of their own energy inputs low, than to profit from coal mining itself[4]. The coal price remained very low until the mid 1970s, when export opportunities opened up through a deep terminal in Richards Bay, and Japanese long term contracts. The low coal price was accompanied by harsh working conditions and low wages for African workers, a tendency to mine only the best coal ("picking out the eyes" in mining jargon) instead of mining the whole seam, and a disregard for environmental impacts.

According to official statistics[5] (DME (Department of Minerals and Energy), around 77 percent of South Africa's primary energy needs are provided by coal. Coal is used for electricity generation, the production of synthetic fuel by Sasol (itself a very dirty process) and used in industry and homes. Around 28 percent of South Africa's production is exported, mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal exporting country in the world.

South Africa's coal reserves lie in 18 coal fields. Historically the Vaal coalfields were the first to be intensively exploited, hosting a number of coal fired power stations as well as steel and heavy industry. The largest coalfields are found in a continuous expanse from Mpumalanga into KwazuluNatal (see map), where seams are between 15 and 100 metres deep, and around seven metres thick, but very variable[6]. More recently, coalfields to the North (Waterberg and Soutpansberg) have been opened up.

South Africa has 64 collieries, ranging from among the largest in the world to small-scale producers. A handful of large-scale producers supply coal primarily to electricity and synthetic fuel producers. About 51 percent of South African coal mining is done underground and about 49 percent is produced by open-cast methods. The coal-mining industry is highly concentrated with five companies accounting for 85 percent of saleable coal production. These companies are Ingwe Collieries Limited, a BHP Billiton subsidiary; Anglo Coal; Sasol; Eyesizwe and Kumba Resources. Xstrata is an important exporter, as the following section shows.

South African coal export and Dutch coal import

Coal is exported from South Africa through the Richards Bay Coal Terminal (RBCT). The terminal was opened in April 1976, with an export capacity of 12 million tons of coal per year (12 Mt/a). Over the years, export capacity has grown to 76 Mt/a in 2008. The last phase in capacity expansion was finalized in 2009: RBCT now has an official export capacity of 91 Mt/a[7]. Several mining operations hold shares in the RBCT, and their percentage shareholding and export allocations, are listed Table 1 (based on the 2008 export capacity of 72 Mt/a).

Shareholder / entity	Shareholding percentage[8]	Mt/a export allocation
Anglo Operations Ltd	26.43	19.78
BHP Billiton Energy Coal South Africa Ltd (Ingwe Collieries Ltd)	23.99	26.96
Xstrata South Africa (Pty) Ltd	20.11	15.05
Optimum Coal Terminal (Pty) Ltd	8.68	
Total Coal South Africa (Pty) Ltd	5.47	4.09
Sasol Mining (Pty) Ltd	4.81	3.60
South Dunes Coal Terminal Company (Pty) Ltd	3.80	
Kangra Coal (Pty) Ltd	2.21	1.65
Main Street 432 (Pty) Ltd	2.00	
Exxaro Coal (Pty) Ltd	1.34	
Eyesizwe Coal (Pty) Ltd	1.16	0.87
TOTAL	**100**	**72**

Out of the extra capacity of 19 Mt/a that has become available with the latest expansion, 4 Mt/a is earmarked for Black Emerging Miners, 6 Mt/a is allocated to South Dunes Coal Terminal (which represents a number of BEE exporters) and 9 Mt/a has been allocated to applicants: Arm Coal (3.2 Mt/a), Exxaro Coal (2.5 Mt/a), Mmakau Mining (0.35 Mt/a), Tumelo Coal (0.60 Mt/a), Umcebo Mining (1.00 Mt/a), Yomhlaba (0.50 Mt/a) and two commercial agreements (0.85 Mt/a together).

The Netherlands imports 17% of all coal used in Europe (40.1 Mt in 2006), of which the Dutch use 8.5 Mt/a for electricity generation[9]. The remainder of the imported coal is distributed to other European countries. The Netherlands is considering building more coal-fired power stations, which would add another 11.5 Mt/a to their coal import requirements (there are no sources of coal in the Netherlands). There are no official figures of the country of origin of the coal that the Netherlands uses for electricity generation, but figures show that of all imports into the Netherlands, 37% of the coal comes from South Africa. Applying this percentage directly to the usage of coal by the Netherlands, this would come down to 3.25 Mt/a of coal being mined in South Africa. This amount could possibly increase to 7.4 Mt/a with the contemplated building of additional coal-fired power stations. 3.25 Mt/a represents 3.6% of South Africa's total coal exports per year.

The politics of coal mining

The dominance of coal interests has imposed a logic on the political economy which is played out in the form of weak regulation and the dependence of local and provincial government on coal interests. Under apartheid, coal mining provided an avenue for advancing Afrikaner capital[10], and is now the focus of a programme for building a black middle class through participation in coal mining.

Coal mining also has a history of cheap labour, and confrontation with organized labour[11]. Mine owners in general, like other business and industry, made a limited presentation to the Truth and Reconciliation Commission, but did not come near to accepting responsibility for, amongst others, miners' deaths and ongoing illnesses[12].

South Africa is a politically sophisticated country and both mine owners and the communities they work in, have developed an understanding of and an interest in mining and its externalities. SA mine owners have played a prominent part in the MMSD, mining council and related initiatives, and have developed sophisticated environmental management, reporting and communication systems, programmes of corporate social responsibility and community outreach. Mining has long been a closed book for researchers, and research information circulated in small circles aimed at immediate practical application and amelioration, under close scrutiny of the mines and with their co-operation. This literature was created under a commitment to guard the confidentiality of the information. In recent years, more information has flowed from researchers into the public realm beyond the narrow circles of scientists beholden to shareholders, much of it concerning mining externalities and legacy costs: including the uranium contamination of water resources and acid mine drainage[13].

