

The precautionary principle

and

public environmental decision-making in South Africa: an ethical appraisal

by

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Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: March 2016

ABSTRACT

The aim of this dissertation was to provide the foundations for building a new risk regulatory mechanism in environmental decision-making, which in most cases is influenced by an expert bias in decision-making (that excludes lay people, indigenous knowledge, affected parties and marginalised groups). With this framework, the aim is also to find common ground between scientific uncertainty and complexity in environmental decision-making.

This dissertation investigated how the precautionary principle can be applied in concert with other decision-making theories such as qualitative risk assessment to prevent, but in some cases also to address, human-induced environmental catastrophes. Given the tension that exists between the scientific and 'non-scientific' communities, a methodology that looks at both options was investigated.

The methodology employed in this dissertation was twofold: (I) Desktop research was conducted in which the divergent views of and argumentation by different scholars on the precautionary principle were interrogated and analysed and, secondly, (II) the precautionary principle was tested in a case study involving acid mine drainage and highlighting the implications that this approach could have had in environmental decision-making that seeks to protect human and environmental health. In the final analysis, the precautionary principle (PP) tests the application and validity of cost benefit analysis, quantitative risk assessment, environmental impact assessment, etc. by analysing those areas in which science is undoubtedly weakest (i.e. situations of uncertainty and complexity where environmental damage may be irreversible or potentially catastrophic).

It is argued in this thesis that the PP is geared to uphold scientific objectivity and integrity in contexts of uncertainty and complexity, and to assist scientists and policymakers to tread carefully when implementing scientific decisions, particularly those that involve the environment, in order to ensure rationality and objectivity.

Lastly, the proposed framework on ethical mining is outlined, helping to set the scene for future environmental decision-making and associated recommendations whose objectivity will help protect human health and the environment by taking uncertainty, complexity and public views into consideration, without side-lining science-based decisions.

OPSOMMING

Die doel van hierdie proefskrif was om die grondslag te lê vir die samestelling van 'n nuwe risiko-regulerende meganisme vir omgewingsbesluitneming, wat in die meeste gevalle beïnvloed word deur die vooroordeel van deskundiges in besluitneming (waardeur die lekepubliek, inheemse kennis, geaffekteerde partye en gemarginaliseerde groepe uitgesluit word). Die doel van so 'n raamwerk is ook om gemeenskaplike grond te vind tussen wetenskaplike onsekerhede en die kompleksiteit van omgewingsbesluitneming.

Hierdie studie ondersoek hoe die voorsorgbeginsel (*precautionary principle*) saam met ander besluitnemingsteorieë soos kwalitatiewe risiko-assessering toegepas kan word om omgewingsrampe wat deur mense veroorsaak word, te voorkom, maar in sommige gevalle ook op te los. Gegewe die spanning tussen wetenskaplike en 'nie-wetenskaplike' gemeenskappe, is 'n metode wat beide opsies in ag neem, ondersoek.

Die metodologie wat in hierdie proefskrif gebruik is, was tweeledig: (I) Akademiese navorsing is gedoen waarin die uiteenlopende standpunte en argumente van verskillende navorsers oor die voorsorgbeginsel ondersoek en ontleed is, en, tweedens, (II) die voorsorgbeginsel is getoets in 'n gevallestudie wat op die dreinerings van suur mynwater gefokus het, en waarin die implikasies wat hierdie benadering kan hê in omgewingsbesluitneming wat poog om die gesondheid van die omgewing en mense te beskerm, beklemtoon is. Per slot van rekening toets die voorsorgbeginsel die toepassing en geldigheid van koste-voordeel-analise, kwantitatiewe risiko-assessering, omgewingsimpakstudies, ens. deur die ontleding van daardie terreine waarop die wetenskap ongetwyfeld die swakste is (d.w.s. gevalle van onsekerheid en kompleksiteit waar omgewingskade onherstelbaar of potensieel katastrofies is).

Dit word in die proefskrif geargumenteer dat die voorsorgbeginsel daarop gerig is om wetenskaplike objektiwiteit en integriteit in die konteks van onsekerheid en kompleksiteit te handhaaf, en wetenskaplikes en beleidmakers te help om versigtig te werk te gaan wanneer wetenskaplike besluite uitgevoer word, veral dié wat 'n effek op die omgewing het, om daardeur rasionaliteit en objektiwiteit te verseker.

Laastens word 'n raamwerk vir etiese mynbou voorgestel en omskryf, wat help om die grondslag te lê vir toekomstige besluitneming oor die omgewing. Die objektiwiteit van die aanbevelings wat hiermee gepaard gaan, sal bydra tot die beskerming van die gesondheid van mense en die omgewing deur onsekerheid, kompleksiteit en openbare menings in ag te neem, sonder om wetenskapsgebaseerde besluite opsy te stoot.

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Acronyms /Abbreviations

AMD	Acid mine drainage
ARVs	Antiretrovirals
BEE	Black economic empowerment
CBA	Cost benefit analysis
CBD	Convention on Biological Diversity
CEC	Communication from the Commission on the Precautionary Principle
CEO	Chief executive officer
CERES	Coalition for Environmentally Responsible Economics
CPB	Cartagena Protocol on Biosafety
CSIR	Centre for Scientific and Industrial Research
DDT	Dichlorodiphenyltrichloroethane
DEA	Department of Environmental Affairs
DME	Department of Minerals and Energy
DMPRD	Minerals and Petroleum Resources Development
DWAF	Department of Water Affairs and Forestry
ECC	European Commission for Environmental Communication
EEA	European Environmental Agency
EIA	Environmental impact assessment
EU	European Union
GDARD	Gauteng Department of Agriculture and Development

GMOs	Genetically modified organisms
LMOs	Living genetically modified organisms
MPRDA	Minerals and Petroleum Resources Development
NATO	North Atlantic Treaty Organization
NDP	National Development Plan
NEMA	National Environment Management Act
NGOs	Non-governmental organisations
NWA	National Water Act
OECD	Organization for Economic Co-operation and Development
PP	Precautionary principle
QRA	Qualitative risk assessment
RA	Risk assessment
RSA	Republic of South Africa
SA	South Africa
SD	Sustainable development
SRA	Standard risk assessment
TUT	Tshwane University of Technology
UNESCO	United Nations Educational, Scientific and Cultural Organization
UK	United Kingdom
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme

US	United States
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

Preface

This thesis was largely influenced and informed by my work experience and by my academic qualification in Environmental Ethics. Firstly, my professional and academic profile is rooted firmly in environmental health and applied ethics, notably environmental ethics. I have been a professional and independent Environmental Health Practitioner for 13 years working for the City of Johannesburg specialising in water, air and noise quality, including food safety, occupational health and safety, sustainable development, building control and related social problems. I have also spent some years working as a meat inspector at the abattoir at the then Department of Agriculture and Marketing in the late 1980s. I later joined the academic world in 2000 as an academic practitioner in the department of Environmental Health at the Tshwane University of Technology. I am currently Senior Lecturer in Environmental Health and also the Chair of the Department. Thus my professional training is deeply rooted in environmental studies. In that regard, my field of study in environmental health, given my experience and interests are wide and varied, and this is precisely the reason why my interest also expanded to include environmental ethics.

Secondly, this thesis was inspired by the outcomes of my ethical investigation on the DDT case during my Masters studies on environmental ethics on the topic of whether it made sense or not to spray with DDT to control malaria¹ This thesis was informed by the outcomes of a case study that I conducted in Limpopo and Mpumalanga regarding the so called dangers associated with spraying with DDT to control malaria. My thesis however revealed that such a one-size-fits-all global policy, despite its claim to be precautionary, would, in fact, be incautious since it is likely to add to the numbers of malaria deaths that would occur otherwise. Specifically, the case study indicated that under a precautionary approach, it makes sense to have a two-tiered approach toward DDT such that the policy for countries where malaria has been eradicated is different from that in countries where malaria is still prevalent. Thus, in developed countries, a ban on DDT makes precautionary sense. On the other hand, in countries where malaria is an ongoing threat, indoor spraying of DDT ought to be encouraged, until it is phased out automatically if and when equally safe and cost-effective substitutes are available and have been accepted by the beneficiaries of indoor spraying in the developing world.

Thirdly, the challenge of acid mine drainage (AMD) and its associated impact has received considerable coverage in the media of late and a gloomy picture of the impending calamity that is about to explode around Johannesburg where I was born has further fuelled me to look at alternative ways of resolving this scourge outside science-dominated decision-making discourse. In short, AMD was perceived as a time bomb waiting to explode unless decision-makers and other role players came up with uncompromising, robust positions like the precautionary principle (PP) which I first came across for the first time when conducting my research on DDT.

¹ Title of thesis: To spray or not to spray with DDT to control malaria: A case study in Environmental Ethics. I completed my Masters' Degree at the Department of Philosophy in Stellenbosch University within their programme in Environmental Ethics, and that the thesis is available in the University Library of Stellenbosch University (URL: <http://hdl.handle.net/10019.1/53698>) it can be found on Sun Scholar.

The PP at the time of my studies was just mentioned as a concern and it was not thoroughly explicated. My PhD studies has, however, given me an opportunity to revisit the PP to determine if it could be used as an alternative decision-making tool to science based decision-making given the flaws that are inherent in the fundamental structure of science.

In order to test the viability of the re-conceptualization of the PP that I have developed in the first part of my PhD thesis, I have conducted interviews and consulted widely with stakeholders in the mining sector itself. In the second part of my thesis I discussed these interviews and consultations. In the extensive literature review on the subjects of qualitative risk assessment and the precautionary principle my purpose was to understand their respective implications for environmental decision-making policies. As a point of departure, both approaches were critiqued with the sole purpose of finding common ground between them, and hence to ameliorate the tensions that exist between them. In addition, given my critical assessment of the arguments levelled against the PP, I conclude that science and the precautionary principle are complementary to one another. However, without contradicting myself, I strongly argue in this thesis that on the strength of my interpretation and comparative analysis of the two decision theories referred to above, that the precautionary principle has been invoked to justify worldwide concerns in respect of the gaps, the uncertainties and the complexities that exist within mainstream scientific enquiry. In my thesis I strongly argue that if decisions are based on uncertainty and complexity, i.e. if a re-conceptualized PP is taken seriously, they are more likely to result in policy that may find favour amongst the non-scientific community. From another perspective, the justification of the PP as an alternative decision-making tool should not be seen as an excuse to discredit scientific risk assessment but to rather see it as a constructive and sensible way in which to protect both humans and the environment from possible catastrophe. Accordingly, to move the concept of the PP forward, I tested the power and promise of the PP in the context of decision-making on AMD. My finding was that the PP largely makes sense in environmental decision-making when adverse irreversible activity was found to be lurking in the darkness. In view of that, the PP was found to be a tool that can be used in partnership with science based decision-making to influence environmental policies in a positive sense.

Section A

Chapter 1

Background, Problem Statement and Methodology

1.1 Background

Scientific and technological advances mostly ignite and often engender public concerns about potential hazards to public health, safety and the environment. Often, however, these claims about potential hazards are scientifically uncertain, so that public officials consequently find themselves in the awkward position in which they have to decide whether protective action should be taken promptly, or whether protective action should be delayed until scientific uncertainties about the potential hazards are reduced or resolved. This dilemma is present in a wide range of contemporary public decision-making contexts, including controversies about synthetic chemicals, nanotechnology, genetically modified food; medical products such as ARVs, etc. (see Halffman, 2003). In circumstances like this, the precautionary principle is usually advanced to help authorities resolve this dilemma (Raffensberger & deFur, 1999; Raffensberger & Tickner, 1999; Tickner, 1999; Wingspread Conference, 1998; O’Riordan & Cameron, 1994). The standard formulation of the precautionary principle, which is a “weak” version, states that: “In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.” (The Rio Declaration on Environment and Development, 1992)

The precautionary principle (hereafter referred to as PP) is eminently sensible, with potential applications in pollution control as in mining, water pollution, air pollution, protection of ecosystems, etc. The precautionary principle reflects that risk assessment is an uncertain science and faulty at best, and that serious harm might occur if we postponed regulatory action until all risks from an activity are fully understood. The weak version of the PP is least restrictive and *allows* preventive measures to be taken in the face of uncertainty, but does not *require* preventive measures. To satisfy the threshold of harm, there must be some evidence relating to both the likelihood of occurrence and the severity of consequences. Under weak formulations, the only requirement is to justify that the need for action (i.e. the burden of proof) generally falls on those advocating precautionary action. This version, however, does not assign liability for environmental harm.

On the other hand, the strong versions of the PP differ from the weak version in reversing the burden of proof. Strong versions *justify* or *require* precautionary measures, and some also establish liability for environmental harm. The Earth Charter (2000), for example, states:

When knowledge is limited apply a precautionary approach ... Place the burden of proof on those who argue that a proposed activity will not cause significant harm, and make the responsible parties liable for environmental harm.

The reversal of proof requires those proposing an activity to prove that the product, process or technology is sufficiently “safe” before approval is granted. Requiring proof of “no environmental harm” before any action proceeds implies that the public is not prepared to accept any environmental risk, no matter what economic or social benefits may arise (Peterson, 2006a). This approach is thus influenced by a principled Kantian discourse that contrasts starkly with the cost-benefit analysis espoused by Bentham and Bowring (1834) and other like-thinking philosophers.

Over time, there has been a gradual transformation of the PP from its weak formulation that appears in the Rio Declaration to a stronger form that arguably acts as a restraint on development in the absence of firm evidence that it will do no harm. The last few years have seen substantial issues around how the burden of proof is applied. For instance, increasing cost has resulted in delays in innovation² which in turn have affected the viability of industries and the customers who rely on those products (Gray & Shadbegian, 1998). This, in turn, has forced industry to change its activities to other jurisdictions with less stringent standards of proof, resulting in a loss of talent in a country.

Both the weak and strong versions of the PP emphasise the anticipation of harm and taking preventive measures in the face of uncertainty, but there are some important differences between the two approaches. Whereas weak versions of the PP permit the government to regulate risks under conditions of scientific uncertainty, the strong version of the PP suggests that some precautionary regulation should be a default response to serious risks under conditions of scientific uncertainty. According to Sachs (2011), such regulation could range from a blanket prohibition or rejection of an activity in relation to a proposed technology or dangerous activity, to less aggressive defaults, such as the use of restrictions or warning requirements. The strong version of the PP represents an affirmative call to action, whilst the weak version of the PP represents something like a “ceasefire” whilst negotiations are continuing.

² Gray and Shadbegian (1998) posit that escalating cost may hamper new innovation, for example a polluting machine may not be replaced, which will result in little investment in seeking for a new abatement solution of air pollution.

The precautionary principle is thus utilised as a guiding principle that we can use to make decisions under conditions of uncertainty. This principle, however, does not help us to get out of trouble, since there is not a universal or generally accepted definition or conceptualisation of the precautionary principle. In fact, studies have reported about 19 formulations and definitions of the precautionary principle³ (Sandin, 1999), that vary in their precision and public implications (Stirling, 1999a; Fullem, 1995; Hey, 1992; Weintraub, 1992). It is this multiplicity of definitions and interpretations that paralyses the adoption of the PP concept by large economies like the USA and, to a large extent, South Africa and other developing nations, because even though it is widely endorsed at the national and international level, the PP continues to be the centre of heated debate in industry and when it comes to practical decision-making.

Therefore, should the PP be a principle receiving much attention in public policy circles – a principle that should be adopted by corporate decision-makers, and if yes, how should it be formulated and implemented, particularly within the context of developing nations? This question, formulated here in a preliminary form, will be unpacked in the following chapters. Towards the end of this chapter, this problem statement will be articulated in more detail – against the background of discussions of the historical emergence of the precautionary principle and challenges related to its adoption world-wide and within South Africa.

1.2 History of the emergence of the precautionary principle

In his address to the Parliamentary Earth Summit of the UN Conference on Environment and Development (Global Forum) on 7 June 1992, the Dalai Lama, the spiritual leader of Tibet, noted that “in the seventeenth century, [Tibetan leadership] began enacting decrees to protect the environment and so we may have been one of the first nations to [enforce] environmental regulations”. The Theravada scriptures of Buddhism provide the earliest written sources which could accommodate the concept of precaution (Martin, 1997a: 276). Theravada teaches us not to commit harm, with the Buddha urging his followers to refrain from “unwholesome action” and monks prohibited from “injuring plants and seeds” (Martin, 1997a: 276).

Undeniably, the origin of the concept of the precautionary principle may well be found in the history of civilization. In the early stage of civilization, humans had a holistic attitude towards nature, which was regarded with sacred veneration. Nature was revered as the provider of life, and therefore exploitation of its generosity was considered unethical. So, in a sense, the struggle to survive and

³ See Morris (2000, reviewed by Sandin, 2002) for several examples.

protect human health led to the early use of the concept of precaution (Deloso, 2005: 14). Subsequently, however, nature's mystery was unravelled by the teachings of monotheistic religions and corresponding developments in science. Lynn White Jr. (1967) had already indicated in his well-known article that the cause of our environmental crisis is the creation of the Judeo-Christian heritage. White's position is that Judeo-Christianity had offered man a license for the unbridled exploitation of nature, and he therefore appealed that such thinking should be replaced by a religious view, such as that of Francis of Assisi,⁴ that supports "the idea of the equality of all creatures, including man" putting it in the place of "the idea of man's limitless rule of creation" (1967: 1207). Though his comments raised eyebrows and caused a stir, White nonetheless managed to expose man's impunity and disregard for nature. In this regard White underscored the point emphasised by contemporary environmentalists that it is highly problematic to elevate the status of humans above the environment. The point made by White is that a monotheistic religion such as Judeo-Christianity expressed a primary regard for human life that in turn gave humans the right to exploit nature without ethical limitation.

Martin (1997: 264) suggests that the earliest formulation of the precautionary principle in contemporary public policy can be traced to the early 1950s under the guise of what was then called "*safe minimum standard of conservation*". Major environmental issues of the 1960s, particularly the case against the use of DDT (dichlorodiphenyltrichloroethane), led environmentalists and policy makers to rethink their approach, specifically to addressing uncertainties. This paved the way in the 1970s for the establishment of the precautionary principle as a reaction to "*the limitations of public policies based on a notion of 'assimilative capacity', i.e. that humans and the environment can tolerate a certain amount of contamination or disturbance, and that this amount can be calculated and controlled*" (Barrett & Tickner, 2001: 1).

It is important, however, to understand the context in which precautionary thinking first developed. For Hajer (1995) and Weale (1992, 1993), *vorsorge* is part of a wider set of ideas or 'ideology', which they labelled "ecological modernisation". This is still a vague notion, but as in the case of the Brundtland Report, it suggests that the relationship between environmental protection and development is not necessarily antagonistic, but potentially synergistic. In fact, the Germans considered precaution a positive facilitator of economic growth rather than as a brake on it; in other words, they saw environmental standards as an opportunity rather as a constraint on growth. High

⁴ St. Francis of Assisi, the patron saint of animals and ecology, was a Roman Catholic saint who took the gospel literally by following all Jesus said and did. Further readings: Viviers, 2014.

standards of environmental protection were seen to have the potential to spur the development of green technologies, reduce wastage and meet the demands of a more environmentally aware public.

As such, this precautionary thinking unfolded at the time of unprecedented concern about environmental damage, particularly to natural forests, which the Germans held very dear. Significantly, the notion of ecological modernisation fitted into the dominant path of post-war development in Germany, that of exporting goods and services with a high technological content. The technology-forcing capacity of progressive environmental standards has served Germany well since the 1970s by encouraging the development of a lucrative clean technology sector, which in the 1990s already employed 320 000 people (OECD, 1992). Both Weale and Hajer show, however, that the precautionary discourse found a less favourable hearing in countries like the UK, which have a more secretive and consensual style of environmental management, and an institutionalised preference for externalising waste, using long pipes and tall chimneys to make the optimal use of the waste assimilative capacity of the environment (Hajer, 1995; Weale, 1992, 1993).

Initially, the German authorities used precaution in the early 1980s to justify the unilateral application of technology-based standards to reduce acid rain. But, once these were in place, the Germans pressed the EU to adopt similar standards across the rest of Europe to prevent its own industries from being placed at a competitive disadvantage (Weale, 1998). This was not enlightened environmentalism at work, but rather the dictates of a competitive market of member states. According to Weale (1998: 237):

The policy debate was more dominated by competitive considerations rather than environmental concerns, as much of the delay [in adopting measures] was due to fears about comparative costs and benefits of individual states.

In fact, the negotiation of the Large Combustion Plant Directive dragged on for nearly five years, but Germany's conversion to green thinking catalysed a transition in EU environmental policy, from reactive policy making to the proactive environmental management that endures today. This is encapsulated in landmark documents like the 1992 Fifth Environmental Action Programme, and is at work in the EU's progressive position on climate change. As Boehmer-Christiansen (1994: 30) noted in a comprehensive review of the German experience:

The precautionary principle therefore helped to lay the conceptual and legal basis for a proactive environmental policy, which, once spread into Europe, was also directed at ensuring "burden sharing" in order that German industry would not lose its competitive edge, but rather gain new markets for its environment-friendly technology and products.

Since then, the precautionary principle has entered into the lexicon of modern environmentalism with remarkable speed and stealth. In fact, the PP appears regularly in national legislation, in international statements of policy and in the texts of international conventions and protocols. More recently, it has been adopted as a guiding principle of environmental policy in both the European Union (EU) and the United Kingdom (UK), and it makes an appearance in the 1992 Rio Declaration – a statement of principles and general obligations to guide the international community towards actions that promote more environmentally sustainable forms of development.

Sadly, though, even with polluting industries emerging in the first part of the twentieth century, South Africa and the rest of Africa have not really ‘come to the party’ or boldly embraced the PP as an ethical, social and political tool to safeguard their environments and the health of their citizens against hypothetical threats that could ensue from uncertainty and poor risk modelling. The researcher is not aware of any forum in South Africa that articulates expert knowledge as well as lay knowledge to determine safe levels of risk. Only scientific experts are responsible for determining safe level of risks. Furthermore, in South Africa, at least, risk policies appear to address chemical threats by focusing on one chemical at a time and not on cocktails of chemicals. This inaction to address the plethora of chemicals sometimes combining with one another has given rise to the fear that policy-makers are also uncomfortable to support decisions that are riddled with uncertainties.

However, the precautionary principle still has neither a commonly agreed definition nor a set of criteria to guide its implementation. “There is”, Freestone in Stephen Gardiner (1991: 30) observed cogently, “a certain paradox in the widespread and rapid adoption of the precautionary principle”: while it is applauded as a ‘good thing’, no one is quite sure about what it really means, or how it might be implemented. Advocates foresee precaution developing into “the fundamental principle of environmental protection policy at [all] scales” (Cameron & Abouchar, 1991: 27). Sceptics claim, however, that its popularity derives from its vagueness; that it fails to bind anyone to anything or resolve any of the deep dilemmas that characterise modern environmental policy making. There are legal scholars, for example, who consider precaution to be too blunt an instrument to act as a regulatory standard or principle of law. Bodansky (1991: 5), for example, is highly suspicious of the precautionary principle because it “does not specify how much caution should be taken” in any situation. It cannot, for example, determine what an acceptable margin of error is, or what exact threshold of risk warrants the application of precautionary actions. Nor can it determine when precautionary measures should be taken, or define the point at which abatement costs become socially or environmentally ‘excessive’ (*ibid.*5). Initially, German politicians used it to justify policies that already had high public appeal. In a review of German policy, Boehmer-Christiansen (1994)

concludes that the PP has “little meaning other than that of enabling the policy process to attempt environmentally more ambitious solutions”. Bodansky (1991: 5) suggests that it constitutes little more than “a general approach to environmental issues”. As such the PP will be discussed in details in the next chapters.

The emergence of the principle has also engendered a very lively debate among scientists and sociologists of science. In the former camp we have writers like Gray (1990: 174-176), who deny the principle any role in scientific research, “[s]ince by definition it does not have to rely on scientific evidence!” He believes that it is, at best, an “environmental philosophy” and purely a matter for administrators and lawyers, rather than scientists seeking “objective scientific evidence”. This view is not, however, shared by critics of reductionist science (Wynne & Mayer, 1993; Johnston & Simmonds, 1990).

Despite claims by different authors/scholars, there is nevertheless consensus on the origins of the concept of PP; the country that is credited with the birth of the precautionary principle is Germany. The concept emerged from the German socio-legal tradition, centring on the concept of good household management. In German the concept is *Vorsorgeprinzip*, or fore-caring, and it was introduced in the late 1970s as part of the bill to ensure clean air (Von Moltke, 1988). The concept includes risk prevention, cost effectiveness, ethical responsibilities towards maintaining the integrity of natural systems, and the fallibility of human understanding. In this sense, the PP is about the transfer of the more generally applied principle of precaution in daily life (for example using seat belts, buying insurance, etc.) to larger political arenas (for example stockpiling arms against hypothetical threats). In short, on face value, the PP is a modern-day articulation of the old saws: look before you leap; better be late than sorry; prevention is better than cure.

The PP is in some ways also an expression of the English law concept of ‘duty of care’, originating in the decisions of the judge Lord Esher in the late 1800s. According to Lord Esher: “*Whenever one person is by circumstances placed in such a position with regard to another that everyone of ordinary sense who did think, would at once recognize that if he did not use ordinary care and skill in his own conduct with regard to those circumstances cause danger or injury to the person or property of the other, a duty arises to use ordinary care and skill to avoid such danger*” (<http://www.leeds.ac.uk/law/hamlyn/donoghue.htm>). This statement surely contains elements of foresight and responsibility. The PP may also be interpreted as the evolution of the ancient medical principle of “*first do no harm*” (Science and Environmental Health Network, 2000).

In economics, the PP has been analysed in terms of the effect on rational decision-making of the interaction of irreversibility and uncertainty. Authors such as Epstein (1980) and Arrow and Fisher (1974) show that the “irreversibility of possible future consequences creates a quasi-option effect which should induce a risk-neutral society to favour current decisions that allow for more flexibility in the future”. Gollier and Treich (2000) concluded that more scientific uncertainty about the distribution of a future risk, i.e. a larger variability of beliefs, should induce society to take stronger preventative measures today. However, in a somewhat more sophisticated sense, the PP in the context of economics has been regarded as a moral and political principle that states that, if an action or policy might cause severe or irreversible harm to the public or to the environment, in the absence of a scientific consensus that harm would not ensue, the burden of proof falls on those who would advocate not taking action (Raffensberger & Tickner, 1999: 88). Loosely translated, the sole purpose of the PP, conceptualized against this background, is to manage risk that otherwise cannot be resolved by appealing to science alone. Some risks are not purely scientific, but may be cultural or otherwise.

The precautionary principle, which has become a critical aspect of environmental agreements and environmental activism throughout the world, thus offers the public and decision-makers a forceful, common-sense approach to environmental and public health problems. In this respect we are at an exciting juncture in the history of the world. On the one hand we are faced with unprecedented threats to human health and the life-sustaining environment. On the other hand, we have opportunities to fundamentally change the way things are done. We do not have to accept "business as usual". The precautionary principle is a guiding principle we can use to stop environmental degradation. As stated by Bell (1976: 250):

Any society, in the end, is a moral order that has to justify ... its allocative principles and the balances of freedom and coercions necessary to facilitate or enforce such rules. The problem, inevitably, is the relation between self-interest and the public interest, between personal impulses and community requirements. Without a public philosophy, explicitly stated, we lack the fundamental condition whereby a modern polity can live by consensus ... and justice.

The foundation of the precautionary principle can then be expressed as the common-sense advice to "err on the side of caution". The principle is based on a desire to prevent harm to the environment, human health, other living creatures and ecological systems. It is intended to apply to a range of situations that involve both a threat of harm as well as scientific uncertainty. This is neatly captured in the widely recognised definition of the precautionary principle from the Wingspread Statement on the *Precautionary Principle* (1998):

Where threats of serious or irreversible harm to people or nature exist, anticipatory action will be taken to prevent damages to human and environmental health, even when full scientific certainty about cause and effect is not available, with the intent of safeguarding the quality of life for current and future generations.

1.3 Widespread adoption of the precautionary principle internationally

Despite the concerns raised above, the PP is already incorporated into many international environmental agreements and European environmental policies. The precautionary principle is central to the Rio Declaration, an international agreement signed at the 1992 UN Conference on Environment and Development (the Earth Summit) in Rio de Janeiro. Principle 15 of the Rio Declaration states (United Nations, 1992):

In order to protect the environment, the precautionary principle shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation.

Despite the many interpretations associated with the PP, the concept remains at the heart of many environmental policies aiming at cleaner production and the prevention of pollution. It has appeared in treaties, declarations and protocols the world over, such as the North Sea Treaty of 1987, the Maastricht Treaty of September 21, 1994, the United Nations Framework Convention on Climate Change of May 9, 1992, and the 1998 Wingspread Statement on the Precautionary Principle (1998), which summarises the principle as follows: *“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”* The PP also serves as a general principle of law in some legal systems, such as European Union law, which means that its application within the European Union is compulsory (Ricuerda, 2006: 65).

On February 2, 2000 the European Commission Communication on the Precautionary Principle noted:

The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU.

The Cartagena Protocol on Biosafety of January 29, 2000 says: *“Lack of scientific certainty due to insufficient relevant scientific information ... shall not prevent the Party of import, in order to avoid or minimize such potential adverse effects, from taking a decision, as appropriate, with regard to the import of the living modified organisms in question.”* The PP was a key focus of contention in the negotiation of the Cartagena Protocol on Biosafety (2000) to the Convention on Biological Diversity (CBD) on trade in living genetically modified organisms (GMOs). Even though there has been an outcry against⁵ the PP, the Cartagena Protocol has reaffirmed the precautionary approach, and on this basis sought to contribute to ensuring that the development, handling, transport, use, transfer and release of living modified organisms are undertaken in a manner that prevents or reduces the risk to biological diversity or human health. Key requirements include an Advance Informed Agreement procedure for transboundary movements of GMOs, and risk assessments by importing states. It is reaffirmed in several places that a lack of scientific certainty shall not prevent states from taking action to avert potential risks.

1.4 Adoption of the PP in South African legislation

Closer scrutiny of South African environmental legislation, such as the National Water Act, Act No 36 of 1998, the old Air Pollution Prevention Act of 1965 and the new National Environment Management: Air Quality Act, Act No 39 of 2004, and the Occupational Health and Safety Act, Act No 85 of 1993, along with many other forms of environmental legislation, show that they all bear the hallmark of a model of risk assessment and risk management that was developed for mechanical problems in which technical processes and parameters are well defined and can be analysed, and fairly accurate predictions can be made about the introduction of certain substances into “the system”. If one takes a closer look at the National Environment Management: Air Quality Act (39 of 2004) one is confronted by its lack of clarity, particularly on human protection and the prevention of pollutants that may imperil the environment and human health alike. Rather, its emphasis appears to be on how to allow industry to continue within the limits demanded by civil society.

Concerns have also been expressed about the adequacy of public participation provisions with regard to human health and safety. The same people who are at the receiving end of pollution are completely ignored in the broader scheme of decision-making processes. Furthermore, these people are also required to demonstrate from their side that the particular exposure causes harm to them, rather than the author of the nuisance being called to account. This is in effect a travesty of justice, as the

⁵ Slovic, 2001; Jenni, 1997; Flynn *et al.*, 2001.

process assists the culprit to get away with bad decisions. Decision-making based on the PP, however, involves making decisions that cannot be based unequivocally on science, and therefore necessarily involves values and judgements of risk, threat and required action, taking a wider context of considerations into account. As such it is important for reasons of equity as well as effectiveness to apply the PP: by its very nature it includes stakeholders in precautionary decision-making, including those who eventually would bear the burdens of precautionary restrictions.

The said environmental legislation in South Africa thus focuses on end-of-pipe reactive control measures, rather than on front-end processes, where preventive measures can be adopted to ensure higher levels of safety. In short, little, if any, evidence can be found in the South African legislation of the adoption of the PP. The argument that the 'polluter pays principle' articulates with the PP is indeed an oversimplification and misrepresentation of the facts (Cooney, 2004). The 'polluter pays principle' is not equivalent to the PP, which is at least democratic in principle. The 'polluter pays principle' is reactive and allows damage to occur before decisive steps are taken, and in fact allows a perpetrator to continue with unacceptable action if that perpetrator is able and willing to pay the price of pollution. It is like opening an account at a shop whose slogan is 'no deposit; pay later'. It is only when you fail to pay, that you are hauled before a court of law. In some cases the account holder will simply disappear from the radar, never to be found. The honest, credit-adherent customers, however, are the ones who will be called in to remedy the situation, when the price of the goods is hiked.

As I will demonstrate in detail in the chapters that follows, it is so that the decision-making process in South Africa is based on science, as is its progeny, risk assessment and risk management. The problem with risk assessment and risk management, however, as I will show, is that they are based on the utilitarian approach, with consequences to the victims not being a main concern, but rather the outcomes for "beneficiaries", which are mostly determined in monetary terms and not in terms of impact. Within this framework, the use of expert knowledge and appeals to science also turns out in many cases to be a strategy of decision-makers (often government) to persuade people to trust them to make decisions without all the information being available, falling back upon the professional judgements and opinions of the experts to legitimise these decisions (Flyvbjerg, 1998). What is typical, but also disturbing about this approach, is that lay knowledge and opinion are largely ignored. Science within this context is usually placed over and against indigenous and lay knowledge that are not trusted, as most is not recorded, but passed orally from one generation to the next. The view is that, if the information is not in scientific journals, then it does not exist. So-called storytelling, therefore, finds no favour and sympathy in this narrow interpretation of the scientific world (Nelson, 2013). As a result, the challenge facing scientists and lay communities/non-scientists today is that they do not

speak the same language and probably will never (Carson, 1962; Cullen, 1990; Likens; 1992; and Woodwell *et al.*, 1967). The irony, however, is that most of the people who are exposed to hazardous environments are the poor and ‘uninformed’, whose knowledge is not contained in scientific journals, while they have first-hand experience of being exposed to hazardous substances.

Serious questions, however, could be asked about the assumptions and effects of this approach as they relate to environmental risk. Firstly: can the analysis of risk referred to above really assume the role of predictor of safety if the environment into which certain substances (for example CO₂ or other chemicals from mining operations) are introduced is characterised by extremely uncertain and highly variable contexts and events? Secondly, is it really responsible to allow certain amounts of pollutants into the natural environment if there is uncertainty about the level of degradation they may cause? Thirdly, does the notion of a “safe” dose of a poison (pollutant) really make sense? Is it not premised on analyses of single chemicals, neglecting the cumulative effects of a cocktail of chemicals in, for example, the ambient atmosphere? And does this, in the fourth place, really enable bureaucrats to ensure the safety of the public, or does “risk assessment” in their hands become nothing but a dangerous tool with which they (the bureaucrats) get to decide with impunity how much of each poison/pollutant the public acceptably can be exposed to? (unngls.org/orf/documents/publications.en/age).

Much of these concerns are borne out by the fact that environmental legislation and risk assessment in South Africa and many Third World and developing countries are failing the poor and vulnerable members of society. A case in point is that mines are mushrooming in South Africa, particularly in Limpopo and Mpumalanga – the very provinces in which respiratory diseases and cancer are on the rise due to unacceptable levels of pollution (<http://www.engineeringnews.co.za/article/respiratory-asbestos-holds-significant-health-risk>). Similarly, the question of the quality of water in the Witwatersrand Basin due to acid mine drainage is a cause for concern. These dangerous episodes of environmental crisis are an injustice to the present and future generations who must live with this misery from risks perpetrated by the mining industry with the blessing of government, in a context in which both received their advice from the scientific community.

The questions that emerge against this background are whether an explicit adoption of the precautionary principle in South African legislation would make a substantive difference to environmental decision-making, and whether it can be argued in principle that the PP can step in and serve as a cushion to absorb the blows that are being unleashed on the health and well-being of citizens and fragile ecosystems. If the answer on this question is positive, a related question arises, namely how this principle should be incorporated in legislation.

Focusing on these questions, however, would not make sense without a thorough ethical analysis and conceptual clarification of the PP, as has been stressed on several occasions (Carr, 2002; Foster *et al*, 2000).

1.5 The contours of an ongoing debate

The inclusion of the PP within numerous legislative frameworks, for example the North Sea Ministerial Declarations, the Rio Declaration of 1992, the 1996 Protocol to the London Convention and others, reflects the need for a mechanism to address the pervasiveness of uncertainty and indeterminacy coupled with the ongoing need to take decisions that facilitate preventive action. It has become a key axiom of international environmental protection initiatives, with a role for science defined explicitly. Science has a definite role to play, although it shall have to embrace other decision-making players such as the PP to make it a sensible, robust and tough tool as it searches for answers in this highly complex, uncertain and demanding world with its plethora of environmental problems facing mankind and the environment.

By apparently dispensing with the need to establish causality, the precautionary principle has been widely criticised as being unscientific, either in whole or in part. It has also been categorised as a wholly political philosophy, rather than a basis from which to consider scientific knowledge and uncertainty as part of the overall regulatory process (Gray, 1990). Just like science, the PP also is not infallible; however, it can be used to make science more scientific by searching for the 'right' truth that cannot be manipulated to appease particular players, who may have financial interests in a particular project (such as mining) that may imperil the environment and the health of a country's citizens. Since the PP allows all role players, irrespective of their scientific prowess, to participate in environmental decision-making, it is well positioned to sound an alarm when scientific process in decision-making becomes derailed. However, what has heightened the controversy is the role and encouragement of political leaders, whose initial burst of concern for the environment has dwindled under the pressure of commercial interests, and with the courts also taking up a greater role of supporting politicians and industry. Concerns have been raised in some quarters pertaining to the role of courts in environment decision-making with some claiming that, courts are now behaving like an opposition party and are not as impartial as they should be (Wiist, 2011). Furthermore, environmental laws have been under attack since the 1980s, particularly in the USA (Mayers, 2004), where many have been modified or scrapped, and all are enforced by regulators who have been chastened by increasing challenges to their authority from industry and the courts.

The courts, and now increasingly international trade organisations and agreements like the World Trade Organization (WTO), have institutionalised an anti-precautionary principle to environmental controls (Wolfenbarger & Pfiher, 2000). They have demanded the kinds of proof and certainty of harm and efficacy of regulation that science often cannot provide (Gray & Brewers, 1996). In opposition to this approach to control exposure, arguments are advanced that decisions need to be made through community-based needs assessments and the assessment of alternatives, so that the affected populations can take part in a democratic decision-making process about whether proposed sources of pollution are necessary, and whether there are safer alternatives that can be employed (Sandin, 1999). In South Africa the question, rightly put, is whether mining activities should be permitted to continue while Rome is burning? (Le Maitrea *et al.*, 2001). In South Africa, The Environmental Management Act, 107 of 1998 allows for pollution to happen and the polluter is then expected to pay the abatement fee. Despite the criticisms levelled against the PP, proponents of this approach believe that the core of the PP entails anticipatory action, with the onus of proof shifting to those proposing projects entailing ecologically hazardous activities, and science being extended to include broader civic participation (O’Riordan & Cameron, 1994: 14-16). In a nutshell, the PP challenges the established science-based regulatory system, and tests the application of cost-benefit analysis in those areas where it is undoubtedly weakest (i.e. situations where environmental damage may be irreversible or potentially catastrophic); it calls for changes to established legal principles and practices, such as liability, compensation and burden of proof; and it challenges politicians to begin thinking in longer times frames than the next election or the immediate economic recession. Lastly, the PP challenges the existing organisation of academic research because it cuts across disciplinary boundaries and raises issues about the quality of life for future generations. It is profoundly radical and potentially unpopular. The fact that so-called First World countries are apparently obsessed with the PP means that developing nations need not follow the ‘slippery slope’ argument.⁶ One size does not fit all.

1.6 Social and political grounds to adopt the PP

Although the PP is increasingly subjected to academic scrutiny and remains a matter of intense debate, its ideological and ethical underpinnings – as well as the interrelations between precaution, public management, and basic concepts in moral philosophy – have received surprisingly exiguous attention. This begs the question: why ignore the PP in the midst of so much environmental devastation and scientific uncertainty? Is there a sinister motive? In general, the ethical and philosophical aspects of

⁶ The slippery slope argument in this context refers to intervention wherein the European community expects developing nations to embrace the precautionary principle if they want to conduct business transactions with them. Kontoleon *et al.*, 2002.

the PP have not been studied much. The PP as an ethical tool, however, seems to have the capacity to protect potential victims of exposure to hazards and, *ipso facto*, it has the potential to give effect to the principle of doing no harm. Whereas international trends show that many developed countries are adopting policies that promote pesticide reduction, for instance, the use of pesticides in South Africa alarmingly continues to expand exponentially. In particular, macroeconomic policies encourage pesticide use among emergent small-scale black farmers, while the potential exposure of workers on commercial farms remains high (Lukey, 2008).

Despite the country having legal controls that seem to conform to international standards, the present health and environmental impacts of pesticide use in South Africa are substantial and generally underestimated. The reasons lie in the fragmentation of regulatory mechanisms, as well as in the absence of public awareness and participation in policy making related to pesticides and other chemical pollutants emanating from industries. Failure to enforce the existing legislation, an ambivalent relationship between government and industry, and the existence of a “pesticide culture” will continue to prevent the implementation of meaningful control measures. As a result, it is marginalised groups, such as small-scale farmers and farm workers, who bear the brunt of policies that have not kept pace with growing international awareness of the hazard that widespread pesticide use and other pollutants pose to human health and the environment (London & Rother, 2000).

These environmental challenges are also transparent in the mining sector, where the quality of air and water has been compromised by the elite mine owners. In view of these challenges, it seems likely that the PP can offer an opportunity to transform “business as usual” to democratic decision-making processes by fostering, among others, the right-to-know principle, and supporting the claims that this right should be treated as obligatory and universal.

1.7 Ethical analysis and conceptual clarification of the PP

In this dissertation the researcher will apply a philosophical approach to study the precautionary principle in decision-making on environmental (and health) risk. The principle says that unacceptable environmental and health risks should be anticipated, and they ought to be forestalled before damage comes to fruition, even if scientific understanding of the risks is inadequate or their causes cannot be proven conclusively. The study will aim to explicate the PP, critically analysing the debate on the principle, and construct a basis for the well-founded use of the principle. The starting question is how the currently embraced PP will stand up to critical philosophical scrutiny. The approach employed in this thesis is thus analytical – mainly conceptual, argumentative and ethical. The study will focus on the international conceptualisation of the PP and on sources of law in South Africa, and by using acid

mine drainage as a case study it will explore ways of influencing precautionary and democratic decision-making in South Africa. The framework will be based on environmental and health risk governance, including related laws and policies.

I will argue that the debate on the PP needs to be shifted from the question of whether the principle is well grounded in general, to questions about the theoretical plausibility and ethical and socio-political justifiability of specific understandings of the principle. The real picture of the PP is more complex than initially presumed in much of the current academic, political and public debate surrounding it. While certain presumptions and interpretations of the principle are found to be sound, others appear to lack moral justification. The analysis of the PP from an ethical perspective will therefore be geared towards arguments on and conceptualisations of the principle that lead to elementary understandings of the PP. The above will be realised through the critical assessment of current practices invoked in the name of the PP and public participation, and seek to build bridges between the PP, practical engagement with real-life issues influencing public health and philosophical ethics. I trust that, by the end of this dissertation, I will be able to provide a sound basis upon which to build a solid argument around the approach to and conceptualisation of the PP that are relevant to the challenges of a developing nation such as South Africa.

1.8 Problem statement and aim

For years the environmental and public health movements have been struggling to find ways to protect health and the environment in the face of scientific uncertainty about cause and effect. The public has typically carried the burden of proving that a particular activity or substance is dangerous, while those undertaking potentially dangerous activities, and the products of those activities, are considered innocent until proven guilty. Chemicals, dangerous practices and companies often seem to have more rights than citizens and the environment. This burden of scientific proof has posed a monumental barrier in the campaign to protect public health and the environment. Actions to prevent harm are usually taken only after significant proof of harm is established, at which point it may be too late. Hazards are generally addressed by industry and government agencies in terms of a single factor or environmental impact (e.g. a single pesticide or chemical), rather than in terms of broader issues such as the need to promote organic agriculture and nontoxic products, or to phase out whole classes of dangerous chemicals. When citizen groups base their calls for a particular activity to be stopped on the basis of experience, observation or anything less than stringent scientific proof, they are accused of being emotional and misinformed, and being 'cry babies'. The challenges posed by the concerned public are not accepted with alacrity, but with scorn, and as such this state of affairs will only increase mistrust between the government, 'specialists' and the affected and interested parties.

Environmental policy depends on public participation for its success, and public participation is about giving the proverbial skeleton some flesh. However, the scientific construction of environmental issues often means that such participation in policy-making is difficult when the public are not considered to be scientific 'experts'. Even if the notion of expertise is broadened to deal with this problem, this does not ensure truly public, i.e. lay, involvement, because lay ideas will still not be included but rather discounted as 'non-scientific'. Further, emphasis on the scientific and environmental education of the public will not guarantee policy implementation by individuals. Therefore, if we wish to design environmental policy that can be implemented successfully, we must consider other ways in which people relate to their environments, such as through culture, morality and social interaction – and build these into environmental policy. South Africa does involve and encourage public participation and discussion within the framework of environmental impact assessment, but not so much in the drafting of environmental policies and actually making environmental decisions; and this is as far as it goes currently. Democratisation of environmental decision-making is absent, as environmental policies and decision-making that should involve the layperson are bureaucratised.

On the basis of this, therefore, the preliminary formulation of the problem statement of this thesis is:

- i. To determine if the precautionary principle can be an effective response to scientific uncertainty and the complexities associated with it in the context of environmental decision-making in South Africa; and
- ii. If the precautionary principle can possibly be reconceptualised so that it can help to address the scientific uncertainty and complexity inherent in scientific discourse about environmental risks and hazards.

The aim of this doctoral study, therefore, is to determine whether and, if so, how the PP can contribute to a more embracing approach to environmental decision-making in South Africa. As such, this study will entail a critical appraisal of the precautionary principle and its potential to live up to the claims made about it by its proponents and supporters. At the same time, this study will entail an assessment of the PP to determine if it indeed is the source of all of the problems it contains or brings about, as is claimed by its opponents and detractors. This study therefore also aims to establish whether a common ground can be found that can resolve the tensions that exist amongst different approaches to risk analysis and decision-making in the face of scientific uncertainty.

Against this general formulation, the particular aims of this study can be formulated as follows:

1. To assess the current definitions of and different approaches to the PP – their assumptions as well as their implications for environmental risk assessment and decision-making in the face of scientific uncertainty.
2. To better understand the assumptions informing the PP, as well as the implications of adopting the PP in a formal system of risk analysis and decision-making about environmental matters and public safety in the face of scientific uncertainty.
3. To determine whether and, if so, to what extent the PP can serve as a tool to protect the public in general and the vulnerable in particular.
4. To determine whether it would make sense to adopt the PP in formal systems of risk assessment and decision-making about environmental matters and public safety in South Africa and, if it makes sense, to formulate proposals for how this should be done.

In this respect, the overall research question that I would like to focus on in this study ***is whether the precautionary principle is a suitable tool to guide environmental and public health decision-making in South Africa in the face of scientific uncertainty and, if it is, how it should be interpreted and used in this context.***

1.9 The importance and feasibility of the study

The importance of this dissertation lies in the critical investigation that will be done on the question whether South African regulators and policy-makers should adopt the precautionary principle in decision-making about the assessment and management of environmental hazards in cases where science cannot provide clear answers about the nature, extent, intensity and/or duration of the hazard itself and, if so, how this adoption should be implemented in the regulatory “system”. The wide range of arguments for and against such an implementation of the precautionary principle, seen against the backdrop of the irony that contemporary society is becoming more and more dependent upon scientific knowledge (Beck, 1992), while that very knowledge is also creating the so-called “risk society” with a fast-growing scepticism about science,⁷ makes this a necessary study – all the more because most studies about the implementation of the precautionary principle are located in developed societies, mostly in the Northern Hemisphere, while the context of this study is a developing country like South Africa. South Africa is regarded as “Europe in Africa”, and therefore the

⁷ Further readings: Elam & Bertilsson, 2003; Jameson, 2004.

locus of the study will be in South Africa. I argue in this dissertation that, if the precautionary principle is adopted as an environmental decision-making tool in South Africa, it will reduce the burden placed on science as the preferred decision-making tool.

1.10 Points of departure

One of the central assumptions informing this study is that many of the most crucial questions that should be asked in risk assessment and decision-making when environmental safety and public health are at stake, cannot be fully answered by science, or by science alone. These questions include the following: “How safe is safe?”; “What level of risk is acceptable?”; “*How much contamination can be avoided while still maintaining the overall goal of a certain activity?*”; “*Do we need this activity in the first place?*”; “*What are the alternatives to this activity?*” As Jasanoff emphasises in her work (e.g. 1986, 2005), this points in the direction of incorporating democratic processes in decision-making in the face of scientific uncertainty, as well as in the direction of shifting decision-making away from the context and influence of experts alone, moving it rather towards a space where the voices of potential victims of decision-making (often lay persons, and the poor or powerless) can be articulated effectively and made audible.

