Annual Conference of the National Association for Clean Air

2024

Air quality Evolution:

Reflecting on

20 Years of Progress and Charting Future Paths

Annual Conference Proceedings

4 – 6 September | GAUTENG

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PROCEEDINGS OF THE

Annual Conference of the National Association for Clean Air

Air Quality Evolution: Reflecting on 20 Years of Progress and Charting Future Paths

4 – 6 September 2024

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Welcome Message

The 2024 Annual NACA Conference, held in collaboration with the Department of Forestry, Fisheries, and the Environment's (DFFE) Air Quality Governance Lekgotla, was a highly significant event. This year, the conference focused on "Air Quality Evolution: Reflecting on 20 Years of Progress and Charting Future Paths."

This theme emphasised South Africa's transformative journey in air quality management following the enactment of the National Environmental Management: Air Quality Act (Act 39 of 2004). This landmark legislation aimed to protect the environment by establishing strong measures to prevent pollution, ensure ecological sustainability, and promote responsible economic and social development. It set national norms and standards to regulate air quality monitoring, management, and control across all levels of government.

The conference provided a unique platform to reflect on the achievements of the past two decades, analyse ongoing challenges, and gather key insights that will shape the future. Attendees anticipated a rich program featuring technical sessions, expert presentations, and research contributions that addressed the evolution of air quality management. The event also showcased cutting-edge strategies and technologies for advancing cleaner air in South Africa.

NACA remains dedicated to fostering collaboration among academia, industry, government, and civil society. By bringing together diverse perspectives, the conference aimed to spark dialogue, inspire innovative solutions, and drive collective efforts toward a cleaner, healthier, and more sustainable future.

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SCIENTIFIC REVIEW

The 2024 National Association for Clean Air (NACA) annual conference proceedings include peer-reviewed publications that underwent a rigorous review process.

A total of forty-three abstracts were submitted for initial screening. Among these, seventeen were poster submissions, including four three-minute research talks.

A total of twenty-three full papers were submitted, of which:

- One was withdrawn by the author, opting to submit only the abstract due to prior publication elsewhere.
- One was withdrawn for other reasons.
- Twenty-one manuscripts were sent for peer review.

Each of the 21 manuscripts underwent a blind review by two to three independent reviewers. The initial review outcomes were as follows:

- 2 papers were accepted as-is.
- 12 papers required minor revisions.
- 7 papers required major revisions.

Authors were required to address reviewer comments, and corrected versions were resubmitted for confirmation. Dr. Brigitte Language, who served as chair, oversaw the review process.

Following the review process, the documents included in the proceedings span three categories: Full Papers, Posters, and 3-MRT.

Among the Full Papers (16):

- Air Resource Management (1)
- CSIR (2)
- Mintek (1)
- North-West University (6)
- Nova Institute (1)
- University of Cape Town (1)
- University of Limpopo (2)
- University of Pretoria (2)

For the Poster category (17):

- Air Resource Management (1)
- Department of Economic Development, University of Cape Town (1)
- National Metrology Institute (1)
- North-West University (4),
- Sol Plaatje University (1)
- South African Medical Research Council (1)
- Stellenbosch University (3)
- University of Cape Town (2)
- University of Johannesburg (2)
- University of Pretoria (1)

In the 3MRT category (4),

- National Research Foundation (1)
- North-West University (1)
- Stellenbosch University (1)
- University of Johannesburg (1)
- In addition, 9 posters were also presented as 3-MRT.

The NACA LOC, chaired by Dr. Brigitte Language, managed the online review process through an online management system. A full archive of the review history was maintained.

SCIENTIFIC PROGRAMME

WEDNESDAY, 4 SEPTEMBER (FULL DAY)