Government has shown increased concern about air pollution, with the declaration of three air pollution priority areas. All three are the result of fossil fuel pollution. The

Eastern Highveld is the third air quality pollution priority area to be declared. It means proper monitoring of air quality plus a multistakeholder development of plans to deal with future air quality system. Up to now pollution monitoring has consisted largely of self-reporting by state owned electricity monopoly Eskom (with its electricity overwhelmingly from coal fired power stations) and Sasol, the coal based liquid fuel and chemicals from coal business.

As a stakeholder politics has developed, communities and activists have become more outspoken, and mines more guarded in their relationships with critical researchers[14]. The popular media – as opposed to a generally uncritical business media – have taken the side of communities and, as the mines see it "sensationalized the issue". Mines also accuse activists of not having a scientific basis for their accusations – while ironically themselves guarding the scientific information very closely! Government departments – mineral and energy, water affairs and local government – operate with progressive legislation, but constrained capacity for monitoring and acting against mining and other industrial polluters. However, pressure is mounting to act because SA water resources are fully committed, and future wellbeing of the nation depends crucially on guarding the water quality. While legislation is in place for a stakeholder driven catchment management system, this has been slow to take effect.

Coal dynamic on the Mpumalanga Highveld

The largest number of collieries – 22 – are concentrated around Witbank, now renamed Emalahleni (place of coal). The export mines are[15]:

- Anglo: Bank, Goedehoop, Greenside, Kleinkopje, Landau.
- BHP Billiton: Koornfontein, Optimum, Eikeboom, Douglas, Middelburg.
- Eyesizwe – Glisa, New Clydesdale.
- Xstrata: Phoenix, South Witbank, Tavistock, Arthur Taylor, Boschmans, Waterpan, Witcons, Goedgevonden, Spitzkop and Tselentis (Bothasrust).

This area was taken as the focus of field work and as a community case study.

A hundred years of coal mining in the Mpumalanga Highveld, South Africa's most important coalfield, has imposed a complicated "coal dynamic" on the area, resulting in extensive environmental and social externalities. This dynamic includes the mining itself, the generation of electricity in coal fired power stations, some of which are serviced by captive collieries, heavy industry using coal to produce steel and alloyed products, coal hauling by truck, and a culture of indoor coal burning for heating and cooking in seasonally cold areas, now recognized as a major health hazard[16].

Major rivers rise from the Mpumalanga Highveld. The Vaal River which is the source of Rand Water's raw water for more than 10 million people and the core economy in Gauteng and neighbouring areas, runs through South Africa's industrial heartland. The Olifants river supplies water to the national electricity supplier, Eskom, and to the Kruger National Park and surrounding private game reserves, the heart of South Africa's conservation and ecotourist industry. The Olifants and the Inkomati rivers are shared with neighbouring Mozambique and Swaziland, where major downstream investments have been made in irrigation. These are sensitive to rising salinity levels in the water.

Coal mining implies the externalities of transport, by train for export and by truck to 8 – soon to be 11 – coalfired power stations. Coal mining and the uses of coal, both domestic at ground level and via coal fired power stations of which the majority are situated in this area, cause air pollution. Associated activities in steel, chrome and vanadium add to pollution levels. Coal mining, which was based on cheap and dangerous work until mechanization started in the 1970s and sped up with the advent of open cast mining (1980s), now almost equally divided between underground and opencast, attracted thousands of job seekers into the area, who stayed on even as job numbers were drastically reduced. Discard coal dumps prone to spontaneous combustion and creating conditions for poor communities to reclaim coal in dangerous conditions, the use of duff (fine low quality coal) in power stations has imposed air pollution on the whole area – and on more distant areas.

Legislation and regulation of coal mines

As far back as 1903, South Africa has had laws that placed the responsibility for mining impacts on the mine owner. When a closure certificate was obtained, this responsibility ceased. However, under a traditionally weak regulation system, many mines became defunct and ownerless. The then apartheid government, attempted to deal with this situation through the 1975 Fanie Botha Accord, between the Minister of Water Affairs and the Chamber of Mines. They agreed that the state would take 100% responsibility for all mines closed before 1976. Mines closed from 1976 to 1986 would be 50% state responsibility and 50% owner responsibility. After 1986 all mines and its closure would be the responsibility of the owner. As a result, the South African Department of Water Affairs has spent more than R120 million the last 10 years to deal with historic pollution – though this is amount is said to only be a fraction of what is ultimately needed[17].

Historical problems include the estimated 6000 abandoned mines (not all of them coal mines). The abandoned Transvaal and Delagoa Bay Colliery outside Witbank has been identified as representing the greatest possible risk of any mine in the D&O Mines database. This is a large colliery which has partially collapsed, leaving large sinkholes in an area adjacent to an informal settlement. The remaining coal in the underground workings is burning, compounding the physical hazard posed by the mine as well as polluting the air. The workings are flooded and have started to decant, producing highly saline acid drainage with unacceptable levels of heavy metals. This water drains into the Brugspruit, a tributary of the Olifants River. Poor water quality resulting from this and other abandoned and operational coal mines has been linked to the death of fish and crocodiles in the Loskop Dam Nature reserve downstream.

