The health impacts of coalmining operations and coal combustion on geographically proximate communities

By Mallory Barnes

2012 ANIP Internship at the Office of Senator Larissa Waters.

DISCALIMER: Although this report was completed at the office of Senator Larissa Waters, it does not necessarily represent Senator Water's views. This report only represents the views of the author, Mallory Barnes.

Table of Contents

List of Figures

List of Tables

Executive Summary

Objective

The objective is to how coalmining operations and coal combustion (herein coal operations) impact upon the health of communities that are in close geographical proximity to these operations. Although coal operations emit a medley of toxic gases, only the effect of Particulate Matter (PM) will be assessed in depth because of its overbearing impact on public health compared to other gases, it's superabundance in areas proximal to coal operations, its amenability to reduction initiatives and the size of the social benefit gained from reduction. The air quality of four regional communities – Mackay (Qld) Moranbah (Qld), The Upper Hunter Valley (NSW) and Latrobe Valley (Vic) – was compared to the major urban centres. All communities are in coal mining or coal combustion hubs.

Literature review

An overwhelming body of literature supports the association between elevated PM and increase population morbidity and mortality. A panoply of independent, epidemiological studies consistently demonstrate about a 1% increase in population mortality with every 10 $\mu g/m^3$ short term increase in PM_{10}. Increases in $PM_{2.5}$ are more lethal, but far less is understood about it. Both forms of PM have a stronger association with respiratory and cardiovascular disease and mortality than any other kind. Long term exposures were more harmful. Very little study has been done in Australia or overseas, into the public health of communities that are have higher exposures to air pollutants because of their close proximity to coal operations.

Findings

All the regional communities investigated were encumbered with a disproportionate health burden from elevated PM exposures, likely resulting from the nearby coal operations. Their exposures to PM were significantly higher than major Australian urban centers, such as Sydney or Brisbane, but remained consistently below the national ambient air quality standards. There is a lot of evidence suggesting that the current ambient air quality standards are too high and allow for harmful exposures to PM.

Conclusions

When the negative externality of significantly reduced public health outcomes is factored in, coal becomes the most expensive source of energy in Australia. However, many of the initiatives to reduce population exposure to PM are cost effective, easy to implement and result in disproportionate social benefits. This paper calls for, amongst things, a ratcheting down of pollution thresholds, a better monitoring system, an independent watchdog to monitor emission from coal operations and an institutional framework that incentivises reductions in PM, such as US style emissions trading scheme. The kernel to solving this problem lies in untangling the economic interdependence of State governments and the coal industry.

Chapter I

Introduction

There is an inextricable link between environmental health and human health.[1] Air-pollution is now an established risk factor in poor public health,[2] and a major source of air-pollution in Australia is coal-fired power and coal mining operations ('coal operations').[3] Pollution load intensities vary dramatically between States and between small regions within States, largely because the major pollution sources – coal-fired power and coal mining – tend to be restricted to small geographical pockets.[4] Thus, our society faces the morally odious dilemma where small populations of regional communities in geographical proximity to coal operations are exposed to disproportionate concentrations of air-pollution and therefore disproportionately bear the corollary health burden.

Australia is the world's largest coal exporter, with $43.1 billion in coal exports between 2010-11.[5] The coal industry spends and estimated $16 billion on goods and services in Australia each year, creates over 100 000 jobs and provides Australia with 55% of its energy requirements.[6] On top of this, the coal industry generates about $4.5 billion in royalties to State governments.[7] The coal industry in Australia has been growing rapidly, and in the last ten years alone, coal exports have risen by 50%.[8] Yet