07:30 - 08:30	Registrations | Refreshments | Exhibit
08:40 - 09:00	Welcome and Opening | Prof Roelof Burger NACA President (NWU)
09:00 - 11:00	**Session 1 | Multi-stakeholder Workshop | HYBRID | Dr Patience Gwaze (DFFE)** Development of the National Nonindustrial Emission inventory ***Mr Maluta Mbedzi (DFFE)*** Present progress and status of the non-industrial inventory - Overview ***Dr Anja van Basten (Gondwana Env. Solutions)*** National on-road Transport Module Development Status ***Mr Prince Chidhindi (North-West University)*** Residential Fuel Burning Module of the National Inventory
11:00 - 11:30	Mid-morning Refreshments | Poster Viewing | Exhibit
11:30 - 12:30	**Session 2 | Keynote | Prof Stuart Piketh (NWU)** ***Mr Peter Lukey (DFFE)*** The Birth of the NEM: AQA – A patchy tale of the transition to objectives-based air quality governance in South Africa
12:30 - 13:30	Lunch | Poster Viewing | Exhibit
13:30 - 14:00	**Session 3 | Keynote | Mr Siya Mkhize (S&W Attorneys)** ***Dr Patience Gwaze (DFFE)*** The Future Direction of Air Quality Management in South Africa
14:00 - 15:00	**Session 4 | Oral | Monitoring, Measurement and Analysis | Dr Gerrit Kornelius (UP)** ***Ms Nomsa Muthelo (University of Pretoria)*** A nationwide assessment of nitrogen pollutants and related species using the CAMx model [Paper] ***Ms Tamryn Hamilton (North-West University)*** High-Resolution Temporal Trends of Near Surface NO2: Insight into Deposition Dynamics at a South African Background Site [Paper] ***Mr Pfano Makhokha (University of Limpopo)*** Evaluation of Simulated Planetary Boundary Layer Heights Against Radiosonde Derived Estimates for Locations across South Africa [Paper] ***Mrs Sarah Dikgale (Council for Scientific and Industrial Research)*** Validation Of CSIR Wind Tunnel Calibration Data Under Different Barometric Conditions Using Comparisons with A Reference Laboratory [Paper]
15:00 - 15:30	Mid-afternoon Refreshments | Poster Viewing | Exhibit
15:30 - 16:30	**Session 5 | Technical | HYBRID | Dr Phathutshedzo Mukwevho (NWU)** ***Dr Montagu Murray - NOVA Institute*** ***Prof Stuart Piketh - North-West University***

Prof Kristy Langerman - University of Johannesburg

Dr Herman van der Walt - Sasol

Mr Brian McCourt – Eskom

Air quality Offsets as an instrument for Air Quality Management in South Africa - Follow-up from Working Group

16:30 - 17:15 **Session 6 | Oral | Policy, Regulation and Urban Planning | Dr Hasheel Tularam (SRK)**

Dr Niké Jacobs (North-West University)

Lost in Integration: Spatial Planning and Air Quality Management in South Africa [Paper]

Ms Oarabile Masekwameng (North-West University)

The Importance of Climate Variables in Spatial Planning: A Comparative Study of North-West Province Planners' Decision-Making Processes [Paper]

Dr Phathutshedzo Mukwevho (North-West University)

20 years of AQ monitoring in South Africa: What have we learned? [Paper]

17:15 - 17:25 Closing of Day | Conference Chair

THURSDAY, 5 SEPTEMBER (FULL DAY)

07:00 - 08:00 Registration | Refreshments | Poster Viewing | Exhibit

08:00 - 08:15 Welcome and Arrangement | Conference Chair

08:15 - 09:00 **Session 7 | Keynote | Mr Grant Ravenscroft (Argos Scientific)**

Dr Hanlie Liebenberg-Enslin (Airshed Planning Professionals)

Air Quality Evolution in South Africa over the past 20 years: A Constants' Journey

09:00 -10:00 **Session 8 | Oral | Community Impacts | Dr Mbalenhle Mpanza (UJ)**

Mr Avishkar Ramandh (Air Resource Management)

The Improvement in Air Quality Due To A Waste Offset Program in Sharpeville [Paper]

Ms Sonja de Beer (North-West University)

Urban Trees and Air Quality and Climate Regulation: Perceptions from a Rural Informal Settlement in South Africa [Paper]

Dr Montagu Murray (Nova Institute)

Towards a better understanding of the impact of demographic and services trends on air quality in low-income settlements: a case study of eMbalenhle and Lebohang [Paper]

Mr Thato Phala (North-West University)

Investigating the contribution of open waste burning to air pollution in Oranjeville, South Africa

10:00 - 10:30 Mid-morning Refreshments | Poster Viewing | Exhibit

10:30 - 11:15 **Session 9 | Technical | HYBRID | Prof Roelof Burger (NWU)**

Mr Ngongang Wandji Danube Kirt - Stockholm Environment Institute (SEI) Kenya, Africa