The change of government in 1994 brought changes in legislation: a Constitution was adopted, and government became the custodian of al natural resources, for the South African people. The National Water Act (NWA) (Act 36 of 1998) regulated the use of water, also for mining, and the protection of the resource. In addition, it supports the ‘Polluter Pays Principle’; mines producing, allowing or causing pollution, including acid mine draining (AMD) should be held liable for the cost of cleaning up and legal enforcement. In practice however, it has not been easy to enforce this legislation, partly due to capacity constraints at the Department of Water Affairs and in DME, which has only 79 inspectors for the whole country to deal with prospecting and mining applications as well as infringements[18] .

The National Environmental Management Act (NEMA) (Act 107 of 1998) is enforced by the Department of Environmental Affairs and Tourism (DEAT), and requires Environmental Impact Assessments (EIAs) and Environmental Management Programmes (EMPs) for activities that affect the environment. In line with the NWA, this Act also requires prevention or rectification of pollution, and if the person responsible fails to do this, DEAT can recover the costs for clean-up from the polluter. Enforcement and implementation suffers from the large degree of intergovernmental cooperation required for EIA and EMP approval, and the earlier mentioned lack of capacity.

The Department of Minerals and Energy (DME) administers the Minerals and Petroleum Resources Development Act (MPRDA) (Act 28 of 2002). While this legislation enshrined the "polluter pays" principle for the first time, it very much focuses on transformation of the minerals and mining industry, and promotion of equitable access to mineral resources. An effect of this has been a focus on developing black ownership of mines, creating a set of mining interests close to the ANC and its cabinet, as detailed in the national weekly Mail and Guardian[19].

Regarding environmental sustainability, the Act requires mines to develop an Environmental Management Programme Report (EMPR), with the EMP also containing adequate provision for financial guarantees for rehabilitation, and arrangements for monitoring and auditing. It should also contain a closure plan, including a financial provision which should be available at the onset, during the life of the mine and at closure. Having to have these funds available at any time poses problems, as mines generally work towards an 'end point', a closure date, and thus do not have enough funds should the mine close today. An interview with a large mining company revealed that they do not necessarily support this approach to impact management, as "environmental impacts at any point are not well known, not by the mines or the government". While larger mining companies generally support mine management 'from cradle to grave', they expressed concern about smaller mining companies that seem to 'dig-and-duck'[20].

In this legislation there is also an expectation of public participation. Public participation is a requirement in agreeing on an environmental management plan, a social and labour plan, and a closure plan. In practice, such participation is often frustrated.

Water quality

The largest water quality problem associated with coal mining is undoubtedly acid mine drainage (AMD). Acid mine drainage consists of three interrelated problems: first, the pyrite in the rock gives rise to water with a low pH. This acid water in turn mobilizes heavy metals from the environment, in the mine or in the river course from the sediments (in Witbank, for example, heavy metals from steel manufacture, vanadium and chrome are all present within polluted fiver courses). Thirdly, treating the water with calcium to raise the pH, makes the water more saline, a problem that requires expensive and energy intensive reverse osmosis or similar processes. It is very difficult, if not impossible, to avoid acid mine drainage. Rock once broken up is open to oxygen, which reacts with the pyrite in both the coal and the surrounding

rocks. Once water flows over this, acid mine drainage follows. In the Ermelo area, there are cases of rehabilitated open cast and underground mines decanting acid water 5 to 20 years after closure. Acid mine drainage is also generated by discard dumps, including those that are rehabilitated. During our field research we observed many discard dumps, stockpiles and mines that are situated close to water courses without any water barriers.

Acid Mine Drainage

When sulphide containing rock (generally pyrite) is uncovered, the oxidizing action of air, together with water and chemosynthetic bacteria convert inorganic sulphur into sulphate and sulphuric acid. In flooded mines, the availability of oxygen is a limiting factor in the rate of pyrite oxidation, but the oxidation process generates excess heat – causing a chimney-like effect, sucking in oxygen to feed the process. The process is autocatalytic, i.e. the chemical reactions catalyse each other, and are therefore difficult to stop once started. The acid circumstances cause a variety of problems, besides only lowering the pH of the water:

* Below a pH of 4.3 hydroxides and sulphides are still soluble, but as soon the pH starts to rise (downstream from the discharge source), they precipitate. Iron(III)hydroxide and oxyhydroxide complexes give the water an orange colour: “ochres” or “yellow boy”. Other hydroxides form flocks, which block light and inhibit photosynthesis, and clog the river bottom which affects water life.
* Biocarbonate serves as a buffer against acidity in water, but below a pH of 4.2 all carbonate and bicarbonate is broken up into carbon dioxide and water. It therefore destroys the water resource’s “coping mechanism”. In addition, this process affects photosynthesis as many use bicarbonate as their inorganic carbon source.
* Under acid circumstances, solubility, mobility and bio-availability of metals are increased: cadmium, copper, chromium, manganese and lead. Additionally, the sulphate-rich water also leads to increased solubility of arsenic, cobalt, iron, magnesium and uranium. A particular problem is the presence of aluminium in its toxic configuration (Al^{3+}).
* Other consequences of AMD are reduced dissolved oxygen (which affects all water life) and an increase in suspended solids (Total Dissolved Solids, TDS) and dissolved solids, and enhanced salinisation. The salinity is in itself a major problem.

A large part of the Upper Olifants catchment is covered by the Witbank coal field, with the Highveld and Ermelo coal fields covering a smaller part. The coal seams can be found at very shallows depths; out of the five separate seams that can be found, all of which (except the lower two) are potentially acid generating. All the effects mentioned above are present in the Upper, and also Lower, Olifants catchment, and the link with coal mining stands undisputed. There are initiatives undertaken to reduce the acidity of the mine drainage water, but many are either expensive (bactericides, lime) or cause another kind of pollution (treatment with lime produces water very high in calcium). In addition, one of the biggest problems is that of ‘abandoned’ mines for which the government is taking responsibility, although not effectively, as the Brugspruit saga shows.. The extent of AMD from those mines alone amounts to 62 ML/d and so far there has been no low-cost, low-management solution to effectively deal with this pollution. Existing mines are using the seasonal high flows in the Olifants river to dilute their AMD through their ‘Controlled Release Scheme’.

