

The Impact of Air Pollution on Public Health through the Lens of the South African Weather Service Air Quality Monitoring Programme

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28 October 2021

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Outline

- ❑ Introduction
- ❑ SAWS Observation Network
- ❑ SAAQIS Network
- ❑ Air Pollutants and Quality Management
- ❑ Air Quality and Human Health Impacts
- ❑ Concluding Remarks



Introduction

- ❑ The South African Weather Service (SAWS) is an entity of the Department of Forestry, Fisheries and the Environment (DFFE)
- ❑ SAWS is the authoritative voice for weather and climate in South Africa

South African Weather Service Act (No. 8 of 2001)

- ❑ Mandate:
 - Provide weather and climate services to all South African citizens
 - E.g., public good (weather, climate and air quality monitoring services)
 - Sector-specific (and tailor-made) solutions and services

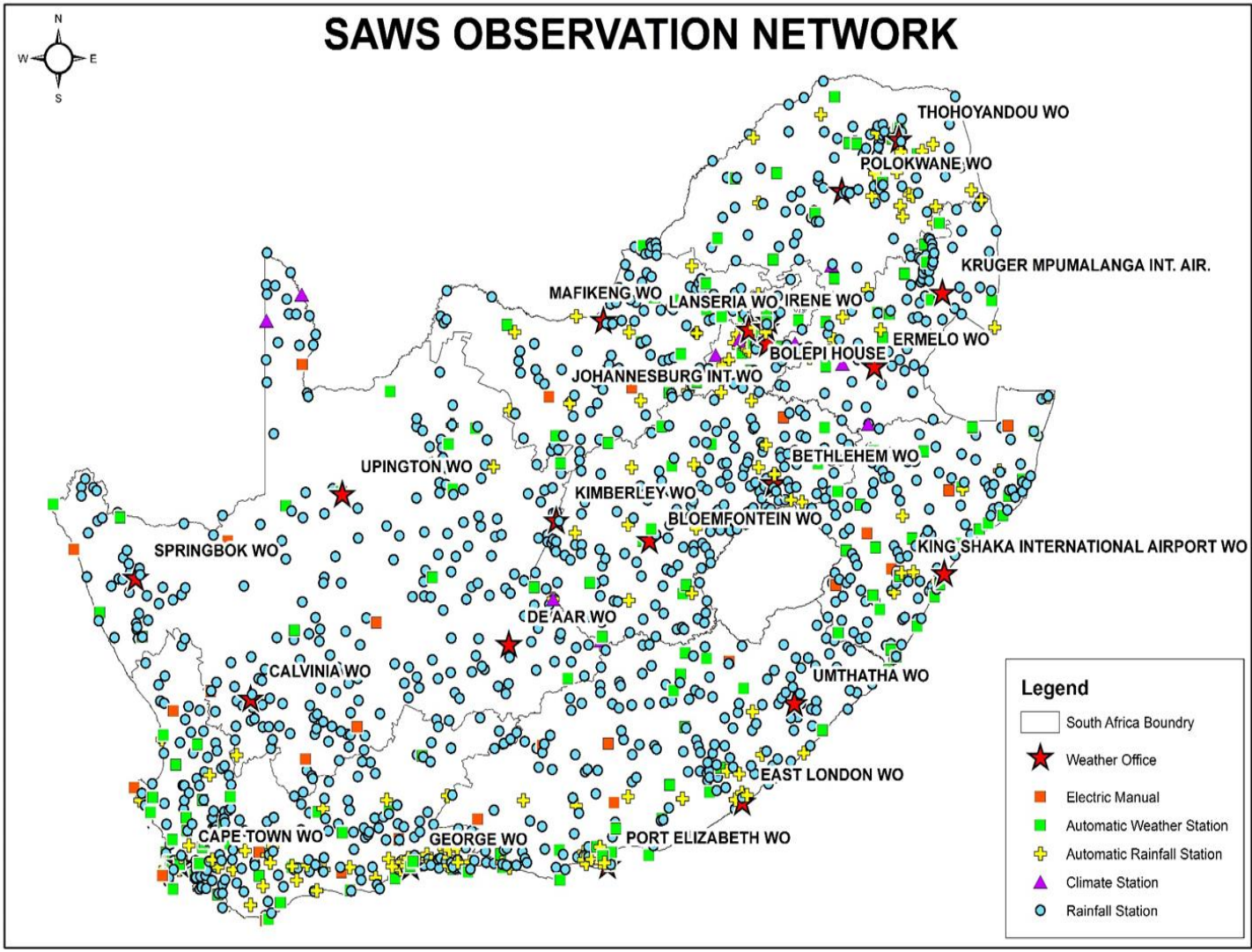
South African Weather Service Amendment Act, 2013 (Act No. 48 of 2013)

