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Abstract

Large companies are becoming increasingly aware of the current climate situation that we are faced with today. Globally, companies are therefore deciding to play their part when it comes to the way in which they function and relay information concerning their operations. With the evolving environmental legislation surrounding climate change, companies are forced to become more efficient and further, reduce their emissions.

There are various internal as well as external factors, associated with companies, which play a key role in determining these companies environmental performance. This research project will therefore identify and examine these factors and look at how they relate to industrial air pollution emissions. And further investigate to what extent they impact on the performance, both environmental and economic, of one of South Africa’s top companies based in the mining industry.

It is apparent that due to concerns of environmental performance together with environmental reputation, companies have opted to allow for a more open approach to gaining not only support and trust from governments but also from the public and communities affected by the operations of these companies. Public disclosure is an important factor that needs to be considered by corporate companies, when dealing with issues of air quality. It is widely understood that concerns surrounding climate change, in recent decades, is becoming increasingly dominant in the corporate arena.
Introduction

In recent decades, climate change has been at the forefront of numerous discussions. It is evident that the climate is changing and now countries with growing economies worldwide are starting to understand the huge problem we are faced with. Scientific evidence has shown that mankind is partly responsible for climate change. The IPCC’s Fourth Assessment Report has shown that during the 20th century, there was an average increase in temperature of 0.74°C and sea levels have risen by about 17cm (IPCC, 2007).

There is also a distinct difference in the air pollution emission concentrations representative of the industrialised north as compared to that of the south. Countries in the south do contribute immensely to the global concentrations of air pollutants, but not nearly as much as the industrialized countries in the north. There are certain developing countries within the south, however, for instance South Africa that although still recognized as a developing country, has experienced high levels of industrialization over recent decades. These countries industrial activities also contribute to the global air pollution emission concentrations (Afsah et al, 1996).

In December 1997, the Kyoto Protocol was established in Kyoto, Japan, in line with the United Nations Framework Convention on Climate Change (UNFCCC). This body’s main goal was to “stabilise greenhouse gas emissions at levels that will prevent dangerous anthropogenic interference with the global climate” (Global Environmental Outlook 3, 2002, 18). The initiation of this protocol was rooted in the happenings of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. This programme was initiated at a time when greenhouse gas concentrations in the atmosphere were extremely high. Countries that have ratified the Kyoto Protocol have done so in acceptance of the binding targets specified by the protocol. The aforementioned targets indicate by how countries need to reduce their emission of greenhouse gases, by a specified date. This protocol was specifically aimed at the larger industrialised countries as they would have been the largest contributors of greenhouse gases to date. It specified that Annex 1 countries, which include the OECD countries and countries with economies in transition, ‘must reduce their emissions of six greenhouse gases by at least 5% below 1990 levels over the commitment period 2008-2012” (Zhang, 1998, 2).

There is overwhelming evidence suggesting that human activities play a key role in the changes being experienced by the earth’s system. For this reason, instruments such as the Kyoto Protocol, dealing specifically with air quality have been established, in order to curb
the vast amounts of air pollutants being emitted. Although the Kyoto Protocol only calls for action from those countries that have been identified as Annex 1 countries, some countries which fall under the non-Annex 1 brackets do contribute greatly to the global air pollution problem.

Society’s demand for commodities, services and transport often equips large corporate companies with an excuse to operate inefficiently, in order to provide for the increasingly expanding population’s needs. In recent times, however, a complete disregard for the environment is rarely witnessed amongst large corporations. Environmental reputation together with environmental performance, play a vital roles in the corporate domain as these companies are either concerned about the state of the earth’s system or that their lack of concern for the environment might dissuade potential investors (Bridge, 2004).

Business and industrial sectors within industrialised and developing countries have contributed to anthropogenic climate change. The combustion of fossil fuels within these sectors contributes immensely to the emission of industrial air pollutants. Although industrialised countries are responsible for a larger portion of the related climate change, developing countries too have increasingly started to contribute significantly. It has been estimated that “by 2020, developing country emissions are projected to exceed those of industrialised countries” (Goldemberg, 1995 sited in Reid et al, 1998). For this reason, companies in developing countries have begun to take the necessary measures to reduce their emissions (Reid et al, 1998).

With respect to air quality and environmental performance, Preston-Whyte (1989) explains that “effective air quality management require the successful blend of technological inventiveness, legal constraints, economic incentives and political willingness” (Preston-Whyte, 1989, 17). Preston-Whyte has identified, in this statement, some of the most significant factors influencing the management of both the environment and the air.
**Literature Review**

Internal or external factors which influence companies’ environmental performance can do so either negatively or positively. Internal factors have been identified as those structural or operational influences that exist within a company. For improvements in environmental performance to occur within this context, changes need to occur within the company itself. Public policy and related environmental legislation, however, tends to focus on the factors present within the external environment as these factors are more open to changes in policy (Peart, 2001).

**Internal Factors**

According to Peart (2001) these changes that require transformation within the firms itself, relate directly to way in which the firm operates. Corporate companies have the ability to change their methods of production and their operational equipment through technology. One would assume, however, that these changes would exhibit fairly high associated cost. Azapagic (2004) explains that this is not always the case. Cleaner technologies and production methods could actually bring about savings in the long term (Azapagic, 2004).

