

Human exposure and health effects of air pollution in priority areas

Rico Euripidou



ground**Work**

Who are we?

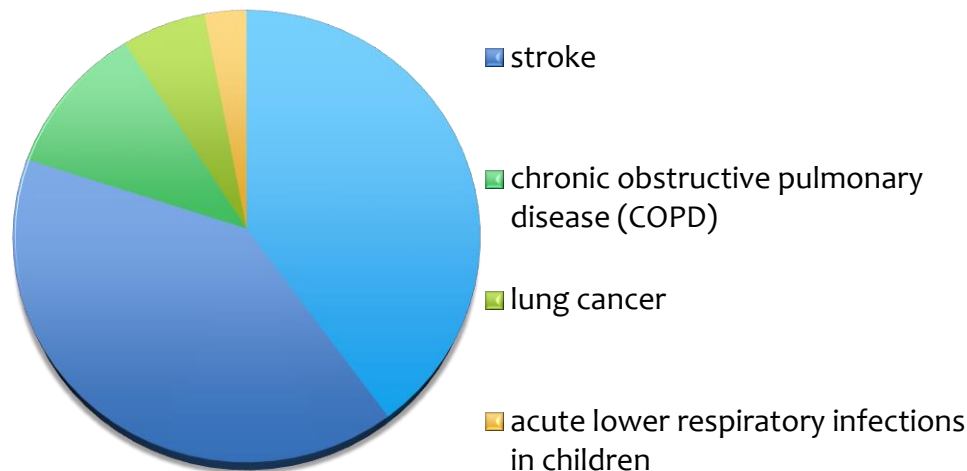
- * groundWork is a non-profit environmental justice service and developmental organisation aimed at improving the quality of life of vulnerable people in South Africa, through assisting civil society to have a greater impact on environmental governance.
- * One of groundWork's campaigns relates to air quality and it works with community people to monitor the implementation of the National Environmental Management: Air Quality Act, 2005 (AQA) in the priority areas over the past 20 years.



Health Care Costs of Air Pollution

WHO estimates **7 Million Deaths** Linked to Air Pollution in 2012

Outdoor Air Pollution Causes of Death



“Excessive **air pollution** is often a by-product of unsustainable policies in sectors such as transport, **energy**, waste management and industry.

In most cases, **healthier strategies** will also be **more economical** in the long term due to health-care cost savings as well as climate gains”

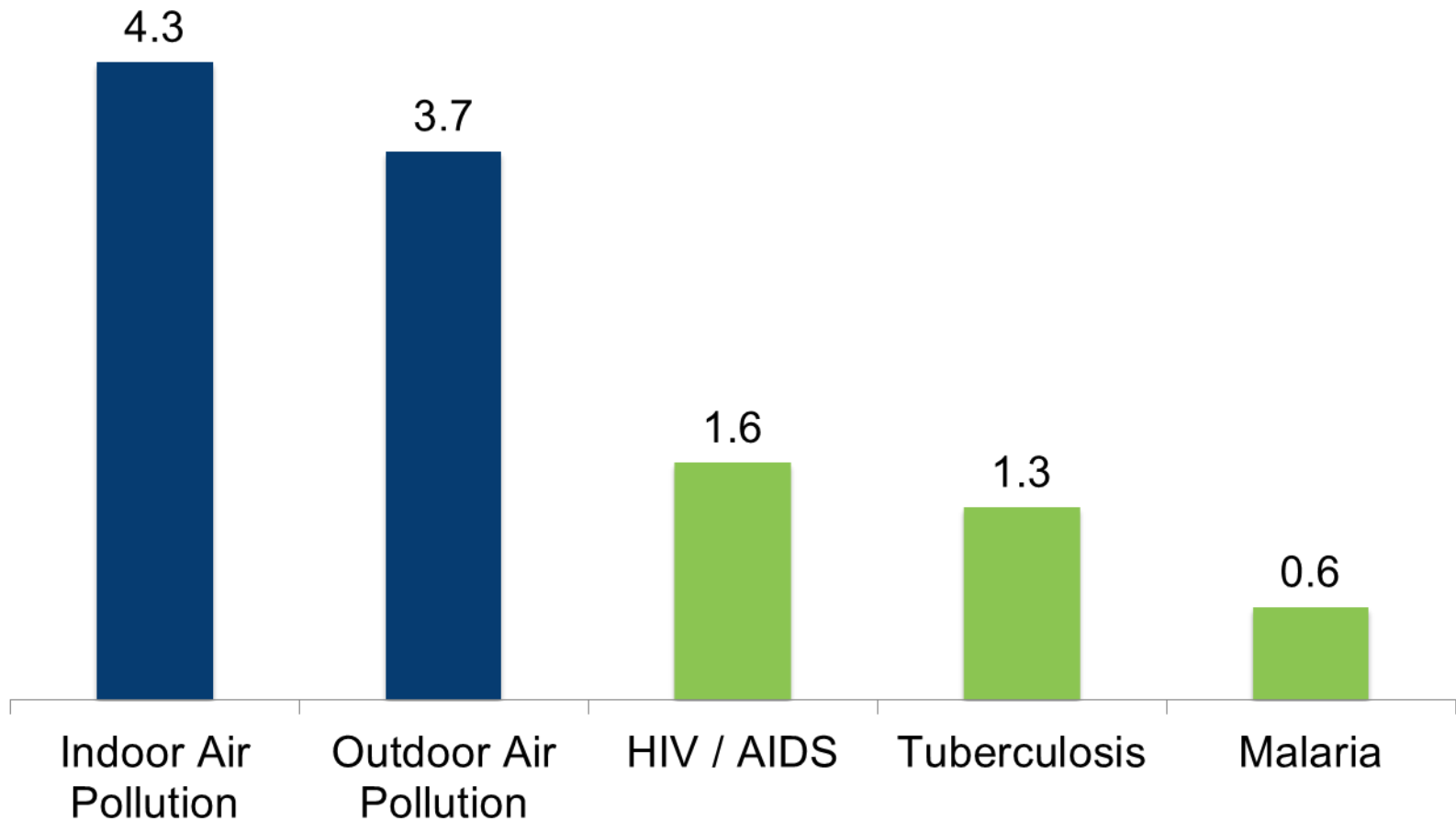
Dr Carlos Dora

WHO Coordinator for Public Health,
Environmental and Social Determinants of Health

Source: World Health Organization (WHO)

URL: <http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/>

WHO Annual Global Deaths in 2012 (millions)



Source: World Health Organization

Coal and community health

- * Particle pollution (PM_{10} , $PM_{2.5}$, PM_1) is one of the most dangerous pollutants for human health.
- * It causes cardiovascular and respiratory disease, asthma, hospital admissions and premature death.
- * PM_{10} & $PM_{2.5}$ levels in the Vaal and the Highveld exceeded the national annual standard permanently over the last 5 years