[1] Dr Linda Selvey, 'The inextricable links between the health of the environment and human health.' Lock the Gate Alliance,' (Speech delivered at the Forum on Human Health Impacts of Open Cut Coal Mining and Coal Seam Gas Mining, Sydney, 9 March 2011).
[2] Cohen, Anderson, Ostro, Kiran Pandey, Krzyzanowski, Ku□nzli, Gutschmidt, Pope III, Romieu, Samet, Smith, 'Comparative Quantification of Health Crises: Urban Air Pollution' (2004) World Health Organisation 1353.
[3] Weng et al 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory' (2012) 19 *Environmental Science and Policy* 78, 79.
[4] Ibid 87.
[5] Anon. *Energy and Construction* (2012) Australian Coal Association http://www.australiancoal.com.au at 20 December 2012.
[6] Ibid.
[7] Ibid.

this growth is mirrored by growing community anxiety for its long-term health impacts.[9] What these mighty figures omit is the immense cost of reduced public health, a negative externality that the public, not the coal industry, has to foot.

The 2011 Council of Australian Governments (COAG) meeting identified air quality as a '*Priority Issue of National Significance'* and agreed that the COAG Standing Council on Environment and Water would develop a National Plan for Clean Air in order to *'improve air quality, and community health and well-being'* to be delivered by the end of 2014.[10] The plan focuses exclusively on Particulate Matter (PM) because of the large benefit gained from reductions, the level of population exposure to PM and low cost of redressing initiatives.[11] There is also a wealth of research into PM, a high rate of PM monitoring in Australia, and, most importantly, PM seems to have a disproportionate impact on public health compared to other pollutants. So although coal operations emit a toxic mixture of gases,[12] this report will focus on the effects of PM.

This report is about the direct impacts of particulate emissions from coal operations on human health, not the indirect impact of an altered climate system. This report will assess the human health impact of PM and then examine the air quality of four, small, regional communities in close proximity to coal operations: in Mackay, Moranbah, the Upper Hunter Valley and Latrobe Valley. All these regional centres have much

---

[8] Ibid.
[9] Weng *et al.,* 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory' (2012) 19 *Environmental Science and Policy* 78, 78.
[10] Anon., *COAG Standing Council for Environment and Water: Public Statement on the Development of the National Plan for Clean Air* (2012) Environmental Protection and Heritage Council <http://www.scew.gov.au/publications/pubs/air/national-plan-for-clean-air-public-statement.pdf> at 20 October 2012.
[11] Ibid.
[12] A J Cohen *et al*., *Comparative Quantification of Health Crises: Urban Air Pollution* (2004) World Health Organisation 1353.

higher PM loads than major urban centres. Very few studies have been done into the health impacts of living in proximity to coal operations, and this report will examine the scientific and anecdotal data available. The report will then review the national pollution standards and provide recommendations. Of the little good news to emerge is that initiatives that mitigate the climate crisis could also have the added public benefit of ameliorating an emerging public health crisis.[13]

Literature review

The connection between air-pollution and reduced public health has been known to science at least as early as the 1952 smog events in London, where concentrated air-pollution caused approximately 4000 deaths.[14] This observation was the catalyst to the modern era of research into the public health implications of air-pollution.[15] The last 15-20 years has seen a dramatic increase in research into the health affects of air pollution.[16]

Occupational safety literature

It has been known for at least 30 years that there is a strong association between occupational exposure to coal dust and disabling respiratory and cardiovascular dysfunction in coal miners such as pneumoconiosis and chronic obstructive pulmonary disease.[17] So well established is the connection between occupational exposure to coal dust and respiratory dysfunction that the condition's clinical name is

[13] Dennekamp and Carey, 'Air quality and chronic disease: why action on climate change is also good for health' (2010) 21 *NSW Public Health Bulletin*, 115, 119.
[14] WP Logan, 'Mortality in London fog incident,' (1952) 14 *Lancet* 336, 338.
[15] Dennekamp and Carey, 'Air quality and chronic disease: why action on climate change is also good for health' (2010) 21 *NSW Public Health Bulletin*, 115, 115.
[16] Cohen, Anderson, Ostro, Pandey, Kryzanowski, Kunzli, Gutschmidt, Pope, Romieu, Samet and Smith 'Comparative Quantification of Health Crises: Urban Air Pollution' (2004) *World Health Organisation* 1353, 1378.
[17] Coggon and Taylor 'Coal mining and chronic obstructive pulmonary disease: a review of the evidence' (1998) 53 *Thorax* 398, 398.