**Corporate Social Responsibility**

Internal company changes as appose to externalities can commonly be identified either as ‘Corporate Social Responsibility’ (CSR) or refer to structural change in terms improvements in technology. Corporate social responsibility, on the one hand, is often attributed to the internal realisation that the company has a problem that needs to be solved, and for this reason, changes need to be made. Lund-Thomsen (2005) indicates that this forms the basis for identifying the difference between ‘Corporate Social Responsibility’ and ‘Corporate Accountability Initiatives’. He explains that corporate accountability initiatives usually involve some sort of government regulation, which is forced upon corporate companies in an effort to control their behaviour. Corporate social responsibility initiatives, however, are performed on a voluntary basis and involve various stakeholders (Lund-Thomsen, 2005; Hamann, 2005). The structural changes, however, could be made for the same reasons, but often these transformations are made in line with regulatory practices. Jenkins et al (2006) explains that within the mining industry, corporate social responsibility has become imperative, because there is an “increasing need for individual companies to justify their
existence and document their performance through the disclosure of social and environmental information" (Jenkins et al, 2006, 271).

Corporate social responsibility lays hand-in-hand with sustainability and further, sustainable development. Jenkins (2006) indicates that “the notions of sustainable development lies in progress within three dimensions: economic development, environmental protection and social cohesion” (Jenkins et al, 2006, 271). For this reason, in order for economic development to occur and for profits to be witnessed, the social and environmental aspects associated with any industrial activity, needs to be considered (Labuschagne et al, 2005).

Sustainable development is a concept that is not well defined by experts and further, not well understood by many people and yet it incorporates a number of the key themes that are essential for development to occur. This concept has been identified in recent years as being crucial for the development in many countries and in spite of that it fails to be properly understood. The origins of this concept, lies in the Brundtland Report, which was constructed by the World Commission on Environment and Development in 1987. Whilst this concept of sustainable development is not new in the international arena, this is not the case within a South African context. Seeing as sustainable development was a global concept when it was first introduced, and that apartheid South Africa was never really recognised as part of the international community, policies that incorporated sustainable development were never adopted and policy makers did not include the concept into policies for that period (Patel, 2005).

Hilson and Murck (2000) explain that there is confusion in terms of “how sustainable development applies to mining companies themselves” (Hilson et al, 2000, 227). The large body of literature surrounding sustainable development does not specifically identify how the mining industry should proceed in order for sustainability to occur. It instead indicates that achieving sustainable development will depend on a country’s political and economic practices, which will in turn reflect directly onto that country’s mining industry. This however, subjects the concept to a variety of different interpretations.

Another tool that is likely to be implemented as a result of a company’s efforts to improve their environmental performance is that of ‘environmental management systems’. Hilson et al (2002) indicate that an environmental management system is extremely useful within the mining industry as it is a step in the right direction in terms of achieving cleaner production. They further explain the “an EMS, which is the component of the overall management system that includes organizational procedures, environmental responsibilities, and processes, can help a mining company comply with environmental regulations, identify
technical and economic benefits, and ensure that corporate environmental policies are adopted and followed" (Hilson et al, 2002, 19). With a general management system already in place, the implementation of an environmental component should in theory be simple and effective. As stated in the above quote, Hilson’s argument indicates that this sort of system can provide valuable insight into some of the external factors, that will discussed in greater detail later (Hilson et al, 2002).

**Improvements in Technology (Implementation of Cleaner Production Processes)**

As previously stated, structural changes, in terms of operational transformations, can be made for one of two reasons. Mining companies are more likely to change their methods of production due to regulation specifications, rather than due to a reflective realisation because it will hold a financial implication. Although unregulated mining practices have environmental costs, the implementation of cleaner production processes and mining technologies bare economic costs (Hilson, et al, 2000).

Often, cleaner technologies and cleaner production methods refers to mining equipment, that is recognised as being more environmentally efficient, together with enhanced environmental management plans (Hilson, et al, 2000).

According to Hilson and Murck (2000), however, mining companies frequently encounter certain obstacles that create difficulty, when trying to implement these improvements. They identify these barriers as being “legislative, technologic and economic in nature” (Hilson et al, 2000, 699). Bridge recognises further that deficiencies in financial resources as well as a lack of workers with technical skills, are two of the key causes of the aforementioned barriers.

According to Warhurst et al (1996), companies within the mining industry have “a reputation of technological conservatism” (Warhurst et al, 1996, 907). He further recognises that within the mining industry, it’s within a company’s best interests to implement innovative mining processes as it will improve the company’s rank within competitive markets as well as better their environmental reputation (Warhurst et al, 1996). Uncertainty in terms of risks related to financial implications, operational effectiveness and political factors often deters mining companies away from prospects of improved technologies.
External Factors

Peart (2001) suggests that the external factors, however, can be separated into four categories: external factors within a natural environment, a social environment, an economic environment and an institutional environment.

Table 1: External Factors influencing the environmental performance of firms (Peart, 2001, 7)

<table>
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<tr>
<th>Environment</th>
<th>Predictive factors</th>
<th>Direction of influence</th>
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<tr>
<td>Natural</td>
<td>Availability of key natural resources</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Assimilative capacity relative to size of business sector</td>
<td>X</td>
</tr>
<tr>
<td>Social</td>
<td>Environmental consumer awareness and willingness to pay</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Income and education of surrounding communities</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Worker education and skills</td>
<td>X</td>
</tr>
<tr>
<td>Economic</td>
<td>Internalization of environmental costs</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Competitiveness of markets</td>
<td>X</td>
</tr>
<tr>
<td>Institutional</td>
<td>Environmental climate</td>
<td>X</td>
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<tr>
<td></td>
<td>Enforcement</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Public availability of information on firms' environmental performance</td>
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Exploitation of Natural Resources

South Africa is well endowed with a vast variety of mineral deposits which has consequently paved the way for the development of its booming mining industry. For centuries, the central interior of the country has been identified as the economic hub, owing to its mining activities. South Africa possesses the largest known deposits of platinum group metals.