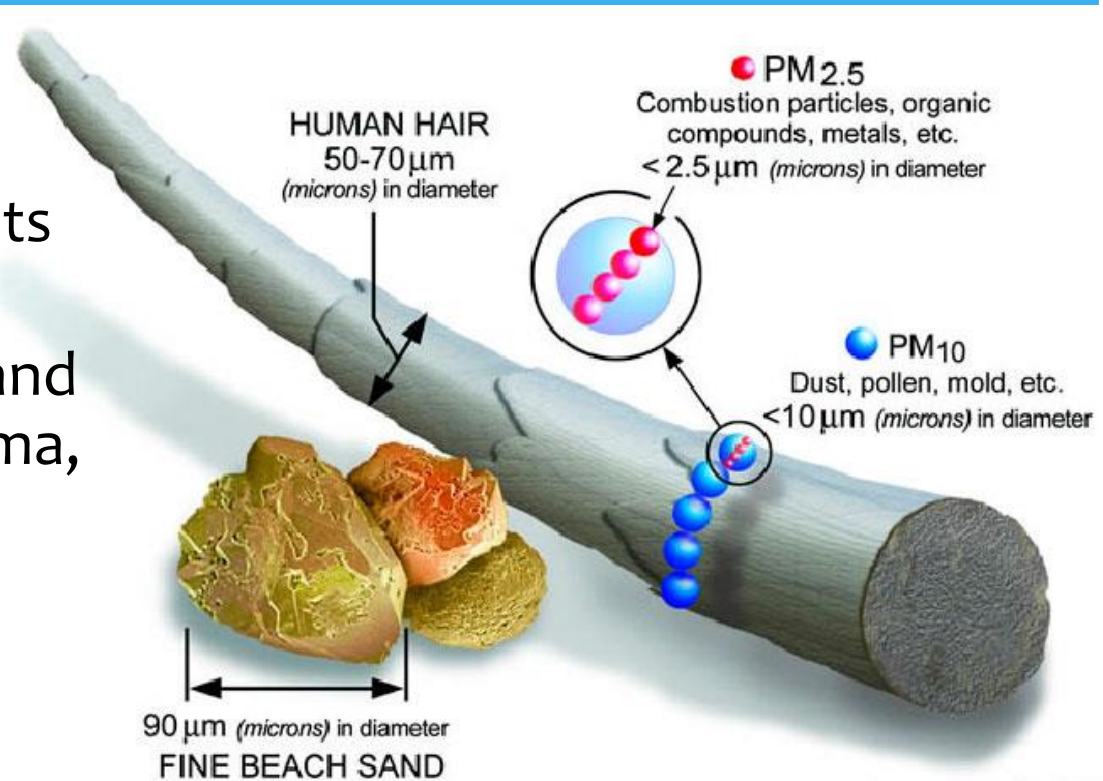


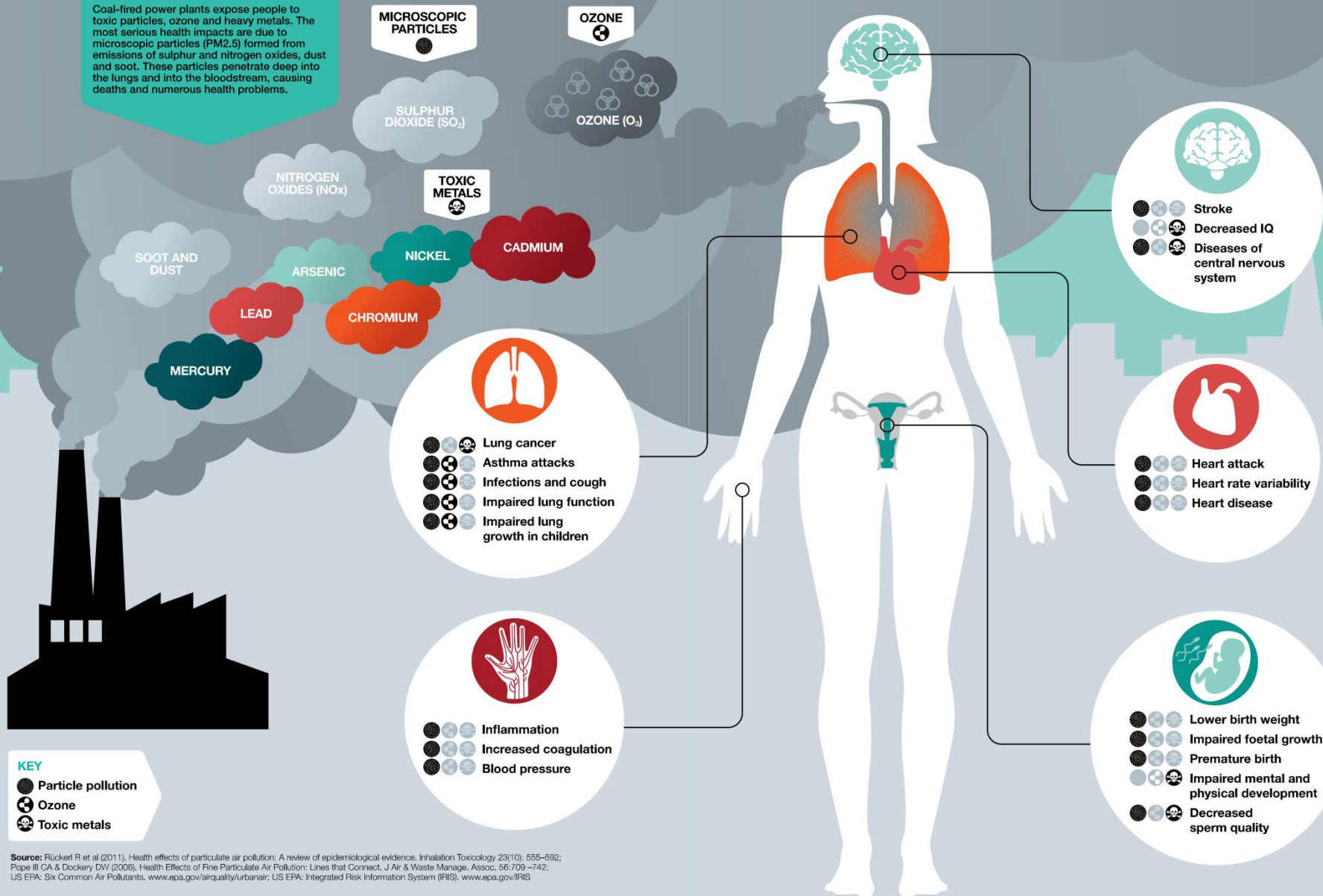
Image courtesy of the U.S. EPA

Table 3-2. Trace Element Concentrations in Three Bituminous Coals

Element	Pittsburgh		Elkhorn/Hazard		Illinois No. 6	
	Concentration (ppm)	σ (ppm)	Concentration (ppm)	σ (ppm)	Concentration (ppm)	σ (ppm)
Na	600	60	340	20	400	30
Sc	1.8	0.1	3.9	0.4	2.2	0.1
Cr	13	4	20	5	14	1
Fe	8220	790	2970	410	13700	550
Co	2.5	0.3	6.2	0.5	3.6	0.2
Zn	17	5	18	5	70	10
As	4.1	0.9	4	1.1	2.7	0.3
Se	0.62	0.51	3.1	0.8	2.2	0.4
Br	17	2	25	3	3.7	1.0
Rb	8	0.1	5.1	1.1	13	2
Sr	160	60	120	70	ND	ND
Mo	0.85	0.18	4	1	4.9	1.1
Cd	0.06	0.013	0.31	0.07	0.15	0.15
Sb	0.26	0.03	1	0.1	0.38	0.03
Cs	0.55	0.19	0.45	0.09	0.99	0.11
Ba	110	20	130	10	52	7
La	4.5	0.1	14	1	4.7	0.3
Ce	8.8	0.3	27	4	9.3	0.5
Sm	0.78	0.05	2.5	0.2	0.9	0.08
Eu	0.2	0.06	0.37	0.12	0.19	0.02
Yb	0.38	0.06	1.4	0.2	0.032	0.021
Lu	0.063	0.005	0.24	0.02	0.0054	0.0022
Hf	0.44	0.04	1.1	0.2	0.056	0.021
Au (in ppb)	0.95	0.22	0.98	0.49	0.51	0.08
Hg	0.11	0.04	0.13	0.03	0.22	0.02
Th	1.2	0.1	4.3	0.5	0.095	0.035
U	0.31	0.15	1.9	0.8	ND	ND

How coal-fired power plants can make you sick

Coal-fired power plants expose people to toxic particles, ozone and heavy metals. The most serious health impacts are due to microscopic particles (PM2.5) formed from emissions of sulphur and nitrogen oxides, dust and soot. These particles penetrate deep into the lungs and into the bloodstream, causing deaths and numerous health problems.