- ❑ Mandate:
 - Maintain, extend and improve the quality of meteorological services for the benefit of all South Africans; include, among others, provisions relating to the
 - South African Air Quality Information System (SAAQIS) and the National Ambient Air Quality Monitoring Network (NAAQMN)



SAWS Observation Network

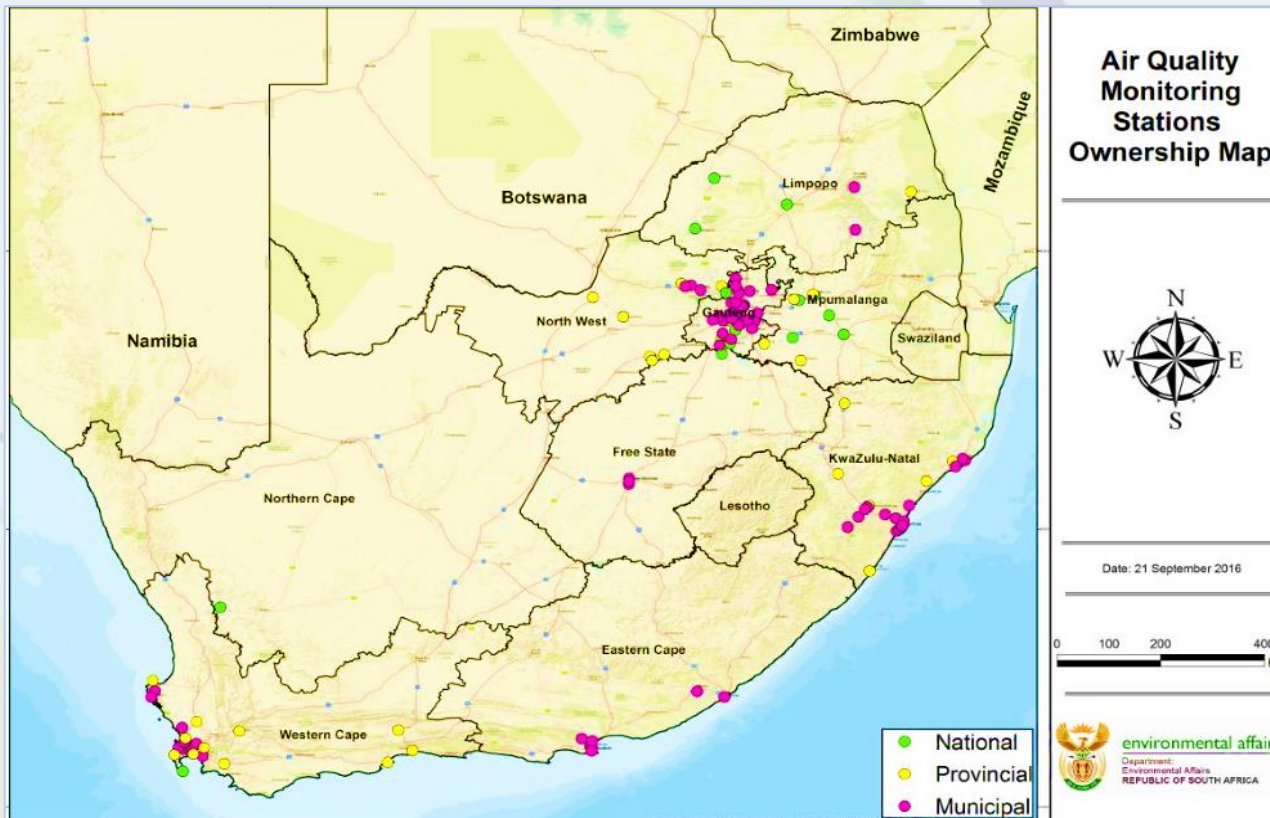
□ Vast observation network of stations managed by SAWS-including SAAQIS network



- 1277**
Rainfall stations
- 214**
Automatic weather stations
- 141**
Automatic rainfall stations
- 25**
Climate stations
- 24**
Lightning sensors
- 14**
Radars
- 10**
Upper air stations
- 13**
Solar radiation stations
- 17**
UVA & UVB radiation stations
- 1**
Global Atmosphere Watch station
- 20**
Weather Offices