Often, it is taken for granted that the South African landscape holds generous amounts of natural resources in mineral deposits. This therefore allows for the exploitation of these resources, with no consideration for the environment. In the mining industry, this is often the case where a vast quantity of ore is retrieved in order to maximise profits.
Public Disclosure

The concept of public disclosure relates directly to the external factors that exist within the social environment. Public disclosure can be described as the propagation of information associated with firms’ environmental performance. Blackman et al suggest that “public disclosure enhances pressure placed on firms by a variety of private and public sector agents including community groups, consumers, financial markets and state regulators”. Firms that are aware of their environmental reputation tend to avoid dealing with other firms that are not environmentally friendly. For this reason, lots more companies, both multinational corporations as well as small enterprises are starting to increasingly disclose information relating to their operations (Blackman et al, 2004).

Afsah et al (2000) infer that it is widely acknowledged that disclosing information regarding a firm’s operations, to the public can ultimately lead to the reduction of that firm’s emissions. They, however also make the case that there are some uncertainties involved in this theory (Afsah et al, 2000). Various surveys have indicated that pressures from community groups based in close proximity to operational sites, is one of the most significant forces encouraging firms to improve their environmental performance. These communities often have huge buy-in and firms need permission from these groups for development to occur at their operations on in surrounding areas. The pressure placed on mining companies, both on a social and an economic level, influences these companies to consider other factors that do not necessarily relate directly to economic gain. As previously mentioned, the reasons as to why large corporations decide transform their methods of operation, specifically in terms their impact on communities, is largely up for debate. But at the end of the day, if the appropriate changes are being made, does it really matter?

Hilson indicates that this is often a source of conflict between large mining corporations and surrounding communities. He further explains that although this presents a challenge for mining companies, it is necessary in order for them to coexist. Mining companies require large areas of land on which to mine, but these areas are usually inhabited by communities that require this land in order to sustain their livelihoods. This sparks negotiations, and very often, conflict between community groups and mining corporations (Hilson, 2002).

The International Petroleum Industry Environmental Conservation Association indicates that one of the conditions necessary for sustainable development to occur successfully, is it requires industries to respect communities’ values and local culture (IPIECA, 1999, as cited in Munasinghe, 2005). This is extremely important in order to receive community buy-in and further trust from community groups.
Economic Incentives and Environmental Reputation

Since there is no sort of actual ‘environmental fee’ for the discharge of industrial air pollution, the costs of environmental impacts need to be internalised by the company itself through market structures. Often market systems do not consider the various costs associated with air pollution because it is allowed to occur. Environmental management within the mining sector has never really been good and as a result, when these environmental costs are not accounted for, it leads to significant levels of air pollution (Peart, 2001). Blackman et al (1999) pose the question as to whether corporate companies in developing countries should improve their behaviour, in terms air quality, for reasons pertaining to economic incentives or environmental regulation. They argue that environmental regulation within developing countries if often inappropriate and ineffective and for this reason lean more towards economic incentives (Blackman et al, 1999).

Another aspect, which is not really considered as an external factor, but is a significant feature influencing the environmental performance of companies is that of economic incentives. To become more ‘green’ and efficient comes with associated costs. Often companies in developing countries do not feel it necessary to comply with weak environmental regulations, which hold little consequence, because they provide no incentives for them to reduce their emissions (Tietenberg, 1998; Atkinson et al, 2001).

Environmental performance of companies is a significant factor influencing consumer decisions as well as the interests of potential investors. Environmental reputation is a concept that is gaining much attention within the private sector (Vogel, 2009). Firms that are aware of their environmental reputation tend to avoid dealing with other firms that are not environmentally friendly or those who possess a poor environmental reputation.

Evolving Environmental Legislation and Policy

External factors within an institutional environment call for “the promulgation and enforcement of environmental regulations and the availability of information on company performance” (Peart, 2001). These factors are greatly influenced by environmental regulation. South Africa has had a history of deficient and ineffective environmental regulation and further a poor capacity for enforcing these regulations. This was therefore a problem when it came to calling companies out based on bad environmental behaviour. This in part was due to South Africa’s historical situation better known as apartheid. South Africa’s history, more specifically the apartheid era, constitutes a great deal of change, both
within its governance system and further, how the environment was viewed. During this period, the environment was also recognised as a political subject. Selected environments were used as buffers or barriers, separating race groups and restricting the entry of certain race groups into various areas. For this reason, it is imperative that South Africa's historical situation be taken into account when examining any sort of environmental legislation or regulation. Apartheid in South Africa was an era marked by mistrust, not only for marginalised communities but also between the larger part of civil society and the government (Patel, 2005).

Since the beginning of democracy in South Africa, environmental policies have been reviewed in order to find ways to address some of the regulatory problems that we are faced with. Peart indicated in 2001, however that "a notable gap in recent legislative reforms is the control of air pollution, which is still regulated under a law over 30 years old". South African legislation however has since been reviewed after the overwhelming response to climate change and the effect of greenhouse gases and now includes more stringent policies on the control of air pollution.