Dr Chris Malley - SEI York, United Kingdom

Dr Kevin Hicks - SEI York, United Kingdom

Dr Charlie Heaps - SEI United States

Dr Aderiana Mbandi - United Nations Environment Programme (UNEP), Africa

International Day of Clean Air (UNEP) - Beyond Monitoring: Using the Low Emissions Analysis Platform (LEAP) for examining Air Quality Futures

11:15 - 12:00	**Session 10 | Oral | Industrial, Urban, and Rural Air Quality | Prof Kristy Langerman (UJ)**
	Ms Meg Pettie (University of Cape Town)
	Evaluating the Relationship Between Loadshedding and Air Pollution [Paper]
	Ms Ncobile Nkosi (North-West University)
	Intra-urban Variability of Non-exhaust Traffic PM_{10} Emissions from Limpopo Province Unpaved Residential Roads [Paper]
	Dr Carla Grobler (MIT, now at the University of Pretoria)
	Public Health Impacts of Residential Heating Electrification in the Contiguous US [Abstract]
12:00 - 13:30	Lunch | Poster Viewing | Exhibit
13:30 - 14:15	**Session 11 | Keynote | Mr Mogesh Naidoo (CSIR)**
	Mr Siyabonga Mkhize (Shepstone & Wylie Attorneys)
	Intersection between Climate Change and Air Quality – A look at the Climate Change Act 22 of 2024 and how it interconnects with existing Air Quality Legislation [Paper]
14:15 - 15:00	**Session 12 | Keynote | HYBRID | Dr Terri Bird (Airshed Planning Professionals)**
	Prof Jesse van Griensven Thé (Lakes Environmental Software)
	Artificial Intelligence in Atmospheric Science: Transforming Environmental Modelling and Forecasting
15:00 - 15:15	**Session 13 | Oral | Aerobiology | Dr Nomfundo Mahlangeni (SA-MRC)**
	Prof Frank Neumann (North-West University)
	Progresses in Aerobiology in South Africa and at NWU: Allergenic Pollen and Spores as a Health Risk of National Importance [Paper]
15:15 - 15:45	Mid-afternoon Refreshments | Poster Viewing | Exhibit
15:45 - 16:45	**Session 14 | Oral | Technological Innovations | Dr James Tshilongo (MINTEK)**
	Mr Keagan Velde (North-West University)
	Biochar as a Sustainable Alternative to Anthracite in Metallurgical Smelting [Paper]
	Ms Shimoné Bridges (North-West University)
	Emission Performance of a Clean Cookstove and Oven Utilising Predominant South African Wood Species [Paper]
	Dr Stephen Opiyo (North-West University)
	Evaluation of aerial thermography as a tool for in-situ determination of the thermal insulation status of dwellings in large settlements in South Africa [Paper]
	Dr Andile Mkhohlakali (MINTEK)
	Volatile organic compounds sensing using CuO based nanocomposite: Addressing Structural and sensing characteristics [Paper]
16:45 - 17:00	Closing of Day | Conference Chair
18:00 – 00:00	Social Evening

FRIDAY, 6 SEPTEMBER 2024 (HALF DAY)

07:15 - 08:00	Morning Welcome & Refreshments
08:00 - 08:15	Welcome and Arrangement
08:15 - 09:00	**Session 15 | Keynote | Dr Johanna von Holdt (UCT)**

	Ms Deidre Herbst (Eskom)
	The Nexus of Air Quality and Electricity in South Africa
09:00 - 10:00	**Session 16 | Technical | Dr Johanna von Holdt (UCT)**
	Mr Brian McCourt (Eskom)
	Eskom Minimum Emission Standards National Environmental Consultative and Advisory Forum Outcomes – an Eskom Perspective
10:00 - 10:45	**Session 17 | Oral | Climate Change and Air Quality | Dr Martin van Nierop (Gondwana)**
	Dr Gerrit Kornelius (University of Pretoria)
	Tier 2 Greenhouse Gas Emission Factors for South African Solid Fuels
	Mr Mogesh Naidoo (Council for Scientific and Industrial Research)
	Investigating the Air Quality Co-Benefits of Transitioning to Net Zero in The South African Energy Sector [Paper]
	Ms Karabo Makgaretse (University of Limpopo)
	Influence of climate change on meteorological conditions affecting air pollution dispersion in South African Air Quality Priority Areas [Paper]
10:45 - 11:30	**Session 18 | 3-Minute Research Talks | Ms Happy Mabowa (MINTEK)**
11:30 - 12:00	Mid-morning Refreshments
12:00 - 13:00	NACA Annual General Meeting | Prof Roelof Burger (NWU)
13:00 - 13:30	NACA Awards
13:30 - 13:45	Closing | Mr Siya Mkhize