'Coal Workers' Pneumoconiosis' (CWP).[18] This is an inflammation of the alveoli, resulting in irreversible lung damage.[19] In a study of coal miners who had been exposed to high concentrations of coal dust, 96% had CWP, while 0.5% suffered an advanced form of lung disease.[20] Lung radiographs confirmed this was caused by coal dust.[21] CWP continues to occur in modern miners despite that they've worked entirely within the contemporary standard for occupational exposure to coal dust, suggesting that exposure is more harmful than previously thought.[22]

Extreme weather events

The association between acute bushfire PM_{10} concentrations and elevated mortality is repeatedly observed. For instance, abnormally high PM_{10} spikes in Sydney between 1994 and 2007 caused by bushfire smoke were associated with a 5% increase in mortality.[23] Morgan et al found a 0.8% increase in mortality associated with every 10 $\mu g/m^3$ increase in PM_{10} resulting from bushfire in Sydney.[24] In Finland, Hanninen et al found that there was a 0.8 – 2.1% increase associated with every 10 $\mu g/m^3$ increase in PM_{10} caused by forest fires.[25]

There is a similar correlation between elevated dust storm PM_{10} concentrations, and increased mortality. Dust storm events in Sydney were associated with a 15% increase

[18] Laney *et al.,* 'Pneumoconiosis and advanced occupational lung disease among surface coal miners - 16 states, 2010-2011' (2012) 16 *MMWR* 431, 431.
[19] Ibid.
[20] Ibid.
[21] Ibid.
[22] Vallyathan, Landsittel, Petsonk, Kahn, Parker, Osiowy, Green, 'The influence of dust standards on the prevalence and severity of coal worker's pneumoconiosis at autopsy in the United States of America' (2011) 135 *Arch Pathol Lab Med* 1550,1556.
[23] Johnston *et al.,* 'Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994 – 2007' (2011) 111 *Environmental Research* 811, 815.
[24] Ibid.
[25] Hanninen *et al*., 'Population exposure to fine particles and estimated excess mortality in Finland from an East European wildfire episode' (2008) 19 *J Expo Sci Environ Epidemiol.* 414, 422.

in mortality.[26] Perez et al found that dust storms in Barcelona were associated with a 0.8% increase in mortality with every 10 μg/m^3 increase in both PM_{10} and $PM_{2.5}$.[27] Similarly, Kwon *et al*. observed a 3.4% increase in mortality during elevated PM events in Seoul as a result of dust storms.[28] Thus PM_{10} appears to be dangerous irrespective of its source.

It must be noted that these studies are unable distill which element of the smoke contributes to the observed mortality. Furthermore, the association between high pollution is compelling in its consistency, but not necessarily indicative of a causal connection. However, the smoke and dust events are often associated with high temperatures, which itself is a contributor to mortality. Considering, that there was often a lag time of days between the pollution event and mortality, it makes the temperature dependant cause of death less likely.

Urban studies

Most evidence regarding the public health implications of PM comes from epidemiological studies in urban locations.[29] It's been known since 1973 that there is a strong correlation between air-pollution and elevated mortality.[30] In the famous, 1974 Harvard 'Six City Study,' the health effects of elevated pollutants, including PM, was studied in six major US cities. This study collected data from 8000 individuals over a period of 14-years and found that people living in more polluted

---

[26] Johnston et al, 'Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994 – 2007' (2011) 111 *Environmental Research* 811, 815.
[27] Perez *et al.,* 'Coarse particles from Saharan dust and mortality' (2008) 19 *Epidemiology* 800, 807.
[28] Kwon, Cho, Chun, Lagarde, Pershagen, 'Effects of the Asian dust events on daily mortality in Seoul, Korea' (2002) 90 *Environmental Research* 1, 5.
[29] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 1.
[30] Lave and Seskin 'An anylysis of the of the association between US mortality and air pollution' (1973) 62 *Journal of American Statistical Association* 342.

