Interdisciplinary reflections on the challenge of environmental management in dolomitic areas of South africa

The case of Delmas and Merafong city local municipalities

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ABSTRACT

Although they are 130 kilometres (km) apart, the areas of Delmas and Merafong City (the former Carletonville mining area) share certain environmental commonalities. The irresponsible environmental management of both areas, despite their different histories, are typical examples of limited and unsustainable environmental management practices. The discussion focuses on a basic understanding of the concept "irresponsible", as well as what "interdisciplinary" in this context covers. This is followed by a geographical and historical description of the two areas. Aspects of the lack of environmental management by the Delmas and Merafong City local municipalities are discussed in terms of an interdisciplinary approach and a case study methodology. Among others, it is concluded that creating and maintaining a healthy, well-managed environment is a group effort. However, all group efforts are doomed to failure if there is just one weak link. It is suggested that any weak link or links must be determined and addressed for the communities of Delmas and Carletonville to benefit.

INTRODUCTION

Irresponsible actions in environmental operations and management structures are not confined to particular areas or countries. Research on past actions shows that governments have not always been morally responsible towards nature (Turton, Hattingh, Maree, Roux, Claassen, and Strydom 2007); that industrial magnates have not shown much concern for creating safe living and working environments for their employees (Lee, McNeill and Holland 2000); that local government (municipalities) mostly mimicked national governments and dominant local businesses; and that nobody now or in the past can be excused for the poor state of the environment and the poor environmental management of the area they operated in or are operating in. Current research worldwide (especially in the natural sciences) reveals, among other things, the poor state of environments; inadequate environmental impact plans (multidisciplinary research should be conducted – especially by people with town and regional expertise); and the concerns of communities regarding local economic sustainability (Goudie 2006). The future of communities and generations to come, as well as their health status as a result of irresponsible environmental management, are being researched from interdisciplinary and transdisciplinary points of view. This research is of interest to researchers from the human and social sciences (Van Eeden 2010).

The discussion in this article deals with case studies in two dolomitic areas in South Africa that have suffered from irresponsible environmental management by a host of so-called moral agents. In both cases, this has resulted in environmental crises. The lack of ecological wisdom (Naess 1966:1–136; Naess 1973:95) is discussed from an interdisciplinary point of view with a specific methodological focus. This point of view should eventually lead to transdisciplinary (TD) research interventions. The Delmas and Merafong City local municipal areas share some environmental commonalities. The irresponsible environmental management in both areas is critically discussed from an interdisciplinary approach. The available historical knowledge of the two local municipalities and their respective environmental crises are discussed, and possible strategies to deal with the crises in both areas are suggested. The role that Government and major economic and general community-based decision-makers can play in environmental sustainability is also discussed.

A short conceptual outline is provided, followed by a geographical and historical description of the Delmas and Carletonville areas. Aspects of the lack of environmental management by authorities (local and national), seen through the research lens of several disciplines, form the central focus of the discussion.

A CONCEPTUAL VIEW

Irresponsible environmental management

In all spheres of human activity, people should take responsibility for acquiring the knowledge they need to ensure that they properly manage whatever they are responsible for. This also benefits those who do not have that knowledge, but who have to rely on those people who are supposed to have the ability to manage a very specific package of knowledge. To be "responsible" implies that the individual or individuals:

- Are legally or ethically accountable for the care or welfare of others.
- Are the source or cause of something.
- Are capable of making moral or rational decisions.
- Can be trusted or depended upon.
- Are reliable in their judgments.
- Can be depended upon for their sound thinking.
- Have the means to pay debts or fulfil obligations (Grolier 1981; Turton *et al.* 2007:13).

With regard to sustainable environmental management of various areas and communities, the following nine criteria by Fuggle and Rabie (2005:2) and Strydom and King (2009:29–30) apply to all people and human activities. They must:

- respect and care for the community of life;
- improve the quality of human life;
- conserve the earth's vitality and diversity;
- minimise the depletion of non-renewable resources;
- keep within the earth's carrying capabilities;
- change personal attitudes and practices;
- enable communities to care for their own environments;
- provide a national framework for integrating development and conservation; and
- create a global alliance.

People who have a moral responsibility are called moral agents. As is evident from the above list, people are also causally responsible for events that are brought about by their actions. Often when people are morally responsible for a situation, they are also causally responsible for that situation. Joel Feinberg (1988), among others, has argued that corporations and other groups of people can have what is called "collective moral responsibility" for a state of affairs. If they do not, a moral hazard can occur. This arises when a party insulated from

risk may behave differently from how that party would have behaved if it had been fully exposed to the risk.