Air pollution from coal mining and coal use

The Mpumalanga province has been declared as an air quality priority area. Currently this province has amongst the worst air quality in the world, largely due to coal mining activities, uncontrollable underground fires and power-stations burning coal. The good quality coal is exported, leaving the lesser quality to be burned by SA coal-fired power stations, adding to SA's carbon footprint and dirty emissions.

Mpumalanga has long been seen as an area of bad air quality. Environmental journalist James Clarke, writing in 1991, compared Mpumalanga to Eastern Germany in its extent of air pollution, and quoted studies showing stunted growth in boy children[21]. In the winter months, a temperature inversion layer traps pollutants in the lower atmosphere. There is little information on the prevalence of respiratory infections in Mpumalanga. However, research by dr. Andy Beke of the University of Pretoria shows that respiratory infections in children under 5 years of age in Mpumalanga province for the year 2000 are higher in the winter months, and peak in the months of March and August.

The most recent and by far the most comprehensive study of air pollution in Mpumalanga[22]notes that elevated pollutants are SO_2, particulates (PM10 and PM2.5), NOxes, O_3, benzene and H_2S. The study "anticipates" that thresholds for SO_2, PM10, NO_2, O_3 and benzene are exceeded. Power generation, fuel combustion by industries and institutions, domestic fuel burning and vehicles emissions contribute to these, while significant sources of benzene include vehicle emissions, domestic coal burning and releases from the petro-chemical complex at Secunda. Eskom's own sulphur dioxide monitoring during 1983-1988, indicated elevated SO2 concentrations near Witbank (Emalahleni) and in the Vaal Triangle. The Vaal Triangle historically preceded the Highveld area as a coalfield with intense coal mining and subsequent industrial development.

Over recent decades, a number of studies have drawn attention to higher than normal rates of respiratory disease and stunted growth in children. Children exposed to coal smoke from incomplete combustion coal processes (the case with most indoor use of coal) have an approximate ten times higher incidence of respiratory tract disease than comparable children not so exposed[23]. There are indications of acid deposition (acid rain) on the Mpumalanga Highveld, but not yet proof that it is affecting soil and water quality[24]

Spontaneous combustion of coal discard heaps – and some working mines observed by the researchers - releases toxic compounds including carbon monoxide, carbon dioxide, methane, benzenes, toluenes and xylenes, as well as sulphur, sulphur compounds, salammoniac, arsenic, mercury and lead. Research published in 2007, identified these coal fire gas minerals as having "the potential to affect the health of mine workers and communities living near the coalfields"[25].

South Africa has been overhauling its air quality legislation under the post-apartheid government. The outdated and ineffectual Atmospheric Pollution Prevention Act of 1965 has been replaced by the NEMAQA of 2004: National Environmental Management: Air Quality Act. The new legislation requires significant emission sources to be identified, quantified and addressed, ambient air quality targets to be set,

and providing for access t information and public consultation. However, there is still a long way to go. Self-reporting by the biggest air polluters – SASOL and ESKOM – is still the norm. DEAT has instituted a study of the 50 worst industrial air polluters.

In November 2008, the DEAT declared the Mpumalanga Highveld a "pollution hotspot", or a priority area for air quality management. It cited the 2004 NEDLAC "Dirty Fuels" study, according to which air pollution exposure related respiratory hospital admissions were predicted to be in the order of 8700 cases per year within the Mpumalanga Highveld region. This was the result of both ambient (outdoor) air quality and the burning of coal and wood indoors. The report's authors predicted an increase in health costs if no action was taken in the area.

Health effects are prominent and acknowledged by the Mpumalanga provincial government. Officials in the Mpumalanga province have talked about "a definite trend towards increased lower respiratory tract infections in children under five years of age in Mpumalanga in the winter months".[26] Local residents in Witbank have a sharp experience of air quality issues. Our host at a bed and breakfast showed us the deposition of silvery particles that form part of the "dust" gathering on the breakfast tables.

Air quality is also affected by coal dust, and clear examples were seen at Tweefontein, which is now a transfer site for coal, of inadequate dusting procedures. Across the road from the transfer site, Mr Nick Joubert is permanently connected to his oxygen tank. He breathes with difficulty. Joubert owned a number of shops serving mining villages, but with the closure of some mines, the mechanization of others, and the demolition of mining villages, he has lost his clientele along with his health. His remaining shop serves hauliers and their huge trucks at the Xstrata Tweefontein coal depot. Xstrata does some – according to Joubert's wife inadequate - dust damping on their side of the road, but none in front of the shop.

Climate change and the political importance of coal mining

South Africa has taken a profoundly ambivalent role in the climate change debate. On the one hand, South Africa is by far the largest emitter of carbon dioxide on the African continent with 10,165 Mt out of a total of 13,867 Mt for the whole of Africa (based on cumulative emissions from 1950 to 2000)[27]. It has the second most carbon intensive economy in the world, after oil-rich Venezuela. And it hosts the single largest carbon dioxide emitter in the world: Sasol's coal-to-liquid plant at Secunda[28]. Its carbon intensity is the result of relying on coal as its primary energy source, and its cheap electricity policy (which flows from the subservience of coal to other sectors with the MEC). Electricity is used 62.7% by industry and mining, with residential at 16.4% and commerce at 10%[29]. After experiencing serious blackouts and electricity interruptions since 2006, Eskom has announced plans to double its generation capacity from the current 40 000 MW to 80 000 MW by 2025. Work is already underway on several new power stations, and the collieries to supply them. Prominent in this drive is the Mpumalanga coal field, as well as the Waterberg coal field which has been known since 1945, but only exploited since 1980. The Waterberg field currently produces metallurgical coal and hosts two coalfired power stations. Six

more power stations are expected, as well as a huge Sasol coals-to-liqued fuels and chemicals complex, including plans for "underground gasification" through burning[30].