cities were more likely to be hospitalised and suffer premature mortality from pulmonary or cardiovascular disease compared to people living in less polluted cities.[31] This relationship was stronger for PM than any other pollutant.[32]

The Six City Study has undergone extensive reanalysis[33] and its findings have been consistently and independently reproduced on numerous occasions, testifying to the robustness of their results.[34] Elevated air-pollution has since been linked to instances of acute respiratory failure all throughout the world.[35] A follow up study of 500 000 US citizens between 1982-98 in 50 different US cities once again confirmed a strong association between PM and increased mortality from cardiopulmonary disease.[36] However, this study has been criticized by the John Locke Foundation for failing to take into consideration mitigating factors like education and migration.[37] It attributes the result to the statistical model rather than an actual relationship[38] and argues that 'healthy people' move away from poor cities with high pollution, leaving the remaining unhealthier population to account for the effect, but offers no evidence to demonstrate this exodus of the healthy.[39]

---

[31] Anon. *Air pollution & cardiovascular disease* (2011) The National Institute of Environmental and Health Sciences <http://www.niehs.nih.gov/about/congress/impacts/cardiovascular> at 20 October 2012.

[32] Ibid.

[33] *Krewski, Burnett, Goldberg, Hoover, Siemiatycki, Jerrett, Abrahamowicz and White* 'Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of particulate air pollution and mortality: a special report of the institute's Particle Epidemiology Reanalysis Project' (2000) *Health Effects Institute* 11 – 31.

[34] Laden *et al.,* 'Reduction in Fine Particulate Air Pollution and Mortality Extended Follow-up of the Harvard Six Cities Study' (2006) 173 *Am. J. Respir. Crit. Care Med* 667-672.

[35] Amiot, Tillon, Viacroze, Aouine and Muir 'Consequences of atmospheric pollution fluctuations in patients with COPD' (2010) 27 *Rev Mal Resp.* 907, 912.

[36] Pope et al., 'Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults' (1995) 151 American Journal of Respiratory and Critical Care Medicine 669-74.

[37] Schwartz *The health effects of air pollution* (2006) The John Locke Foundation<http://jlfadmin.info/acrobat/policyReports/airpollutioneffects-schwartz.pdf> at 20 October 2012.

[38] Ibid.

[39] Ibid.

A 2006 study of 11.5 million Medicare enrollees in the US found short-term spikes in $PM_{2.5}$ concentrations resulted in short-term increases in hospital admissions in all areas, especially cardiovascular and respiratory admissions, but excluding injuries.[40] The most compelling association was for cardiovascular problems, which saw a 1.28% increase per 10 $\mu g/m^3$ increase in $PM_{2.5}$.[41] Air pollution has been linked to arterial hardening,[42] and the development of Alzheimers–like neural damage.[43]

Multi-City studies		
Region/Country	**No. of cities**	**Increase in population mortality per $10\mu g/m^3$ in ambient PM_{10} concentration**
US	90	0.41%[44]
US	20	0.5%[45]
Meta-analyses		0.27%[46]
US	10	0.7%[47]
Meta-analyses		0.8%[48]