PAPER XIII: N24_015

Strategic Spatial Planning for Air Quality: Evaluating Policies in South African Urban Development

Thehann BJ van Niekerk[1], Niké S Jacobs*[1], Phathutshedzo Mukwevho[1], Roelof P Burger[1] and Jako Viviers[1]

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The integration of spatial planning and air quality management is essential for sustainable urban development and is, expectedly, strongly advocated in the Municipal Systems Act (32 of 2000). Rapid urbanisation and industrialisation in South Africa induced air quality challenges, particularly affecting low-income settlements near heavy industrial zones. This literature review aims to critically analyse the alignment between South African spatial planning and air quality management directives. By examining key directives (policies, frameworks and legislation), this study investigates whether these directives are aligned to mitigate air pollution and promote equitable urban development. The findings highlight gaps and synergies in directive implementation, providing insights into the effectiveness of current directives to intercept rapidly decreasing air quality. Ultimately, this review underscores the need for improved and aligned directives that address urban planning and air quality management to facilitate healthier living environments for all South Africans.

Keywords: South Africa, Spatial Planning, Air Quality Management, Spatial Planning Directives, Air Quality Management Directives, Directive Alignment, Sustainable Cities

1. Introduction

Air quality is a cross-cutting issue influenced by various sectors, including infrastructure, transportation, and urban form. It is essential to consider air quality in relation to these sectors, as they all contribute to, and are affected by, air quality management. Spatial planning, as one of the governance systems, significantly impacts air quality. Figure 1 illustrates Hersey *et al.*'s (2015) monthly averaged PM_{10} levels for ground monitoring sites in Johannesburg, Tshwane, Ekurhuleni and the Vaal Triangle Air Quality Priority Area. Solid lines represent residential areas and dashed lines represent industrial sites. Notably, the data shows that PM_{10} levels are higher in residential areas than at industrial sites, highlighting the critical role of spatial planning in managing air quality and mitigating pollution in residential zones.

Poor air quality in urban settlements has emerged as a pressing global issue over the past few decades, with profound implications for public health and environmental sustainability. (Zell *et al.* 2010). Urban areas are significant contributors to air pollution, driven by human activities e.g., transportation, industry, and residential development (Valavanidis *et al.* 2016). The accelerating pace of urbanisation and population growth exacerbates these challenges, leading to increased energy consumption, greater travel distances, and reduced open spaces (Cho & Choi 2014). While countries of the global North have predominantly urbanised landscapes, countries in the global South are experiencing rapid urban growth rates, causing disparities in urban development (Dahiya 2012, Haase 2018).

South Africa faces significant air quality challenges from high greenhouse gas emissions due to energy generation, metallurgical industries, and transportation, ranking among the top global carbon dioxide (CO_2) emitters (IEA 2024). The country's legacy segregated historic development patterns exacerbates these issues, as heavy industrial development is placed near dense, low-income settlements, predominantly inhabited by the urban poor (Pieterse 2002). Despite efforts to enhance infrastructure and service delivery, these areas continuously experience unique environmental challenges adversely impacting the quality of life, highlighting the persistent disparities in urban development and resultant air quality (Matooane *et al.* 2004).

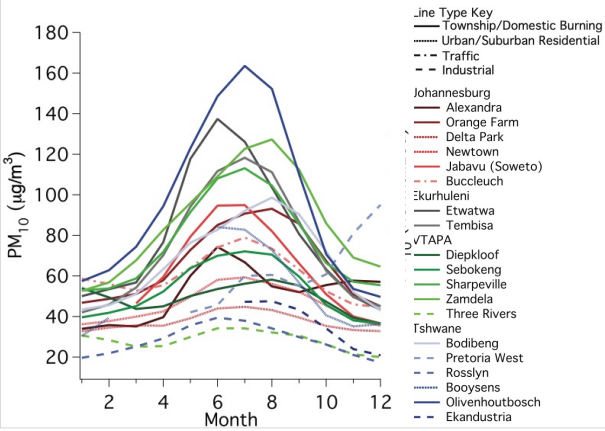

Figure 1: Monthly averaged PM_{10} for ground monitoring sites. Solid lines represent residential areas, and dashed lines represent industrial sites. Source: Hersey *et al.* (2015)

In response to global trends of poor air quality, the international community has fostered multilateral environmental agreements to address air quality issues (IPCC 2014). As a signatory to the Kyoto Protocol and the Paris Agreement, South Africa has committed to reducing greenhouse gas emissions and improving air quality management (Goitom 2018). The South African National Environmental Management: Air Quality Act (NEM:AQA) was introduced in 2004 as a comprehensive framework to replace outdated legislation and enhance ambient air quality management (Barnwell 2009).