A further assumption of this study is that the discourse about the PP is ultimately a political discourse. Besides all the philosophical and ethical choices that are entailed by positions supporting or opposing the PP, the discourse about the PP entails, in the final analysis, a power struggle between different ideologies regarding the role of science and democracy in decision-making procedures about public health and environmental safety (again, see the work of Jasanoff, 2005, as well as Ruckelshaus, 1985). A critical analysis of the arguments for and against the PP therefore inevitably will touch on the struggles in society between the powerful and the rich on the one side, and the powerless and the poor on the other side. As such, this study will also have to touch on the question how the simplistic dichotomy of this political struggle can be overcome.

A third assumption informing this study is that the precautionary principle entails an appeal to “slowing down” decision-making and development processes as we currently know them – with a view to critically assess the goals that are pursued in these decisions/development processes, and the means adopted to reach these goals. As such, it seems to be an appeal for a different kind of rationality compared to that currently dominating society (see Giddens, 1999; Beck, 1998, 1992; Freudenburg, 1993; Shrader-Frechette, 1991; Short 1984; Flyvbjerg, 2006; 2008). At the same time, however, it will not be assumed that the “alternative rationality” of the PP should merely replace the dominant

rationale of the decision-making and development processes in society; it will rather be assumed that a creative rapprochement between them should be sought.

A fourth point of departure is that South African decision-makers and policy-makers, particularly on pollution management, have not taken seriously or adopted the PP in matters relating to environmental safety and public health. It is assumed in this study that this is due to a standard model of risk assessment and risk management that ultimately does not allow for scientific uncertainty. A thorough, in-depth analysis of the standard approach to risk analysis (see, for example, Jasanoff, 1993, 1988, 1986; Shrader-Frechette, 1991, 1985; Cranor, 2001) will therefore have to precede an equally in-depth analysis of the PP – to determine if it can overcome the problems of the standard approach to risk assessment and risk management.

A fifth assumption of this study is that a thorough analysis of the PP can deepen our understanding of risk, as well as our understanding of responding to risk in the face of scientific uncertainty within the context of a developing nation.

All five of these assumptions will not be taken for granted in this study. They will rather become part of the critical analysis and assessment that will be executed in this study.

1.11 Methodology

With a view to answering the central questions that are posed in this research, a mixed methodology was followed. On the one hand, a critical survey of the literature was conducted to differentiate between, and assess, the different approaches to the PP. A critical survey of the literature was also used to elaborate on and assess the standard approach to risk analysis and management regarding environmental matters today. Relevant philosophical and ethical literature was used in this regard, as well as relevant literature about risk assessment and the PP. On the other hand, a case study approach was followed to determine what, if any, differences the adoption of the PP could bring to risk analysis and management in South Africa.

In the first part of my study that was devoted to a critical analysis of the PP, Chapter 2 focussed basically on two questions: firstly how uncertainty and bias inherent in science can adversely affect good decision-making; and secondly how decision-making based on science can become influenced by politics, thus leading to arbitrary decision-making. The thrust of this chapter was thus to highlight the weaknesses and strengths of science and how science can be manipulated politically to advance partisan agendas at the expense of communities.

In Chapter 3 I shifted my attention to a critical analysis of the controversy surrounding the PP. By looking at both the positions of its proponents and its detractors, my aim was to identify dimensions of the PP that could be used to formulate a new interpretation of it that can at the same time take into account uncertainty, complexity and bias in science, as well as basic elements of societal decision-making.

Such a new conceptualization of the PP is formulated in Chapter 4 with reference to it as an ethical tool that can function as an ally to scientific decision-making by giving a voice in decision-making to those communities that have become marginalised by conventional approaches to risk assessment and management.

The execution of the case study involved multiple "mini" case studies executed in five provinces of SA, namely Gauteng, North West, Limpopo, the Free State and Mpumalanga. The said provinces were chosen on the strength of their history of decommissioned mines, which have resulted in acid mine-drainage (AMD) of massive proportion. All of the mines targeted contained large amounts of gold, coal and platinum, which predisposed them to the challenge posed by AMD, discussed particularly in Phase 1 of the case study, which involved interviewing high-powered personnel with a rich understanding of AMD locally and internationally. The interviews were punctuated by wide consultation and critical interpretation of documentary resources relating to AMD in the five provinces. In addition, in-depth consultations with role players, notably scientists, the Department of Water Affairs, the Department of Minerals Affairs, CEOs and managers of mines, supervisors, etc. as the respondents, were conducted drawing on their specific knowledge of the historical approach to the problem of AMD and mining in SA. The scientists specifically know the physics and chemistry of AMD formation. Affected communities were also consulted. The questions that were asked and answered in these interviews and consultations have been attached to this dissertation as an annexure. The questions formulated were informed by the results of the theoretical part of this study, as well as the survey of documents interrogated in the following chapters. Phase 1 of the case study investigated by way of questions why AMD as an emerging problem is suddenly rearing its head, as well as what went wrong and why? It also looked at whether we could have done things differently, and if not, why not? Phase 2 of the case study tested the conceptual model of the PP that was formulated based on the outcomes of the responses to questions in Phase 1, which led to exploring, and even testing, the promise and power of the precautionary principle if it were used to think about future responses to the challenges posed by AMD.

The second phase of questions was directed at the same respondents to validate or invalidate the promise of the PP. This was done by confronting the newly developed model of the PP with the lines

of argumentation that were initially found about the PP in Phase 1 of the case study. In other words, the respondents were sensitised to looking at other decision-making tools than those conventionally used to address the impact of AMD. The second phase of questions about an alternative conceptualization of the PP was also aimed at determining whether the PP could restore public trust in the institution of science and in policy-makers.

1.12 Conclusion

There seem to be a general understanding that science has limits, particularly in relation to issues that contain elements of uncertainty. Although environmental and human health decisions should be protected, the regulatory systems that are envisaged should also appeal to alternative decision-making rules in order to democratise decision-making. In earlier discussions of the PP there is no contradiction in the role that science and the PP can play. If science can be applied along the lines of participatory democracy, which of course entails an implementation of the PP, it can be a formidable tool to address risks that are complex and uncertain, as it will force decision and policy-makers to become sensitive to the plight of those on the receiving end. To that end, the precautionary principle will be evaluated and benchmarked to expose not only the gaps and problems that are inherent in this approach, but also its power and promise. However, in this dissertation I will also ask whether science can be trusted as a lone voice in implementing environmental decisions.

In the final analysis, I strongly would like to point out that this dissertation is not geared to debunk science, but rather to make science more potent by forging links with alternative decision-making tools.

Chapter 2

Uncertainty and political bias in the standard approach to risk assessment and management

2.1 Introduction

Since the Industrial Revolution, technological innovations have brought about new challenges, possibilities and solutions that have enabled or empowered us to challenge and dominate nature. The developed nations seized the opportunity to shape their environments to suit their needs, albeit with disastrous consequences for their environments and the health of their citizens. Third World countries and developing countries, on the other hand, were slow starters in the technological renaissance and therefore were left behind by the train of development, as they were fighting colonial wars. Initially, technology was perceived to be 'goods' – tools that improved our capacity to utilise natural resources such as water, and mine resources such as gold, diamonds, etc., and to manage the risks imposed upon us by nature. But we are now increasingly experiencing the unanticipated side effects and horrors associated with technology (Harremoës *et al.*, 2001; Beck, 1992). Since then, technology has become highly problematic to many of those who first hailed it as messianic, and thus we need to adjust to cope with these technological developments.

The development of modern and postmodern biotechnology, particularly after the discovery of the double helix by Watson and Crick in the 1950s, led to the perception that science and technology has finally usurped control over nature. Based on a mechanistic view of nature, scientists have sought to understand how genes function – e.g. to determine what specific trait each gene codes for – in order to manipulate the genome or move genes within and between species. In this way, scientists seek to control the traits of organisms, and develop organisms with particular desirable characteristics. Modern biotechnology is currently applied in a wide range of fields within the medical and biological sciences. Different bacteria, viruses, plants and animals have been genetically modified (GM) for medical, agricultural and scientific purposes. The adoption of this technology has grown quickly. For instance, since the first commercial cultivation of GM crops in the mid-1990s, GM crops are currently cultivated on approximately 134 million hectares of farmland throughout the world (GMO compass, 2010; James, 2009).

In turn, the modern technology that was employed in mining activities in South Africa, for instance, is an example of a technology that has brought about a number of unanticipated consequences, one of which is acid mine drainage (AMD). Over time, scientists have become acutely aware of the

complexities involved when unravelling the intricacies of science and technology. What was initially perceived as progress in the name of science and technology did not live up to its claim of progress; rather, people are paying a heavy ecological price. In addition, as I will demonstrate in later chapters in this thesis, a blame game has been ignited between government and scientists on the one hand, justifying the damage done to the environment in the name of development, and on the other hand, those that detest the monster that has been unleashed in the name of progress. It is an open secret that progress comes at a price, at the behest of technology.

Decisions about the use of novel technologies are generally based on risk analysis, which typically consists of three stages – risk assessment, risk management and risk communication. According to this approach, scientists first perform risk assessment, during which potential adverse impacts associated with introducing a given technology are identified and the probability of their occurrence being calculated. The risks identified by the scientists are then evaluated by policy-makers, who decide the relative importance of the risks in question and how they will be managed. Once decisions have been made, the general public is informed about both the risks and the chosen management initiatives. Thus, scientists play a crucial role in the introduction of novel technologies – they are the ones who develop technologies and often are the ones who are called upon as experts to evaluate safety aspects. As knowledge obtained through scientific investigation is generally perceived as verifiable and objective fact, scientists have traditionally played, and continue to play, a dominant and privileged role as advisors to policy-makers (Millstone, 2007).

The uncountable number of unanticipated and undesirable aspects arising from the impacts of technologies, which most often become evident only after a technology is introduced (such as hazards emanating from mining activities, impacts of chemical pesticides, lead, smoking, asbestos, etc.) (Harremoës *et al.*, 2001; Beck, 1992), however, have led to the questioning of the ability of this approach to predict consequences, and resulted in increasing attention being paid to the existence of uncertainties in policy-relevant science (e.g. Felt & Wynne, 2007; Walker *et al.*, 2003; Stirling & Gee, 2002; Stirling, 1998, 1999b; Funtowicz & Ravetz, 1993; Faber *et al.*, 1992; Wynne, 1992). What nevertheless is important is that uncertainties cannot be conceived and handled purely as incomplete knowledge that can be reduced sufficiently with more research. Instead, more research might actually increase uncertainty (Funtowicz & Ravetz, 1993), as it reveals more of the complexity characterising the system under investigation (for instance in the case of the Human Genome Project). The variability and complexity of natural and social systems create irreducible uncertainties, allow for multiple scientific interpretations and, consequently, open up fault lines of scientific disagreement over possible beneficial and adverse consequences.

Acknowledging the many forms that scientific uncertainties may take, and developing tools and frameworks within which to handle them, is particularly important for policy-relevant science, as this knowledge forms the basis upon which scientists make their judgements and policy-makers their decisions (Von Krauss, 2005; Walker *et al.*, 2003). Failing to deal adequately with uncertainties undermines – sometimes fatally – the quality of the knowledge and consequently the quality of the decisions.

In order to better understand this problematique, I will start this chapter with a brief overview of the assumptions underlying the conventional approach to risk assessment, management and communication. Then I will proceed to a critical examination of the notion of "uncertainty", showing that it not only puts these assumptions into question, but also that a failure to deal with uncertainty opens up science to the risk of becoming an ideological tool in a political power game.

2.2 The assumptions of conventional risk assessment in decision-making

Risk assessment is typically viewed by government agencies and those in industry as the “sound science” approach to decision-making, in which decisions are made on the basis of what can be quantified, without considering what is unknown or cannot be measured (Diebold *et al.*, 2008). The latter are usually lumped into the category of uncertainty, as will be shown further on in this thesis. Although few scientists will admit it, risk assessment and other “sound science” approaches to decision-making are highly reliant on a number of policy and scientific assumptions, which are frequently unscientific and subjective (Stirling, 2008).

There is, however, a proper, if secondary, role of risk assessment in increasing our understanding of the complexities of environmental harm, as will become clear further on in this chapter. But, as practiced traditionally, risk assessment has often stood in the way of protecting human health and the environment. This can be attributed to the following assumptions on which the conventional approach to risk assessment is based:

- a. Risk assessment focuses typically on quantifying and analysing problems, rather than solving them. It asks how much pollution is safe or acceptable; which problems are we willing to live with; how should limited resources be directed? While these are valid questions, they bar more positive approaches and deeper questions: how do we prevent harmful exposures, and how do we move forward from here? (Resnik & Portier, 2008).
- b. The practice of scientific risk assessment as way of analysing the possible harm of products and technological inventions is widely used in modern societies. Risk is typically defined as the

“magnitude of a possible hazard” multiplied by the “probability that a hazard will occur” (Stirling & Gee, 2002: 521-533). Hence, the basic steps of risk assessment are to identify the possible hazards associated with a given technological invention and then to calculate the magnitude of each hazard and the probability of it occurring. This exercise is performed by scientists with expert knowledge in relevant fields. While scientists conduct various tasks, such as basic research, product development and policy advice, in the context of policy making the role of science in risk assessment is largely based on the assumption that every hazard can be accurately predicted, and that its respective probabilities can be calculated using scientific methods.

- c. The prominent position of expert-led risk-based approaches in decision-making rests upon the generally and widely shared image of science as a process that produces verifiable, reproducible and therefore trustworthy and objective facts and theories about the material world – an image rooted in the modern tradition of the European Enlightenment. This tradition considers reductionism as the best way to reveal facts and theories – expressed in both the methodological belief that the best way to pursue an understanding of complex systems is to break them up into their component parts, and in the ontological belief that the system itself is nothing more than the sum of these components. Consequently, the conventional approach in science has been to study isolated sub-systems under controlled conditions, to use this knowledge to generate an understanding of the system’s function and, by extrapolation and synthesis with other reductive investigations, to predict the future behaviour of the overall system. This image of science and scientific knowledge, born at the time of the European Enlightenment, secures the view that scientific advice and risk assessment deserve a privileged position in the decision-making processes. Policymakers manage risk by evaluating the information and advice given by scientists, and weigh the perceived benefits against the risks. Therefore, a defining characteristic of this approach is the assumption of a clear distinction between factual and objective, expert-led risk assessment, and normative and value-based (i.e. subjective) risk assessment (Felt & Wynne, 2007).
- d. Risk assessment assumes “assimilative capacity”, that is, that humans and the environment can render a certain amount of pollution harmless. Eliminating risk altogether is not a plausible outcome of risk assessment. Risk assessment is used to manage and reduce risks, not to prevent them. This deters progress towards moving to cleaner production (Raffensperger & Tickner, 1999)

As a first critical observation on these assumptions, it should be pointed out that risk assessments are susceptible to uncertainty. While it is generally assumed in the conventional approach to risk assessment that science yields results that cannot be doubted, the fact of the matter is that even scientifically based risk assessments generate results or outcomes that are extremely variable in that

they often do not determine the nature and magnitude of uncertainties associated with such risks. A case in point is the questions of safety regarding genetically modified organisms (GMOs) that has become problematic to the extent to which testing of a GMO to identify allergens often prove to be not effective, depending on the tests that are used. As a result, the quantitative results of risk assessments of GMOs are often highly variable (Bailar & Bailer, 1999), leaving policy and decision-makers with as much uncertainty, if not more, as existed before the scientific testing begun.

It should also be pointed out that conventional risk assessment is based on a number of different assumptions about exposure, dose response, and extrapolation of these from animals to humans. All these have subjective and arbitrary elements. As a result of this as well, the quantitative results of risk assessments based on animal models are also often highly uncertain, if not extremely variable. As such, this was recognised as a problem by the European Union when it embarked on its European benchmark exercise in hazard analysis. For example, eleven European governments formulated terms and brought scientists and engineers together to work on a problem about the accidental release of ammonia. The result of the exercise was eleven different risk estimates, placing the magnitude of the risk in range from 1 in 400 to 1 in one million. The organisers concluded that “at any step of a risk analysis, many assumptions are introduced by the analyst and it must be recognized that the numerical results are strongly dependent on these assumptions” (Contini, 1991: 87).

At the same time, conventional risk assessment leaves out many variables, especially multiple exposures, sensitive populations, or results other than cancer. Conventional risk assessment is typically geared toward setting single chemical standards and is incapable of analysing the rich and variable mixtures of chemicals found in many communities. It does not adequately take into account sensitive populations, such as the poor, elderly and children, or those already suffering from environmentally induced diseases. It also rarely looks at effects other than cancer, although many environmental health problems involve respiratory diseases, birth defects, and nervous system disorders. Risk assessment is furthermore designed to analyse linear response (more exposure leads to more harm), and is stymied if this is not the case (Rom, 2006). For example, emerging evidence about the ability of some synthetic substances to disrupt the hormone system in humans is showing that lower doses, rather than high doses, may lead to these effects (Poongothai *et al.*, 2007). So the notion of a ‘dose makes poison’ may not always be spot on. It is not only large doses that cause disease, but small amounts may also induce serious disease.

It is therefore clear that the assumptions of conventional risk assessment need to be qualified and contextualized from a platform of a thorough and critical understanding of uncertainty, and the

manner in which uncertainty itself exposes science to certain risks – at least the conventional notion of science.

2.3 Understanding uncertainty

Contemporary scientific knowledge is characterised increasingly by uncertainty (O’Riordan & Cameron, 1994; Van der Sluijs *et al.*, 2008, Grieger *et al.*, 2009). This is not only because both the risk and the unpredictability linked to it are increasing, but above all because of the intrinsic incompleteness and indeterminacy of scientific knowledge compared with the need to make social choices, public policy and legal decisions (Retzbach *et al.*, 2011). Such uncertainty is actually the daily condition in which science works, and it shapes the social issues in which complex collective and individual trends must be reformulated through methodological decisions and through the reductionist analytical character of scientific procedures. The expression ‘scientific uncertainty’ has been used to refer to different forms of ignorance in science: the lack of data, the incompleteness of theories, the complexity of knowledge, the unpredictability of results, and the stochastic character of predictions. This means that the experts involved in regulatory science increasingly are unable to adopt an unequivocal position and, therefore, science produces different or partially diverging theses. The unending work that characterises scientific research has already shifted to radical forms of indecisiveness. Beginning in the 1980s, uncertainty in science has been widely explored after the philosopher Ian Hacking (1986: 146) remarked that “the centrality of ignorance in contemporary science has not received attention enough as to its epistemological statute”.

The problems with decisions based on scientific uncertainty are difficult to address, mainly because what is regarded as a non-complex matter suddenly becomes complex, and the solutions will naturally become complex and even be subjected to manipulation to get the “right” outcome to win favours with those with stakes in the project. Thus, when we make judgements affecting the environment and public health, understanding what we do not know, and why, is as important as pinning down facts. It therefore is important to draw a distinction between risk, which is an event with known probability, and true uncertainty, which is an event with unknown probability.

Scientists often define “scientific certainty” as “being 95% sure that cause and effect have been correctly identified” (Tickner, & Raffensperger, 1999: 171). It is exceedingly rare for a large group of scientists, though, to be 95% certain about anything, especially about something as complex as an environmental problem. When you talk about living systems, great scientific uncertainty is the norm (Montague, 1999). Even in the case of an ultra-well-studied chemical like dioxin, scientific uncertainty far outweighs firm knowledge of cause and effect (Montague, 1999).

The manner in which scientific uncertainty is currently treated by decision-makers in government and industry alike in matters regarding environmental protection and human health is disconcerting. For years it has been used permissively, even to postpone actions that would protect public health and the environment. The following case study demonstrates how uncertainty in science provokes untold mayhem:

In 1922, chemical and automobile corporations announced that they were going to put highly toxic tetraethyl lead into petroleum. At the time, numerous public health officials demonstrated their disgust at this by publicly pronouncing that the practice would put the lives of people and the environment at risk. As a result, they urged delay and careful study of tetraethyl lead (Tickner & Raffensperger, 1999). The corporations involved argued that there was no scientific agreement about the threat; in the absence of convincing evidence of widespread harm (which had not yet occurred, and thus was not yet documented), they insisted they had the right to proceed. Basically they argued: “Until you can line up the dead bodies, we can do whatever we want.” On that basis, the corporations pressed ahead heedlessly with the new toxic technology, thus setting the standard for corporate behaviour over the next 50 years. The consequences of that particular decision are now a matter of record – tens of millions of Americans suffered brain damage, their IQs permanently diminished by exposure to lead dust (Tickner & Raffensperger, 1999).

A similar train of thought has been present for a long time in government and industry circles the world over to justify inaction in the area of climate change prevention. The basic argument is that there is scientific uncertainty about the causal links between the burning of fossil fuels and general climate trends, let alone particular extreme weather events, so there is no justification to do something about the use of fossil fuels. For instance Bent Flyvbjerg (2003: 318-329) argued that the notion that science is science should have to be revisited, since decisions that derive from science are informed not only by knowledge in the narrow sense of the word alone, but also by values and interests standing “outside” of science in this narrow sense. According to Flyvbjerg, the ability to choose a right decision in every specific situation is a kind of practical wisdom which has been ignored by modern science. Following Aristotle, Flyvbjerg thus argues for the notion of *phronésis* (practical wisdom) to assist science and policy-makers in taking rational decisions which are not only influenced by knowledge but also by power and values. Flyvbjerg’s argument is that decisions that are based on science alone tend to ignore democratic values for the sake of sectoral gains which in the end falter or are abandoned, or sometimes reinforced under the influence of power relations. In the final analysis, *phronésis* is a mechanism which simply asks questions to get to the bottom of the truth, such as when a decision to initiate a project is mooted: Who gains and who loses, and by which mechanism

of power? Is a project like mining for instance, desirable? If desirable or not what should we do about it? *Phronésis* is thus simply searching for practical truths and at the same time tries to level the playing ground.

Furthermore, because we have allowed scientific uncertainty to postpone controls on dangerous activities, we now have hazardous levels of mercury in most of the world's freshwater fish. Coincidentally, high levels of mercury have also been found in fishes harvested in South African waters (Papu-Zamxaka *et al.*, 2010). The earth's ozone shield has similarly been dangerously depleted; global warming is upon us, with the attendant droughts, as it was experienced in the Southern and Northern Cape, and fires, floods and hurricanes in KwaZulu-Natal have taken their toll on the environment and the health of people. More frightening, however, is the normal ratio of male to female babies that has changed in numerous industrialised countries, and human sperm that has declined 50% in 50 years (Montague, 1999). The world's coral reefs are dying, cancers of the brain, the lymph system, the blood system and the testicles are increasing, cancer in children is escalating, and many species have become extinct. This list may readily be extended. But people are now waking up to the fact that scientific uncertainty should be cause for caution, not for plunging ahead recklessly. When you are uncertain, you should proceed slowly and carefully, or perhaps not at all. Better be safe than sorry – that is the philosophy of the precautionary principle.

One often sees contradictory stories in the media quoting “reputable scientific sources” who claim, one day, that “global warming will occur, and the results will be catastrophic unless something is done immediately”, and on another day, that “there is no direct evidence for global warming, and people should not waste money on something that may or may not happen” (Constanza & Cornwell, 1992: 407-412). On yet another day, one hears that “toxic chemical X causes cancer”, followed on the next day by the statement that “toxic chemical X occurs in too low a concentration in the environment to cause cancer”. And similarly we hear one day of the advantages of a low carbohydrate diet, and the next of how detrimental this could be to one's health (Noakes, 2013; Naude *et al.*, 2014; Volek *et al.*, 2009).

These seemingly contradictory statements from the scientific community send social decision-making into a tailspin. On the one hand, because scientists cannot agree on what is happening, should policy-makers wait until better information is available before acting? On the other hand, if society fails to act, the situation may deteriorate rapidly and irreversibly. What are people expected to do (particularly those on the receiving end of the environmental situations), and why has science failed to provide the certain and unbiased answers on which good policy-making depends? What is wrong with the link between science and policy, and how can it be improved? Is a different, non-regulatory

approach needed for managing the environment? Before these questions can be answered, we need to explore the role of uncertainty in decision-making as pertaining to threats of human and environmental challenges.

The notion that science is like a church, and that it therefore cannot go wrong, must be guarded against. On the other hand: we should not allow conjecture (guesswork), or educated guesses and tentative assumptions to determine our destiny, because if handled badly, uncertainty can lead to good judgement being masked by ignorance. Since the knowledge base available for decision-making on global and local environmental problems, particularly in the context of sustainable development is sometimes subjective, it follows then that decisions taken under such conditions can be costly.

2.4 Different Types of Uncertainties

2.4.1 Scientific uncertainty

Given the challenges associated with uncertainty, reducing or exorcism of uncertainties is a central feature of and driving force behind science, in the sense that science aims to generate knowledge in order to improve our understanding of the world we live in. Reduction of uncertainties is the prerogative of science. Scientific uncertainty can be addressed if their origins are identified. Walker *et al.* (2003) describe uncertainty as manifesting itself at different locations and in their study they have identified the following parameters as being the chief sources of scientific uncertainty:

- a. Knowledge-related (epistemological) uncertainties, which refer to the unknown effects of cumulative, multiple and/or interactive exposures. Systematic or epistemic uncertainty can be an important confounding factor in large-scale or long-term analysis;
- b. Parameter uncertainty, which refers to missing or ambiguous information in specific informational components of an analysis. Parameter uncertainty can be reduced by gathering more information or using better techniques to gather and analyse it. However, if it is due to variability, this may not be the case. In environmental releases, individuals not only receive various exposures; they also vary in their susceptibility to harm. Attempts to measure and control exposure to hazards may inadequately protect many in the population;
- c. Model uncertainty refers to gaps in scientific theory or imprecision in the models used to bridge information gaps, for example in a dose-response model. Models are constructed to explain current or past events or predict the future. They are only as good as the information used to build them, which is necessarily incomplete when models refer to open and

- independent environmental systems. Models can be improved as they incorporate more and more precise, information;
- d. Smokescreen uncertainty refers to the strategies of those who create risk and have a stake in concealing the effects of a specific substance or activity (e.g. the hiding of the effects of cigarette smoke, Hirschhorn, 2000). They may refrain from studying the hazard, conceal knowledge of its effects, or design studies to create uncertainty. Critics of regulation often uses uncertainty to avoid it;
 - e. Politically induced uncertainty refers to deliberate ignorance on the part of agencies charged with protecting health and the environment. The agency may decide not to study a hazard, limit the scope of its analysis or alternatives to solve a problem, downplay uncertainty in its decisions, or hide uncertainty in quantitative models;
 - f. Indeterminacy uncertainty means that the complexity involved are of such magnitude and variety that they may never be significantly reduced; and, lastly;
 - g. Ignorance, which has two faces: positively, a humble admission that we do not know how much we do not know, and negatively, which is the practice of making decisions without considering uncertainty.

Methods for characterising these uncertainties were developed early, particularly through the use of statistics. Quantitative statistical measures, such as estimates of standard deviations, standard errors, confidence intervals or statistical tests for significance, etc., have been the principal language in which to express uncertainties in scientific findings. Importantly, these uncertainties have simply been perceived as incomplete knowledge – reducible through further investigation (Janssen *et al.*, 2003). In addition, since the environment is so complex, it is not surprising that it is so imperfectly understood and imperfectly reduced into models, and yet the policy process requires the best of our knowledge to support decision-making (Van der Sluijs, 1997). Typically, sometimes decisions need to be made before conclusive scientific evidence is available, while at the same time, the potential error costs of wrong decisions can be astronomical.

For example, Freudenburg *et al.*, (2008) have noted that where decisions and actions are required, science can offer a valuable degree of certainty; however, it can never offer a guarantee. Horgan (2005) describes how this point is sometimes intentionally ignored as part of what he calls an “Orwellian tactic”. Some organizations sometimes seek to shift all discussion on some issues away from “conclusions that are most scientifically likely to ‘even the more probable conclusion which is still uncertain””. Mooney (2005) has also made a claim that these tactics are used most often to undermine scientific evidence, so that at the end those who are tasked with implementing decisions end up in a

misguided pursuit of 'balance' which results in some undue biased reporting. For example, Mooney offers the Teach the Controversy Campaign which seeks to cast doubt on some aspects of explanations offered for evolution, and other campaigns that seek to cast doubt on certain aspects of anthropogenic climate change.

Freundenburg *et al.* (2008) further posits that the deliberate omission to ignore other negative aspects coming out of a scientific report is tantamount to what they call "an attempt to shift burden of proof in an argument" (2008: 2-38). For example, cigarette lobbyists combating laws that would control smoking via trivialising evidence as uncertain is offered as an example of a SCAM (Scientific Certainty Argumentation Method). They maintain that what is mostly needed is what they term a balanced approach that carefully considers the risk of both Type 1 and Type 2 errors⁸ in a situation while noting that scientific conclusions are always tentative. Freundenburg *et al.* conclude that politicians and some lobby groups are often able to make "*successful efforts to argue for full 'scientific certainty' before a regulation can be said to be 'justified' – and that in short is a SCAM*" (Freundenburg *et al.*, 2008: 32).

Thus, it follows that decisions based on uncertainty, or what Hank Campbell and Alex Berezow (2009) call "feel-good fallacies", can drop us into deep trouble. It is therefore my contention that decisions that are taken in haste without thorough reflection may result in the loss of trust in the scientific basis for policies, based on lack of understanding of the nature of knowledge fuelled by ignorance. Unfortunately, when this happens, both humans and the natural environment will be the great losers. Therefore, uncertainty appears to have a direct bearing on most aspects of our life, particularly when we make decisions that have consequences that we cannot predict. Driving a car without a valid driver's license carries the risk that you could be stopped by compliance officers. So, it is natural that, whenever we make decisions with unpredictable outcomes, we weigh up the possible results and their risks and benefits. Indeed, some decisions carry more severe risks than getting a penalty for driving without a license; the decision to approve a new drug or to ban certain chemicals in products can have far-reaching consequences for health, the environment, society and economies. In such cases, where lives are at stake, decision-making and the handling of uncertainties have important ethical dimensions.

More recently there has been evidence and increasing awareness of the fact that there are other dimensions of uncertainty, all of which are not adequately expressed in quantitative terms (Walker *et*

⁸ Type I and Type II errors are incorrect rejection of a true null hypothesis and incorrect failure to reject a false null hypothesis, respectively. More simply stated, a type I error is detecting an effect that is not present, while a type II error is failing to detect an effect that is present.

al., 2003). This has become particularly evident when investigating potential impacts from introducing novel technologies into complex systems. The multidimensional and unpredictable nature of these systems has revealed other dimensions of uncertainty, generally referred to as ‘qualitative dimensions’⁹. Several typologies characterising these different dimensions of uncertainty have recently come to the fore (Felt & Wynne, 2007; Walker *et al.*, 2003; Stirling & Gee, 2002; Stirling, 1998, 1999b; Funtowicz & Ravetz, 1993; Faber *et al.*, 1992; Wynne, 1992).

2.4.2 Complexity

There are different ways of describing complexity and the properties of complex systems (see Mazzochi, 2008; Cilliers, 2005; Krayner von Krauss, 2005; UNESCO, 2005; Holling, 2001; Funtowicz *et al.*, 1999). According to Gillund (2010), complexity relates to the structure of the system – complex systems are open and composed of several dynamic and non-linear output-input interactions operating at different but interrelated hierarchical levels. This makes unpredictability an intrinsic property of complex systems – changes in the initial conditions of the system can have pervasive and unpredictable effects or results in completely novel properties of the overall system, or stated differently: the system may be chaotic. This does not, however, necessarily mean that all complex systems are naturally unstable. Under some circumstances the diversity of complex systems may result in high resilience and a strengthened ability to adapt to shifts in environmental conditions, while in other circumstances complex systems may be vulnerable to change.

Importantly, complex systems can, due to their diversity and multidimensionality, be described in several equally plausible ways, depending on the assumptions made and the framing of the analysis. This implies that scientists become intrinsic components in the process of gathering knowledge and performing research, and that their choice of approach influences the knowledge generated. Based on this, it can be deduced that there is no unique, more plausible or more legitimate approach through which to analyse complex systems, although there may of course be approaches that are more useful than others (Gillund, 2010).

From this it follows that knowledge of complex systems is necessarily partial, e.g. all descriptions could, in some sense, be corrected, but as no description can provide the full picture, they could all possibly, in some sense, also be wrong. This, therefore, implies that the recognition of complexity requires acknowledging uncertainties – both due to the unpredictable nature of complex systems,

⁹ EFSA, 2006b.

scientists have a limited capacity to fully describe this complexity, and the value-laden choices of scientific approaches.

Against the background of this discussion of uncertainty and complexity, I will now describe in the following section the role of science and the conventional public perception of science as making informed, rational decisions in regulatory systems, emphasising that it is crucial to identify and recognise uncertainties and complexities that go beyond the traditional notions of quantitative and reducible entities or systems.

2.5 Science as instrumental rationality

The scientific endeavour as it is conventionally practiced is embedded in the hegemony of instrumental rationality. Instrumental rationality has been defined as “*the capacity to devise, select, and affect good means to clarified and consistent ends*” (Dryzek, 1995: 19). The argument is that, along with centralised bureaucracy, modern nation-states, capitalism and industrialisation, science reproduces the view that natural systems are a means of achieving prosperity. As such science plays a central role in reproducing unsustainable lifestyles and modes of production, and contributes to the depletion of natural resources and the pollution load. The scientific mind set in this format thus paves the way for a rationalisation of the environment as a mere resource, which is a key feature of modernity. This implies a larger institutional control over natural resources, made possible by a reduction of the natural world to a number of discrete atoms in physical interaction with one another, which in turn lead to a growing disenchantment of the environment (as something alive that has more than just resource value).

The reductionist imperative inherent in scientific methods and practices, i.e. the disaggregation of complex natural systems into smaller pieces, however, is at odds with the holistic view of nature and society (Commoner, 1971; Wissenburg, 1998: 50-51). This also collides with the commitment to decentralise society and with small-scale technology, which are central to green political thought (Dobson, 2000), and is an extension of the general theme of a deep disenchantment with Enlightenment values, to which Zimmerman (1994) refers. Consequently there is a widespread suspicion of the increasing reliance on science in contemporary societies, something that ecofeminist thinkers have highlighted by making explicit links between the instrumental rationality of science, the exploitation of the environment, and patriarchy (Warren, 1994; Plumwood, 1993; Shiva, 1989). As it is stated by ecofeminist thinkers, the scientific endeavour is marked by enlightenment values that turn both women and nature into objects and resources to be exploited. In ecofeminist thinking there is thus a common ground between their critique of science, their critique of patriarchy, and

environmental concerns. As it has been stated by Keller (1992) and Merchant (1980), the androcentric bias of the Baconian vision of science, with its disembodied knowledge,¹⁰ has legitimated the death of nature. In this perspective, the very 'mind-set of science' precludes it from playing any constructive role in environmental protection, and it fails to represent the fluid boundaries, independence and holism that are defining properties of the environment. This disenchantment with Science (Wissenburg, 1998: 50-51), however, does not reflect conventional public perceptions of science.

Despite different terminologies used to explicate uncertainty, I will attempt to put the different typologies mentioned above into clearer perspective using Smith (n.d). According to Smith, in decisions taken under conditions of risk, the main variables of the problem are known and the respective probability of different outcomes can be quantified. In contrast, in decisions taken under conditions of uncertainty, even if we know the main variables of a system we do not know the quantitative incidence of the relevant factors, and so we typically ignore the probability of the event. In this understanding, a different definition qualifies uncertainty as "a probability of the second order" (Bodansky, 1994: 209). This means that, while we can quantify the probability of the event in cases of risk, in cases of uncertainty we can only quantify the probabilities relating to alternative assessments. Ignorance is thus the situation defined as that of "unknown unknowns" (European Environmental Agency, 2001) when, since the basic elements of a problem are unknown, the possible negative outcomes are also unknown; they are unpredictable unless new cognitive elements emerge. So, *indeterminacy*¹¹ is actually the concept that summarises the basically open and conditional characteristic of all knowledge, particularly its contextual meaning and its socio-cultural determination (Smith, n.d).

It must be pointed out that uncertainty is thus an ethical challenge, and the prudent strategy of dealing with ethical challenge is to diminish uncertainty by acquiring knowledge of the issue under study. When it comes to decisions that affect people's lives and health including the environment – the regulation of potential harmful substances to predict an individual's propensity to develop a severe disease – carrying out research to diminish uncertainty and, consequentially, risks can become an ethical duty. If this is not possible – because decision-makers cannot wait for the relevant research, or the gaps in our knowledge are not accessible to scientific investigation – the precautionary principle

¹⁰ Beacon implies that at times science does not understand itself, for it lacks the intrinsic valuing of the world, thereby failing to translate knowledge into action, for example science produces the best innovative research and technology without understanding its impact thereto.

¹¹ *Indeterminacy*¹¹ is the concept that summarises the basic, open and conditional characteristic of all knowledge, particularly its contextual meaning and its socio-economic determination.

is increasingly advocated and used as an alternative strategy to make decisions in light of uncertainties.

However, the application of the precautionary principle itself can create dangers (Wiedemann & Schütz, 2005) that have to be weighed against the benefits of adopting the PP, and therefore also have serious ethical dimensions that need to be considered. But this is to run ahead of my argument, constituting a theme that will be further elucidated in Chapter 3 where I will go into more depth regarding controversies around the PP. Within the context of this chapter, though, it is important to elaborate on the manner in which insistence on scientific certainty can lead to bias and an ideological abuse of science, and how this, in turn, can lead to mistrust in science.

2.6 Why science fails in policy making

2.6.1 Science: From neutral instrument to ideological abuse

South Africa is a democracy and by implication politicians are democratically elected to take up formally designated decision-making positions. However, certain sections of the populace feel that some political decisions that are taken are undemocratic, and therefore immoral. Government, scientists and civil society thus often seem to be at loggerheads with each other. Take for example the complex question of the causes, extent, components and impacts of the environmental problem of acid rain (Likens, 1998): Scientists in the USA suggested that acid rain would not have any serious impact on forests, buildings, and water quality. In fact, one scientist suggested that acid rain might even function as a "mild fertilizer" for forest ecosystems. We now know from long-term studies that acid rain can cause substantial leaching of base cations, primarily calcium, from forest soils, with consequent, major ecological impact (Likens *et al.*, 1996).

Thus, a lesson learned so far is that science can be complicitous in decisions (for example not to do anything about acid rain) that are not consistent with the real problem, but are often put forward as if they were. The irony, however, is that even in times when science was deemed to be apolitical, the force of science was important in relation to understanding and protecting human health and the environment. There is no doubt that without science, the world would not have learned about the impact of fossil fuels on climate change, mad cow disease, emerging cancers resulting from human activities, and so forth. Indeed, the primary epistemic aim of science at work is the achievement of truth and the avoidance of error (Goldman, 1999). And it is in this context that science is regarded as rational to the extent that the beliefs that it accumulates are seen as true, and scientific reasoning is regarded as rational to the extent that it tends to produce what are seen as true beliefs. As such, this

approach is captured in the philosophical position of scientific realism which states that science aims to produce true theories (Thagard, 2004). Therefore, science cannot just be discarded as inherently flawed, but should rather be seen as a vanguard of the truth, and as such as a basis for real-world problem solving.

One of the problematic aspects of science functioning as the only basis for environmental decision-making, however, is that science driven only by empirical adequacy¹² (and not by observable phenomena) often has little power to resist political pressure and incentives in such decision-making (Van Fraassen, 1980). The same also applies to people who may happen to be confronted with environmental decisions that are experienced as unfair. When they reject a "science based" environmental decision, they in effect are also rejecting the data and the scientific theory behind the data. In his article, Van Fraassen (1980) thus points out that decisions that are informed by science theories alone tend to generate data which is empirically adequate, but can stand in opposition to the experience of people in everyday life. He therefore warns that in such situations people are put into a double jeopardy in which they, in the first place, cannot rationally distance themselves from unfair environmental decisions, and in the second place, can become skeptical about the claims of science that, even if they are purely scientific, do not address their concrete and observable experience of things and events.

The converse of this problem is that of politicians using the "rationality" of science to drive and justify certain decisions that will make them popular to civil society. When this happens, science is actually hijacked by politicians for partisan reasons, and this is also unacceptable. The ideal situation would rather be that science is given the space to do its work properly along the lines of its epistemic imperatives to produce reliable knowledge to solve societal problems. So, instead of being seen to be 'cherry picking' and partisan when testing their theories, scientists should rather be in the position of making sure that all interests, including the communities' point of view, are included in an objectively specified sampling set to reduce bias that may affect the data, including political agendas. In fact, if science is used to rationalise political agendas, we are dealing with ideology and rational decision-making.

In order to avoid the abuse of science by ideology in the critical, Marxian sense of a false consciousness legitimizing the narrow class interests of those dominant in society, society has over the years learned to address emerging challenges through a structured and systematic process of enquiry,

¹² Empirical adequacy: The core doctrine of empiricism is that experience is the sole source of information about the world.

interpretation, assessment, learning and action. Where the challenges are complex and there is uncertainty about the nature of the problem, the solutions and outcomes, society expects that science will provide direction and solutions. In this sense, science and society cannot be seen to be operating in isolation. That is despite the noise coming from certain sections that the relationship between the two should be carefully circumscribed (Lackey, 2001).

Nevertheless, it is important to note that according to the most recent insights into the relationship between science and society, science is inherently political and is to a very large extent driven by prevailing trends (Flyvbjerg, 1998; Soule, 1985, 1987; Clark *et al.*, 1998; Gill, 2001; Likens, 1984, 1992). To convince its detractors (or perhaps to silence them), science often uses complex formulas to put a point forward. Non-scientific communities would then typically not understand such scientific jargon, for example, acronyms like MAP3S (Multi-State Atmospheric Power Production Pollution Study), or phrases like "cluster analysis of air-mass back trajectories". To a non-scientific outsider, the quantitative data or empirical adequacy these examples point to, fail to convince communities because it clearly leaves out the most important approach people understand better, the qualitative approach which does well in environmental decision-making. Hence, decisions that are skewed towards empirical adequacy may not appeal to those who are already suspicious of science, since they hold a belief system that says that science is not the only game in town. To that end, communities, particularly the non-scientific community, will most likely become indifferent if the suspicion takes root that indigenous knowledge is side-lined.

2.6.2 From confidence in science to mistrust of science

The relationship of science to environmental decision-making is to some extent problematic in that science often does not bolster the public's confidence in environmental decision-making, because of the public's perception that both environmental decision-making and science are biased (Leshner, 2003). However, the role that science plays in public environmental decisions cannot be underplayed and undermined. Science, when practiced properly and rigorously, clearly has a force of convincing that is, and should be widely recognised. A case in point is the manner in which the international and national communities represented at the World Summit on Sustainable Development in Johannesburg in 2002 (WSSD, 2002) explicitly acknowledged the role of science in poverty alleviation and economic development. Similarly, there have been a few times in our contemporary history when the force of science was more important in relation to our understanding and protection of the environment and its inhabitants. For instance, the discovery of penicillin which subsequently brought down the mortality and morbidity rates among communities who were under siege from some of the deadliest diseases the world has ever seen, such as gonorrhoea, syphilis, etc. is one good example of the success

of science. However, even if Science has been central to poverty alleviation and economic development, the large chunk of the benefits of science and technology has not reached the majority of the poor in both developing and developed nations. This truth has been assertively acknowledged by the United Nations Commission on Science and Technology Development (UNCSTD, 1979).

Science has also been misused to the detriment, disadvantage and risk of the society, including for the development of weapons of mass destruction, as well as contributing in a highly ironic way through combatting diseases to a growing population which is not self-sustaining in terms of health and food, including the loss of biodiversity as a result of environment degradation. In addition, research and development in science has created technological gaps among nations. Many poor countries of the world, particularly those in Africa, Asia and South America, have largely lagged behind in terms of science and technology because they cannot access and utilise advances in science and technology (UNCSTD, 1979). As long as this status quo remains, society will most likely perceive science as an enterprise in the service of an elitist agenda and not as pro-poor, not as pro-women, etc. For science to succeed, then, it has to transform and undergo a 'face-lift' to become a partner of society at large and thus not perceived to be distant to realities on the ground.

Today, the public armed with new knowledge and confidence that stems from their understanding of their legitimate claims and rights guaranteed and protected by all kinds of national and international legal instruments,¹³ rejects the notion that scientists are the sole arbiters and protectors of "sound knowledge", and that the world of science should be taken as definitive, objective and neutral (Tesh, 2000).

Indigenous knowledge has become indispensable to the resolution of environmental challenges triggered by technology. A case in point is that of the largely divergent conceptualisations of the concept of risk by scientists and non-scientists with regards to the case of acid mine water, which is going to form the basis of my discussion in the second part of this thesis. Acid mine drainage which is currently one of the biggest and most acute environmental problems in South Africa, has been found to be an albatross which requires decision-makers and the scientific community alike to act with urgency and robustness in collaboration with affected communities to correct this unfortunate state of affairs. The affected communities mostly conceptualise their concern in terms of the quality of the water, as reflected in taste, smell and aesthetic appearance, whilst scientists focus on the many constituents of water, many of which are not detectable by ordinary human senses, and since they

¹³ Of which the South African Constitution is but one example.

recognise that risks cannot be completely eliminated, argue for a position where the risks of acid mine water is only greatly reduced (WHO, 2008).

Communities, however, are not interested in merely a reduction of hazardous practices, but rather in their complete elimination. In view of this, an alternative decision-making tool, other than solely depending on scientific risk assessment needs to be investigated to obviate challenges such as those experienced with acid mine drainage (AMD). This need is mostly informed by the perception that policy-makers and largely scientific communities take decisions unilaterally without the input of communities.

On the question of whether science is rational or not, the answer will be legitimised also by what the affected communities are saying, otherwise a certain section of the community will perceive science as an extension of government by proxy, and scientists as the so-called third force that represents government's narrow interests (Avni 2007). In view of that, because of perceptions associated with this dominant thinking, science is at its lowest ebb, and I sincerely hope it will not go any lower. As I will argue further in my thesis, I believe that this ebb can be stemmed by a newly conceptualized precautionary principle

2.7 How should we then deal with scientific uncertainty?

The relationship between science and decision-making is not as simple as some technocrats would like to believe. It is a rollercoaster relationship, punctuated by mistrust and misgiving. Each party in the process of decision-making is intent on pushing its own agenda, despite the costs that will ensue. Firstly, the technocratic ideal of science speaking "value-free" truth to political power gained institutional currency in the nineteenth century. It was based on the expectation that the impartiality and objectivity of scientists could help to overcome political conflict (Proctor, 1991). In the twentieth century, however, it became evident both that science cannot be value free and that politics deals more and more with issues that are clouded with uncertainty (Petersen *et al.*, 2011).

Furthermore, science has proven to be a capricious adviser of regulatory policy (Halffman, 2003). For example, Hans Von Storch *et al.* (2012a) posited that they fear science is taking a role in political decision-making processes which it is not entitled to take. For instance, the question of global warming is one area of concern which has placed mainstream climate change scientists and climate change sceptics at odds. Each claim they are right in terms of the contribution of man-made CO₂. This has resulted in the proliferation of global warming. According to Grundmann (2007), politicians have a tendency of taking sides to justify all sorts of inhumane, deliberate and repressive political measures,

often with support or at least complicity with scientists. Werner and Von Storch (2012) and Anonymous (2011), posit that history has shown that the mixing of science and values, the use and abuse of science to direct political and social life of a society is never a good idea. It is bad for politics, and it is bad for science (O'Neill & Weinthal, 2013). Science and politics together thus can be calamitous. Each one needs to know its place.

It is therefore no surprise that often, when regulatory bodies ask a question about a particular hazard, they do not usually get the kind of answer that they desire. For instance, scientists may point to uncertainties, incomplete records, lack of information, or – a classic – a need for more research (Halfman, 1995) to cover up the gap that exist in the knowledge regarding a particular hazard. In most cases, scientists insist that the definition of “hazard” is not purely a scientific matter (Webb, 2006). They may indicate that decision makers need to define exactly what it is they want to protect: specific species of wildlife, human health, vulnerable groups, etc. Certain sections of the communities, mostly the scientific community and business sector, have thus been vociferous in arguing that questions asked about the alleged hazard associated with projects that may imperil the health of communities, species etc. is nothing else but a ploy to postpone inaction while protecting industrial interests (Rosenstock, 2006). To aggravate matters further, scientists are often at war with each other. They do not seem to agree, as they bear different bodies of professional knowledge (Ozawa, 1996). Therefore, science cannot assume the role of being a monolithic institution, since it is not in a position to answer challenges that may not be inherently scientific.