SAAQIS Network

- There are currently 135 government owned stations across the country and 50 private stations



Source: Editorial- South African Air Quality Information System (SAAQIS) mobile application tool: bringing real time state of air quality to South Africans



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2021/11/01



South African
Weather Service

SAAQIS Website

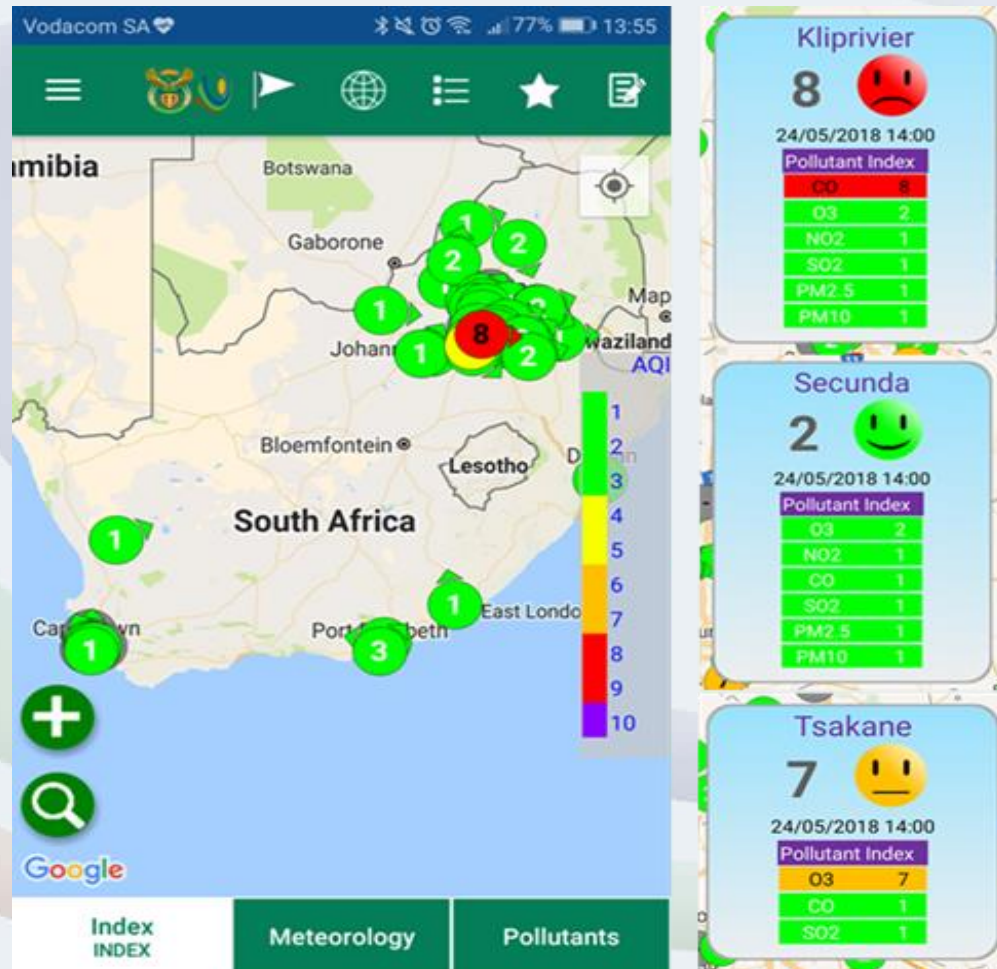
The screenshot displays the SAAQIS (South African Air Quality Information System) website. At the top left, there are logos for the Department of Forestry, Fisheries and the Environment and the South African Weather Service. The main header includes the SAAQIS logo and the text "South African Air Quality Information System". A navigation menu on the left lists various sections like Home, Ambient Monitoring Data, and Emission Reporting. The central part of the page features a map of South Africa with numerous circular markers indicating air quality index levels at different locations. A legend at the bottom left of the map shows color-coded categories: 1 (Good), 2 (Moderate), 3 (Unhealthy), 4 (Very Unhealthy), 5 (Hazardous), and 10 (No current data). On the right side, there is a sidebar with a search bar, a date and time display (20/10/2021 | 09:00), and several interactive buttons such as "Search Stations", "Stations Filter", "Index Gauge", "News", "Dynamic Tables", "Contact Information", "Report Event/Contact Official", and "About". At the bottom right, there are buttons for "Map View" and "Download the app".