KEY

- Particle pollution
- ⊕ Ozone
- ☠ Toxic metals

Source: Rückerl R et al (2011). Health effects of particulate air pollution: A review of epidemiological evidence. *Inhalation Toxicology* 23(10): 555-592; Pope III CA & Dockery DW (2006). Health Effects of Fine Particulate Air Pollution: Lines that Connect. *J Air & Waste Manage. Assoc.* 56:709-742; US EPA: Six Common Air Pollutants. www.epa.gov/airquality/urbanair; US EPA: Integrated Risk Information System (IRIS). www.epa.gov/IRIS

Air quality limits and public protection

Risk of Nonaccidental and Cardiovascular Mortality in Relation to Long-term Exposure to Low Concentrations of Fine Particulate Matter: A Canadian National-Level Cohort Study

Dan L. Crouse,¹ Paul A. Peters,² Aaron van Donkelaar,³ Mark S. Goldberg,⁴ Paul J. Villeneuve,^{1,5} Orly Brion,¹ Saeeda Khan,² Dominic Odwa Atari,² Michael Jerrett,⁶ C. Arden Pope III,⁷ Michael Brauer,⁸ Jeffrey R. Brook,^{5,9} Randall V. Martin,^{3,10} David Stieb,¹ and Richard T. Burnett¹

¹Environmental Health Science and Research Bureau, Health Canada, Ottawa, Ontario, Canada; ²Health Analysis Division, Statistics Canada, Ottawa, Ontario, Canada; ³Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada; ⁴Department of Medicine, McGill University, Montreal, Quebec, Canada; ⁵Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada; ⁶School of Public Health, University of California–Berkeley, Berkeley, California, USA; ⁷Department of Economics, Brigham Young University, Provo, Utah, USA; ⁸School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada; ⁹Air Quality Research Division, Environment Canada, Downsview, Ontario, Canada; ¹⁰Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA

BACKGROUND: Few cohort studies have evaluated the risk of mortality associated with long-term exposure to fine particulate matter [$\leq 2.5 \mu\text{m}$ in aerodynamic diameter ($\text{PM}_{2.5}$)]. This is the first national-level cohort study to investigate these risks in Canada.

OBJECTIVE: We investigated the association between long-term exposure to ambient $\text{PM}_{2.5}$ and cardiovascular mortality in nonimmigrant Canadian adults.

METHODS: We assigned estimates of exposure to ambient $\text{PM}_{2.5}$ derived from satellite observations to a cohort of 2.1 million Canadian adults who in 1991 were among the 20% of the population mandated to provide detailed census data. We identified deaths occurring between 1991 and 2001 through record linkage. We calculated hazard ratios (HRs) and 95% confidence intervals (CIs) adjusted for available individual-level and contextual covariates using both standard Cox proportional survival models and nested, spatial random-effects survival models.

RESULTS: Using standard Cox models, we calculated HRs of 1.15 (95% CI: 1.13, 1.16) from non-accidental causes and 1.31 (95% CI: 1.27, 1.35) from ischemic heart disease for each $10\text{-}\mu\text{g}/\text{m}^3$ increase in concentrations of $\text{PM}_{2.5}$. Using spatial random-effects models controlling for the same variables, we calculated HRs of 1.10 (95% CI: 1.05, 1.15) and 1.30 (95% CI: 1.18, 1.43), respectively. We found similar associations between nonaccidental mortality and $\text{PM}_{2.5}$ based on satellite-derived estimates and ground-based measurements in a subanalysis of subjects in 11 cities.

CONCLUSIONS: In this large national cohort of nonimmigrant Canadians, mortality was associated with long-term exposure to $\text{PM}_{2.5}$. Associations were observed with exposures to $\text{PM}_{2.5}$ at concentrations that were predominantly lower (mean, $8.7 \mu\text{g}/\text{m}^3$; interquartile range, $6.2 \mu\text{g}/\text{m}^3$) than those reported previously.

KEY WORDS: Canada, cardiovascular mortality, cohort study, fine particulate matter. *Environ Health Perspect* 120:708–714 (2012). <http://dx.doi.org/10.1289/ehp.1104049> [Online 7 February 2012]

monitoring stations in 11 of Canada's largest cities; this necessitated using only a subset of the cohort for which exposure could reasonably be assigned from the network data. Then, to include the whole cohort, we applied estimates of concentrations of ground-level $\text{PM}_{2.5}$ throughout the country from satellite observations of aerosol optical depth (van Donkelaar et al. 2010).