A moral hazard is a special case in which one party in a transaction has more information than another. The party that is insulated from risk generally has more information about its actions and intentions than the party exposed to the negative consequences of the risk. More broadly speaking, a moral hazard occurs when the party with more information about its actions or intentions has a tendency or incentive to behave inappropriately from the perspective of the party with less information (Van Eeden 2007:55). For example, if a party with more information does not comply with this broad definition of environmental responsibility, it plainly means that the party is acting irresponsibly. Although the circumstances differ in many ways, the two case studies discussed in this article both share the consequences of irresponsible environmental management in dolomitic areas in South Africa.

Interdisciplinary knowledge and insight into local environmental management

The concept "interdisciplinary" involves research by several related or unrelated academic disciplines. The intention is to create a new set of knowledge and theory through a common research goal (Tress, Tress and Fry 2004:481; Tress, Tress, Van der Volk and Fry 2003; Tress, Tress and Fry 2009:2849). The accumulation of a new set of knowledge should lead to an improved understanding of the specific research focus. Notably, a project must first be researched in a disciplinary (D) context before interdisciplinary (ID) research processes and phases are started (Van Eeden 2010). This methodology was followed in both case studies. An ID focus with clear objectives also requires one or more objectives that reflect the individual contribution of a discipline before the data is analysed and refined to contribute towards a very specific research aim (Van Eeden 2010).

In the environmental history of Delmas and Merafong City, it is the latter that has a long history of disciplinary research and results – especially in the natural sciences. A number of research projects up to the early 21st century were carried out with the purpose of contributing more broadly towards improving environmental management (Van Eeden, Nealer and Liefferink 2009a). The ID focus in the discussion on the environmental management legacies of Delmas and Merafong City reflects two approaches to research content. Delmas is a typical example of a research effort where disciplinary research is combined to yield more responsible conclusions on environmental management. The Merafong City case study set out to analyse environmental management from previous (before 2000) and contemporary (after 2000 for this discussion) scientific reports, as produced by various related and unrelated disciplines, but mainly from a social and human sciences angle. Both cases show a similar outcome with regard to irresponsible environmental management, although the assigned "responsible" role-players

