




## Chapter 10

# The role of scientific evidence in public policymaking for the bio-physical environment where South Africans live

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### Abstract

We explore the role of evidence in policymaking in ambient air, waste, and water against the background of the main pieces of legislation covering these areas. Evidence is defined narrowly as corroborated results of properly conducted scientific research and data sourced from scientific technology, as well as science-based advice by experts. Policy in the areas that we investigated is articulated on several levels, subject to Section 24 of the Constitution: white papers (white papers on the environment and sector-specific white papers), Acts, strategies



and frameworks, regulations, and finally norms and standards. This set of policies embodies a conceptual hierarchy but also a historical sequence. We found that the role of evidence as defined grew with time, but also as attention moved from concepts to the physical environment. Interesting aspects that surfaced were the role of consultants and the degree to which policy was based on imported or local research.

Keywords: ambient air policy, policymaking, science-based, science-informed, waste policy, water policy

## **Prelude**

Here is the philosophical argument for evidence-informed policymaking in a nutshell: reality is not always obvious and known, it is not necessarily what we imagine or wish, it does not per se conform to our ideological preconceptions, and our plans will not automatically work out. Therefore, rigorous empirical research is necessary to inform responsible decisions.

We assume that science can contribute to a better bio-physical environment via government policy. Past research has established that polluted air and water, and toxic waste cause illness with all its consequences. Pioneer researchers who found incontrovertible evidence for pollution as a cause of diseases were the British John Snow (1813-1858), and the Americans Alice Hamilton (1869-1970) and Harriet Hardy (1906-1993). Thus, the very existence of extensive environmental policy-based interventions in South Africa is a manifestation of evidence-informed policymaking.

## **1. Introduction**

This articulated case study investigates the intersection between Policy Studies, scientific research, and the world where South Africans live daily. We ask empirical questions about the role of evidence in policy formation since democracy. The National Policy Development Framework (RSA, 2020a, p. 4) states that “policy-making challenges prevail in the country, as the government does not have a standardised or systematic

approach on how to develop evidence-based policies in South Africa”. According to Godfrey and her co-authors (Godfrey et al., 2010) scientific knowledge and evidence played a key role in developing environmental policy and legislation in South Africa. The authors highlight, amongst others, the importance of bridging the “science-policy gap”. Were they right in 2010? And is scientific knowledge still “key” in 2025?

In this chapter, we explore answers to questions of how scientific knowledge contributed to policy in the fields of ambient air, water, and waste. We describe how evidence (defined below) plays or does not play a role over time in environmental policymaking in various contexts and cases and on various policy levels. This is a first exploration in the hope that more detailed studies will follow.

## 2. Conceptual aspects

Xuan Yu and his colleagues conclude that “Although the definition of ‘evidence’ has attracted the attention of many scholars in different disciplines, there is no widely recognised and accepted definition of this term in scientific research” (Yu et al., 2024, p. 41). For us, evidence means corroborated results of properly conducted scientific research, including data sourced from scientific technology, as well as science-based advice by experts. This is a strong definition that is not necessarily adhered to in the policy literature. For example, “evidence as represented in outcomes of deliberations” (Cairney, 2016, p. 102); and according to Kathryn Oliver and her colleagues, “Much of the research in this area is theoretically naive, focusing primarily on the uptake of research evidence as opposed to evidence defined more broadly” (Oliver et al., 2014, p. 1). We do not agree and prefer the narrow definition.

Officials and politicians regularly regard the inputs of stakeholders as ‘evidence’ even though these inputs are not related to any scientific research. In government deliberations, the fact that a proposed policy is highly unpopular will be regarded as ‘evidence’ against it. That is not how we intend the concept. However, our concept is still wide: we include scientific

models and data or information gathered by employing scientific methods as evidence.

Next, a definition of policy. *Policy* is a decision and assessment rule (or set of rules) to arrange possible action in a specific domain on a scale between obligatory (it must be done) and forbidden (it must not be done) (Sadiki & Pauw, 2017). Public policy is policy made by a public authority. In the literature, it is often assumed (as discussed, for example, by Patrik Marier (Marier & Van Pevenage, 2017)) that policy is about solving problems. Here, the concept *policy* has a larger scope in the sense that it would bring order or structure to aspects of public reality, for instance, in a white paper. Not all issues in the public sphere are the objects of policymaking at one point because neither the authorities nor the public have unlimited attention spans and resources. Therefore, the issues that receive attention at a specific time are referred to as being on the policy agenda. How something lands on the policy agenda is one of the things that is researched in policy studies. A wide array of items regarding the biophysical environment falls under the above definition of policy. It covers Section 24 of the South African Constitution (RSA, 1996c), but also norms and standards for regarding certain waste materials as toxic or not. It covers laws and white papers, regulations, frameworks, official guidelines, and departmental strategies.

Evidence can thus drive policy in at least three ways: a) by indicating what is the case, b) by providing guidelines on what should be the case, and c) by showing the relative strengths or weaknesses of real or imagined interventions. Take residential air as an example: evidence has shown that a) polluted air in dwellings causes illness, b) what standards of purity should be striven for, and c) whether the *basa njengo magogo* intervention developed by Nova<sup>1</sup> (Le Roux et al., 2009) is more or less efficient and effective than other interventions.

There is a supply and a demand side to the evidence-policy nexus. Strydom and her colleagues write about pull and

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1 Editors' note: Discussed in the previous chapter under a slightly different name.

push factors (Strydom et al., 2010). Much of the evidence-based policymaking literature stems from a kind of entitlement from the scientists' side, where researchers expect their supply of knowledge to be taken seriously without duly understanding that policymaking is a political process. On the other hand, politicians and officials might be loath to ask scientists for the needed evidence to support policy and rather rely on the inputs of other stakeholders with vested interests. There is also the disingenuous use of evidence where one receives policy-based evidence instead of evidence-based policy: "The tendency of policymakers to decide what they want to do, then seek enough evidence, or distort that evidence, to support their decision" (Cairney, 2016, p. 121).

Lastly, although the term "evidence-based policymaking" has wide currency, "evidence-informed policymaking" is often a better choice of words. This is exemplified by the title of a report by the Department of Environmental Affairs: *Evidence-informed policymaking in practice: an overview from South Africa's Department of Environmental Affairs* (Shaxson et al., 2015).

### **3. First description of the statutory and policy background**

In this section, we indicate and discuss the main elements of the statutory and policy background as the loci in our case study. An overview of the statutory and policy background is broadly set out in Figure 26. The environmental policy field is articulated along three dimensions: the conceptual (broad policy and strategy), the statutory (what is compulsory) and the ontological (sectoral). Along the conceptual dimension, we find broad government policy set out in the form of green and white papers (and also certain aspects of strategies<sup>2</sup>) that indicate what specific government approaches and actions are in the offing. Along the statutory dimension, we mainly look at five Acts in this chapter: the framework Act (National Environmental Management Act, 107 of 1998 (NEMA)) and four sectoral acts

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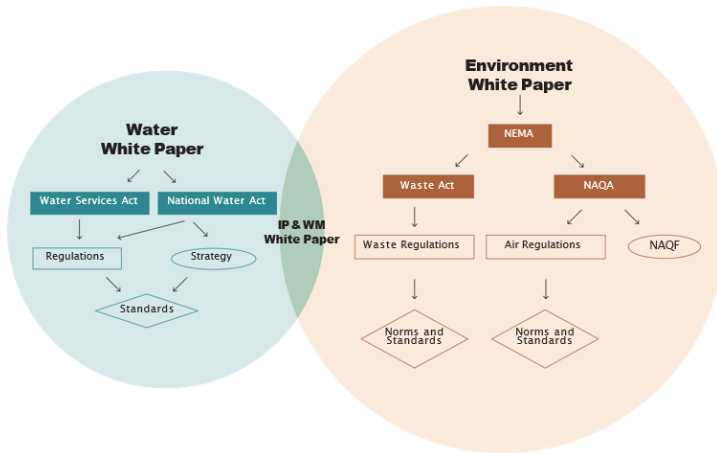
2 It will be clear below what formal strategies (which may be akin to regulations) entail.

for air quality, water, and waste, respectively. The regulations promulgated in terms of these Acts, legal frameworks, aspects of strategies, and norms and standards contain provisions that must be legally complied with.