For many communities, science sceptics, environmentalists, etc., science and technology seems the only way to resolve current environmental challenges (Huesemann, 2001). However, an approach based on science alone, in the hope that quick solutions can be found, is an attitude doomed to fail (Droz & Lavigne, 2006: 25). Such an approach does not consider the impact of individuals and collective behaviour as pertinent for solving problems. In fact, it does not recognise the power of citizens in a decision-making process (Sclove, 1995: 43). This therefore implies that participatory politics and problem structuring – the political condition in which we find ourselves when science cannot speak “the truth” to power – can be seen as an opportunity for the democratisation of both the scientific advisory process and politics in general. This democratisation can start from a renewed awareness suggested by Barber (1984: 121) that says when there is uncertainty:

To be political is to have to choose – and what is worse, to have to choose under the worst possible circumstances, when the grounds of choice are not given a priori or by fiat or by pure knowledge (epistème). To be political is thus to be free with a vengeance – to be free in the

unwelcome sense of being without guiding standard or determining norms yet under an ineluctable pressure to act, with deliberation and responsibility as well.

So neither governments falling back on science, nor scientific communities and moral communities, can deduce the norms that should govern our behaviour from empirical research or pure thought alone. The key concepts of the democratic state or politics lie in deliberation and responsibility, and this is the terrain in which scientists and ethical communities can engage in discourse to achieve what I will term just policy, and this inclusivity will result in non-experts/non-scientists feeling empowered.

It is normal in democratic and 'non-democratic' states to seek the advice of science to formulate and deal with policy challenges. It is assumed in this dissertation that even states that do not subscribe to democratic principles also appeal to science for policy direction. However, science should not be dictatorial and assume a 'know-it-all' mentality. Indeed, scientific advice, for example in the form of "regulatory science", often plays a crucial role even in policy-making. But, as Jasanoff (1990) suggests, in the context of risk regulation we cannot hope for more than scientific advisers delivering what she calls a "serviceable truth": "A state of knowledge that satisfies tests of scientific acceptability and support reasoned decision-making, but also assures those exposed to risk that their interests have not been sacrificed on the altar of an impossible uncertainty" (Jasanoff, 1990: 250).

Given the debate on the use of scientific risk assessment and risk management as tools to influence policy decisions, this has also invited numerous perceptions regarding how hazards and risks might be conceptualised and interpreted since risk and hazards interpretation are informed by, and thus influenced by a number of factors, such as profession, gender and political ideology. Moreover, people tend to treat risks differently, depending on their level of knowledge (epistème) about potential consequences, whether the risk is familiar and whether the risk exposure is undertaken voluntarily or being forced on them (Slovic, 1987). De Melo-Martin and Meghani (2008) argue that it should be recognised that defining what counts as a serious risk is a value-laden choice, as are choices of time frame for investigating risks, and what counts as evidence of risk (e.g. what level of statistical significance is used in the studies and what constitutes the baseline for the comparison of harms). Hence, although risk assessment can be a useful tool for decision-making on its own, it is inadequate for addressing the many social, ethical and cultural concerns relevant to the future safe environment and health status of the citizens of South Africa. Worse still, in a democratic society the privileged role of science in framing risk and its assessment is exclusionary: it effectively limits who can legitimately participate in discussions to the community of scientific experts.

2.8 Conventional risk assessment revisited

The most important fundamental question that conventional risk assessment is attempting to answer is “how much harm is allowable” (Holley, 2011) to lessen the impact on human and ecosystem in terms of health and degradation respectively. This approach appears to suggest that small quantities of degradation will not be a catastrophe, since nature can take care of itself. The risk management approach does not appear to push for avoidance of risk, but appears to be canvassing for the opposite: the “management” of risk. Furthermore, the insinuation of conventional risk assessment proponents is that humans can manage their environment by discovering its assimilative capacity, and ensuring that its assimilative capacity is not exceeded, because the scholars of risk assessment seem to think that they have everything under control since they know all the threats associated with their projects. However, what we know is that today we are living in a risk based world, governed by environmental and health laws and regulations. We also know that the environment and human health continue to be under siege by a continued reliance on risk based decision-making. The notion that “innocent until proven guilty” has set in motion doubts that begin to alienate communities from mainstream science and technology. Research and practical project experience has shown that limiting risk assessment to purely quantitative risk analysis does not address a broad range of project risks, including social, professional and ethically negative project impacts. When that happens, humanity and the environment will find themselves on the cross-road.

It is thus that in this context, an alternative tool in, or approach to decision-making under conditions of uncertainty, that is more forward looking, is strongly opposed by those that fail to account for uncertainty, ignorance and complexity in decision-making processes. My thesis in this dissertation is that the philosophy of the PP can help in this regard: if there is a clear sign of irreversible damage or harm, take stock and take defensive action.

2.9 Conclusion

Environmental risk assessment is a relatively new and immature field, yet it is a potent decision-making theory and practice and this is evident in the state of development of its analytic methods for assessing exposure levels and their potential adverse effects. Furthermore, humanity is well off today as a result of policies that were influenced by science that resulted in the protection of the environment and humans. However, the successes of science and technology are also clouded by uncertainty and extraordinary risk that science alone is not able to resolve. In addition, current methods of estimating human or ecological exposure levels generally focus on individual hazards and isolated incidents or constant long-term exposures. Therefore, they inadequately account for

common, real-life conditions, such as fluctuating exposures to multiple hazards. There is no doubt that conventional risk assessment and risk management have helped us to broaden our knowledge about risk. But, like any decision-making tool, risk assessment and risk management have their Achilles heel, as I have shown in this chapter. It would be short-sighted, though, to completely reject risk assessment and risk management on the basis of the weaknesses inherent in them as decision-making tools. We need to take the positives out of risk assessment and strengthen our environmental policies that will protect all those affected by poor environmental decisions. We can further use the most developed and well established methods of risk assessment and management to assist other emerging decision tools to make a robust contribution in the formulation and application of environmental legislation, one of which is the precautionary principle.

To further our understanding of the PP I will focus my attention in Chapter 3 on the debate between the two opposing positions on the adoption or non-adoption of the PP as an alternative tool to close the gaps that are inherent in science based risk assessment and management. The whole objective is to draw the two concepts closer together so as to be able to address the tension that is playing itself out in environmental controversies and decision-making. The grey area that exists between science-based risk assessment and the precautionary principle will be investigated in order to come up with a unifying position that takes the views of both the scientific world and the non-scientific communities into consideration in policy formulation and decision-making. As I will argue in Chapter 3, decisions that are going to influence complex systems and human health should not be left solely at the door of science, but that an integrated approach should be used, where science, the precautionary principle and other approaches combine with one another in an intelligent, mutually critical and enlightening manner.

Chapter 3:

An interpretation of the precautionary principle in the light of controversy surrounding it

3.1 Introduction

The elevation or institutionalisation, or even the constitutionalisation, of the PP as it was described above in chapter 1 has been regarded as a marker of ecological rationality (Eckersley, 1992). Despite the praise for it, however, the PP has been criticised from a number of angles. Therefore, to justify a role for the PP in risk management it is not enough to show that there is scope in risk assessment for something along the lines of the PP. The criticism raised against the PP must be examined and evaluated forthrightly. In the end, a case can be made only for a PP that withstands or circumvent those criticisms of it, criticisms that are substantive. Therefore, this thesis will also highlight the controversies around the PP and attempt to find common ground to reduce the tensions that exist between the two schools of thought that are for or against the PP. I do not argue or claim that any objection to the application of the PP here is serious enough to reject the PP entirely. However, to the extent that most of the major objections are captured, it could be conjectured that a PP is capable of dealing effectively with these objections, one way or another, might *prima facie* be taken seriously.

Although the PP is a fairly new concept in environmental regulation it has taken centre stage in a number of recent international discussions on trade, the environment, and human health. As a result, it has also stirred criticism as well as interest. Likewise, the discussions regarding the pro and contra positions of the PP and risk assessment regarding their relevance in environmental decision-making will be extensively explicated by comparing and contrasting these two decision-making theories. The need to pay special attention and how it is conceptualised by both its adherents and detractors is further buoyed by the growing number of media reports on the PP, its criticisms and their corresponding qualifications that are repeated with some frequency. Since a lot has been written and said about the precautionary principle with much of it being critical and misleading about the principle (Holm & Harris, 1999), it has also become important to deconstruct some of those allegations levelled against the PP as well as point out the gaps in the PP.

Therefore, the purpose of this chapter is to discuss the different positions advanced by different scholars on the adoption or rejection of the PP as a decision-making tool to influence regulatory power and thus environmental decision-making. In the previous chapter, it has become abundantly clear that uncertainty characterises much of contemporary decision-making in environmental and human health. The relevance and the application of the PP have attracted substantial attention because it

encompasses many of the underlying dimensions of decision-making under uncertainty and provides a framework to support it. Several philosophical and societal questions contribute to the complexity of this (Sharp, 2002) and they will be further explicated in this chapter. The positives derived from the argument will be used as a basis of my case study on AMD.

3.2 The strong claims against the adoption of the precautionary principle

3.2.1. The null hypothesis argument

Before I delve into the discussion regarding the null hypothesis, it is important to let the reader of this thesis know what a hypothesis in the context of this study is. A *hypothesis* is a speculation or theory, based on insufficient evidence, which lends itself to further testing and experimentation. With further testing, a hypothesis can usually be proven true or false. A null hypothesis thus (H_0) is a hypothesis that says there is no statistical significance between the two variables in the hypothesis. It is the hypothesis that the researcher is trying to disprove. For instance, the approach to hypothesis testing would commence with a hypothesis that asserts that a proposed action has deleterious consequences. The alternative hypothesis H_1 then states that the consequences are not deleterious. The seemingly contrasting conceptualisation of the null hypothesis, however, lends itself to misuse and abuse in risk assessment cases such as the determination of whether AMD is as a result of mining or not or, whether AMD is or, not the danger it is purported to be.

For example, denialists of global warming have a habit of merely ignoring evidence and claiming that the burden of proof rests with the proponents of those concepts. Debates frequently descend into arguments about which side the burden of proof lies with: those affirming or those denying that a proposed action is safe. In other words, if someone presents you with an idea and says that the burden of proof is on you to disprove the idea, one needs to work out what the null hypothesis is and then put their evidence for the idea against it. The person claiming something is possible or dangerous or has happened (e.g. AMD) thus needs to produce evidence to refute null hypothesis that it is not dangerous. If they have considerable and well-tested evidence, the burden of proof may reasonably be considered to be on the person claiming that the evidence does not hold. The critical question thus becomes who owns the null hypothesis, and how do they define it?

Therefore, the PP debate is basically a quarrel about who owns the null hypothesis (Parson, 2000; Randall, 2009). The issue of burden of proof is raised directly in the Wingspread Statement, which defines the null hypothesis as "*the proposed action is harmful*" (Randall, 2009: 77), when it assigns the burden of proof to the proponent (ibid.) which requires that the proponent of an action would have

to prove that the action is safe. Furthermore, in hypothesis testing, two kinds of errors are possible: a true hypothesis might be rejected, and a false hypothesis might be accepted. According to Peterson (2006: 305) "*the precautionary principle can be interpreted as an analogous epistemic principle that prescribes that it is always more desirable to avoid false negatives than false positives when it comes to assessing risks*". For example, scientists traditionally try to reduce the frequency of type-I errors (accepting a false negative) to 5 in 100 ($\alpha=0.05$), below which the p must fall in order to reject H_0 . In contrast, if the p value falls above 0.05, and we are not 95% sure that there is an effect, we do not reject H_0 . In this case, if the discharge indeed has an effect, then we commit a type-II error by not rejecting H_0 .

But, traditionally scientists have paid little attention to the risk of committing a type-II statistical error, missing an effect. This is a very conservative strategy which makes it hard to reject H_0 because there is a crucial connection between the frequency of type-II error and the statistical power of a study. Statistical power¹⁴ refers to the probability of correctly rejecting the H_0 , which is, statistically detecting an effect. For example, if an analysis of data from a monitoring programme fails to reject the H_0 , and if the statistical power is high (usually defined as at least 0.8) for some specific effect that is deemed to be biologically or economically important, then one can say that there was at least an 80% chance of rejecting the H_0 if such an effect had been present (and less than a 20% chance of committing a type-II error). Thus, as the risk of committing type-II error increases, the power of a data set decreases. However, there is a trade-off between type-I and type-II errors. By traditionally avoiding type-I errors, scientists have increased the risk of committing type-II errors resulting from lower statistical power. The debate between Gray (1990) and Josefson (1990) illustrates the difference between types-I and -II errors.

The two scientists, Dr. Alf Josefson and Dr. John Gray, conducted separate long-term studies of eutrophic levels, investigating changes in biomass in order to determine whether increased nutrient load from human activities were having an environmental impact. Josefson, collecting data from 14 different localities, found increases in 12 of them and extrapolated that there was an overall increase in eutrophication in the Skagerrak area in general. Gray disagreed completely, saying that Josefson was not using his statistical data properly. Gray argued against Josefson's results on two fronts. First of all, he noted that it is improper statistics to pool data and extrapolate from the part to the whole

¹⁴ Statistical power is the likelihood that a study will detect an effect when there is an effect there to be detected. If statistical power is high, the probability of making a Type II error, or concluding there is no effect when, in fact, there is one, goes down.

without a high enough significance level, and second, that it is irresponsible to publicize results of this sort. The phrase, “numbers don’t lie”, is one most of us have heard. On the face of it, this seems true. Numbers, if carefully collected and reported correctly, are objective facts. How is it possible then that two highly respected, experienced marine biologists, both spending years in the field collecting and analyzing data from Sweden’s Skagerrak area, could be accusing each other of misusing statistics? This argument, in all its details and with a discussion of ramifications for both public policy and ethics, was the subject of a provocative article in an October 1998 volume of *Science and Engineering Ethics*. The disagreement between the two researchers highlights two critical aspects of research: 1) the actual statistical analysis, and 2) how to much certainty must be present to disseminate the information from research. Gray clearly argued that the level of certainty must be very high before results can be published, while Josefson in contrast, followed the precautionary principle which require of scientists to publish results from preliminary studies in order to lessen the risks to either the environment or the public.

Gray (1990) holds, in his answer to Josefson (1990), that regulatory actions should be taken only when H_0 is rejected by standard statistical tests, which increases the risk that an effect will not be observed and thus increases environmental risk. The statistical power of a scientific programme, or its possibilities of rejecting a false H_0 , is therefore crucial to how reliable results are. H_0 may not have been falsified because the effect was missed due to few or very variable data resulting in low statistical power. In responding to Gray and Josefson argumentation, Welin and Buhl-Mortensen (1998) also posit that their argument, in all its details has a discussion of ramifications for both public policy and ethics.

It follows then that environmental studies are mostly prone to high levels of natural variation. Thus, to focus on avoiding type-I errors in environmental studies, by setting α to 0.05, without accounting for how this affects the chances of missing an effect, is not particularly objective or scientifically defensible. Because if there is a risk of missing an effect and this risk is not estimated, how can scientists and policy makers know how to interpret results? Peterman (1992) has shown that 98% of recently surveyed papers on fisheries and aquatic science that did not reject some null hypothesis (H_0) failed to report the probability of making a type-II error not rejecting H_0 when it should have been rejected. He also found that about 50% of these studies made recommendations or interpretations as if H_0 had been shown to be true. Peterman and M’Gonigle (1992) claim that if statistical power had been evaluated historically many past political decisions probably would not have been justified and undesirable effects on the environment could have been avoided. They also suggest that power calculations can help to identify those cases in which precautionary regulatory actions may be

justified, i.e. where the uncertainties are large. Therefore, to protect against incorporating false statements into the body of accepted knowledge, tests are usually constructed so that it will take overwhelming empirical evidence to reject the null hypothesis (usually that a treatment has no effect). The Wingspread Statement therefore defines the null hypothesis as “the proposed action is harmful”, which assigns the burden of proof to the proponent (Parson, 2000: 123). South Africa environmental policy however makes proof of harm, on the basis of an environmental impact assessment,¹⁵ a prerequisite for regulation intervention. “The thing (or act) is safe” is treated as the null hypothesis.¹⁶

What does the above criticism imply? Firstly, it is clear that the formulation of the null hypothesis, or who bears the greater burden of proof, matters and it is apparent that many participants in the PP debate focus on this issue.¹⁷

However, the PP debate is not only about who bears the burden of proof. The question of evidence and its relationship to remedy is intertwined with burden-of-proof issues. For an example, we might expect a coherent precautionary principle to set an evidentiary standard higher than merely “crying wolf”, but lower than is appropriate for admitting empirical findings to the scientific knowledge base. Then the null hypothesis (and its assignment of the burden of proof) will be *ipso facto* less important. There will be work to do on both sides of the argument – establishing that the thing (or act) is potentially harmful, and making the case for its safety (Parson, 2000). In the same breath, any discussion of the PP in the context of international trade seems mostly to proceed in legalistic terms (Peterson, 2006). By its very nature, such discussion seeks enforceable interpretations, and is uncomfortable with competing definitions and inconsistencies (either internal, or with other widely-honoured values). However, the precautionary principle cannot be expected to provide the clear, coherent and enforceable laws demanded by critics in the trade literature on its own. At best, it is just one of the touchstones for the on-going process of developing trade laws and interpretations that respect precaution in the face of certain kinds of threats and the broad slate of legitimate trade concerns.

This matter is complicated in a legalistic manner because of the uncertainty inherent in the formulation of PP. For instance, about twenty different formulations of the PP are in circulation or

¹⁵ Rabie, 1992.

¹⁶ The null hypothesis refers to a general statement or default position that there is no relationship between two measured phenomena. See NEMA, Act 1998.

¹⁷ For instance the United States of America environmental policies are not comfortable with burden of proof and rather have elected to use proof of harm as a prerequisite for regulatory intervention as overall environmental legislation excluding the endangered species legislation— “the (thing or act) is safe” is treated as the null hypothesis.

have been identified, which led Sandin (1999) to ask how it can be taken seriously in the real-world (law and policy)? This complaint ignores the distinction between a principle and a road-ready rule. The on-going discourse about how the PP might apply to real-world policy and management is an essential part of the process of developing rules, policies and practices that are informed by principles.

3.2.2 The precautionary principle is ill-defined

It is often complained that the PP is vague and/or ill-defined. “[*The precautionary principle*] is too vague to serve as a regulatory standard”, writes Bodansky (1991: 5; see also Bodansky, 1992). Other authors claim that a version of the precautionary principle used in the context of marine pollution “poses a number of fundamental problems”, as the logic of the principle is unclear and its key terms are not defined (Gray & Bewers, 1996: 768). The fact that the PP has occurred in some important official documents (e.g. the Maastricht Treaty; see, for instance, Kramer (2000:16) and a recent EU communication (Commission of the European Communities (CEC), 2000) without explicit definition also fuels the perception that it is poorly defined. Furthermore, the fact that there are a number of different versions of the PP supports the argument that it is poorly defined.

Given the vagueness of many ‘official formulations’, it is therefore necessary for critics to interpret the principle before criticising it. Their interpretations, however, thus need to satisfy certain constraints: firstly, if the criticisms are to have any force, they will have to make sure that their criticism is actually aimed at the principle that is actually advocated, and not merely against a “straw man”; and secondly, if it were argued that no form of the PP is acceptable, then the interpretations of the PP criticised should be reasonable interpretations of the PP. Furthermore, while many formulations of the PP refer to the use of scientific knowledge, and accept that the concept of uncertainty is critical, the idea of precaution has not been extended to influence the production of scientific knowledge. Gray goes further than this, asserting that “*the precautionary principle should not be part of science*” (Gray, 1990: 174).

Why are the detractors of the PP so skeptical about the realistic chances of implementing the PP as reliable tool in making a meaningful contribution to environmental decision-making? A number of facts support an affirmative answer to the first question posed above. The claim that the PP is ill-defined (in different senses) can be argued for as follows. Originally, the first references to the principle in official environmental policy documents were short and without a definition. In addition to the phrase ‘precautionary principle’, terms such as ‘precautionary measure’, ‘precautionary approach’, ‘precautionary action’, ‘principle of precaution’, and ‘precaution’ have been employed.

Still, whilst most of the authors speak about one definite principle (e.g. Wiener & Rogers, 2002), others use the indefinite plural form (e.g. Löfstedt *et al.*, 2002).

Furthermore, whether there is a difference in meaning between ‘precautionary principle’ and ‘precautionary approach’ is not commonly agreed upon (see e.g. Conko, 2003: 642–643, Trouwborst, 2002: 3–5, VanderZwaag, 2002: 166–167). Even if we sidestep the terminological issues, a positive answer to the first question is also supported by, at least, two further facts. Following David VanderZwaag’s (2002: 167–168) use of terms, these may be called as definitional variations and definitional generalities. The former refers to the fact that, not only one right (or commonly accepted) definition of the PP exists, but rather that there are several formulations of it. This is true of judicial texts and other official documents and also holds in regard to the commentary literature of the principle. In his article on the dimensions of the PP, Sandin (1999) presents 19 different formulations of the principle. Neil A. Manson states that “[v]ersions of the pre-cautionary principle are many, both in terms of wording and in terms of surface syntactic structure” (2002: 263, see also Adams 2002: 302).

In addition to the surface structure and wording differences, the formulations differ significantly in regard to their content (see e.g. Ahteensuu, 2007). Given the multiple and differing formulations of the PP, it seems strange that the Commission of European Communities did not define the principle in their Communication (CEC), which was aimed to clarify the principle and its use. Definitional generalities, in their turn, refer to the fact that different formulations of the PP are “loaded with generalities” (VanderZwaag, 2002: 167). Most of the particular formulations (or definitions) of the principle do not provide specific guidance as to what exactly must be shown to justify precautionary measures, for instance. Thus, they leave much space for discretion. In their analysis, Turner and Hartzell (2004: 449) use the Wingspread Statement to illuminate definitional generalities. According to them, the statement “fails to indicate who must bear the cost of precaution; what constitutes a threat of harm; how much precaution is too much; and what should be done when environmental concerns and concern for human health pull in different directions”. It should, however, be noted that even if the official formulations of the PP include definitional generalities, attempts to clarify and specify the principle have been made in the academic literature (e.g. Sandin, 1999; 2004). Admittedly, these analyses have illuminated various aspects of the PP – yet much of the work seems to be undone. VanderZwaag (2002: 167), for instance, contends that “[a]cademic efforts to clarify the meaning of the precautionary approach have also left considerable fuzziness”.

On the basis of the above, I conclude that the PP is currently indeed vague in a number of senses (and also a matter of ongoing disputes). It would, indeed, be hard to assure the opposite. This brings us to the second question, namely that of whether – and if so, to what extent – this matters. On the one

hand, it has been argued that the (problem of) vagueness should be taken seriously. Kenneth Foster *et al.* (2000) consider the extreme variability of interpretations of the PP as its greatest problem when it is used as a policy tool. Turner and Hartzell (2004) argue that the ambiguity of the PP can only be seen as a good thing from a rhetorical perspective, not from those of moral philosophy and practical decision-making.

On the other hand, some proponents of the principle do not seem to be concerned about the vagueness at all. According to Jordan and O’Riordan (1999), it is not problematic that the PP only offers broad guidelines (or a frame) to policymakers. They even think that the vagueness is, in fact, desirable and a precondition for the functionality of the principle. *“Paradoxically, I conclude that the application of precaution will remain politically potent so long as it continues to be tantalizingly ill-defined and imperfectly translatable into codes of conduct, while capturing the emotions of misgiving and guilt”* (ibid.). In their view, the precise meaning of precaution will only emerge when stakeholders come together to make a decision in a particular context, trading costs against benefits and determining the (un)acceptable levels of damage (ibid.). Whether using ambiguous principles in societal decision-making is desirable or not remains debatable. There are reasons as to why the latter view might be too optimistic, however. That this understanding of the PP undermines the principle’s status as a legal principle has been argued (e.g. Gardiner, 2006). The principles of environmental law, however should be consistent with values shared in a society, not be based upon mere hunches, gut feelings or emotions. Nonetheless, certain (moral) emotions play a significant role in morality, and legislation has strong connections to morals as ethical analyses can serve as a basis for changes in legislation and for new laws.

But should the vagueness of the PP result in its abandonment? As correctly pointed out by Sandin and his colleagues (2002: 289), the lack of precision in the definition is not unique to the PP, but also holds in regard to several other decision rules.¹⁸ (Writing general policy objectives in legislation is, in fact, a common practice.) Consequently, the same objection could be raised in these other cases as well. This implies two options for the critics of the PP. One option is to argue that principles (such as the PP) in general are vague, and thus cannot provide useful guidance for decision-making. This might be based upon the fact that (decision-making) principles do not imply context specific guidance, and thus their application to concrete situations presupposes interpretation (see e.g. Beauchamp and Childress 1983: 5; Nollkaemper 1996: 80–81).

¹⁸ Sustainable development, for example, has several definitions and interpretation. So has justice, human rights, human dignity and human security.

Following Ronald Dworkin's (1978: 26) description of legal principles, "[a] principle [...] states a reason that argues in one direction, but does not necessitate a particular decision. [...]. There may be other principles or policies arguing in the other direction [...] if so, our principle may not prevail, but that does not mean that it is not a principle of our legal system, because in the next case, when these contravening considerations are absent or less weighty, the principle may be decisive". All that is meant, when I say that a particular principle is a principle of our law, is that the principle is one which officials must take into account, if it is relevant, as a consideration inclining in one direction or another (1978: 26). Here Dworkin makes two important observations specifically that principles (of law) have to be considered in the realm of other principles and that they (usually) leave room for discretion. Given the vague nature of principles in this sense, the argument from ambiguity has consequences which are not satisfactory.

It follows then that if the PP should be abandoned because of its nature as a principle, then – in the name of consistency – other principles should go with the same strain. Provided that we are not willing to abandon most of our (conduct-guiding) principles – as a kind of a *reductio ad absurdum* – this way of argumentation is not plausible. The other, and more plausible, option would be, if one seriously would try to discredit the PP, to try to show that even if principles in general are vague and in need of interpretation when applied to concrete cases, the PP is ill-defined in a special way, and that this makes the principle flawed.

Again, two sub-options for such an argument emerge. First, that there is an essential difference between the PP and (most of the) other decision-making principles might be argued for. Yet what that difference could be in practice is hard to imagine. It is thus not the case that the PP offers us no guidance for action. The principle offers a rationale to act in the case of uncertain risks before the scientific proof of the causal relationship between an action and the assumed damage is achieved. Moreover, the existence of several definitions is not unique to the PP. The principle of sustainable development, for instance, has several definitions (and interpretations). Lastly, other legal principles and terms also require interpretation and deliberation when applied to particular cases. Thus, the burden of proof seems to remain with the proponents of this view that the PP should be rejected because it is ill defined. Second, following the argument presented by Sandin and his colleagues, even if other decision rules are not in principle more well-defined than the precautionary principle, they might in fact be, in the sense that due to their long period of use there has emerged a substantial body of interpretations and practices that partly compensate for the lack of exact definitions.

There are, for instance, governmental guidance documents and court cases that can be of help in interpreting these principles Sandin (2002: 289). I do not deny this because the history of the PP in

official texts and court decisions is still a brief one. Nonetheless, when considering the weight of this argument, the following facts should be taken seriously. Why the PP could not be defined more precisely in principle is hard to imagine. Several governmental documents (such as the CEC¹⁹) have been established in order to clarify the principle and its use. In addition, academic efforts have been dedicated to define the principle more precisely (e.g. Ahteensuu, 2007; Sandin, 1999). Lastly, a number of court decisions already exist, and they can be used as precedents in the future. In sum, the PP is currently vague in several senses, but so are various other decision-making principles which we use. In order to demonstrate that the PP should be abandoned on this basis, one would have to show why the case of the PP is different from, and more problematic than other principles with respect to its vagueness, and that this reason is strong enough for the rejection of the principle.

In summation: according to what the detractors have alluded to above regarding the concerns in which the PP is taking, one can thus conclude that the PP is easily interpreted in different ways, and its variability in terms of interpretation makes it look questionable. In other words, though the PP is fairly simple, it is precisely that simplicity that makes it so appealing, and simplicity is the virtue that the PP represents. However, its opponents are digging their heels that the PP lacks clarity, because when it talks about “irreversible harm”, it does not give account of irreversibility, though most environmental changes can be reversed, albeit at an astronomical cost, e.g. acid mine drainage.

To its detractors, the PP leaves too many questions than answers in its quest to be relevant, because it fails to determine how the authors of environmental degradation can, for instance, prevent harm that arrives with benefits – and this is the rule rather than the exception. Comments indicated above seem to suggest that the PP is a robust tool that is used by certain environmentalists to halt technological progress arguing from the irreversibility and complexity of the natural environment and human health. I, however, strongly disagree with the notion as described above. My take is that the PP represents virtue, and my question is thus what is in the definition that will disqualify the concept from being operationalised?

3.2.3 The precautionary principle causes more harm than good

Applying the precautionary principle is often represented as “erring on the side of safety”. Although the Precautionary Principle may appeal to common-sense notions of safety, the argument of detractors go, its application will not produce a safer, cleaner world. Quite the opposite—the

¹⁹ The Commission for European Communities has called for the precautionary principle to be considered when dangerous, irreversible, or catastrophic effects are identified, but scientific evaluation of the potential damage is not sufficiently certain, and actions to prevent these potential adverse effects need to be justified.

precautionary principle diverts the attention of regulators and resources from real issues to speculative concerns (Lewis, 2002; Whelan, 2000).

For example most regulatory decisions in the United States are based on scientific evidence and risk assessment (JoRR, 2001). This system encourages innovation, better products, economic growth and consumer power while minimizing consumer and environmental risks (Apel, 2002; Mitra, 2001; Conko & Miller, 2001). In assessing risks, the U.S. regulatory bodies incorporate conservative assumptions and factors of safety when determining if a product is safe or should be restricted (American Trucking Association Versus EPA, 2002; Sunstein, 2003). In addition, U.S. law provides for private lawsuits and regulatory actions when a product or technology causes harm (US Food and Drug Administration, 2003).

It is also commonly believed that the failure to regulate risky activities could result in severe harm and that "over-regulation" is harmless because it only costs money. According to Cohen (2001) these assumptions are overly simplistic and potentially dangerous. Why? We adopt new technologies because they tend to improve our wellbeing (Conko, 2001). We live in a world full of hazards including diseases, accidents and earthquakes, especially in poor countries. Most of the new technologies that are themselves risky (Gulberg, 2003), such as pesticides, automobile innovations and construction practices, are intended to reduce more problematic dangers. Policy-makers, therefore, must acknowledge that, while many technologies will pose new risks, most make the world safer, new building materials tend to be stronger, new medicines usually are more effective, and new manufacturing facilities generally pollute less than older ones (Conko, 2001). Delaying their introduction solely because they are new can hurt the very people such precautions are intended to protect (Burnett & Wess, 2001).

According to Harris and Woolley (2009), scientific innovations always involve uncertainties and risk. This therefore implies that it is always appropriate to consider potential dangers before a new technology is adopted and to reject those that on balance would do more harm than good. Conko (2001) appears to be in concert with the view that precautionary principle does not do that. The Precautionary Principle delays, discourages, and may prohibit the new technologies that can improve human health and the environment (Ruwart, 1979; Conko, 2001). Both Conko and Ruwart argue that the precautionary principle is based on a false premise that assumes no harm can come from delaying the introduction of new products into the market. It considers only the potential drawbacks of a new product and never its benefits. Dr Mary Ruwart further posits in support of the above that Aspirin deforms the unborn young of almost every animal species but humans. The most critical question

implied in this argument is why, then, should we adopt a policy on health and on environmental risk that intentionally fails to consider both sides of the risk equation?

The opponents of the precautionary principle further suggest that policy-makers appear to face little public scrutiny when they ban good innovations because the innovations' benefits are often uncertain until they reach the market (Holm & Harris, 1999). Thus, governments have powerful incentives to sit on their hands until a product is proven "safe". But science can never prove the absence of a risk, as it is impossible to prove a negative (Holm & Harris, 1999). Certainly there will be times when a product or service would be stopped. A case in point was the recall of the "ThinZ" tablet in South Africa which was considered unsafe to use as a slimming mixture. Condoms and foreign cigarettes were also recalled as a precautionary measure based on the risk they posed to users (Rigillo, 2009).

As I have already indicated above, risk can never be disproved, no matter how carefully it is scrutinized. Critics always can demand more testing and assurances. Conko (2001) argues that, the best we can expect of policy-makers is that they try to choose in a way that is most likely to make our lives and communities safer. Herein lies the problem. The precautionary principle does not provide regulators with guidance on how to proceed when the safety benefits of a product appear to outweigh its risks (Gardiner, 2006). In real life, many decisions fall into this grey area, which the precautionary principle advocates pretend does not exist. A precaution-based policy, therefore, would give near total discretion to politicians and politically appointed regulators, leaving consumers at the whim of political deal-making.

It is my contention that indeed there is no perfect system for evaluating risks, but, on the other hand, that a system that presupposes danger only lies in progress and never in stagnation is worrisome. When it comes to innovation and risk, an overly conservative society is a dangerous society (Tjeltveit & Gottlieb, 2010). Life involves confronting risks and measuring potential consequences before making decisions, not just hoping that those choices never have to be made (Tjeltveit & Gottlieb, 2010). From the preceding discussion, the detractors of the PP strongly believe that the PP does not protect, but it easily can harm by keeping beneficial products from the market; delaying or prohibiting products that are beneficial to humans and the environment; adding cost to a product through additional regulatory burdens; hurting the economy by creating an undesirable market place; and finally clogging or draining the regulatory and research resources to investigate negligible risks (Conko & Miller, 2001; Conko & Miller, 2001, 2003; Conko, 2002; Ruwart, 1979; Jordan & O'Riordan, 1998; Conko and Miller, 2003).

The precautionary principle when taken to its logical end in the public policy realm can, according to its detractors, be more harmful than many of the worst technological threats. As a regulatory guideline, it may pose a threat to the vitality and progress of human and environmental health (Conko, 2001).

Finally, according to Doering (2009), beyond its lack of practical utility; the concept of the PP seems to create its own danger: it could for example, undermine innovation as pointed out that all of the great scientific advances of the past 200 years or more have come from a process of “learning as we went along”. Thus it is assumed that if the PP had not been a guiding maxim our society would have been denied, for example, lifesaving technologies such as x-rays, and to a large extent, chlorine to purify our water. In the end, reckless application can easily lead to more harm than initially anticipated, so the argument goes. On the contrary, I strongly contend that the PP, given its simplicity, will also lessen or ameliorate hazards once it is thoroughly examined in terms of its "content" and application.

3.2.4 The precautionary principle clashes with other important values

Another strong claim against adopting the PP is that it conflicts with other important values that good law and policy would surely respect, and fails to provide clear instructions for resolving these conflicts (Lofstedt, Fischhof & Fischhof, 2002). Again, what reasonably can be expected of a principle? A principle captures a serious moral intuition, but enunciating a principle neither claims nor establishes its lexical priority over other principles. In complicated exercises in law and policy, important principles will come into conflict and resolution requires a weighing of the principles involved, the values at stake, and the facts of the case. Sandin *et al.* (2002) and Peterson (2007) claim that the PP is devoid of normative content and shares a common misconception. For instance Sandin and his colleagues posit that the PP cannot be taken seriously in that it clashes with world views on risk. Firstly, the ongoing discourse regarding PP is perceived as being distant to contemporary world policy and management in so far as how to deal and handle issues related to scientific uncertainties. Sandin *et al.* (2002) seem to suggest that policies, rules and practices that inform reasonable and fair decision-making are not taken seriously by the PP. These controversies appear to owe their origins to the different conceptions of the PP.

This claim is fuelled by the argument mentioned above that the PP causes more harm than good. In this vein, detractors of the PP argue that the PP is contradicting the rational assumptions and utilitarian decision rules of society which calls for risk averse behaviour, i.e. the need to avoid catastrophe and solutions that in fact cut corners. Because of reasons like this, critics of the PP see it

as being incomplete, inconsistent with other important moral principles and values, and not being a good stand-alone decision rule. In my view, however, this is simply to misunderstand the nature and role of principles in moral and legal discourse.

3.2.5 The precautionary principle is unrealistic

In *Laws of Fear*, Sunstein (2005) defines the extreme version of the precautionary principle as “*avoid all risk*”, because more moderate and circumscribed versions are uninteresting. It is true that the injunction to avoid all risk is self-defeating, because there is risk in every conceivable course of action, including the no-action alternative. So, to avoid all risk would mean that no action whatever is possible. Nonetheless, Sunstein’s critique is like playing tennis with the net down: his critique is actually nonsensical, because it is levelled at an absurd, and actually a very weak version of the precautionary principle, while there are numerous versions of the precautionary principle that are much stronger and can be taken seriously. Serious formulations of the PP (e.g. UNESCO, 2005) are focused on risks that are in some sense of the word real, and are moderated by various provisions addressed at the domain of application, for example the protection of vulnerable groups from undue burden, or in relevant contexts, cost-effectiveness. The Sunstein critique mentioned above is at best interpreted as an injunction to take risk-risk trade-offs seriously, and to specify the precautionary principle carefully so as to direct it towards risks that are in some sense unusually serious. It is important to note, however, that the PP need not always be directed at extreme cases. It would be unrealistic to do so, because risks also exist in ordinary forms, and are therefore not less of risks to also consider in decision-making.

Today the precautionary principle has assumed the role of “a central plank” of European Community policy (CECC, 2000). However, its opponents in the US still perceive the PP as controversial. Opponents argue that the precautionary principle is unscientific; can be triggered by irrational concerns; and that it aims at an unrealistic goal of zero risk and consequently it may result in the banning of useful chemicals and preventing technological innovation (Berder, 2006). In actual fact, as this thesis will show, detractors of the PP blame the PP for taking other factors into account besides peer-reviewed science. In other words, the PP is accused of representing empty rhetoric in that it exaggerates harm where there is none. As it stands, the PP is further accused of being too “serious” and rigid (Ibid) and failing to take risk, for the greatest risk is not taking one. For example in 2013 when I visited the US for my daughter’s graduation, I was confronted by a huge billboard that reads: “The United States is a nation built by immigrants”. Recently, an advertisement appeared in the New York Times, August 2013 with a headline that proclaimed: “Sometimes, the greatest risk is NOT taking one!” The reader’s attention is drawn to a very large photograph featuring an immigrant family standing at the rail of a

ship in New York Harbor while passing the Statue of Liberty. The photo was interesting because it looked as if someone had erased large portions of the four people in it. It forces the reader to pause and contemplate what kind of a nation we would be today if our ancestors decided against taking the risk of coming here simply because they did not have a 100% guarantee that everything would turn out just fine.

Strictly speaking, the opponents of the PP perceive it as extremely radical in that it demands the impossible, zero risk which is not possible in our contemporary society. Hence, the detractors of the PP contend that the PP as a philosophy represents a veiled form of “Environmental McCarthyism”.²⁰ They caution that the PP in its current form is unduly alarmist, aimed at bypassing rigorous scientific activities while imposing personal agendas. Thus zero risk is not something that can be achieved, and in fact zero risk perpetuates new risks in that it forces more regulation, which perpetuates more complex problems. Simply put, the PP is seen as being paranoid to technology which inhibits progress and innovation as it hides behind the veil of “McCarthyism” (Harker & McConkey, 2001). Put differently, the PP leads to the imposition of new risk since cautiousness in one respect often leads to unintended risk in another. For example, use of DDT in a developing nation like South Africa may be forbidden due to perceived health risks, but then South Africans can easily fall prey to a malaria risk. Accordingly we are both victims of progress and risk, for if we don't take risk by using DDT we may perpetuate suffering.

According to what has been articulated above by different scholars opposed to the PP, adoption of the PP implies that pesticides, cell phones, genetically modified crops, plastic food containers, medical devices, and pharmaceuticals must all be done away with since they can be challenged in the name of the precautionary principle (on the basis of invoking the precautionary principle as meaning to say that the absence of evidence of no harm does not mean that something is not potentially harmful). They often ridicule the PP by claiming that the PP actually requires that someone should have to prove that new products or technologies are not harmful before they are allowed to see the light of day. To strengthen this ridicule, they "demonstrate" that the application of the PP would, if applied retroactively to existing products — those that have already demonstrated their value in the marketplace - require that such products should be removed if it cannot be demonstrated that they are 100 % risk-free. This would clearly apply to any household utensil, a motor car, a road, a bridge, etc. Such line of argumentation, however, is clearly ridiculous, and in fact is not reducing the PP to

²⁰ McCarthyism means the practice of making unfair allegations or using unfair investigative techniques, especially in order to restrict dissent or political criticism. This refers to McCarthy's crusade in the 19th Century to eradicate Communism from the USA, which led to numerous cases of false accusations against people.

absurdity; it rather displays what happens to an argument if it is based on the formal logical flaw that a negative cannot be proven.

The bottom line of this critique is the assumption that if every possible ramification of a decision is not fully understood, or if every potential risk is not known, the precautionary principle says we should apply the brakes. As such, it is claimed that the default position required by the PP is to stand pat, that the status quo should be accepted and that nothing risky or uncertain should ever be undertaken. But doing so clearly sacrifices the potential benefits of discovery and innovation. The mantra has become: When in doubt, stop. Stop the human inclination towards exploration and innovation. Stop pushing the edges of the envelope of scientific knowledge and human accomplishment. As Samuel Johnson is quoted as saying: *"Nothing will ever be attempted, if all possible objections must first be overcome."*

This, however, is not how I see the PP and how its content should be interpreted. As I will show in my analysis further on, the precautionary principle claims exactly the opposite: it makes it possible for us to actually act and move forward under conditions of uncertainty. It shows us how to make decisions precisely when we are uncertain about what we know and what we do not know.

3.2.6 The precautionary principle is fundamentally a threat to scientific advancement

Harris and Holm (2002: 356) criticise the precautionary principle on a number of grounds. The core of their critique, however, is what they call the "paradox of precaution". The alleged paradox is that, while the precautionary principle instructs *Homo sapiens* to forego or delay the introduction of potentially risky new practices in order to prevent harm, that delay will itself cause harm in the form, for example, of lost opportunities to prevent disease and death. Thus, in order to prevent this harm, the precautionary principle would instruct us to refrain from implementing itself. Whether this is an accurate description depends on how the precautionary principle is interpreted, but even versions of the principle that are not strictly paradoxical may be vulnerable to the related, but more general, charge of excessive conservatism, leading potentially to an increase rather than reduction in harm (Harris & Holm, 2002: 357). On a more sour note, Harris and Holm (2002: 357) give an even more pessimistic view of the PP, claiming that it poses *"a fundamental threat" "for scientific advance and technological progress"*, and therefore they argue that the precautionary principle should be rejected in bioethics. Thus, according to its critics, adopting the precautionary principle can increase risk to human health and environmental protection by focusing on the risks posed by the introduction of new technologies while ignoring the risks that new technologies can alleviate or prevent.

Tuck (2003) and Sunstein (2003) further posit that the PP in its application undermines the very basis of science, in that it lowers either evidentiary standards or procedural criteria to determine what

constitutes a “threat of harm”. It also does not clearly specify for instance what quantity or quality of evidence or information is required to “raise a threat of harm”.

However, as I will show in my discussion below, these arguments represent a short-sighted view that does not take into account the manner in which science, scientific evidence, scientific progress, and the PP can in fact be related to one another in numerous ways.

3.2.7 The precautionary principle is anti-business

The precautionary principle has been used widely in the past to conveniently support trade protectionism: the European Union continues to use it to prevent the incorporation of Canadian and American beef and genetically modified corn into their markets (Doering, 2009). The US also uses it to prevent the importation of live cattle from Canada and elsewhere after discovering mad cow disease (Bovine Spongiform Encephalopathy (BSE)), while Japan retaliated by imposing the same conditions on American imports.

The precautionary principle therefore is abused for settling old political and economic scores rather than using science and reason for that. Detractors of PP like Klinke & Renn, (2002) and Randall, (2009) have argued in the past that we already have tools to manage new risks, often called “*science-based risk assessment*” or “*risk-informed decision-making*”, so what is the need for an alternative decision-making rule?

In the context of business, for instance, the argument goes in this context, scientific risk assessment gives business an opportunity to review the law and the rules and regulations applicable to them, with a view to determine what is required to comply. If a business is contemplated, or if an old business intends to expand, business can always find out what the requirements are they have to meet to obtain a licence or permit to trade, and if they meet those requirements, they can obtain a permit or licence. For example Tuck (2003) in defence of the scientific-based risk assessment, argued that if a business knows upfront what the rules are, it can generally determine how much it is going to cost to obtain the permit, to buy and install the best available technology, etc. Though it is difficult to comply, nonetheless the business knows what they are.

According to Tuck (2003), however, the PP is not workable and thus cannot be trusted in that it prohibits or limits an activity based on allegations or assumptions. For example, a strong version of PP may call for banning and extra regulation of a product to keep business away from using it based on untested allegations. As such, the argument goes, the PP actually undermines business and entrepreneurship, making it impossible to risk ventures that, in a business sense, could either succeed

or fails. And as such, it is argued, adopting the PP undermines job creation and sustaining the economy. Accordingly, Max More (2008) argues that business confidence can be restored if people dissociate themselves from the aggressive, ignorant tool like the PP in that it for one reason or the other calls for caution without knowledge and aggravates fear without objectivity, to drive people's thinking and decision-making astray. What More (2008) insinuates is that when we overly focus on avoiding new products in the market without proof of harm, or what we perceive as a threat, we thus narrow our awareness, and constrain our thinking, and so distort our decisions.

Against this background, my view is that the PP must be realistic and not divorce itself from the realities on the ground. It needs to recognise the benefits that go with dangers/risk. In any case, there appear to be a consensus that we are living in a risky society. From the foregoing it is also clear and a mantra that the PP must be modernised so that it can also align itself and move in tandem with the developmental needs of the country or the world. Though today's hazards owe their origins to modernity, according to Beck (1992: 21) the PP can be used as a *"systematic way of dealing with hazards and insecurities induced by modernisation itself"*.

While Americans have been a driving force in punching holes into the PP to discredit it as being a tool that wants to reverse the achievements of science and thus is an unworkable decision-making tool (see the Wall Street Journal, 2010 & Bocking, 2004 for further readings), the criticisms discussed under this heading reveals that a glaring weakness of the PP is that it does not pay adequate attention to the benefits that goes with risk. For example the PP does not provide mechanisms for taking into account the benefits of a proposed activity. Detractors of the PP are thus right when they argue that if the administration of vaccines had not been allowed because of risks, or the construction of an aeroplane stopped or not allowed because of risks, humankind would not have been where it is today. It is thus clear that a formulation and an interpretation of the PP should be found that do not expose themselves to this kind of critique.

3.2.8 The precautionary principle interferes with political decisions

As a tool that has been widely supported and endorsed by governments, non-governmental organisations, non-scientific communities, etc., the PP nonetheless remain contentious in the management of risk. The degree in which it is contested became evident during the 2001 Stockholm Convention on Persistent Organic Pollutants, which provides an excellent opportunity to examine the principle and its implications for global chemical risk management. In this context it became evident how the PP, under certain conditions, generates more risk management work for regulators (Maguire & Ellis, 2003). When that happens, the PP is inadvertently translating some forms of scientific

uncertainty into policy uncertainty. This essentially means that policy-makers will be left in a state of more indecision in that these indecisions will culminate; or rather trigger more policy deliberations about how the politicians need to act when confronted by potential risks.

It is my view in this regard, however, that the PP in this instance is falsely accused of politicizing decision-making. Or to put it differently: I acknowledge that the PP introduces a political dimension in decision-making, but it is a politics that benefits the weak and the marginalized by putting serious question marks behind the mechanisms by which powerful elites with unfair advantages are created and kept intact. As I will show in more detail further in my thesis, I am of the following opinion: Firstly, I argue that the PP indeed represents a loss of “non-decision-making power” – for the erstwhile beneficiaries of bad decision-making owing to scientific uncertainty. Secondly, it is my view that the “greatest mistake” ever committed by the PP was to demand greater commitment on the part of risk management to play its scientific role of ameliorating risk rather than permitting an escalation of degradation. Thirdly, I claim that the objective of the PP is solely that of rendering the political nature of risk simpler and more explicit.

Finally, it is my contention that rather than falsely accusing the PP of meddling in politics, it is important that we move away from the game of blaming and rather seek common grounds by bringing the two concepts of risk management and that of the PP closer together so as to play a mediating role. On the one hand, we cannot play a political game with the lives of people and the stability of our ecosystem by appealing to politics. In order to be able to find middle ground between humanism, safety, environmentalism and capitalism, we need to embrace holism which Lee (1993) argues as being the solution towards addressing societal and environmental health. Kai Lee introduced the notion of what he calls “*civic science*”²¹ which I believe will help narrow the tension amongst those who are capitalists, humanists, environmentalists, etc. The discourse initiated by Albert Weale (1992, 1993) on “*ecological modernisation*” also calls for a more meditative science policy relationship, the nurturing of communicative and arbitral mechanisms at early stages in dispute resolution, and the preparedness to give both the Earth and the marginalised groups in society space to breathe in the application of environmental policies. Finally, it is my view that the PP is not only political, but also moral in that it also confines itself to exposures and impacts related to risk, and maybe it is good that it is there to serve as an environmental “watch dog”.