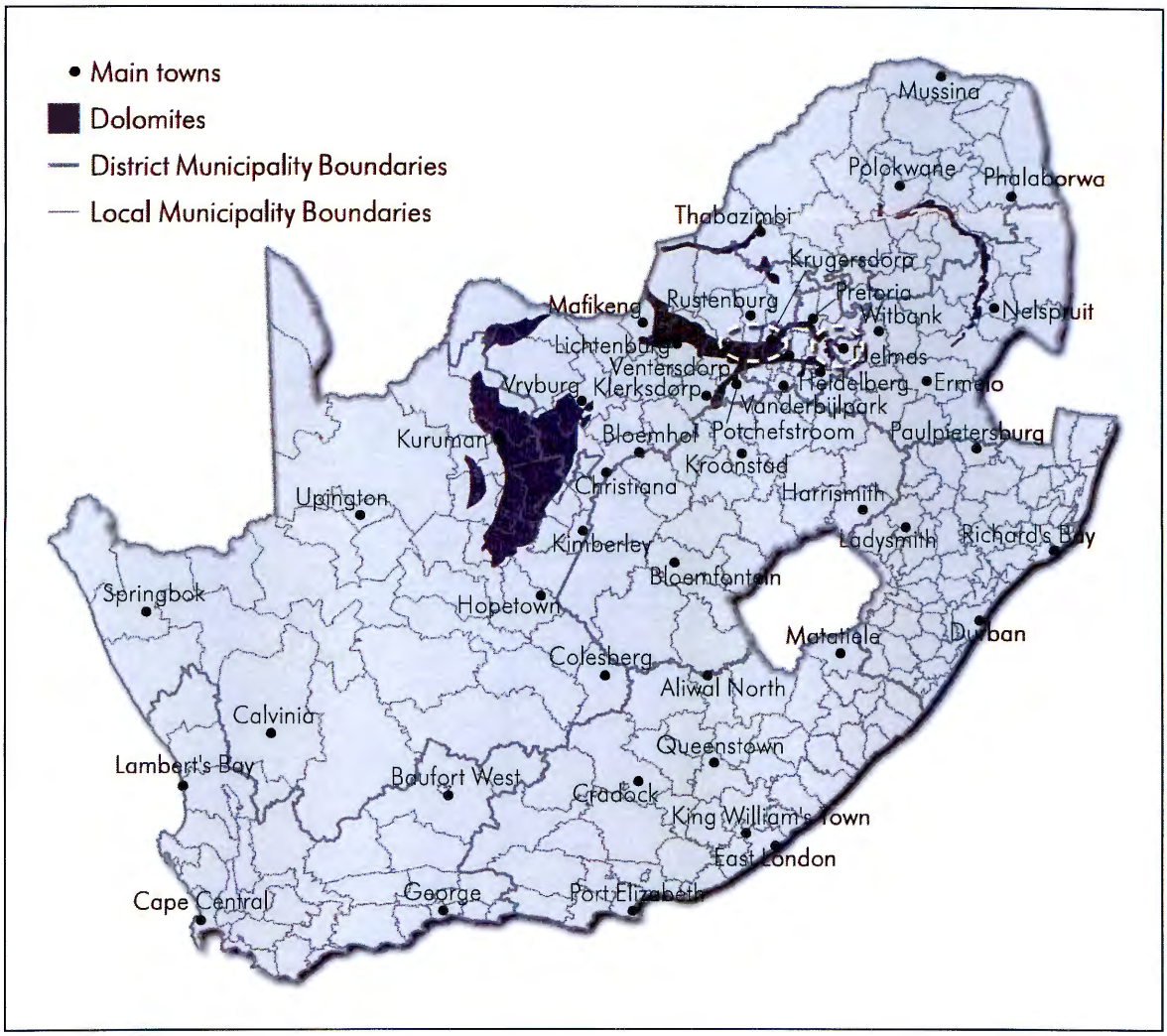
differ somewhat. The only feature absent in the ID research methodology, which would provide an all-inclusive perspective on environmental management, is the role of community members, community expertise (municipal officials) and environmental activists. Without their continuous research input, contributions as well as knowledge sharing, ID research will not be able to progress towards transdisciplinary (TD) research, which can be regarded as the ultimate goal of ID or multidisciplinary research (Tress *et al.* 2003). Although some current research initiatives regarding Merafong City's environmental history feature evidence of TD research, it is still far from what TD founder, Nicolescu (2002) had in mind. However, the following discussion mainly attempts to understand and deal with past and present knowledge and evidence of irresponsible environmental management in two local environments within an ID research methodology structure. The participation of municipal officials did therefore not form part of this research focus.

AREA ORIENTATION

Topographically, the Delmas Local Municipality is located in the north-eastern part of the Highveld region in South Africa, and forms part of the Nkangala District Municipality of the Mpumalanga Province (Delmas Local Municipality 2006). The Delmas municipal area borders on the Gauteng Province in the north, west and south, in which the Merafong City Local Municipality in the far western corner of Gauteng is located. The topography of the Merafong City municipal area is dominated by the Gatsrante, a series of east-to-west trending cuestas with an average height of approximately 100 metres (m) above the footslopes (Van Eeden, De Villiers, Strydom and Stoch 2003). See Figure 1 for the location of the two municipal areas.

Geologically, both the Delmas and Merafong City areas are located in a karst area (dolomite underlain bedrock) that is characterised by features such as natural fountains, underground water aquifers and vast volumes of groundwater. Although these dolomitic areas have been and still are being economically exploited in different ways, historically they both suffered irresponsible environmental management that brought about serious pollution. Strategically, both the Delmas and Merafong City areas play a pivotal role, as they are important urban hubs that provide essential local services in association with the larger surrounding towns. They serve farming communities, as well as industries and mines. Delmas is associated with coal mining (Khumalo and Page 2008)), and Merafong City, which is also part of the West Wits Gold Line region, has been associated with gold mining since the 1930s. The Witwatersrand Group yielded more than half of all the gold excavated in the history of humankind. One of the unexpected

Figure 1: Map of municipalities and the karst (dolomite) areas in South Africa. The Delmas and Merafong City areas are partially indicated



Source: Adapted from GPM Consultants, 2009

windfalls of mining in this geological sequence was the discovery of uranium deposits in the same formations that yielded the gold (Van Eeden 1992; 2006).