Central to South Africa's governance approach is an integration of various governance systems, including strategic spatial planning and environmental management, to create a cohesive framework for sustainable development (Local Government: Municipal Systems Act (32 of 2000), Retief 2015, Simphiwe 2014). However, effective integration of air quality management and spatial planning processes remains a critical challenge in South Africa (DEA 2013). Integration of these governance systems is essential as spatial planning determines the distribution of land uses and infrastructure, directly impacting emissions and exposure levels in urban environments (Bertaud 2002). Considering the impact of the urban environment on air quality management (Badach *et al.* 2023), this study provides an initial analysis of the integration of South African governance systems for spatial planning and air quality management.

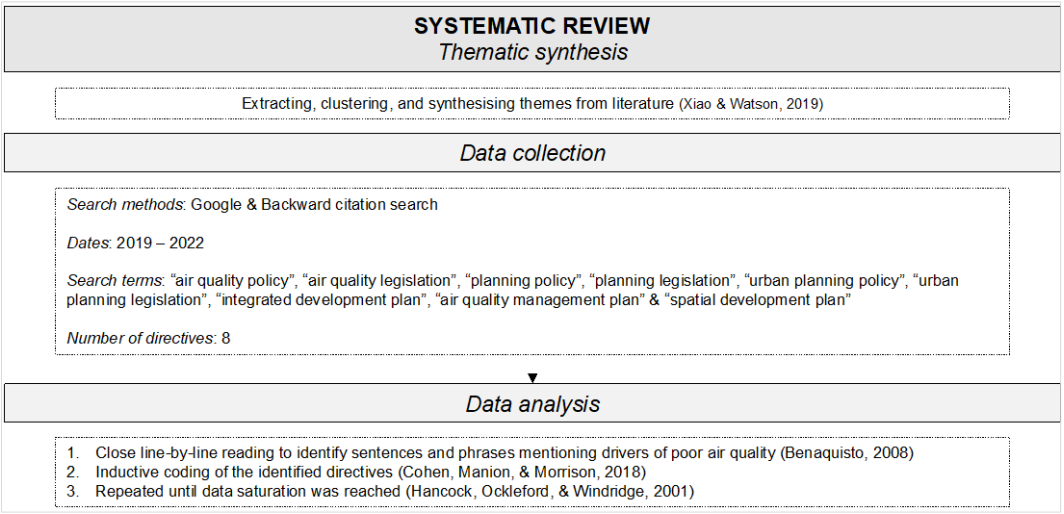

Figure 2: A diagram indicating the methods followed for this research

2. Methods

A systematic review (Figure 2) was conducted to explore the alignment between policies, frameworks and legislation governing South African air quality management and spatial planning. The policies, frameworks and legislation were collected through a Google search and subsequent backward citation searches of cross-references within documents. The search terms included: "South Africa" AND (respectively) "air quality policy", "air quality legislation", "planning policy", "planning legislation", "urban planning policy", "urban planning legislation", "spatial planning policy", "spatial planning legislation", "urban planning guidelines", "spatial planning guidelines", "integrated development plan", "air quality management plan", and "spatial development plan". A total of ten documents were identified (Figure 3).

Figure 3: Legal framework of South African air quality management and spatial planning.

Figure 4: A Sankey diagram Illustrating the top twelve themes found within policy, frameworks and legislation guiding the air quality management and spatial planning governance systems in South Africa.

The collected documents were subsequently analysed through close line-by-line reading (Benaquisto 2008) to identify sentences and phrases focussing on certain areas of focus, such as transportation, economic development, low-carbon economy, emission reduction, and urban air quality. This process was repeated until data saturation was reached (Hancock *et al.* 2001). The identified sentences and phrases were subsequently reduced by applying a process of inductive coding (Cohen *et al.* 2018). A single code (label) was allocated to similar focus areas, and the selected codes were finally reorganised into themes. The twelve most prominent themes were included in the results (Figure 4).