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SECTION 24 of the Constitution

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**Figure 26:** Environmental policy map in South Africa. Source: Authors’ conceptualisation

The democratic transition in South Africa led to the development of its Constitution of 1996. In Section 24, the Constitution provides for environmental rights for everyone. It further delineates the legislative and executive powers of each sphere of government within a framework of cooperative governance, which resulted in allocating key responsibilities for environmental management amongst national, provincial, and local authorities (Scott, 2010).

According to Scott (2010), the Department of Environmental Affairs and Tourism (DEAT) (Department of Forestry, Fisheries and the Environment (DFFE) as we write this) has, since 1992, realised the inadequacy of pollution and waste management governance in addressing South Africa’s evolving social and industrial landscape. To address this, the

DEAT launched the Integrated Pollution Control (IPC) process aimed at policy development. However, this initiative faced numerous criticisms from civil society and was eventually discontinued. Subsequently, in 1995, a new process named the Consultative National Environmental Policy Process (CONNEPP) was introduced. CONNEPP was charged with crafting a comprehensive environmental policy for South Africa (Scott, 2010). The CONNEPP management team appointed the following people to draft the Green Paper Environmental Management Policy; *Mark Butler - Community Agency for Social Enquiry (CASE) (environmental NGO sector)*; *Dick Cloete - Umanyano Media Service (editor)*; *Ingrid Coetzee - Department of Environmental Affairs and Tourism (central government)*; *Mike Cohen - CEN Integrated Environmental Management Unit (provincial government)*; *Jenny Hall - CRM International (community-based organisations)*; *Arend Hoogervorst - Eagle Environmental (business and industry)*; *Shirley Miller - COSATU (organised labour)*; *Dan Walmsley - Steffan, Robertson and Kirsten (drafting manager) (RSA, 1996a)*. It must be noted that not one of the drafting team was signalled as a scientist, for example, as representing a science council or a scientific discipline.

In 1997, CONNEPP reached its conclusion with the release of the White Paper on Environmental Management Policy in 1998 (RSA, 1997a). (It was officially gazetted on 15 May 1998.) This publication outlined the government's national stance on environmental management, delineating its vision, principles, strategic goals, and objectives. The word 'evidence' does not occur. There are references to knowledge and scientific knowledge without giving the latter precedence over informal, everyday or indigenous knowledge.

The National Environmental Management Act (NEMA) 107 of 1998 was enacted to operationalise the National Environmental Policy (RSA, 1998c). The NEMA was regarded as the foundational legislation providing a comprehensive framework for all subsequent environmental laws. It was built on the White Paper that sets out the principles that the government would utilise to guide, develop, and evaluate

policies and subsequent actions, encompassing decision-making, legislation, regulation, and enforcement.

A second white paper followed. Scott (2010) wrote that the release of the DEAT's White Paper on Integrated Pollution and Waste Management (IP&WM) in 2000 represented a significant milestone for pollution and waste governance in South Africa. It is a subsidiary policy of the all-inclusive environmental management policy, as set out in the White Paper on Environmental Management Policy for South Africa (RSA, 2000, p. 12). This policy aimed to proactively address pollution by emphasising prevention, waste minimisation, and the regulation of impacts. The DEAT developed this policy in collaboration with the then the Department of Water Affairs and Forestry (DWAF), followed by a rigorous public participation process across provinces with various stakeholders, including labour, non-governmental organisations, community-based organisations, business and industry, mining, and individual members of civil society (RSA, 2000). At the time, the following drafting team, partially dominated by consultants, was appointed by the project committee to develop the Integrated Pollution and Waste Management (IP&WM) discussion document: *Dr Herman Wiechers - Lead consultant from Stewart Scott Incorporated Bohlweki Environmental; Mr Errol Cerff - Environmental Risk Services (Pty) Ltd; Mr Michael Goldblatt - University of the Witwatersrand; Mr Jan Glazewski - University of Cape Town.* Several specialists assisted the drafting team: *Mr Newton Adams - Catts; Mr Jarred Ball - Jarred Ball and Associates; Mr Llewellyn Botha - Environmental Law Consultancy; Dr Mike Cohen - CEN Integrated Environmental Management Unit; Ms Terry Winstanley - Private Consultant; Mr Thabani Masuku - University of Cape Town (RSA, 2000).*

In this White Paper, scientific knowledge and expertise receive more recognition than in the previous one, but not by much. For example, “developing ambient quality standards, emission or discharge limits in a consultative manner that is based on sound scientific and management principles, as well as local knowledge” (RSA, 2000, p. 51); and “The government will assist people to act in an informed manner by promoting sound scientific research and monitoring and recognising local

knowledge and information” (RSA, 2000, p. 54). “Government will apply a risk-averse and cautious approach that recognises the limits of current knowledge about the environmental consequences of decisions or actions” (RSA, 2000, p. 71).

At the time of the development of the IP&WM, there were 26 international agreements about IP&WM that South Africa had acceded to or ratified. Some of the agreements that influenced the IP&WM policy process were specific requirements imposed on South Africa by international agreements such as the Framework Convention on Climate Change (UN, 1992), which focuses on greenhouse gases, and the Basel Convention (UN, 1989), which deals with transboundary movements of hazardous waste (RSA, 2000).

NEMA was followed by several sector-specific Acts, as depicted in the diagram, that are specifically relevant to this chapter. We subsequently discuss air quality, waste, and water.

## **4. The development of the air quality<sup>3</sup> legal framework in the democratic South Africa**

### **4.1 Introduction to National Environmental Management: Air Quality Act (NEM: AQA)**

The IP&WM policy encapsulated in the White Paper identified several critical issues regarding air pollution that needed attention in policy implementation, such as particulate emissions from coal and fuel burning, vehicle exhaust, industrial emissions, mining and industrial dust, various greenhouse gas sources, waste disposal sites, incinerator emissions, acid rain, and noise pollution (Scott, 2010). Acknowledging the fragmented and uncoordinated approach to air quality management, the policy highlighted the inadequacy of resources for implementing, monitoring, and enforcing existing legislation. From an air quality standpoint, the policy advocated for a comprehensive overhaul of air quality legislation to align with the paradigm shift away from the previous APPA

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3 Editors’ note: Extensively discussed in Chapters 3 and 4, but from an intervention point of view.

(Atmospheric Pollution Prevention Act (Act No. 45 of 1965)) approach to a more robust air quality management strategy.

The IP&WM policy became the foundation for the development of the National Air Quality Management Programme (NAQMP) strategy, which outlined the government's plan to develop the new National Environment Management: Air Quality Act (NEM: AQA) (RSA, 2004a); amongst others, by offering a comprehensive breakdown of objectives, outputs, activities, and inputs for the programme's key components (RSA, 2002). It became law in 2004. Before the promulgation of the Act, the National Environmental Management: Air Quality Amendment Bill was distributed for public comment on 1 April 2003. The DEAT received numerous submissions from various stakeholders, of which a total of 240 comments were received from 23 distinct organisations (Scott, 2010). Following public hearings, presentations and comments from various entities, including industry, non-governmental organisations (NGOs) and community-based organisations (CBOs), the amended Bill was debated in the National Assembly on 25 August 2004 and passed (Scott, 2010). Scott makes no mention of the input of scientists.

After a long and tedious process, NEM: AQA was finally promulgated in 2005 to supersede the previous APPA. The development and implementation of NEM: AQA primarily aimed to synchronise with the broader regime change, such as the advent of democratic governance in South Africa in 1994 (Naiker, 2012). During this period, there were extensive policy and legislative revisions (the IP&WM and the NAQMP) that integrated best practices and international norms. Additionally, there was a modernisation of the approach to environmental management (Naiker, 2012).

The long process leading to the ultimate development of NEM: AQA (from the White Paper on Environmental Management Policy to IP&WM to NAQMP to the Bill) was mainly through engagements with various stakeholders, including specialists in the air quality field. The NEM: AQA makes clear provision for establishing science-based instruments such as the

National Ambient Air Quality Standards (NAAQS) adopted from the World Health Organization (WHO) (This is discussed below).

The development process of NEM: AQA was complex. It can be difficult to establish the extent to which this process was based on scientific evidence. However, if one considers the definitions in the Act of, for example, *greenhouse gas* and *ozone-depleting substance*, it is clear that some science lies underneath it. We find an obvious marker of science in Schedule 2 of the Act, providing standards for the values of various potential pollutants.