In the Merafong City municipal area, underground water in dolomite compartments were eliminated through a decades-long dewatering process by several goldmines to enable them to continue exploring for gold in the area. These water systems are still managed by many kilometres of pipelines and recycling mechanisms. The goldmines have played a decisive role in influencing the environment, economy and communities that settled close to the mining activities. Among other things, the topography of the upper reaches of the Wonderfontein Spruit that flows through the area, has been altered drastically. The main impact has been caused by the presence of mine-tailings dams, rock dumps and surface infrastructure. Sinkholes also formed in this catchment area, most of which were the result of the gold mines' dewatering of the dolomite

Figure 2: Delmas locality showing groundwater abstraction borehole positions and possible pollution sources

Source: MetroGIS 2009

compartments (Van Eeden 1992). The Mooi River downstream in this area and the Wonderfontein Spruit became seriously contaminated (WRC 2006; Nealer and Van Eeden 2010).

As far as Delmas is concerned, the municipal area also features the occurrence of sinkhole formation. As the area was not deliberately dewatered, it is far less visible than in Merafong City. However, the biggest portion of Delmas' potable water is still abstracted from groundwater boreholes in four well fields, called A, B, C and D (see Figure 2 for a locality map of the boreholes).

Research done during 2008 by Mthethwa (2008) found that the groundwater resource (boreholes) in well field A was heavily contaminated and that the water quality was deteriorating. In 1993 and 2005, the quality of the well field A groundwater was already reported as polluted. Tests of the quality of surface water resources in the Delmas area confirm pollution in the vicinity of the underground dolomitic aquifer. The hydrological connectivity had already been indicated by the Directorate Geo-hydrology of the then Department of Water and Environmental Affairs, which stated that the quality of the groundwater could be declining due to default recharging of the groundwater resource by polluted surface water (stream and run-off). Sinkholes can easily accelerate infiltration of surface water and result in groundwater pollution (Mthethwa 2008; DWAF 2006; GCS 2006).

The Delmas community and Municipality experience difficulty when the groundwater levels sometimes drop during the dry winter months. The Municipality then has to augment its potable water supply from the Rand Water pipeline, which has its own problems. Moreover, it is suspected that both the town's wastewater treatment facilities (WWTF) are discharging mostly sub-standard effluent into the downstream receiving streams. The discharge from the older works in town, which also maintains water-flow in the passing Delmasloop, is causing constant environmental pollution through Botleng Proper and Mandela Park. The discharges by the WWTFs, as well as polluted run-off from the residential areas, could therefore be regarded as the primary cause of the unhealthy state of the environment that prevails in the surrounding areas of Delmas (Nealer and Van Eeden 2009).

INTERDISCIPLINARY REFLECTIONS ON PAST AND PRESENT ENVIRONMENTAL DECISION-MAKING

Delmas: When the past speaks for itself

With their problematic location due to the underlying dolomite, the Delmas and Merafong City municipal areas have over many decades suffered from

irresponsible municipal management, a lack of timely public decision-making, and a lack of proper environmental impact assessments to determine the feasibility of managing industries and communities in dolomitic areas in a more environmentally sensitive manner. For example, in the Delmas municipal area, diarrhoea outbreaks in 1993, 2005 and 2007 have consistently been caused by groundwater contamination of its well field A's groundwater abstraction boreholes (Van Niekerk 1993; DWAF 2007). According to officials in the area, in 2005 approximately 528 cases were reported and 69 people had to be hospitalised (*SAPA* 2005; DWAF 2007; Khumalo *et al.*). Health officials and scientists were unable to determine whether typhoid was responsible for the outbreak. More than 90 health workers were dispersed throughout the community to inform the public of essential strategies to combat the spread of the disease (Kahn 2005). Delmas was once more in the news in November 2007, with one infant death and 648 people being treated for diarrhoea (Viljoen 2007). At this time, there were indications that discontent with local water- and health-related conditions were likely to spread well beyond the town's borders.