The results are visually presented and discussed in the following section.

3. Results

The themes identified during the exploratory review in the identified policies, frameworks, and legislation are indicated in Figure 4. This illustrates the cross-cutting level of the South African governance system, specifically related to air quality management and spatial planning.

There are notable overlaps between directives. For instance, sustainability is addressed across multiple directives, indicating its cross-cutting importance in spatial planning and air quality management directives. The themes of green economy and green energy reveal a push towards environmentally friendly economic growth. Transport highlights the critical role of sustainable transport solutions in spatial planning and air quality management.

3.1. Air Quality Management in South Africa

The air quality management legal framework (Figure 3) consists of the National Environmental Management Act (NEMA), the National Environmental Management: Air Quality Act (NEM: AQA) and the National Framework for Air Quality Management.

Central to the NEM: AQA is the development of a National Framework for Air Quality Management, which mandates regular revisions every five years. This framework is a blueprint for comprehensive air quality management strategies, integrating national norms and standards across governmental levels. It requires all national, provincial, and municipal entities to develop Air Quality Management Plans (AQMPs) that are integrated into local planning norms and standards across governmental levels.

All national, provincial, and municipal entities must develop AQMPs aligned with local planning frameworks to ensure coordinated environmental management.

Supporting the implementation of AQMPs is the Manual for Air Quality Management and Planning (2008), which offers guidelines for setting objectives, conducting baseline assessments, implementing intervention strategies, and evaluating outcomes. These guidelines aim to foster consistency, alignment and effectiveness in air quality planning across different governmental spheres, emphasising the importance of proactive management and sustainable development practices.

The most prominent themes within the air quality management legal framework are air quality and air quality monitoring and management. Sustainability and the natural environment received a few mentions and spatial planning was mentioned only once (in NEMA). Several themes, including energy, green economy, green energy, local economic development, low-carbon economy, socio-economic development, and transport are not present.

3.2. Spatial Planning in South Africa

The spatial planning legal framework (Figure 3) consists of the National Development Plan (NDP), the Spatial Planning and Land Use Management Act (SPLUMA), the Medium-Term Strategic Framework, the National Spatial Development Framework, The Integrated Urban Development Framework, the National Land Transport Strategic Framework, and the National Transport Master Plan (NATMAP).

The NDP outlines sustainable development strategies across housing, energy, transportation, and infrastructure, aiming for a low-carbon economy and environmentally sustainable living environments. Aligned with this, the Medium-Term Strategic Framework focuses on reducing greenhouse gas emissions and integrating environmental considerations to mitigate poor air quality, especially in dense, low-income areas.

The National Spatial Development Framework addresses historical spatial inequalities in South Africa. It targets transit-oriented development, ecological conservation, economic transformation, and spatial justice to ensure a prosperous and equitable future for all South Africans.

Transportation, highlighted by the National Transport Master Plan and its obligatory Municipal Integrated Transport Plans, promotes sustainable modes to cut energy consumption and urban air pollution. Yet, challenges in managing its environmental impact persist. The Integrated Urban Development Framework addresses spatial inequalities with resilient, inclusive urban settlements, advocating for integrated planning that optimises urban form and minimises environmental impacts.

Most recently, the SPLUMA emphasises the preparation of Spatial Development Frameworks (a compulsory Integrated Development Plan (IDP) sector plan) at various spheres of government, including a strategic environmental assessment and making references to the diverse concepts of "spatial sustainability" and "sustainable land development" within its norms and standards. Nonetheless, the act is resolute that the coordination, alignment and integration of all sectoral policies must be spatially expressed in a municipal Spatial Development Framework (SDF).

Integrated Air Quality and Spatial Planning Governance Systems in South Africa The IDP, mandated by the Municipal Systems Act (2000), is a cornerstone of integrated local governance in South Africa. It aims to foster sustainable urban development by aligning various sectoral strategies within municipalities (Figure 5). The IDP is designed to ensure that all strategies, including those related to air quality and spatial planning, are effectively coordinated and supported by appropriate budget allocations.

Despite the IDP's role as integration vehicle, challenges persist in effectively aligning sector plans. Sector plans are often developed in isolation, leading to fragmented implementation and ineffective budget alignment (PARI 2018). This fragmentation highlights a critical issue: while the IDP is intended to serve as a unifying framework, its current application reveals fragile direct links between air quality management and spatial planning.