On the other hand, South Africa has developed climate change response frameworks and studies, particularly the Long Term Mitigation Scenarios, which define the need to reduce its emissions of greenhouse gases in line with what s "required by science"[31]. These scenarios emphasize energy efficiency, replacing private with public transport, a rising carbon tax, nuclear power (up to 12 plants by 2030) and subsidies for renewables[32]. As a result of the prominent role of coal interests in the political economy, "clean coal technologies" and "carbon capture and storage" play important roles in the LTMS, even though they are unlikely to work in practice. Climate change policy remains subservient to the interests of coal producers.

Coal miners' health and labour issues

SA's cheap coal is not only due to it its relative abundance, but also a reflection of low wages, questionable attention to mine safety and the long-term health of mineworkers.
Historically, black mines have been cheap in the South African coal mining industry. Mines were exposed to black lung disease for want of protective equipment[33]. From 1981 to 1995, some 70 methane explosions resulted in the deaths of miners. In one incident in 1926, the entire night shift of 125 men was killed. Roof falls were also common. 431 black and 6 white miners were killed in the Coalbrook disaster in January 1960. This incident was caused by the practice of "robbing pillars" – taking out coal pillars that had been left to support the roof, in order to increase production quickly. The bodies of the miners were never recovered from the collapsed mine[34].

The migrant labour or hostel system of housing black mine workers without their families (who had to remain in the Bantustans), led to a break-up of the fabric of society, as mine workers often acquired local sexual partners, and the spread of HIV/Aids. The submissions by the Chamber of Mines and Anglo American to the Truth and Reconciliation Commission into human rights abuses by business under apartheid did not acknowledge the exploitation and degradation of African labour, and did not include the externalization of the costs of miners' occupational disease.

Recent research shows that silicosis, other lung diseases, and hearing loss are recurring problems among ex-mineworkers[35]. These medical costs are being shifted from the mines onto the state and constitute a subsidy to the mines and their profitability. Miners and ex-miners are also not properly informed of what their rights and remedies are, and therefore these costs are borne by them. National Union of Mineworkers' health and safety officers Pumla Mboniswa and Lennox Mekuto argue that many mineworkers do not receive compensation for the occupational diseases they contract while working in the mines. Medical personnel and human resource officials use HIV/Aids and tuberculosis to mask the fact that lung diseases are the result of working in the mines, and so the industry saves itself the costs of proper compensation. They estimate that up to 60% of compensation cases are not properly reported as resulting from silicosis. They also argue that mining companies avoid liabilities by not keeping proper files. The DME itself expressed concern about the lack of proper information. When companies go out of business, they destroy the medical files and with that, also their liabilities to pay compensation. There are many

things that companies can do to make the workplace safer, including providing comfortable protective equipment, on a sustained basis, not “on and off”.

Ongoing debates about mine accidents and the high death rate in South African mines result in frequent public stand-offs, and the South African minister of Minerals and Energy has promised to tighten up on health and safety regulation. In the period 1984 to 1993, on average 69 coal miners died, and on average 508 experienced injuries in South African coal mines[36]. Since then, rates have improved. According to official statistics[37], out of a current 57 955 coal miners, there were 15 working fatalities reported in 2007/8, down from 20 in the previous year. There were 183 injuries reported in 2007 compared with 253 injuries reported in 2006.

Roughly half of South African coal is now mined through open cast methods, which are capital intensive and employ far fewer mineworkers. Mineworkers who have spent their lives on mines in hostels and mine villages, now lose their residences together with their jobs. Mines increasingly demolish their mining villages as they find it too cumbersome to rent these out as housing, or sell them, although there are local examples of mines using their housing stock in a socially responsible way. Such demolition has happened at Tweefontein, now a depot for coal dumping and hauling (and a long list of other places, including Anglo’s Landau). It is incomprehensible to local residents that in the midst of a housing shortage “these fine houses” could be destroyed.

Biodiversity effects of current coal mine expansion

More mines are using open-pit and strip-mining techniques to exploit shallow reserves – with severe environmental impact in some areas. A range of organizations, from local farmers to the Wildlife and Environment Society of SA (WESSA) has pointed out the loss of wetlands, grasslands and the species that live in them, both through abuses by existing mines and by the large numbers of prospecting applications. An extreme example of this conflict is proposed opencast mining within the catchment of the Mpumalanga Lakes District which present “a very severe threat to this unique and pristine wetland system[38]”.

Aretha Strydom lives on a dairy farm, with a bed and breakfast business which overlookes the spectacularly beautiful Lake Chrissie in the Mpumalanga Lakes District. She is part of a growing ecotourist industry in the area. She is deeply concerned about acid mine drainage and other pollution from coal mines encroaching on this near pristine area. She has reason to be concerned. The Mpumalanga Lakes District consists of 38 lakes in a geologically unique landscape: an ancient surface, 10 to 20 million years old. The perennial lakes (a rarity in South Africa with its relatively low rainfall) lie in a depression between the headwaters of four major South African rivers, and on a continental watershed: the Vaal, which flows to the Atlantic Ocean, and the Komati, Usuthu and Umphuluzi rivers which flow to the Indian Ocean. Because the lakes lie in a depression any pollution – of acid mine drainage and associated heavy metals that are certain to result from coal mining within this unique catchment – will accumulate in the lakes without any chance of being flushed out. The lakes, which are known for their extensive frog and bird life, associated wetlands with a large variety of flowers, will become lifeless and toxic[39].