²¹ Citizen science is sometimes called “public participation in scientific research”.

In this section I have attempted to point out the gaps that exist in the PP argued by different scholars and critics, and out of the whole argument in opposition to the PP it is clear that the precautionary principle is construed to be travelling in the opposite direction of development, and that if it is taken for all that it is worth, it leads in no direction at all. The reason is that risks of one kind or another are on all sides of regulatory choices, and it is therefore impossible, in most real-world cases, to avoid running afoul of the principle. So, the Precautionary Principle, according to its detractors, seems to offer guidance only because people have blinded themselves to certain aspects of the risk situation, focusing on a mere subset of the hazards that are at stake instead of looking at the bigger picture of risk. It is possible, however, to paint a different picture of the PP, to which I will now turn in the last part of this chapter, as well as in Chapter 4.

3.3 Strong claims for the adoption of the precautionary principle

Prior to the emergence and ascension of the PP, the prevailing assumption guiding policy-making was that the environment was capable of absorbing pollutants, the exploitation of resources and other forms of interference up to some knowable capacity (Hey, 1992: 303). Take, for instance, chemical policy, where historically *“it was thought that a mere decrease of concentration of a substance in a particular concentration is sufficient to mitigate its ultimate impact”*. This practice, and the underlying thinking, were sometimes summarised as *“dilution is the solution to pollution”* (Anastas & Warner, 2000: 6). The public’s historical experience of scientific fallibility in numerous issues, from fisheries management to the regulation of toxic substances, has meant that these assumptions have been shaken. It has become even more apparent to policy-makers and citizens alike that scientists may not be capable of identifying safe levels of resource exploitation or pollution. In that vein, its supporters argue that the degradation playing itself out in the environment can be brought to a halt by the PP which is an uncompromising tool when it comes to environmental protection. It is important, however, to emphasise that, although this principle operates in the context of scientific uncertainty, it is considered by its proponents to be applicable only when, on the basis of the best scientific advice available, there is good reason to believe that harmful effects might occur.

The precautionary is informed by the following assumptions:

- The notion of seeking alternatives to harmful technologies;
- The idea of shifting to proponents of a technology the responsibility for its safety; and
- The goal of transparency and democracy in making decisions about technologies.

Therefore, the following section will be dedicated to eschewing the assumptions regarding the reliability and applicability of the PP in the context of environmental decision-making in the context of scientific uncertainty and risk.

3.3.1 The precautionary principle addresses scientific uncertainty

The Rio Declaration states that, in the qualifying circumstances, lack of scientific uncertainty “*shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*” (Rio Declaration on Environment and Development, 1992). This does not imply that preventive action must be taken on suspicion of risk, but merely rules out one particular ground for not taking such action, namely that the existence of the threat has not been demonstrated with the very high standard of evidence necessary for its acceptance as scientifically established fact. Construed in this way, the PP is a response to those (commercial interests, for example) who would use lack of scientific uncertainty as grounds for arguing against regulatory interference. This does not exclude there being other reasons to refrain from preventive action, and indeed one such reason – lack of cost-effectiveness – is specifically referred to in the Declaration. This statement of the PP is perhaps best viewed as establishing not an obligation, but permission, to take action to counter risks in the absence of scientific certainty, so that uncertainty about the threat will not constitute a decisive objection to such actions. In this dissertation I am not advancing the PP as the *prima donna* of environmental protection, the know-all tool of environmental policy and decision-making, but rather as an alternative tool to assist scientists when there is no shortcut to determining scientific uncertainty, which has been identified as the Achilles heel of risk-informed decision-making.

3.3.2 The precautionary principle is coherent

The objection to the PP because of its poor formulation, as discussed earlier, certainly poses a huge problem for the proponents of this ideal. However, the proponents’ response to this criticism is that, despite the lack of specificity of the PP, it is not something extraordinary, as other decision-making rules also possess this ambiguity and the same objections could equally be raised against them. An example is a rule such as ‘only perform those risk reductions that are essentially justified’, which seems no less in need of specification than the precautionary principle (Cameron & Abouchar, 1991: 23). Though the defence that the PP is not the only ill-defined rule may be true, it nevertheless does not offer a good defence of the PP, as it is a self-serving and desperate attempt to absolve itself from further criticism. Secondly, the ill-definition may be as a result of over-interpretations of other decision rules, although one can always appeal to the courts in the eventuality that the concept becomes a problem. We should not defend a position for the sake of defending it, but we need to be

honest in handling such a concept, particularly if a universal definition is not available. Thus, proponents of the precautionary principle should acknowledge that the absence of a clear definition is a problem, although it can be managed or addressed. One way in which it can be addressed is by argumentation, as found in Principle 15 of the Rio Declaration (UNCED, 1993), although the word caution is used instead of the concept, precautionary principle. This version merely requires “*that lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*”.

Morris (2000: 1-21) writes that “*The PP is inherently incoherent*”. The basic logic of incoherence is as follows: an incoherent principle should not be used as a basis for societal risk decision-making; the PP is incoherent, thus it should be abandoned. Gary Comstock (2000: 121), for example, has argued that “*the precautionary principle commits us to each of the following propositions; (1) We must not develop GM crops; (2) We must develop GM crops*”. His main argument is that the PP cannot coherently be employed as a decision rule, an epistemic rule, or a moral principle.

However, if one pauses and takes a closer look at the formulations of the PP, one is intrigued by their coherent, and not contradictory, nature (see the Wingspread Statement, 1998). The PP, as commonly defined, does not simultaneously state that the precautionary measure should be taken and should not be taken; its conceptualisation of risk appears to be ambiguous. Nevertheless, the PP is not incoherent in this sense, and the possible incoherence can be reformulated or revised.

Finally, interpretations of the PP are emerging, albeit it very slowly. For example, the European Commission (EC) communication of 2000 (CEC, 2000: 10) is a case in point. The EC has also expressed its concerns about the lack of precise definition of the PP, which is used as an excuse not to act. The Commission has noted that “*it would be wrong to conclude that the absence of a definition has to lead to legal uncertainty*” (CEC, 2000: 10).

Lastly, I put forward that the PP can be used in argumentation and in actual policy-making even though it is considered to be an approach that is inconsistent by its detractors; nonetheless, it is an approach that can be embraced to mitigate the risk associated with uncertainty inherent in science. Thus, its shortcoming should not be used to provide a sufficient reason to abandon the principle altogether. Not only the PP, but also other decision-making principles, can be employed in inconsistent ways. They should not be used in this way, however, as it will undermine faith in decision-making; rather, the PP should be used consistently with other, similar measures implemented earlier.

Finally, I acknowledge and admit to some extent, that the PP is poorly defined, and that it is even worse off than other competing decision rules. However, it does not mean that the PP should be

dismissed and discarded as insignificant, but it should rather be seen as an opportunity to search for an inclusive and robust definition that is not scared to make other role players complacent. In summation, the arguments put forward by the opponents of the PP are not convincing, as these arguments are derived from imperfect knowledge about nature and its causal relationships and human interactions.

3.3.3 The precautionary principle is a proactive decision-making tool

The notion that the PP is overly rigid and likely to break a culture of innovation and discovery is farfetched and dubious. The argument that the PP is absolute is a misconstruction. The principle only insists that actions should be taken once a lack of full scientific certainty is established after and within the context of scientists doing their work meticulously and properly. According to Nollkaemper (1996: 73), the PP is formulated in absolutist terms, according to which if risk is identified, preventive measures should kick in in order to erase or manage the said risk effectively. This implies that, should risk be identified, it must immediately be quantified and tackled head on, without fear or favour. The opponents of the PP see this as being anti-progress and bordering on denying people an opportunity to make mistakes and learn from them. The oversimplification of the PP encourages critics to become the totemic bad boys of the scientific world.

Contrary to what its distracters are saying, the PP requires that actions be taken in cases where scientific certainty is lacking or absent. This does not mean that we need to appeal to the PP even when there is no evidence, scientific or otherwise, of the presence of a possible harm. In fact, there has been no definite formulation of the PP that supports such an extreme requirement. However, some documents, such as that of the European Council (2000: annexure iii), demand that harm must first be established before it can be quantified. To address the question of how much harm must be quantified; one can safely say that it will depend on the strength of the risk, informed by full scientific proof or by benchmarking the threat. This response is based in the *de minimis* principle, which excludes scenarios with very small probabilities (Fiksel, 1987).

Although some proponents of the PP see it as an alternative to risk-based decisions, I would nevertheless advocate that it be used in conjunction with risk management to reduce the tensions that are inherent in its application as the only tool or alternative to science-based decisions. In conclusion, to obviate the label of the PP being absolutist, I will rather use the absolutist version as a guide for decision-making in that the absolute view is categorical in terms of how risk ought to be handled. For instance the absolutist view argues that once risk of a certain magnitude is identified, preventive measures should kick in immediately without any delay to obviate the ripple effect that

may ensue. In other words, abating or halting risk is mandatory in a strong sense. In a weak formulation, the PP argues that a trade-off between over-regulation (false positive) and under-regulation (false negative) should be sought, reduced and if possible be eliminated through the development of more accurate risk assessment methods and data.

3.3.4 The precautionary principle is scientific

When science does not have an answer to a problem, people who are seen to be pushing for answers are usually ridiculed and branded unscientific and being against progress. It is indeed worrying when one is likened to a maverick when looking for a solution to a problem that is eluding science. The idea that the PP marginalises science will have to be investigated on a case by case basis, and then either defended or abandoned on the basis of the new information. I have already asked above whether it makes sense to abandon ship when water appears to be filling the ship? A *real* captain will try to save the situation by trying to plug the hole or scooping out the water.

Adherents of science view the PP as being insensitive to science and failing to acknowledge the gains made by science, as it requires that precautionary measures also should be taken against the threats for which full scientific evidence has not been established. The question, however, is what is wrong about taking evasive measures when a threat is perceived? We wear seatbelts even when the threat of risk associated with driving without a seatbelt has not yet been established. There is a notion that decisions taken in the absence of science will be of lower quality, yet not all environmental problems are scientific in origin; some may be moral or social, and this is where the PP comes in handy. Outcomes-based decisions will not always result in worse outcomes if science is made big brother. Science could not stop the carnage caused by the nuclear disaster at the Chernobyl plant, which resulted in catastrophic outcomes for the environment and human health. To return to the point of unscientific arguments, something is unscientific if it is not based on science – this is the weak sense, and it becomes unscientific if it contradicts science (strong sense). One can thus argue that creationism is unscientific in the strong sense, but aesthetic judgements are unscientific in the weak sense.

From the above, one can deduce that the precautionary principle is unscientific in the weak sense, but this also applies to other decision rules, including the rule that equates the evidence required for practical measures against a possible hazard with evidence required for scientific proof that the hazard exists. The PP is not unscientific in the strong sense. When, for instance, a role player makes decisions, such decisions are mostly informed by scientific evidence that is used to arrive at rational decisions. This, very importantly, will mean that the decision maker shall afford the same weight to different kinds of evidence before a decision is eventually taken. However, the difference between science and

the PP lies in the amount of such evidence that each requires for a decision to act against a possible hazard. The scientific part of the process, i.e. the production and interpretation of scientific evidence, does not differ between the two decision-makers. This proves, in essence, that the PP does not even momentarily contradict science, but instead supports science (Hansson, 1999; Santillo & Johnston, 1999). We must also note that some, if not most, of the proponents of the PP are also scientists, which means that they are unlikely to shoot themselves in the foot. Therefore, the PP will not serve a just purpose if it is seen to be prejudicial and malicious to science by marginalising it. In the same breath, there will be no PP principle without science.

The PP therefore highlights the limits and shortcomings of science; it fills the vacuum created by a science that continually searches for certainty, but which fails to deliver (Adams, 2002: 311). The proponents of the PP believe that the PP merely entails an appeal to fellow humans to care for our planet and its future to ensure human and environmental survival.

3.4 Weighing the controversy – finding a third way?

The rationale for the adoption and application of the PP is that it is a tool that guides public policies in areas where there may be extraordinary risk, uncertainty, and gross ignorance about future consequences. The PP further alludes that we have theory and methods for risk assessment and risk management – but the PP is founded on the claim that something more robust, much stronger, more uncompromising than risk assessment and risk management is needed. The claim that it makes is when making public decisions: act in such way as to avoid or mitigate potential harmful consequences, and such risk must be accorded the highest priority.

The PP further argues that uncertainty about harmful consequences does not justify failure to take precautionary action (United Nations, 1990). The PP further asserts that in an event of a plausible or probable risk or hazard, uncertainty justifies precautionary intervention (UNESCO, 2005). Given its uncompromising stance on human and environmental protection, the PP is categorical in terms of burden of proof. It argues that the proponent and not the victim should demonstrate that a technology or activity will not cause harm (Wingspread Statement).

Despite the promise of the precautionary principle, it remains one of the most contested strategies and decision theories in both risk assessment and risk management. Despite its growing popularity as seen in a number of national jurisdictions, economic sectors and environmental areas (EU; De Sadeleer, 2002), the controversy about its adoption and application remain vociferous among its opponents who see the PP as unworkable and overly pessimistic. The strong opposition of the precautionary principle and its intellectual home for its rebuttal has its roots in the USA, and according

to Wiener and Rogers (2002) the US has become circumspect about PP to a point of totally rejecting it as a danger to prosperity and innovation.

Inherent in the precautionary principle is a requirement that says all hazards should be meaningfully addressed (Tickner & Geiser, 2004). While most accept the obligation to examine all reasonably foreseeable hazards of a proposed activity, the precautionary principle imposes an open-ended requirement to evaluate scenarios that lack even the slightest causation for any proposed adverse effect or hazard. It is doubtful any innovation can fulfil such a requirement. Anyone can come up with a random adverse effect not included in the original analysis – without any hypothetical connection to the activity – and then assert that the analysis was incomplete and therefore failed to meet precautionary standards.

The precautionary principle apparently requires innovators to address an endless list of hypotheticals that have no basis in science (Kaizer *et al.*, 2010: 1-14). Even if resources are available for this analysis, it is a question of a classic “Catch-22” to address issues that have no scientific bearing with any scientific substance. Innovators of technology or products do have a marked and meaningful obligation to understand the impact of the proposed action. Other parties, including policy-makers and the non-scientific community, should in essence be able to question the completeness of any analysis. However, these inquiries must have some logical basis. If the developer has to answer every unbounded and hypothetical question, then development will be held captive by individuals and groups engrossed in the endless chasing of “*perfect*” analysis (Kaizer *et al.*, 2010: 1-14).

There have been lots of uncertainties regarding the relevance of PP in risk assessment and risk management and whether it can be trusted as a rational decision-making tool given its ambiguities and queries regarding its nature and appropriate role in governance (Cross, 1996; Morris, 2000; Majone, 2002; Löfstedt, 2004). For example, within the frame of risk analysis, risk management hinges on the best scientific estimates of probabilities and potential damages in order to adjudge or adjudicate the ability to tolerate the risk and design protective measures that are cost-effective in relation to the magnitude of the threat, and at the same time is just and equitable to the affected population or communities. In these instances, the PP may be assumed to be conservative when making judgements and erring on the side of caution when calculating exposure or determining safety factors. In addition, as Martin Peterson (2006: 305) posits: “*The precautionary principle can be interpreted as an analogous epistemic principle that prescribes that it is always more desirable to avoid false negatives than false positives when it comes to assessing risks.*”

3.5 Conclusion

What is very clear and unambiguous, is that the critique of the PP discussed above brought its strengths into better relief. The argument that the PP is worded differently each time it is articulated, is not uncommon in international law, although some statements of the principle are more detailed than others, there are no major conflicts among them. At the core of each statement is the idea that action should be taken to prevent harm to the environment and human health, even if scientific evidence is inconclusive.

Put simply, the PP implies: What now beyond “harm” and “scientific uncertainty”? And this is addressed by seeking alternatives to harmful technologies; shifting to proponents of a technology or project the responsibility for demonstrating its safety; and the goal of transparency and democracy in making decisions about technologies.

Despite the opposition to the applicability of the PP as a decision rule, it is clear from the arguments advanced so far that the PP has a future in decision-making, particularly in complex environmental decision-making. The PP is not trying to replace science-based decisions, but rather is trying to highlight gaps that are inherent in science to try to find common ground between science, the PP and other decision-making tools. If the PP is applied without prejudice, it can help science to be science as we came to know about its successes in nature, particularly in technology related advances. Since science also acknowledges its limitations embedded in uncertainty, the PP can step in and resolve challenges in scientific and technological uncertainty.

However, the strength of the PP lies in its ability to democratise decision-making by involving the public to determine and draw up the environmental agenda by applying the democratic principle. The contribution of science cannot be undermined and underestimated, however the proponents of the PP see it as monocratic, non-transparent and pro-business at the expense of the environment.

It is therefore my contention that despite the precautionary principle’s apparent weaknesses expressed by its detractors, it remains the most potent tool to assist science in being more scientific, hence the need to apply it in concert with other decision-making tools to ameliorate environmental and human crises orchestrated by techno-science. The bottom line here is that the precautionary principle is intended as a mechanism that will ameliorate polarisation that plays itself amongst the most important decision-making theories when formulating environmental policies.

Therefore, In Chapter 4, I will attempt to demonstrate the imperatives of the precautionary principle and the extent in which it can influence environmental policies by serving as a cushion against the

environmental onslaught perpetrated by science and technology. The strength of this approach as a moral and political tool will be tested in a case study in Chapters 6 and 7 as an honest tool that seeks to protect the environment and foster participation by all those who are affected by the mining project. An effort will be made to convince the detractors of the PP of its moral imperatives and how we can appeal to the PP as an alternative decision-making tool to science-based decisions, or as a partner to influence environmental policy. Chapter 4 will therefore build on the discussion thus far in rethinking the concept of the precautionary principle. In this chapter the focus will be on an effort to move the concept forward against the background of the insights gained from the discussion thus far. The aim of this will be to find common ground between different and clashing interpretations of the PP that will pave the way for a more workable solution to address the concerns of those who oppose and those who support adoption of the precautionary principle in decision-making.

Chapter 4

Rethinking the precautionary principle in environmental decision-making: moving the concept forward

4.1 Introduction

Risk assessments, by nature, rely on many assumptions — which are frequently unscientific or subjective (Van Leeuwen & Vermeire, 2007). Additionally, risk assessment is based on setting an acceptable level of harm and giving low relevance to the lack of scientific evidence and certainty on which many decisions are based. Risk assessment perpetuates a ‘business as usual’ approach (Delogu, 1998). The precautionary principle calls for dynamic change towards sustainability which takes into consideration the concerns of the present and future persons (Kibert *et al.*, 2011). An underlying theme of the principle is that decision-making in the face of extreme uncertainty and ignorance is a matter of policy and political considerations. Science can inform the decision, but it is foolish to think that independent or ‘sound’ science can resolve difficult issues over cause and effect. In the end, the decision to do nothing, to carry on as before, or to change course and take preventive action is a policy decision, not a scientific one. Additionally, the precautionary principle encourages planning based on well-defined goals, rather than on future scenarios and risk calculations that may be plagued by error and bias. Finally, the PP is buoyed by the democratic principle that seeks to involve communities and those affected by an activity to be part of the decision-making team that give insight into prioritising activities such as hazardous waste, site clean-ups and hazardous activities such as mining (www.cleanproduction.org).

The detailed theoretical difference between these two concepts has been explained in the previous chapters, notably Chapter 2 and 3. Nevertheless, to test the policy implication of these decision rules, I will attempt to reconceptualise the two values, namely risk assessment and the precautionary principle, and on that basis try and make sense of the PP in policy making and implementation thereof. Having highlighted the gaps that exist between these two decision-making tools as argued by the pro and contra scholars of PP in the Chapter 3, my endeavour thus is that of looking for a mediating solution by bringing risk based decision-making and precautionary based decision-making together in order to reduce the tensions inherent in both tools.

4.2 The conceptualisation of science-based risk assessment and the precautionary principle in policy formulation

The discourse of risk has increasingly come to dominate decision-making processes and has been particularly prominent in public policy deliberations relating to the environmental impact of new technological developments (Jasanoff, 1999). There is however an emerging shift in the intellectual climate and literature on environmental decision-making away from a focus on quantifying the environmental risk of new technologies to an increasing concern with how scientific uncertainties are to be managed and negotiated. While risk and uncertainty are inherently related concepts, in the past, the primary focus of environmental decision-making theory has by far and large arguably been on how to quantify the environmental risks associated with an activity or technology, whereas now, there is increasing attention being paid to how the inherent uncertainties can be most appropriately handled (Palmer & Hardaker, 2011). Johnson *et al.* (2012) posit in their argument that scientific risk assessment and management approaches to environmental decision-making have generally employed a realist concept of risk. This concept suggests that risks exist out there in the real world and can be objectively quantified by teams of scientific experts. Governments employing this concept of risk therefore tend to adopt an approach to decision-making that privileges scientific knowledge and the advice of scientific experts which excludes lay 'experts' in risk based environmental decision-making. In this sense, it is clear that the approaches to environmental decision-making that are now emerging in the theoretical literature could be contrastingly described as precautionary and uncertainty-based (Wickson, 2005).

Applying the precautionary principle to environmental decision-making on the other hand tends to adopt a constructivist rather than a realist stance towards scientific knowledge and the notion of risk (Klinke & Renn, 2002; Wickson, 2005). Glanz *et al.*'s (2008) conception of a constructivist's view is that while risks may indeed be real, social values and cultural beliefs are grounded in what will ultimately influence our wherewithal to know, comprehend and determine the risk pertaining to any activity or technology. In assuming this position, therefore, the emerging approaches to decision-making described in this thesis as the precautionary principle, tend to reduce the monastic authority of scientific knowledge and create a space or environment to understand the environmental impact of new technologies better in so far as to how they can be ameliorated.

The most difficult conundrum that has emerged and impacted risk based decision-making negatively in our contemporary discourse is the question of uncertainty, which Wyanne (1992: 127) describe as a situation where important system parameters are known but the probability distributions are not – i.e. uncertainty occurs when we don't know the odds involved. Uncertainty thus appears to represent

lack of knowledge, and is therefore something that can conceptually be reduced through further research (Wyanne, 1992) and this is precisely what the precautionary principle is pushing for. According to both Harding and Wayne, science will never be complete as long as the gaps that are inherent in its application remain glaringly apparent. This, therefore, implies that science based risk assessment cannot be trusted to make complete, logical decisions on its own, and therefore it may need a partner to achieve its objectives that are unbiased. Pursuant to that, uncertainty, which may be both scientifically and socially based, is an inherent feature of environmental management and arises at many points through the environmental decision-making process (Harding, 1998). Many examples are evident in the previous chapters. It is apparent that failure to address the uncertainty as a limitation to environmental decision-making will derail attempts finding lasting environmental solutions. Uncertainty raises doubts and those who have been charged with the task of designing environmental policies will without doubt lose credibility, particularly when public confidence is at its lowest ebb against science. Therefore, uncertainty in this context will ignite suspicion and when there are suspicions by those who are supposed to comply, they may not necessarily do so.

Ignorance is one other typology of uncertainty which Wyanne perceives as undermining rational decision-making and has seemingly found a home in science based risk assessment (Stirling, 2007). Wyanne (1992: 111-127) describes ignorance as situations where *"we don't know what we don't know"*. Ignorance in this sense refers more to ignorance in relation to the relevant questions rather than ignorance about answers. For example, in testing the environmental impact of chemicals many years ago, governments and scientists were "ignorant" about the potential risks of endocrine disruption. It was not a question of lack of enough information to make a judgement and being uncertain, but it was a question of ignorance that people can be exposed to such high levels of risk, and obviously at the time, no one knew that scientists and governments did not know about it. Hence, Wyanne strongly posits that ignorance is endemic to scientific knowledge because science has the tendency of reducing complex systems and reducing a plethora of potential hazards formulations to only a few which are applicable to particular disciplinary models and methods. Value judgements in terms of the relevant endpoints and pragmatic considerations in view of what is possible within a particular paradigm of thought, timeframe or financial position all structure what develops as scientific knowledge and this excludes other potential ways of framing a problem or research approach. Therefore, the inherent weakness of science is ignorance in the way scientific knowledge develops (Stirling, 2007; Wyanne, 1992). The challenge of ignorance therefore as engrained in science based risk assessment and management possess a danger that might be applied to policy making without clear recognition of the limitations of that knowledge.

Surely, there is clearly a proper role for risk assessment in increasing our understanding of our environment, but, as traditionally practiced, science based risk assessment and management have often stood in the way of protecting human health and the environment. The underlying basis of policy-making and decision-making must be precaution and prevention, rather than risk. Therefore, to limit or completely remove ignorance Ravetz (1987) suggests that we need to embrace the issues of uncertainty and ignorance through a broader social debate that talks about a commitment toward technological trajectories. In other words, we need to look ahead in terms of what works well and recognise that uncertainty and ignorance are part of our lives and we cannot thus ignore them. We know that drunk-driving is an offense and that is why in most cases rational people will ensure that they are not caught on the wrong side of the law. Thus uncertainty and ignorance can be avoided by thorough thought analysis involving more research made possible by the precautionary principle.

Similarly, science can seek public endorsement of a policy by actively engaging in debate with those who are victims of an environment onslaught and not only on the cost and benefits involved with particular technological developments, but also on the uncertainties involved in the project. This means that there must be more rigorous scientific research before a policy is implemented, i.e. the policy must be subjected to debate and deconstructed where a need to do that arise and similarly renegotiated through engagements with various stakeholders and respect of values and epistemological commitments each side bring to the table (Ravetz, 1987).

All those concerns listed above can ethically and morally be addressed by the precautionary principle as it possesses all those traits of transparency, democracy, responsibility and research.

4.3 The Precautionary Principle and Environmental decision-making

Based on an explicit recognition of the importance of scientific uncertainty for environmental decision-making, the precautionary principle has been influential in enabling an acknowledgement of the limitations of scientific knowledge for assessing the future environmental impacts of certain activities or technologies (Kribel *et al.*, 2001). In a precautionary approach to environmental decision-making this translates into the requirement for a greater degree of humility about scientific knowledge in the face of various types of incertitude (Ravetz, 1987; Stirling, 2007). Associated with this need for a greater degree of humility about scientific knowledge is the requirement for a more reflective approach to science that enables the knowledge to be examined, reflected upon and considered in terms of the uncertainties, underlying assumptions and subjective judgements involved (Beresford, 2010). This reflective approach to scientific knowledge can be undertaken by not only exposing particular knowledge claims to the scrutiny of various other scientific disciplines but also to

stakeholders and the public more broadly – i.e. to a process of 'extended peer review' (Funtowicz & Ravetz, 1994). The suggestion that precautionary approaches to decision-making require humility and reflection on scientific knowledge therefore leads to calls for broad based participation in decision-making processes. Broad based participation in decision deliberations is certainly justified when decisions involve value judgements and widespread uncertainties, but it is also said to be important for encouraging an engagement with the ambiguities and subjective elements involved in the framing of risk science (Fiorino, 1990; Stirling & Gee, 2002). In addition to a reflective approach to scientific knowledge and the encouragement of broad based participation in decision-making processes, precautionary approaches are also said to require detailed consideration of the benefits and potential adverse effects associated with a *range* of alternative options (Fairbrother & Bennett, 1999). This means that a range of policy options for delivering a particular good or service need to be considered when a particular activity or technology is judged in a regulatory arena (Stirling & Gee, 2002).

This requirement to consider various alternatives has also led to the suggestion that decisions need not necessarily focus on what is the 'best option' but perhaps also on how to maintain diversity, resilience, flexibility and adaptability across a range of policy options (Klinke & Renn, 2002). This is said to represent not only a way to handle ambiguity (diversification offering a way to accommodate different values and interests) but also as a way to approach the challenges associated with ignorance “when there are things we don't know we don't know, the best approach might be one focussed on flexibility and adaptability, or in other words, 'not putting all our eggs in one basket’” (Stirling & Gee, 2002).

While the idea of making political decisions to encourage flexibility and minimise error costs may not be a new idea in itself, it does represent an important point of difference between what the precautionary principle says is important for decision-making and what is seen to constitute a precautionary approach. Another important element in what constitutes a precautionary approach to environmental decision-making is stated as being the requirement for ongoing research and dedicated monitoring efforts (Klinke & Renn, 2002).

Through a commitment to ongoing research and environmental monitoring the idea is that uncertainty can continue to be reduced and our degree of exposure to surprises that may arise due to our ignorance can be minimised (Stirling & Gee, 2002). In summary then, the elements of what represents a precautionary approach to environmental decision-making are conceptualised thus:

1. Scientific knowledge has limitations and it should be able to demonstrate the willingness to expose scientific claims to a reflective process of broad based public participation and engagement through a process called 'extended peer review'.
2. The PP should reflect a commitment to robustly and unambiguously attempt to reduce uncertainties through rigorous scientific research and monitoring.
3. The PP should apply scientific methods that articulate ethics, democracy, transparency and social justice to ameliorate environmental policies.

In general, a precautionary approach can be seen to represent a more inclusive, democratic and reflective process for decision-making than conventional approaches to risk assessment where decision-making is viewed as primarily a technical matter and the advice of scientific experts is granted ultimate authority. The precautionary principle therefore represents the voice of conscience and it puts red robots against the dangers of reckless impunity derived from strident demands for progress and prosperity. Thus the precautionary principle can play a leading role in mediating a middle ground between humanism and capitalism, and this can be achieved through what Kai Lee (1993) describes as 'civic science'. In the final analysis, the PP is simply appealing to the nurturing of communicative and arbitral mechanisms at early stages of conflict resolution, and the preparedness to put the interest of the Earth and marginalised communities first to arrive at informed environmental policies that aims to seek a win-win situation amongst the warring factions.

4.4 Science-based and Precaution-based Approaches to environmental decision-making

According to Wickson, (2005) and Goncalves (2008), critics of using the notion of precaution in environmental decision-making often emphasise the concept's vagueness and ambiguity, although this criticism is usually directed at a specific formulation of the precautionary principle rather than the process based precautionary approach to decision-making that has been outlined above. Critics of approaches to decision-making that are based around the notion of precaution, however, often hold up science/risk-based assessment approaches as being the preferred alternative (Vermeule, 2012). The claim that regulation should be "science/risk-based" as opposed to "precaution/uncertainty-based" appeals to the traditional image of science as providing certain and objective knowledge, revealing the real world as it exists outside of social and cultural frameworks. The presentation of precaution and science based approaches as representing mutually exclusive decision-making strategies serves to suggest that precaution based approaches result in decisions that are not based on a rigorous assessment of the facts (Glanz, *et al.*, 2008; Stirling, 2007; Wickson, 2005). As described

in the introduction, a constructivist understanding of scientific knowledge suggests that the facts are always influenced by social factors and subjective framing assumptions (McCall, 2000). As a precaution based approach accepts this and attempts to provide a process for dealing with the various types of incertitude involved in environmental decision-making, this approach will usually be favoured by those adopting constructivist positions on the nature of scientific knowledge. It has, however, been argued that science-based and precaution-based approaches to environmental decision-making do not have to be conceptually separated and that in fact, the type of precautionary approach outlined above holds a more authentic claim to what it means to be 'science-based' than the traditional narrowly framed approaches to risk analysis (Stirling & Gee, 2002). The argument in this case is that denying the existence or relevance of the challenges associated with uncertainty and ignorance for decisions involving the prediction of impacts in complex, interacting and open-ended systems does not really represent a rational approach to decision-making. To that effect, Stirling & Gee (2002: 521-533) suggest that:

A precautionary approach's greater breadth of scope and attention to a greater diversity of information and knowledge could be considered more scientifically robust than the relatively narrow and uncertainty suppressing tendencies of so-called science-based approaches like cost benefit analysis and risk assessment.

The process of using risk analysis to make decisions has traditionally been based on a belief in the certainty and objectivity of scientific knowledge (Wickson, 2005; Dixon & Oyebode, 2007). The challenges associated with applying this approach to decision-making, regarding for example the environmental impact of new technologies, have largely been made visible through the conceptualisation of new and different types of incertitude that are involved in these types of decisions (Wickson, 2005; Glanz, 2008). Wickson argues that these challenges which requires a new approach to decision-making that is better able to acknowledge and handle the full range of types of incertitude; an approach that recognises the limitations of scientific knowledge, engages the public and a range of different stakeholders in decision deliberations, assesses a range of different policy options and focuses on the fostering of diversity, resilience, flexibility and adaptability – an approach that has been characterised as precautionary rather than science based. By distinguishing between science and precaution based approaches to decision-making, I do not mean to imply that approaches using scientific information cannot involve the adoption of a position of caution, or that precautionary approaches do not involve the use of scientific knowledge or experts. What I am essentially distinguishing between them is the role and degree of influence awarded to scientific knowledge and expertise. In science or risk based approaches to decision-making, science has traditionally held a

plurality of rationalities and value sets and a broader range of concerns to be a monopoly on authority, whereas in precaution based approaches, science is recognised as having limitations and this enables a plurality of rationalities and value sets and a broader range of concerns to be recognised and embraced in the decision-making process.

4.5 Precaution as the overarching principle

There is no denying that science is an important actor in translating scientific results into social reality, and the knowledge that is harnessed or generated through investigation and research will therefore translate into moral responsibility (Mitcham & Schomberg, 2000). Similarly, I strongly argue that those with the most information on and best insights into possibilities and dangers have a special co-responsibility to utilise their knowledge in assisting communities to make rational choices in terms of what is good or bad for them.

However, as discussed in the previous chapters, no science can deliver the 'right' answers. The application of the PP as an ethical tool cannot be considered as a matter of an 'objective' standard of science, or routine administrative work, as there is no straight objectivity attached to the PP (Kaiser, 2003). The strength of the PP is that it is a belief and a regulatory tool, but also much more. It is increasingly clear that the PP must be established as an overarching principle if it is to be a robust force for protecting human health and the environment. As an overarching principle, the PP will do two things. First, it will help us make decisions far in advance of where they occur in the current regulatory system. By the time a technology gets to the point of current regulation, a company has often spent millions if not billions developing it. Government is squeamish about saying no when so much money is at stake. The PP offers us a chance to move precautionary decisions upstream and establish a precautionary, public interest research agenda (Heath & Dan, 2010). By setting goals for the kind of development such as mining activities or any other developmental activities and the control thereof, for example, we can develop technologies that are responsive to public need and ecological principle that are less likely to pose imminent threats.

Not only will the PP set the research agenda, it will also carry over into all aspects of society's interface with technology. From the research agenda, through public participation and the conceptual phases of technology, to judicial injunctions and court deference to scientific uncertainty, the PP must imbue our decision-making processes (Peterson, 2006). Additionally, the PP as an overarching principle is more specific to the regulatory phase of technology development: The PP is not pitted as an alternative to risk assessment, but will sit above risk assessment and all the other tools in the regulatory toolbox. Accordingly, it will determine the tools to be used, including the assessment of

alternatives, performance bonds, ongoing monitoring, and other precautionary techniques (O'Brien, 2000).

From the position of opponents of the PP, I strongly argue that, if we restrict the use of the PP to a level of irrelevance, we risk the danger of demoting it to the category of risk management, which does not embrace values first, and does not consult widely with those affected by the operations and activities of mining projects, for instance. On the other hand, when the PP is fully operationalised, it offers the possibilities of all its components – vigilance and prompt action based on full and fair consideration of need, alternatives, and the responsibility of proponents. Therefore, as indicated earlier, the PP as an overarching principle offers decision makers, scientists and those who have invested their lives in saving humanity and its non-human subjects from risk associated with uncertainty to do things right.

It is my contention in this thesis that it is not too late for politicians, the corporate world and communities (both scientific and non-scientific) to change the way decisions about technology are made (typically within the framework of an anthropogenic agenda). There is too much at stake to risk the health and beauty of this wonderful world that has been bestowed on us as custodians. We cannot and shall not sell our survival and our flourishing cheaply. Adopting the PP as an overarching principle means that we are tenaciously holding on to our belief system (having a say in what affects us and the environment), that we operate within the regulatory framework that is grounded in an ethical foundation, and that carries the concerns of citizens at its heart, is transparent and in which decisions are not taken only on the basis of the outcome of the activities (consequentialism), but also in terms of whether an action is right or wrong (deontology). The PP should embrace both ethical strategies espoused above to satisfy not only the victims of environmental onslaught, but also the powers that be.

As a society we need to get out of our comfort zones and engage intellectually, using the lay knowledge of risk we possess to survive and thrive. We need to be proactive and robust to safeguard present and future persons. We cannot operate from a position of simplistic formulas and outdated rules (mining legislation that has not moved with the times). We need to reclaim our personhood (ubuntu) by not being greedy, no matter what the consequences will be. The PP is a way out of this political and scientific bind in which we find ourselves and which is destructive. The PP introduces flexibility, foresight, fairness, thoughtfulness and honesty into our development and use of technology. What we expect of any mature individual, we must learn to practise as a society (Tickner, 1999).

4.6 The precautionary principle as a comprehensive decision-making tool

The PP emphasises the importance of comprehensively modelling a decision situation. This involves considering not just a singular act or interest, but rather the full set of feasible alternatives. Tickner (2004: 274) refers to this assessment of alternatives as “the heart of solutions-oriented approach of the PP and central to sound, forward-looking environmental decision-making”. It involves considering different strategies and technologies that might be employed to realise a particular goal, rather than confining attention to some pre-established way of doing things. In terms of policy recommendations, this aspect of the PP might amount to a requirement on public agencies to survey and assess a range of strategies for carrying out a particular social service. Consideration of the set of feasible alternatives moreover affects whether the actions of an independent agent should be restricted given a level of risk to human health and the environment (Tickner, 2003/4). For example, if the introduction of mining activities to a particular province or region is considered as the only viable strategy for producing gold or diamonds, more leniency is justified with regard to environmental risk and liability for damage. If a number of low-risk mining options are otherwise available, however, the pursuit of risky alternatives should be less tolerated or aborted.

In a given situation or a particular course of action, the PP calls for acknowledgement of all potential outcomes, even those that are scientifically uncertain. In this regard, Resnik (2003), Keeney and Von Winterfeldt (2001) and Sandin *et al.* (2002) all claim that the PP appeals to a difference between practical decision-making and epistemological decision-making. In practical decision-making, all potentially significant consequences of an action must be taken into account, not just those that are established as scientific fact. Epistemological decision-making, on the other hand, could be understood as giving credence only to hypotheses that are shown to be highly probable in light of the relevant data/statistical tests. *“To give an example, theoretical speculation might predict a certain chemical to have potentially harmful effects on a particular ecosystem, and if so, this should affect public decision-making regarding the use of chemicals, even before the precise causal links are established through scientific experiment”* (Adams, 2002: 308). This basic point is expressed in the Rio Declaration, which is considered by many to be an early statement of the PP in international law (ibid. 306). The PP refers to decisions about whether to undertake preventative action, given incomplete scientific knowledge about whether a current practice is environmentally damaging, hence the concern that scientific uncertainty shall not be used as a reason to postpone action, given an appropriate cost-benefit analysis.

Therefore, the PP is useful in contributing to decision-making because it advocates discretion in terms of which potential outcomes of an action should be taken into account, whether one applies the catastrophe principle²² or the ‘maxi-min’ decision rule²³ calculus (Resnik, 1987: 26-27).

4.7 The precautionary principle as an ethics of uncertainty

A prudent strategy of dealing with ethical challenge is to diminish uncertainty by acquiring knowledge of the issue at hand. For example, one would have to establish the impact of any risky projects on the health of the environment and humans if the precautionary principle is not adopted, and conversely investigate the impact if the PP is adopted as a decision-making tool. When it comes to decisions that affect the health of people and of the environment – the regulation of potentially harmful substances or diagnostic tests to predict an individual’s propensity to develop severe disease, for example – carrying out research to diminish uncertainty and, consequently, risks can become an ethical duty. If this is not possible because decision-makers cannot wait for the relevant research, or the gaps in our knowledge are not accessible to scientific investigation, the PP is increasingly advocated and used as an alternative strategy to make decisions in the light of uncertainties. However, the application of the PP itself can create dangers (Wiedemann & Schütz, 2005) that have to be weighed against the benefits of adopting it. These dangers are so-called iatrogenic risks²⁴ (Wiener, 1998) and give rise to a serious ethical dimension that needs to be considered.

The concept of uncertainty has been around for a much longer time, starting with Socrates and Plato; philosophers doubted whether scientific knowledge, no matter how elaborate, sufficiently reflected reality (Pörksen, 2002; Kant, 1783). They realised that the more we gain insight into the mysteries of nature, the more we become aware of the limits of our knowledge about how “things as such” are (Prauss, 1989; Kant, 1783). These limitations to our understanding also make it impossible to foresee future events or the effects and implications of decisions with certainty.

Knowledge is perpetual and never ending, and research can only produce estimates of what we think is happening. Science, at least in part, is not about facts but odds (Tannert *et al.*, 2007). Yet accepting and realising this principle of uncertainty is a conceptual challenge, and it is within this framework

²² The catastrophe principle is based on three foundations: an emphasis on people’s occasional failure to appreciate the expected value of truly catastrophic losses; a recognition that political actors may engage in unjustifiable delay when the costs of precautions would be incurred immediately and when the benefits would not be enjoyed until the distant future; and an understanding of the distinction between risk and uncertainty.

²³ The maxi-min rule is a decision rule used in decision theory statistics and philosophy aimed at *minimizing* the possible loss for a worst case (*maximum* loss) scenario.

²⁴ Iatrogenic is any consequence of medical treatment or advice to a patient.

that we must make decisions of a moral nature. Beck (1992: 63) concludes that *“risk calculations are the phenotypes of the resurrection of ethics [...] in economics, natural sciences and technical disciplines. Uncertainty has no ethical quality – it is an inherent attribute of a situation. However, in a potentially dangerous situation, uncertainty can trigger ethically adjusted behaviour that aims to avoid dangers and diminishes risks.”*

When we know that a certain situation is dangerous or risky, implies that that danger has a prescribed quality and a defined probability, that that danger can be avoided or counteracted. For example, car accidents that caused severe or deadly injuries prompted regulations for the mandatory installation and use of safety belts, while risk can either be accepted by, or imposed on, a person. For example, driving without a safety belt is a self-accepted risk, while selling cars with faulty safety belts imposes a risk on unsuspecting buyers. It is thus a proactive and morally justifiable activity to reduce gaps in our knowledge if this can counter danger or minimise risk. However, if the cause of ignorance is a lack of knowledge, which cannot be reduced owing to the stochastics and randomness of the matter under study and/or the structure of our cognitive apparatus, it is called closed ignorance or ‘nescience’ – an absence of knowledge (Gross, 2007).

Closed ignorance stems from rejecting or ignoring available knowledge, which is referred to as the ‘Galileo effect’ – inspired by the cardinal in Bertolt Brecht’s play *Galileo Galilei*, who refused to look through a telescope in order not to accept the knowledge that the planets are revolving around the sun.

Not surprisingly, the Galileo effect is itself a risk factor and increases danger, although it can be overcome. A change in attitude would transform closed ignorance into open ignorance, which can, at least in part, be addressed by learning or by research, and this is the goal of the PP to inculcate open ignorance.

Therefore, the ultimate aim of the PP in risk and danger uncertainties is to objectively attempt to close the gap between epistemological uncertainty (gaps in knowledge that can be closed by research) (Van Asselt & Rotmans, 2002) and ontological uncertainty (caused by the stochastic features of a situation, which will usually involve complex technical, biological and/or social systems) (Shrader-Frechette, 1996) and, lastly, subjective uncertainty (which is characterised by an inability to apply appropriate moral rules). These types of uncertainty can lead to societal anxiety or conflict, which Emile Durkheim called *“anomie”* (Durkheim, 1996). Even within the state of anomie, decisions have to be made.

The PP can help us cope with open ignorance by encouraging more research on the matter under discussion whenever there is a threat of uncertainty; however, research shows that the PP measures

can have negative side effects because they might lower public trust by amplifying an unreal public risk perception (Wiedemann & Schütz, 2005). Thus, in a state of uncertainty, the application of precautionary measures has to be carefully weighed against other outcomes, especially spurious anxieties and fears, and a principal scepticism towards technological innovations. It is therefore on those grounds that the PP does not (Renn, 2007) and should not (Peterson, 2007) be assumed to be a decision rule, but rather as a “*state of mind*” (Renn, 2007: 303) that helps decision-makers to avoid false negatives, and to be more sensitive to uncertainties, ambiguities and ignorance (Stirling, 2007).

Finally, uncertainty has been shown to be a thorn to the central claim of science that all problems are presumed to be solvable by research. Many social, health and environmental issues, however, have been shown to be complex to the extent that it may never be possible to make reliable predictions about the effects of manipulating complex environmental systems. This position therefore attempts to highlight some critical ethical considerations about the limit of knowledge in the assessment of risks to human health and the environment. This therefore implies that decisions taken in a state of uncertainty can escalate to ethical challenges: ignorance caused by rejection of knowledge that can ostensibly lead to danger. However, knowledge can also lead to ethical challenges: it can create risks if the exposed person decides to accept threats, which is imposed on another person or accepts that such a threat is imposed. Nevertheless, a responsible application of the PP in a state of uncertainty ought to be considered carefully and specifically in every case with respect to all possible outcomes to obviate shooting the PP in the foot.

4.8 Democratising decision-making through the precautionary principle

Environmental policies depend for their success on public participation. However, the scientific construction of environmental issues means that such participation in policy making is difficult when the public is not considered scientifically ‘expert’. Even if the notion of ‘expertise’ is broadened to deal with this problem, this does not ensure truly ‘public’, i.e. lay, involvement, because lay ideas are still not included but are discounted as ‘non-scientific’. Furthermore, emphasis on the scientific and environmental education of the general public will not guarantee policy implementation by individuals. Therefore, if we wish to design environmental and health policies that can be implemented successfully, we must consider other ways in which people relate to their environments, including through scientific mediation – ways in which people understand their environment through culture, morality and social interaction and build this understanding into environmental policies.

According to the UNCED document (1992), “*countries ... should encourage public participation in discussion of environmental policies and assessments*”. The necessity of public participation for

successful environmental policy has been recognised for some years at both the international and national level. In South Africa, for instance, we have seen massive street protests by residents because they perceive government as not being consultative on issues that affect them directly, such as the imposition of leadership particularly at the municipal level. This is a vindication that people know what is right or wrong, and that leadership that is not people oriented is bound to be rejected. This is a vote of no confidence. Similarly, policies that exclude public participation are bound to fail dismally before they can be implemented. The Information Bill proposed by the SA government has elicited protests by civil society, opposition parties and media organisations. The power of the people can therefore not be ignored.

For instance, the Rio Declaration of key principles emanating from the (UNCED, 1992: 34) includes public involvement in paragraph 10:

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities ... and the opportunity to participate in the decision-making process. The State shall facilitate and encourage public awareness and participation by making information widely available.

Under this globally agreed interpretation, environmental policy should aim to involve the public not only in its design, but also in its implementation, to ensure that its targets are met through the actions of all individuals. There is no doubt that the two aspects are complementary: policy should be designed so that it can be implemented by individuals, i.e. it must appreciate their views and constraints. Successful environmental policy has therefore been linked to the notion of “concerned citizens”, coupling individual action to institutional change in the name of environmental protection (O’Riordan, 1991: 167).

But because scientific domination of the debate precludes public participation in policy design, this unfortunately will inadvertently diminish policy implementation and will attract mistrust of the so-called ‘experts’ by the “non-scientific” community. To further suggest that communities can be empowered by environmental information and education may not be enough; after all, citizens have their own experiences of certain risks. It therefore is my contention that some risks may be underplayed to protect ruthless business interests. In some cases information that is disseminated to the public may be inaccurate or insufficient. Although there has been talk of the need for community participation and involvement in wider processes of public decision-making as an integral part of

sustainability, to date there has been little or no evidence of such participation outside the impressive but still limited arena of academics, NGOs, government and business (Macnaghten *et al.*, 1995: 9).

From the discussion above, it is very clear that science is generally very important in environmental debates: in setting the agenda, defining the scale of the problems and evaluating solutions, often in conjunction with other 'expert' discourse offered by economics and business. This is explicitly acknowledged in Agenda 21, (UNCED, 1992), which states in Chapter 35) that the "*role of science should be to provide information to better enable formulation and selection of environment and development policies in the decision-making process*", thereby bringing science within policy circles. Beck (1992: 162) therefore argues that science is one of a set of "*sub-politics*" which are increasingly gaining the political power that was once solely the preserve of government, and yet is failing to guarantee its own public accountability because of its distance from public attention and legitimation. This reinforces my initial problem in terms of which public participation is sought by policy makers in policy implementation, but neglected in policy formulation in favour of more scientific accounts. Where the link to implementation is built subsequent to policy determination, which weakens policy effectiveness.