<https://saaqis.environment.gov.za/>



SAAQIS APP

Available on Android and on IOS



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Air Pollutants

❑ There are many air pollutants that pollutes our environment

Criteria Pollutants	Main Sources
Carbon monoxide (CO)	<ul style="list-style-type: none"> • Vehicle emissions • Bush fires
Nitrogen dioxide (NO ₂)	<ul style="list-style-type: none"> • Vehicle emissions • Industry emissions • Power plants • Gas stoves
Sulphur dioxide (SO ₂)	<ul style="list-style-type: none"> • Power plants • Oil refineries
Particulate Matter (PM ₁₀ & PM _{2.5})	<ul style="list-style-type: none"> • Industry (mining) • Vehicle emissions • Dust storms • Bush fires
Ozone (O ₃)	<ul style="list-style-type: none"> • Not emitted, but form through chemical reaction of gasses in the air

air contamination



Stricter regulations



Air Quality Management

- ❑ Air quality management through air quality limits and thresholds
- ❑ National Ambient Air Quality Standards (NAAQS) are standards established under the National Environmental Management: Air Quality Act 39 of 2004
- ❑ Standards specify the level of concentration of number of pollutants that are allowed in the air
- ❑ Standards are set to protect human health (mostly the vulnerable), animals and properties
- ❑ Each locality and country set standards depending on number of local conditions
- Technological feasibility (electric cars)
- Economical factors (investments)
- Political and social factors

Is there compliance to the set air quality standards?



Unhealthy levels of Air Pollution

Non-compliance in O₃, PM₁₀ and PM_{2,5}

Summary of Exceedances of Ambient Air Quality Standards record at VTPAMN (01 January 2021 – 31 July 2021)

Pollutant & Averaging Period	Standard	Annual Number of Permitted Exceedances	Station Name	Exceedances Per Month												Total Exceedances to Date	
				January	February	March	April	May	June	July	August	September	October	November	December		
PM ₁₀ 24h ★	75 µg ^m - ³	4	Zamdela	0	0	1	8	16	18	22							65
			Three Rivers	0	0	12	19	9	8	22							70
			Sharpeville														0
			Sebokeng	0	0	0	5	9	13	20							47
			Kliprivier	0	0	0	8	13	12	22							55
			Diepkloof	0	0	0	1	0	0	2							3
PM _{2.5} 24h ★	40 µg ^m - ³	4	Zamdela	0	0	1	4	8	17	17						47	
			Three Rivers	0	0	2	8	6	7	3						26	
			Sharpeville														0
			Sebokeng	1	0	0	2	8	12	15							38
			Kliprivier	1	0	0	6	15	14	13							49
			Diepkloof	1	0	0	1	0	1	1							4
SO ₂ 10 min	191 ppb	526	Zamdela	0	0	0	0	0	9	10						19	
			Three Rivers	0	0	0	2	2	0	2						6	
			Sharpeville														0
			Sebokeng	0	0	0	0	0	0	1							1
			Kliprivier	0	0	0	0	5	0	0							5
			Diepkloof	0	0	0	0	0	0	0							0
SO ₂ 1h	134 ppb	88	Zamdela	0	0	0	0	0	3	2						5	
			Three Rivers	0	0	0	1	1	0	1						3	
			Sharpeville														0
			Sebokeng	0	0	0	0	0	0	0							0
			Kliprivier	0	0	0	0	3	0	0							3
			Diepkloof	0	0	0	0	0	0	0							0
SO ₂ 24h	48 ppb	4	Zamdela	0	0	0	0	0	0	0						0	
			Three Rivers	0	0	0	0	0	0	0						0	
			Sharpeville														0
			Sebokeng	0	0	0	0	0	0	0							0
			Kliprivier	0	0	0	0	0	0	0							0
			Diepkloof	0	0	0	0	0	0	0							0
NO ₂ 1h	106 ppb	88	Zamdela	0	0	0	0	0	0	0						0	
			Three Rivers	0	0	0	0	0	0	0						0	
			Sharpeville	0	0	0	0	0	0	0							0
			Sebokeng														0
			Kliprivier	0	0	0	0	1	0	0							1
			Diepkloof	0	0	0	0	0	0	0							0
O ₃ 8h (Running) ★	61 ppb	11	Zamdela	2	7	4	0	0	0	0						13	
			Three Rivers	22	6	12	1	0	4	5						50	
			Sharpeville	0	0	0	0	0	0	0							0
			Sebokeng	2	0	0	0	0	0	1							3
			Kliprivier	10	3	9	0	0	0	0							22
			Diepkloof	0	0	0	0	0	0	0							0
CO 1h	26 ppm	88	Zamdela	0	0	0	0	0	0	0						0	
			Three Rivers	0	0	0	0	0	0	0							0
			Sharpeville	0	0	0	0	0	0	0							0
			Sebokeng	0	0	0	0	0	0	0							0
			Kliprivier	0	0	0	0	0	0	0							0
			Diepkloof	0	0	0	0	0	0	0							0
CO 8h (calculated on 1 hourly averages)	8.7 ppm	11	Zamdela	0	0	0	0	0	0	0						0	
			Three Rivers	0	0	0	0	0	0	0							0
			Sharpeville	0	0	0	0	0	0	0							0
			Sebokeng	0	0	0	0	0	0	0							0
			Kliprivier	0	0	0	0	0	0	0							0
			Diepkloof	0	0	0	0	0	0	0							0