[40] Dominici *et al.,* 'Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases' (2006) 295 *Journal of the American Medical Association* 1127, 1127.
[41] Ibid.
[42] Hoek et al 'Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study' (2002) 360 *Lancet* 1203, 1209.
Hardening of the arteries (2004) The National Institute of Environmental Health Sciences <http://www.niehs.nih.gov/research/supported/sep/2004/hardarts/index.cfm> at 20 October 2012.
[43] *Inflammation & Alzheimer's-like damage caused by severe air pollution*(2007) The National Institute of Environmental Health Sciences <http://www.niehs.nih.gov/research/supported/sep/2004/inflam/index.cfm> at 20 October 2012.
[44] Samet *et al.,* 'The national morbidity and mortality air pollution. Part II: Morbidity and mortality from air pollution in the United States' (2000) 94 *Health Effects Institute* 5, 79.
[45] Samet, Dominici, Curriero, Coursac and Zeger 'Fine particle air pollution and mortality in 20 US cities, 1987-1994' (2000) 343 *New England Journal Medicine* 1742, 1749.
[46] Dominici *et al.,* 'On the use of generalized additive models in time-series of air pollution and health'(2002) 159 *American Journal of Epidemiology* 193, 203.
[47] Schwartz 'Assessing confounding, effect modification, and thresholds in the association between ambient particles and daily deaths' (2000) 108 *Environmental Health Perspectives* 563, 563.
[48] Ostro, 'The association of air pollution and mortality: examining the case for inference' (1993) 48 Archives of Environmental Health 336, 336; Dockery and Pope 'Acute respiratory effects of particulate

Europe	29	0.6%[49]

Table 1 PM_{10} associated mortality for multicity-studies

In addition to the multicity studies, over 100 single city studies have been conducted.[50] Although these studies confirm the results of the multicity studies, they have been criticized for differing statistical techniques and bias.[51]

Single-city studies	
City	**Increase in mortality per 10µg/m³ increase in ambient PM_{10} concentration**
Bangkok, Thailand	1.7%[52]
Mexico City, Mexico	1.83%[53]
Santiago, Chile	1.1[54]
Inchon, South Korea	0.8%[55]
Kuala Lumpur	1%[56]

air pollution' (1994) 15 Annual Review of Public Health 107, 107.

[49] Katsouyanni et al 'Confounding and effect modification in the short-term effects of ambient particles on the total mortality: results from 29 European cities within the APHEA2 project' (2001) 12 *Epidemiology* 521, 521.

[50] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 7.

[51] *Council Expansion of the Multi-City mortality and morbidity study: Final Report* (2010) Environmental Protection and Heritage http://www.scew.gov.au/archive/air/pubs/aq_rsch__multi-city__mm_executive_summary_sept__final_201009.pdf at 20 October 2012.

[52] Ostro *et al.,* 'Air pollution and the impact of particulate matter on daily mortality in Bangkok, Thailand' (1999) 49 *Waste Management Association* 100, 100.

[53] Castillejos, Borja-Aburto, Dockery, Gold, Loomis, 'Airborne course particles and mortality' (2000) 12 *Inhilation Toxicology* 62, 62.

[54] Ostro, Eskeland, Sanchez and Feyzioglu, 'Air pollution and health effects: a study of medical visits among children in Santiago, Chile.' (1999) 107 *Environmental Health Perspectives* 69, 69.

[55] Hong, Leem, Ha and Christiani 'PM10 exposure, gaseous pollutants, in Inchon South Korea' (1999) 107 *Environmental Health Perspectives* 873, 873.

[56] Sastry, 'Forest fires, air popllution and mortality in south east asia' (2002) 39 *Demography* 1, 1.

Brisbane, Australia	1.6%[57]
Sydney, Australia	0.95%[58]
Melbourne, Australia	2.19% (10.40% for respiratory mortality)[59]

Table 2 - PM_{10} associated mortality for single-studies

Epidemiology methods

One of the challenges with epidemiological studies is the difficulty in isolating the effect a single independent variable, in this case, air pollution. To overcome this, complex statistical techniques are used. Within the last decade, most of these studies into the effect of air pollution on public health have used standardized and increasingly sophisticated statistical models to control for these confounding factors that may also be associated with mortality.[60] There is widespread use of multivariate regression models to control for parameters such as lifestyle choices, meteorological variables or migration.[61]

Time-series studies are also a widely used experimental design technique to track the changes in mortality in accordance with daily fluctuations in pollutants.[62] The strengths of this design is that there is a large sample size, a wide range of demographics, and the exposures being measured are 'real world' measurements that represent what populations are actually being exposed to.[63] The technique is also