The Act does make provision to implement the use of instruments which by design should be scientifically based, such as the AQMP (in Chapter 3), NAAQS (in Chapter 2) and environmental impact assessment (EIA) and atmospheric emission licences (AEL) (in Chapter 5). However, some of these tools, such as the AQMP and NAAQS, were not in existence at the time of the promulgation of the Act in 2004. These scientifically informed policy instruments were only implemented into law years after the Act was promulgated. For example, NAAQS were gazetted on December 24, 2009, taking into account health impacts, ambient levels at the time, and South Africa's developing economy (Garland et al., 2021; Okello et al., 2020). Engelbrecht and Van der Walt (2007) highlight that when the Act was promulgated, there was a specific requirement for municipalities to develop and implement AQMPs; however, there was no guidance on the content of such plans.

## **5. Examples of where scientific evidence has influenced the development of air quality-related interventions**

### **5.1 Air Quality Management Plans (AQMPs)**

Air Quality Management Plans (AQMPs) serve to assist governmental entities in strategising the execution of NEM: AQA, encompassing mitigation strategies and financial provisions to deal with air quality matters (Naiker et al., 2012). Additionally, per section 15 of the NEM: AQA, every national department,

province, and municipality must develop an AQMP outlining the actions necessary to fulfil the mandates of NEM: AQA and comply with NAAQS (Naiker et al., 2012). Section 17 goes on to provide that the state organs responsible for drafting the AQMP must also submit reports on the plan's implementation.

Furthermore, the Minister is required in terms of section 7 of NEM: AQA to promulgate the Framework for Air Quality Management in the Republic of South Africa (NFAQM). The National Framework aims to fulfil the goals of the Act (RSA, 2007a). Also referred to as the national AQMP, the National Framework provides a medium- to long-term plan for the practical implementation of the NEM: AQA. It also provides mechanisms, systems, and procedures to promote holistic and integrated air quality management through pollution prevention and minimisation at source and impact management and, hence, provides norms and standards for all technical aspects of air quality management. The first framework was established in 2007 and revised in 2012. According to the DEAT (RSA, 2007a), the development of the National Framework has been a collaborative and evolving process drawing upon inputs from various projects and both inter- and intra-governmental processes. Stakeholder feedback was gathered during public hearings for the Air Quality Bill, as well as through a public participation process that was an integral component of developing the National Framework.

The following projects formally became the information bases that contributed to the development of the National Framework: *Development of a South African Air Quality Information System (SAAQIS)- Phase One project*; *AQA Implementation: Listed Activities and Minimum Emission Standards Project*; *APPA Registration Certificate Review Project*; *Air Quality Management Planning Implementation Manual Development Project*; *Vaal Triangle Air-shed Priority Area Air Quality Management Plan Development Project*; *Framework for Setting and Implementing National Ambient Air Quality Standards [South African National Standards (SANS 69)]*; *Limits For Common Air Pollutants (SANS 1929)*; and *Greenhouse Gas Information Management Project*.

AQMPs are detailed in Chapter 5 of the NFAQM, with instructions for developing AQMPs outlined in the Manual for Air Quality Management Planning (DEA, 2012a) (herein referred to as *the Manual*). The Department of Environmental Affairs (DEA, later DFFE) first issued the Manual for Air Quality Management Planning in South Africa in 2008, aiming to standardise the process of developing AQMPs, thereby ensuring consistency and coherence in the planning process. The Manual was compiled by consultants from Zanokuhle Environmental Services (ZES) on behalf of DEAT (RSA, 2008). The development of this initial Manual was based on a comprehensive examination of ongoing air quality management initiatives in South Africa (RSA, 2008). This ensured a consistent approach to implementing and reporting air quality management plans throughout the country, adhering to the most effective practices available. The review process involved forming a project reference group comprising Air Quality Officers from all South African provinces and representatives from municipalities engaged in AQMP initiatives. This group shared insights, exchanged information, and fostered collaborative partnerships and networks. Throughout the review, particular attention was given to the air quality management system in the South Durban Basin, identifying it as a focal point for air pollution concerns within the region (RSA, 2008). A case study was developed to address acknowledged pollution issues within this area, as documented in the DEAT Air Quality Government Publication Series C, Book 12. The insights gained from this project proved invaluable in refining and enriching the content of the Manual. The initial Manual refers to several local and international scientific sources such as research studies, reports (such as previous AQMPs), guidelines and standards (such as WHO air quality guidelines and SANS ambient air quality), which informed its development. The second revision of the manual was published in 2012.

As outlined in the Manual, there are six steps to follow in developing AQMPs. These steps include: (1) setting up stakeholder groups, defining the AQMP's geographic scope, and establishing a baseline; (2) analysing gaps and problems; (3)

setting air quality goals; (4) creating interventions and a plan to reach air quality objectives; (5) putting intervention strategies into action; and (6) monitoring, reporting, and evaluating progress. However, according to a survey conducted in the 2011 assessment of the National Air Quality Management Planning Report, not all the consultants who developed the AQMPs used the Manual to develop the AQMPs (RSA, 2011). Those who did also suggested that they supplement the manual with inputs from other sources such as the UK – *Urban Air Quality Management Toolbox*, parts of the *United Nations Environment Programme* and *United Nations Human Settlements Programme*; *National Framework, Environmental Protection UK*; *US EPA and South Coast AQM District*; *Environment Canada*; specific requirements outlined by the client and reference to plans developed internationally (RSA, 2011).

This raises the question, signalled by the literature, of whether the results of the scientific evidence on which interventions in other localities rest can easily be applied to South Africa (see Ettelt et al., 2012). Cairney writes, “Evidence of success from other countries or regions is a key source of inspiration for new policies in an ‘importing’ country” (2016, p. 36); and also, “the emphasis in some policy transfer studies on the potential risks to transferring the policy to another region without local ‘ownership’, and the different cultures and expectations in each policy field that warn against the assumption of a one-size-fits-all approach” (2016, p. 75).

The scientific input in AQMP development and implementation is found in the development of baseline air quality assessment, which is incorporated into an AQMP report. Baseline air quality assessment is a technique used to collect data on the historical and current conditions of a specific geographic area, enabling the evaluation of temporal variations and trends (Sivertsen & Bartonova, 2012). Conducting a baseline assessment helps to determine whether additional studies are necessary, utilising existing knowledge of ambient air levels. The assessment should identify emissions sources, pollutants, areas of concern, and unaffected background areas (RSA, 2012a; Sivertsen & Bartonova, 2012). This baseline assessment

provides crucial information for input into pollution area modelling and simulating dispersion characteristics (Moreoane et al., 2021). Dispersion models are used in the quantification of ambient air quality concentrations by applying software tools that use scientific data as inputs from various sources of emissions, as well as localised meteorological data to estimate the concentration of pollutants in the atmosphere (Haripursad, 2007; Tshehla & Wright, 2019). Results from air pollution dispersion modelling can be used in various ways, such as predicting of current and future air quality status quo of an area, predicting pollution episodes, assessing impacts arising from the emergency release of emissions from industries and identifying a suitable location for placing the ambient air quality monitoring station (Haripursad, 2007).

The DEA formulated the Air Dispersion Modelling Regulations and the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa. This code of practice serves as an adjunct to the air dispersion modelling regulations, outlining technical standards for the implementation of air dispersion models. Developed under Section 53 (f) of the NEM: AQA, these regulations are applicable in various contexts, including the drafting of AQMPs as outlined in Section 15 of the NEM: AQA, priority area AQMPs specified in Section 19 of the NEM: AQA, atmospheric impact reports as detailed in Section 30 of the NEM: AQA, and in applications for atmospheric emission licenses (AEL) as stipulated in Section 37 (2)(b) of the NEM: AQA. The air dispersion regulations aim to establish uniformity in model usage and to ensure that dispersion modelling procedures in South Africa are executed consistently to ensure that results from one dispersion modelling study can be compared to those from another. These regulations will guarantee uniformity and fairness in model applications, fostering trust and clarity in their appropriate usage.

The development of the regulations and code of practice was done by the DEA in collaboration with an Air Dispersion Modelling Working Group. Established in 2010, the working group consists of atmospheric science and modelling specialists. Its primary objective is to assist the DEA in

offering nationwide guidance on air dispersion modelling. Comprising professionals from government entities, industries, environmental consultancies, academia, and research institutes familiar with South Africa's regulatory framework, the group operates voluntarily. Coordination and leadership of the group are overseen by the DEA's Chief Directorate: Air Quality Management. The development of the guidelines was influenced heavily by the British Columbia dispersion modelling guideline (DEA, 2012a). In addition, in the Code of Practice for Air Dispersion Modelling in South Africa, all recommended models originate from the scientific evidence of the US Environmental Protection Agency's (US EPA) regulatory framework. The US EPA guidelines require that, in selecting and employing the most suitable model, it is essential to take into account the meteorological and topographical characteristics of the modelling area, the intended outcomes, the reliability of input data, and the technical proficiency of the modeller (Haripursad, 2007).