The integration between governance systems for air quality management and spatial planning reveals a limited explicit connection. Air quality management is heavily concentrated in the National Environmental Management: Air Quality Act and the National Framework for Air Quality Management, which provide comprehensive guidelines. Conversely, spatial planning is primarily addressed through policies such as the National Development Plan, Integrated Urban Development Framework, and the National Spatial Development Framework, with air quality considerations receiving minimal attention.

This gap in integration is evident when examining the attention given to various themes. For instance, air quality monitoring and management, energy, and green economy receive sparse mention in spatial planning frameworks. This lack of explicit linkage, combined with minimal indirect references, highlights a significant opportunity for more cohesive coordination. The IDP, as a central integration mechanism, must enhance its role in bridging these gaps to ensure a more unified approach to managing air quality and spatial planning objectives.

Moreover, this review has found that there is a silo approach between major sectoral legislation such as NEMA: AQA and SLPUMA and their associated development plans. For example, NEMA and NEMAQA makes no reference to spatial planning instruments like SPLUMA and SDF. Although SPLUMA makes reference to NEMA and "any other legislation that regulates a specific aspect of the environment", it does not specifically mention NEM: AQA and National Framework for AQ management which are main instruments for AQ governance in South Africa. Key strategic planning documents such as the NDP and National Land Transport Strategic Framework are found to be misaligned to other sectoral instruments. These documents for example make mention of NSDF and SPLUMA but also fail to make specific reference to relevant sectoral environmental management tools such as NEMA and NEMAQA.

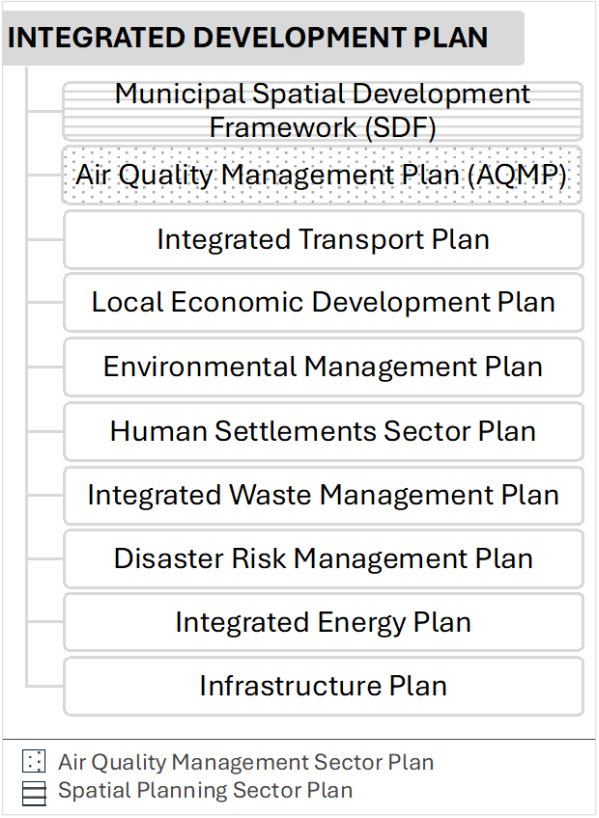

Figure 5: A list of sector plans related to the identified themes (Figure 4) included in the South African Integrated Development Plan. Source: CoCT (2022), Viviers (2019)

4. Conclusions

The South African air quality management governance system, particularly under the National Environmental Management: Air Quality Act (NEM: AQA), is heavily focused on command and control measures for industrial emissions. This approach, while crucial, reflects a narrow perspective that lacks cross-

sectional integration with other sectors influencing air quality. This exploratory review reveals a gap in incorporating broader sectoral considerations into air quality management, such as transportation, energy, and spatial planning, which are critical to addressing air quality comprehensively.

The initial analysis of the integration between governance systems of air quality management and spatial planning appears limited. While spatial planning frameworks and directives emphasise sustainable urban development and address socio-economic factors, they often overlook the direct and indirect impacts of urban development on air quality. Such separation highlights a missed opportunity to synergise efforts across different governance areas.

To address these challenges, existing gaps must be bridged and a more holistic approach fostered that integrates air quality considerations into all relevant sectors. Improved alignment and coordination between air quality management systems and spatial planning policies can enhance the effectiveness of both frameworks. Ultimately, this integrated approach can lead to more sustainable urban development and better air quality outcomes, benefiting all communities.

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