[57] Simpson, Williams, Petroeschevsky, Morgan and Rutherford, 'Assocviation between outdoor air pollution and daily mortality in Brisbane, Australia' (1997) 52 Archives of Environmental Health 442, 442.
[58] Morgan, Corbet, Wlodarczyk, Lewis, 'Air pollution and daily mortality in Sydney, Australia, 1989 through 1993' (1998) 88 *American Journal of Public Health* 759, 759.
[59] Simpson *et al.,* 'Effects of ambient particle pollution on daily mortality in Melbourne, 1991-1996' (2000) 10 *Journal of Expusre Analysis and Environmental Epidemiology* 488, 488.
[60] Ibid 7.
[61] Ibid 6.
[62] Ibid.

limited in so far as it is difficult discern the local pollution concentrations to which sub-populations are exposed generating the potential to misclassify exposure, and it is also difficult to isolate the effect of a single pollutant when multiple pollutants covary.[64] Some multicity studies suggest the elevated mortality arises from a cocktail of pollutants including PM and nitrogen dioxide.[65]

Another confounding issue with studies into short-term urban exposure are meteorological fluctuations, such as daily weather, season and climate.[66] For instance, temperature is known to modify the effect of PM exposure.[67] A comparative study of Brisbane and Beijing found that the effect of elevated PM on mortality was exacerbated on high temperature days.[68] All studies were controlled for meteorological variables, but had they not been, the consistent results between cities with vastly different climates (e.g. Detroit and Montreal versus Bangkok and Mexico City)[69] also strongly mitigate the effect this confounding influence.[70] Smoking, occupational hazards and personal habits do not confound the results of the short-term studies because they do not vary with pollution.[71]

Weaknesses in the literature

---

[63] Ibid 1.
[64] Ibid 6.
[65] *Council Expansion of the Multi-City mortality and morbidity study: Final Report* (2010) Environmental Protection and Heritage http://www.scew.gov.au/archive/air/pubs/aq_rsch__multi-city__mm_executive_summary_sept__final_201009.pdf at 20 October 2012.
[66] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 15.
[67] Li *et a.,l* 'Temperature Modifies the Effects of Particulate Matter on Non-Accidental Mortality: A Comparative Study of Beijing, China and Brisbane, Australia' (2012) 2 *Public Health Research* 21, 21.
[68] Ibid.
[69] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 14.
[70] Ibid 13-4.
[71] Ibid.

The voices of dissent are few, but must be noted. Firstly, it is unclear how much of a difference that acute versus chronic exposures makes to health risks, [72] and the effect of co-pollutants is also unknown.[73] PM includes a range of materials, both solid and liquid of varying compositions[74] and it is very unclear how these different compositions alter the health impact.[75] One study suggests that PM composed of specific metals is more toxic than other forms of PM[76] however this is a very nascent space in the literature.[77] Shape and mass of the particle might also affect the severity of the health impact sit has, but again, the literature says very little about these parameters.[78]

One of the biggest criticisms of the epidemiological data is that because our knowledge of the health effects of PM exposure is based on ambient air concentration rather than actual exposures, there are uncertainties surrounding causality. [79] This apparent lack of a causal connection is used to explain why some of epidemiological data seems to suggest that the risk of PM exposure is far greater for those with less than high school education, and less for those with higher levels of education

---

[72] Laden, Schwartz, Speizer and Dockery, 'Reduction in Fine Particulate Air Pollution and Mortality Extended Follow-up of the Harvard Six Cities Study' (2006) 173 *Am. J. Respir. Crit. Care Med* 667, 667.

[73] Simpson *et al.,* 'Effects of ambient particle pollution on daily mortality in Melbourne, 1991-1996' (2000) 10 *Journal of Expusre Analysis and Environmental Epidemiology* 488, 488.

[74] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) viii.

[75] Mallory Barnes, interview with Prof. Krassi Rumchev (conducted via telephone between Canberra and Perth at 12.00pm AESD on 12 September 2012).