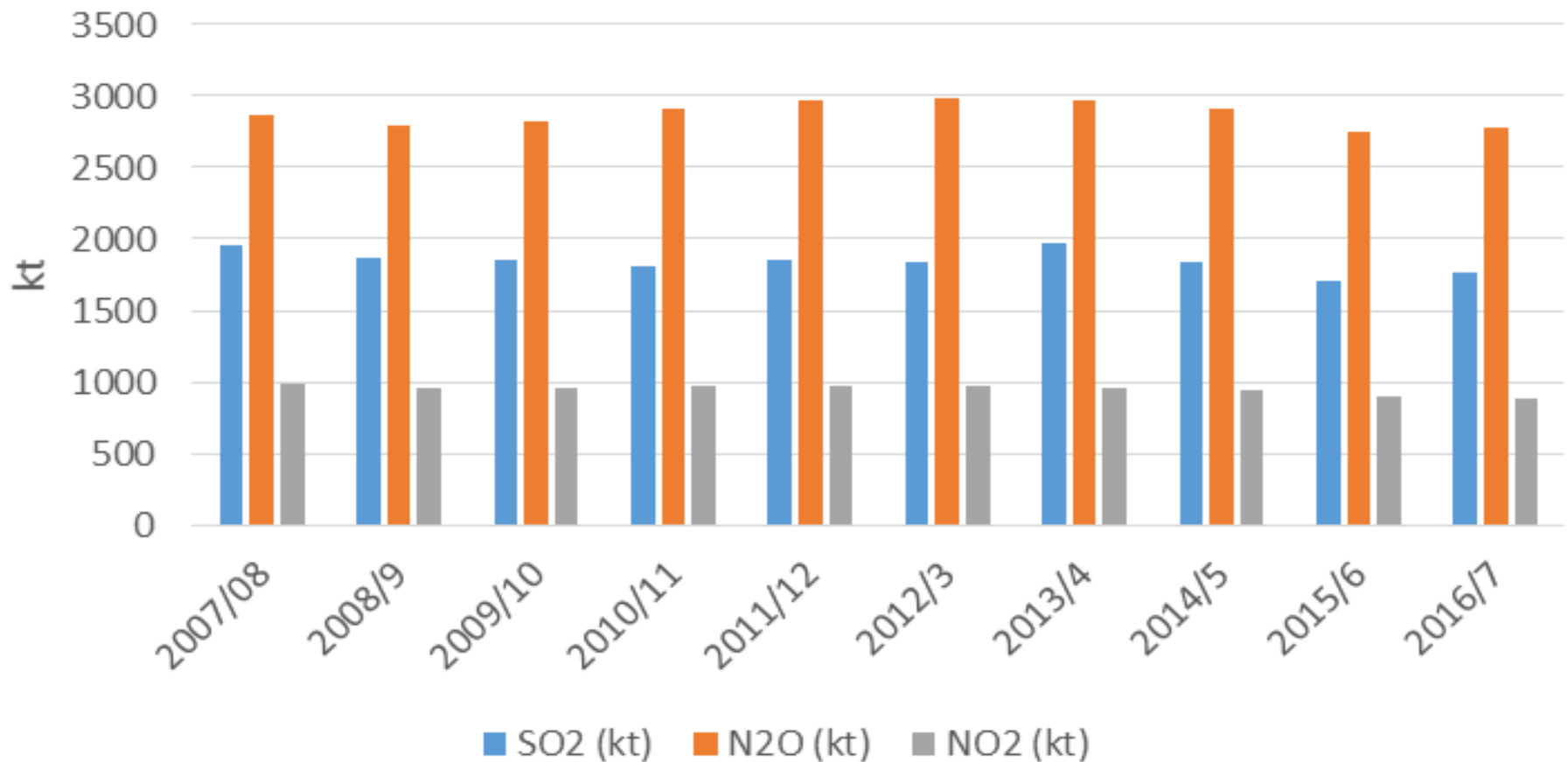
Methods

The study cohort. The study cohort is a subset of the 1991–2001 Canadian census mortality follow-up study (Wilkins et al. 2008). Persons were eligible for the census mortality cohort if they were ≥ 25 years of age; were a usual resident of Canada on the census reference day (4 June 1991); were not a long-term resident of an institution such as a prison, hospital, or nursing home; and had been among the 20% of Canadian households (~ 3.6 million respondents) selected randomly for enumeration with the mandatory long-form questionnaire. Subjects in the census

* Neither the concentration limits set by governments nor the World Health Organization's air quality guidelines are fully protective of health