From the above it is evident that public participation is absolutely necessary for environmental policy-making, but is prevented with respect to global issues because of scientific mediation and dominance of policy formulation, which consequently excludes public input. However, when we move away from the global picture, there are other ways in which the general public can connect with environmental issues, also through scientific mediation and 'top-down' environmental education, which can be seen to be more empowering than these. For example, ordinary people cannot make meaningful contributions by way of argumentation in matters that talk, for instance, about global warming, but can have a lot to say about AMD, air pollution in the area, etc. These are matters that strike directly at home.

While science is seen by business and government as a hegemonic authority, it still has limits. Because of the power it yields, science has achieved the status of autonomy from other fields, and yet it lacks accountability. The exclusionary nature of science is in effect increasingly causing or creating a wedge between or distance from ordinary people (The Royal Society, 1985). This means that the public's relationship with science is complicated and, although people can be both critical and credulous of science, in the public arena they have not always had the power or the confidence in their own 'expertise' to raise their criticism forcefully: people exercise self-censorship of their scientific critique because they perceive science to have far greater power than they do. In compensation for this silence

in the public arena, Lash and Wynne (1992: 6) suggest that a “vernacular critique may operate in people’s private worlds”. As Michael (1992: 23) notes:

People are not solely disenchanting and disinherited in the face of science; rather they discursively maneuver [sic] around in a variety of trajectories that can, on the one hand, sustain the mystique and the status of science and, on the other, undermine them.

It is the ways in which people undermine the domination of science in their own worlds that would seem to offer scope for active public participation in environmental policy. This should not be the case, though, and public participation should not be dictated to by resentment to science, and similarly science should also revisit its standing in the public by not trying to dominate events. People on the ground have first-hand experience that can come in handy to predict risks, because people look for justification through non-scientific knowledge, at the same time as seeking the ‘second-hand non-experience’ that science offers them.

It is also true that people look to science for unequivocal ‘data’, although they can adopt their own interpretation through the use of either moral judgements or ‘first-hand experience’, and hold to this where science would contradict it. The balancing of the two, i.e. the “*first-hand experience and second-hand non-experience, must be investigated through research and a model or framework should be designed in which these two ‘understandings’ can work closely to achieve an unambiguous position*”. People’s experience often relates closely to local environments, in contrast to the scientific experience, and therefore ways must be found to assess the relation of environmental knowledge to scales of perception. By doing this, people will compare their own, more local perceptions with those of (traditional and counter-science) experts (Burgess, Harrison & Maiteny, 1991: 499-519).

So, first-hand experience of local environmental issues is contingent upon local knowledge, direct perception and familiarity. The conflict that this can have with ‘expert’ and ‘second-hand’ knowledge is clear from the study by Burgess *et al.* (1991), demonstrating that it is not only through scientific mediation that people perceive and construct ideas about their environment. However, we can usefully distinguish between the global and local environment, because the former lends itself to scientific mediation, whereas the latter is more open to public construction of ideas and therefore to potential policy input. It therefore is clear that environmental policy on all scales needs to relate explicitly to everyday behaviour, not merely to educate people in the secrets of environmental science: the local and the mundane are also critically important.

Since the PP acknowledges a space in which local knowledge and experience can be articulated that cannot be captured directly in the language of science, this researcher strongly argues that the PP is

central to public participation, and participation is a necessary condition for successful environmental policy, but its formulation is incumbent upon scientific and expert discussion. However, if we want public policy to succeed, we should not only appeal to science and public participation, but also to the moral, ethical, cultural and behavioural dimensions of environmental issues, especially those linked to local environments. To build successful environmental policy and adequate public participation, these different elements need to be conjoined, but this proves a problem for academia because of the disciplinary boundaries that divide studies of science from those of public, cultures and morals. But this dilemma can be resolved by applying Beck's (1992: 172-173) "*pluralisation of experts, but it should not be a democratisation that overthrows power based on knowledge differentials, as this will counter or hinder communication channels based on a local lexicon because of the perception that 'non-experts' do not possess the scientific power and prowess needed in helping formulating policies that are of scientific nature, while ignoring the power of the local knowledge*". What I can say in the final analysis is that power (first-hand and second-hand experience) must be further researched to address the complexities of the public relationship with science and the overall development of the environmental debate. We need to bring together scientific, counter-scientific and non-scientific contributions to encourage full public participation and effective implementation, and all these can be achieved through the PP.

4.9 The precautionary principle and burden of proof

Scientists are trained to try to add provisionally only reasonably certain information to the body of knowledge, as opposed to more speculative knowledge. Accordingly, one prescription governing the traditional scientific methodology is that scientists often, if not always, try to minimise type I errors, because this is the most conservative course of action in situations of uncertainty, and because it reduces the chances of accepting false positive results. Hence, scientists typically use something like a 95% confidence level as a basis for rejecting a null hypothesis (the 95% rule). Because scientists are more interested in avoiding false positives (type I errors) rather than false negatives (type II errors), they place a greater burden of proof on the person who postulates some, rather than no, effect. Clearly this is an injustice, because the victims of the environmental onslaught are thus required to demonstrate that exposure to a particular hazard causes health challenges. For example, the residents of the Limpopo and Mpumalanga provinces who were exposed to dangerous levels of toxic asbestos for years were surely failed by science and the SA government, who ignored type II errors. The outcomes of that neglect are body bags piling up and huge medical bills.

However, scientists conventionally support the 95% confidence level as a basis for rejecting a null hypothesis. In practical terms this means that science conventionally places the burden of proof on

those who postulate that an action or a policy entails some. Reasons include that (i) it represents the primary way to improve the utility of the sciences in decision-making because it enhances their predictive capabilities; (ii) it minimises adding speculative knowledge to our body of knowledge; (iii) it provides a useful standard or benchmark against which other scientific studies can be compared, including a kind of automatic credibility insofar as conclusions are based on a standard level of confidence; (iv) it provides a neutral standard in public policy debates that might be politically or ethically charged; and (v) it protects the status quo when sought by regulatory agencies (Lemons, 1996).

The world is at war with itself, ecologically speaking, and in war you do not take a middle position or the role of a mediator. Environmental degradation is accelerating at a much higher pace than we can cope with, science included. Some environmental laws require a finding of environmental harm as a factual prerequisite for protective regulatory action, while others don't even require protection from harm, but rather compensation after harm has occurred, as is done by the polluter pays principle in the National Environmental Management Act, Act 107 of 1998. When the environmental statute is precautionary in nature, however, evidence is difficult to come by. Firstly, it is common knowledge that uncertainty inherent in science, is at the forefront of scientific knowledge; secondly, regulations are designed to protect public health, and the decision is that of an expert administrator; thirdly, the court will not demand step-by-step proof of cause and effect; but the administrator may apply his/her expertise to draw conclusions from suspected, but not completely substantiated, relationships between facts, or from trends among facts. Therefore, theoretical projections, from imperfect data may result in probative preliminary data that may not be certifiable as fact and the like (Lemons, 1996).

The prescription governing burden of proof requirements in science, combined with the burden of proof requirements in law governing the adjudication of environmental disputes, thus creates enormous practical, political/economic and ethical problems with respect to public policy and decision-making (Funtowicz & Ravetz, 1993). As we have seen, many decisions about human health and environmental threats must be made in the face of pervasive scientific informational and methodological uncertainty, which means that legal rules on the use of scientific evidence in court proceedings may determine when laws that might be used to protect human and ecosystem health may be enforced or implemented (Lemons & Brown, 1995).

The question of whether or not to minimise type I errors seems to extend beyond the boundaries of science, because there is no overriding or prima facie reason for using the 95% rule. The fact that the rule is a prevailing scientific norm begs the question of whether it ought to be followed in all contexts. While 95% may be appropriate in strictly scientific studies, it is less appropriate to use for

environmental or human health regulatory purposes, because statistical studies used in regulatory settings are aimed not at discovering new scientific results, but rather at discovering whether environmental or health risks exist. The fact that the 95% rule represent a consistent standard against which the studies can be compared is important for consistency, but only for that. Consistency per se is not and shall not be a reason for following any particular practice, if the practice otherwise would produce bad or harmful results in other areas. Finally, because the 95% rule may preserve a status quo that is causing risk or harm to humans and the environment, its continued use under all circumstances ought to be thoroughly probed.

Finally, therefore, why should there rather be an ethical preference for minimising type II errors in environmental issues (this will increase the risk of type I errors), and why should the burden of proof for demonstrating no adverse environmental harm from development or human activities be placed upon those calling for such development, and not the other way around? If that was done, my argument is then would we have lived in a world that is much safer and healthier and with fewer environmental problems than the one we live in now.

To unpack this in more detail:

1. Minimising the chance of not rejecting a false null hypothesis with important public policy consequences is reasonably based on the grounds of protecting present and future persons;
2. The proponent of an activity or development that potentially threatens the health of humans and environmental resources typically receives more benefits from the activity than do members of the public and, consequently, minimising type II errors would result in a more equitable distribution of benefits and risks;
3. Natural resources typically require more protection than do promoters of development or an activity, because the advocates for protection usually have fewer financial and scientific resources than developers or promoters of activities that potentially can harm resources;
4. The public have the right to protection against decisions that could impose damages on natural resources for which compensation is not possible;
5. The public has the right to environmental integrity and ought to decide the fate of development and human activities that potentially threaten natural resources; and;

6. Finally, minimising type II errors would allow enhanced protection of non-human species that typically receive exiguous attention in decision-making based on cost-benefit analysis.

In the final analysis, the successful protection of the environment and human health resides in cooperation between science and the precautionary principle, and I will propose that, rather than using the precautionary principle and science-based decision rules as if they operated in two different realms, I propose a new concept that I will term "precautionary science", where these two 'understandings' can function together effectively to resolve environmental and human-related challenges.

4.10 An ethical appraisal of the precautionary principle in decision-making

The precautionary principle as a decision-making tool is concerned with preventing harm or promoting the most beneficial outcome for both humans and the environment. In its most common use and application, the PP refers to the protection of the environment and sustainable development. Among the most fundamental principles of sustainability one finds the notion of inter- and intra-generational equity. Broadly defined this means that the interests of the future person must be considered in the decisions made by current generations. The precautionary principle rests firmly on the idea of intergenerational equity, which encompasses rights and equal opportunities for those who must benefit from sustainable development, irrespective of their financial background and social standing.

The PP encourages decision makers and those who advise them to protect the rights of individuals or communities who are on the receiving end of an environmental decision. A right is an entitlement to act or have others act in a certain way. If you have the right to do something, then others have a correlative duty to act in a certain way. Human rights are universal, equal and not transferable and cannot be relinquished, and they are natural rights that are not derived from human institutions (Shaw & Barry, 2001: 73).

Negative human rights reflect the interest that humans have in being free from outside interference, e.g. the right to freedom of speech, whereas positive human rights reflect the interest we have in receiving certain benefits, e.g. the right to health care. Moral rights have the effect of moving the focus of moral judgement from society as a whole to the individual. Rights would thus appear to require a living subject to which they can be ascribed. In the absence of a subject there can be no rights or obligations (Beckerman, 2000). Although some have argued that there is no temporal dimension to human rights, this seems a difficult stretch, since how do I consider my rights and

obligations relative to generations past or future? There is no future or past person relative to my rights or obligations. Furthermore, should the future pose such rights it would be reasonable that such moral obligations would be considered prima facie obligations (ibid. 70-71). As such, it would seem to be an obligation easily overridden by a more important obligation to current persons. However, if we are serious about sustainable development, and through the precautionary principle we are serious about protecting people living in the present, we are also simultaneously protecting the future person.

4.11 Conclusion

The conceptualisation and articulation of uncertainty and ignorance dealing with the environmental impact of technology has revealed the traditional weakness of conventional science based risk assessment and management. Unfortunately conventional science fails to acknowledge the inherent weaknesses informed by uncertainty when formulating risk based environmental decision-making. As a result, a new theoretical trend called the precautionary principle that is ready to confront uncertainty and ignorance has come to the fore. The precautionary principle represents process based intervention to guide public and private policy in areas where there may be extraordinary risk, uncertainty, and gross ignorance pertaining to present and future generations.

In addition, the process based precautionary principle is geared towards realigning science based environmental policies and advocate for more reflective, more robust, deliberative and participatory approaches to decision-making. It is also critical to acknowledge that the weaknesses inherent in both approaches should not be underestimated, but rather they should be researched in further detail.

The precautionary principle is most powerful when it serves as a guide to making wiser decisions in the face of uncertainty. Any action that contributes to preventing harm to humans and the environment, learning more about the consequences of actions, and acting appropriately is thus inherently precautionary in nature.

However, precaution does not work if it is only a last resort and results only in bans or moratoriums. It is best linked to these implementation methods:

- Exploring alternatives to possibly harmful actions, especially clean technologies that eliminate waste and toxic substances;
- Placing the burden of proof on proponents of an activity rather than on victims or potential victims of the activity;
- Setting and working toward goals that protect health and the environment; and

- Bringing democracy and transparency to decisions affecting health and the environment.

In cases like this, there is thus a strong moral argument for the adoption of the PP. Much of the world has started to embrace the principles of the PP. South Africa and Africa has an opportunity to embrace the PP fully to address their environmental challenges and decision-making processes. In Chapter 5, the PP, as it has been elaborated above, will be tested within the context of a case study focussing on AMD – with a view to evaluating whether adopting the PP would have made a difference to the decisions that have led to the problem of acid mine drainage in South Africa. Despite the resistance by some powerful countries like the USA to adopt the PP, the PP offers an opportunity to share decision-making and to remove institutional resistance to democratising decision-making in a transparent manner.

Although there are legitimate reasons for its use, a lively debate continues to try to find common ground between the PP and science. This debate has remained strong in technical, economic and political circles, but has not been as robust amongst ethicists and participants in the philosophy discourse. But, when one considers the general use of the PP, its adoption in key international agreements and the interests of globalisation, it seems that the trend toward adopting the PP is shifting favourably and becoming more significant.

Section B

Chapter 5

Introduction to the Acid Mine Drainage Case Study

5.1 Background and central questions

Environmentalists have termed AMD the single most significant threat to South Africa's environment and public health, and this is being driven home by AMD problems being experienced in the Witwatersrand Basin and the East Rand operations of provisionally liquidated and JSE-suspended Pamodzi Gold. The AMD challenge at Pamodzi Gold's Grootvlei mine in Springs reached desperate proportions recently (8 May, 2009), when Graham Chamberlain, the General Manager: East Rand Operations of cash-strapped Pamodzi Gold, was close to the point of being forced to release untreated AMD water on the surface in order to save Grootvlei's underground pumping station from flooding, which would have had far-reaching regional consequences.

An interim solution for the toxic tide of acid mine water rising beneath the surface of South Africa's Witwatersrand area will cost government an estimated R145 million, according to claims made by former Water Affairs Minister, Buyelwa Sonjica, while addressing the Agri SA Water Conference in Johannesburg (*Mail and Guardian*, 8 August 2011). The minister highlighted that the current initiative to tackle the problem revolved around a public-private partnership, which would see government and the mines contributing to the capital costs for the infrastructure needed to pump and treat the water. According to the Minister, 70% of mines in South Africa are ownerless, which means that the liability would fall on the shoulders of the state, hence the R145 million. The other 30% are owned by private enterprise, which will contribute about R73 million to the interim acid mine solution (www.miningweekly.com/article/interim-acid-mine-water-solution-to-cost-r218m-m).

Every mine in SA is unique in terms of its AMD potential, thus the nature and size of the associated risk and feasibility of mitigation options will vary from site to site. There are no standardised methods for ranking, measuring and reducing the risk of AMD. Considering how large the penalties can be for miscalculating any of the aforementioned variables, the onus is on the individual mining companies to take charge of their own destinies on this front. It must also be noted that the general standards that respond to AMD are to pump the polluted water away to the surface, where it can be treated. However, since this is an expensive option, and since pumping is a problem in many un-owned mines, the Acid Mine Drainage Plan of SA (September, 2010) makes provision for pumping water from the mine or decanting to lessen the impact of the heavy pollution. In terms of this plan the underground

morphology of the areas was mapped, and areas were identified to which water could be decanted if pumping stopped. The health risks and effects on the environment were predicted should polluted mine water decant to the surface. Management options were developed to avoid the uncontrolled decanting of polluted mine water to the surface, but questions arise whether this amounts to a “do nothing” option, and the extent to which potentially affected communities were consulted in the process of risk assessment and decision-making.

The question that arises in this context is twofold: firstly, what is the approach to risk analysis and risk management that was used in the mining sector (and perhaps condoned in mining legislation in South Africa up till now, and how was it possible for the AMD problem to have emerged within that framework? Secondly, since there seems to be a large measure of scientific uncertainty in determining the further escalation of the AMD problem, what difference, if any, will it make if the precautionary principle was applied in risk analysis, risk management and the formulation of future mining policy related to the AMD issue? Would the problem of scientific uncertainty in response to AMD be mitigated by the use of the PP? Would participatory, democratic principles make a difference to public decision-making regarding responses to the AMD issue? Would an application of the precautionary principle provide better protection than the current approaches to the poor and the vulnerable who are exposed to current and possible future problems of AMD?

5.2 Methodology

In order to find answers to these questions this case study was conducted in two phases. In Phase 1, the focus fell on the identification and assessment of the conventional risk assessment and management strategies²⁵ that were followed in the mining sector, within the framework of which the AMD issue emerged. In this context, a retrospective analysis was done of legislation that was applicable at the time, standard practices and approaches, all of which arguably have had in combination with one another an influence on the emergence of the acid mine drainage problem.

²⁵The Mining Phakisa Process was noted as a mining methodology borrowed from the Malaysian government with a view of exploring a “win-win resolution to the beneficiation of both bulk resources and precious metals for social and community development in South Africa. The emphasis of this methodology was on provision of housing by accelerating exploration activities, including providing more detailed geo-scientific information to explore”. In the final analysis I did not pursue this methodology as it was entrenched in resource exploitation which goes against the spirit of this thesis and it was not adding new insight into the understanding of the PP as a decision-tool.

In Phase 2 the focus fell on a prospective assessment of the promise and power of the precautionary principle to make a difference to future responses to the AMD issue, and to draw implications from that assessment for approaching risk analysis, risk management and policy-making regarding AMD.

In both phases relevant documentation in the public domain were critically analysed to gain insight into the history of the AMD problem, as well as an understanding of possible alternative approaches that could have, or should have been used to prevent the problem from the start, or could be used to overcome the problem.

A number of individual interviews were also conducted with key role players with in depth knowledge of the AMD problem. These included not only scientists, but also employees working at affected mines, or ex-employees who have worked at decommissioned mines in the past. It was difficult to determine which employees or ex-employee of the decommissioned or mines pending closures would be most appropriate for this interview process. Based on this difficulty, purposive sampling was supplemented by a "snowballing" methodology in which contacts at the mines or environmental departments would suggest other employees who would be most helpful in my research.

In these interviews the perspectives of engineers, supervisors; officials of various environmental departments, retired skilled miners, etc. were uncovered. They were not only asked about the standard and conventional approaches followed in the past in risk analysis and management, but (in Phase II of the case study) questions were also posed about the PP. Because little information is presently known regarding the PP, these employees were first exposed to the main principles of the PP in a lecture.

For the purposes of this study, interviews were conducted with employees of mining companies in 5 provinces²⁶ where coal and gold are mined. Gold and coal mines were selected for the study because of their potential to create AMD. Specific mines were selected for this case on the basis of the magnitude of the environmental problems that they have created, their age (older than 20 years), their geographical location, and the availability of accessible records and long serving employees with institutional memory.

The type of interview that was used in this study was the focused interview, "in which a respondent is interviewed for a short period of time – an hour or so, for example. In such cases, the interviews may still remain open-ended and assume a conversational manner, but you are more likely to be following

²⁶ Gauteng, Limpopo, Mpumalanga, Free State and North West.

a certain set of questions derived from the case study protocol" (Yin, 1994: 84-85). The interview questions that were used were dominantly open-ended, in particular to hear "the respondents' opinions in their own words" (Palys, 1992: 173).

The main ethical consideration for interviews like this is that of participant confidentiality. This is particularly important as the participants who were formally interviewed were questioned directly about the controversial issue of ameliorating the scourge of AMD. While interviews like this normally only pose minimal ethical risk, participants were nonetheless guaranteed that their views will be kept anonymous (See attached letter of consent in Annexure A).

5.3 Limitations of the study

Firstly I must point out that this case study was greatly influenced by events happening on the ground after the tragic massacre of the 34 Marikana miners in August 2012 by members of the South African Police Service. Given that, tension was thick at the mines that I visited for my interviews with lots of mistrust of outsiders like myself. It was also clear that responses that one was trying to elicit from the respondents were going to be circumspect. Though the tragedy unfolded in the platinum belt, its impact reverberated throughout the mining sector of gold and coal fields where this study was focusing. Therefore some of the responses may not have represented the scale of the problem of the AMD.

As a result of the above, fifty percent of the time scheduled for interviews were not taken up because some respondents would either cancel the appointments at the last minute or simply the interview would be interrupted by emergency management meetings. In worst cases I would travel hundreds of kilometres for a meeting and be told on arrival that the respondents have other engagements, or that the dates have been changed without notifying me.

While performing interviews within the mining sector and the Department of Environmental Affairs, a certain degree of apprehension was encountered with regard to this study and the interview questions. This was unfortunately concentrated at the front-line level of interviews, notably Phase 1 of the questionnaire. There were only one formal interview in most mines because of constant disruptions caused by sirens and telephone interruptions which tended to affect the rhythm of the interview. Though the original idea was to ask interview questions in different days, that proved to be difficult and therefore in most cases, I would say in 90% of cases, Phase 1 and Phase 2 questions were asked on the same day punctuated by the lecture on the precautionary principle. More interviews obviously would have been more helpful; nevertheless, I had to do with what I had. This complication

made it difficult to make generalisations about the level of understanding of the PP within the ranks of front-line workers. Also, it made it difficult to gain intimate information regarding the use of current regulations in question.

5.4 Assessing data collection

The data was assessed based on the following criteria:

1. Attitude and behaviour. This assessment method was used to gauge the attitude of the respondents to determine their level of interest in the study, which would determine if the responses so elicited from the interview were honest and not prejudiced by fear and/or a hidden agenda. If the responses to the questions posed were negative or indifferent, it would in the long run have an inevitable impact on the analysis of the data, which may give skewed results. Attitudes were measured by the way the respondents responded to questions, their posture and eye contact, things like looking at the watch while the interview was in progress, mobile phone interruptions, etc. The respondents were urged to participate in this study honestly, with the promise that their responses would be confidential and that their names would not be mentioned without written permission. The rights of the respondents would be respected and they would not have to answer questions they felt uncomfortable with.
2. Level of knowledge: the respondents were tested on the level of knowledge they possessed with regard to AMD – its causes, impacts, the role of science in decision-making, and their understanding of alternative decision-making tools like the PP. The personal views of the respondents on the threat from AMD and their envisaged solutions were determined. An effort was also made to find out what alternative solution could be employed if the envisaged ones should fail. The level of education of the respondents was not used to undermine answers so given. If a situation arose where it became apparent that the respondents failed to answer certain questions as expected, the questions were rephrased for the purpose of soliciting an honest response. The respondents were not tricked into answering questions that exposed their inability to talk about the intricacies of AMD.

5.5 Data analysis process

I must indicate as a point of departure that the data analysis was done purely on the basis of the interpretation of information derived from the literature review and intensive interviews with participants to make sense of the data so derived. No computer programs were utilised in the analysis of data.

On completion of the main data-gathering process, the data was analysed with the purpose of interpreting it and identifying common themes. Coffey and Atkinson (1996) posit that there are three main qualitative research analysis methods that can be adopted in the analysis of data. These methodologies are a categorising strategy, a connecting strategy and a memos and display approach. In categorising strategies, data is fractured and rearranged into categories from which themes can be established (Strauss, 1987). Categories in this approach could include broad topics, and concepts and beliefs of the participants derived either before or after the analysis. However, Maxwell (2008: 237) cautions that such an approach may “lead to the neglect of contextual relationships among the data”. In a connecting strategy approach, an attempt is made to understand the relationships within the data, without first fracturing it. The memos and display approach basically refers to the regular compilation of memos to “stimulate and capture ideas” (Maxwell, 2008: 234), whereas displays are a method for the reduction and presentation of data in a holistic manner through concept maps.

From the abovementioned options, a combination of categorising and connecting strategies was utilised in the analysis and interpretation of the underlying themes highlighted by the various stakeholders/participants. The analysis and interpretation of the data occurred simultaneously with the data collection process, as recommended by Creswell (1997).

Before I start to actually report on Phase 1 and Phase 2 of my case study, it is appropriate to first take into account an overview of the history of mining in South Africa.

5.6 A few pointers on the history of mining in South Africa and the emergence of the AMD problem

I must from the onset indicate that the history of mining is well researched and well documented in South Africa, and as such; I do not intend to repeat what was documented already by different research scholars.²⁷ However, I need to take this argument forward in terms of how AMD manifested after the closure or decommissioning of mines, particularly gold and coal mines, and how politics changed the tides in relation to how the mines were managed in the past and managed to date. Accordingly I will briefly reflect on the mine history in the context of AMD and how decommissioned mines are posing a threat to human and environmental health.

Krige (2005) submits that mining in SA started in the West Rand around 1886. At the time, relatively “clean” water was pumped from the mines into the streams feeding the dolomite aquifers via the

²⁷ For further readings on this topic consult: Harrington *et al.* (2004); Crush *et al.* (1991); and De Kiewiet (1978).

Tweelopiespruit, to enable deeper mining to commence. Pumping was only stopped in 1998 to allow the mine void, created over the previous 110 years, to flood. In 1903, the erstwhile government established the Rand Water Board, which was tasked with monitoring the supply of water to the mining establishments, to industry and for domestic purposes. Then, in 1957, the Chamber of Mines research organisation was commissioned to draft a report to determine the extent of the challenges posed by mine effluents to the quality of water in the Reef. The research committee was headed by an eminent scientist called M. Frost (Adler *et al.*, 2007).

From 1960 onwards, repeated attempts were made to check the status of the water quality in the West and East Basin, and this culminated in the establishment of the South African Scientific and Industrial Research Council in 1963. The mandate of SASIRC was to finalise the report on the dolomitic mine water, which was subsequently forwarded to the National Institute for Water Research (Fourie, 2006). The recommendation of the report resulted in the establishment of the State Coordinating Technical Committee on Sinkholes and Subsidence. Then, in 1966, the Commission of Enquiry into Water Matters was established to seek state intervention in what was then called “*marginalized gold mines*” (Prinsloo, 2010).

In 1996 geologists, geo-hydrologists and environmental scientists predicted the West Rand decant in 2002, and hence the birth of an Integrated Strategic Water Management Plan for the Gauteng gold mines. The proposed solution was to form a private company that would continue to pump water from the mining basins, which ultimately would result in the water becoming available for use in the following phases: (i) process water, (ii) general effluent water, and (iii) potable water (Funke, 2010). However, the success of the proposed solution hinged on the mines, water suppliers, water users and finally government adopting this integrated approach (Department of Mineral Resources, 2009). The proposed solution was adopted, albeit indirectly, with the adoption of the Constitution of the Republic of South Africa, which has been hailed as the best in the world. The RSA Constitution of 1996 enshrines the right to an environment that is not harmful to the health and well-being of its citizens, conservation of its natural resources and upholding the tenets of sustainable development (Van Eeden, 2007). Therefore, access to information by the country’s citizens is a mantra, particularly where government departments have information pertaining to acid mine drainage (Avni, 2007b).

The then erstwhile government in their quest to address underground water pollution arising from mining activities, led to the establishment of the Mine Health and Safety Act of 1976, which unfortunately was solely looking at the safety and health of mine workers instead of both the mine workers and local communities. The pumping of water into mines to further increase their depth was stopped in 1998, particularly in the Western Basin. In the same year, the promulgation of the National

Water Act and the National Environmental Management Act (Act No 107 of 1998) was completed. Thereafter, a series of other legislation came into being, such as the National Nuclear Regulator and the Nuclear Energy Act, Acts No 47 and 46 of 1999. On closer scrutiny, said legislation was modelled on the notion of qualitative risk assessment and was generally reactive (Von Moltke, 2007).

Since the Constitution makes provision for access to information on all threats, including AMD, to fast track this obstacle the government also promulgated the Promotion of Access to Information Act, Act No 2 of 2000, which was followed by the Promotion of the Administrative Justice Act, Act No 3 of 2000. Although the intention of this legislation was not malicious, it seemed, however, to address and talk to a particular section of the community – the elite who can read and write and who generally can also access the most expensive legal brains in the country (Liefferink, 2006-2010). It did not seem to accommodate the poor, the recipients of the environmental violence perpetrated indirectly by permissions contained within the legislation.

South African mines were previously operated by a cohort of conglomerates known as the Big Six, comprising Anglo American/De Beers, Gencor/Billiton, Goldfields, JCI, Anglovaal and Rand Mines. Together they controlled more than half of the country's economy. Their dominance waned, however, when former President Thabo Mbeki came into power: the focus shifted towards black economic empowerment, or BEE, ushering in a new wave of players comfortably connected to both the business and political elite. The second cohort could have imposed much-needed worker and environmental protection, neutralising errors caused by their predecessors. Instead, they used their political connectedness to amass personal wealth; so the legitimate expectations of the country's electorate concerning accountability, transparency and governance were frustrated (Zeelie, 2010).

According to Zeelie (2010), the third cohort followed soon after the Mbeki era, with mining elites under the leadership of the current president, Jacob Geihlihlelekisa Zuma, further eroding public trust with the way they handled the Aurora saga²⁸ under the leadership of Zondwa Mandela and Khulubose Zuma, who are former president Nelson Mandela and Jacob Zuma's grandson and niece respectively. The mismanagement has escalated to the courts, where the two former directors have been subpoenaed to answer to charges of mismanagement and leaving legitimate mineworkers with high medical bills and unpaid salaries. The two were later called to answer to the charges of failing to buy

²⁸ For further reading see: Cartelblanche's Story on Aurora gold mine, <http://www.solidaritylegal.services.co.za/aurora>. Basically this entailed government inaction in addressing the plight of miners who were left stranded and jobless after the mine was stripped of its asset by faceless people after massive corruption by African National Congress cronies.

chemicals for the treatment of contaminated water. Whether the “family” will be prosecuted successfully in court is anyone’s guess.

Throughout the Mbeki and Zuma administrations, the lines between global mining consortiums, government and BEE have become increasingly blurred and undermined. Where acid mine drainage is concerned, governing documents such as the National Water Act, the Mine and Safety Act, the National Environmental Management Act, and the Constitution are being undermined by industry’s ties to government. As a result of the country’s post-democracy neo-liberal economic policies, continued dependence on natural resources extraction, and little distinction between the regulators and the regulated, the rights of South Africans and of the environment have become secondary and hopeless to that of government officials’ prominence and payrolls.

Acid mine drainage is the culmination of the decommissioning of a mine, whereby the underground water becomes highly polluted as acid water flows outwards to the surface, often containing very high dosages of toxic substances coming from abandoned mines (Cobbing & Taylor, 2008). Currently in South Africa there are close to 6 000 mines that were decommissioned and not rehabilitated (Baartjes & Gounden, in prep). The financial liability of these derelict and ownerless mines, to the state, is estimated to be R1.6 billion over 10 years but ultimately requiring a conservative estimate of R30 billion. The social and health impacts of these closures on the state remain to be determined. The Department of Mineral Resources in South Africa has a strategy to deal with these mines that have closed (DMR, 2009), but this strategy does not consider in any great detail the exact causes of decline and ultimate closure. Even though there are 6 000 derelict mines in South Africa, this is small when compared to the almost 600 000 found in the United States (US Bureau of Mines, 1994).

South Africa’s gold mining industry had played a crucial role in creating some of the country’s most important historical milestones, while shaping certain sectors of South African society. However, over time, some mines have begun to shut down as a result of the depletion of the finite resources found within them. With the termination of mining activities, an ecological process has begun in which water in these underground mines rises to its previous levels and comes into contact with sulphide minerals, thus becoming highly acidic. This water then reacts with other minerals, which in turn produce other pollutants in the water such as aluminium, lead, zinc, uranium, radium as well as bismuth. AMD therefore refers to the phenomenon whereby the underground water becomes highly polluted as acid water flows outwards to the surface, often containing very high dosages from abandoned mines (Cobbing & Taylor, 2008).

Frequently, the most important sites for the proliferation of AMD are storage in open pits, expulsion from underground mining shafts, as well as ore stockpiles (Mandres, Godfrey & Hobbs, 2009). Thus, the water that spews from these mines is essentially a toxic end product of underground mining activities (Corcoran, 1994). Moreover, because the formation of AMD is impacted by mineralogy as well as other variables, the formation of AMD will differ from one area to another, which renders the predictive capacity with regard to its formation, as well as its occurrence, both highly expensive but also of ambiguous reliability (US EPA, 1994). Nevertheless, AMD should remain high on the agenda in terms of its origins and the related treatment, which, if not attended to urgently, may ruin many lives, communities and fragile ecosystems.

As this underground polluted water rises to the surface, it becomes a part of the drinking water that is utilised by both the urban as well as the agrarian population (Taylor, 2008). There is further an aggravated claim that, by 2015, SA will not have drinkable water as a result of severe over-pollution, with no remedy being present to reverse this trend once it comes into place (Water Sense, 2010). Moreover, the intake of this water is highly hazardous to human health because of the presence of uranium in the water (Zeelie, 2010).

Some environmentalists describe AMD as a type of toxic pollution caused when acidic water flows out of abandoned mines (Amandla Newsletter, 2011). As the water flows out of the mine, it trickles into waterways, permeates the soil and enters the water table, causing widespread contamination. Scientists like Akcil and Koldas (2006), on the other hand, describe AMD as sulphide-bearing material which is exposed to air and water. Though it is a naturally occurring phenomenon, mining promotes AMD formation simply by increasing the quantity of sulphides exposed (Akciil & Koldas, 2006). Once the AMD is released, some of its characteristics include low pH, high electrical conductivity, elevated concentrations of iron, aluminium and manganese, and raised concentrations of toxic heavy metals. The acid so produced dissolves salts and mobilises heavy metals from mine workings. This will result in dark, reddish-brown water and pH values as low as 2.5 persist at many sites (Akciil & Koldas, 2006). AMD is not only associated with surface and groundwater pollution, but also is responsible for the degradation of soil quality, for harming aquatic sediments and fauna, and for allowing heavy metals to seep into the environment (Adler & Rascher, 2007).

In the next sections I will go into more detail on the findings of the interviews conducted with different stakeholders within the mining sector, government departments and experts in acid mine drainage in order to give a balanced view of the intricacies involved in AMD.

5.7 Reporting on Phase 1 of the interviews

5.7.1 Phase 1: Questions

My field work, as mentioned above, was conducted in two Phases. In Phase I the focus was on the conventional approach to risk assessment and management. Accordingly, in this phase, questions were asked to all respondents clustered around the following themes – with a view to gauge their understanding and impact of risk assessment in environmental decision-making.

1. What caused the AMD problem? Over what period? Where?
2. When did AMD surface as a problem?
3. What was done about AMD by whom? How? Why?
4. Was any risk analysis ever used in the process of identifying issues in mining? How? Why? If not, why not?
5. If risk analysis was used, which risks were identified and which not [from a position of hindsight]?
6. If AMD was identified in this risk analysis, was it properly responded to at the time? If not, why not?
7. If AMD was not identified as an issue in this risk analysis, why did it happen?
8. What was the general approach in risk analysis and why?
9. What was the general approach to risk management and why?

5.7.2 Phase 1: responses

In the first phase of the interviews, twenty six open ended questions were posed and the responses in some cases were put on a tape recorder, but I must indicate that the majority of the respondents, out of a total number of twenty six, declined to be put on record, despite assurances from me that their responses will not be shared with anyone. Some respondents who were floor supervisors were clueless about AMD manifestation, what caused the AMD, and how long the problem has been going on. Time was lost and wasted during my interviews as some (revealingly) wanted to know about the history of AMD and the accompanying challenges.

There was a big reluctance from many respondents to give an answer to the question on the period of how long this problem has been going on at a specific mine, arguably because they were worried that if they gave a definite response, government may demand that they pay or contribute towards cleaning up the mess created by AMD. I must further report that the same kind of apprehension was displayed by all who were interviewed on the question what was done to correct it and who bears the greatest responsibility to correct the problem of AMD.

The impression that I formed was that the anxiety that was displayed by some respondents were unfounded, or simply that there was strict instruction from superiors not to respond to sensitive questions. At the beginning of the interview, of course, as required by ethical principles, respondents were made aware that they need not necessarily respond to questions that they feel uncomfortable with. Great care was taken to allay the fears of the respondents, even if they did not explicitly admit to that. Hence, according to my assessment, question 1 and 2 in Phase 1 was perceived to be too cumbersome as they felt that it implied that they did nothing about it since it was first reported. The seven respondents out of the total of twenty six were able to give responses to question 1 and 2. Of those who gave responses, five were engineers, while a water researcher, a manager, and a deputy director from the department of environmental affairs made up the other three that responded. From the interviews conducted, it was clear that the dates in which the AMD was first noticed was not clear as each category of respondents gave its own dates and place. The rest of the respondents (nineteen in all) were unsure about its origins or were clueless about the AMD manifestation in South African mines, notably coal and gold mines. In some cases questions were slightly adjusted so that the respondents could have the confidence to respond.

Furthermore, six respondents indicated that the history of mining in South Africa and the world at large did not put lots of emphasis on environmental protection. They pointed out that South Africa was not the only country plagued by the scourge of AMD, even technologically advanced countries like the USA and Europe were also victims of technology. Ten respondents further indicated that the main focus of mining historically and now was purely economic, which was the main drive of stability for any country, political and socially. They further posited that at the time, science was also in its infancy and hence there was no way they would have thought about the danger of AMD. The mining legislation is thus perceived as not being forward looking, and only reactive. One of the respondents in Pilgrims Rest intimated that the design of the current environmental laws is simply pro-business and capitalist oriented.

However, the engineers seemed to be clued up about AMD, its origins and impact. Among them, however, there were differences about the year in which AMD was first noticed. Some claimed that

the first time it surfaced as an environmental problem was around 1976 (Professor Jannie Maree),²⁹ whilst other respondents argued that it first emerged in the West Rand, notably in the Krugersdorp area in 1986. This latter claim was validated by the desktop research (Hobbs & Cobbing, 2007 and Jamison, 2007).

Given the confusion regarding the emergence of AMD, thirteen of the nineteen respondents interviewed indicated that they never invested in a hypothetical threat called AMD, since it is a relatively new phenomenon that still needs to be investigated and researched. Their contention was even if AMD exists, it had no bearing on their business, because there is no record of anyone dying from AMD related complications. It was apparent that the respondents could only be convinced of the existence of a problem by the number of body bags it produced. Otherwise, in the absence of body bags, AMD remained an illusion for them. They further argued that communities have learnt to be risk averse, and that nothing risky surprised them anymore. From this I deduced that there is clearly a high degree of denialism and scepticism regarding the existence of AMD. There is even a suggestion that the notion of AMD was seen by some respondents as a creation by those who don't want to see science succeeding. In this instance there seemed to be clearly a lot of "cherry picking" by those among the respondents whose agenda apparently was to make money without thinking about the environment.

In terms of the response to question 3, thirteen of the respondents who still oversee the decommissioned mines were adamant that they did not have issues with AMD, since they continued to pump out water from tailing dams so as not to accumulate and create the challenges of AMD. From these responses one can deduce that the thirteen respondents out of twenty six were not forthcoming with answers since the mines have ceased to operate and not generating any income. Surely, their point of view seemed to be that one cannot inject millions of Rands towards clean-up operations of something that did not exist.

The response to question 4 was a mixed bag. The question that was posed was solely to understand whether scientific methodology was pursued when the thought of decommissioning the mines were mooted. Only one respondent in a Free State mine indicated that the commissioning and decommissioning of the mines under their control was informed by scientific inquiry. He indicated that impact studies were conducted to determine the extent of the impact that will ensue in the event of decommissioning of the mine. The respondent also indicated that an EIA is a participatory process

²⁹ Quoted with his explicit permission.

wherein those who are interested and affected by the closure of the mine would have a say. Unfortunately I was not able to validate or invalidate the claim whether this participatory process actually existed. The respondent further indicated that the scientific methodology employed by their mine was strictly to look at the safety of its workforce and not protection of the environment. Clearly in this sense, reading between the lines, economic incentives seemed to protect the status quo whilst failing to acknowledge environmental degradation as a result of mining.

Question 5 read with question 4 are closely related because the thrust of the question was to determine the reliability of science based decision-making in matters of policy on the environment. The responses gathered for this question clearly pointed to the reliance on science as a monolithic tool that cannot go wrong in the eyes of those supporting science. There appeared to be an insinuation that science was the only game in town. The risks identified as per the follow up question in question 5 in terms of the response elicited seemed to point in the direction of risks associated with machinery breakdown which may affect productivity, rather than anything else.

On question 6, the response regarding what would have happened if AMD was identified in time, and why was it not responded to accordingly, raised many questions. Nine of the respondents argued that because AMD was not an issue at the time, surely there was no way that they could have wasted resources investigating something whose hazard and risk was not known. They pointed out that since AMD is a recent phenomenon, it must wait in the queue for its turn to be investigated. One respondent was even outright by saying that we should worry how we are going to create jobs and not why mining destroyed the environment. Clearly this indicated a massive ignorance and lack of education regarding the environmental challenges of the impact of mining on the environment. The impression created is that mines create jobs and put food on the table, and that this could be done regardless of the consequences. The thinking here is purely anthropocentric with total disregard of the environment.

In question 7, I wanted to know why AMD was not identified as an issue, what was the reason for this oversight? Three respondents were quick to place the blame squarely on a poor formulation of environmental laws, as well as poor coordination amongst various departments. The problem here identified by a respondent in the department of environmental affairs, referring more to current reality in terms of responses rather than causes, was that each department was having its own agenda in terms of how they resolved the questions around AMD. The Department of Mineral Resource, Water Affairs, and Department of Water Affairs and Forestry seem to be having different approaches and vision on how they will tackle the issue of AMD. When this happens, it undermines the confidence of those who are supposed to tackle and address this issue.

The three respondents also had a field day hammering and deconstructing the way in which the previous regimes' legislation was structured. The respondents argued that the erstwhile Water Act of 1956 did not deal effectively with the mining sector with regard to managing the decommissioning of mines. This means that once a mine become less profitable, for instance, two distinct things happened: count your costs, and abandon ship. The state would then have to take ownership of the mine, with the accompanying problems. In an ideal world, this will not have been permitted. Those engaging in exercises of this nature (like mining) would be required to clean up the mess and demonstrate that the ecological status of the area and human health will not be compromised. The respondents argued that it is the opposite in SA, however, and it is not difficult to find the reason: because there is collusion between government and the mining sector, at the exclusion of the public according to one respondent in Crown mines. This response is further corroborated by the literature review. For instance, the confirmation of the government takeover after the decommissioning of mines is clearly illustrated in the Fanie Botha Accord of 1975. The 1975 Fanie Botha Accord stated that mines that closed before 1956 are the responsibility of government, with those that closed afterwards to be remediated by the responsible company. This agreement was reached between government and the Chamber of Mines and allowed government to intervene when it became clear that mining operations would be aborted or boarded (DWA, 2011).

On the other angle, six respondents decried the limitations that are inherent in environmental legislation. Firstly, they argued that the current legislation like the National Water Act and the National Environmental Management Act are toothless in that they shift responsibility to the authors of the nuisance rather than government that should assume responsibility of monitoring the mining operations. Therefore the respondents felt that government that should reactive rather than proactive when dealing with hazards associated with mining. Accordingly one of the respondents of the six who has 'retired' from active mining felt that the mining industry is allowed to operate without oversight hence the scourge of AMD.

Loosely translated, the respondents seemed to agree that the mining sector is not obliged by law to comply with environmental legislation. This claim was corroborated by a review of literature which indicated that under the Department of Mineral Resources, articulated in the Mineral and Petroleum Resources Development Act (Act no. 28 of 2002) (MPRDA) the mining industry is able to obviate the more strict environmental legislation of the Department of Environmental Affairs. This claim was further corroborated by Professor Jannie Marais³⁰ of the Tshwane University of Technology, who is

³⁰ Quoted with his explicit permission.

also Chairperson of the Water Council and also of the TUT Water Unit. A respondent at the Department of Water Affairs has also alluded to the fact that there are two parallel processes for the application of EIAs, one in the Department of Environmental Affairs and the other is the responsibility of the Department of Mineral Resources which approves laws on prospecting and mining applications. So, from this it was evident that mining enjoyed "favour" above all of the other industries that have this privilege of being virtually exempted from environmental legislation (Fourie, 2011). It perhaps also explains why government is so lax in dealing with mining challenges relating to AMD in particular.

These two parallel instructions in terms of the application of the EIA process opens the two organisations, namely the Department of Mineral Resources (DMR) and the Department of Environmental Affairs (DEA) to environmental queries, since their instructions are fragmented and it becomes difficult to place accountability in one department or hold any one accountable. AMD also makes it difficult to fathom the role of the Department of Water Affairs and Forestry, and yet it has a stake in the water politics of this country. My submission is that the AMD buck should stop with the Department of Water Affairs. They are the custodians of the fast depleting water resources. This conflict of interest has resulted in the Ministers of Mineral Resources and Environmental Affairs signing an agreement that would result in environmental legislation, including EIAs, being managed from one office.³¹ The custodian of water will thus be the DEA. However, the proposed amendments, although finalised,³² are yet to be actualised. One respondent at Pontdrif indicated that the struggle between different departments on matters relating to AMD management has become a huge problem. His view was that the seemingly developing tensions within the said departments is undermining the people's confidence and service delivery notably in that policy-makers who are charged with the responsibility of enforcing the law cannot even agree on a simple matter – a coherent strategy to robustly address the emerging threat of AMD. This assumption is further confirmed by the Water Research Council Report (WRC) of 2012. In this Report it is suggested that bureaucracy and red tape are hindering progress in so far as the legal control of AMD and mining generally are concerned.

Eleven respondents from the group of interviewees lamented the fact that they have been left with the massive headache of cleaning up the mess that was created by the Big Six mining houses³³ in South Africa who appeared to have vanished into thin air. This poses a big challenge, since they cannot be

³¹ Notice 654 of 2010. Department of Environmental Affairs. National Environmental Management Act, 1998 (Act no. 107 of 1998, as Amended. Publication of Implementation Guidelines for Comment.

³² National Environmental Management Amendment Act, 2008. Clause 12: Amendment of Section 12 and Repeal of Section 13.

³³ The Big Six mining house in South Africa are: Anglo American, De Beers, Gencor, Billiton, Goldfields, JCI, Anglovaal and Rand Mines.

called to account for their environmental atrocities and pay for their legacy. They further argue that it will be difficult to trace the owners as some previous owners have 'conveniently' died, some are untraceable, while others are alive and refusing to co-operate with investigations on the question of AMD. One respondent suggested as way forward to help prevent or mitigate the environmental impacts through remediation by putting upfront trust funds, but he stressed that these cannot be addressed retrospectively, as some mines are near the end of their productive life. There is consensus amongst the respondents that the water quality challenge will continue to exist for many years to come because provisions to stop mine water decant and discharge from waste mining dumps and tailing dams are being delayed at the DME footsteps. What is clear is that, as long as there is no synergy between government departments like the DWA and DMR, the threat of AMD will continue unabated, with unimaginable results. The government's reaction to the AMD saga seem not to be serious, because the waste that comes from mines is not classified as waste (Turton, 2009). This begs the question in that the government cannot be seen to be shooting itself in the foot. The respondents' views are supported by Turton who points out that AMD has never been a serious political matter as seen by the budget allocation towards abating and managing AMD³⁴. In addition, some respondents (ten) were acutely suspicious of government relationship with mining houses, since they alleged that some government ministers are shareholders in the mines, a fact that has been corroborated by the Marikana Commission. One respondent has even referred to the relationship between government and mining houses as toxic, which opens itself to massive corruption.³⁵ Some respondents accordingly argued that this is why the issue of AMD cannot be resolved: because government has a stake in the mines, just like in the arms deal. Ten respondents argued that the ruling party will not act decisively in the AMD issue because it is well represented in the mining houses.

Six respondents at Crown Mine, Randfontein, Harmony mine, Springs and Krugersdorp gave a clear picture of how they approached the general issue of risk analysis that was addressed in question 8. One respondent was quick to admit that indeed there is a challenge of AMD which is placing the lives of the residents of Johannesburg's biggest sprawling township under huge risk. However, the respondent gave a detailed account on how they go about conducting their risk analysis by showing me the documented steps currently in use in Crown Mine and surroundings mines in Gauteng. These steps derived from a report prepared by Lin and Hanssen (2010) and a Report to the Inter-Ministerial Committee on Acid Mine Drainage (December 2010), confirming what most respondents (nineteen in total) said about the risk analysis process currently in use to address the question of AMD decant.