Unhealthy levels of Air Pollution

Non-compliance in O₃, PM₁₀ and PM_{2,5}

Table 4: Summary of exceedances of ambient air quality standards record at WBPAAM (December 2018).

Pollutant & Averaging Period	Standard	Annual Number of Permitted Exceedances	Station Name	Exceedances Per Month												Total Exceedances to date			
				January	February	March	April	May	June	July	August	September	October	November	December				
PM10 24h ★	75 µg ^m - ³	4	Lephalale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mokopane	0	0	2	1	12	23	12	26	23	9	0	1	109	109		
			Thabazimbi	0	0	0	0	2	8	5	3	9	0	0	0	27	27		
			Xanadu	0	0	0	2	3	3	1	20	7	0	0	0	36	36		
PM2.5 24h ★	40 µg ^m - ³	4	Lephalale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mokopane	0	0	0	0	0	0	0	2	2	0	0	0	4	4		
			Thabazimbi	0	0	1	0	0	7	1	0	1	0	0	0	10	10		
			Xanadu	0	0	10	9	1	26	9	27	26	8	12	2	130	130		
SO ₂ 10 min	191 ppb	526	Lephalale	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	
			Mokopane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Thabazimbi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Xanadu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SO ₂ 1h	134 ppb	88	Lephalale	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2	
			Mokopane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Thabazimbi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Xanadu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SO ₂ 24h	48 ppb	4	Lephalale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mokopane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Thabazimbi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Xanadu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NO ₂ 1h	106 ppb	88	Lephalale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mokopane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Thabazimbi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Xanadu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O ₃ 8h (Running) ★	61 ppb	11	Lephalale	0	0	0	0	0	0	0	8	54	0	0	0	0	0	62	
			Mokopane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Thabazimbi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Xanadu	12	9	4	0	0	0	0	24	75	48	42	51	265	265		

Table 6: Summary of exceedances of ambient air quality standards record at HPAMN (01 January 2018 – 31 December 2018).