Nearby Tselentis mine is the object of the unhappiness of Ben Bezuidenhout, who owns a coffee shop at the entry of the quaint village of Lake Chrissie, right on the lake. As the mine blasting came closer, it has caused cracks in his 100 year old historic house, built with sandstone and Indian bricks which were brought in as return ballast on ships when Lake Chrissie was a stopover on the route between the Maputo harbour and Pretoria. He shudders at the thought of what coal mining may do to the lakes and the ecotourist potential of the area which boasts old San (Bushmen) rock paintings, stone age tools, a rich biodiversity and a cultural history of San, Swazi, English and Boer in breath taking settings.

In the north of the country, a mining company in which minister of housing Tokyo Sexwale's Mvelaphanda has interests, is threatening to mine metallurgical coal (which is scarce in South Africa) within a few kilometers of Mapungubwe, arguably the most important historical site in South Africa, where the first black city was created around 1400, which traded with the Far East via the Indian Ocean coast.

Community Case Study

The Witbank-Middelburg area is one big case study, and our research provided insight into a number of issues that coal mining creates for communities.

Ligazi is an informal settlement next to the Middelburg Steam Mine, where the land buckles and sinks in unexpected ways. These conditions worry the residents, says resident Kedibone Magata who meets us near a deep sinkhole with her granddaughter, Kgothatso, tied to her back. She participated in a project of the ANC women's league in Ligazi, which, in preparation for the 2009 national election, counted 126 sinkholes. Some are deep enough for people to be able to see into the mine.

Smoke sometimes comes out of these holes. Holes appear suddenly inside people's houses, she says, and shows us a shack where residents have been filling up a hole in the kitchen floor which keeps sinking, with rocks and soil. Some make houses topple over, as happened to Mrs Magata's near neighbour, William Digomo. She tells the story of another resident who owned a number of wheelbarrows. One morning, he saw that they had disappeared. They had fallen into the earth. The sinkholes are dangerous for the children – and for late night revelers, says Mrs Magata.

In Maguqa, children play on salt-encrusted fields, the result of acid mine drainage. They report that they swim in holding dams – where the water is warm, although acidic and filled with heavy metals and carcinogenics derived from burning coal. They have the bad fortune to live near an abandoned coal mine, whose acid mine drainage is not properly treated.

Throughout the area, blasting is a regular occurrence. Thunder sounds appear despite the blue, cloudless skies. The constant blasting makes local children nervous, listless and not keen to learn, according to veteran activist, Mathews Hlabane. Outside the town of Middelburg, blasting from the Xstrata Metallurgical coal mine outside Middelburg has collapsed the lounge of the wattle-and-daub house of Maria Mtswene. She has also lodged a claim to land on which the mine is. The mine management maintain that although the blasting is the cause of the collapse, their blasting is within limits. There are no South African limits on blasting intensity, so the mine has defined

its own limits – the United States limits which are the highest in the world and clearly not designed for use next to wattle and daub houses. In Ermelo, where two different mines are very close (500m to 1 km) to the houses of Wesselton township, 200 cracked houses have been listed by the Wesselton Crisis Committee. The local municipal manager, stands accused of having shares in the mines and having improperly given permission for them. One mine is right next to the municipal WWTWs in the river course.

Abandoned mines and abandoned discard coal heaps hold many dangers, even if they hold opportunity as poor people dig through the heaps for burnable coal. It is known that the coal dumps can collapse, but two mothers we spoke to, but did not want to give their names since they felt embarassed about this “dirty work”, explained that they had their young children with them because they did not trust “the strangers” who are their neighbours.

Trucks loaded with coal thunder past both motorists and pedestrians incessantly, and the secondary roads in the area are severely potholed, becoming dangerous to traffic. It will cost the Transport department an estimated R500 million to fix these potholes – an expense for the taxpayers, not the mining companies.

Community response

The mining industry is deeply entrenched in the South African economy, and protected by historical precedent and legislation. Communities affected by mine-related pollution have struggled to challenge companies and government to regulate mining activities.

Mathews Hlabane, veteran community activist, who was also active in the anti-apartheid struggle when he spent a year in detention, has been responding to coal mining abuses for more than a decade. He now heads the Revolutionary Green Council and is bringing together community activists and crisis committees from all over the Mpumalanga province who face similar issues. He has long experience of the tactics that mine companies use: “Their environmental managers will show you the good places, and hide the bad. They buy off community leaders who then support the mines’ practices. For example, active and popular trade union shop stewards get promoted into human resource posts with much bigger salaries. They then manage the workers and the activists. This deprives the trade unions of able leaders.” He is very aware of the asymmetry in power: “NGO funding is small and not dependable. The mining companies command far greater resources.” Indeed, one mining company in the area has more than thirty environmental managers. That may top the number of activists and likely also the number of mining inspectors!

Dr Koos Pretorius is a veterinary surgeon and cherry farmer in the Ermelo district, who discovered 8 years ago that a mining company was prospecting on the farm next to him. He quickly learnt what the consequences are and today is an activist monitoring the growing consequences of the current explosion of new coal mines in the area. His methods include organizing, monitoring, participation in processes including EIAs, lobbying officials and parliament, and working with the media. The heart of his activities is a belief that when enough members of the public as well as big decision makers understand the risks of uncontrolled coal mining, the tide will be

stopped. He is especially concerned about the long term ruination of the water resources of four major rivers that start in the coalfield and are crucial to economic and ecological health of the country.