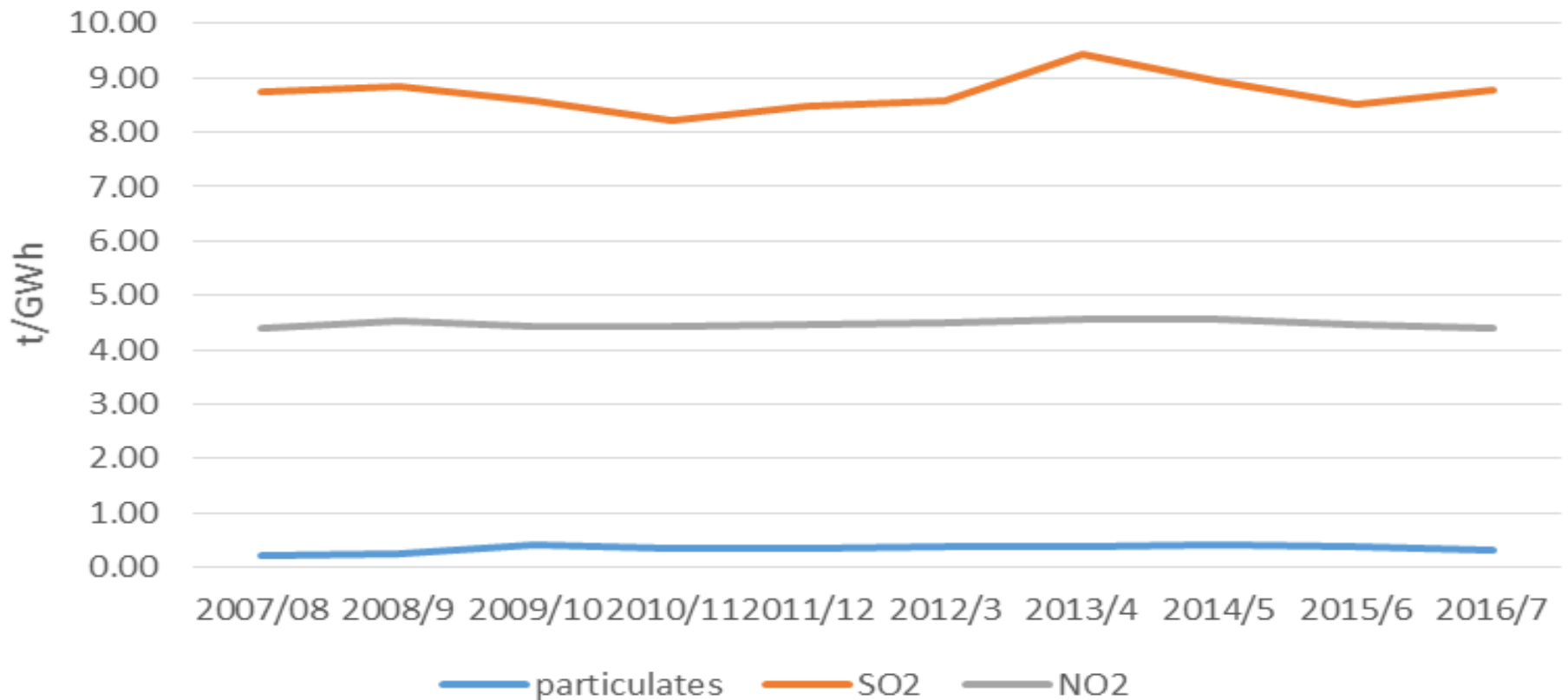
Annual Emissions by Eskom CFPS 2008-17

2008-2017 Eskom- Emissions

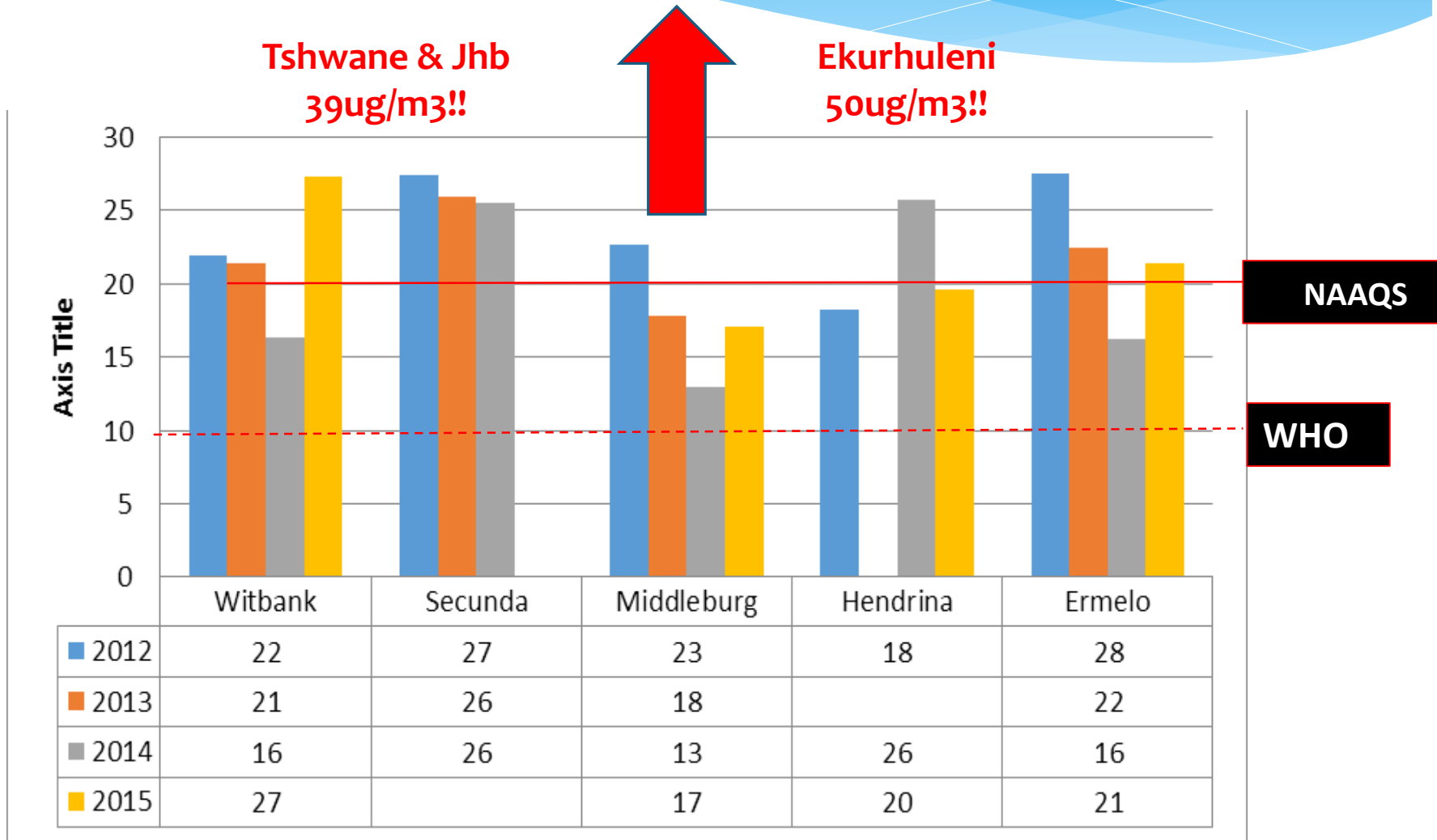


Annual Emissions per unit of coal-generated electricity

Emissions for particulates, SO₂ & NO₂ relative to coal generated electricity sent out (nett) 2008-2017

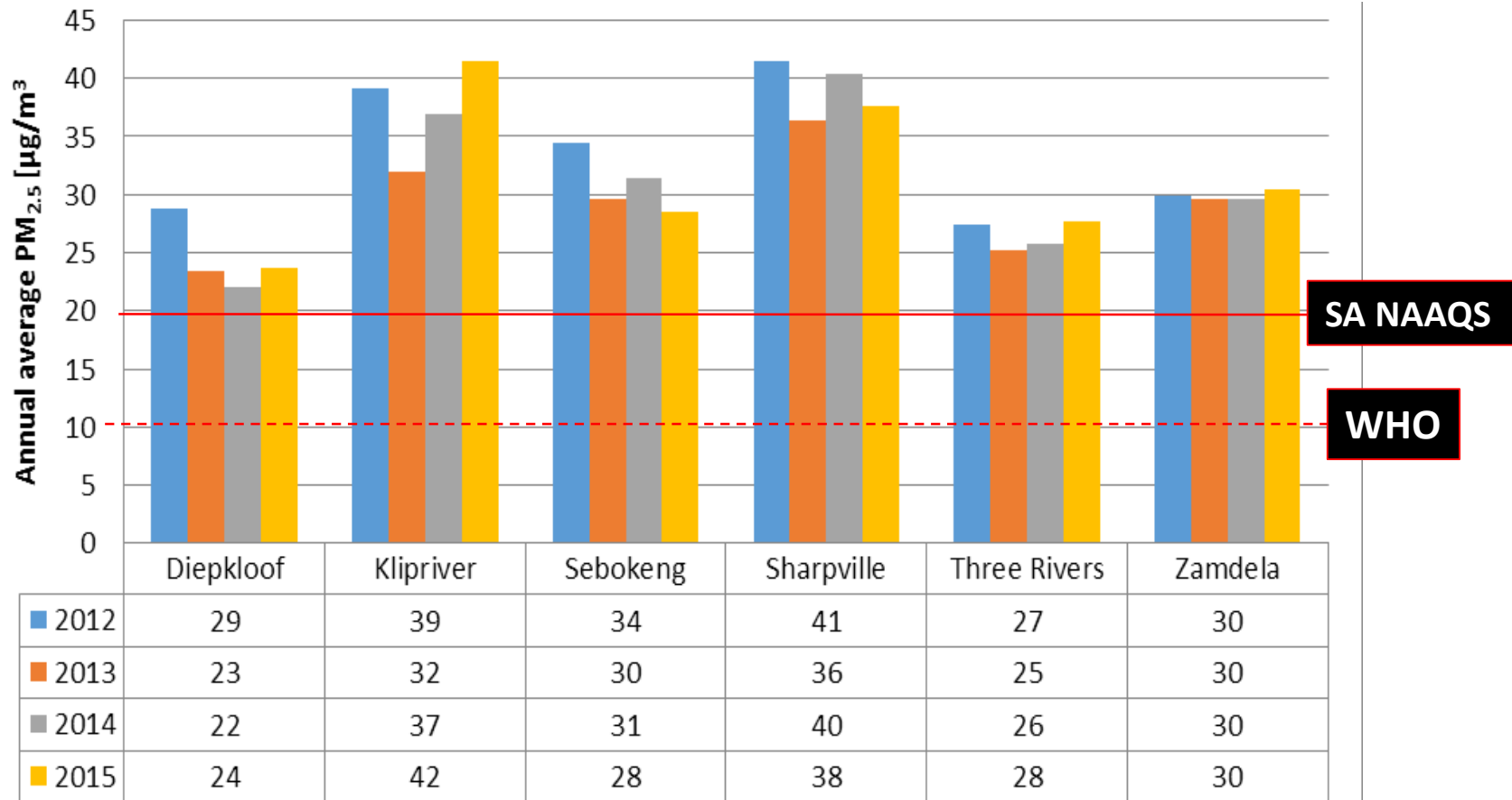


Annual average PM2.5 concentrations in the Highveld Priority Area 2012-2015



Cairncross, E. (2016). *The State of South Africa's Air Quality Monitoring Network and Its Air Quality*. Paper presented at the National Association for Clean Air.

Annual average PM_{2.5} concentrations in the Vaal Triangle Priority Area 2012-2015



Cairncross, E. (2016). *The State of South Africa's Air Quality Monitoring Network and Its Air Quality*. Paper presented at the National Association for Clean Air.