The Department of Water Affairs and Forestry (DWAF, 2006; 2007) reported the following findings:

- The November 2007 diarrhoea outbreak was most probably triggered by an unrecorded pulse of contaminated water that could have entered the reticulation system during the period when free chlorine levels were found to be lower than the norm (0.2 mg/l). The DWAF acknowledges that this finding is based on scientific speculation in the absence of any record of deteriorated drinking water quality during this period.
- The Delmas Local Municipality failed to comply with Section 21 of the Water Services Act 108 of 1997 to enact and enforce by-laws for the conditions of water service provision – especially managing for the quality and volumes of industrial effluent discharged into the municipal sewer system. The quantity and quality of industrial effluent that is being discharged into the sewer systems is a huge contributing factor to both wastewater treatment plants' inability to produce effluent of an acceptable standard.
- The capabilities and expertise of process controllers at the Town's wastewater treatment works did not comply with Regulation 2834 of the *Water Act 54 of 1956*.
- The quality of discharge at the town's wastewater treatment works did not meet the Licence / General Authorisations conditions as set according to the *National Water Act 36 of 1998*.

As can be noted from the DWA report, there was negligence in dealing with concerns about the provision of basic community services. Furthermore, care for the environment and the community's health was said to be lacking in the

Delmas municipal management structures. Some discussions on improvement were at least begun, and in October 2008 the DWA signed a R100-million contract for a 38 km long potable water pipeline between Bloemendal and the town of Delmas. In what was an historic *Memorandum of Agreement*, the Department announced that this development was one of a variety of "measures to prevent the outbreak of water-borne disease in Delmas town" (Khumalo *et al.* 2008). At the time of writing, environmental impact assessments still had to be completed before this promise could be met (Prinsloo 2009; 2010).

Merafong City's tragic environmental history – a slow crisis transforms into a "time-out" state

The Merafong City Local Municipality's municipal area (which also historically includes the black township of Khutsong) and surroundings are currently best known for the destructed state of its environment (Van Eeden 2001). It is probably the most dangerous dolomitic environment in the country and bears the scars of 75 years of irresponsible environmental management (Nealer *et al.* 2009; Durand, Van Eeden and Liefferink 2009).

Mining in the Merafong City area accelerated officially from 1934 (Van Eeden 2001). By the 1960s, seven gold mines were operating in the area (Macnab 1987; Van Eeden 1994). Because of mining development, six towns were founded in the area, which for years were managed by the Peri-urban Areas Health Board (RSA 1953). On 1 July 1959, the Local or West Wits Area Committee's dream was realised when Carletonville (by 2010 known as Merafong City) became an independent municipality (*Rand Daily Mail* 1959). By the time Carletonville had gained municipal independence, the mining sector gradually featured as the dominant role-player, landowner and exploiter of this environment. Eventually, the gold mines simultaneously became uranium spin-offs, which are currently causing consternation due to its associations with radioactivity. However, urbanisation in the gold mining areas increased to such an extent that people were living and working only tens of metres away from mine dumps and slimes dams, which proved to be radioactive. This had the potential, among other things, of further polluting water sources in the area (Coetzee 2005).

By the 21st century, the groundwater from former springs/eyes has been increasing gradually since some of the mines closed. This is after they have been dewatered and dry for almost 60 years. Nobody has taken responsibility for monitoring the re-watering process or has been prepared to fund the continuous pumping and circulating of water in the underground compartments. The consequence is that not only is groundwater decanting from these springs, but also acid mine drainage (AMD) that consists of a concoction of highly toxic and radioactive waste materials (Hobbs 2004; Oberholster 2008). A number of

people from different communities and various economic sectors are said to be affected (Liefferink 2010).

Impressions of environmental management by 2009

The nature of water and sanitation management in the Delmas Local Municipality's municipal area

The potable water demand of the Delmas town area is about 16 Ml per day; about 10 Ml of this demand are abstracted from groundwater well fields A, B, C and D consisting of 17 boreholes, of which only 10 are currently in operation. The remainder of the potable water demand is being augmented via a 250 mm diameter Rand Water pipeline from Bloemendal. In spite of this augmentation, the Municipality is unable to keep the potable water reservoirs at adequately elevated levels. This is most probably due to water losses and leakages in the reticulation system. However, since an accurate and effective water balance has not been carried out up to now, the figure for unaccounted-for-water is unknown (Nealer *et al.* 2009).

The older established part of Delmas town has two potable water reservoirs (5 Ml and 6 Ml), and there are two newer potable water reservoirs in Botleng (3.2 Ml and 6 Ml). These reservoirs are fed from the boreholes that extract water from the A, B and C well fields. Before being pumped to the water reservoirs, rapid-gravity sand filters and flocculation channels are used to treat the potable water from the A7 and B2 boreholes (2.6 Ml/day). The rest of the potable water supply is only treated by disinfecting it with chlorine (DWAF 2007).