Baseline assessment and dispersion modelling are, therefore, tools using scientific evidence that must inform the development and implementation of intervention strategies within the AQMP report. Intervention strategies are the steps and measures taken after the baseline air quality assessment to mitigate further impacts on the environment (Gulia et al., 2015; Miranda et al., 2015; Sivertsen & Bartonova, 2012). Once the emissions sources have been identified and quantified, the interventions are developed and implemented either in combination or individually (Gulia et al., 2018). In the end, the AQMP needs to influence decision-making, especially in government institutions, by being incorporated into decision-making instruments such as the integrated development plan (IDP) and other sector plans such as environmental implementation plans (EIPs) and environmental management plans (EMPs) (Mukwevho, 2023).

## **5.2 Example: Waterberg-Bojanala Priority Area (WBPA) AQMP (October 2014)**

The following information can be considered as scientific evidence that is found within the WBPA AQMP baseline characterisation report (RSA, 2014a):

- Meteorology and climate description, i.e. description of the climate of the area;
- Presentation of wind, temperature stability inversions, and precipitation data;
- Identification of sources and pollutants of concern: a list of pollutants and compounds and their main sources and types (point, line, area) identified;
- Assessment of the impact of industrial activities, greenhouse gases, indoor exposure and other regional issues, including acid rain, regional ozone and transboundary issues
- Pollutants impacting health, environmental impacts, and climate change related
- Assessment of available emissions data and emissions inventories;
- Atmospheric Dispersion modelling conducted for the area.

(The WBPA AQMP assessment used the CALPUFF model to estimate ambient concentrations of SO<sub>2</sub>, NO<sub>2</sub> and PM<sub>10</sub> resulting from listed activities, residential fuel burning, mining, and transboundary sources in Botswana. The report indicated that the model performed the best in terms of the predicted zone of maximum influence and the magnitude of predicted concentrations).

The report was compiled by uMoya-NILU Consulting (Pty) Ltd.

## **5.3 National Ambient Air Quality Standards**

National ambient air quality standards are a key command and control policy instrument in air quality management in South Africa (Garland et al., 2021). The implementation of the NAAQS in South Africa provided a transition in air quality management with a shift in emphasis from source-oriented to receptor-

oriented, which commenced with the inception of the NEM: AQA. NAAQS were formulated on 24 December 2009, considering health effects, prevailing ambient conditions, and the evolving economic landscape of South Africa (Garland et al., 2021; Okello et al., 2020). These standards were developed based on adopting and adapting the WHO guidelines and interim targets. Like the WHO guidelines, the NAAQS specifically focuses on the following priority pollutants: NO<sub>2</sub>, O<sub>3</sub>, CO, C<sub>6</sub>H<sub>6</sub>, Pb, PM<sub>10</sub>, PM<sub>2.5</sub> and SO<sub>2</sub> (Garland et al., 2021; Mdluli, 2010; Okello et al., 2020; Tshehla & Wright, 2019). According to Garland et al. (2021), the new WHO guidelines are based on the evidence of the effect of air pollution on human health. The limits for these pollutants in South Africa are less stringent than the WHO limits (WHO, 2005).

To comply with these limits, various emissions reduction technologies and measures have been developed in many countries, including South Africa for industries to reduce emissions of PM, SO<sub>x</sub>, and NO<sub>x</sub> (Tshidzumba 2024). These measures may vary in terms of efficiency and the extent of application. For example, some industries use water to control dust, while others prefer using chemicals for the same purpose. Regarding emissions from specific sources, strategies for emissions reduction and technologies for controlling pollution can also vary. These strategies might include lowering production rates to decrease particulate emissions, using technologies such as low NO<sub>x</sub> burners to reduce NO<sub>x</sub>, and employing pulse jet fabric filter (PJFF) plants or electrostatic precipitators (ESPs) to tackle particulate matter emissions (Tshidzumba, 2024).

#### **5.4 Air quality offsets and a strategy for air pollution in low-income settlements**

In 2016 and 2019, the Minister of Environmental Affairs published two documents that, although not obligatory for all role-players in air pollution, form part of the legal framework of air quality government. They can be described as 'soft law'. These are the *Air Quality Offsets Guideline* (RSA, 2016) and the *Strategy to Address Air Pollution in Dense Low-income Settlements* (RSA, 2019a). Mitigation interventions thus rely not only on

the traditional command and control approach but could be undertaken in a hybrid manner with other approaches, such as civil-based approaches (Mukwevho et al., 2022).

Both documents show a resolve of the Department to evidence-informed interventions. In the offsets guideline, one of the principles is that offsets must be measurable and scientifically robust: “The measure of impacts on air quality and the design and implementation of air quality offsets should be based on relevant and sound science” (RSA, 2016, pp. 10–11). In the strategy document, the following undertaking is given: “Government will actively support research aimed at ensuring that decisions relating to the selection and prioritisation of interventions to address poor air quality impacts in dense low-income communities are informed by reliable science, i.e. good science must inform decisions on where interventions must be prioritised and what activities should be prioritised” (RSA, 2019a, p. 28). This will be informed by, amongst others, basic research and technical testing.

## **5.5 Conclusion on the current air pollution situation in South Africa**

Despite the existence of these scientifically informed or evidence-based instruments, the problems associated with air pollution in South Africa are far from being resolved, particularly with the observed levels of PM and O<sub>3</sub> in areas declared as hotspots (Feig et al., 2019; Govender & Sivakumar, 2019, Tshehla & Wright, 2019). PM and O<sub>3</sub> are two pollutants for which there is non-compliance with the NAAQS in all priority areas, of which a comprehensive scientific study may be required to identify and assess all sources of PM and O<sub>3</sub>. This would be necessary to develop abatement strategies for these sources (Tshehla & Wright, 2019).

Regarding the AQMP system in South Africa: since the promulgation of NEM: AQA in 2004, not all spheres of government, such as some provinces, and district and local municipalities, have developed their AQMPs as required by Chapter 3 of the Act (RSA, 2021a; Tshehla & Wright, 2019).

Mukwevho (2023) highlights that some of the underlying issues that can be attributed to the lack of scientific evidence include inadequate availability of key resources, such as ambient air quality monitoring networks within municipalities and no existing or functioning monitoring stations or useable data. In addition, other underlying issues pertain to the quality and completeness of AQMP reports on key scientific aspects such as poor description of geographical area, land use, topography, landscape and natural resources, list of areas that use fossil fuels for domestic use, health status, inventories of industries that may cause air pollution and are not listed (e.g., controlled emitters, pollutants affecting health, environmental impacts and matters related to climate change) (Mukwevho, 2023).

Regarding the NAAQS, the South African government is currently embarking on a process to review the existing NAAQS to align them with the new WHO Global Air Quality Guidelines (AQG) published in September 2021 (WHO, 2021). Interestingly, the new WHO limits for PM and NO<sub>2</sub> are considerably lower than the previous ones, and this may indicate that there is a risk to human health with almost any exposure to these pollutants (Garland et al., 2021). Garland et al. (2021) further highlight the fact, which cannot be ignored, that many countries, including South Africa, have been unable to comply with the limits in the existing WHO guidelines. This can somewhat be attributed to emissions from different natural sources such as dust, biomass burning, biogenic and marine sources. Furthermore, the gap between current air pollution levels in South Africa and the NAAQS limits, as well as the new WHO limits, can be worrying, as these targets may seem unattainable (Garland et al., 2021). There is, therefore, a great need for extensive scientific informed assessments to quantify emissions from natural sources that need to be considered in the review of the NAAQS. However, this does not erase the current need for action to also mitigate the current air pollution levels, which are exceeding the NAAQS in many parts of South Africa (Garland et al., 2021).

## 6. Scientific evidence towards waste-related<sup>4</sup> policy and legislation

### 6.1 Introduction

Scientific understanding of the environmental impacts of various waste management practices, as well as the potential risks to human health, forms the foundation upon which policies should be built. By relying on empirical data and rigorous research, policymakers can design regulations that address the specific challenges facing the country, whether it be the management of hazardous materials, the promotion of recycling initiatives, or the reduction of overall waste generation. In an ideal world, scientific evidence provides the necessary framework to assess the long-term consequences of different waste management strategies, enabling policymakers to make informed decisions that balance economic, social, and environmental considerations. In a country as diverse and ecologically rich as South Africa, a science-based approach would ensure that waste policies are not only robust but also tailored to the unique circumstances and challenges of the region (Roux et al., 2006).