DEA MSRSG presentation of the State of the Air report 2017

Daily and Hourly Exceedances

	PM ₁₀ (4)	PM _{2.5} (4)	SO ₂ (4)	O ₃ (11)
Ermelo	41	13	2	241
Hendrina	1	1	0	329
Middelburg	2	0	0	33
Secunda	105	98	0	1130
<u>eMalahleni</u>	81	52	6	562

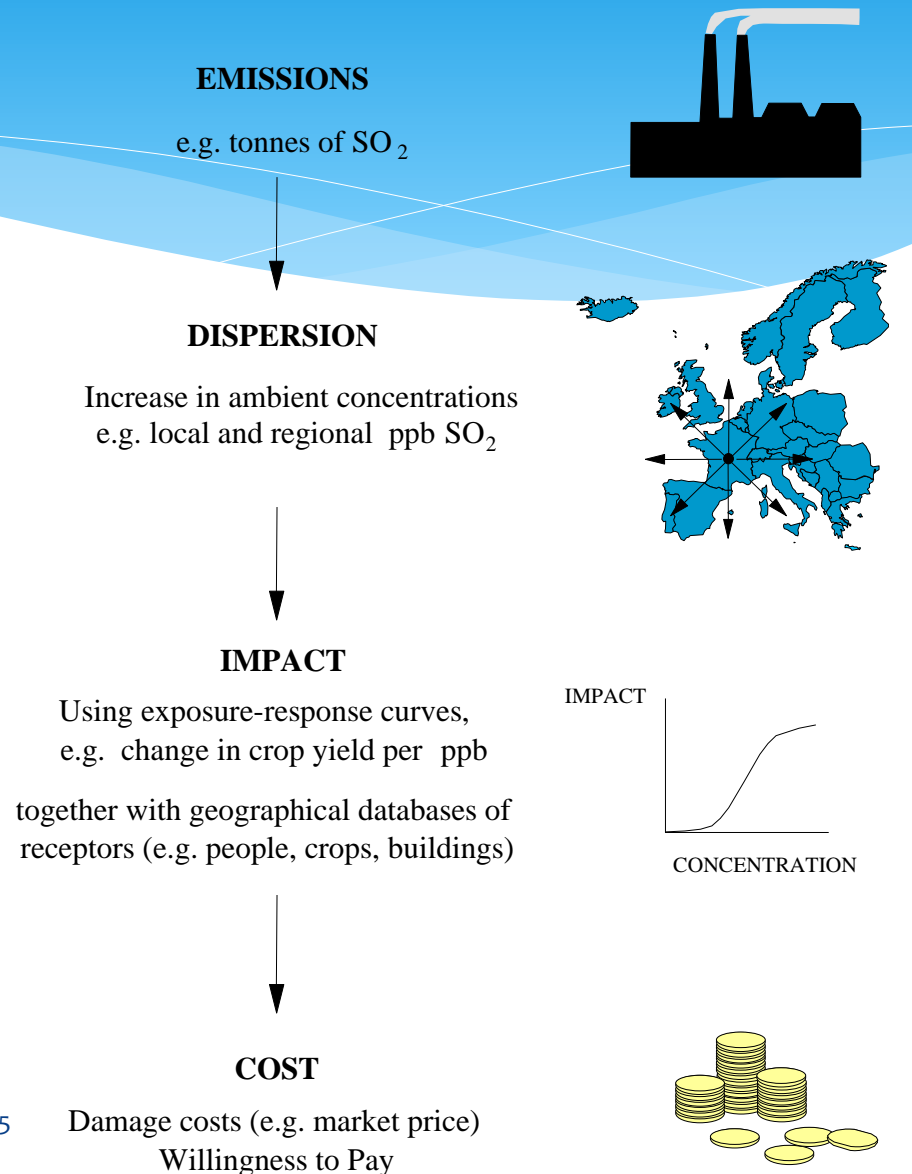
Health impacts of delays in meeting emission limit values by coal fired power plants in South Africa

Dr Mike Holland (EMRC) mike.holland@emrc.co.uk 26/3/2017

- * Worked for European Commission, various governments (UK, France, Sweden, China), the European Commission, OECD, World Bank.
- * Report provides estimates of the health impacts and associated economic costs of current emissions of air pollutants from coal fired power stations in South Africa.
- * Results are provided both in aggregate, and disaggregated to individual Eskom power stations.