In South Africa, the Department of Minerals and Energy (DME) is the principal government department, responsible for regulating the mining industry. The Minerals and Petroleum Resources Development Act No. 28 of 2002 (MPRDA), recognised under the DME, is the key piece of legislation governing the activities of mines as well the impact that the industry poses on the environment. MPRDA, promulgated in 2002, replaced the Minerals Act of 1991. This act provides the foundation for the efficient protection of the environment in the process of mineral resource extraction (RSA, 2002).

Other governmental departments that work in collaboration with the DME, in terms of mine related legislation, include the Department of Environmental Affairs and Tourism (DEAT), the Department of Water Affairs and Forestry (DWAF) and the Department of Agriculture and Conservation (DAC).

With respect to air quality, however, South Africa's response in terms of the adoption of NEMAQA was one that has gained much credit over the past few years. South Africa's initial policy on air quality management was the Atmospheric Pollution Prevention Act No. 45 of 1965 (APPA). This act was deemed inadequate in terms of its enforcement and thus compliance. In 2005, APPA was replaced with the National Environmental Management Air Quality Act No. 39 of 2004 (NEMAQA). Although this act does not exist within the boundaries of the Department of Minerals and Energy, it is still important for the mining industry as it depicts air quality standards specifically relating to mines. For example, Section
32 and 33 of this legislation illustrates the assessment of dust relating to mining activities. However, the currently evolving South African legislation on air quality hosts a variety of areas that still need to be reviewed and further vigorously enforced (RSA, 2005).

**Environmental Regulatory Instruments**

Foulon et al (2002) recognise that the inefficient implementation of environmental regulations and laws in developing countries are often due to the lacking capacity of governments to effectively enforce these regulations. Regulatory instruments, although often sound and appropriate for the country in question, is not accompanied by stringent enforcement regimes (Foulon et al, 2002).

Helland (1998) explains that “targeting is the practice of inspecting firms most likely to violate a regulation” (Helland, 1998, 141). He argues that if a firm is willing to publicly disclose information relating to their operations, then it will reveal their compliance to environmental regulation. Firms unwilling to abide by rules set out by environmental regulatory instruments often do poorly in terms of environmental performance and possess a poor environmental reputation (Helland, 1998).

**The Platinum Mining Industry**

South Africa is a powerful player, not only within the platinum mining industry, but within the entire mining industry as a whole. Being the world’s largest supplier of platinum group metals, they produce over eighty percent of the global platinum group metals, dominating the global platinum market. Platinum group metals include platinum, palladium, rhodium, ruthenium, iridium and osmium. About eighty percent of all platinum mined in South Africa, is extracted from the Merensky Reef, which is situated in South Africa’s Bushveld Igneous Complex. There are four individual process involved in platinum mining, the first being the actual extraction of the ore, which contains the platinum. The ore then undergoes a process of smelting and thereafter a refining process.
Methodology

My study was conducted applying both qualitative and quantitative methods of research. I looked at past studies, within the mining sector, that have examined the individual internal and external factors mentioned previously in this study. I then identified the most common factors that exist within all areas and then specifically looked at their impact, and how they are applied within the platinum mining industry.

My research also entailed looking into how environmental legislation relating to air quality has evolved over the past two decades. And further, at how public policy has been incorporated into this sector since the early 1990s, since public disclosure did not really feature much in policy before then. This provided further insight into whether the policies and related practices adopted by developed countries are appropriate and effective in a South African context.

As part of my study, I facilitated an informal meeting and discussion session with an environmental and sustainable development manager positioned at a corporate level at one of South Africa’s largest platinum producing companies (hereafter referred to as Company X). The information acquired from this meeting affording me some indication as to why this company has decided to change the way in which it operates, both at a corporate level and further down at the individual operational sites.

Lastly, I selected four operational sites that are situated within the Rustenburg region, representing the four different processes involved in platinum mining. These processes include mining, smelting and refining, both at a base metals refinery and at a precious metals refinery. I acquired production and emissions figures for the period 2000 to 2008, relating to sulphur dioxide and particulate matter for these different sites. After analysing this data, the figures were represented in graphs in order to identify possible trends and ultimately compare the results, to establish whether the changes in internal or external factor have had any impact on the emission of these two air pollutants over the past decade.
Results

Platinum mining involves four major processes. These include mining, smelting and refining, both a base metals refinery and thereafter at a precious metals refinery. For this reason, I have chosen a platinum mine, a smelter, a base metals refinery and a precious metals refinery to carry out my research. All four operations of interest fall within the aforementioned Rustenburg region.

Mining

The first step of the process entails the actual extraction of the ore, containing the precious metal, from the ground. This process is both land and machinery intensive and therefore poses great impacts on the land and surrounding environments. In terms of air quality, the process of mining in itself does not involve chemical processes and for this reason large amounts of sulphur dioxide and particulate matter do not arise from this extraction process. A major contributor to the deterioration air quality around a mine is dust and small amounts of particulate matter. Key sources of dust within the boundaries of a mine can be attributed to the various tailing dams and gravel roads. Dust fallout within the mine in the Rustenburg region is the highest, when compared to other mining sites of this company.

The Environmental Management Programme Report for this specific mine indicates that dust fallout, together with the total amount of dust deposition is determined in accordance with the ASTM D 1739 method (Company X, 2000). This system entails the collection and measurement of dust fallout from specific locations, where measurement stations have been set up. Cylindrical containers, called dust fallout buckets, are strategically placed at these various measurement points. The buckets are filled with a specified amount of deionised water and left to stand for a month, collecting airborne dust. Small quantities of copper sulphate and distilled water are added to these buckets to minimise the production of algae and the loss of collected sample, respectively. The results of this measurement method are then compared with guidelines set by the South African National Standards (SANS) 1929: 2005, Edition 1.1.