The *Waste Research, Development and Innovation Roadmap for South Africa* (2015–2025) is signalled on its webpage as “a Government initiative aimed at supporting South Africa’s transition to a circular economy, through the generation of scientific evidence for the waste sector”. It has a specific outcome related to evidence-informed decision-making:

*“Strengthening skills and generating evidence to inform decision-making, planning and policy development by government and industry”* (RSA, 2014c, p. 9).

Furthermore, the National Waste Management Strategy (RSA, 2021b, p. 52) highlights the importance of scientific information

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<sup>4</sup> Editors’ note: Compare Chapter 4 for a discussion of the problem and specific interventions to mitigate.

gleaned through the Waste RDI Roadmap towards informed decision-making:

The Waste Research Development and Innovation (RDI) Roadmap has a critical role to play in building technical capacity within the waste sector and undertaking research to support development and innovation in the Waste Sector. As such, the implementation of the Waste RDI Roadmap should provide scientific support for informed decision-making and policy development, integrated waste management planning by provinces and local government on Integrated Waste Management Plans (IWMPs), and to the private sector in terms of Extended Producer responsibility (EPR) schemes.

A meeting of the National Assembly Committee for Forestry, Fisheries and the Environment in February 2022 (PMG, 2022) dealt with the *Status of Waste Management in South Africa*. The meeting noted that the Department of Forestry, Fisheries and Environment (DFFE) collaborates with scientific institutions such as the Department of Science and Innovation (DSI), the Council for Scientific and Industrial Research (CSIR), and the Technology and Innovation Agency (TIA) to develop strategies such as the Waste Research, Development, and Innovation Roadmap. This collaboration indicates a reliance on scientific expertise to inform policymaking in waste management.

However, the scientific evidence-policymaking nexus is not always achieved within the South African context, and waste management policymaking at times falls short in terms of incorporating scientific evidence. As highlighted by Strydom et al. (2010, p. 3), there are several barriers to “using science in policymaking”. These include different world views and priorities of scientists and policymakers; factors related to accountability and vested interests; poor communication and lack of engagement; uncertainty, credibility, and risk; timing and timeframes, amongst others (Strydom et al., 2010).

The next section provides a brief overview of the legal framework (already alluded to in Section 3 above) for waste

management in South Africa since the National Environmental Management: Waste Act (59 of 2008) was promulgated in 2009.

## **6.2 Overview of the legal and policy framework for waste management in South Africa**

This section provides a brief overview of the legal framework for managing waste in South Africa. The purpose of the section is not to provide a comprehensive legal framework but rather to give an illustrative overview of the laws and regulations regulating waste in the country.

**National Environmental Management: Waste Act (NEM: WA):** Enacted in 2008, this Act establishes the fundamental principles and objectives for waste management in South Africa. It provides a legal framework for the classification, monitoring, licensing, and control of waste management activities.

**National Waste Management Strategy:** The National Waste Management Strategy (NWMS) in South Africa provides a comprehensive framework for the country's approach to managing waste in an environmentally sustainable and socially responsible manner. The NWMS is aligned with the National Environmental Management: Waste Act (NEMWA) and serves as a guiding document for waste management practices across the nation.

**Waste-related regulations:** Since the NEM: WA came into effect in 2009, various regulations have been promulgated to give effect to the Act. For example:

- *List of waste management activities that have, or are likely to have, a detrimental effect on the environment* regulates the authorisation of waste management activities and infrastructure (GNR 718 of 2009, replaced by GNR 921 of 2013).
- *Waste information regulations* (GNR 625 of 2012) regulate the submission of waste-related information to the government.

- The *Plastic Bag Regulations* aim to reduce the use of plastic bags through a plastic bag levy and regulate the thickness and composition of plastic carrier bags (GNR 317 of 2021).
- *Waste Classification and Management Regulations* (GNR 634 of 2013), which establish a system for classifying waste based on its potential environmental, health and physical hazards. The classification is crucial for determining appropriate management and disposal methods.
- *Regulations regarding the planning and management of residue deposits and residue stockpiles from a prospecting, mining, exploration or production operation* (GNR 632 of 2015): These regulations provide unique requirements for the management of residue deposits and stockpiles.
- *Extended producer responsibility regulations*: NEM: WA provides for the principle of extended producer responsibility (EPR), which places responsibility on producers for the entire life cycle of their products. Producers are required to take measures to minimise the environmental impact of their products and manage post-consumer waste. The EPR regulations took effect in 2021 and require certain industries (such as paper and packaging, lighting, electrical and electronic equipment) to implement these regulations.

**Norms and standards:** Since 2013, South Africa has seen a progressive shift from regulating waste management activities through a waste management licence application process, supported by a basic assessment or scoping and full environmental impact assessment (EIA), to regulating through norms and standards determined by the minister. This occurred with the introduction of Category C as part of GNR 921 of November 2013. The advantage of regulating through norms and standards is that the administrative burden is less on the regulator, while the applicant/proponent (person or entity conducting the waste management activity) does not need to go through an expensive and lengthy EIA process. Some of the norms and standards applicable to the management of waste include:

- Norms and standards for the storage of waste (GNR 926 of 2013);
- Norms and standards for the flaring of landfill gas (GNR 924 of 2013);
- Norms and standards for the sorting, shredding, baling, crushing, screening and baling of general waste (GN 1093 of 2017);
- National norms and standards for remediation of contaminated land and soil quality (GN 331 of May 2014); and
- Norms and standards for organic waste composting (GNR 561 of 2021).

### **6.3 Case studies or examples where scientific evidence has influenced the development of waste-related legislation**

The next part provides a few illustrative examples of the incorporation of scientific evidence or science into the development of waste-related legislation.

#### *6.3.1 Framework for the Management of Contaminated Land and Norms and Standards (2010); and National Norms and Standards for Remediation of Contaminated Land and Soil Quality (GN 331 of May 2014)*

The compilation of the *Framework for the Management of Contaminated Land* (DEA, 2010) was undertaken to carry out Part 8 of Chapter 4 of the National Environmental Management: Waste Act (59 of 2008). The purpose was, amongst others, to establish norms and standards facilitating the identification and registration of contaminated sites and to develop a risk-based decision support protocol for site assessment. Section 6 of the document (*Application of Site Specific Quantitative Risk Assessment*) is pertinent to our research question. It exhibits a high degree of reliance on scientific results, albeit from international sources, but also a critical awareness of the limitations of such results (DEA, 2010, p. 42).

This framework incorporates a tiered system of soil screening values for priority soil contaminants. The soil

screening values are informed by toxicological research on contaminants of concern. The collaborative development of the framework involved engagement with stakeholders from government, industry, specialist consultants, and the public, encompassing national workshops and sector-specific forum groups. The framework outlines:

- A Protocol for Site Risk Assessment;
- Reporting Norms and Standards for Contaminated Land;
- The Derivation and Use of Soil Screening Values;
- Application of Site-Specific Risk Assessment; and
- Quality Control and Quality Assurance of Field Sampling and Laboratory.

In May 2014, the Department of Environmental Affairs published the *National norms and standards for the remediation of contaminated land and soil quality* (GN 467).

The purpose of these norms and standards is to (a) provide a uniform national approach to determine the contamination status of an investigation area; (b) limit uncertainties about the most appropriate criteria and method to apply in the assessment of contaminated land; and (c) provide minimum standards for assessing necessary environmental protection measures for remediation activities (RSA, 2014b, p. 5).