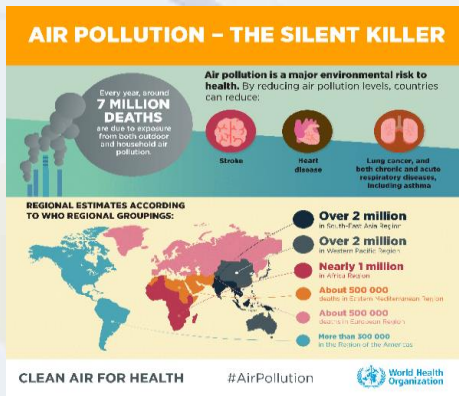
Pollutant & Averaging Period	Standard	Annual Number of Permitted Exceedances	Station Name	Exceedances Per Month												Total Exceedances to Date			
				January	February	March	April	May	June	July	August	September	October	November	December				
PM10 24h ★	75 µg ^m - ³	4	Ermelo	4	15	8	5	17	20	20	18	19	9	4	4	143	143		
			Hendrina	-	-	-	-	-	4	5	7	-	-	-	0	0	16	16	
			Middelburg	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
			Secunda	18	5	1	4	16	16	3	22	17	1	0	0	0	0	103	103
			Witbank	-	0	0	7	11	13	10	21	21	8	1	0	0	0	92	92
PM2.5 24h ★	40 µg ^m - ³	4	Ermelo	4	12	4	6	17	19	17	11	10	0	0	0	100	100		
			Hendrina	-	-	-	-	-	3	1	3	-	-	-	0	0	7	7	
			Middelburg	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
			Secunda	20	5	2	5	16	17	9	17	12	0	0	0	0	0	103	103
			Witbank	-	0	1	7	9	12	11	16	17	1	0	0	0	0	74	74
SO ₂ 10 min	191 ppb	526	Ermelo	0	6	0	0	0	0	0	0	0	0	0	0	0	6	6	
			Hendrina	3	0	3	1	2	0	1	0	4	0	4	1	19	19		
			Middelburg	0	0	0	0	2	0	0	0	0	0	0	0	0	2	2	
			Secunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Witbank	0	0	0	1	2	0	4	0	0	6	1	0	0	14	14	
SO ₂ 1h	134 ppb	88	Ermelo	0	3	0	0	1	0	0	0	0	0	0	0	4	4		
			Hendrina	1	0	1	1	2	0	0	0	1	0	0	0	6	6		
			Middelburg	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Secunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Witbank	0	0	0	0	0	0	2	0	0	1	0	0	3	3		
SO ₂ 24h	48 ppb	4	Ermelo	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Hendrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Middelburg	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Secunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Witbank	0	0	0	0	0	0	1	0	0	0	0	0	1	1		
NO ₂ 1h	106 ppb	88	Ermelo	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Hendrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Middelburg	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Secunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
			Witbank	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
O ₃ 8h (Running Averages) ★	61 ppb	11	Ermelo	4	0	2	0	0	0	0	7	36	3	0	10	62	62		
			Hendrina	7	2	0	0	0	0	0	9	69	15	14	0	116	116		
			Middelburg	0	2	0	0	0	0	0	0	0	0	0	3	5	5		
			Secunda	-	0	0	0	0	0	0	6	11	5	0	0	22	22		
			Witbank	187	90	7	0	0	0	0	0	0	0	0	0	284	284		



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Air Pollution, Human Health and Well-being

- ❑ Air quality is an important public health issue
- ❑ Exposure to air pollution cause short-term and long-term health effects
- ❑ Health effects depend on number of factors (type of pollutant, concentration, length of exposure and individual characteristics)
- ❑ Symptoms vary from minor (irritation of the nose, eyes and throat) to severe medical conditions such as: lung diseases, heart diseases, stroke and cancers)
- ❑ Increase in hospital admission and mortality
- ❑ The most vulnerable include the elderly, children under the age of 5, people with pre-existing chronic or lung diseases



Air Pollution, Human Health and Well-Being

Global Perspective

- ❑ **92%** of the world's **population** lives in places where air quality levels exceed **WHO limits**
- ❑ Exposure to air pollution causes millions of premature deaths and healthy years of life lost every year *[WHO 2021 AQ Guidelines]*
- ❑ **About 7 million** people are killed by air pollution **annually** *[https://www.who.int/health-topics/air-pollution#tab=tab_1]*
- ❑ Of that, about **4.2 million** people exposed to ambient air pollution die **from stroke, heart disease, lung cancer, and acute and chronic respiratory diseases** *[https://www.who.int/health-topics/air-pollution#tab=tab_2]*
- ❑ **Low- and middle-income countries, and vulnerable groups** such as **children, women and people with pre-existing diseases** are at greatest risk
- ❑ Exposure to **household air pollution** is a leading cause of **disease and premature death** in the above-mentioned countries and groups
- ❑ In 2013, the World Health Organization's International Agency for Research on Cancer (IARC) classified outdoor air pollution and specifically **Particulate Matter as carcinogenic** *[WHO 2021 AQ Guidelines]*

Air Pollution, Human Health and Well-being South African Perspective

- ❑ Few local studies on air quality and human health
- ❑ **Evidence** on air pollution and human health is **growing** (through research and publication output)
- ❑ Local scientists are conducting research that will **inform policy to transit to low carbon economy**
- ❑ Previous studies estimated:
 - In 2000, **outdoor pollution** contributed **4%** to **national mortality** from **cardiopulmonary disease** and **5% attributable** to **cancers** of the **trachea, bronchus and lungs** in adults 30 years and older [Norman et al., 2007, *S Afr Med J*]
 - In 2000, household **air pollution** affected **20%** of **households** in South Africa and caused **2 500 deaths** mainly among **Black Africans** [Norman et al., 2007, *S Afr Med J*]
 - **7.4%** of all **deaths** in South Africa in **2012** were due to chronic exposure to fine **PM**, costing the country up to **6%** of its **GDP** (IGC study, 2016)
 - In 2016 **PM emissions** caused **305** to **650 deaths** in the Highveld Priority Area [Gray 2016]

> Int J Environ Res Public Health. 2012 Nov 5;9(11):3978-4016. doi: 10.3390/ijerph9113978.