Farmers and other residents have set up a number of organizations in the area: the Escarpment Environmental Protection Group, the Wonderfontein Community Association, the Carolina Protection Group, the Mpumalanga Lakes District Protection Group, the Ermelo Crisis Centre, and the Highlands Headwaters Protection Group. Dr Pretorius regularly monitors streams below coal operations: active mining areas, loading heaps, discard heaps and rehabilitated areas that produce acid mine drainage.

Democracy, regulation, rule of law

An aspect of the coal mining social impact that is hard to quantify, is the impact on South Africa's young democracy, its capacity and willingness to regulate environmental and social impacts, and respect for the law. The weekly Mail & Guardian reported that several prominent politicians, their relatives and associates are involved in coal mining.. This makes it a high career risk activity for water affairs officials of any rank to act against offenders. There are large numbers of coal mines operating without water use licences, and they face no consequences for it. This undermines respect for the law and encourages other companies to also operate illegally. In Early October, it was reported[40] in parliament that 104 mines were operating without water use licences (not all of them coal mines). While doing fieldwork in early September, a case was brought to our attention of a senior politician in Mpumalanga overriding a record of decision that a mine was operating illegally. The dramatic and roughshod expansion of mining is driven as part of a general expectation of economic growth, as well as economic opportunity for rapidly growing black bourgeoisie well connected to the political elite. In Ermelo, a local government official was widely believed to be behind allowing a coal mine to mine in a river, and within less than 500 meters of the township.

The effects of creating immediate poverty around the mines, and the longer term effects of displacing farming and associated livelihoods, causing air pollution and the health impacts and costs of it, and the long term destruction of much of the nations' water resources, are not calculated. According to local activists, mining receives political protection and this makes regulation impotent. Established companies like Anglo Coal, BHP Billiton and Xstrata work with and through these companies, sometimes using them as contractors, sometimes buying coal from them, and sometimes offloading or selling mines – and their liabilities – to them.

The drive to mine as much coal as possible and as quickly as possible, without consideration of the consequences, is built into the system. Currently all mineral rights are held by the South Africa government, and allocated on a "use it or lose it" principle. A prospecting right is allocated for a period of 5 years. If it is not used and turned into a mining operation, the prospecting right is lost and another applicant may start the process over again.

Conclusions: the externalities

An extensive literature review showed that there are not many publications that quantify externalities, partly because of the constraints in methodologies and partly because the costs associated with remediation and mitigation are also strongly determined by the location and type of mining. In addition, there is a stronger trend towards costing environmental externalities than social externalities. Environmental externalities can often be 'solved' with technical interventions such as soil rehabilitation, re-vegetation, pollution control works, etc. Still, due to the complexity of nature it is not guaranteed that the anticipated rehabilitation will materialize with the chosen methods. It has been pointed out in articles and reports from South Africa and the United States that EMPR approvals (with mining licenses) take a long time, because also the authorities are not sure what future (negative) effects will be of (ceased) mining operations.

Trying to incorporate externalities in prices and thus show the "real" price of coal is nearly impossible: firstly, the number of externalities, and their effects in time and space, are so large, they are almost "immeasurable". Secondly, some things are difficult to put a price on. Despite many methodologies proposed by economic science , none have proven to be satisfactory to everyone. Expert assessments by the United States' Environmental Protection Agency in 1987 concluded that "problems related to mining waste may be rated as secondly only to global warming and stratospheric ozone depletion in terms of ecological risk. The release to the environment of mining waste can result in profound, generally irreversible destruction of ecosystems".[41] In many cases the polluted sites may never be fully restored, for pollution is so persistent that there is no available remedy. This begs the question how effective remediation measures will be.

In the section below, where ever possible, we try to give an overview of some of the costing of externalities of (coal) mining in South Africa we have come across.

Environmental externalities

There are approximately 6000 abandoned mines in South Africa (not all coal mines), and the costs of rehabilitation (soil- and land-wise) has been estimated at 100 billion Rand (2008 amounts – US$ 14 billion at the time) by Ms Elize Swart, Director of Environmental Policy at the DME[42]. In addition, at the current rate of rehabilitation, it will take 800 years to rehabilitate the abandoned mines. The Brugspruit Water Pollution Control works were built by the South African Department of Water Affairs to deal with the AMD emanating from defunct and underground defunct coal mines in the Witbank area. The infrastructure was built in 1997 at a cost of R26.5 million. There has been doubt about its effectiveness though due to inactiveness caused by staff shortages, electrical cable theft and lack of maintenance. The rehabilitation of the abandoned Transvaal and Delagoa Bay colliery (750 ha) in Witbank is estimated at R100 million[43].

Mines that are still active are required to have EMP(R)s and Social and Labour Plans in place, including the financial means to implement these. Mines however are not keen to share the financial details of their plans. Some details that were found regarding mitigations strategies include more than R100 million spent by Ango Coal

in drainage, storage and treatment systems to improve the quality and quantity of its water discharge. Also, almost R300 million has been spent by the same mining company to realize a water reclamation plant that purifies water from three active and one defunct mine to drinking water standards. This expensive process – R10.00 per cubic metre (or kl) - includes reverse osmosis in order to deal with high salinity or total dissolved solids. The water is sold to Emalahleni municipality at R3.90/kl.