We next present an example illustrating one kind of limitation of evidence-based policy. Scientific evidence was used to make policy (*Framework for the Management of Contaminated Land*), but allegedly based on unreliable results. Papenfus et al. (2015) critique and question the scientific correctness of the soil screening values proposed in these policies. The regulations determine a soil screening value (SSV) for the protection of groundwater resources, which relies on a two-phase equilibrium partitioning and dilution model, incorporating a dilution factor and partitioning coefficient ( $K_d$ ), thereby translating the water quality guideline into a comprehensive soil screening value. Concerns have arisen regarding the validity of these screening values, particularly caused by uncertainties surrounding the

$K_d$  values utilised within the *Framework for the Management of Contaminated Land*. The research by Papenfus et al. (2015) delve into the  $K_d$  values of copper (Cu), lead (Pb), and vanadium (V) across selected South African diagnostic soil horizons to assess the reliability of current  $K_d$  values employed during Phase 1 screening (as in the *Norms and Standards for the Assessment of Contaminated Land*). The study found that the  $K_d$  values for Cu ranged from 13 to 19,044  $\ell \cdot \text{kg}^{-1}$  across the 10 horizons, surpassing the Framework's value of 10  $\ell \cdot \text{kg}^{-1}$ . Similarly, Pb values ranged from 25 to >252,294  $\ell \cdot \text{kg}^{-1}$  compared to the Framework's 100  $\ell \cdot \text{kg}^{-1}$ , while the recommended V value of 200  $\ell \cdot \text{kg}^{-1}$  exceeded the measured values of 15 to 173  $\ell \cdot \text{kg}^{-1}$  across all 10 diagnostic horizons. These wide  $K_d$  value ranges were attributed to variations in fundamental soil properties such as pH, organic carbon, clay, iron (Fe), and aluminium (Al) content. Consequently, the  $K_d$  values for Cu, Pb, and V currently utilised by the Framework do not accurately reflect typical South African diagnostic soil horizons. Papenfus et al. (2015) have developed linear regression models to predict Cu, Pb, and V  $K_d$  values based on measured soil properties, offering the potential for soil-specific  $K_d$  values.

Given the implications under the National Environmental Management: Waste Act (NEMWA), precise Phase 1 screening assessments are crucial, yet uncertainties persist because of  $K_d$  value variability across soils. The authors argue that relying on a single  $K_d$  value, as suggested by the *Framework for the Management of Contaminated Land*, could lead to erroneous Phase 1 screening outcomes, carrying environmental and economic ramifications (Papenfus et al., 2015). The study advocates for the consideration of soil properties such as pH, organic carbon, clay content, cation exchange capacity (CEC), Fe, Al, and manganese (Mn) contents in calculating soil screening values. Moreover, it emphasises the potential for more reliable  $K_d$  value estimations through regression analyses, offering equations that account for these soil properties. In the absence of detailed measured soil properties, preliminary  $K_d$  values generated from this study for a range of diagnostic horizons could serve as a valuable resource.

Papenfus et al. (2015) motivate an alternative approach to determine the water-soluble fraction of samples in addition to the total analysis required by the *Norms and Standards for the Assessment of Contaminated Land*. This would increase the certainty with which screening is conducted and could prevent significant inappropriate screening. The authors highlight that cost could be justified through the potential cost savings, thus preventing unnecessary Phase 2 assessments or the reduction of undetected risks that could impact the environment. The authors conclude that their results may be useful when reviewing and revising legislation applicable to contaminated land assessment. Whether their research led to policy amendments is not known to us.

In his dissertation, Muller (2020, p. 60) reports that the legal framework for the rehabilitation of contaminated land is:

largely technical, which prescribes scientific and technical standards and methods for obtaining and reporting contaminated land information in terms of Part 8 of [the NEM: WA]. This is not surprising as determining the human and ecological risk of contaminated land is a highly technical and complicated matter. As part of its Protocol for Site Risk Assessment, for example, it sets out a scientific methodology for the screening of soil.

Muller (2020) concludes that although these details are useful and based on scientific information, the “technical or scientific information could confuse” the end user of these documents.

### 6.3.2 *Waste Classification and Management Regulations (GNR. 634 of 2013)*

In 2013, the *Waste Classification and Management Regulations* (GNR. 634) were published to replace the classification process prescribed by the *Minimum requirements for the handling, classification and disposal of hazardous waste* (RSA, 1998b). According to these regulations, all waste streams, except a few pre-classified ones, must be classified within 180 days of generation and reclassified every five years or within 30 days

of any process modification leading to waste generation. This classification is crucial for labelling and preparing safety data sheets for waste transport. According to the *Waste Classification and Management Regulations* (2013), waste classification adheres to the *Globally Harmonized System of Classification and Labelling of Chemicals* as applied in South Africa by the National Standard (SANS 10234).

The *Globally Harmonized System for the Classification and Labelling of Chemicals* (GHS) (UN, 2011) is an internationally recognised framework developed to standardise the classification and labelling of chemicals. It provides a comprehensive and consistent approach to conveying information about chemical hazards, facilitating global communication and trade. The scientific basis for the classification of chemicals under GHS is rooted in a rigorous scientific assessment of their properties, potential risks, and effects on human health and the environment.

The groundwork for the Global Harmonized System (GHS) commenced in 1989 when the International Labour Organization (ILO) passed a resolution aiming for the alignment of classification and labelling systems. During the initial stages of formulating this universally harmonised system, various international organisations' and countries' existing chemical classification and labelling frameworks were considered.

This collaborative effort involving the World Health Organization, the International Labour Organization, the Organisation for Economic Cooperation and Development (OECD), and the United Nations, along with member countries, enjoyed broad support from the chemical industry and scientific community (Winder et al., 2005). The harmonisation process was overseen by the Inter-Organization Programme for the Sound Management of Chemicals (IOMC).

The GHS encompasses all hazardous chemical substances, dilute solutions, and mixtures. It is emphasised that the classification of a chemical substance relies on defined criteria and the reliability of associated test methods. Tests determining hazardous properties, conducted per internationally recognised

scientific principles, can inform hazard determinations for health and environmental risks. The GHS criteria remain neutral towards test methods by specifying criteria rather than tests, thus emphasising performance and scientific validity according to international standards. Specific test methods are linked to criteria for physical hazards such as flammability and explosivity (Winder et al., 2005).

The GHS employs a hazard classification system that considers physical, health, and environmental hazards. The scientific criteria for classification encompass a range of factors, including acute and chronic toxicity, carcinogenicity, mutagenicity, and environmental impact. This systematic approach ensures that chemicals are classified based on their intrinsic properties, promoting transparency and enhancing the understanding of potential hazards associated with their use. The classification process is based on toxicological research, ecotoxicological studies, expert review and consensus, and international collaboration (Winder et al., 2005) and is considered to be based on “scientifically sound data, validated according to international procedures and criteria already referred to in existing systems for the hazard class of concern” (UN, 2011, p. 6).

Overall, the development of the GHS was a science-driven process, with scientific evidence serving as the foundation for hazard classification criteria and labelling requirements. By integrating the latest scientific research and expertise, the GHS provides a standardised approach to chemical classification and labelling that promotes the protection of human health and the environment on a global scale.

### 6.3.3 *National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR 635 of 2013)*

The assessment of waste for landfill disposal follows the *National Norms and Standards for the Assessment of Waste for Landfill Disposal*, deviating significantly from the methodology outlined in the *Minimum Requirements for handling, classification, and disposal of hazardous waste* (RSA, 1998b). The new protocol involves a distinct analytical procedure based on the Australian

Standard Leaching Procedure (Australian Standard AS4439), incorporating total concentration analysis alongside leachable concentration analysis and prescribing different leaching solutions based on waste type. The outcome of the assessment process indicates the waste type (Type 0 to 4).

The Australian Leaching Procedure is a standardised method used to classify waste materials, focusing on assessing the potential environmental impact of waste during disposal through its leachability. This procedure is scientifically grounded in the principle that certain contaminants can leach out from waste materials when they come into contact with water, potentially leading to groundwater and soil pollution. The method involves simulating the leaching process in a controlled environment to measure the concentration of contaminants that can be released into the environment under specific conditions (Scott et al., 2005). The scientific basis of this procedure lies in understanding the chemical behaviour of contaminants within the waste matrix and how they interact with leaching media. It evaluates the mobility of hazardous substances, providing critical data for determining the environmental risk associated with the disposal or reuse of waste materials.

In her PhD thesis titled *Investigating the leaching of heavy metals from cementitious waste and contaminated soil: assessing the applicability of standard leaching procedures*, Halim (2004), however, argues that the Australian Leaching Procedure (AS4439) may not be the most appropriate method to assess waste types for landfill disposal. The study highlights that AS4439, along with other leaching procedures such as the Toxicity Characteristic Leaching Procedure (TCLP), may not fully capture the complexities of leaching behaviour under landfill conditions. Specifically, the comparison with municipal solid waste (MSW) leachate indicates discrepancies in metal leaching estimations when using synthetic leachates. However, the study also suggests that certain components of AS4439, such as water and sodium tetraborate buffer, may be appropriate for estimating leaching by non-putrescible landfill leachate. Overall, while the application of AS4439 for waste assessment is not outrightly dismissed, the study emphasises the need

for careful consideration of various factors and conditions when utilising it for waste assessment for landfill disposal. It emphasises the importance of recognising the limitations and potential shortcomings of standardised leaching procedures and encourages a comprehensive approach that considers the specific characteristics and conditions of the waste and landfill site in question. If the application of AS4439 in Australia is not straightforward, the application to South Africa must be handled very carefully.