Ambient air pollution exposure and respiratory, cardiovascular and cerebrovascular mortality in Cape Town, South Africa: 2001–2006

Janine Wichmann¹, Kuku Vuyi

Affiliations + expand

PMID: 23202828 PMID: PMC3524609 DOI: 10.3390/ijerph9113978

Free PMC article

> Environ Sci Pollut Res Int. 2020 May;27(14):16677-16685. doi: 10.1007/s11356-020-07938-7. Epub 2020 Mar 4.

Temperature as a modifier of the effects of air pollution on cardiovascular disease hospital admissions in Cape Town, South Africa

Christian L Lokotola¹, Caradee Y Wright^{2,3}, Janine Wichmann⁴

Affiliations + expand

PMID: 32133609 DOI: 10.1007/s11356-020-07938-7

Research article

Household air pollution exposure and respiratory health outcomes: a narrative review update of the South African epidemiological evidence

Busisiwe Shezi¹ and Caradee Y Wright^{2,3,4}

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Received: 18 March 2018 - Reviewed: 10 June 2018 - Accepted: 14 June 2018

<http://dx.doi.org/10.17159/2410-972X/2018/v28n1a11>

Research Article | [Open Access](#) | [Published: 07 April 2021](#)

Association between ambient air pollution and cause-specific mortality in Cape Town, Durban, and Johannesburg, South Africa: any susceptible groups?

Nomsa Duduzile Lina Thabathe  Kuku Vuyi & Janine Wichmann

Environmental Science and Pollution Research **28**, 42868–42876 (2021) | [Cite this article](#)

Norman, R. et al., 2007. Estimating the burden of disease attributable to urban outdoor air pollution in South Africa in 2000. *South African Medical Journal*, 97(7), pp.782-790.

South African

AIR QUALITY IMPACTS AND HEALTH EFFECTS DUE TO LARGE STATIONARY SOURCE EMISSIONS IN AND AROUND SOUTH AFRICA'S MPUMALANGA HIGHVELD PRIORITY AREA (HPA)