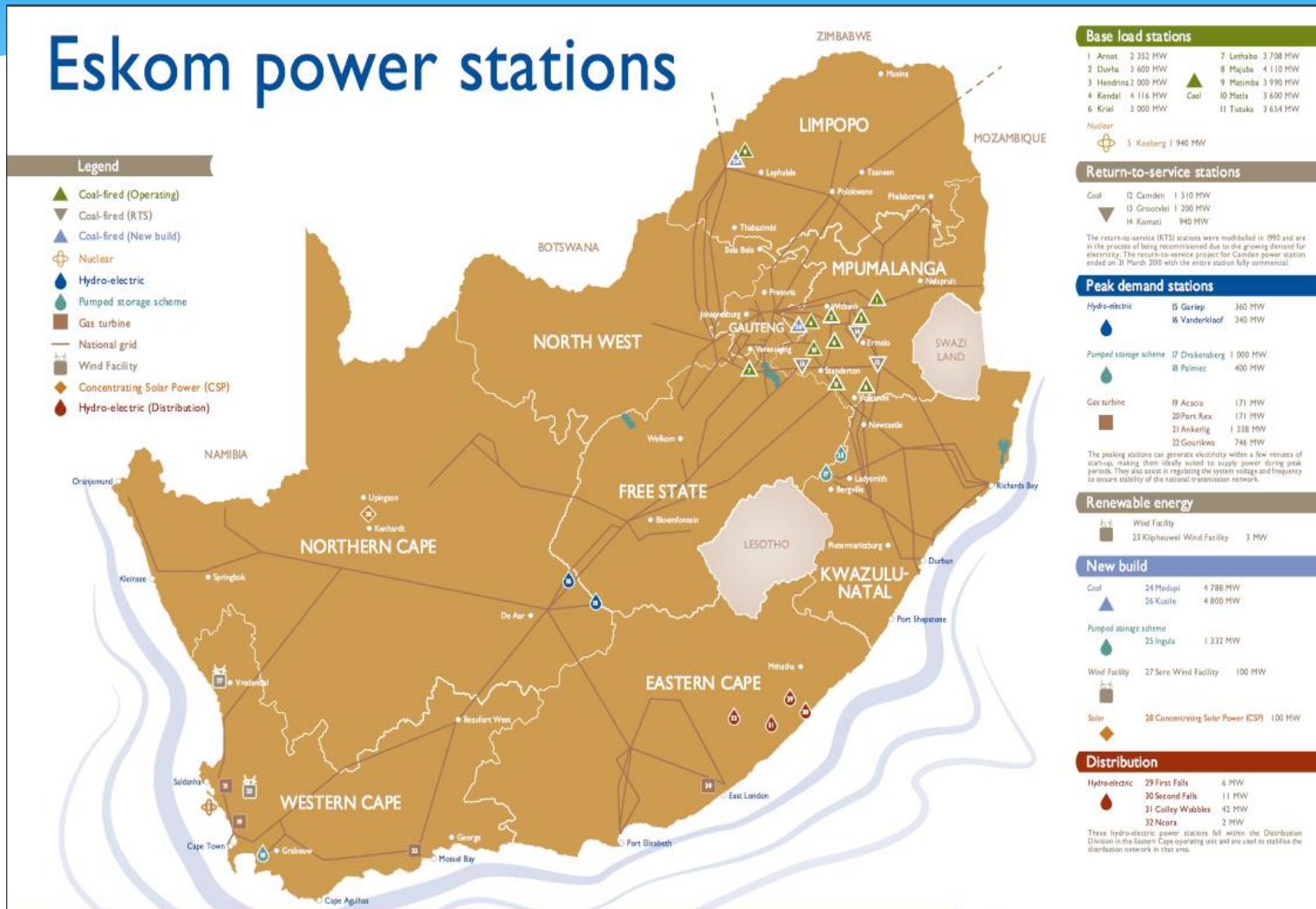
Impact pathway approach

- * Tracks emissions through to impacts using best available science

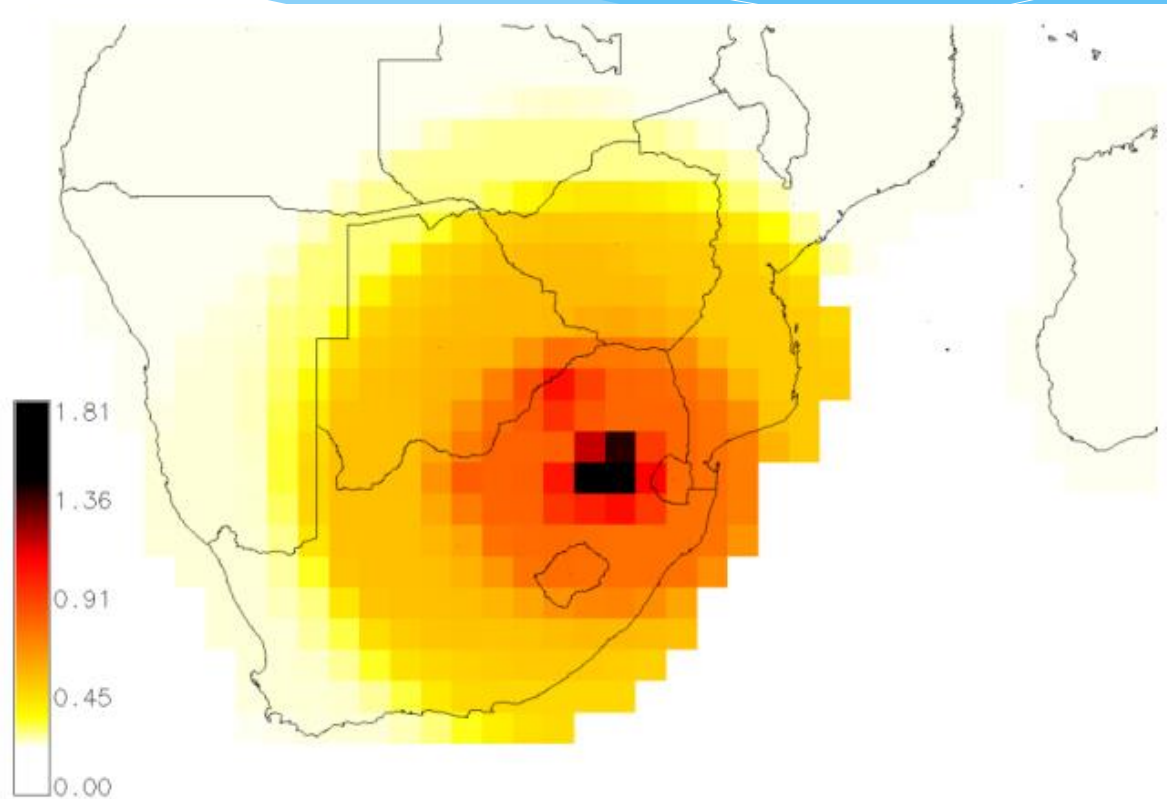


Starting point: emissions from the power stations

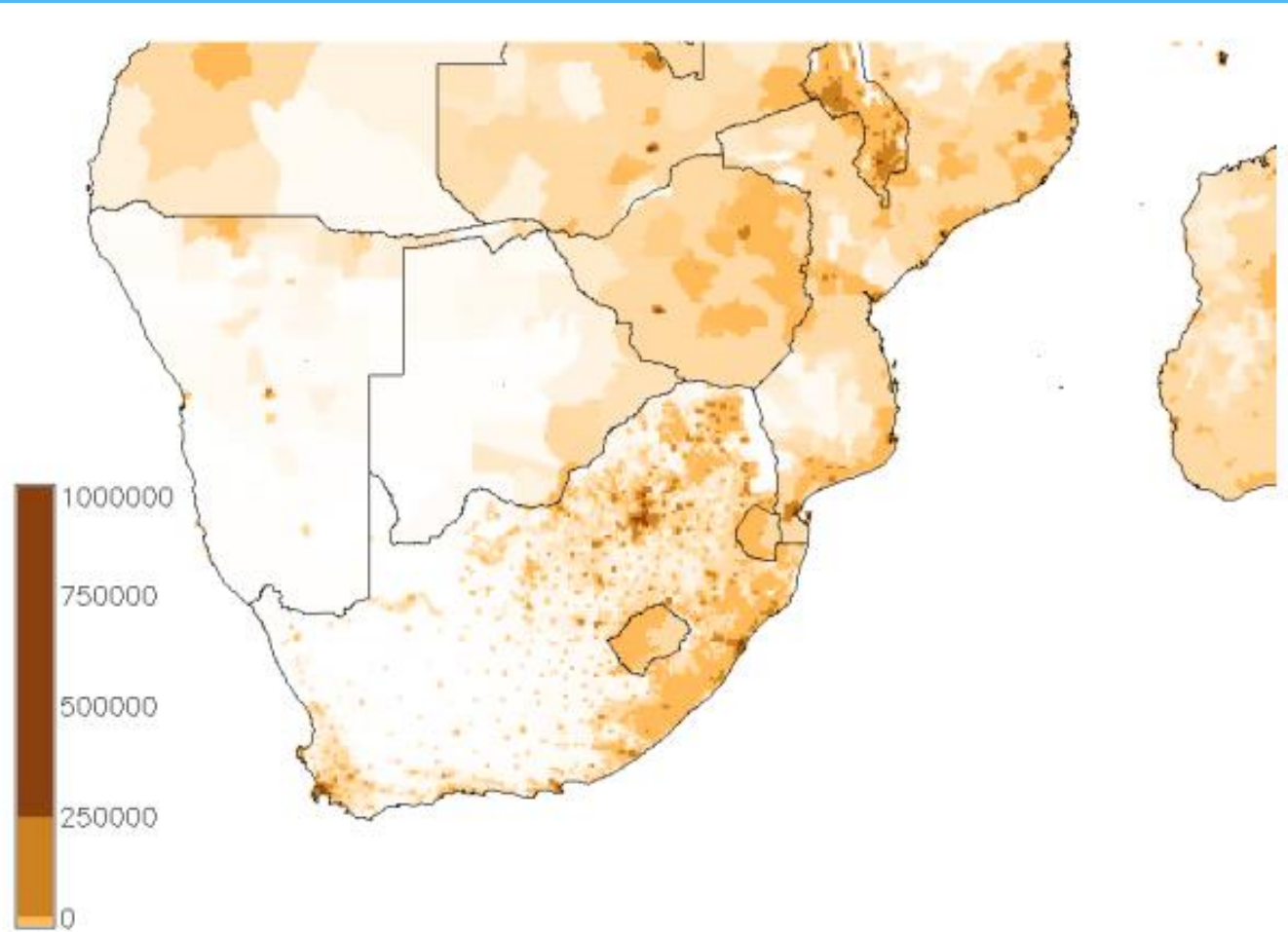
Eskom power stations



Forecast annual average PM_{2.5} contribution from plant covered by Eskom's application for emission limit derogation, ug.m⁻³



Map of population distribution



Annual impacts of coal fired generation in South Africa

Table 3-2. Annual health impacts linked to coal fired generation in South Africa.