#### **6.4 Towards improving evidence-based waste regulation: The National Waste Information Regulations**

Since the late 1990s, South Africa has made several attempts to gather data and information on waste generation and management, primarily through voluntary systems, most of which proved unsuccessful (Godfrey and Nahman, 2007). Before the enactment of the NEM: WA in 2008, the initial NWMS and the White Paper on Integrated Pollution and Waste Management (IP&WM) emphasised the necessity of establishing a waste information system. These documents advocated for the creation and maintenance of databases and information management systems to serve the needs of local, provincial, and national governments by gathering reliable national waste data (RSA, 1999).

Since the implementation of NEM: WA in 2009, the South African Waste Information System (SAWIS) has been formally regulated and enforced through the 2012 *National Waste Information Regulations* (referred to as “Waste Information Regulations”) (GNR 625 of 13 August 2012) (RSA, 2012b). This system was developed to act as a national repository of waste information, covering various waste management activities such as hazardous waste generation, recovery, recycling, treatment, exportation, and disposal to landfills (ibid).

Data from waste information systems is crucial for monitoring waste processes such as generation, storage, transport, and disposal and for pinpointing potential pollution sources. This information on waste – including its sources,

amounts, trends, types, and composition – is vital for planning effective waste management (UNEP, 2015). Most importantly, it serves as a foundation for setting policy objectives and evaluating the effectiveness of existing policy interventions, such as reduction, recovery, and recycling (Godfrey et al., 2012). However, it is acknowledged that managing waste data is complex, as it involves an interconnected system that is difficult to measure or model because waste can be both an output and input of different processes (RSA, 2018a).

Research by Sehaswana (2021), *A critical reflection on the challenges in implementing waste information systems: A case of the South African Waste Information System*, highlighted various challenges in implementing the SAWIS, such as data capturing, lack of equipment to accurately measure waste quantities, capacity and resource limitations, high staff turnover, confidentiality of data, and Internet accessibility. The findings support the notion that for waste information systems to be successful, there must be investment in infrastructure, improved skills and capacity of SAWIS users and administrators, and stronger enforcement of the waste information regulations. An absence of correct and reliable waste information renders waste information systems useless in contributing to evidence-based policy development.

## **6.5 Waste: Conclusion**

The preceding sections illustrate the incorporation of scientific and evidence-based information into waste-related legislation in South Africa. It is, however, recognised that evidence-based information does not always find its way into legislation. As highlighted by Godfrey et al. (2010) in their abstract, “To support the uptake of evidence in policy, it is also important to stimulate an environment of ‘evidence pull’ by the policy community from the research community, as well as increasing the dialogue between these communities”. This still leaves some work to be done in terms of stimulating collaboration between the scientific community and policymakers.

## **7. Scientific evidence towards water-related policy and legislation**

### **7.1 Introduction**

The evolution and transformation of water-related policy and legislation in South Africa can be traced back to pre-colonial times and have ever since been sculpted by the social, political, and economic philosophy of the ruling regime (Tewari, 2009). During the mid-1850s, the British colonisers of the Cape regulated the use of water based on the *riparian principle*, which granted the exclusive ownership and use of water to property owners adjacent to rivers. The riparian rights system was later adopted in the 1956 Water Act and further distinguished between private and public water. The implications of these concepts would see the majority of the population – mainly the black population – be excluded from accessing and using water to ultimately benefit a minority white population. With the looming political changes in the early 1990s, an overhaul of water-related policy and legislation was on the table to ensure that water would be an imperative human right for all in post-apartheid South Africa.

### **7.2 Overview of the water-related policy and legal framework for water management in South Africa**

This section provides an overview of the most notable policy documents which consequently formed the basis of our current legal framework governing the use of water in the country.

#### *7.2.1 Fundamental principles and objectives for the new water law in South Africa*

The water law reform process was initiated through the publication of the *Fundamental principles and objectives for the new water law in South Africa* in 1996, and contained 28 principles concerned with the legal aspect of water, the water cycle, water resource management priorities and approaches and water institutions and services (RSA, 1996b). After an intensive consultation process which relied on inputs from scientific

councils, communities, water users, academic institutions, and national, provincial, and local governments, these fundamental principles were adopted and became the foundation for the *White Paper on a National Water Policy* in 1997.

#### 7.2.2 *White Paper on a National Water Policy for South Africa*

The main objective of the *White Paper on a National Water Policy for South Africa* (RSA, 1997b) was to outline the direction for the development of water law and water management systems in South Africa. One of the directions the *White Paper* took was to abolish the riparian rights system and adopt guiding principles for future water management interventions. For this section, only the most relevant principles of the *White Paper* will be discussed and are summarised below:

1. existing water uses (which also include rights) will be recognised...
2. water required to ensure that all people have access to sufficient water shall be reserved...
3. the quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved...

The *White Paper on a National Water Policy* (RSA, 1997b) states: “Ongoing monitoring and assessment of the patterns of resource use, and the response of the resource to use, are critical to our ability to manage and protect those resources on the basis of sound scientific and technical information and understanding. Adequate information is essential for effective resource management and protection” (RSA, 1997b, Section 6.8.1).

The *White Paper* also recognised that the newly adopted principles and objectives will require novel and enabling water resource management interventions. These interventions had to be based on “the application of law, economics, natural resource management approaches and the science of organisations, reinforced with the skills of communication...”. (Ibid., Section 6.1). In so doing, the government had to develop an enabling legal framework which made provision for water resource

management approaches, which are based on science and implemented by skilled and competent people.

### 7.2.3 *National Water Act (36 of 1998)*

This came in the form of the *National Water Act* (NWA) (No. 36 of 1998) (RSA, 1998a), which was applauded for being a progressive, forward-thinking, and ambitious policy intervention (MacKay et al., 2003). They paraphrase the long title of the Act. According to them, it recognises that water is a natural resource which belongs to all people and that the National Government is responsible for equitable allocation of water and aims to achieve sustainable use through the integrated management of all aspects to ensure the protection of the quality of water resources at a regional or catchment level so as to enable everyone to participate.

The Act further sets out its aims, amongst others, to meet the basic human needs of present and future generations, promote equitable access to water, redress the results of past racial and gender discrimination and promote the efficient, sustainable, and beneficial use of water in the public interest.

### 7.2.4 *National Water Resource Strategy*

The NWA makes provision for the development of a National Water Resource Strategy (NWRS), which serves as a framework for the protection, use, development, conservation, management, and control of water resources for the country as a whole (RSA, 2004b). The NWRS emphasises the importance of “science and knowledge that leads to innovation that benefits the sector” and “the provision of evidence that guides policy and the implementation thereof” as cross-cutting aspects in all the technical domains of the water sector. *Science/scientific* is mentioned eight times in the document, and *evidence* in the sense that we use it four times.

### 7.2.5 *A notable water-related regulation*

In this section, we discuss the *Regulations for the Establishment of a Water Resource Classification System, GN R810 of 2010* (RSA, 2010).

Before the Reserve determination can be calculated, one needs to follow a seven-step procedure to determine different classes of water resources. These steps require (i) the delineation of the units for analysis and a description of the status quo of the water resources; (ii) linking the socioeconomic and ecological values and condition of the water resource; (iii) the quantification of the ecological water requirements and changes in non-water quality ecosystem goods, services, and attributes; (iv) the determination of an ecologically sustainable base configuration scenario; (v) evaluation of scenarios within integrated water resource management (IWRM) processes; (vi) evaluation of the scenarios with stakeholders; and ultimately (vii) the promulgation in the Government Gazette and implementation of the class configuration.

Numerous policy-based instruments have been developed to assist in realising the overall purpose and objectives of the NWA and the NWRS. The following section will briefly discuss two such instruments: the Reserve and the authorisation for the use of water utilising an existing lawful use (ELU).

### **7.3 Case examples of where scientific evidence has influenced the development of water legislation**

#### *7.3.1 The Reserve*

The reform in water legislation in the country provided an opportunity to develop sound policy-based instruments which are founded on scientific, political, and social principles, of which the Reserve is an example of such an instrument (Mackay, 2001).