[76] Chi Chen and Lippmann, 'Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health' (2009) 21 *Inhalation Toxicology* 1, 1.

[77] Mallory Barnes, interview with Prof. Krassi Rumchev (conducted via telephone between Canberra and Perth at 12.00pm AESD on 12 September 2012).

[78] Englert, 'Fine particles and human health— a review of epidemiological studies' (2004) 149 *European Congress of Toxicology* 235, 235;
Mallory Barnes, interview with Prof. Krassi Rumchev (conducted via telephone between Canberra and Perth at 12.00pm AESD on 12 September 2012).

[79] Englert, 'Fine particles and human health— a review of epidemiological studies' (2004) 149 *European Congress of Toxicology* 235, 235; Chi Chen and Lippmann, 'Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health' (2009) 21 *Inhalation Toxicology* 1, 1.

attainment.[80] It is argued that better nutrition and access to health care modify the PM exposure effect because there isn't one in the first place.[81] However, low socio-economic background is also associated with residence closer to pollution sources, suggesting that low-socio-economic status is merely associated with higher exposure to existing sources rather than a legitimate effect modifier.[82]

There is little dispute that air pollution causes poor health. One aforementioned paper, which categorically denies the connection between air pollution and mortality, does so on the grounds that these concerns are mongered by activist groups that are deliberately inciting fear, cherry-picking, exaggerating and even fabricating data.[83] This same paper also argues that air-pollution is not a plausible cause of asthma, and denies that it exacerbates pre-existing lung disease.[84] It is instructive to note that in assessing the health-risk, the paper only takes into account ozone pollution, not PM.[85] The paper argues that there is a publication bias against studies that show no connection between air-pollution and poor health.[86] The findings of this paper are at odds with the mass of scientific literature that finds a clear and consistent connection between mortality and air pollution. It must be also be considered that this paper is funded by the John Locke Foundation – a political think tank in the US- and importantly, that it has not been published by a scientific journal because it is a policy report, rather than original scientific research.

---

[80] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 18.
[81] Ibid 17.
[82] Ibid.
[83] Schwartz *The health effects of air pollution* (2006) The John Locke Foundation<http://jlfadmin.info/acrobat/policyReports/airpollutioneffects-schwartz.pdf> at 20 October 2012.
[84] Ibid.
[85] Ibid.
[86] Ibid.

In summary, there are four outstanding similarities in the literature. Firstly, the effect of PM_{10} exposure on mortality appears to occur independently of meteorological phenomena - such as temperature and season - which was controlled across all studies.[87] Secondly, the studies included the full spectrum of environments, pollution-temperature conditions, background health conditions, health care systems, socio-economic statuses and age distributions.[88] Yet, despite this enormous variability, the range of association between PM_{10} increase and mortality across all studies was small: 0.5 – 1.6% increase per 10μg/m^3 increase.[89] This effect cannot be explained by exposure to other pollutants.[90] Thirdly, all studies show there is no safe exposure threshold level as the association is linear.[91] Finally, the mortality effect of long term exposure - about 4 to 7% per 10μg/m^3 increase in PM_{10} - is far greater than the short term exposure mortality – about 1% per 10μg/m^3.[92]

Summary

The literature has established an incontrovertible connection between PM and poor public health. Very little research has been conducted into the public health of regional communities in close proximity to coal operations. This is alarming considering that these regional communities are exposed to much higher pollution loads.

[87] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 16.
[88] Ibid 15.
[89] Ibid 16.
[90] Ibid.
[91] Ibid.
[92] Ibid 17.

Chapter II

Health effects

There is no doubt that the type of air-pollution emitted from coal operations enhances the risk of chronic morbidity and premature mortality, particularly from respiratory and cardiovascular diseases.[93] The health affects of air-pollution are so well known that even the Federal Government acknowledged in 2011 report that:

> *'The health effects arising from exposure to [PM] are well documented. Although associated with small individual risks, the health effects translate to*

[93] Dennekamp and Carey 'Air quality and chronic disease: why action on climate change is also good for health' (2010) 21 *NSW Public Health Bulletin*, 115, 115-116.

large population risks and public health burden because the entire population is exposed."[94]

The reason PM is used to index air-pollution is because it's a constituent gas that's consistently linked with a range of serious health effects.[95] This chapter aims to describe elucidate these effects and outline their impact on Australian and international communities.