Dust, blown by even the slightest winds, becomes a harsh consequence for the local communities surrounding this mine, specifically in terms of health and visibility implications. Inhalation of dust causes numerous respiratory illnesses, which is often the case for these communities, situated in close proximity to the operation. For this reason, in 2007, the company embarked on a tailings dam management scheme to suppress the large amounts
of dust originating from the dam. This management plans included a number of suppression tools, the first of which made use of mobile water sprinklers.

This part of the implementation plan entails the installation of water sprays on tailings dams and in the areas where dust deposition is rife. These water sprays are fed by water that is either discharged or used within the mining process, therefore incorporating proper water management as well as limiting their own additional costs.

Secondly, various species of grass were planted on the side walls of the tailings dam in order to keep the dust grounded, thereby reducing the amount that is airborne.

The large amounts of dust emanated as a consequence of vehicle movement along the edges of the tailings dam, were suppressed by a further mechanism. The DSM 1 dust suppressant product was applied to the areas of the tailings dam that were frequently ridden on by motor vehicles. This saw a substantial decrease in the amount of dust blown off the dam as a result of cars.
I did, however, not manage to acquire dust fallout data from this company in order to analyse whether there has been a reduction in the amount of airborne dust since the dust management plan has been implemented.

**Smelter**

Data and results gathered from the smelter was far more promising in terms of identifying trends that exist in line with the internal and external factors mentioned above and further within the literature.

The smelting process is perhaps the ‘dirtiest’ of the four processes under investigation. Once the ore is extracted from the ground, it is subsequently sent to the smelter where it undergoes several different chemical processes to generate a product ready for refining.

Although Company X’s smelter production over the nine year period proved to be relatively constant, the same cannot be said for the smelter’s emissions of sulphur dioxide and particulate matter. The sulphur dioxide and particulate emissions for the smelter did in fact decrease over the nine year study period.
Graph 1: Smelter production from 2000 – 2008

Graph 2: Sulphur Dioxide emissions from smelter for 2000 - 2008
The smelter is the largest emitter of sulphur dioxide from the four operational sites of interest. On average, from year to year, the smelter contributes to about 80% of the company’s total sulphur dioxide emissions. Company X has been criticized previously as a result of this, which has in turn affected their environmental reputation.

With the aim of decreasing their sulphur dioxide emissions, Company X embarked on an air quality monitoring and management plan, which incorporated numerous changes, as indicated in the graph. Perhaps the most successful of these to date was the commissioning of Project A in 2002. This project focuses on turning cleaner technology into cleaner production by introducing a technologically improved pyrometallurgical process, which aims to reduce the smelter's sulphur dioxide emissions significantly. 2002 also marked the introduction of the sulphur dioxide permit, which is quoted to be less than 20 tonnes per day, in line with the World Health Organisations’ (WHO) air quality recommendations. This regulatory permit target, together with the implementation of cleaner technology is largely responsible for the considerable reduction in sulphur dioxide emissions witnessed over the following years.

As indicated in Graph 2, a breakdown of the acid plant at the beginning of 2003 caused a peak in sulphur dioxide emissions earlier on in the year. Acid plants are utilised in the mining industry to treat gas emissions. Any discharge created in the smelting process, is transported through various processes at the acid plant, to remove some of the sulphur dioxide before the remainder is emitted into the atmosphere. This caused a large stir amongst surrounding communities, which paved the road for the introduction a scheduled process reduction plan, in the form of ‘Section 54’. Not long after the introduction of the sulphur dioxide permit, followed the Section 54 regulation. The first quarter of 2003 saw the sulphur dioxide emission reduction plan, Section 54, as approved by the Department of Mineral and Energy (DME). Section 54 encompasses strict reduction targets, based on international trends on emissions limits.

The smelter initiated an upgrading of its air quality monitoring and management system during 2004. The primary objective of this improvement was to ensure that the appropriate management systems were established in order to achieve the necessary targets specified by the Provisional Scheduled Process Registration Certificate released by the Chief Air Pollution Control Officer (CAPCO), under the Atmospheric Pollution Prevention Act No. 45 of 1965. 2004 also witnessed the completion of Project A, which in itself, is largely responsible for the tremendous reduction in sulphur dioxide emissions.
Graph 3: Particulate emissions from smelter for 2000 – 2008

As previously mentioned, the smelter production figures show a fairly constant production rate, but once again we see a reduction in the amount of particulate emissions from 2000 to 2008.

Particulate emissions produced from smelting operations are not as severe as the emissions of sulphur dioxide. Project A, does however, include equipment that reduces particulate emissions as well. Controls and measurement instrumentation have been created to monitor these emissions. The smelter installed in-stack ceramic filter in 1998 and have over the years made numerous and substantial improvements to these filters.

South Africa’s Department of Environmental Affairs and Tourism indicates that ambient air quality guidelines for particulate matter with an aerodynamic diameter of less than 10 microns (PM 10), are the same as those for total suspended particulates (TSP), as indicated by the US-EPA and are quotes as follows:
Highest 24 hr average – 300 μg/m³ (not to be exceeded > 3 times a year)
Annual average – 100 μg/m³

Base Metals Refinery

Graph 4: Base Metals Refinery production from 2001 – 2008

Once smelted, by-products known as converter matte, is sent to the base metals refinery. The base metals refinery contributes minor amounts of sulphur dioxide, when compared with the total amount emitted by all the operating sites.