The Reserve and the determination thereof are regulated by Sections 16 to 18 of the NWA and deal with the (i) basic human needs reserve and the (ii) ecological reserve. It is deemed as the primary right to water, as no water may be allocated to other water users and water uses until the requirements of the Reserve have been met (RSA, 2006). This, however, requires various scientific methods and assessments to determine the necessary water for human needs and ecological functioning.

The following paragraphs briefly allude to these two concepts contained within the Reserve and how scientific and social principles inform determining the Reserve.

### **Basic human needs reserve**

The concept of basic human needs can be traced back to when ancient civilisations recognised their reliance on water for human health and survival (Vuorinen, 2007). Within the South African context, the basic human needs reserve relates to “...the essential needs of individuals served by the water resource in question and includes water for drinking, for food preparation and for personal hygiene” (see Part 3 of the NWA, 1998). In 1997, the *White Paper on a National Water Policy* suggested a 25 litres per person per day quantity to satisfy basic human needs and acknowledged that this quantity is relative and should increase as the standard of living increases. The prescribed quantity at the time was based on the guidelines provided by the World Health Organization to ensure that basic human needs such as cooking, sanitation and personal hygiene can be achieved. More than a decade later, the basic human needs quantum would be legally challenged. Reflecting on the outcome of the *City of Johannesburg and Others v Mazibuko and Others* (2009), the court held that the 25 litres per person per day, as suggested by the *White Paper on a National Water Policy*, should be increased to 42 litres of water per day based on the availability of water within the municipality. It should be noted that this court judgement is only applicable to the municipality and the related free basic water policies in question. (These volumes of water allocated for basic human needs must be taken into consideration when determining the ecological reserve for water resources (DWA, NWRS 3, 2023, Chapter 12)). We were not able to find out on what basis the court arrived at the quantum of 42 litres. Nevertheless, it is an interesting example of policy determination by the judiciary where, ideally, scientific evidence should have played a crucial role.

## **Ecological reserve**

The ecological reserve is deemed to be an endogenous South African concept (Biggs et al., 2008) which stemmed from engineering practices implemented for the construction of the Pongolapoort dam in the 1970s (Bourblanc, 2015). Since then, hydro-ecologists have managed to increase their influence on water resources management decision-making and have refined the concept to such an extent that it has been adopted as a legal requirement within the NWA (Bourblanc, 2013). The NWA defines the ecological reserve as "...the water required to protect the aquatic ecosystems of the water resource" (RSA, 1998a) and needs to be determined for all individual water resources, for the quantity and quality of water needed. It requires highly technical administrative decision-making over an extensive period (Kidd, 2011) by using approved methods for quantifying the flow, habitat, and water quality requirements of the ecosystems within the water resource (Thompson, 2006; Quinn, 2012). Since 1989, two comprehensive, holistic scientific methods, namely the Building Block Methodology (BBM) and the Downstream Response to Imposed Flow Transformations (DRIFT), have been applied. Development of the BBM was undertaken jointly by the Department of Water Affairs and Forestry (DWAF) and river scientists and aims to provide scientific guidance on river flows where biological data and the functioning of the river are limited (King & Louw, 1998). At the same time, the DRIFT method was developed in actual water-resource development projects in several rivers, including the Palmiet River, Breede River and the Lesotho Highlands Water Project. The main purpose of the DRIFT is to describe selected potential flow regimes and link them to the biophysical and socioeconomic consequences of the river ecosystem (King et al., 2004). These two methods have been supported by a more recently developed method, namely the Flow Stressor-Response (FSR), which may be used on its own or as part of holistic methods to capture specialist knowledge on the relationship between flow, hydraulic habitat and the response of instream biota (O'Keeffe et al., 2002).

Subsequently, several Reserve determinations have been gazetted for water management areas by using the above-mentioned methods. They include the Inkomati Catchment (see Notice 998 of 2019) (RSA, 2019b), the Mvoti to Umzimkulu Catchments (see Notice 1097 of 2018) (RSA, 2018b), the Olifants to Doorn Catchments (see Notice 189 of 2017) (RSA, 2017a), and the Vaal WMA (see Notice 1019 of 2020) (RSA, 2020b). Notices of the proposed Reserve determinations have also been published for the Olifants and Letaba Catchments (see Notice 1038 of 2017) (RSA, 2017b), the Mokolo to Matlabas Catchments (see Government Notice 1669 of 2022) (RSA, 2022), and the Crocodile West and Marico Catchments (see Government Notice 1050 of 2020) (RSA, 2020c).

### **7.4 Case example of where scientific evidence has not influenced the development of water legislation**

#### **Water use authorisation – existing lawful use (ELU)**

According to the NWA, all water uses must be authorised in terms of a water use licence unless the water use constitutes a Schedule 1 water use. It then falls under a General Authorisation, and the need for a licence is dispensed with, or it is recognised as an Existing Lawful Water Use (ELU). For this section, we will only focus on the latter as a case example. An ELU permits the continuation, under certain conditions, of an existing water use derived from a law repealed by the NWA. As mentioned in the introduction, the National Water Policy (RSA, 1996b) specifically highlighted that these existing rights *...will be recognised...* under a reformed water law. The decision to recognise an ‘apartheid era water right’ under the reformed NWA was purely<sup>5</sup> based on the government not wanting to disrupt the economic sector, which relied mainly on agricultural activities. Ever since the adoption of ELUs into the reformed water legislation has often been criticised for perpetuating inequality in the access to water. This criticism is firmly grounded in the historical context of the country. Historically, apart from customary water rights

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5 Editors’ note: This “purely” makes for a very strong claim which the authors fail to substantiate.

that applied in the former self-governing territories and 'TBVC states' the black majority was largely restricted from owning land, resulting in a lack of formal water rights. In contrast, the white minority, especially large-scale irrigation farmers, secured water rights through the riparian rights principle and the notion of private water. This historic imbalance enabled these large-scale water users to buy an ELU more easily, reinforcing the existing disparities in water access even after 1998 (Van Koppen & Schreiner, 2014; Van Koppen et al., 2014).

## 8. Conclusion

Government policy on the environment in South Africa is wide-ranging and complex. We investigated the role of evidence in three fields: ambient air, waste, and water. Legislation and policies in these three areas, although articulated severally, are covered by an umbrella Act, the National Environmental Management Act, 1998 (107 of 1998). However, as far as the governance of water is concerned, the National Water Act (36 of 1998) also has a large part to play.

We contribute to the evidence-policy discourse by exploring the extent to which scientific evidence influences South African environmental policy. We cast light on the question both along the a) time and the b) policy-level dimensions: that is, firstly, the unfolding situation resulting from the democratisation of South Africa, and secondly, the articulation of policy from the level of broad policy and legislation down to the operational level. The environmental policy context is legally complex.

At the same time, we wanted to contribute to conceptual clarity around the notions of evidence and policy. We preferred a narrow definition of evidence but a broad definition of policy.

We found that scientific evidence played a lesser role when the country was still establishing the new democratic order. At the beginning of the democratic order, it was important to recognise the contribution of non-specialists and to show respect for knowledge that was not of scientific research origin.

As the broad policies were articulated in sector-specific legislation at the start of the millennium and regulations and strategies were developing, the role of evidence increased. Sometimes, legislation presumed evidence was available before it was established by scientists. Often, the evidence originated overseas.

The level of norms and standards is where science came into its own. However, we discussed an interesting example in the field of waste assessment where subsequent research cast some doubt on the science on which screening values for the policy in the form of norms and standards were originally determined. Scientific results may thus be inherently fallible, as Karl Popper (1902–1994) has shown, but they do move in the direction of truth. This is another reason why *evidence-based* policy may be too strong a term and why one should rather talk of *evidence-informed* policy. Science is not static but grows in the direction of validity and reliability. This implies that a government must have the capacity to remain au fait with the latest findings. We did not discern a strong in-house scientific research capability in the relevant government departments. There may be an overreliance on consultants.

It is understandable that on the broad conceptual level, scientific results would play a lesser role than the interests of stakeholders and political aims. However, it is in the interest of all that the self-correcting characteristic of science also be applied in the administration of a country. When results show that policies do not work or that the data and information from which, for example, norms and standards are derived are not valid, changes must be made. This requires scientific capabilities in the state and respect for reality. And respect for reality is synonymous with science.

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