An analysis over the longer term[44] predicts that

> "… perhaps a century from now, all of the mines will be flooded and leaking acid water. In their upper reaches, the rivers will run red and both river and groundwater will be undrinkable. Aquatic life will be minimal, and only very hardy aquatic vegetation will survive. The rivers will also be choked with sediment. Extensive areas of the region will have become devoid of vegetation due to the acidification of the soil, setting in motion severe erosion which will strip the soil cover and eat into the backfill of the old opencast workings. The eroded sediment will choke the rivers and all dams will be filled with sediment. In short, the region could become a total wasteland."

This study estimates that by 2030, a total of 2 000 cubic metres of acid mine drainage will be discharged into the Witbank and Middelburg dams per year, at a present day operational cost (and capital costs of around R30 000 million) to treat that water.

The Upper Olifants River is already seriously degraded by coal mining. The Loskop Dam, part of a nature reserve in the Olifants River, has experienced die-off of fish, turtles and crocodiles, which is widely thought to be the result of water quality in the river. This has already affected tourist visits to the area. Two big municipal dams – Witbank and Middelburg – are periodically too salinised to meet drinking water standards. The same fate awaits the Vaal – with the Grootdraai and Vaal Dams – and the Usuthu and Komati basins if the current applications for coal mining in the area are granted. These costs have not been estimated. Agriculture in the area has also been affected – but not quantified – as export markets have been lost due to water quality concerns.

The Mpumalanga costs do not take account of similar external costs incurred in the Vaal Triangle, South Africa's first industrial coal field, and in the Waterberg, the next big coal field to be explored and estimated to contain half of South Africa's remaining coal reserves.

The externalities of the coal economy extend to climate change. A 2002 study[45] estimates a price for coal internalizing the damage cost caused by carbon dioxide (CO_2) and methane (CH_4) emissions due to its contribution to climate change. However, it leaves out to local pollutants such as sulphur dioxide (SO_2), ash and volatile matter and their respective health impacts, as well as the impact of these emissions on water quality. Nevertheless, it calculates that the price of coal would more than double if these costs are internalized.

The Vaal Triangle, South Africa's first industrial coal field which houses many heavy industries as well as the first coal-to-liquid fuel and chemical Sasol plants, was declared a pollution priority area by DEAT in 2006. This decision was supported b y calculations of the health impacts of air pollution in the area, based on the likely

exposure to and impacts of three pollutants: sulphur dioxide, nitrogen oxides and particulates (PM10) all of which result from the combustion of coal. It was calculated[46] that in the Vaal Triangle, about 24,000 people per year would suffer chronic bronchitis, 11,600 would be hospitalized for respiratory ailments and 90 for heart diseases, and about 25 people would die prematurely. On her account, "domestic fuels… are predicted to be responsible for 60% to 65% of health effects" but industrial emission will account for "65% of chronic bronchitis cases" and 30% of all respiratory health effects[47]. But it is worth noting that these findings seriously underestimate the health effects of pollution, because of partial and under-reported emissions, not considering benzene and other carcinogenics, not accounting for the cumulative and synergistic impacts of pollution, nor for industrial accidents and exceedances[48]

A recent "Dirty Fuels" study[49], produced a proxy for national health risks from inhalation exposures, including coal burning. Total direct health costs due to respiratory conditions related to fuel burning (in Cape Town, Ethekwini, Johannesburg and Ekurhuleni, Tshwane, the Vaal Triangle and Mpumalanga) were estimated to be around R3.5 billion in 2002. Exposure to fuel-combustion-related pollutant concentrations was estimated to be associated with some 300 premature deaths.

In the Waterberg coal field, where coal mining is planned to support up to 8 coalfired power stations, Eskom's Chief Executive Officer Jacob Maroga announced in July 2007 that Eskom had saved R6 billion by not installing flue gas desulphurization equipment because of the relative underpollution of the area. This underpollution is of course very temporary, while the retrofitting of the power station will be difficult to enforce even when air quality has deteriorated. In a few years, air quality impacts in the Waterberg will match those in the Vaal Triangle and Mpumalanga.

The fact that no closure certificates have been granted in the past 8 years, gives a clear indication that the government has an understanding of the scale of the liability of future pollution and related costs from closed coal mines. The Brugspruit experience – although this plant does not deal with salinity – has shown government and the public the difficulties of dealing with acid mine drainage. The sheer costs of proper treatment at the Anglo treatment plant also makes this point forcefully.

Mining companies have not finalized their closure plans and shared these with the public – also a reason for concern. Some activists argue that the costs of closure that would properly mitigate the damage done by mining, and the future damage that can be reasonably expected, may well outstrip the profits that these companies are making[50]. If this is the case, then the profits of these coal mining companies – and those who buy from them at "reasonable prices" – represent a transfer of wealth from present neighbours' and future generations.

Recommendations

Coal importers in the Netherlands could undertake an analysis of the situation with coal mining in South Africa, and ask the following questions:

1. Are coal miners taking adequate measures to deal with acid mine drainage?
2. Are closure plans and closure funds in place and are they adequate?
3. Are coal miners prospecting and mining within important ecological and historical zones?
4. Are public participation processes adhered to, and do public interest bodies such as citizens' associations agree to these? Are there arrangements in place for public interest bodies to review monitoring results, permit decisions, infringements and consequences of infringements?
5. Is regulation of the coal mining industry adequate, e.g. are there sufficient regulators, are they sufficiently resourced and are they subject to political interference from politicians who may have direct or indirect interests in coal mining?
6. Is detailed information about coal mining decisions and impacts easily available to the public?
7. Is there adequate support for the catchment management institutions in the area, and are they effective in protecting water resources in the catchments where coal mining is taking place?
8. Are the health and other social impacts of coal mining and coal use recognized, quantified and managed by the polluters and the state?
9. Coal importers should fund research and public action to ensure that the standards implied in the above questions can be met.

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