The Delmas municipal area is served by only two wastewater treatment facilities (see Figure 2). Both of these facilities are constantly overloaded and fail to adequately treat the stormwater and wastewater before acceptable quality effluent is released back into the natural surface water streams draining northwards towards the Bronkhorstspruit Dam. In the past, the effluent of both facilities has been shown to exceed the allowable limits prescribed in the licence conditions. The receiving surface water streams and resources are therefore being polluted after receiving the discharges. The older of the two wastewater treatment facilities (WWTF) is situated closer to the residential areas of the town centre. It has a capacity of 5 Ml/day activated sludge type with maturation ponds. The facility is situated about 2 km upstream of the well field A. The dolomite groundwater aquifer is thus directly downstream from the natural catchment of the stream receiving the WWTF effluent (Nealer *et al.* 2009). See Figures 3 and 4 for some careless municipal management realising in the Delmas municipal area.

Another irresponsible management aspect of the current development and municipal management of the Delmas municipal area is the fact that the Integrated

Figure 3: Refuse dump area immediately upstream of the B field potable water abstraction boreholes

Source: Nealer *et al.* 2009

Figure 4: Small surface dam of raw sewage near the D field potable water abstraction boreholes and 300m from the municipal offices in Delmas

Source: Nealer *et al.* 2009

Development Plan (IDP) of the Delmas Local Municipality for 2006/2007 does not acknowledge the nature and extent of the dolomite bedrock foundations (karst) underlying the entire area and the risk of disasters due to the formation of cracks, ponors and sinkholes (Delmas Local Municipality 2006; GCS 2006). This aspect requires urgent and complete geophysical surveys, transparency with regard to the findings, and access to information by all role-players and stakeholders. The reason for this approach is that the Municipality is utilising its local groundwater resources, thereby possibly lowering the natural groundwater level, which affects more than just the Municipality.

Some other destructions of concern in the Delmas municipal area, which are also due to the Municipality's careless environmental management approach, are:

- The lack of borehole data (such as yield and water quality) and statistics by the Municipality and the DWA – especially for the production boreholes – is disconcerting. This indicates the Municipality's lack of knowledge or unwillingness to accept responsibility for effective geo-hydrological data management, which may stem from a lack of knowledge about managing any groundwater source in an effective and efficient manner.
- The nature and extent of the geography, hydrology, geology and geo-hydrology must be shared with all role-players and stakeholders (the communities). Therefore, the underlying dolomitic rock formations and the water-flow in and through them, the sinkholes in the bedrock, as well as the danger of new sinkholes forming, must be managed in a transparent manner.
- There is consensus that the groundwater quality in the Delmas area has been compromised. The local groundwater aquifer has been subjected to salination (caused by the increase in salts mainly from human activities, such as the discharge of industrial effluents, irrigation return flows and urban run-off); eutrophication (the increase in plant nutrients such as phosphates and nitrates) due to treated sewage effluent discharge into rivers and streams, causing excessive algal growth (including toxic blue-green algae) in dams and rivers, with associated taste and odour problems and increased water treatment costs; and bacteriological contamination (rising faecal contamination levels) associated with increasing population densities and inadequate sanitation – especially in informal settlements (Hobbs 2004).

The lack of an interdisciplinary approach to environmental management should not be excluded as a reason why irresponsible environmental management practices still prevail. This also applies to the Merafong City municipal area. Due to the greater emphasis on profits by industry and the authorities that oversee the Merafong City area, irresponsible environmental management has led to the devastating consequences seen up to 2010. In this regard AMD has become an issue of great concern. See Figure 5 for an example of severe ground surface pollution.

Figure 5: Example of AMD in the Merafong City's municipal area

Source: Van Eeden and Brink 2007

Merafong City and acid mine drainage (AMD)

Due to years of negligent environmental management by mines and Government in the Merafong City area's gold fields, AMD spillages and pollution have resulted in a fierce debate between authorities and communities since 2007, with environmental activists joining in. These debates and whistle-blowing attempts have been run as awareness and action campaigns – especially by non-governmental organisations (NGOs), such as the Federation for a Sustainable Environment (FSE). Failure to take responsible decisions (and responsibility for poor public decision-making in the past) is considered to be something for which civil society could also hold Government responsible (Oberholzer 2010):

A media statement that was released by the Ministry of Water and Environmental Affairs (consisting of the two separate departments of Water Affairs and Environmental Affairs) on 11 February 2011 provides a detailed outline of the future management of AMD in the broader Merafong City region. The statement confirms the need to take urgent steps to counter the threat AMD poses to humans and the environment. Some of these urgent steps, which hold promise of improving responsible environmental management, include:

- A public-private partnership has been formed between Government and the mining houses to treat the mine water, discharge treated water that meets Resource Quality Objectives, as well as augment stressed water systems.
- On 18 March 2010, the Minister of Water and Environmental Affairs, Buyelwa Sonjica, visited the decant area in the West Rand basin and budgeted R6.9-million for the interim treatment of the AMD.