Once again, we see a relatively small decline in the production relating to the base metals refinery, over the study period. As indicated, however, I was unable to attain production figure for the years 2000 and 2001. This does impact on the results to a certain extent, but I am still able to identify the trends that occur over this shorter period of time.
Graph 5: Sulphur dioxide emissions from Base Metals Refinery for 2001 – 2008

As mentioned above, the base metals refinery emits relatively small quantities of sulphur dioxide into the atmosphere after the first part of the refining process.

The introduction of the sulphur dioxide permit was done so throughout the company. It is evident that once the permissible sulphur dioxide amount was announced, the emissions from the base metals refinery started to flatten out and become more constant, before decreasing quite substantially.
Graph 6: Particulate emissions from Base Metals Refinery for 2001 - 2008

Of greater concern, with respect to air quality is that of particulate emissions from the base metals refinery. Once again a gap in the data acquired from Company X, does not allow for an analysis from the last quarter of 2005. However, the data that was received is sufficient to show that there has been a significant reduction in the particulate emissions and therefore I am able to show the subsequent causes of this decrease.

The commissioning of an additional boiler in the early parts of 2002, at the base metals refinery, proved beneficial in terms of reducing particulate emissions. This was done in order to reduce the load of the already existing boilers, rendering them all, more efficient, thereby reducing emissions from the boiler stacks. Further improvements to this boiler were conducted in 2005, when pollution abatement equipment was installed.
Precious Metals Refinery

The second part of the refining process and the last part of the platinum mining process occurs at this operational site. There are two major pollutants that are emitted from this process, namely dioxins and furans. These pollutants are usually created as a result of the incineration of process wastes. There is also a fair amount of sulphur dioxide produced from this process, but nowhere near as large as the amounts generated from smelting or from the base metals refinery for that matter. The amount, however, should still be significant enough to record. I did not receive sulphur dioxide emissions data or data related to particulate emissions for the precious metals refinery as it has not been recorded to date. Company X, however, has put systems in place that started recording sulphur dioxide emissions from the beginning of this year.
Discussion

The Rustenburg Region

Rustenburg has been described as one of the fastest growing towns in South Africa, both economically and in terms of development and population size. The high levels of urbanization experienced by this region can be attributed to the occurrence of the vast amount of mining activity. Rustenburg has been erected over South Africa’s famous Bushveld Igneous Complex, which includes the Merensky Reef, the platinum bearer. For this reason, this area is now also home to some of the world’s largest platinum mines.

The mining activities and thus the consequent development have placed tremendous stress on the environment over the last few decades. There are various longstanding communities that also still exist within this region and even further, due to the increased rate of industrialisation, expanding growth of informal settlements. Additional stress is placed in the land in order to provide for the increasing population. This, however, is minor compared to the impact of the mining activities on the surrounding environment.

Company X has indicated that in order to improve their environmental performance, the following needs to be accomplished: (Company X, 2008)

- Conserve environmental resources
- Prevent or minimise adverse impacts arising from the Group’s operations
- Demonstrate active stewardship of land and biodiversity
- Promote good relationships with, and enhance capacities of, the local communities of which it is part
- Respect people’s culture and heritage

Mining is an activity that utilizes both renewable and non-renewable resources. This therefore not only has an impact on the environment but also the surrounding communities that share these common resources. The atmosphere and ultimately the air, although not classified as easily as a mineral resource for instance, is still a resources that is both used and exploited. The atmosphere into which air pollutants are emitted can be identified as a ‘Tragedy of the Commons’. Many would not classify the atmosphere as such, as it is vast and not conventionally recognised it this manner. But arguably; the atmosphere can be
viewed as a free resource that is being exploited. Often, with any resource that is identified as being a ‘Tragedy of the Commons’, the poor, or in this case the surrounding communities are commonly left to bare the brand of the consequent harsh conditions.

Air quality tends to be a significant problem relating to mining activities. South Africa’s air, not only within mining districts, but in general is one of the most challenging environmental issues that the country is faced with. Pollutants such as sulphur dioxide and particulate matter, often released as a result of mining activities, have devastating consequences for human health and welfare.

Management Systems and Programmes

Company X has tried as far as possible to limit the impact that their operations pose on both the environment and communities residing in close proximity to the mining sites. All four sites included in my study, received their ISO 9000 certification in 2002. In 2004, all four processing divisions further received their ISO 14001 accreditation, as well their OHSAS 18001 accreditation in 2007.

ISO 14001 is an international standard for environmental management systems (EMS), issued by the International Organisation of Standardisation. A technical report released by Company X indicates that these environmental management systems are “based on three key principles, namely prevention of pollution, compliance with relevant environmental law and continual improvement in performance” (Company X, 2007, 76). They further explain that the “achievement and continued ISO 14001 certification gives testimony of a company’s environmental commitment to stakeholders such as employees, communities, government and customers” (Company X, 2004, 57). The OHSAS 18001 accreditation, issued by the Occupational Health and Safety Assessment Series, is also a management system based on health and safety specifications.