Dr. H. Andrew Gray
Gray Sky Solutions
San Rafael, CA USA

June 3 2019

SAWS contribution to Air Quality and Human Health Research

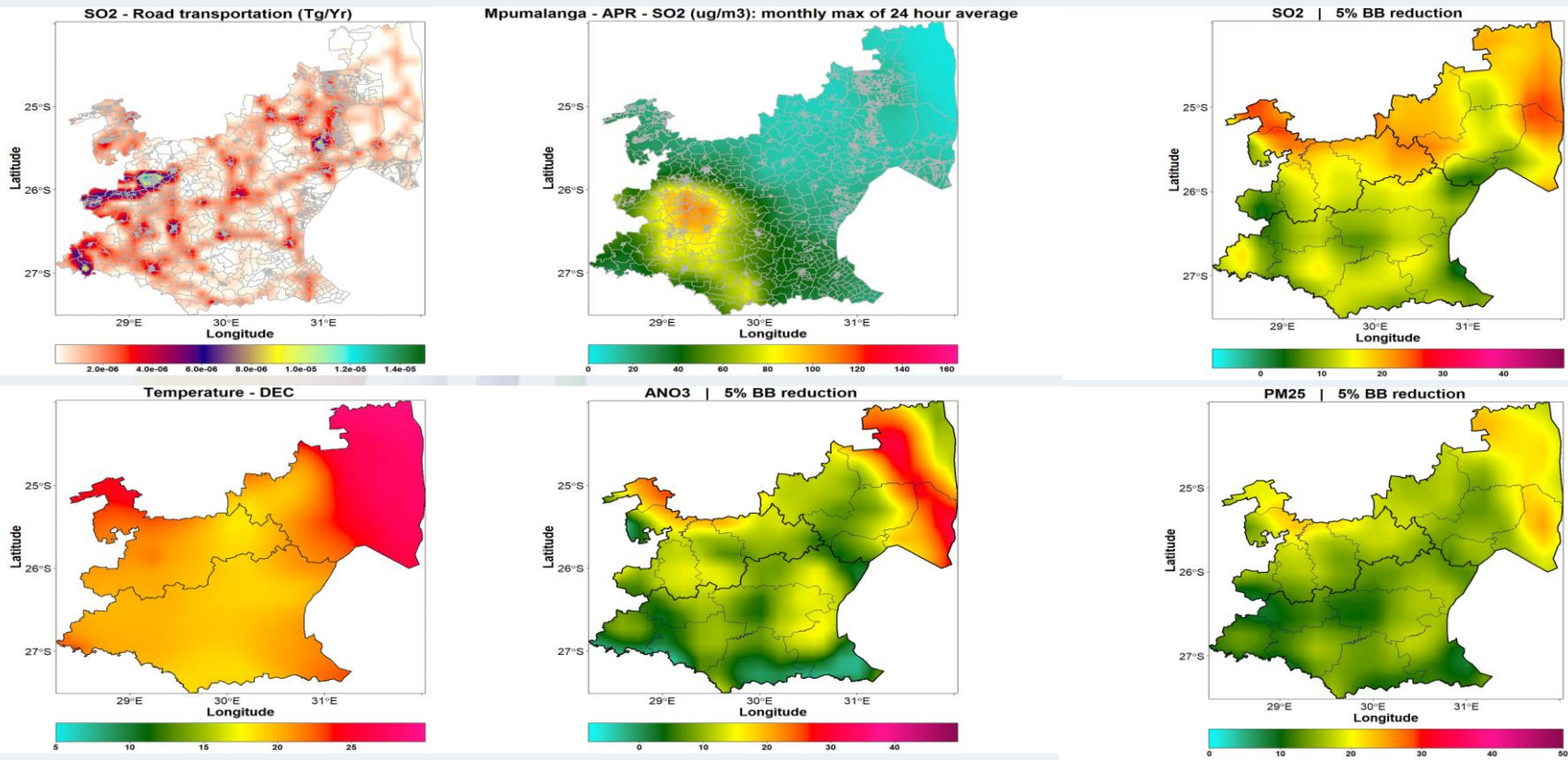
- ❑ SAWS in collaboration with South African Medical Research Council (SAMRC) and the Department of Health (DoH) has completed the National Burden of Disease (NBD) study attributable to ambient air pollution
- ❑ **The following diseases attributed to poor air quality were assessed:**
 - Lower Respiratory Tract Infection (LRTIs)
 - Trachea
 - Bronchus
 - Lung cancers
 - Diabetes
 - Ischemic Heart Disease (IHD)
 - Stroke
 - Chronic Obstructive Pulmonary Disease (COPD)
- ❑ The impacts are presented at both national and provincial scales in terms of death, disability-adjusted life years, years of life lost, and years of life lived with a disability
- ❑ The NBD study is currently under review and will be released soon by the Department of Health along with SAWS and SAMRC
- ❑ The outcome of the NBD will be communicated to the public, scientific communities, as well as to both regional and national decision/policy makers through scientific publications and etc



SAWS contribution to Air Quality and Human Health Product: Scenario-Based Air Pollution Management Tool

- ❑ Quantile downscaling of sector-based emission scenarios and multi-scenario model simulations for Mpumalanga
- ❑ The product package includes 4 major components:
 - Downscaled localized emission estimates
 - Spatio-temporal distributions and threshold of photochemical pollutants
 - long-term climatological information
 - Sector-based simulations of photochemical pollutants
- ❑ Benefits

Support provincial and national policies and strategies on Air quality and health



Concluding Remarks

- ❑ South Africans are affected and vulnerable to poor air quality
- ❑ Mortality and morbidity cases are high, straining our health system
- ❑ Enforce compliance through targeted regulatory actions on taxes and polluting activities
- ❑ Reduce sources of air pollutants by adopting low emissions technologies (shift to energy efficient and cleaner energy sources and public transportation)
- ❑ Behavioral changes in business model and lifestyle (e.g., travel actively (walking and cycling), car sharing, teleconferencing, teleworking)
- ❑ Improve monitoring (more stations should report to SAAQIS)
- ❑ Expand scientific research to inform policy
- ❑ Conduct cost-benefit analysis studies that will determine the impact of air pollution on the economy of South Africa
- ❑ Seize low carbon opportunities across all sectors
- ❑ Decarbonized economic growth that “ensure healthy lives and promote well-being for all at all ages” (SDG 3)





Thank you



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