- In her speech in Parliament on the Environment Budget Vote delivered on 16 April 2010, the Deputy Minister of Water and Environmental Affairs, Rejoice Mabudafhasi, acknowledged the urgency and seriousness of the AMD situation that "threatens the groundwater resources and the very integrity of the environment and human survival" (RSA 2010).

Even the famous Cradle of Humankind, a World Heritage Site immediately north-west of Krugersdorp, is under threat from AMD in surrounding areas. The DWA recently indicated that they were engaged in short-term interventions to alleviate the worst effects. However, Mabudafhasi remarked that the, "time has come for those responsible to account for their actions". "Those responsible", as she vaguely referred to, should indeed include the mining authorities, Government and local industries, communities and individuals alike (RSA 2010; Liefferink 2010). The academic community also has ethical obligations to carry out the type of research that will benefit more than just the economy (Van Eeden *et al.* 2009a).

By March 2010, the R6.9-million that the DWA promised, was being used to add significant volumes of lime where untreated AMD flows into the Krugersdorp Game Reserve. This inflow causes toxic and radioactive heavy metals, including uranium, to precipitate into the Hippo Dam (the first receptor in the Krugersdorp Game Reserve). Since the iron is not removed, it is thought to result in secondary chemical reactions with resultant pH shocks. The acidification causes these heavy metals in the Hippo Dam to become mobilised and solubilised. The Aviary Dam, the last dam in the Krugersdorp Game Reserve after the water has flowed through wetlands, has a pH of 4, and the dam contains elevated spikes of sulphate, manganese, iron and uranium. The Tweelopie Spruit forms part of the Crocodile River system in South Africa. While Minister Sonjica has acknowledged that AMD is a "triple A priority" and a "ticking time bomb", the Government's environmental management approach remains "band-aid"-like or reactive. Government's approach is not always proactive in the quest for more effective, efficient and sustainable management of water resources (Liefferink 2010; Liefferink and Van Eeden 2010).

The Department of Mineral Resources' publication of the Regional Mine Closure Strategies for the West, Far West, Central, KOSH and East Rand gold fields is a significant advance compared to the past management of the environment and water. It details the medium-, short- and long-term water management options. It, for example, recommends that, "*mine water management interventions must be put in place within prescribed time frames, in order to prevent uncontrolled decant of AMD charged with toxic metals and extremely high sulphate content to surface environments.*" (DMR 2010). It also recommends that, "catchment management agencies are the best vehicle for an integrated effort". However, the Inkomati Catchment Management Agency (CMA), which was the first to be announced in 2004, was only established in late 2006 (Kasrils 2004:Online). The rest of the

total of 19 CMAs are being established at a slow pace. By early 2010, the Breede-Overberg (BOCMA) was the second CMA to be established (Breede-Overberg CMA 2011:On-line). In the same year, the DWA reported that more CMAs would be established soon – 12 years after the *National Water Act 36 of 1998* (NWA) was promulgated (RSA 2010; Liefferink *et al.* 2010).

Before the NWA was enacted, various constraints hindered any solid progress towards a more responsible and sustainable approach to environmental management in the Merafong City's municipal area. These include the following:

- Decades-long ignorance by Government and especially the local government municipalities of looming environmental crises in the Merafong City area.
- Decades-long avoidance by gold mining authorities of the environmental reality in dolomitic areas.
- Limited access by all those interested and involved to "confidentially assigned" research.
- The too-soft and calculated voices of most of the involved and concerned academia have helped to enhance environmental irresponsibility (Enslin and Kriel 1967; Enslin, Kleywegt, Beukes and Gordon-Welsh 1976; Vegter 1987; Barthel and Funke 2007; Van Eeden *et al.* 2009b).
- Information gaps in companies and Government are left when informed employees resign or go on pension (a lack of information management also influences proper environmental management).
- Lack of healthy co-operation between the so-called injurer and the injured in the same environment has been, and remains, a difficult constraint in dealing with the more effective management of environmental crises. (Van Eeden 2006; Van Eeden *et al.* 2009b).