³⁴ See Borch, 2003.

³⁵ See Wentzel, 2012.

According to the respondents in Crown Mines, the risk assessment plan was used to prioritise the risk of AMD as there have been lots of anger emanating from environmental NGOs as well as criticism from Greenpeace and social scientists regarding the emerging threat of AMD. There was also a concern raised by the respondents at Crown Mines, Stilfontein Mine and Orkney Mine that government is not responsive to the dilemma of AMD to a point of showing no interest. The respondent made reference to the budget allocation that has been put aside by the fiscal to combat the rising threat of AMD, which according to them is a drop in the ocean, and the budget does not go far in terms of addressing this serious issue which has become a social and political scar to the poor communities and those who are affected by the scourge of AMD. Eight of the twenty six respondents indicated that alternative solutions other than purely scientific solutions had to be researched. While acknowledging that science based risk assessment to address the question of AMD cannot be rejected out rightly, they maintained that this scientific approach, that is seen by many as the most reliant approach to risk analysis and management, has not delivered on its promise.

The question as to how risk associated with AMD is managed appears to be the only area according to my perception where there was some kind of a consensus among respondents. Nineteen of the twenty six respondents indicated that a generic approach to the management of AMD has to be prioritised and implemented to reduce the load of AMD, with subsequent eradication of AMD in decommissioned mines. In this their responses resonated with the Report to the Inter-Ministerial Committee on Acid Mine Drainage (December 2010), which explicitly prioritises the management of AMD according to three priority areas:

1. Decant prevention and management: this entails pumping the water levels at or below the relevant Environmental Critical Level to lower the amount of AMD that is already on the surface.
2. Ingress control: this involves the reduction of the rate of flooding and the eventual decant to reduce the volume of water to be pumped and treated. The Ministerial Report further states that the flooding is not only caused by mine water but by other natural sources such as rainfall, surface streams, sewage and storm water reticulation. To abate this challenge, though costly, it will require preventing the recharge of the shallow groundwater above the mine void by canalisation of surface streams,³⁶ as well as the sealing of surface cracks and mine openings. In some cases the Ministerial Report on AMD calls for extraction of clean water from the aquifers that feed water into the mine voids thereby reducing the volume of water that

³⁶ Canalization of the surface water means to draw and discharge surface water into rivers, streams, etc.

becomes polluted. The Report also suggests that the possible losses from water, sewage and storm water systems must also be addressed.

3. Lastly, the water quality management plan recognises the importance of the above listed steps, it nevertheless still reckon that even if the above measures are implemented, AMD will still be around much longer and hence, water shall have to be subjected to treatment even though it will be costly to the taxpayers while alternative technologies are sought. Given the variability in water quality between the different basins it is possible that the water quality in the mine voids will improve over time. Hence the need to invest in more technology.

5.7.3 Initial discussion and interpretation

It is clear from the discussion above that the challenges of addressing and even abating AMD has become an embarrassing political challenge. Firstly, uncoordinated and conflicting approaches to implementing EIAs are a challenge. For example different environmental departments seem to be having different understandings and senses of urgency in so far as the question of formulating and enforcing EIA reports go. Each department relies on the other department to deal and handle this sensitive issue. This therefore plays itself out in a “blame game” between departments with no one willing to take responsibility. Environmental legislation also appears to pass the buck to mining houses, while they in turn blame government for lack of action. Which brings us to asking this central question. Who actually own the mines? Private companies or government? And if the latter: Which department(s) should really take responsibility for AMD? Since there appear to be no clear answers to these questions, the challenge of AMD is guaranteed to linger on until someone takes responsibility. However, be this as it may, while government has failed to take the authors of the nuisance of the AMD to account; taxpayers have been given an added burden of helping to pay for cleaning up the mess.

Secondly, the government’s commitment to resolving the AMD issue also comes to question. This is clearly seen in the fiscal budget dedicated to address the AMD issue: it is in fact far below what is required to really address AMD effectively. It is therefore unfortunate that this looming disaster of AMD might have serious ripple impacts on the ecosystems and the quality of water in South Africa and beyond our borders.

Thirdly, the standard scientific approach to risk assessment and management of AMD has failed to address the challenges of AMD. As alluded by some respondents, science has limits and therefore it cannot be seen to be operating *carte blanche*. Alternative non-scientific options thus have to be considered amongst which includes the precautionary principle.

5.7.4 Closing remarks on Phase 1 of the interviews

I have established in this Phase of my interviews that environmental decision-making in gold and coal mines during the era when the AMD problem was caused was typically based on a fairly conventional approach to scientifically based risk assessment, and that the same applies to efforts that have been made since the recognition of the AMD problem to find solutions for it.

Gaps in environmental legislation were identified by 3 respondents who pointed out the lack of coordination between different environmental departments such as Water Affairs, Environmental Affairs and Mineral Resource in terms of how they can collectively address the threat of AMD. Five respondents from the mining sector on the other hand put the blame squarely on government for failing to enforce environmental laws partly because they have an interest or a stake in mining.

From the first phase of my interviews, and from my initial observations on the responses I obtained, it is my view that the challenges associated with AMD have become a political and social issue. This point will be elucidated further in the next section.

The government obsession with science based risk analysis and management by way of EIAs has further eroded public confidence for the reason formulated in simplistic terms, those science decision-theories have failed to deliver. If that was not the case, the scourge of AMD would have been a thing of the past. It can thus be stated with confidence that government may have had a hand in the proliferation of AMD because of its toxic relationship with mining houses. This is further confirmed by the Fannie Botha Accord and the then Deputy Director in the Department of Environmental Affairs. It is thus my view that unless government get on board as custodians of these resources (mines, water, ecosystems, etc.) the country risks being shunned by the world because of crippling economic devastation.

I further argue that a shift in mind set can move this country forward if we begin to embrace other decision-making theories other than the standard science based decision-making tools. While, as I have alluded numerous times in this thesis, that the public has legitimate reasons to lose trust in both science and government, there apparently is an alternative route available out of this unsatisfactory situation, which, as I argue, can be found in the precautionary principle, properly understood.

Therefore in Phase 2 of my interviews I turned my attention to an investigation of the power and promise of the precautionary principle as an alternative decision-making tool that can overcome the challenges of uncertainty in science and how it could play out in effort to resolving of the AMD problem. My questions in this regard, therefore, probed how respondents understood and

conceptualized the concept of the PP, gauged their level of understanding of the concept, and whether it opened up the possibility of thinking in alternative terms about risk in general, and the risks of AMD in mining in South Africa in particular. These sets of questions were discussed after exposing respondents to a short lecture on the precautionary principle.

5.8 Phase 2 Interviews

5.8.1 Phase 2 questions: Prefaced by a lecture

The second set of questions was focused on the PP and the differences it could have made to the understanding of AMD as a potential problem – as well as its possible effects on responses to minimise its effects. The basic principles of the precautionary principle were discussed with respondents when feedback was given on the results of Phase 1. Questions 10 and 11 were also posed to respondents on an individual basis before the basic principles of the precautionary principle were discussed:

10. Currently, what is your perception of the PP – its definition and its use in the mining sector?
11. What is the basis of your views in question 10?
12. [After the presentation on the precautionary principle.] If this conception of the PP was available at the time (specify as the time when AMD was not recognised as a problem), what difference would it have made to exploring and understanding risks in mining, AMD included?

Before question 12 was introduced, I asked respondents to imagine in concrete detail: what would have changed in managing AMD by applying the PP? What difference would it have made? Difference to what? (Which other outcomes would have emerged?). Thus, I challenged respondents to engage in a thought experiment, and it was highly interesting and revealing to hear what they had to say in this context.

Given the ignorance of respondents regarding alternative tools like the PP to help address the questions of uncertainty and complexity in decision-making, I had spent forty minutes giving a short lecture on the PP. To give context to my questions during the field work, I focussed my lecture on the history of the emergence of the PP, the rationale for applying it, how the PP can be used to address uncertainty and complexity, as well as its relevance to policy formulation and implementation. Emphasis was also placed on the imperative of adopting it as a principle since the World has come to invest in it to reduce environmental catastrophe. The respondents were also informed about the debate currently taking place amongst the pro and contra scholars of the PP. A comparison between science based risk assessment and management and the PP was explained.

In this regard, the respondents were also made aware of the concerns raised by communities relating to policy decisions which exclude public participation. The respondents were informed that communities feel alienated by science because it ignores their indigenous and local knowledge when formulating environmental policies. The respondents were also informed that like any decision-making tool, the PP also has weak spots just like sustainable development, but that this did not warrant its rebuttal. Today the sustainable development concept has grown in leaps and bounds and it has been embraced internationally. Therefore in the same spirit respondents were urged to give PP a chance and an opportunity to be part of decision-making and not to replace science based decision-making. It was also impressed on the respondents that the PP has a long way to go as a new concept, given the manner in which it has been attacked as an unworkable tool in decision-making. The respondents were encouraged to have a retrospective look at the PP before simply wishing it away.

Subsequently the respondents were also given an opportunity to test the PP concept in their projects to see if it will work or not. They were also reminded that the fact that the PP is being criticised so much, implies that there is some kind of substance in its conception that could be of value to society, but at the same time questions the status quo and challenges prevailing power relations.

I further posited to the respondents/interviewees that the fact that scientists and regulators are perplexed by the magnitude in which the public reject expert opinion, they may feel that the solution lies in better communication with the public to explain the threats that arise and the underlying scientific evidence. It was put to the interviewees that the prospects of success of any environmental policy lie in public participation.

It was also pointed out that any attempt to introduce any environmental policy that was not adjudicated by public engagement will imply that if such issues talk, for instance, about community values, the public may reject the policy since it will be perceived to be an idea that is conceived by science, which in all account is seen as authoritarian. I therefore pointed out that any attempts to exclude the views of the lay person may backfire and increase distrust in those affected by an unfair environmental policies.

I have also indicated to the interviewees the importance of recognising and re-evaluating our commitments to exclusively science based approaches to decision-making, and the need to search and embrace other forward looking approaches like the PP which respond to uncertainty, ambiguity and complexity in decision-making.

5.8.2 Phase 2: Responses

Phase 2 interviews were conducted shortly after Phase 1 given financial constraints³⁷ as well as instability in the mines during 2012 in May to September and 2013 around February and July. The interviews were conducted either in mining houses or private residencies. In mines where decommissioning was successfully concluded, you could still find old experienced engineers who could relate well to the concept of AMD and the PP. This, however, represented a small percentage³⁸ of the people who were interviewed about the challenges of AMD.

The questions in Phase 2 were based on the claim that when making public decisions, act in such a way as to avoid/mitigate potential harmful consequences, and such consequences should be accorded the highest priority. These questions were trying to gauge the knowledge level of respondents of an alternative decision-making tool that could be used to resolve challenges associated with uncertainty in science and with regards to AMD, and interventions that could possibly be used to resolve the problem of AMD. From the discussion thus far it is clear that conventional risk assessment and management are not effective in dealing with questions of AMD, and hence these questions were also informed by the claim that something more robust, more fundamental than science based decision-making must be employed to address the challenges inherent in science as far as environmental decision-making is concerned.

The general question that was posed to all respondents was to gauge their understanding and conceptualisation of the concept of the precautionary principle. During the interview, eight respondents of the 26 respondents have indicated that they have seen or read something about the PP elsewhere, but could not associate it with anything drastic that will influence policy. They saw the PP as a theoretical tool rather being a pragmatic tool, and hence the respondents were sceptical about its prognosis. It was largely also perceived as a poor choice on which to base decision-making, since it was seen as inherently unscientific and thus flawed. Three of the respondents who represented the category of engineers argued that South African environmental legislation is the best in the world as it embraced the concept of the PP through the polluter pays principle.³⁹ On being asked if they know a specific piece of legislation that make reference to the PP directly as per for instance the Wingspread

³⁷ The funding for this study was limited and as a result it derailed the travelling arrangement to conduct interviews as planned. This means that in 90% of cases Phase 1 and Phase 2 interviews were conducted simultaneously to reduce traveling costs. The unrest at the mines at the time of a major incident such as Marikana, and labour action elsewhere, impacted negatively on the study.

³⁸ This represented less than 10% of experienced workforce or former workers.

³⁹ In Chapter 1 and 2 I have indicated that the PP and the polluter pays principle do not imply one another.

Statement, the answer was no, while others insisted that the PP is implied in our environmental legislation as represented by the Environmental Management Act, the National Water Act, etc.

On the other hand some of the engineers who were interviewed were aware of the PP, though their view was strongly influenced by political overtones. They thought that if the PP was adopted, government could use it to dismantle existing scientific structures, as the government may want to retrospectively try and implement its unscientific policies thereby delaying implementation of better technology. Accordingly, one respondent from this group strongly argued that any alternative solutions for the AMD problem, including the PP in so far as it seek to address the AMD problem, must also include technical solutions informed by scientific methodology. Further discussion of these politically informed perceptions of the PP will be given in Chapter 6.

What was also very revealing from the responses to Phase 2 questions was the level of ignorance regarding the PP. Almost two thirds of the twenty six respondents (58% to be exact) did not know or were clueless about the concept of the precautionary principle. Hence the group could not give a view point on question 11: they simply did not know.

However, what was positive was that 73% of the respondents (nineteen respondents) were optimistic about the adoption of alternative solutions to science, provided it was not going to erode confidence amongst scientists and reduce the importance of science in decision-making. Three of the twenty six respondents indicated that the PP cannot replace science in decision-making, since science is the most tested and tried approach and the PP is not. Fourteen respondents also indicated that if science were replaced or substituted by another tool, it could result in job losses and those lucky to remain in their jobs will be exposed to more risk in that the new tool, the PP, has no track record of keeping people safe from danger.

Hence, the focus of the mining sector seemed to be strictly centred on issues of health and safety for its workforce and not the environment. This was confirmed by the eleven respondents who felt that death and injury in the mines were prioritised more than the environmental issues, yet the mission statements of mines as typically contained in their environmental policies clearly talks of containment, and yet acid water continues to wreak havoc in the mining communities.

This, therefore, implies that their approach to risk assessment is purely anthropocentric as its focus is on the protection of humans only. One can therefore deduce that AMD for instance is not a priority for the said respondents. When asked about safeguarding the environment against the threat of acid that is undermining the integrity of the natural system like water bodies, their response was that there are other departments charged with the task of protecting water resources and such departments will

have to act accordingly to safeguard the water resources. This group also appeared not to notice the role of alternative decision-making tools beyond science, and appeared to reject other alternatives even before one has taken time to explain the available alternatives to science. It is clear from this group that the door has been shut regarding other alternative solutions. Science based risk assessment appeared for them to be the only game in town. I sense that they have become too comfortable to want to venture into unknown terrain like the PP.

Though 73% (19 respondents) of the twenty six respondents strongly saw an opportunity for alternative decision-making, nine of the respondents in this category seemed to think that alternative decision-making should also revolve around science. Despite the majority of respondents in the category of 73% favouring alternative approaches, 60% (11 respondents) were adamant that EIAs can rather substitute qualitative risk assessment and management. The impression created here, was that the majority of respondents wanted to replace science with science. What is also clear is that the engineers who represented concrete experience in the mining industry were mostly old and retired, and because of politics in mining, some have taken the route of being mining consultants. They reported that they rather wanted to influence change in the mining sector as outsiders. However, as some politicians will tell you, in South African politics, when you are outside government, it is “cold” and to remain warm you must remain in government to influence policy. Literally, as South African politics goes, the input of those outside government will for all intent and purposes not be entertained, and this category of people "on the outside" will be seen as critics of government, and are therefore not to be taken seriously.

From the interviews in Phase 2 of my field work, it also became clear that politics seem to be at the forefront of frustration with the challenges of water quality being impacted upon by AMD. While the participants spoke highly of the mechanisms of risk assessment currently employed, such as the dilution of water contaminated with AMD with water from the Lesotho Highlands Water Project, this is unsustainable and even deadlier, as the damage of AMD to the ecosystem and human health has not been studied well. The mentality of ‘dilution is the solution’ has not been proven to work.⁴⁰ The emphasis should therefore be on pollution prevention rather than pollution creation. Some respondents even went so far as to say that water from the Emalahleni Treatment Site⁴¹ is safe, according to which AMD is treated and sold to the public (mining supervisor at Carolina, 2012). It was difficult to understand or commit when some respondents were asked if the same water could be sold

⁴⁰ See Cohen, 2002.

⁴¹ Acid mine water is being treated at Emalahleni Water Treatment Plant (Witbank in Mpumalanga Province) and passed out as safe water to the communities in the surrounding areas.

to Woolworths stores. The answer was not clear, as they said the target group for said water was local communities – a scary thought indeed. One respondent in the Free State intimated that we cannot claim that water is 100% pure, because it can still contain traces of chemicals that are deemed to be safe. Seawater is desalinated from time to time, as in Namibia, with no deaths recorded. The respondent was asked what if there had been deaths that were not reported as a result of complications stemming from using water contaminated with AMD, to which he responded that what you don't know won't kill you. He said science has put in place minimum standards that are assumed to be safe as long as margins are not exceeded. On being asked further about the cumulative effects of these exposures, he said science has not studied the same; therefore the assumption will be that the water will be declared safe for human consumption. The respondents in Carolina further posited that AMD problems will be overcome by science, and that the public and 'learned' environmentalists, with their innuendos and comical posturing, according to them, will perpetuate the scourge because they bark without offering solutions. When the respondents were asked if they were prepared to wait while investigations continue, he said science wants to make contributions now and not later. He reminded the researcher that SA is a water-scarce country, and that the reverse osmosis currently used by BHP and Anglo Gold at Emalahleni that treats 25 million litres per day to a potable water standard is winning the war against water challenges stemming from water pollution in mines.

5.8.3 Initial discussion and interpretation of Phase 2 interviews

From the discussion above, it is clear that science has cemented its role in the responses of most interviews about the conventional approach to decision-making since, and that it is also endorsed by politicians as a reliable tool in confronting and resolving AMD issues. Where science fails to deliver, the conventional approach maintains, it will appear that the onus of demonstrating harm will then shift from the proponents to those affected by the decision. An example came from one respondent who said that if indeed AMD was the culprit and the monster it was purported to be, proof of the record of people who demised as a result of it should be produced to convince him and others. In other words, his argument was that if there are no body bags that point fingers to the problem of AMD, then it cannot be that AMD is responsible. Similarly some respondents (three) firmly believed that the PP is just a hype geared towards undermining the successes of science. The respondents further posited that the PP is a new boy on the block who has not passed the vigorous tests set by science. The respondents argued that scientific intervention like risk analysis contained in the *Report of the Inter-Ministerial to Committee on AMD* is reliable and effective in addressing AMD issues, and hence why fix it if it is not broken by appealing to other decision-making theories like the PP. The respondents were alerted to the ongoing concerns regarding AMD whose solutions appear to be

eluding the best brains in the scientific communities to correct it. The respondents were also made aware of the failures of the much vaunted and trusted risk analysis and management in other countries like the US in managing the scourge of AMD. The respondents were further informed about the lessons learnt in the West about the ramifications of trusting in one theory of decision-making like risk assessment and management which has not produced the results so desired whilst ignoring alternative solutions. But despite that, some respondents were still adamant and of the view that science-based risk analysis is the way to go.

From a different angle, eleven respondents were of the view that an alternative approach like the PP is an empty concept that cannot prove anything, and the respondents were thus reluctant to leave the comfort zone of science. Since the PP endeavours to include communities in environmental decision-making some respondents were sceptical that science will simply be devalued by non-scientists. My contention, however is that it is indeed so that if the PP is followed, communities will bring their knowledge of their environment and help articulate solutions in a manner that will appeal to both the scientific and the non-scientific community alike, but this does not necessarily mean that this kind of locally contextualized knowledge will erode confidence in science.

My argument is that the artificial borders that have been constructed to divide scientific and non-scientific communities must come down like the 'Berlin Wall' to allow for more constructive discussion, and finding each other to fight the common enemy which is AMD. I argue strongly that despite the fears of adopting and implementing the PP as articulated by the respondents, its success is unparalleled as seen by its effectiveness in decision-making about genetically modified organisms, mad cow disease, climate change debates, etc. (Immordino, 2003; Calzolari and Immordino, 2003). Furthermore the success of applying the PP in decision-making is well documented in accredited peer-reviewed journals,⁴² whereby the PP has been acclaimed for improving environmental quality and human health. My contention therefore is that the PP as an ethical and political tool possesses the possibilities of clearly giving direction to decision-making in contexts of uncertainty. I argue further that given the uncertainty of science, the PP can help decision-makers to instil democratic principles in decision-making, and to gain more clarity on the general direction that need to be followed in decision-making. In other words, the PP acknowledges that the experience of communities cannot be ignored, and can come in handy to assist the scientists to get to the bottom of the AMD issue in particular.

⁴² Further reading see: Van der Belt, 2003; Peterson, 2006; Wilson and Ricketts, 2004.

What was clearly apparent during the interviews was the ignorance I encountered regarding the PP. I am thus of the opinion that the views expressed by the respondents who appear to be anti-PP is informed by a lack of understanding of the concept of the PP and its application in environmental decision-making. Regrettably, the interviews have revealed that the concept of the PP is misunderstood to a point of misinterpreting it, like assuming that the polluter pays principle is equivalent to the PP. I thus quickly had to intervene and explain that the two approaches to decision-making are not the same.

From the interviews conducted, it is also clear that the mining industry focused more on health and safety of its employees and not the environment, i.e. mines generally followed an anthropocentric agenda. These interviews have also clearly revealed massive ignorance in the mining industry about the status of the quality of the environment and its surrounding communities. For example, as it was clearly observed during the interviews that the long term implications of AMD to the present and future generations is not on the agenda of most mines, and most respondents were thus not even aware or were unsure about the ramifications of AMD on humans and the environment. It is also clear that the respondents' views on AMD were grounded on the conventional approach to risk analysis and management despite the uncertainty inherent in this decision theory. Alternative decision-making theories like the PP, in my considered opinion, have not been given the attention they deserve. As I will show in Chapter 6, alternative decision-making tools like the PP are yet to find a footing in a science dominated environment which is highly politicised.

It is thus my view that the conventional approach to risk analysis and management is deeply rooted in the mining industry whilst an alternative decisions-making tool like the PP is available. Hence, from the discussion above it is clear that the concept of the precautionary principle is not well understood. Few respondents in the mining sector understood the concept and hence it is difficult to have this concept broadened and demonstrated as an alternative solution or a partner when dealing with complex environmental issues that seeks alternative solutions that are not scientific in nature (in the narrow sense of the word scientific).

What can one then in summary deduce from the interviews conducted in Phase 2 of the case study?

A number of things:

1. The concept of PP is not well understood by all who are custodians of the mining industry.
2. Those who know something about the PP, think that it is too theoretical and hence they cannot find any practical application for it.
3. Among those involved in the mining sector, there is a lot of scepticism about the relevance of the precautionary principle.

4. Fear was expressed in embracing what was regarded as a foreign concept, as the environmental terrain in South Africa is different from others (notably, as seen by Europeans and Americans).

In addition, Phase 2 of my field work revealed that the impact of AMD has come to highlight the dangers in which communities who reside in close proximity to these hazardous activities find themselves. It also became clear that mining activities undermine the human and social rights of those communities. Despite the good environmental laws that South Africa has, such laws are not able to protect the environment and human health adequately because of blind trust in science. As I will show in the discussion of Chapter 6, decision-makers place lots of trust in expert knowledge whilst lay knowledge is marginalised. Thus from the discussions in the previous chapters and interviews conducted with respondents, science has proven to have implementation challenges because it is perceived as monolithic.

5.9 Conclusion

What is evident from the interviews with the different stakeholders is that the threat of AMD is real in terms of human health and environmental stability and integrity. According to the literature, and following from the interviews, the problem of AMD has surfaced even more aggressively as a result of the corrupt relationship between the government and the mining industry (the question of corruption is discussed in more details in Chapter 6), as seen in the government failure to intervene decisively in the AMD and Marikana debacle, failure to force the mining house to account for their environmental impacts, and failure to come up with clear policies that will force the big polluters to clean up their act. This follows to a great extent from the well-known fact that certain high ranking officials of the ruling party in South Africa (the African National Congress) is known to have interests in mining, and thus the ruling party is playing the role of being a player and a referee in the mining industry.

It has therefore emerged from my interviews that science alone cannot be relied upon in environmental decision-making and will therefore need to work in close association with other decision theories like the PP to manage and reduce the impact of mining on ecosystems and human health, as well as the risks associated with AMD. While attention in the mining industry is clearly directed at maximising profit and neglecting environmental protection and human health, sustainable solutions need to be reinforced with participatory approaches to legitimise and give credence to environmental decision-making.

On the basis of the literature assessed and the intensive interviews, I have arrived at the conclusion that the threat of AMD, although political, also has a number of other important dimensions to it: (i) the failure to effectively address it is clearly the result of inconsistent legislation; (ii) there is a knowledge gap because of insufficient research on AMD impacts on ecosystems and human health; (iii) decision-making about AMD is characterised by a lack of public participation; (iv) responses to the challenges of AMD are undermined by corruption (further discussed in details in Chapter 6); and (v) that the problem of AMD will continue to haunt societies due to fragmentation in decision-making owing to different government departments dealing with the same issue.

Chapter 6

Deeper Dimensions of the AMD Case

6.1 Introduction

In Chapter 5 I have reported on the responses that were provided to me as direct answers to the questions that I posed respectively in the two phases of my interviews. While, as I have shown, these direct responses were already highly revealing in that they clearly demonstrated the dominance of the conventional approach to risk assessment and management around the AMD problem, the problems created by this approach, as well as shockingly low levels of knowledge of and commitment to an alternative approach such as the PP, they also revealed deeper dimensions of the AMD problem that need to be discussed in the context of an assessment of the power and promise of the PP as a decision-making tool. These deeper dimensions have to do with the socio-political context within which the AMD problem emerged and is currently playing itself out. Since these contextual dimensions also have a bearing on any efforts, be they conventional or alternative efforts, to address the AMD problem, it is important that they are highlighted here in a separate chapter. It is also important to take an in-depth look at the context to incorporate the highly important insight supported in this thesis, namely that science, even if it has problems of its own in terms of dealing with uncertainty and complexity, cannot summarily be discarded, but need to be used in combination with the wider precautionary approach to decision-making.

At the start of this chapter it is important to know that most, if not all of the deeper dimensions of the AMD problem that have come to light in my interviews carried a very high political load, given the political landscape of our country in general, as well as the political landscape of the mining sector in particular, during the time of conducting my interviews. As it happened, I conducted my interviews just before and just after the Marikana massacre in August 2012, which sent huge shock waves throughout the mining sector in South Africa. While Marikana was directly linked to platinum mining and my interviews were conducted at working and decommissioned gold and coal mines, the political atmosphere within which respondents engaged with my questions, lent itself to a lot of political "venting". While this could be seen as a serious constraint of this thesis, introducing problems of bias, which I acknowledge, I also interpreted the perspectives shared with me on a political level as access to concrete experiences that otherwise might have gone unmentioned. As I see it, the concrete experiences of people affected by public decision-making need to be taken seriously, and as I propose, I am of the view that this can be done better by the PP than by the conventional approach to science based risk assessment and management.

Accordingly, I represent and discuss political perspectives as they were present and articulated to me in the mining sector at the time. I see my task as a researcher to report honestly and openly on what I found in my field work. In order to deepen a critical insight into the contextual dimensions of the AMD problem, I will start my discussion in this chapter by referring to decision-making about AMD as it was conventionally done within the narrower context of the mines themselves. Then I will move to a discussion of the effects of this decision-making on communities around affected mines as well as the broader public, and then I will address larger structural issues influencing decision-making about the AMD problem. Before I conclude this chapter, I will attend to a legal, political and ethical perspective on the problem of AMD as it has emerged from my overview of literature and field work. In order to enhance the primary research material that I gathered through my interviews, I also make use of secondary literature from the press as well as academic writing.

6.2 Conventional decision-making and practices in the mining context

From academic literature on this topic it is evident that the challenges facing the governance of water resources and in particular AMD, its principles, and the scale at which it is organised and managed, is at the forefront of conflicts and tensions playing themselves out worldwide between government and scientists on the one hand, and communities and non-scientists on the other hand. As we have also seen from the discussions in the preceding chapters, insight into the power relations that underpin and inform nature-society relations, as well as the views of environmentalists have advanced our understanding of how acid mine drainage and water can be politicised to a point of undermining public confidence (Swyngedouw, 2004; Linton, 2010). In this literature, for instance some of the perspectives and dimensions are highlighted in which government institutions and processes of water governance and management (e.g. Bakker, 2003a; 2003b) can lead to social struggles (e.g. Norman and Bakker, 2009), which will impede or halt the search for a lasting solution (e.g. Loftus, 2006). It is thus critical that issues that have the potential to derail efforts that seek to reduce the impact of mining be identified with the aim of managing the tensions that so arise to give or suggest alternative solutions regarding AMD and the quality of water (e.g. Perreault, 2005). Although this body of work has acknowledged the scalar dimensions of the governance of water and mineral resources, and has demonstrated that both water and its governance are politicised, linkages with the politics of scale – the recognition that scale is socially constructed and politically mobilised – are relatively promising (Cohen & Davidson, 2011; Norman & Bakker, 2009; Perreault, 2005; Swyngedouw, 1999, 2007). However, much of this work continues to take the hierarchical physical boundaries and administrative structures that characterise most instances of water governance as given, thus a closer examination

of the scalar politics and other related dimensions with which water and AMD governance is organised may yield valuable insights.

As it will be substantiated below, reviews of literature and the interviews that I have conducted across the decommissioned and commissioned gold and coal producing mines in Gauteng, Free state, Limpopo, North West and Mpumalanga provinces have revealed deep rooted challenges in so far as the governance of water and mineral resources goes, particularly in so far as AMD is concerned. Environmentalists, scientists, communities and certain representatives of government alike have alluded to the notion that AMD is a challenge with the potential to erupt into another "Chernobyl" kind of disaster. As I will demonstrate below, there are a number of underlying factors that initially led to a denial in government and industry circles that there actually is a problem regarding AMD, as there are a number of factors, decision-making strategies and perspectives contributing to difficulties in adequately addressing, or just managing the AMD problem. As I will demonstrate below, these factors have to do with inadequate legislation, or inadequate implementation of legislation, the profit motive, and a general attitude of scepticism and denialism of the AMD problem. I will furthermore show what the effects of these factors are on communities on the receiving end of decision-making (or the lack thereof) about AMD, and then I will proceed to discuss further dimensions of the AMD problem when they are approached from a political and a moral perspective.

6.2.1 Constraints from legislation, implementation and the profit motive

One of the first things to point out in Section 6.2, is that the AMD problem currently faced by government and society in South Africa is to a large extent a result of a governance failure, characterised on the one hand by a lack of strong legal provisions that could have prevented the problem of AMD during earlier phases of mining in South Africa, and on the other hand by a lack of implementation when stronger legal requirements were eventually put in place with regards to mining and mine closures. In this section I argue that this lack of implementation can be ascribed to a large extent to mining houses and government alike focussing more on profits and cost-cutting than on legal and moral requirements not to pollute (or to address pollution where it in fact has occurred).

Prior to the promulgation of the National Environmental Management Act (No. 107 of 1998, also known as NEMA) and the National Water Act (No. 36 of 1998, referred to below as the NWA), mining companies were only really bound by the Water Act of 1956 which was insufficient in dealing with mine closures (DWA, 2011). Thus, historically, it was legally possible for mines that were no longer profitable to be boarded up and abandoned and the land transferred to the government. Confirmation of this, was the Fanie Botha accord of 1975 (Chamber of Mines), where an agreement was reached

between the Chamber of Mines and government, which stated that after 1976, government would take over the ownership of abandoned mines, if they existed before 1976 (DWA, 2011).

However, even within the framework of the latest environmental legislation, there was actually very limited regulation by government in real terms. While both NEMA (Act no. 107 of 1998) and NWA (Act no. 36 of 1998) stipulated that *“a party has to take all reasonable measures to prevent pollution or degradation from occurring, continuing, or recurring as a result of mining operations for which it is responsible”* (Van Eeden *et al.*, 2009), this was never effectively enforced by government. In fact, according to current legislation, mining companies are only required to comply with environmental legislation reflected under the Department of Mineral Resources, as covered in the Mineral and Petroleum Resources Development Act (MPRDA) (Act no. 28 of 2002), and thus are able to avoid the more stringent DEA environmental legislation (DEA, 2011).

Pursuant to that, mining activities are regulated by legislation from the mining, water and environmental divisions. In terms of the Mineral and Petroleum Resources Development Act (MPRDA), the principles set out in Section 2 of the National Environmental Management Act (NEMA) apply to all prospecting and mining operations.⁴³ In essence, this means that any prospecting or mining operation must comply with generally accepted principles geared towards sustainable development by articulating social, economic and environmental factors into planning and implementation of such operations. The NEMA and the National Water Act (NWA) stipulate that a person(s) or party answerable or responsible for any mining operation shall take all reasonable steps to ameliorate pollution or degradation from taking place.⁴⁴ Accordingly, the MPRDA⁴⁵ requires that the holder of a mining right or permit is responsible for any environmental damage and pollution including rehabilitation of the environment affected by mining to its natural state until a closure certificate has been issued.⁴⁶

However, amid all these stringent legal provisions, implementing them has proven to be a debatable task and cumbersome. This point has been affirmed numerous times in my interviews when it was stated that the role of NWA was complicated considerably by a murky description of the fundamental issue of how high AMD levels are allowed to rise below the surface. For instance, abandoned mine drainage if allowed to rise, it may run off from its original spot and contaminate nearby water bodies, thus affecting water quality negatively and rendering it undesirable for use (Johnson & Hallberg,

⁴³ RSA, 1998. National Environmental Management Act No. 107 of 1998.

⁴⁴ RSA, 2008. National Environmental Management Amendment Act, No. 62 of 2008.

⁴⁵ RSA, 2002. Mineral and Petroleum Resources Development Act, No.28 of 2002.

2005). In addition, heavy metals can be leached from rocks that come in contact with the acid, a process that may be substantially enhanced by bacterial action (Younger *et al.*, 2003). The resulting fluids may be highly toxic and, when mixed with groundwater, surface water and soil, may have harmful effects on humans, animals and plants (Clark, 1995).

It is therefore clear that where there is lack of official oversight from and coordination amongst government departments that work and deal with water and mining issues on daily basis, the AMD crisis is likely to proliferate, which may further frustrate efforts to effectively implement the legislative framework to deal with the AMD rampage (Van Eeden *et al.*, 2009). The fact that the different departments dealing with the same issue of water governance are not working in unison is a cause for concern which unfortunately has the propensity to thwart efforts to address the sensitive and complex issues related to AMD, e.g. the Department of Water Affairs and the Department of Mineral Resources. Thus, lack of cohesiveness by different government departments in terms of how they coordinate their efforts will have far reaching consequences according to some respondents interviewed at various mines of SA. Accordingly, some respondents argued that failure to adequately and robustly address the proliferation of AMD may result in cumulative disaster which may become evident decades later. It is also important to explicitly state that the question of water management and its governance is fuelled by the failure of both government and mining houses to take responsibility for the AMD crisis. The greatest challenge facing enforcing legislative requirements is the question of courage as to who takes the first step towards paying for the remediation of AMD (Adler & Rascher, 2007). There is apparently a stalemate here. No one wants to lose face lest they lose their integrity, one respondent ironically quipped.

It has also emerged during the interviews that there is fear to act against those responsible for the proliferation of AMD, and weak enforcement of environmental legislation has made some parties to appear as bold and untouchable because government is seen as being 'shy' in forcing mining companies to comply with legislation, according to some respondent. Thus, failure to act has provided communities with the arsenal to accuse the government of colluding with the mining industry through their inaction. This perceived inaction resulted in unprecedented levels of protestation in some communities.

For example, this inaction culminated in a massive protest by communities in and around Carolina in Mpumalanga Province that resulted in mayhem and destruction to government property. Several governments owned properties were torched in Carolina in Mpumalanga Province on 10 February 2012 as a prelude to the Marikana crisis (McCarthy & Humphries, 2013). There is no denying that the AMD issue had severely undermined the quality of life in Carolina and surrounding communities,

particularly farmers who are struggling to make ends meet as a result of polluted waters. The government as the custodian of natural resources was expected to apply the law robustly so that those who are undermining the constitution by failing to prevent water pollution stemming from the AMD challenge could be brought to justice (Tempelhoff *et al.*, 2012).

It also appears that failure to robustly implement environmental legislation to remedy the AMD problem and ensure sound water quality management generally is biased in most instances by economic interest and concerns rather than by environmental concerns which, according to me, is a travesty. Turton (2009: 59) has posited that the evolution of South Africa's mining industry was one where *"powerful financial interests coincided with the interests of a racially defined elite, which saw government becoming a collaborator rather than a regulator of the mining industry"*, which for the last century has manifested itself as a policy and practice of extraction. This view is supported by Van Eeden, Liefferink and Durand (2009: 28), who postulated that *"both parties⁴⁷ benefited economically from this relationship, while government turned a blind eye to environmentally and socially harmful practices of mines"*.

In his seminal work, Turton (2009) determined that throughout the history of mining in South Africa, the focus was on the generation of profits, and reducing operating costs and thus all liabilities were avoided – basically these costs were externalised. As such, this policy of extraction has basically continued through to our present day government. The environmental legacy of past mining, frequently poses major problems (Danielson and Lagos, 2001), which are similar to the potential impacts of existing mines, but pose the problem of liability for clean-up and its costs. The largest liability in this field is acid mine drainage which may be a long term problem, such as in the Rio Tinto region in Spain, which has been a source of acid mine drainage for at least 200 years (Balkau and Parsons, 1999). Some examples of past mining environmental legacies in sub-Saharan Africa include: The mining industry has traditionally been a major recipient of foreign direct investment in sub-Saharan Africa, and has commonly been an important foreign exchange earner for the region. To that end, mining in South Africa, like in the rest of the world has become a cash cow. Sadly, profit margins in South Africa appear to have taken precedence over environmental protection. Against this backdrop of considerations such as the above, having been supported by many respondents in the interview, it is my contention therefore that as long as government and business fail to respond positively in terms of how they will implement smart anti-pollution strategies stemming from AMD, the two parties (government and mining houses) are likely to prolong and accelerate the devastation

⁴⁷ That is: government as well as mining houses.

of water quality in the country and thus also impact negatively on water governance, and so, government and mining houses should not be seen as separate entities working for their own interest but as partners, because it is absolutely clear that they are not acting in the best interest of the environment as alluded in the interviews.

Lastly, it has also strongly emerged during the interviews that the failure on the side of government are much deeper than meets the eyes. Firstly, government and mining houses have been accused by some respondents of colluding through denialism, or under- misrepresenting the magnitude of the AMD problem as it will be discussed below. Furthermore, the scepticism displayed by certain sectors of the mining industry and some politicians seem to be firmly grounded and thriving as will be also discussed below.

6.2.2 Denialism regarding the AMD problem

The greatest challenge that impedes AMD resolution and management is by far denialism and scepticism that play out in the public arena and political environment. For instance, the announcement by former minister Buyelwa Sonjica⁴⁸ that the problem of acid mine drainage is exaggerated, is indeed a great concern, for such statements are open to misinterpretation, and place a big question mark behind government's commitment to resolve this issue (I-Net Bridge, 2010). Furthermore, the outburst by past Planning Minister Trevor Manuel in parliament⁴⁹ did not help the cause of AMD either in that he accused an unspecified private sector interest of meddling and portraying a false picture to the world of the extent of the AMD issue in South Africa. The Minister perceived this so called interference as vindication that certain sectors did not serve the interest of the country but have a hidden agenda of trying to undermine government's sincere efforts to redress the question of AMD. Politicians like Trevor Manuel therefore insinuate that certain sectors and some people want to dominate the agenda on AMD (SAPA, 2010; De Lange 2010a; De Lange 2010b: 6-8). This state of affairs

⁴⁸ Minister Buyelwa Sonjica, responding to the opposition in Parliament regarding the crisis of AMD in Gauteng on the 10 August 2010 responded thus: "The exaggeration of this problem is un-called for and I would like to urge all interested and affected individuals and organizations to refrain from making alarmist statements in relation to this issue", Sonjica said, adding that the financial interests of the private sector are also to a large degree playing a role in fuelling some of the hype around AMD. "Government views the matter of the Acid Mine Drainage in a serious light and a series of engagements with my counterparts in the government have taken place on this urgent matter". (19 August 2010, in the South African Parliament)

⁴⁹ In response to a statement on 10 August 2010 made by Independent Democrat MP Lance Greyling that decisive government action was necessary on the question of acid mine drainage, Manuel responded: "What we need is a rational discussion ... informed by an empirical basis, because the idea that there will be acid mine drainage running through the streets of Johannesburg next week, and that we should all walk around in gum boots, is completely ridiculous." (SAPA, 2010).

is a clear red flag that the government is failing to intervene decisively in order to respond adequately to the urgency of the problem after years of neglect, hence the blame game that does not add value to the resolution of AMD.

According to McCarthy, (2010: 6) Government has for decades been paying pumping subsidies to mines to cover the cost of pumping inflow from defunct, adjacent mines as it is; and he notes that *“Government is invariably the largest single beneficiary of mining ventures through the state share of profits formulae, taxation of company profits and taxation of salaries paid to workers”*.

In the same breath, Maslin (2009), has argued that in human behaviour, denialism is exhibited by individuals choosing to deny reality as a way to avoid dealing with an uncomfortable truth. O’Shea (2008: 20) also stated that denialism is *“the refusal to accept an empirically verifiable reality. It is an essentially irrational action that withholds validation of a historical experience or event”*. It has been proposed that the various forms of denialism have the common feature of the rejection of overwhelming evidence and the generation of a controversy through attempts to deny that a consensus exists (Diethelm & McKee, 2010).

Several motivations and causes for denialism have been proposed, including religious beliefs, self-interest, or as a psychological defense mechanism against disturbing ideas (Hambling, 2009; Monbiot, 2006). It is in this sense that the phrases *“Holocaust denialism”* and *“AIDS denialism”* have been used (Kim, 2007; Cohen, 2007; Smith & Novella, 2007), and similarly the phrase *“climate change denialism”* have been applied to those who argue against the scientific consensus that global warming is occurring and that human activity is its primary cause (Colquhoun, 2009; Goodman, 2007). The concept *“denialism”* has thus become a widely used label for a highly undesirable set of ideas or practices, and as can be understood, this usage has been criticised as a polemical propaganda tool to suppress non-mainstream views (Fitzpatrick, 2009).

Individuals, organisations, businesses and politicians who reject propositions on which a scientific or scholarly consensus exists (i.e. denialists) typically make use of certain rhetorical tactics to give the appearance of argument or legitimate debate, when in actual fact they engage in nothing of that sort but rather in ideological posturing (Hoofnagle, 2007). Then there are those who engage in denialist tactics because they are protecting some ‘agenda’ or ‘overvalued idea’ which is critical to their identity. Since legitimate dialogue is not a valid option for those who are interested in protecting unreasonable ideas from scientific scrutiny, their only recourse is to use these types of rhetorical tactics (Stoff, 2007).

Accordingly, Edwin Cameron, a senior South African judge who is also an AIDS activist has posited how Aids denialists typically use the same tactics as those who deny the Holocaust. He states: *"For denialists, the facts are unacceptable. They engage in radical controversy, for ideological purposes, of facts that, by and large, are accepted by almost all experts and lay persons as having been established on the basis of overwhelming evidence"* (Mail & Guardian, 17 April, 2003). To do this they employ *"distortions, half-truths, misrepresentations of their opponents' positions and expedient shifts of premises and logic"* (Mail & Guardian, 17 April, 2003). According to Cameron, the tactic used by denialists is to *"make great play of the inescapable indeterminacy of figures and statistics"* (Ibid), as scientific studies of many areas rely on probability analysis of sets of data, and in historical studies the precise numbers of victims and other facts may not be available in the primary source.

As in all scientific endeavours, certainty and consensus go hand in hand with uncertainty and debate, thus providing denialists ample *"material"* for their efforts to destroy or discredit scientific investigation and consensus building on a certain issue. The history of HIV/AIDS correlation is no exception to this rule, nor the question of acid mine drainage.

Like AIDS denialism, the scale of AMD denialism is also profound in South Africa and characterised by the rhetorical tactics sketched above. For example the South African government, specifically the Department of Water Affairs and Forestry appointed an eminent water specialist, Helgard Muller who later became Chief Director in the Department of Water and Environmental Affairs to advise them on the impact of AMD. This was sequel to the number of scientific findings and arguments that were submitted to the South African parliament regarding the reality associated with AMD that was underplayed by both the erstwhile government and the present ruling party, the African National Congress. The sole aim of his appointment was to lend supporting evidence or credibility to the government's position that the challenges of AMD are exaggerated. The two well-known AMD denialists in the government of Thabo Mbeki were Trevor Manuel and Bulelwa Sonjica (Mining Weekly, 2011; Cloete, 2010). To support this view, Helgard Muller made special references in his own statements to anomalous critical papers that supported his views on AMD while staying silent on those articles that differs from his views (Mining Weekly, 2011). He denied, for instance, any suggestion that there was a water crisis owing to rampant AMD proliferation in the country (Mining Weekly, 2011). Instead, he saw business opportunities emerging as a result of this purported 'AMD disaster', and he foresaw the GDP increasing with the prospects of job creation and poverty alleviation. In the same breath it was not surprising that a number of respondents interviewed also questioned the veracity of certain environmentalists who have argued that AMD is undermining the quality of life of the people of South Africa by denying them good quality of water.

According to Liefferink (2010) AMD is not taken seriously by government, motivating her view by stating that the Minister of Water Affairs, Edna Molewa, has allocated a paltry R433 million towards the AMD issue, but deemed it fit to announce the building of a new head office for the Ministry for R8 Billion. Mariette Liefferink (Foundation for Sustainable Development) posits that AMD has been denied and downplayed even before the dawn of democracy in 1994 in South Africa. For instance, she laments the fact that the question of AMD has not been properly acknowledged: *“Acid mine drainage is not a uniquely South African problem. What is unique — is that it is denied, it is suppressed, it is minimised — and not addressed”* (Liefferink, 2010: 34). On the other hand Melissa Fourie, executive director of the Centre for Environmental Rights (2012/2013), argues that *“the response has been small because government officials are paralysed by the enormity of the problem. The big things like liability have been difficult to deal with. It’s difficult to change the status quo, it’s difficult to challenge the mining companies. But it has to be done”*.

From what has been discussed above, it is clear that the notion of denialism is and has always been part of the discourse in the environmental arena where economic interests are at stake. The fact that the impact of AMD has been downplayed and even denied by government and mining houses is disappointing to say the least. It appears that the only groups that see the danger associated with AMD are environmentalists, the print and electronic media, and to an extent communities who bore the brunt of this environmental onslaught (Scott, 1995; McCarthy, 2011; Liefferink, 2010). The devastation of ecological systems and the well-being of affected communities as a result of the aftermath of mining, particularly with the AMD scourge, are well documented (Rawat, 1982; Berghorn & Hunzeka, 2001; Gray, 1997; Gaikeard & Gupta, 2008; Alder & Rascher, 2007).

It is therefore my contention that when we deny the seriousness of AMD, it will not necessary make it go away. Rather acknowledging the ramifications of AMD will enjoin policy-makers to formulate appropriate responses to this scourge (McCarthy, 2010; Liefferink, 2010). We also need to accept that AMD is the result of a century and more of environmental damage, and importantly so hundreds of mining companies have long closed down — so which companies must be held accountable for a century of pollution? Mines in many affected areas are no longer operational, making it difficult to enforce compliance. But if indeed we must accept McCarthy’s point, how then must government ensure that companies currently mining are not allowed to sidestep culpability for the destruction of the environment because some of their predecessors are not around to foot the current bill? Again, an integrated and balanced solution lies with the state and existing mining houses to contribute towards AMD resolution.

Given the challenges associated with denialism, and importantly where the discourse on AMD tend to play out in the political and business realm, and notably in the face of the exclusion of community members affected by AMD in decision-making, the following paragraph will further give credence as to why solutions that exclude community members are likely to fail. The following paragraph below will also attempt to demonstrate why policy-making and implementation fall flat when people who matter most are excluded in decision-making, particularly in the context of environmental decision-making surrounding the questions of AMD.

6.3 Mechanisms of marginalisation and discreditation

Generally speaking, the vulnerable communities are the ones who usually pay the ultimate price of environmental mismanagement. The said group are for all intents and purposes mostly side-lined in environmental decision-making because of pre-conceived ideas that their input in environmental decision-making cannot be trusted if subjected to intense scientific scrutiny. The bottom line is that local knowledge has been seen or perceived as unreliable and thus cannot be trusted since decisions based on it are mostly informed by experience that has not been tested using rigorous scientific methodology.