Company X has also, in recent years, introduced Environmental Management Programmes (EMP). These programmes are approved by the Department of Minerals and Energy (DME) and include thorough environmental impact assessments. Operational sites that have attained environmental management programmes are legally obligated to comply with proposed environmental management plans and further development and expansion initiatives need to be carried out in line with the EMP’s specifications. These EMP’s also incorporate detailed environmental management plans aimed at lessening the negative impacts posed by the different sites. Comprehensive environmental management
programme performance assessments are also executed in accordance with Regulation 5.18 of the Minerals Act.

Company X has adopted the Global Reporting Initiatives’ (GRI) guideline as an assessment tool to measure their environmental performance. Another technical report explains that “GRI (global reporting initiative) was established in 1997, with the mission of designing globally applicable guidelines for preparing enterprise level sustainable development reports” (Company X, 2007, 109).

**Environmental Law**

South Africa’s environmental law has evolved significantly over the last decade. The replacement of South Africa’s Atmospheric Pollution Prevention Act No. 45 of 1965 (APPA), with the new and improved National Environmental Management Air Quality Act No. 39 of 2004 (NEMQA), was vital in South Africa’s transformation in terms of bettering air quality. This transformation was made in line with the specifications of, and approved by South Africa’s Department of Environmental Affairs and Tourism.

Within the mining industry, however, legislation relating to environmental impacts is often adopted in line with the specifications of South Africa’s Department of Mineral and Energy. The DME, together with its Minerals and Petroleum Resource and Development Act, provide the necessary and appropriate legislation that govern the mining industry.

**Stakeholder Engagement**

Stakeholder engagement and community involvement is a necessity when dealing with environmental issues, associated with the mining industry. This region is densely populated with formal as well as informal settlements, together with scattered farmsteads. Four formal settlements exist within the Rustenburg region. Therefore the activities of the various sites within this area affect all these communities. Company X endeavours to include public participation in all their environmental initiatives. All key stakeholders, including communities, employees and government are engaged through public participation forums, open days and various other forms activities that encompass reviewing the mine’s operations. This is a platform on which not only environmental issues can be discussed, but also the associated health implications. Open days hosted by Company X, HIV/ Aids awareness, corporate
social investment and housing developments. The health implications associated with mining activities are vast. Specifically with the case of platinum mining and it consequent production of sulphur dioxide, communities situated in close proximity to the mining and processing sites are at risk of being affected severely. Thus it is absolutely imperative that these communities specifically are involved in decision-making processes that have an impact on them directly.

**Pollutants**

As previously mentioned in the results section, sulphur dioxide and particulate emissions are the two key pollutants associated with the platinum mining industry. There are however, other pollutants that are significant in terms of air quality.

Although some ambient air quality standards follow international trend limits, the limits set for ambient pollution concentrations still have to be evaluated according to the guidelines set out by the Department of Environmental Affairs and Tourism. Air quality standards in line with the South African National Standards were published by the Department of Environmental Affairs and Tourism in 2004. These guidelines specifically relating to rates and targets of dust fallout are shown below.

**Table 2:** Four-band scale evaluation criteria for dust deposition (SANS 1929, 2004 as cited in Piketh et al, 2005).

<table>
<thead>
<tr>
<th>Band Number</th>
<th>Band Description Label</th>
<th>Dustfall rate (D) (mg/m²/day, 30-day average)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residential</td>
<td>D &lt; 600</td>
<td>Permissible for residential and light commercial.</td>
</tr>
<tr>
<td>2</td>
<td>Industrial</td>
<td>600 &lt; D &gt; 1200</td>
<td>Permissible for heavy commercial and industrial.</td>
</tr>
<tr>
<td>3</td>
<td>Action</td>
<td>1200 &lt; D &gt; 2400</td>
<td>Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.</td>
</tr>
<tr>
<td>4</td>
<td>Alert</td>
<td>2400 &lt; D</td>
<td>Immediate action and remediation required following the first incidence of dustfall rate being exceeded. Incident report to be submitted to relevant authority.</td>
</tr>
</tbody>
</table>
Company X’s environmental management programme reports (EMPR) for the various sites, that all fall within the boundaries of the mine itself, indicate that there have been exceedances of dust over the years. These report, however, only date back to 2002 at the latest and were complied before the dust management plan and dust suppression techniques were introduced.

Table 3: Target, action and alert thresholds for ambient dustfall (SANS 1929, 2004 as cited in Piketh et al, 2005).

<table>
<thead>
<tr>
<th>Level</th>
<th>Dust-fall Rate (D) (mg m⁻² day⁻¹, 30-day average)</th>
<th>Averaging Period</th>
<th>Permitted frequency of exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>300</td>
<td>Annual</td>
<td></td>
</tr>
<tr>
<td>Action Residential</td>
<td>600</td>
<td>30 days</td>
<td>Three within any year, not two sequential months.</td>
</tr>
<tr>
<td>Action Industrial</td>
<td>1200</td>
<td>30 days</td>
<td>Three within any year, not sequential months.</td>
</tr>
<tr>
<td>Alert Threshold</td>
<td>2400</td>
<td>30 days</td>
<td>None. First exceedance requires remediation and compulsory report to the authorities.</td>
</tr>
</tbody>
</table>

Table 3 highlights to what extents exceedances for industrial activities are permitted.