After turning a blind eye for decades, Government is still not taking proactive action against anyone who disrupts a responsible environmental management approach in the Merafong City municipal area (Liefferink *et al.* 2010). Some of the environmental destructions that are still not being addressed by a responsible management approach in the Merafong City area, are:

- It is now a permanently destructed area with only one major underground compartment; the underground dolomitic water is contaminated with heavy metal and sediments; permanent pumping costs; and extensive expenses of maintaining stability in the environment for further exploitation.
- Farming is limited to a minor economic role.
- The Far West Rand Dolomitic Water Association (a mine association) owns the land.
- Health concerns are becoming more evident among municipalities, farming communities and informal settlement groups. But, as in the past, "more evidence" is required to force authorities to take action.

- Accusations that Government is still sympathetic towards the woes of mining companies.
- Concerns regarding the closure of the State Coordinating Technical Committee on Sinkholes in 1998, while more sinkholes are expected to appear in future.
- Rumours of the closure of the Far West Rand Dolomitic Water Association are raising concern, as this would cause many unique problems.
- The danger of the expansion of AMD pollution, which remains ill-managed.

After more than 45 years of extensive, additional and new research reporting there is still no responsible environmental management approach in the Merafong City's municipal area. The key reason for this being that it has never been viewed holistically in multidisciplinary terms (Fuggle *et al.* 2005; Van Eeden *et al.* 2009b).

CONCLUSION

The discussion on the evidence of irresponsible environmental management in the two dolomitic areas of Delmas and Merafong City has highlighted the importance of not approaching environmental problems from a reductionist point of view (a one-expertise approach). Rather, human-land relationships require a holistic, multidisciplinary approach (Fuggle *et al.* 2005). Two slowly developing crisis scenarios in dolomitic areas of Delmas and Merafong City were discussed. The article also looked at how past research was either overlooked because it was not approached interactively, or was simply ignored because of managerial incompetence or economic concerns.

It is therefore possible to agree with Genthe and Steyn (2008; GCS 2006), who remarked that the typhoid epidemic in the Delmas municipal area in 2005 is an example of how important effective co-operative governance is in dealing with a public health problem. The national, provincial and local authorities who are responsible for, among others, health and social services, water and environmental affairs, housing, agriculture and land administration, as well as the mines and the Delmas Local Municipality simply have to take a more proactive lead in bringing about responsible governance.

As far as the broader Merafong City region is concerned, the Regional Mine Closure Strategies recommends that:

- The polluter pays principle must apply.
- Cradle-to-the-grave precautionary principles must be adhered to.
- Water management actions must be implemented during planning.
- Operational, closure and post-closure phases of a mine must be developed.
- Water should be treated as an asset with social, environmental and economic value.

- Clear accountability must be apportioned.
- Total company and mine management commitment is fundamental to ensuring effective implementation of the strategic management of mine water.
- Radical plans with specific time frames must be put in place. (Oberholzer 2010).

The negative aspect is, however, that these laudable recommendations for responsible environmental management in the Merafong City Local Municipality's municipal area of jurisdiction are not being acted upon.

To create and maintain a healthy, well-managed environment is a group effort. However, all group efforts are doomed to failure if there is even one weak link. It must be determined where any weak links are in the Delmas and Merafong City local municipalities' managerial structures. Local authorities, especially in the more rural areas of South Africa, have unfortunately acquired a negative reputation for effective basic service delivery, especially in the water services sector. This also applies to the mining groups, which mainly engage with environmental problems on their own terms, most of the time without a sustainable input from expertise in the human and social sciences.

In conclusion, we quote Fuggle and Rabie's (2005:6–7) reasons for environmental deterioration: *"...human-land relationships require a holistic perspective, an ability to appreciate the many aspects that make up the real problem ... An ability to understand the relationships between the specific elements is central to dealing with human-environmental problems in a responsible way. After 1994 the administrative system for environmental management in South Africa changed in an evolutionary way. It necessarily brought about problems manifesting themselves more openly in the quest for changing and fragmenting past systems of environmental management"* (Fuggle *et al.* 2005:53–63; Adler, Claassen, Godfrey and Turton 2007; Turton *et al.* 2007:33–41).

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