6.3.1 Exclusion of communities in decision-making

It is very clear from the preceding discussion that denialism by the scientific community and their cohorts have undermined and impacted negatively in democratic processes of finding common goals between the scientific community, government and the non-scientific community. To that end, exclusion of local communities in environmental decision-making can easily undermine and complicate conventional thinking on natural resource management and amelioration of AMD in some parts of South Africa's provinces. This means that those who feel powerless tend to vent their frustration in a violent manner. A case in point, as already indicated earlier, includes violence that erupted in Carolina in Mpumalanga and elsewhere as a sequel of exclusion in decision-making. Therefore, where vulnerable communities felt totally isolated, disempowered and marginalised in environmental decision-making, particularly in matters involving AMD, they then turn to lawlessness to achieve their goals. With the issue of AMD, it is clear that policy-makers continue to place their trust in technical solutions to problem solving (Uphoff 1986; Ramirez 1999; Groot and Maarleveld, 2000). Scientists and policy-makers like to work with inherently linear approaches that clearly define steps of creating a goal statement, assessing constraints or problems and opportunities for achieving the goal; as well as identifying ways to solve problems and selecting the best solutions (Groot and Maarleveld, 2002). Politicians similarly demand technical information on which to inform decision-

making. Politicians also benefit from the ability to deflect responsibility onto technical failures when those decisions do not turn out for the best. Bad decisions, say about managing BSE (bovine spongiform encephalopathy, 'mad cow disease') or foot and mouth disease, for example, can be conveniently blamed on inadequate science. In this instance, Rayner characterizes the present era as the 'age of assessment' (Rayner, 2003), alluding to the tendency of only accepting scientifically "proven" assessments as the basis of decision-making.

On the one hand, policy-makers who are largely reliant on science tend to create a wedge in thinking that suggest that communities by virtue of them not being specialists cannot be trusted to make meaningful contributions to environmental decision-making, especially on the question of AMD. The responses from interviews and my interrogation of literature seem to concur that decision-making is compounded by competing requirements such as flexibility, or the often conflicting goals of knowledge or data extraction vs empowerment (Guijt & Shah, 1998; Cooke & Kothari, 2001; Sarin, 1998). It seems as if the government and the communities do not seem to see the problems of AMD at the same level. When these competing values emerge, conflicts abound because it becomes difficult to find the most appropriate methods to suit each other's objectives. Therefore, the weaknesses and strengths that so emerge as a result of the said conflicts further create a divide in the context of resource management and governance.

The other critical point that emerged during the interviews was that policy-makers have vested interest in the outcomes of research, as has been demonstrated by research on the AMD dilemma, and since they (policy-makers) are funders of research they often seem to neglect participatory methodologies and only rely on the output of the 'experts'. This was a new revelation during the interviews that clearly indicated that stakeholders are not all taken on board when decisions that involve the AMD complexity are taken. It was clear therefore that decisions that require research about local resources demands the same level of local engagement (Sheil *et al.* 2003). Whereas most citizens feel that they are competent to judge what moral or aesthetic values appeal to them in the context of environmental challenges, particularly AMD, however, they are less confident in their competence to second-guess technical expertise. This makes them vulnerable to participate in decision-making because the type of expert language used put them off and hence they disengage themselves from further participation.

Therefore, resolution of AMD is possible if professional knowledge such as risk assessment (National Research Council, 1996) can be applied in conjunction with local knowledge, rather than dismissing local knowledge as irrelevant and insufficient to resolve key environmental problems emanating from complex processes like mining. Community activists often draw from their experiences of seeing their

own or a neighbour's sick children, combined with observations of industry smokestacks and foul odours, to piece together credible evidence (Tesh 1999). Therefore marginalising communities cannot be a justifiable option, since when that happens it may lead to polarisation, which is fertile grounds for anarchy.

It has emerged also during interviews and in my review of literature that communities have also become aware of their environmental rights and individual rights. In other words when a mining project is envisaged, communities around the proposed mine are aware that mechanisms should be in place to improve revenue derived from royalties, income taxes, land taxes, lease rents, etc. which must be shared and distributed at local level. Many examples of these new approaches abound (ECA, 2004).

Importantly so, the war against AMD cannot be waged and won from a narrow thinking that local communities cannot add value to the solution of AMD. Instead, the power of local knowledge can be assimilated into the wider context of resolving AMD. Local communities can contribute more to the body of scientific knowledge by infusing local experience towards resolution of the AMD problem. On the other hand, AMD will/may continue to proliferate if community members perceive their exclusion as paternalistic. In that view therefore community members' playing field tends to tilt towards distrust, and lack of inclusivity destroys trust (Slovic, 2000: 316-326).

Therefore, there is a need to empower local communities to effectively and meaningfully participate in mineral resources development in their constituencies, a need to capacitate them through training and improvement of their right of access to information. Participation should also be extended to policy formulation and planning and monitoring of project implementation. Communities must, as a basis of inclusivity and burden sharing, be allowed to participate in environmental impact and social assessments. Such participation should be mandatory through the elected leadership of the local communities.

Accordingly, it has become imperative to recognise the power of public participation in affecting any policy decision that will be embraceable and endorsed by all. Nevertheless, any adoption of any legislative framework or policy may be prevented by other serious challenges which, amongst others, include side-lining and discrediting the voices of concern. Therefore, the paragraph below will attempt to demonstrate and point out the dangers of discrediting voices of concern since such undermining of concerns articulated by community members may jeopardise and derail decision-making that will undermine efforts to mitigate and resolve AMD related issues.

6.3.2 Discrediting voices of concern

Fresh water in South Africa is scarce and the supply fully accounted for in terms of existing use. Much of the country is semi-arid, and only fourteen percent of its surface is available for arable farming (DWA, 2009). Cities are facing water stress and in some cases, due to drought, municipalities have had to recycle sewerage or institute expensive desalination projects (DWA, 2009). However, the greatest voices that raised concern about the impending looming disaster came from groups like Civil Society Advocacy on AMD (Centre for Environmental Rights, 2012/2013; Business Day, 28 October 2010; Business Report, 22 October 2010; Business Report, 6 September 2010). Unfortunately the response from government was equally to the task with government discrediting such concerns as unscientific and hyperbole of the greatest order. Some responses were scathing in that those who raised concerns were viewed as a “*third force*” trying to undermine and score cheap political points.

I want to place on record from the outset that some mining companies, as well as those who have a financial interest in mining, are extremely antagonistic to insinuations that mining is responsible for AMD. Some of the respondents interviewed at Ponderif and Bushbuckridge in Mpumalanga, Phuthaditjhaba in the Free State, etc. holding management positions indicated that certain environmental groups and scientists seem to subject communities to periods of moral panic. A moral panic is an intense feeling expressed in a population about an issue that appears to threaten the social order (Jones & Jones, 1999). AMD in this instance falls within the parameters of this definition and is clearly responsible for social disorder as evidenced by social protest around the communities affected by AMD. It is, however, clearly a ploy from mining houses to shift the attention away from the AMD issue by accusing those who raise concern about it, as raising panic and protests.

Government and mining houses have been waging lyrical wars against certain environmental group who they blame for fermenting rhetoric that suggest that the mining industry is responsible for the AMD debacle without hard facts, given the selective knowledge these groups possess. They further insinuate that, by using such scare tactics and misinformation they are threatening societal values and interests. They further allege that mass panic can result in violence and the undermining of law and order (McClellan, 2008). The mining industry had singled out the print and electronic media as building mountains out of molehills regarding the extent of the AMD challenge (McChesney, 1999), and similarly the AMD saga, according to the mining industry, has been blown out of proportion by the hype surrounding it.

Some respondents in my interviews claimed that AMD provides such a good story, it has generated enormous media reaction. This in one hand has resulted in violence amongst communities affected

by AMD. It is indeed true that sometimes the media may elicit moral outrage as was the case in Carolina in Mpumalanga in 2012. A supervisor at one of the mines in Gauteng, however, offered a different response to the question of the mass media. He sees the role of the media in the AMD saga as nothing but mass deception. Mass deception is created when distorted mass media campaigns are used to create fear, reinforce stereotypes and exacerbate pre-existing divisions in the community, often based on political affiliation and class (Bonn, 2010).

Against this backdrop, mining houses have maintained that the AMD matter has been transformed into 'folk devils' (McRobbie & Thornton, 1995), and that those who are opposed to irresponsible mining should be seen as deviant, outsiders, and people who want to fan the flames of violence. The saga involving AMD thus appears to be downplayed to such an extent that detractors see it as a political creation to try to discredit former miners.

Mining magnates also point out that public outrage which they portray as mass hysteria over a perceived problem like AMD can influence politicians' perceptions, which could result in the promulgation of legislation that is more punitive, and absolutely unnecessary. This is done in order to rationalise the agendas of those who are detractors of AMD.

While it is not that the media may have a tendency of exaggerating stories (Jewkes, 2011), my contention is that the government nonetheless has a duty to investigate and respond accordingly. If the allegations so levelled are incorrect, government can demand a retraction. However, if it is found that there is a clearly a further duty of government to address these substantive issues and not deny their existence. As such the press and voices of concern can become allies of government in the fight against, instead of being treated as enemies that have to be eliminated.

In the next paragraph I would like to shift my attention to broader structural issues in the mining sector and its governance that lay stumbling blocks in the way of effectively addressing the AMD challenge. In this section I will focus on the lack of coordination between different government departments, labour legislation and black economic empowerment, and poor decision-making by government.

6.4 Broader structural dimensions

Issues of water governance and management are in many cases impeded by a number of poor working relationships and distrust amongst different divisions of government. There appear to be fear of losing power and authority by different line function managers if efforts are coordinated at a certain level. When this distrust manifest outwardly, tensions amongst different government departments also tend to rise to a point where the real question of AMD becomes relegated to the bottom. This on its

own will have serious ramifications for resolution of AMD challenge and this will leave communities at wits end. In the sub-section below I discuss this problem with reference to lack of coordination between different government departments, labour legislation and decision-making in government.

6.4.1 Lack of coordination between different government departments.

From my research it is evident that the failure to resolve the South African AMD threat has not been as a result of a lack of ideas or knowledge among experts about possible solutions (Johnson & Hallberg, 2005; Kidd, 2009; Ewart, 2011). While the AMD challenge in South Africa has been well researched, this failure is the result of divergent responsibilities and implementing strategies of various government departments charged with the management of AMD. Government departments, private institutions, mining houses, university professors and scholars have conducted research on AMD, the impact thereof and possible solutions. However, the evidence reveals that researchers have adopted a reductionist approach regarding AMD, with studies that have typically revolved around isolated solutions to individual elements of the process, such as: sulphate reduction (Poinapen *et al.*, 2005), the treatment of heavy metals (Van Hille *et al.*, 1999) and cost savings through the use of alternative reagents (Somerset *et al.*, 2009). Regardless of the numerous solutions that have been researched and proposed, the immediate AMD threat posed by the abandoned mines (of which there are a reported 8000 in South Africa (Turton, 2010) still awaits urgent intervention.

As I have indicated above, delays in conclusive actions may have been prompted by debates on who is to blame and thus who should foot the bill when addressing AMD – government or the mining companies? However, there are much more to this beneath the surface that can explain the failure to effectively address the AMD problem in South Africa. Stemming from a DWA commissioned task team: the DWA announced in February 2010 that an agreement had been reached in a joint collaboration with the mining houses on a model to deal with AMD (McCarthy, 2010: 8). While the announcement made mention of the establishment of a public-private partnership that would assume technical and operational responsibility for the model, it made very little mention of the exact treatment approach that would be followed. Reference was only given to the refurbishment and development of infrastructure for the collection, conveyance and treatment of mine water at a central point.

Richard Doyle of Earth Metallurgical Solutions has further suggested that there may be various other reasons for the delay in implementing a solution, including *“technical complexity, responsibility, cost, changes in government and the state’s shortage of skills”* (Ensor, 2011). McCarthy (2010: 9) questioned whether the inaction was *“due to the nature of government or the proximity of government to mining companies and their revenue, or the impact of BEEllionnaires in the mining*

sector". However, in the latter half of 2010 (prompted by what some say was sensationalism by environmental activists and the media), it appeared that action would finally commence when the South African government announced a reappraisal of the threat of AMD by a special team of experts commissioned by the Minister of Water Affairs.

The assembled team of experts were tasked with reappraising the research and risks associated with AMD, assessing viable short-term solutions and exploring medium- to long-term sustainable options in partnership with the private sector (DWA, 2010). The findings of the team were compiled into a report in December 2010 that was submitted to the DWA for approval.

The DWA (2011) believes that a lack of synergy between DWA and DMR contributed to the governments' delayed response to the AMD threat. While the DWA has been mandated to manage AMD at an environmentally critical level (which is believed to be around 150 m below ground level), this would result in the flooding of the country's mineral assets, and where the responsibility for the protection of such resources falls with the DMR, it was expected that the DMR, would have acted first – although to date, they have yet to take any action. According to Marius Keet, the Department of Water Affairs (DWA) water-quality management senior manager, the challenge is that *"in the western basin, we have managed to stop the decant and draw the water down to one metre below surface level. However, this was before the rains started, which will cause the water to rise again"*. Keet further argued that if the DWA had enough pumps and treatment facilities, it would be able to draw the water down to the environmental critical level, which is 150 m below surface and which would create a buffer capacity if it rained. Therefore, in terms of the central basin understanding, the DWA could only implement the construction of the treatment plant if the budget could be made available for that purpose (Mining Weekly, Sep. 21, 2012). This therefore, according to me, implies that solutions to remedy AMD can only be informed by availability of funds. This is the scary thought indeed that emergency funds cannot be made available to address the AMD issue until and after the approval of the fiscal for the next financial year.

On that breath, the credibility of the current solution as proposed is thus questionable. Of the solutions that have been proposed, most have been reductionist in approach and have only focused on dealing with the surface decant of contaminated water from predominately non-functioning mines. The health risks associated with radioactive and highly toxic waste have been down played or simply ignored (Ewart, 2011). The absence of a comprehensive solution also raises questions as to the assessment and decision-making process utilised to date by the Department of Water Affairs (Ewart, 2011).

To further complicate matters, legal experts⁵⁰ noted that overlapping governmental roles and responsibilities make it easy for one department to shoulder the problem of AMD onto another, leading to a perpetual blame game. A CSIR note on AMD claims that roles and responsibilities of different government departments are “*vaguely defined*,” and that the government is “*reactive rather than proactive*” (Oelofse, 2008). It seems as if DMR and DWA sit almost in competition. DMR on the one hand wanted jobs and money, while the DWA are tasked with looking after the environment (Oelofse, 2008). Whether they take one another seriously or not is a huge challenge (Oelofse, 2008). The mining department has a clear mandate and a moral imperative of ensuring that mining is not done under a cloud, thereby undermining the principle of sustainable development⁵¹. Thus, the conflict playing itself in terms of the role each has to play between DMR and DWA has resulted in externalising the costs of the mining industry onto the agricultural sector and the poor, effectively (DWA, 2010). Matthew Havinga, a resident of Gauteng’s East Rand has postulated or rather made a claim that increased governmental leadership is essential to remediating polluted water. According to Gareth Morgan⁵² “*political will is what’s required to fix the problem of AMD, and it’s lacking*” (Mail and Guardian, 10 December, 2010).

This lack of synergy between the departments as alluded above is seriously putting the lives of communities at risk and undermining the stability of our environment. In addition, the fragmentation of environmental governance in South Africa is set to exacerbate the ineffectiveness of the statutory liability regime.⁵³ The regulation of mines is fragmented and the enforcement of environmental legislation is generally poor.⁵⁴ In this respect the Minister of Mineral Resources, who has the mandate of promoting mining and mineral resource development, has the power to approve the environmental management programme of a mine in terms of the Mineral and Petroleum Resources Development Act (MPRDA)⁵⁵, which approval is subject to consultation with the Minister of Water Affairs. In terms

⁵⁰ The IMC report of 2010 prepared by a team of experts working in a wide spectrum of disciplines relevant to understanding the nature and implications of AMD serves as a vital and crucial source of information for this study. A team of experts that included directors general of Mineral Resources and Water Affairs were selected to advise the IMC, which also included the Ministers of Mineral Resources, Water Affairs and Science and Technology, the Minister in the Presidency and the National Planning Commission. Their focus was on AMD in the Witwatersrand gold fields (Coetzee et al. 2010: 2).

⁵¹ Sustainable development is the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

⁵² Gareth Morgan is a member of parliament representing the Democratic Alliance (DP) in South Africa and he is a shadow minister in mineral and resources portfolio.

⁵³ This fragmentation has been exacerbated by the recent appointment of separate Ministers for the environment and for water affairs.

⁵⁴ On the general issue of fragmented environmental governance in South Africa see, among others, Kotzé 2007 SAPL 34-60; Kotzé *et al.*, 2007 SAJELP 57-81; Kotzé "Environmental Governance" 103-125.

⁵⁵ Mineral and Petroleum Resources Development Act 28 of 2002.

of the NWA, the Minister of Water Affairs has the power to license the use of water by a mine, which could include dewatering for the purposes of excavation, as well as the disposal of contaminated water and residue resulting from the mining activities. In addition, certain activities associated with mining, such as road construction, the construction of diesel storage tanks, etcetera that could impact on the environment are governed by the Ministry responsible for water resources.⁵⁶ The inevitable result is that the governance of mines in South Africa is primarily driven by a fragmented, and in the case of the Department of Mineral Resources (DMR), more economically ambitious agenda, which follows a distinctly separate track from environmental governance efforts, which instead should focus on environmental issues.⁵⁷ There is also considerable overlap and conflict between these ministries because of their different mandates.⁵⁸

A case in point is that the National Nuclear Regulator has been accused of entirely failing to protect the public from the radioactivity associated with AMD. A report that was commissioned by the national government on the impacts of uranium and other radioactive substances in the Wonderfonteinspruit catchment did not note any immediate danger to communities (NNR, 2010). The said report has been decisively challenged by a number of radiation experts. Prof Chris Busby, a member of the International Society for Environmental Epidemiology and the European Committee on Radiation Risk subsequently visited some of the tailings dams and informal settlements in the Wonderfontein catchment during December 2010. Busby warned that radiation levels were 15 times higher than normal, and recommended that the question of radiation exposures to the public in this area be addressed properly, and should be scientifically overseen by an independent committee of experts. Busby felt that some informal settlements subject to radioactive contamination needed to be relocated urgently (Mammburu, 2010).

Dr Rianne Teuel of Greenpeace Africa (2000) has also questioned and demonstrated her position regarding the accuracy of the scientific report issued by the NNR. Firstly she questioned their

⁵⁶National Water Act 36 of 1998 (NWA).

⁵⁷ For example, in *Maccsand (Pty) Ltd v City of Cape Town* 2012 4 SA 181 (CC), DMR argued that a land use authorisation in terms of the Land Use Planning Ordinance 15 of 1985 (LUPO) was unnecessary where a mining right or permit had been issued in terms of the MPRDA. They submitted that in the event of a conflict between these laws, the MPRDA prevailed because it regulated a functional area vested in the national sphere of government.

⁵⁸ It has been acknowledged specifically that with respect to the governance of mining and AMD: "... the delegation of powers between various government departments at the national, provincial and municipal levels is unclear. Institutional roles and responsibilities are fragmented, overlapping or vaguely defined. There is a need to rationalise and align national legislation to remove ambiguity". Manders, Godfrey and Hobbs 2009 [http://www.csir.co.za/nre/docs/ Briefing Note 2009 2 AMD draft.pdf](http://www.csir.co.za/nre/docs/Briefing Note 2009 2 AMD draft.pdf).

methodology that informed the accuracy of their report, implying that it could be unscientific and thus unprofessionally produced. To drive her point home, Dr Teuel escalated her disillusionment to the attention of the International Atomic Energy Authority in Vienna (Mammburu, 2010). This on its own represents a damning critique of the regulator, whose entire *raison d'être* is protection of the public from the ill-effects of radioactivity, and which is facing the future expansion of the nuclear industry in South Africa with questionable scientific approaches and methodologies.

The other serious challenge that tends to frustrate efforts to address the question of AMD is what detractors perceive as interference by BEE beneficiaries who bring nothing to the table but more confusion, as the focus seem to be on profiteering at the expense of finding a long lasting solution to the AMD quagmire. The following paragraph will thus explore and point out the challenges embedded within BEE saga that makes decision-making difficult.

6.4.2 Labour laws and black economic empowerment

Black Economic Empowerment (BEE) is an attempt, as I will explain below, to marry redistributive and neo-liberal economic policies, and as I argue in this section, labour laws and black economic empowerment as they have been implemented in the mining sector in South Africa, have also contributed substantively to delays in effectively responding to the challenges of AMD.

With regards to BEE, the South African state has differing degrees of power to force redistribution on different sectors of the economy. Mining is one of the sectors where state allocation of licenses and exploitation rights makes the prospects for BEE promising. In this context, BEE is perceived as redistributive processes in the mining industry. Despite its redistributive intentions, BEE has been doubly conducive to the interests of large-scale South African capital (Ponte & Van Sittert, 2007). To begin with, it has by and large confirmed the historical share of mining rights to incumbent, largely white-controlled, operators. Second, it has created a layer of 'black captains of industry' to whom incumbents are increasingly outsourcing primary production in a volatile, high-risk and currently loss-leading sector. While mining operations are being outsourced under the banner of redistribution, the mining trade remains under the effective control of white capital. Furthermore, the frantic replacement of white capital monopoly has been replaced by black capital monopoly albeit with massive failures.⁵⁹ The move by government to apply the BEE policy has also been seen as a guise by

⁵⁹ The debate making rounds in political discourse is that BEE has become its own enemy in that it only benefits those who are politically connected. BEE is also seen in some quarters as something that has failed to live up to its humanism it purported. Labour organisations like NUMSA, including those within COSATU, see BEE as something that reduces humanity to spending power. This is partly because it discards those without spending

the ruling elite to enrich a selected few connected individuals. This assertion was confirmed by Professor Maree⁶⁰ who posited that BEE will not resolve the issue of AMD but a collective could. A glaring point in this regard stem from the fact that some of the proprietors of the mines that originally caused the AMD problem sold their mines to new companies, including companies established within the context of the Black Economic Empowerment (BEE) framework of government. In doing so, they have tried to walk away from their liabilities. This was illustrated in the case of Harmony Gold, which was ordered by the High Court in 2005 to comply with a directive issued by the Department of Water Affairs (DWA) to pump underground water containing AMD in an effort to avoid water pollution. The company sold the mine in 2007 to Pamodzi Gold Orkney (Pamodzi), a BEE company. After the land on which mining took place was transferred to Pamodzi, the company took the view that the directive was no longer applicable to it.⁶¹

A further connection between BEE and the failure to address the AMD problem is the preferential treatment bestowed to those who are politically connected to the ruling party. They tend to receive huge and lenient consideration. Many high-ranking, prominent appointments in BEE companies turned out to be of a political and not a managerial nature.⁶² These political appointments rather than managerial, culminated, for instance in the colossal failure of BEE at Aurora mining in the East Rand that saw the proliferation of AMD. The impact of the failure was also experienced in the Witwatersrand as a result of which AMD finding its way in fresh waters of Gauteng leaving millions of people at the mercy of mining houses and government. Thus it is my view that BEE should be monitored so that priority should be given to appointing those with the necessary 'expertise' predetermined by solid skills in mining, and not only partisanship that are guided and informed by political connectedness to a ruling party. To avoid the astronomical costs that manifested itself socially (unemployment resulting from closure of mines) and ecologically as demonstrated by the challenge of AMD, it is thus an opportunity to review all applications of those who really want to get into the business of mining to obviate similar challenges from happening again. I am not suggesting that BEE should be scrapped, but rather it should be implemented fairly and equitably. Thus, the buck stops

power to the waste dump or waste rock. There is also a narrative in the social and political spheres that tend to suggest that the poor are getting poorer and the rich richer, thereby failing the marginalised groups.

⁶⁰ Quoted with his explicit permission

⁶¹ The Court did not agree and ruled that the directive remains valid until it has fully been complied with. See *Harmony Gold Mining Company Ltd v Regional Director: Free State Department of Water Affairs 2012 ZAGPPHC 127 (29 June 2012)* para 48.

⁶² Zondwa Mandela and Khulobose Zuma are a grandchild of Former President Nelson Mandela and niece of President Jacob Zuma respectively and both were beneficiaries of government empowerment policy. However, both beneficiaries never had any formal training in mining and did not possess the necessary skills and experiences. Their lack of necessary experience to manage mining has been linked to the proliferation of AMD and the devastation playing itself in the central and western basin in Gauteng.

with government as the custodian of the mineral resources of the country to ensure that problems of water quality, as is AMD, are dealt with effectively without jeopardising the health and well-being of its citizens and the environment. The two are intertwined. With reference to section 27 of the Constitution, the national, provincial and local government have a duty to progressively realise the right of access to water.

A further important link between labour laws, BEE and AMD has been made by Professor Maree,⁶³ a Water Specialist at Tshwane University of Technology and a consultant at CSIR. In response to the question as to why the AMD problem is so difficult to address despite having arsenals of technology, he said *“that all these problems partly owe their origin to the BEE (Black Economic Empowerment) which had progressively over the years ignited the brain drain and qualified persons have left the country en masse to seek refuge in other countries”*. The brain drain has left SA with the colossal challenge of tackling both the academic gap as well as the threat of AMD. Stenman (2006) describes brain drain as a large emigration of individuals with technical skills or knowledge from one country to another usually for better conditions of service and good living environment. Most respondents in my interviews agreed with this view, thus blaming the escalation of AMD on the brain drain driven by BEE.

The lessons learnt with BEE is thus that if consideration is not given to the empowerment of groups that are qualified to take charge, we are likely to see many more Auroras mushrooming with devastating effect. When one reflects and looks back at the tragedy of the AMD one of the most mismanaged water crisis ever, it is clear that the lives of 11 million Gauteng residents are at risk.

In the following section I will focus my attention on the perceived failure of government to act decisively in addressing the issue of AMD. All this has been blamed on the perceived poor decision-making of government, which is seen subsequently as mismanagement of resources in addressing the AMD problem. This, I believe, has to do with another structural issue in the approach to the AMD problem: the role of science in the decision-making by government.

6.4.3 The role of science in the decision-making by government

AMD represents arguably the most mismanaged environmental disaster South Africa has ever witnessed (The Pump Handle, 2010). Scientists and environmentalists have battled for action since 1996, when they first became aware of potential damage. The eastern, central, and west basins of the

⁶³ Quoted with his explicit permission

Witwatersrand are polluted, immediately affecting residents living in half-a-dozen surrounding communities (Zeelie, 2010).

Governments' response with regard to the AMD disaster has been varied, lethargic and confusing: any response involves five departments, each with divergent interests. In an ideal world, industry would pay to clean up the devastating amount of AMD within South Africa, under government oversight. However, extreme government inaction has led to little payments and even less accountability (Zeelie in *The Pump Handle*, 2010).

Politicians and some members of the public tend to have a serious obsession with science when discussing policy proposals about environment protection because they consider science as universal (Pick, 2001) which means that it has the image of carefully directing the understanding of causal linkages and relationships underlying the connection of policy to environmental protection. Governments everywhere seek the endorsement of science to legitimise unpopular policy documents, as science is perceived as a means to an end (Staver, 1998). Accordingly, there appears to be phobia regarding decisions taken outside of the scientific discourse as is the case with the PP which is seen as an extremist decision-making tool.⁶⁴ No decisions can be rationalised if science has not had an input, despite the uncertainties inherent in it. Whatever reasons prevail regarding the preference of science in decision-making, science is still open to different interpretations by different interests. This thus brings us to the role of science in the proliferation of AMD. Some commentators, as I have pointed out in Chapter 4 above, suggest that science has misled government by underplaying the impact of AMD on human health and the ecosystem. Another interpretation could be that government appropriates the open-ended nature of scientific investigation and scientific uncertainty when it is politically useful (Oreskes, 2004).

In the areas of intense environmental conflict such as AMD (about which, for instance, there is a political struggle between communities and government, or between different interest groups), scientists actually have little influence, if any, where policy is concerned. It is therefore not surprising that the public has become a great deal more critical than they once were in discerning the bias embedded in communication about scientific findings (Soden, 1996).

Various solutions have been put forward towards addressing the problem of acid mine drainage on the Witwatersrand. It should be noted that the problems of mining waste management (historic and

⁶⁴ See chapter three and chapter four on this topic.

current) will be present for many years ahead (Oelofse 2008: 6). Solutions need to be sustainable, use resources efficiently and have an eye on the long term.

To further understand the intricacies which makes decision-making around the issues of AMD so difficult, I will take this argument forward by focussing on the imperatives of politics in decision-making and why such decisions have a far reaching impacts on the resolution of AMD. Therefore, the following paragraph will try and investigate the role of politics in decision-making around the issue of AMD and how politics impact on the management and governance of water quality.

6.5 The challenges of AMD from a political perspective

From a general perspective it is clear that mining in South Africa cannot be discussed without mentioning its inherently political dimensions that are deeply intertwined with a colonial history of more than a century. In view of the magnitude and potential consequences of the problem of acid mine drainage, it was no wonder that in almost all of my interviews, references were made to these political dimensions as they pertain to AMD in particular.

With the advent of a new Constitution, and legislation reflecting a post-apartheid reality, as citizens we are entitled to a “clean and healthy” environment as a matter of an enshrined right (Section 24 of the Bill of Rights). As such recent international laws⁶⁵ have made clear two key principles: the precautionary principle (which speaks to avoiding predictable harm or potential harm where there is uncertainty) and the principle that the polluter should pay for any harm caused to people and the environment.

What has prevented these principles from being enforced? Part of the answer lies in the question of the state’s continued complicity with mining capital. During the years of segregation and apartheid, the state wilfully turned a blind eye to the industry’s damaging impact on the environment. While some of this analysis has focused on the behaviour of current mine-owners, it needs to be made clear that the heaviest responsibility lies with the major mining houses which profited from South African gold and uranium during the boom years. Key gold mining companies like the Anglo American Corporation, Gencor, Goldfields, and Johannesburg Consolidated Investments, have largely been transmuted into new legal structures, but clever corporate forensics could establish the extent to which they were beneficiaries over the lifetime of their mining operations, and make provision for appropriate measures for restitution – that could include addressing the AMD problem where

⁶⁵ Freestone, D. & Hey, E. 1995. *The Precautionary Principle and the Law, The Challenge*. Kluwer Law International.

relevant. Clearly this would require a good deal of political will, which is unlikely to be forthcoming. For example, the state has not supported the efforts by civil society organisations to obtain restitution from key transnational corporations which benefited from apartheid. The same reluctance to take on the mining industry still applies. Instead, the state and its taxpayers are likely to be saddled with any remaining bills for mining pollution.

During the interviews, it was mentioned by numerous respondents from different areas (largely in Gauteng, Mpumalanga, Free State and Limpopo provinces) that there was a strong politicisation of government decision-making, particularly as it relates to AMD. The majority of respondents confirmed that mining in South Africa is highly politicised, and pointed out the apparent mistrust between government and its citizens, and to a large extent with environmental NGOs, which has led to polarisation of ideas on the nature, extent and possible solutions of the AMD problem. This largely was attributed to the apparent quietness of government on the issue of AMD, until the matter was raised first by foreign media in 2002 who were later joined by local environmental activists, as well as the print and electronic media. Thus some respondents concluded that government is playing politics with the lives of its citizens by failing to inform and take the necessary steps to stop the proliferation of AMD. The respondents added that it is always difficult to gauge the government's level of commitment, as there is a perception among members of affected communities that the powers that be are dishonest because they distort the facts about AMD.

There was even a suggestion and suspicion among the respondents that decisions that are made at the top (i.e. by government) contain inertia-based 'approvals' and 'agreements' in which government moved to act, unless objected to by affected people, while these potentially affected people felt that they have not been consulted or notified about the closure or opening of new mines. As such, government did not support and enable people to make informed decisions, but rather disempowered and effectively prevented them from doing so. Some respondents also indicated that the government is secretive about the issue of AMD and therefore lacks transparency, as well as refusing to investigate information provided by groups that are concerned about the impact of AMD in their communities. The respondents argued that the harm that is currently occurring in the country, particularly from AMD, is unethical and unlawful in that the environment and the lives of humans are being affected deleteriously.

The blame for such harm was thus squarely placed at government's failure to react decisively to the scourge of AMD. Both the sitting government and the erstwhile government have been blamed for this lackadaisical performance on the issue of AMD. Respondents pointed out that there is no difference between the present government and the erstwhile government. Both were shown to be

disinterested in the AMD, mostly because they have an interest in mining, either as source of state revenue, or, in some cases, as overt or covert shareholders in particular mines. In this context the erstwhile government was also blamed for the AMD legacy because it was not concerned with environmental matters but matters of entrenching racial policies.

The interviewees seemed to concur that the challenges posed by AMD needed leadership and not politicking to resolve. The general point raised in relation to AMD by the respondents was that because the government treats this issue with apathy or misinformation it could explode right into their faces when people started to getting sick or dying in great numbers. They argued that the people of Gauteng and elsewhere who are overwhelmed by the AMD scourge should rather be protected by telling them the truth about the impacts of AMD, and this, I believe, can be justified by following an alternative approach, one that is informed by decision-making guided by the Precautionary Principle.

One respondent decried the role of government in mining by stating that the government is evangelizing or imposing their own standards and views on people. The implication of this statement is that government is behaving in a paternalistic way when it comes to matters that affect the community directly. AMD is thus seen as a toxic mix (no pun intended) of government indecision and recklessness by failing to decisively take action about matters related to the challenge of AMD. Thus it is my view that government needs new decision-making processes that can capture a variety of views, exploiting the diverse and collective wisdom of many stakeholders and communities, and minimize politically related biases in environmental decision-making particularly on the question of AMD.

From the above it is clear that the government is playing into the hands of mining houses who pursue the generation of profit vis-à-vis reducing operating costs and the tactical avoidance of liabilities. It is thus critical that government needs to take decisions that are comprehensive and embracing where everyone matters. The government cannot pretend as if it is business as usual.

Ethics on the other hand is a tool that can be used and applied successfully by both governments and scientists to recognise that political and scientific power alone cannot resolve the AMD crisis the country is currently facing. Ethical solutions to these impasses are needed as in yesterday. We can use ethics as a mirror for reflection as we seek solutions that will not hurt anyone, or rather help find common ground in our quest for a lasting solution. Thus the following section will elucidate the imperatives of ethics in search of win-win solutions with regard to AMD.

6.6 The challenges of AMD from an ethical perspective

According to interviews and reviewed literature, AMD is unjust in that it distributes the costs of mining to the poorer, black part of SA's population; and becomes doubly unjust in that little or no restitution seems imminent. There is administrative injustice around AMD in that decision-making about mining and AMD has always been top down and expert based, excluding communities from participative decision-making. Since, AMD also infringes on people's basic rights (see our Bill of Rights), and thus their dignity, therefore AMD also infringes on the rights of future generations to live a decent life.

According to Confucius (551-479B.C.E.) it is morally wrong to impose on others what you yourself do not desire (Allinson, 1992). The same is clear from a Kantian perspective in which the so called reversibility test can be used to determine the ethical acceptability of actions or decisions. Besides the emphasis placed by Kant on human dignity and respect for persons as non-negotiable principles, utilitarian ethics clearly state that imposing harm on others is morally unacceptable.

This implies that government, mining houses, and BEE billionaires have a duty to prevent water pollution from occurring and have an obligation to take responsibility of cleaning up in an event of AMD occurrence without burdening the taxpayers and the affected communities. The mantras of ethics are clear: what is unacceptable to you, do not do to your neighbour, and: don't impose harm. If mining is going to result in hurting other people by way of contamination of water bodies and negative impact on human health, it is unethical to continue with the project and rather it must be abandoned irrespective of the economic value of the project. The bottom line is that some harm may be irreversible, and thus the degradation may be indefinite. Thus it is my contention that the golden rule and the harm principle of ethics should be used as a basis of environmental decision-making which is well articulated in the precautionary principle.

Mining is by its nature inherently unsustainable, is destructive to the biophysical environment and its contributions to human well-being are uneven and often overwhelmed by the damage it inevitably inflicts (<http://ensia.com/articles/mine-over-matter/>). How such a devastating project like mining can be allowed to continue is always a moot point. Given the devastation in terms of damage to the ecosystems and possibly human health it has become necessary to review mining practices and steering them towards drastically scaling back; restricting them, not expanding; and where it cannot be avoided it must be carried out carefully and responsibly. These proactive steps will help policy-makers to evaluate their environmental approach to mining for the sake of future generations. In recognising our obligations to future generations, we are acknowledging and affirming a responsibility

to people who remain incapable of actively representing their own interests. Thus, the manifestation of AMD technically takes away that right.

Mining is also a generational episode which affects present and future generations. Though mining provides benefits, it also bestows burdens. Every non-renewable natural resource that we consume now leaves less for future generations. According to former Vice President of the USA, Al Gore, when we deplete the earth's natural resources and live unsustainable lives "*the future whispers while the present shouts*" (Al Gore, 1992). While mining is widely welcome, it does not necessarily have to translate into paralysis and adversely affects humans and non-human species, rather we need to promote caring about tomorrow by acting responsibly today.

Thus we have ethical obligations to protect people separated by the boundaries of time and space. When we protect the present and future generations from the scourge of AMD, we are basically appealing to social justice which is intergenerational justice. It is thus paramount that strict regulations and enforcement are robustly applied to protect our current and future water supplies as well as aquatic ecosystems from unethical and unsustainable mining practices. It is less costly to prevent contamination from surface mining than it is to attempt to correct the contamination through remediation and reclamation.

I therefore posit that the precautionary principle as a decision-making tool can be used in conjunction with other decision-making tools to take on board the concerns of all stakeholders. Wingspread Statement on Precautionary principle (1998) says, "*When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.*"

My conclusion is that if policy-makers and those interested in the resolution of AMD can honestly answer the ethical questions raised above, the solution to AMD proliferation should not be too far off. I further propose that a tool like the PP can be used in parallel to several other eco-conception tools that employ a preventative approach. The PP entails a methodology that is reflective, exploratory, and prudent (Vigneron *et al.*, 2003), and the resolution of AMD actually hinges on that approach, i.e. it calls for responsibility by those undertaking a mining project. The PP furthermore calls for solidarity and participation which are the hallmark of democratic decision-making. In conclusion, Confucius posited that: "one who rules by moral force may be compared to the North Star — it occupies its place

and all the stars pay homage to it" (Tu, 1979). As I see it, South Africa needs a well-ordered world that possesses aesthetic, moral and social programmes that protects both the environment and its citizens and this I believe can be provided by taking the power and promise of the precautionary principle seriously in government and business decision-making.

6.7 Conclusion

There is no doubt from the interviews conducted as well as the literature interrogated in this chapter that AMD is the most mismanaged crisis in contemporary history in South Africa. In addition, AMD has proven to be an albatross around the neck of policy-makers whose response to this disaster has been lethargic. From the above discussion it is very clear that government's efforts to finally act on this scourge are compromised by numerous issues that tend to take the focus away from this challenge.

Firstly, environmental legislation that can enable action to address the AMD problem has been found to be inadequate in terms of enforcement. The focus seems to be on making profit rather than resolving this pertinent issue. The question of enforcement appears to be compromised by government collusion with mining houses wherein government is seen as shareholders in the mines by proxy, instead of its governors.

Lack of government commitment, coupled with denial and scepticism, has also made the case of managing AMD very difficult. It appears from my overview as if the extent of AMD is being downplayed in government circles, creating the perception that government doesn't want to scare foreign investors away. The bottom line from the discussion above is that government has placed profit before protection of the environment and affected communities. In this sense, government is perceived as shooting itself in the foot by failing to protect the constitutional rights of its citizens as enshrined in the Bill of Rights.

The tensions that seem to exist within the different government departments charged with managing water resources and the question of AMD are intricate. The Department of Water Affairs and Department of Mineral Resources are seen to be playing a blaming game with no one willing to take responsibility. The aftermath of the lack of synergy between different departments has failed the communities affected by the onslaught of AMD, who are left to count the costs of this indecision.

Besides politics, I have also demonstrated in this chapter that the marginalisation and discreditation of non-scientific communities in decision-making has taken centre stage, the one reinforcing the other as part of the many reasons why the problem of AMD has gotten out of hand. All the challenges identified are thus so serious that they need to be addressed immediately to obviate more serious

damage to the environment and the communities residing within and without where the AMD saga is playing itself out.

This is confirmed by the general thrust of the argument in this thesis, namely that science alone is not in the position to address environmentally related challenges, owing to its inherent nature of being uncertain as a tool, and its inability to deal and handle complex environmental challenges. Science as a tool of decision-making sometimes or most times is conservative, because in the absence of precise scientific knowledge it relies on traditional decision rules by choosing options that includes a margin of safety that is adequate to avoid bad effects or outcomes, thereby creating the possibility of endangering the health of ecosystems and communities alike. All these owe their origins to the history of science that has always been uncertain when addressing environmental matters in particular.

It is also very clear from the interviews conducted that the challenge posed by acid mine drainage has become politicised amid claims of its impact being underplayed by certain sectors in government, industry and science. It is also very clear from my discussion that economic gains have been placed above the interest of the environments, as seen by the proliferation of AMD, with the blame game assuming centre stage. My conclusion from this chapter is that ecosystems have been eroded by neglect fuelled by greed and nepotism with no concern for future persons, so I have demonstrated that these have no concern for future persons. In the same breath, I have demonstrated that the policies that govern mining and water usage are flawed and subject to abuse by those who are politically connected. It is also clear that BEE is wreaking havoc by virtue of being abused by the beneficiaries that government has appointed, with cries of cronyism on the ground. This implies, in essence, that there is no political will to address the question of AMD. It is also abundantly clear that the government is in cahoots with certain contracted⁶⁶ scientists. Since government has an interest in mining by virtue of being a shareholder in it, it thus is not in a position to enforce mining and water legislations seriously and effectively.

In Chapter 7 I will elucidate recommendations based on the case study and my discussion of the precautionary principle preceding that. I will also make general recommendations that emerged from what I argue is a better, in-depth understanding of the AMD challenge. The recommendations so proposed will be informed by the precautionary principle. I am also of the belief that the current forms in which the PP is defined should be put into perspective by suggesting a definition that will be more

⁶⁶ Scientists commissioned by government to perform scientific task on their behalf.

universal, unlike the current one which has been designed to meet the requirements of the rich nations, whilst excluding the developing and underdeveloped nations.

After this process, the overall conclusion of this thesis will follow.

Section C

Chapter 7

Findings, Recommendations and Conclusions

7.1 Background

The aim of the case study discussed in the previous chapters was to determine whether, and if so how the precautionary principle (PP) can contribute to a more embracing approach to environmental decision-making in South Africa. The research findings were based on a two pronged approach that included, amongst others, the review and appraisal of existing literature on qualitative risk assessment and the precautionary principle, which was found to be largely supported by the intensive interviews. This investigation was driven by the failure of the conventional scientific decision-making process to help protect our environment from an anthropogenic onslaught, and to appeal to an alternative decision-making tool like the PP to ameliorate the impact of indecision by policy-makers. In other words, this research tried to find out what could have gone wrong with our reactive approach to the issue of AMD.

Despite my best attempts to gain insight into the application of the conventional approach of quantitative risk assessment (QRA) and the PP in addressing a more preferable diagnostic method for resolving or mitigating environmental degradation, it has become clear that this may not be an exhaustive exercise, and that we may never get to the heart of the problem. This is because the outcome of the case study and the interviews conducted were able to demonstrate the true picture of AMD, which in most cases is not articulated well in the literature and arguments. The debate, particularly the ethical arguments about the application of QRA in environmental decision-making is weak, as it does not provide an opportunity to advance other arguments that are not scientific in nature.

It is clear from my study that the PP that started off as a narrow concept has grown in stature as seen by its inclusion in the environmental laws in most countries. The PP as a concept and its adoption continues to expand and progress. Since its conception in the 1970s, it has extended its influence to international agreements. As well, it has begun to infiltrate the legislation of individual countries

through these agreements. This broadening use of the PP is well documented, and comprehensive summaries can be found in the literature.⁶⁷

Despite its weakness pointed out by its detractors, I must however point out as earlier explained in the previous chapters, that we need to judge the PP also in terms of the positive elements that it possesses to actually be part of, and strengthen a world view in which communities and the environment are treated with much more respect and circumspection than before. Thus, I argue in this thesis that the application of the PP can be worthwhile if the concept is given broader content.

7.2 Findings from Phase 1 of the field work

The information gathered during the interviews with 25 mine officials (19 active and 7 retired) and an official from the Department of Environmental Affairs has revealed uncertainty regarding the history of AMD in South Africa generally. None of the respondents could give a definite date in so far as the first time the case that AMD was recognized as a problem. The response for this particular question varied from one respondent to another. Some indicated that it started to be acknowledged as a problem around 1976 (4 respondents), whilst the rest indicated that the challenge of AMD emerged in the late 80s (21). The responses to this question were clearly speculative and uncertain. At the early stage of this interview one could postulate that the AMD is not clearly seen as a big challenge within the mining sector particularly since some interviewees joked about its 'real' existence.

The question as to where the AMD originated was also speculative, with some stating that it started in the West Rand (4 respondents), notably Krugersdorp, while some said it started in Nigel, in the East Rand (6 respondents), whilst the rest (16 respondents) said they don't know. Clearly there is a gap in knowledge in terms of understanding the AMD problem, and surely more education on this challenge has to be prioritised to understand its ramifications and manifestation.⁶⁸ Twenty two of the twenty six interviewees, however indicated positive knowledge about the causes of the AMD and how it manifests, while four respondents were not really sure about its history and its proliferation.

The response regarding their knowledge about AMD was high. For instance from the responses received from the respondents, against the backdrop of what was done to remedy this problem from when it surfaced as a problem, 20 respondents indicated that nothing was done about it because it was not well understood, and there was not enough material to study AMD. However, despite all these, the respondents argued that government as the custodian of the land and environmental law

⁶⁷ Becigo, 1995; Freestone & Hey; Cameron and Abouchar, 1991.

⁶⁸ The effects and manifestation of AMD was extensively discussed in Chapter 5.

was supposed to lead from the front by commissioning research into the AMD case and taking action to reduce its impact.

On the question of whether risk analysis was ever used in the process of identifying issues in mining, the overwhelming majority (19 respondents) indicated that before any mine is commissioned, a detailed EIA is conducted to determine the risk that may ensue if that was not done. However, in terms of the legacy of AMD today, they indicated that prior to 1994; the erstwhile government did not conduct risk analysis when the mining licenses were issued. Hence the problem of AMD is partly as a result of the colonial past (7 respondents), whilst (7 respondents) blame the sitting government for failing to take a leadership role when this was reported by the foreign media. On the other hand (5 respondents) indicated that the AMD problem is the legacy of mining, it is also happening in the rest of the world.

The question why risk analysis was not done in the past, 20 respondents indicated that technology at the time was still at its infancy and no one could have predicted the magnitude of the problem it would pose. The responses for the question: if risk analysis was used, which risk were identified and which not? The responses here also varied. Nine respondents indicated that in the past no one knew the extent of the problem mining will have. At the time the language spoken was the language of finance, and a question relating to the safeguarding of the environment was not there, the latter point being made with reference to the new Constitution of South Africa.

The responses by the majority of respondents (20) were hammering on the uncertainty of technology at the time. They posited that no technology, no matter how advanced it was could have predicted AMD. AMD at the time was a remote possibility, and business people and the government of the day were thinking only in terms of profit margins and not AMD. One respondent even went further by formulating an analogy that the government of the day in the late 1970s and 1980s could not have, for instance, planned and pumped millions into the threat of HIV-AIDS by mass production of Antiretroviral because there was no one who predicted its imminent arrival at the time. While six respondents indicated that if AMD was known during those early years perhaps millions would have been pumped in to remedy the AMD problem.

The question then emerges: if AMD was not identified as an issue in earlier risk analyses, why did it happen? The answers by 16 respondents to this question was that AMD was not an issue here at home and even internationally, either because its impacts were underplayed or they were not known at all, and therefore, there was also no way of knowing if it was going to be a problem in the future. The 5 respondents further claimed that the concept of AMD is poorly understood, even by scientists because

they don't even seem to know its actual impact. After all, there were not even signs of its impending arrival because the old technology was not meant to deal with AMD, but it was more of a cost-benefit-analysis which mattered.

Furthermore, information gathered during the interviews when responding to the question of risk analysis of AMD, suggested that risk analysis was mostly focussed on health and safety issues at the mine, which is well documented in their risk analysis plans. However, the systems that are currently in place to deal with AMD risk issues are an end-of-pipe solution which fails to look at the causes of AMD. The focus is on its management that includes the pumping of water from tailing dams to avoid water decanting. It is abundantly clear in this regard that mining houses and government think that the only solution of dealing with the AMD challenge is treating it as a technical problem. Almost all of the 24 respondents indicated that scientific solutions are the only ones capable of resolving the impasse associated with AMD.