As previously mentioned, sulphur dioxide is the single most significant pollutant when dealing with platinum mining. The highest concentrations of air pollutants in the platinum mining industry are attributable to the smelting process. And this process in itself generates the largest percentage of sulphur dioxide comparable to the total amount emitted by all the operational sites combined. Owing to the fact that such huge quantities of this gas is produced as well as the harmful nature of this gas, Company X, have over the years spent considerable amounts of money on sulphur dioxide reduction mechanisms. Permits placed on sulphur dioxide emissions, also makes it imperative to create a proper reduction plan so as not to exceed to specified limits. For this reason, we see a large array of contributing factors present on graph2, influencing the decreasing trend of the smelter sulphur dioxide emissions. Table 4 below, indicates the permissible quantities of sulphur dioxide over particular averaging periods.
Table 4: Limit values of criteria pollutants (SANS 1929, 2004 as cited in Piketh et al, 2005).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Limit Value (μg/m3)</th>
<th>Limit Value (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur dioxide SO₂</td>
<td>10-minute running average</td>
<td>500</td>
<td>191</td>
</tr>
<tr>
<td></td>
<td>24-hr</td>
<td>125</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>50</td>
<td>19</td>
</tr>
<tr>
<td>Nitrogen dioxide NO₂</td>
<td>1-hr</td>
<td>200</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>40</td>
<td>21</td>
</tr>
<tr>
<td>Carbon Monoxide CO</td>
<td>1-hr</td>
<td>30 000</td>
<td>26 000</td>
</tr>
<tr>
<td></td>
<td>8-hourly running average</td>
<td>10 000</td>
<td>8 700</td>
</tr>
<tr>
<td>Ozone O₃</td>
<td>1-hr</td>
<td>200</td>
<td>102</td>
</tr>
<tr>
<td>Particulate matter PM10</td>
<td>24-hr</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Lead Pb</td>
<td>Annual Average</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Benzene C₆H₆</td>
<td>Annual average</td>
<td>5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

The base metal refinery only contributes minor quantities of sulphur dioxide, comparable to the smelter. Particulate emissions, specifically particulate matter with an aerodynamic diameter of less than 10 microns (PM 10) is considered to be more significant for this operational process. Once again, the permissible amount of PM 10 indicated to be in line with the South African National Standards, is highlighted below in table 5. The introduction of the additional boiler with emission abatement equipment at the base metals refinery was largely responsible for the decrease in particulate emissions witnessed in this area. Studies carried out have shown that the base metals refinery’s emissions, when combined with emissions from tailings dams and domestic coal burning activities exceed the ambient PM 10 specifications, increasing the pollution levels in the surrounding communities. This fuelled Company X’s decision to install the pollution abatement equipment into the additional boiler. This equipment was designed, however, not only to reduce the amount of particulate matter but also the quantity of sulphur dioxide being released into the atmosphere.
Table 5: Target values (SANS 1929, 2004 as cited in Piketh et al, 2005).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Limit Value (μg/m³)</th>
<th>Limit Value (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter PM10</td>
<td>24-hr</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual Average</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Ozone O₃</td>
<td>1-hr</td>
<td>200</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>8-hourly running average</td>
<td>120</td>
<td>61</td>
</tr>
<tr>
<td>Lead Pb</td>
<td>Annual average</td>
<td>0.25</td>
<td></td>
</tr>
</tbody>
</table>

The precious metals refinery emits primarily dioxins and furans, with smaller amounts of sulphur dioxide, chlorine and particulate matter. Dioxins and furans are emitted as the by-products of the process waste incineration process. These two pollutants are significant as they have a cancer risk associated with them and for this reason, have to be in line with stringent limits. Company X is aware of the related consequences of these emissions and has therefore acknowledged the fact that these pollutants are harmful by introducing improved incinerator to the precious metals refinery. Incinerators equipped with activated carbon absorption, will reduce the emissions of both dioxins and furans significantly, thereby remaining well below the limits that are deemed harmful. As noted in the results section, sulphur dioxide emissions, which also pose a health threat to surrounding communities, have not been recorded from this processing operation. I have, however, been informed that data pertaining to concentrations of sulphur dioxide emissions have started to be documented from the beginning of this year.
Conclusion

Corporate companies, specifically those within the mining industry affect the environment in a variety of ways. This in turn often leads to a host of potential social impacts. Mining companies have thus taken strides to improve their environmental performance in line with various evaluation criteria, and in turn decrease their environmental footprint. Mining companies and the environment, however, cannot be discussed in isolation. Platinum mining and its associated activities such as smelting and refining utilize a range of renewable and non-renewable resources, the most significant of these being land, air and water.

My research has concluded that not only are some factors more prominent than other within the mining industry, but also that the literature ‘does not go past corporate company doors’. The expected decreasing trend in both sulphur dioxide emissions and particulate emissions was witnessed, indicating a concerted effort on the part of Company X in emissions reduction.

The first major result that I discovered, which was the focus of my study, indicates that one internal and one external factor dominate companies’ decisions to improve their environmental performance. The introduction of cleaner technologies seems to be one of the greatest driving forces behind major emissions reduction. As previously stated, this transformation could either be pertaining to forceful legislation or as a consequence of an internal realisation on behalf of the company that changes need to occur.

The external factor relating to the institutional environment, specifically in terms of legislation is another key factor influencing mining companies to reduce their emissions. These two internal and external factors mesh well, in the sense that, cleaner technologies and cleaner production could be answer to improved air quality. It is a requirement that should be considered more closely and possibly even included, to a greater extent, into legislation.

Access to and availability of data was one of the hugest problems experienced during a study of this sort. The literature states that large corporate companies are making strides towards improving their environmental performance through methods such as public disclosure. It is, however, not always easy to access data pertaining to emissions values. It is therefore imperative that companies put in place proper management systems in order for information to be accessed readily.
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