	Cases, <u>etc</u>	Value, \$ <u>int</u> , millions
Equivalent attributable deaths		
<i>Lung cancer</i>	157	
<i>Ischaemic heart disease</i>	1,110	
<i>Chronic obstructive pulmonary disease</i>	73	
<i>Stroke</i>	719	
<i>Lower respiratory infection</i>	180	
Total equivalent attributable deaths	2,239	2,121.94
Chronic Bronchitis (adults, cases)	2,781	64.64
Bronchitis in children aged 6 to 12	9,533	2.19
Equivalent hospital admissions	2,379	2.79
Restricted Activity Days (all ages)	3,972,902	132.72
Asthma symptom days (children 5-19yr)	94,680	1.44
Lost working days	996,628	47.05
Total costs		2,372.78

Health impacts and associated costs (\$int, millions) allocated to individual power stations.

	Total equivalent annual death	Chronic Bronchitis (adults, cases)	Bronchitis in children aged 6 to 14	Equivalent hospital admission	Restricted Activity Days (all ages)	Asthma symptom days (children 5-19yr)	Lost working day	Total costs, \$int, million:
Arnot	79	98	335	84	139,569	3,326	35,012	83.36
Camden	84	104	357	89	148,980	3,550	37,373	88.98
Duvha U1-3	143	178	609	152	253,845	6,050	63,679	151.61
Grootvlei	58	72	247	62	103,011	2,455	25,841	61.52
Hendrina	105	130	445	111	185,467	4,420	46,525	110.77
Kendal	210	261	894	223	372,400	8,875	93,419	222.41
Kriel	141	176	602	150	250,866	5,979	62,931	149.83
Komati	28	35	120	30	50,188	1,196	12,590	29.97
Lethabo	204	253	868	217	361,646	8,619	90,721	215.99
Majuba	177	219	752	188	313,579	7,473	78,663	187.28
Matimba	262	326	1,117	279	465,404	11,091	116,749	277.96
Matla	192	238	817	204	340,278	8,109	85,361	203.23
Medupi	364	453	1,552	387	646,706	15,412	162,230	386.24
Tutuka	192	239	818	204	340,963	8,126	85,533	203.64
Totals	2,239	2,781	9,533	2,379	3,972,902	94,680	996,628	2,373



The cost of air pollution in South Africa

SHARE



Developing countries like South Africa have a heavy reliance on fossil fuels, resulting in productivity losses and mortality due to high concentrations of air pollution, namely, fine particulate matter (PM). A recent IGC study indicates that 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. High rates of TB and HIV/AIDS infection mean there is a critical need for South Africa-specific studies on the association between air pollution and mortality.

Authors



KATYE ALTIERI

Senior researcher

University of Cape Town



SAMANTHA KEEN

Researcher

University of Cape Town

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COUNTRY

Africa, International

RESEARCH THEME

Best of #2016, Energy

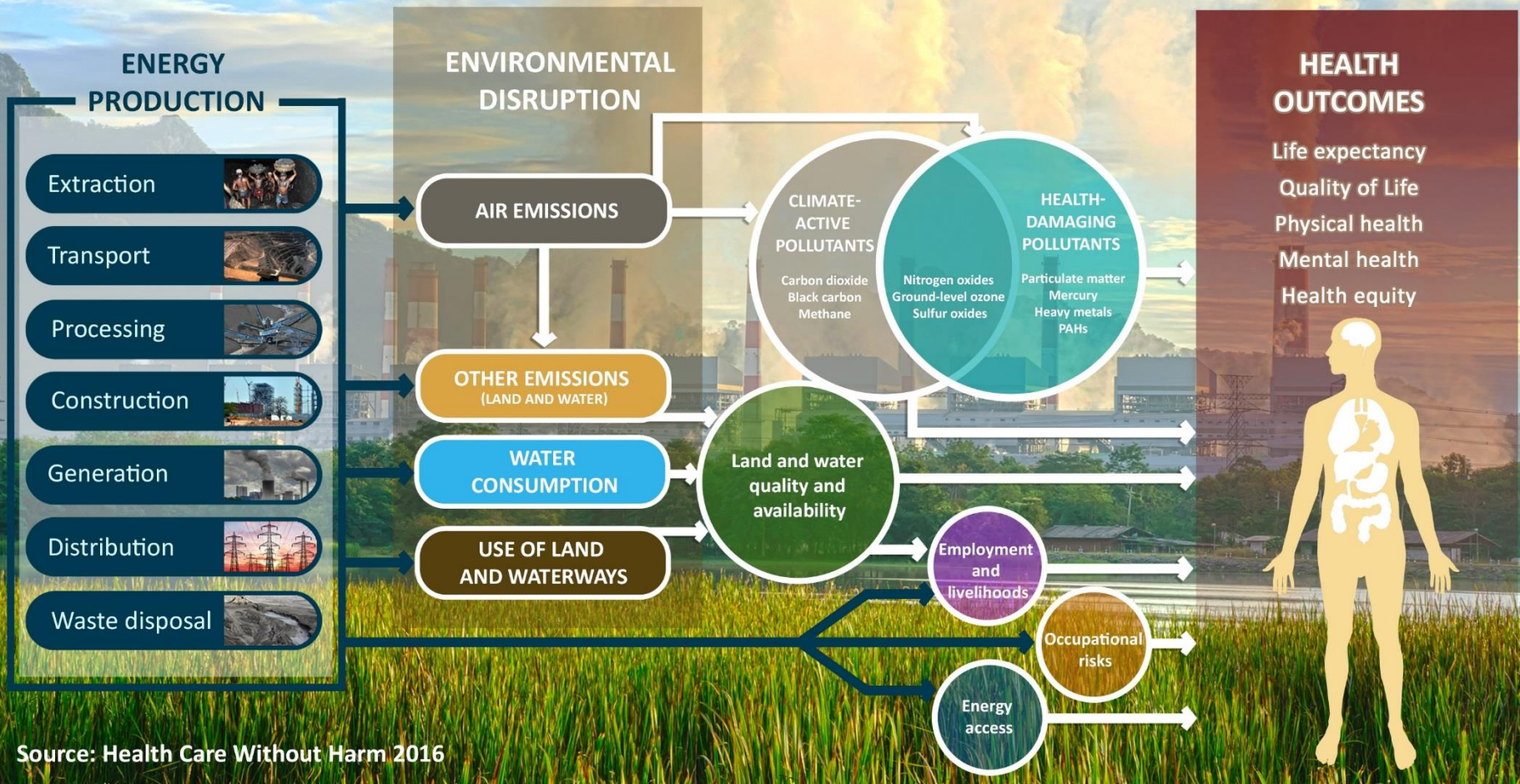
Benefits & costs of the Clean Air Act

... a law which **regulates emissions** of sulfur dioxide, oxides of nitrogen, carbon monoxide, and particulate matter in USA were calculated.

The **ratio of health care cost savings to compliance costs** was **25:1** in **2010**.

For every dollar spent complying with the Clean Air Act, twenty-five dollars were saved in health care costs due to **lower disease burden**, including a reduction in premature deaths, and cases of bronchitis, asthma, and myocardial infarction. *US Environmental Protection Agency Office, 2010*

The Health Impacts of Energy Choices



Source: Health Care Without Harm 2016

Key questions

- * **Delink between DEA and DoH!**
- * **Track pollution & effects in real time!**
- * Why are there no decommissioning plans in place especially for older polluting plants now there is an excess?
- * What are the plans for a just transition by ESKOM to a renewable energy future?
- * MES postponements responsible for bulk of emissions!
- * MES stds. are not a measure of BAT/BEP!
- * MSRGM meetings have become a finger pointing exercise!
- * Offsets are unjust – electrify instead!

Thank you!

- * All resources available at:

www.healthyenergyinitiative.org

- * Briefing Papers
- * Fact Sheets
- * Infographics
- * Stay in touch: rico@groundwork.org.za