The interviews conducted have thus revealed the blind trust in science and technology by respondents. It is also clear that though AMD is a recent phenomenon in South Africa, the current risk analysis process is not adequate to deal with hazards associated with the closure of mines. It is also very obvious from the response of the interviewees that when mines are decommissioned, they result in the shutting down of the pumping stations that previously maintained the underground water level. The rising water level around the West Rand Basin is for instance resulting in seismic activity. Which is further evidence that current science based decision-making is not effective in dealing with the proliferation of AMD. It is also very clear that the current policies on pre and post mine closure studies do not adequately predict the extent of the risk of closing the mine. It is therefore my take in this regard that science is overwhelmed by the AMD scourge, and thus that there is a need to apply an alternative decision-making tool which is reliable, effective and robust. The alternative I propose is the precautionary principle which serves as a guide in how environmental decisions can be implemented, particularly where uncertainty in science is clear.

In the discussion below I will look and analyse the responses by the respondents in Phase 2 of the case study regarding their understanding of the Precautionary Principle and how the precautionary principle could be applied in the case of AMD to assist policy makers, scientists and lay persons in finding solutions to the challenge of AMD.

7.3 Findings from Phase 2 of the field work

Information gathered during the second Phase of my field work indicated that some employees within the mining sector were generally not aware of the precautionary principle as it was confused with the “polluter pays principle”. Those who were generally aware of the PP, their personal interpretations of the precautionary principle was somewhat limited, as well as their reconceptualization of the scope of the PP. These responses ranged from misinterpretations of the concept, to a limited interpretation focusing specifically on the aspect of scientific uncertainty. Only three of the 26 interviewed indicated a solid knowledge of the principle and its underlying themes, though not endorsing it as an effective tool in environmental decision-making. Despite the solid knowledge of the PP by the three respondents, they did not mention the concept of shifting the onus of proof to the proponent of an activity. Based upon these interviews, it was deduced that any application of this principle at present would be limited at best. Because of the limited understanding of this principle, it is necessary that the mining sector, particularly the departments that deal with sensitive environmental issue like water and mineral resources, should define the PP in their policy documents, its role, before there is any formal attempt to use it.

Clearly, there was variance in definitions of the PP with a particularly low number of employees indicating concepts outside that of scientific uncertainty as playing a role in the PP. Consequently, the line of questioning relating to changes in environmental protection over time was used instead to determine if the mining sector has been recognising those aspects of the PP which were missing from the explanations gathered.

Some of these missing aspects of the PP were noted by the interviewees, but by a relatively small group. This group included one manager and two engineers. It should be noted that this question⁶⁹ was not worded in a manner which would direct these employees to necessarily focus on such aspects of environmental protection, which might account for the low number of expected responses. Two key terms were mentioned by all three interviewees: the one concept mentioned which supports the PP, was the *recognition of a proactive or planning approach* to environmental protection. The other was the term *pollution prevention*, which complements the PP.

⁶⁹The question which was posed to the respondents was: What is your perception of the PP its definition and its use in the mining sector?

The information gathered in this section indicates that there is a general lack of understanding with regards to the PP and its complexities within the mining sector and Departmental of Environmental Affairs. Consequently, it is likely that its application will be limited without additional training.

The other concern that was picked up during the interviews was that the respondents struggled to explain threats of serious or irreversible damage. When interviewees were asked to provide their interpretation of these terms, a number of answers were encountered. Five of the employees, one official from the Department of Environmental Affairs, two managers and two supervisors indicated that this was very difficult to interpret and that they struggle with these definitions.

However, the two phases of my interviews not only revealed the negative aspects of conventional risk assessment or lack of knowledge about the precautionary principles. It also pointed to a number of aspects related to the power and promise of the precautionary principle in environmental decision-making in general, and the treatment of AMD in particular. In the sections below I elaborate on this power and promise of the PP in different contexts.

7.4 Findings from the conceptual overview of conventional risk assessment and precautionary principle

7.4.1 Conventional scientific risk assessment is flawed

It is clear from the interviews that I conducted and from my review of literature that conventional risk assessment is the preferred modus operandi of resolving the AMD issue. The fact is further informed by all the respondents who indicated that science based risk assessment is currently the only tool that can be applied to resolve issues that are related to AMD. Hence I found that conventional risk assessment is perceived as sacrosanct.

This line of discourse is not surprising because all scientific approaches are based on the articulation of two fundamental parameters, which are then reduced to an aggregated concept of risk. First are things are listed that might happen: hazards, possibilities or outcomes. Second is an assessment of the likelihood or probability associated with each. Either of these parameters might be subject to variously complete or problematic knowledge. This articulation yields four logical permutations of possible states of incomplete knowledge⁷⁰ — of course; these are neither discrete nor mutually exclusive and typically occur together in varying degrees in the real world. Conventionally, risk assessment

⁷⁰ Further readings on this issue refer to Stirling, A. (2007).

addresses each of these states essentially by applying the same battery of techniques: quantifying and aggregating different outcomes and multiplying by their respective probabilities to yield a single reductive picture of 'risk'.

To state it in more detail: conventional risk management entails the identification, assessment, and prioritization of risk, followed by a coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events.⁷¹ As per its definition, it is thus clear that conventional risk assessment is a reactive process riddled with uncertainty, hence its challenge to meaningfully address AMD issues successfully.

The mining industry, government and scientific community, however, must in my opinion desist from arguing that absolute safety cannot be proven or guaranteed, because I think that this is an excuse and also an attempt to hide the shortcomings inherent in conventional risk assessment. Firstly, incomplete knowledge or lack of knowledge of the natural systems is making scientifically based environmental decision-making cumbersome. The shortcomings of conventional risk assessment are found in its inability to effectively address uncertainty, which is the hallmark of science based decision-making. As alluded in the previous chapter it is because science is inherently uncertain that it struggles to deal with the AMD problem.

The uncertainty of conventional risk assessment is mostly driven by lack of knowledge, which to some extent is influenced by the failure to understand complex natural systems, and also by the uncertainty inherent in science. All these issues cloud the implementation of reliable environmental decision-making by shifting the burden of proof from the proponents of an action to the victims of it, as is the case with the AMD issue. The victims of the AMD scourge are expected to prove that mining is responsible for AMD and not the proponents of mining activity. This state of affairs is morally incomprehensible and needs to be reviewed by appealing to an alternative decision-making tool like the precautionary principle which shifts the burden of proof from the victims to the initiator of a project.

On a conceptual level, confirmed by my interviews, it is clear that conventional risk assessment relies on only one mode of knowledge, scientific knowledge, while indigenous knowledge and lived experiences as they are articulated by the broader public, are typically side-lined, and are typically not trusted by the scientific community. Indigenous knowledge and lived experiences on, for instance, the

71 Hubbard, Douglas (2009). *The Failure of Risk Management: Why It's Broken and How to Fix It*. John Wiley & Sons. p. 46.

effects of mining on communities, is typically ignored, something that is often confirmed by the lack of participation of communities in decision-making affecting their lives. The only time they are allowed to participate is when conducting EIAs during scoping processes. The main drivers of these processes are scientists whose decisions have a final say even if there are objections raised by communities. The decisions of the scientific community will subsequently be rubber-stamped by bureaucrats. It is my considered view that the non-scientific community may assist scientific communities and policy-makers in resolving the AMD issue by articulating indigenous knowledge and lived experiences in decision-making. Unfortunately this exclusion of non-scientific communities has led to mistrust of science whilst the victims are left to count the cost of the AMD mismanagement.

My conclusion is that conventional risk assessment has its inherent weaknesses, notably with regards to uncertainty; in most cases it fails to understand the complexities inherent in social and environmental systems. Conventional risk assessment is also monocratic and it borders on autocracy because it takes decisions without embracing and articulating community concerns. The way communities have been treated by both government and the scientific community has led to mistrust and violent response in some cases as it was pointed out in this thesis in the preceding chapters. Thus it is my conviction that conventional risk assessment protects the status quo, is unreliable and shifts the burden of proof in an unjust manner away from the proponents of an action to the victims of it. It is my considered view that conventional risk assessment is flawed and it cannot be relied upon as an effective tool to resolve environmental problems like AMD.

7.4.2 The Precautionary Principle can respond to scientific uncertainty

The PP determines that scientific uncertainty about the causal relationship between an activity or product and harm to the environment (serious or irreversible) shall not be a reason for postponing action to protect the environment. The PP, thus in the case of scientific uncertainty and risk of significant harm to the environment requires the taking of measures to protect the environment, yet, it, as the prevention principle, does not determine the type of measures that need to be taken. Such measures could include transparent environmental/risk assessment procedures, combined with participative community decision-making processes, on the basis of which all relevant factors can be considered, and concerned individuals and groups can participate in decision-making.

The test for knowing when to apply the PP is the combination of threat of harm and scientific uncertainty. For an example, some people may say that the threatened harm or hypothetical harm must be serious, or at least irreversible, whilst others point out that this does not necessarily allow for cumulative effects of a large number of relatively small risks. The PP moves from the position that

instead of asking how much damage or harm we will tolerate (this is typical of the conventional risk based approach), rather it asks how to reduce or eliminate hazards, and it considers all possible means for achieving that goal, including scrapping the proposed risky project or activity. It is also critical, according to the PP approach, to look for alternatives to a hazardous activity or project, and such alternatives must be subjected to some gruelling scrutiny of the hazardous activity itself.

My conclusion is therefore, that the PP can help science to deal with uncertainty by providing a tool that recognises uncertainty, and indicates a strategy to respond to it.

7.4.3 The Precautionary Principle shifts the burden of proof

The precautionary principle states that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is not harmful, the burden of proof that it is *not* harmful falls on those taking an action.

The precautionary principle assumes that the proponents of a product or project should provide evidence that (a) they have looked at all reasonable alternatives and are going about their business in the least harmful way possible; and (b) that their activities are not likely to degrade human health or the natural environment. For example in the case of environmental decision-making involving mining, the proponents of mining should be able to demonstrate that their actions or policies are not harmful.

The precautionary principle therefore takes a clear and unambiguous position: policy makers must justify discretionary decisions in situations where there is the possibility of harm from making a certain decision (e.g. taking a particular course of action) when extensive scientific knowledge on the matter is lacking. The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result.

In other words, the mining houses, government, and scientists have a moral obligation to demonstrate that the environmental project in question that is envisaged will not result in irreversible damage. The buck stops with the initiator of the mining project and the decision-makers to prevent harm; the burden cannot be shifted to the victims of the environmental onslaught to prove otherwise. In other words, the precautionary principle clearly states that those who have an interest in the mining endeavour should not allow collateral damage to ensue on afflicted communities. Those who initiate mining projects, or any other project for that matter, should therefore be placed under a strict obligation to make a persuasive case for what they wish to do and must accept the consequences of that project. Part of burden sharing means an obligation on the part of those who initiate and get

involved in mining projects. When someone talks about shifting the burden of proof, the proponents of the activity have an obligation to ensure at the end of its lifetime that the decommissioning of a mine will not result in AMD. Formulated in more detail: The proponents of mining or the mining industry have the obligation to test the ground for possible AMD causation, and to communicate such information publicly without distortion. On the other hand, the PP acknowledges that communities and people affected by mining have the right to know the details of the project, as they are the ones who are going to pay the price if things go wrong. This is a right enshrined in the Bill of Rights of the Constitution of the Republic of South Africa, and the PP is clearly a viable decision-making tool that can give effect to this right.

7.4.4 The Precautionary Principle entails an ethics of care

The PP plays an important role in terms of the question when to take protective and preventative action. As such, the PP entails a duty of care which is closely related to the duties of good neighbourliness and due diligence emanating from sources such as Roman Law, which speaks to relations between neighbours, the duty of reasonable and equitable use, and the obligation to refrain from abuse of rights. The duty of care enjoins policy makers to take proactive action in situations where the risk of endangering the environment or human health is high. The duty of care as articulated in the PP can be reinforced by scientific knowledge about the environment in question and the availability of technology that is able to protect the environment and its citizens.

As such, the PP encourages that the more we know about the vulnerability of an ecosystem and how to protect it against degradation, together with the increased availability of technology to protect the ecosystems or sensitive sites, the more concrete the preventive measures are required. In the case of mining in SA which has contributed to the scourge of AMD, the government thus has a constitutional duty of care to take appropriate and timely action to protect the environment and the public from harm that can be reasonably foreseen to follow from mining activities, even if causal links between the envisaged mining activities and its possible effects are not scientifically proven. In cases where harm has been demonstrated by lived experience to be clear and present in communities and in the environment, as is the case with AMD, the duty to address this harm is even clearer.

As I have argued in this study, it has become absolutely clear that mining house has to demonstrate a duty of care as propagated by the PP, thereby ensuring that, for instance, mining projects or any other environmentally related projects do not hinder valuable ecosystems upon which communities depend. This can be achieved by ensuring that no-go areas are established where mining will not be allowed at if it is proven that the mining activity may result in harm to the ecosystem and the

communities around it.⁷² In other words financial considerations should not be in the forefront when such decisions are taken. Instead, the driving motivation should be that of protecting and safeguarding the environment and the health of people.

7.5. Implications of the Precautionary Principle for responding to AMD

It is clear from the interviews conducted in Phase 2 of my fieldwork that policy-makers have allowed industry to escape responsibility for the negative impact of mining on the environment. Some arguments that came out during interviews included references to the failure of government to robustly enforce environmental legislation in the mining arena; government's financial interest in mining (government is a shareholder in the mining sector), thereby playing the role of being both a player in and the referee of the mining sector at the same time, which in essence curtailed government's influence in decision-making; while an over reliance on science and technology in environmental decision-making by way of instituting environmental impact assessment, which is to a large extent a component of conventional science based decision-making also came to the fore. Furthermore, the interests of the erstwhile government and the present government were firmly grounded on generating profit rather than protection of the environment and its citizens. As I have argued extensively above, the challenge of AMD is the result of such mismanagement. Therefore, in the following discussion below, I will make a few suggestions about new ways of thinking that can be followed in environmental decision-making about mining in general and the AMD in particular when the PP is followed.

7.5.1 Planning a new mine

If a new mine is envisaged, the PP strongly argues that such a mine should be subjected to stringent environmental laws by way of transparent prospecting licensing. As first step in all of this, the PP will require that all role players should be effectively consulted and effectively incorporated in the decision-making process to make sure that all their concerns are addressed, even if "only" based on lived experience and non-scientific knowledge, before a single action is taken to start to embark on the mining activity. This will include that notice of prospecting should be advertised in local newspapers using the languages mostly used in the area in question. It will also entail that before any prospecting can be allowed, feasibility studies must be undertaken by way of conducting environmental impact assessment studies which will be adjudicated by non-scientific communities

⁷² A case in point is mining in wetland areas, which should in fact be prohibited in terms of the Ramsar Protocol (see the Ramsar Convention Secretariat, 2007).

with their elected environmental scientists, together with the scientists representing government through the scoping process of the EIA. In the final EIA report, all concerns raised by communities and other interested and affected parties should be reflected, particularly where there is suspicion of potential hazard to the environment and to the parties affected by the proposed mining project.

Equally so, the PP dictates that those who have an interest in the development of a mine and those who may be affected by the impact of the environmental project should have a big say in terms of accepting or rejecting the status quo if signs of environmental degradation are beginning to emerge. However, long before any mining commences, the PP requires that any information about environmental impact emerging from conventional EIAs or CRAs must be made available publicly, so as to enable communities and people that could be adversely affected to validate and assess that information by experts chosen by them. By following this approach, decision-makers will avoid the objection of bias, ignoring affected communities, and/or moving ahead unilaterally. The PP thus also requires that EIA or CRA reports should also be communicated to the public in non-technical terms in the language best understood by those affected by the decision that is envisaged.

In addition, on a technical level, the PP enjoins those actors or initiators of a mining project to conduct, as part of their EIAs and QRAs, pre-mining sampling and analyses for acid producing minerals, based on acceptable practices.⁷³ For the purposes of transparency and effective community participation, as required by the PP, the typical practice of keeping any sensitive information regarding the possible or actual harm that may occur on particular sites away from the public domain, should be regarded as anathema, irresponsible and unethical. In fact, sensitive information regarding mining sites and operations should be declassified and published to enable any affected role players to give their input through their appointed experts, making sure that methods of sampling and analysis are meeting the standards of the best available practices and techniques.

In terms of identifying sites for mining development, the PP similarly requires that it shall be the responsibility of the proposer or proponent to indicate to the relevant government departments that the environment that the sites identified for the development of the mine will not cause physical damage to the environment or surrounding communities by increasing or initiating risks, of which AMD is but one example.

⁷³ This kind of sampling and analysis should of course also be done in all cases of mining activities already in operation.

7.5.2 Oversight and Monitoring

Given the flaws inherent in science as discussed in the previous chapters of the thesis, it is a given that if science induced projects are not monitored in and through processes going wider than science, they are likely to impact negatively on the environment and communities surrounding it. In this regard, the PP in the first place imposes a duty of care on policy-makers and the mining industry alike to make sure that natural ecosystems and communities are not adversely affected by the activities that they respectively have licenced, or embarked upon. In practical terms this entail not only effective oversight by the board members and regulators of companies impacting the environment, but also detailed and meticulous monitoring of routine activities, with effective community involvement in all of these processes.

Further, in cases where violations occur, the duty of care required by the PP dictates in the second place that owners (i.e. mining houses in the case of AMD) should immediately take steps to contain the challenge getting out of hand.

In order to ensure that these aspects of an ethics of care are properly discharged, the PP effectively requires that the environmental performance of mining houses should be audited by a team of highly trained specialists, and that their findings should be addressed in independent environmental audits. These kinds of audits should be conducted regularly and peer reviewed by, as I have indicated above, affected communities as well through their chosen experts and such results must be communicated and made available. As such, the PP states that communities, through their elected leadership, should have the right to independent monitoring and oversight of the environmental programme, taking into account the lived experiences of those communities involved, together with the lay and/or indigenous knowledge they may have of the environment or their health that are affected.

7.5.3 Decommissioning and post closure of mines

Since the challenge of AMD manifests during the decommissioning and post closure of a mine, the PP enjoins government, mining houses and those who have an interest in the project to ensure that the details of closure and post closure are made available to those impacted by the activity. Firstly, a detailed report regarding the reclamation and restoration of the mining site must be drawn up by a team of specialists, particularly those who have first-hand experience of the AMD issue. Against the background of the argument articulated above, it is clear that the PP will require that if affected parties feel that the team so selected may not meet their expectations, they should be able to force the mining industry and government to commit financial resources to make available such expertise, even

if it means getting such expertise from beyond our borders. Those affected by the decommissioning of a mine should thus not be expected to fund the decommissioning, or the studies that should precede it; because in a sense this will already reduce them to victims. Positively stated, the PP requires that role players, including lay communities affected by the closing of a mine, should be part of plenary meetings when decommissioning is planned and implemented. Part of the purpose of such meetings will of course be to draft reports and detailed plans for post-closure monitoring and maintenance of all mine facilities, including, as was so clearly revealed by the case of AMD, surface and underground water. Post-closure tailing dams, for instance, should be monitored for overflow and be subjected to periodical 'flushing' as well as general waste that could impact on the functioning and health of the systems and communities surrounding the closed mine. In addition, the plan should periodically be revisited to make sure that the newest technology or best practices are applied to monitor and manage the effects of the closed mine.

7.6 The role of different role players in the resolution of AMD

In the following paragraphs, the roles of different role players and stakeholders will be explicated with a view to infusing a new way of thinking in environmental decision-making by ensuring that everybody who is in the business of mining takes responsibility for their action without having to shift blame on others. In other words the thrust of the following discussion is grounded on a reversal of the conventional notion of the burden of proof, and how each sector can meaningfully contribute towards resolving or ameliorating the scourge of AMD.

7.6.1 The role of mining house in addressing AMD

The mining industry has a duty to adopt a new way of thinking in order to protect the quickly vanishing waters of SA. The new way of thinking should be an agenda of top management in order to internalise all their liabilities and the technical solution thereof as part of their moral responsibility. On the other hand, the mining industry should also be made to account legally by including appropriate sanctions in legislation to enforce the disclosure of risks associated with mining activities and their decommissioning.

This could be done by making the permit system or licensing regime more stringent, so that mining companies have to demonstrate that their actions will not imperil the health of humans or the ecosystem. Since science also creates uncertainty, the companies have a moral duty to avoid ambiguous responses, as these create more uncertainty and mistrust. This literally means that the incestuous relationship between the mining industry, the 'scientific' community and government

should be terminated without delay so that it is no longer easy for mining companies to exploit and abuse our ecosystems.

The business model for managing the environment should be reconsidered, as it currently is exploitative and benefits only the select few at the expense of the majority. Since the AMD conundrum is the creation of industry, it is morally right that the costs of the clean-up should be borne by the mining conglomerates, and that taxpayers should not be expected to contribute anything.

Finally, the mining companies need to learn that prevention is better than cure. Companies need to look elsewhere and avoid the catastrophic path of relying on natural resources such as gold. Gold and other minerals are only needed in small quantities to make jewellery, and therefore its mining is not sustainable. Its usage is very limited compared to the harm it unleashes on the fragile ecosystem. Here we actually have two choices to make: to mine or not to mine. Perhaps mining is not an option after all?

7.6.2 The role of government in addressing AMD

Since mining is likely going to continue, and chances is that it will (World Bank, 2004), thus governments must enforce robust management strategies on the environment which include the PP. Part of the management strategy will be the capture of iron pyrite before it becomes a danger. Government should encourage more research so as to avoid the temptation of focusing on one technology only. Other technology options must be investigated to address the question of AMD.

The challenge of AMD must also be escalated to Cabinet level to seek parliamentary approval for addressing this scourge. Independent scientists also must be brought on board, together with the affected and interested communities, and the results of such research must be made public. Whatever is done, it must be done in the interests of the country, as a collective. The government must ensure that water quality standards are maintained and bench-marked according to international standards.

The issuing of mining permits and licenses should also be transparent to obviate the resurrection of the ghost of AMD. Government should measure and monitor its environmental performance in terms of the United Nations Environment Programme (UNEP). The gaps that exist that will impact on sustainable development should be highlighted (Singh *et al.*, 2008). The government should also embrace the guidelines of the Coalition for Environmentally Responsible Economics (CERES) and show how it complies in terms of its reporting.

Lastly, mines that contribute to the problems of AMD must be named and shamed, with the possibility of being shut out of mining projects permanently if they do nothing about the problem that they themselves have caused.

7.6.3 The role of science in addressing AMD

In this dissertation, I have learned that there is nothing such as an independent scientist. This notion is informed by the argument that individuals have biases and personal motives. As I alluded earlier, certain scientists' services are for sale, hence the personal motives to earn extra cash and political legitimacy by appeasing those who hold power. In the real-life situation, one cannot easily say that biases can be eliminated; rather, biases should be identified and managed.

These biases can be addressed by ensuring that scientific advisors act purely in their capacity as professional scientists, and that all extraneous influences which they are aware of having been excluded, or at least openly acknowledged and managed. When in doubt, the advisors should understand their primary duty: when giving advice to government on risk-related issues, their first duty is to the broader public, and such duty should take precedence over any personal or professional consideration. If such an approach is indeed embraced, the scientific advisors would resist any inappropriate external pressures. It is a question of public interest versus self-serving agendas.

The most fundamental approach that will enhance public trust in scientists who are perceived to be biased towards the government's project is to ensure that they do not hide behind uncertainty, or apply hidden 'safety margins', since this would be straying into policy-making and the unfair, biased judging of societal values. Furthermore, it will be poor judgement if, for instance, the advisors seek closure on issues where there are genuine differences of view. The advisors should therefore faithfully record and present to policy-makers the alternative views and the evidence to support them.

7.6.4 The role of the non-scientific community in addressing AMD

As it was earlier demonstrated in this thesis that the role of communities in environmental decision-making should not be disregarded by those in power; because if this exclusion occurs, it may easily culminate in violence, more environmental degradation, and communities may not respect imposed decision-making. It is thus my contention that during the decision-making process, the interested, affected and other stakeholders should be proactively involved in seeking decisions that demonstrate the democratic principle by application of the following precautionary principle:

- i. Allowing communities to identify the issue under discussion;

- ii. Defining policy questions and possible options with all role-players involved;
- iii. Framing scientific questions in conjunction with communities;
- iv. Selecting advisors to represent the lay public and communities;
- v. Assessing and monitoring findings in light of the lived experiences and local knowledge of communities and individuals at the receiving end of activities;
- vi. Gaining prior informed consent from communities on decisions to commission or decommission mines.

Therefore, when and if the above proactive considerations are taken on board, they have the propensity to draw community members to become partners with government and scientists in finding a lasting solution to the problem of AMD. Currently there are indeed partnerships of this kind that are being forged in Carolina and some parts of Gauteng, particularly in the Western Basin between government and communities with a view of addressing the challenge of AMD.

7.7 Reconceptualization of the Precautionary Principle in the context of a developing nation

Firstly, the interviews conducted in both Phase 1 and Phase 2 has revealed the weaknesses of the conventional risk assessment, thereby giving the proponents of risk assessment options available outside science. Whilst the conventional risk assessment offers a narrow view of looking at solutions which encompasses scientific methodologies to justify bad decision, the PP on the other hand offers a bird eye view of issues by appealing to common sense approach: look before you leap, which is an ethical approach of obviating harm. Whereas conventional risk assessment has been exposed by the PP as reactive and flawed, the PP on the other hand is proactive in that it says ceasefire until you know what the target is. The PP is a cheap, reliable, and alternative tool to use to avoid costly mistakes which will need costly technology to remediate and avoid activities which should not have taken place in the first place. With the question of mining for instance, the PP would have rejected mining to take place unless it is proven beyond reasonable doubt that there will be no irreversible harm that will ensue. The PP thus posits that the days of doing business as usual in environmental decision-making are over by exposing the flaws inherent in risk based decision-making and offering alternative tool that includes rejecting the activity in totality or demanding proof of no harm to the environment and its citizens.

The PP has thus underscored the challenges that policy-makers face in making and implementing regulatory decisions. These challenges are mostly related to the matter of risk assessment in practical terms, thus the PP has highlighted the need for research that seeks to discover a scientific standard

for harm that industry cannot override. In other words the PP enjoins us to look elsewhere for solution rather than getting stuck at something that does not work effectively and thus is unreliable. Thus, the PP endeavours in this instance for collectivity in decision-making rather than leaving the fate of the environment's health and its citizen's health at the hand of only one tool called risk assessment which is widely perceived in some quarters as the alpha and omega of environmental decision-making.

Secondly, the power and the promise of the PP were further highlighted by the PP which advocates for public participation in environmental decision-making. The PP has demonstrated its common approach by pointing out the marginalisation of communities in decision-making by subjecting indigenous knowledge to the periphery. It is clear that communities are not taken on board on matters that affect them and their environment. The PP has demonstrated that decisions that are taken outside the realm of democracy are likely to rebound with vicious consequences. The PP on the other hand insists on retrospection and reflection by calling for common sense, which will include participatory democracy wherein the views of the affected communities are taken into consideration thereby avoiding blood bath such as those which unfolded in some parts of the country as earlier discussed in this thesis. The PP, thus calls for cease fire in environmental degradation by appealing to common sense approach which amongst other includes democratisation of decision-making and recognition of indigenous knowledge. The PP thus argues that some of the failures of finding lasting solution to the scourge of AMD can best be addressed by articulation of indigenous knowledge in the mainstream scientific discourse. Given that, the PP stands ready to plug the gaps created by the politics of exclusion which undermines public confidence, particularly where public concerns are not taken into considerations. In other words, the PP says everybody is equal before the law notwithstanding their social standings.

Thirdly, the PP in the context of environmental protection has revealed that government is failing in its duty to robustly implement its legal obligations contained within the constitution because it wears two heads: that of governance and business. The PP therefore demands for painful choices: swim or drown. Therefore, in areas where science has failed to respond to the complexity of environmental health problems, the paucity of information and the uncertainty that accompanies cause-effect relations, and the slow pace of government testing and government decision-making, the PP calls for proactive intervention wherein policy-makers and business will be held accountable for pollution of water bodies stemming from mismanagement of mines. The PP thus strongly argues for strong action to be taken against anyone who breaks the environmental law of SA irrespective of who the perpetrators are. The PP thus argues that government as the custodian of the natural resources of SA

has a moral responsibility to ensure that no pollution happens and if does happen, the government and the responsible parties must bear the cost of clean-up and not the tax-payers.

Fourthly, scepticism and denialism about the reality of AMD by some government officials, is a cause for concern. The PP through its robust questioning techniques has forced the truth to prevail on the part of the respondents of interview thereby ensuring and fostering transparency, probity and accountability on the side of those who make misplaced environmental decisions. The PP, therefore, has also highlighted the need to respect nature and its inhabitants, and it openly advocates for patience and not rushes untested decisions.

Lastly, the PP has shown that it is not against good science but bad science, since bad science can easily lead to bad environmental decision-making. The mantra of the PP is therefore clear: to safeguard the integrity of the natural systems and the health of its citizens. Therefore, the power and the promise of the PP lies in its ability to mitigate and halt the impact or misuse of the conventional risk assessment tool as alluded in this thesis in order to obviate barriers to precaution. If well used though, risk assessment, may well be part of the precautionary approach. The PP can assist policy-makers and scientific community alike to obviate situations where science can be manipulated to support economic interest at the expense of the environment.

However, one things that I picked up during the interviews and which was indeed disturbing was the lack of knowledge regarding the PP by the respondents who in a way represent government and mining house position of how mining and its effect such as the AMD must be managed. In essence, this lack of knowledge has inadvertently contributed to degradation of the environment and the poor communities having to pick up the pieces. This is morally unfair thus unethical. The fact that conventional risk assessment is the only known, trusted and preferred tool in decision-making in all levels of government decision-making also demonstrates lacklustre performance by government and mining industry around the question of their commitment in search for alternative and viable solutions to the challenges of environmental degradation currently plaguing South African waters. Given that, it is clear that more needs to be done to create awareness to government, scientific communities and mining house regarding available options of decision-making such as the PP. However, the implementation of the viable, alternative tool like the PP in decision-making according to my view is hampered by the manner in which the PP is conceptualised which serves as a rationalisation for rejecting to implement it or even trust it

Accordingly, the current conceptualisation of PP appears to be problematic and exclusive in that it appears to focus on the nations that can afford to implement it. A notion is therefore created that

the PP belongs to the exclusive club of the rich nations in that in its formulation as earlier discussed it is revealingly stated that those who have the capacity to implement it should do so. I, therefore, find this formulation problematic. Rich nations currently are the drivers of the “Green Agenda”⁷⁴ whilst poor and developing nations are trapped in the “Brown Agenda”⁷⁵ which in essence allow for environmental degradation. The challenge is that the current formulation of the PP seems to focus on rich developed countries that have the means to implement it. In my opinion it is more like perpetuating a notion of allowing degradation of the environment in poor countries whilst safeguarding those in the North, and this is highly unethical and immoral. To that end, my recommendation is that a need exist to level the playing grounds wherein the concerns of the developing nations are taken on board as well, in order to universalise its scope of definition, since developing nations cannot be excluded on the basis of geography. Accordingly, I propose the following framing of the PP that articulates the concerns of a developing nation like South Africa:

In order to protect and safeguard the environment and public health, the precautionary principle shall be universally applied by states and governments; and nations shall invest their resources to achieve sustainable development, notwithstanding their economic position. The application of the precautionary principle shall be informed and reviewed in cases of scientific uncertainty that will otherwise imperil the environment and the health of the community concerned.

7.8 Recommendations

The problems of the burden of scientific proof, of scientific uncertainty, and of the complexity of our environmental systems have posed a monumental barrier over decades now in the campaign to protect human health and prevent environmental degradation. It is clear that in most cases actions to prevent harm are usually taken only after significant proof of harm is established, at which point it may be too late.

Therefore, to overcome this barrier, it is critical that we advocate for a decision-making and action tool with ethical power and scientific rigour, the precautionary principle, which has become a critical aspect of environmental agreements and environmental activism throughout the world, because it

⁷⁴ Green Agenda is a participatory method for developing and implementing local sustainable development strategies and plans with active involvement of the different sectors in the local community where the process is conducted.

⁷⁵ Brown Agenda is about pollution. It is about toxic waste contaminating the environment and poisoning people. It is about rapid, loosely regulated industrialization and the legacy of toxic waste left behind, even from factories, mines and other facilities that have been shut down because of excessive pollution.

offers the public and decision-makers a forceful, common-sense approach to environmental and public health problems.

In that respect in the following paragraphs I will explicate and recommend the contributions that a number of different role player can respectively make in environmental decision-making by applying the precautionary principle as a tool of decision-making with a view of preventing environmental degradation and protecting human health.

7.8.1 To scientists

Since the most preferred decision-making tool (conventional risk assessment) is in most cases failing to resolve complex environmental challenges, given its inherent uncertainty and ambiguity, chances are that we may begin to experience an escalation in the levels of environmental degradation as is currently unfolding in most provinces of SA within mining communities. It is therefore my view that if the scientific community adopts the PP, it will help scientists to respond to uncertainty and ambiguity that is strongly rooted in science; to appropriately deal with complexity; and reversing the burden of proof by insisting that the authors of an environmental project ought to prove that the project in question is safe and not the other way round. The PP is also participatory; hence democratic, since it allows all stakeholders to be part of decision-making under conditions of uncertainty, ambiguity and complexity, and as such the PP is a potent tool that can be relied upon to address the gaps that exist in science based decision-making. The precautionary principle is a broad-based theory that can be applied to answer questions of ignorance and assist science to be more scientific.

Hence, scientists have a duty to monitor, understand, investigate, inform and act. Ignorance and uncertainty are no longer excuses for postponing actions to prevent harm. In summation, I would like to recommend the following points to the scientific community, in which I include myself, hence, the personal plural pronoun in my formulations below:

1. We should acknowledge that science, like other approaches, has limitations;
2. We should acknowledge that the strength of science can be enhanced through the embodiment of ethics as a tool to universalise decision making.
3. We should make sure that science is democratised by embracing the precautionary principle, and, accordingly, that the precautionary principle is not perceived as antagonistic, but as an ally of science.

4. We should ensure that any cessation or decommissioning of mining activity should be transparent, and that the victims of mining operations should have a say about the manner in which it is done.
5. We should make sure that new mining operations are not informed by utilitarian approaches only, but by an assessment of the outcomes that the mining activities may have (it should be assessed whether mining is a liability to the environment and/or human health, or whether it is an asset).

In conclusion, I also strongly suggest that science should help decision-makers with guidelines that robustly push for urgency in terms of how they respond and act in the midst of an irreversible harm emanating from environmental mismanagement, particularly if the issues at stake are uncertain, values are in dispute and the stakes are very high. Science must also provide inputs by engaging in a multidimensional argumentative process as a “process of debate and dialogue operating continuously over all phases of a policy process called Post-Normal Science. An appeal to post-normal science forces science to explain itself on what constitutes a good decision” (Faucheux & Froger, 1995: 29). What this means is that science should give decision makers a choice when science is stable or where reversibility is possible.

7.8.2 To mining houses

The precautionary principle provides the mining industry with an opportunity and the tools to adopt a new way of thinking. The new way of thinking should be an agenda of top management in order to internalise all their liabilities and the technical solution thereof as part of their moral responsibility, and this can be achieved by mining’s management through their environmental management plans, while adopting a radically transformed approach to business decisions, acknowledging that they are not purely business decisions but embedded in society, and having to make sense to communities. Such a plan and such an approach should reflect how the mining house is continuously going to ameliorate, in particular, the challenge of AMD, and they must determine the costs of clean-up and how much they will contribute to a pollution relief fund that will be geared towards their commitment towards continuous improvement, something that must be featuring in every agenda review their operational plans for business and environmental management. On the other hand, the mining industry should be made to account legally by including appropriate sanctions in legislation to enforce the disclosure of risks associated with their mining activities. What I therefore recommend is that the conventional business model for managing the environment typically used by mining houses should be reconsidered, as it currently is exploitative and benefits only the select few at the expense of the majority.

7.8.3 To government

It is the duty of government to ensure that the permit system or licensing regime should be made more stringent, so that companies with an impact on the environment or human health, including mining companies, have to demonstrate that their actions will not imperil the health of humans or the ecosystem. Since there is a fundamental issue regarding science when it comes to responding to uncertainty and complexity, companies have a moral duty not to exacerbate this situation by adding ambiguity and more uncertainty, thereby building mistrust instead of trust.

Similarly, those who show an interest in mining should be subjected to stringent environmental mining guidelines in the formulation, monitoring and revision of which communities must have a say. A case in point could be that mining licences must have a short-term of no longer than five years, and that it can only be renewable subject to compliance. In light of my consideration of the precautionary principle above, I furthermore would like to recommend that government in its regulatory function must stipulate and ensure that the management plans of companies in general, and mining houses in particular, must include elements that:

- 1 Enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future persons;
- 2 Provide for equity within and between generations;
- 3 Protect biological diversity and maintain essential ecological processes and life support systems;

Furthermore I recommend that government develops a national strategy for mining that forces the mining industry to manage mining resources efficiently in terms of ecologically sustainable development that includes, amongst others, initiatives to ensure that sound environmental practices are used and promoted throughout all sections of mining. In this national strategy provision should also be made for incorporating local and indigenous knowledge in the planning, operation and decommissioning of mines in South Africa. It is thus my contention that if the precautionary principle is applied by government to embrace the views as indicated above, it will accept its responsibility to have a contract with everybody, including lay communities, scientists, policy-makers and the mining industry.

7.8.4 In summary: the Precautionary Principle as a moral obligation

The greatest moral responsibility of science lies in the fact those future generations should be considered beyond the traditional structures of economic freedom; rather the criterion of substantive rationality should be embraced. The PP subscribes to the values of science that respect communities' choices. Therefore, science should not be a pre-condition for rational decision making, but rather should be an ally of alternative decision-making tools like the PP.

The government should regard the PP as a morally and legally binding principle. As such it should be recognised as one of the most important principles by governments in pursuing the goal of sustainable development. The PP should therefore serve as a trigger in the assessment of the risk of serious or irreversible harm on the basis of available information.

I therefore strongly posit that the precautionary principle should be used as a guide to formulate and implement public policy decision-making, since the PP responds to the realization that humans often cause serious and widespread harm to people, wildlife, and the general environment. According to the precautionary principle, precautionary action should be undertaken when there are credible threats of harm, despite residual scientific uncertainty about cause and effect relationships.

As we have a moral obligation to safeguard the integrity and stability of our natural environment, and since we have a moral obligation to safeguard the future of our children and their children by ensuring that the protection of human health and the environment are given greater consideration by policy-makers and the scientific community, instead of giving priority in our actions to mostly financial interests, my contention is that we will do well if we adopted the precautionary principle as the basis of our decision-making. In my view it will be wrong to suggest otherwise.

7.9 Closing remarks

Firstly, this thesis has revealed that environmental risk assessment is a relatively new and immature field, yet it is a potent decision-making theory and this is evident in the state of development of its analytic methods for assessing exposure levels and their potential adverse effects. Furthermore, humanity is well off today as a result of policies that were influenced by science that resulted in the protection of the environment and humans. However, the successes of science and technology are also clouded by uncertainty and extraordinary risk that science alone is not able to resolve. In other words, there is a suggestion that science based risk assessment is flawed and therefore it cannot be trusted as the only reliable tool of environmental decision-making.

Secondly, it has emerged in this thesis that the PP has been accused of being anti-science, anti-business, and that it interferes with political decision-making. Accordingly, it is seen by its detractors as bad news to environmental decision-making. Despite the opposition to the applicability of the PP as a decision rule, it is clear from the arguments advanced so far that according to its proponents, the PP has a future in decision-making, particularly in complex environmental decision-making that involves uncertainty and ambiguity. Therefore, the aim of the PP is to assist science in identifying its own limitations, but to also help scientists to know about their successes in nature, particularly in technology related advances.

Thirdly, a conceptual analysis of the conventional risk based decision-making and precautionary principle was determined. The conceptualisation and articulation of uncertainty and ignorance in particular was the focus of this thesis, specifically around the questions of environmental impact of technology. The conclusion based on this articulation and reconceptualization has revealed the traditional weakness of conventional science based risk assessment and management. Unfortunately conventional science fails to acknowledge the inherent weaknesses informed by uncertainty when formulating risk based environmental decision-making. As a result, a new theoretical trend called the precautionary principle that is ready to confront uncertainty and ignorance has come to the fore. It has been demonstrated in this study that conventional risk assessment has its inherent weaknesses and thus the role of the PP is to advocate for more reflective, more robust, deliberative and participatory approaches to decision-making. It is also critical to acknowledge that the weaknesses inherent in both approaches should not be underestimated, but rather that they should be further researched.

Fourthly, the precautionary principle's purported robustness was tested in a case study on acid mine drainage. The aim was to test if the PP is well understood in the mining sector and government alike; whether the PP which is largely perceived as theory can find any practical application; and how the scepticism regarding the PP that plays itself out in the mining sector can be addressed. On the other hand, science based decision-making has been seen to be monolithic, since it neglects to embrace those affected by poor and mismanagement of mining, particularly around the issue of AMD.

Lastly, the deeper dimensions of AMD were explored using both interview questions and review of literature which was largely desktop research. What unfolded from the interviews was shocking as issues which were not expected emerged that pointed to numerous impediments to the resolution of AMD. It is also very clear that the case of AMD, and mining in general, as well as the review of literature on science based decision-making and the precautionary principle has broadened our view and understanding that demonstrates that our current decision-making policies and procedures do not

seem to demonstrate a comprehensive understanding or concern for the huge changes in the environment and human health, particularly that of future persons, caused by technology in general, and mining in particular.

The serious issues that came out in this study and were not anticipated included the failure to robustly implement environmental legislation, whilst putting profit before environmental protection; the mining sector's denialism of the AMD issue, that included scepticism of the PP; the marginalisation and exclusion of communities that are affected by the AMD scourge; and discreditation of local knowledge in efforts to resolve the AMD issue. Other important challenges that emerged during the interviews and review of literature included what is perceived as a lack of synergy and cooperation between government departments dealing with the same issue of AMD; as well as the misuse of BEE in awarding tenders to unqualified persons and who lack mining credentials.

The role of science in decision-making by policy-makers was also interrogated and was found to be inadequate as it left stakeholders even more uncertain about environmental decisions they need to take. Conventional science continues to be a preferred *modus operandi* for most decision-makers and as such it closes doors for other alternative decision-making tools like the PP.

The ethical imperative of ethics was also explored and found to be a bridge to resolve environmental problems and guide policy-makers in making right decisions by choosing right and legitimate decision-making tools like the PP. It was highlighted in Chapter 6 why policy-makers need to embrace the PP as a reliable and potent tool that can guide rational environmental decisions that conventional science is unable to resolve.

It is thus my contention that environmental decisions that are based on conventional science only, also need decisions that are not purely scientific in nature. This implies that, when decision-makers define the factual predicate for taking precautions, non-scientific decisions are necessary. Non-scientific decisions are in fact inherent in the findings about risk that are required to justify precautionary measures. I further posit that despite the criticism levelled against the PP as being anti-scientific, anti-business, etc. I believe that the PP represents a challenge to scientists and policy-makers to develop newer and more effective tools for characterising and preventing complex risks, in addition to being more explicit about uncertainties. Therefore, I conclude that the PP is not at odds with conventional science, but rather complements evidence-based practices in situations of scientific uncertainty and complex risks.

Furthermore, it is my fervent belief that the precautionary principle is consistent with good science and good public policy, because it acknowledges the inherent uncertainty and limitations in our

understanding of complex risks challenges. Therefore the PP enjoins policy-makers, scientists, members of the community, etc. to develop new methods and tools to characterise these threats and focuses our attention on opportunities for prevention and innovation. The precautionary principle acknowledges that public environmental decisions in the face of great uncertainty should be informed by science, but in spite of that also acknowledges that environmental decisions are ultimately deeply political in essence. The precautionary principle implores those who are engaged in policy-making on the environment, given its complexity, to take ethical decisions based on values, accountability, democratic principles and probity. Given the arguments and facts elucidated above in support of the PP, and given my critical assessment of the arguments levelled against the PP, I conclude that science and the precautionary principle are complementary to one another. However, the precautionary principle has not been studied enough in SA, and this researcher therefore calls for further research on this concept so that it can form part of decision-making in other legislation besides that on the environment and mining.

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Annexure A



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvennoot • your knowledge partner

STELLENBOSCH UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

[Insert title of the study.] [If the study involves using different consent forms for different populations, identify the population group as the subtitle of the study.]

You are asked to participate in a research study conducted by *[insert names and degrees of all investigators]*, from the *[insert department affiliation]* at Stellenbosch University. *[If student, indicate that results will be contributed to research paper, thesis or dissertation.]* You were selected as a possible participant in this study because *[explain succinctly and simply why the prospective subject is eligible to participate]*.

1. PURPOSE OF THE STUDY

[State what the study is designed to assess or establish.]

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

[Describe the procedures chronologically using simple language, short sentences and short paragraphs. The use of subheadings helps to organize this section and increases readability. Medical and scientific terms should be defined and explained. Identify any procedures that are experimental.]

[Specify the subject's assignment to study groups, length of time for participation in each procedure, the total length of time for participation, frequency of procedures, location of the procedures to be done, etc.]

3. POTENTIAL RISKS AND DISCOMFORTS

[Describe any reasonable foreseeable risks, discomforts, inconveniences, and how these will be managed.]

[If there are significant physical or psychological risks to participation that might cause the researcher to terminate the study, please describe them.]

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

[Describe benefits to subjects expected from the research. If the subject will not benefit from participation, clearly state this fact.]

[State the potential benefits, if any, to science or society expected from the research.]

5. PAYMENT FOR PARTICIPATION

[State whether the subject will receive payment. If not, state so. If subject will receive payment, describe remuneration amount, when payment is scheduled, and proration schedule should the subject decide to withdraw or is withdrawn by the investigator.]

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of *[describe coding procedures and plans to safeguard data, including where data will be kept, who will have access to it, etc.]*.

[If information will be released to any other party for any reason, state the person/agency to whom the information will be furnished, the nature of the information, and the purpose of the disclosure.]

[If activities are to be audio- or videotaped, describe the subject's right to review/edit the tapes, who will have access, if they will be used for educational purpose, and when they will be erased.]

[If researcher is planning to publish results of study, describe how confidentiality will be maintained in publication]

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. *[If appropriate, describe the anticipated circumstances under which the subject's participation may be terminated by the investigator without regard to the subject's consent.]*

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact *[identify research personnel: Principal Investigator, Supervisor, and Co-Investigator. Include day phone numbers and addresses for all listed individuals. For greater than minimal risk studies, include night/emergency phone numbers.]*

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché *[mfouche@sun.ac.za; 021 808 4622]* at the Division for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to *[me/the subject/the participant]* by *[name of relevant person]* in *[Afrikaans/English/Xhosa/other]* and *[I am/the subject is/the participant is]* in command of this language or it was satisfactorily translated to *[me/him/her]*. *[I/the participant/the subject]* were given the opportunity to ask questions and these questions were answered to *[my/his/her]* satisfaction.

[I hereby consent voluntarily to participate in this study/I hereby consent that the subject/participant may participate in this study.] I have been given a copy of this form.

Name of Subject/Participant

Name of Legal Representative (if applicable)

Signature of Subject/Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ [*name of the subject/participant*] and/or [his/her] representative _____ [*name of the representative*]. [He/she] was encouraged and given ample time to ask me any questions. This conversation was conducted in [*Afrikaans/*English/*Xhosa/*Other*] and [*no translator was used/this conversation was translated into _____ by _____*].

Signature of Investigator

Date

ANNEXURE B

Interview Questions

Phase 1

1. What caused the AMD problem? Over what period? Where?
2. When did AMD surface as a problem?
3. When did AMD surface as a problem, and what was done about it by whom? How? Why?
4. Was any risk analysis ever used in the process of identifying issues in mining? How? Why? If not, why not?
5. If risk analysis was used, which risks were identified and which not [from a position of hindsight]?
6. If AMD was identified in this risk analysis, was it properly responded to at the time? If not, why not?
7. If AMD was not identified as an issue in this risk analysis, why did it happen?
8. What was the general approach in risk analysis and why?
9. What was the general approach to risk management and why?

Phase 2

The second set of questions was focused on the PP and the differences it could have made to the understanding of AMD as a potential problem – as well as its possible effects on responses to minimise its effects. The basic principles of the precautionary principle were discussed with respondents when feedback was given on the results of phase 1. Questions 10 and 11 were also posed to respondents on an individual basis before the basic principles of the precautionary principle were discussed:

10. Currently, what is your perception of the PP – its definition and its use in the mining sector?
11. What is the basis of your views in question 10?
12. [After the presentation on the precautionary principle.] If this conception of the PP was available at the time (specify as the time when AMD was not recognised as a problem), what

difference would it have made to exploring and understanding risks in mining, AMD included. Ask informants to imagine in concrete detail: what would have changed? What difference would it have made? Differences to what? (Which other outcomes would have emerged?)

13. Also explore what, if any, difference it would make if the PP was used today to think through responses to AMD as it exists today as a problem.