Particle Matter (PM) pollution

There are two kinds of PM: particles with an aerodynamic diameter between 2.5μm and 10μm known as PM_{10}, and particles with an aerodynamic diameter less than 2.5μm, known as $PM_{2.5}$. PM has many different natural and anthropogenic sources, including bushfires, dust storms and wood-burning, but by far the most prolific source of PM is coal mining operations (including transport) and coal combustion.[96] Harm from PM occurs across all temporal scales – including daily and monthly - and is not just limited to long-term damage daily.[97]

PM has a spectrum of health effects, ranging from eye irritation to death.[98] The most significant health effects of PM are mainly related to cardiovascular and respiratory diseases, including heart attacks and lung cancer, acute and chronic bronchitis,

---

[94] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 2.
[95] Cohen, Anderson, Ostro, Pandey, Kryzanowski, Kunzli, Gutschmidt, Pope, Romieu, Samet and Smith 'Comparative Quantification of Health Crises: Urban Air Pollution' (2004) *World Health Organisation* 1353.
[96] Mallory Barnes, interview with the Department of Sustainability, Environment, Water, Population and Community (Interview in the office of Senator Larissa Waters at Australian Parliament House, Canberra conducted on 19 September 2012).
[97] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 15.
[98] A J Cohen *et al., Comparative Quantification of Health Crises: Urban Air Pollution* (2004) World Health Organisation 1353, 1353.

changes in blood composition and blood pressure and exacerbation of asthma.[99] Elevated PM_{10} has been consistently and independently correlated with respiratory and cardiovascular disease[100] and mortality.[101] PM also causes increased incidence in acute bronchitis and increased prevalence and exacerbations of COPD, reduced respiratory function and asthma.[102]

PM has been shown to be a risk factor for lung cancer in China where subjects were exposed to domestic coal use.[103] Elevated concentrations of PM have been associated with neonatal and infant mortality in independent studies in Rio de Janeiro, The Czech Republic and the United States.[104] High PM is also associated with low birth weight and premature delivery.[105] However, this correlation is dubious due to the difficulty in disentangling confounding factors such as poverty.[106] According to WHO, a reasonable estimate of mortality increase due to PM air pollution is between

---

[99] Ibid.

[100] Cohen, Ross Anderson, Ostro, Pandey, Krzyzanowski, Künzli, Gutschmidt, Pope, Romieu, Samet and Smith 'The global burden of disease due to outdoor air pollution' (2005) 68 *Journal of Toxicology and Environmental Health* 1, 1-7.

[101] *Air Pollution Economics: Health Costs of Air Pollution in the Greater Sydney Metropolitan Region* (2005) Department of Environment and Conservation NSW <http://www.environment.nsw.gov.au/resources/aqms/airpollution05623.pdf> at 20 October 2012.

[102] Ibid.

[103] Kleinerman *et al.,* 'Lung cancer and indoor exposure to coal and biomass in rural China' (2002) 44 *Journal of Occupational Environmental Medicine* 338, 338; Lissowska, Bardin-Mikolajczak, Fletcher, Zaridze, Szeszenia-Dabrowska, Rudnai, Fabianova, Cassidy, Mates ,Holcatova, Vitova, Janout, Mannetje, Brennan, and Boffetta 'Lung Cancer and Indoor Pollution from Heating and Cooking with Solid Fuels' (2005) 162 *American Journal of Epidemiology* 326, 326-325.

[104] Penna and Duchiade, 'Air pollution and infant mortality from pneumonia in the Rio di Janero metropolitan area' (1991) 25 *Bulletin of the Pan American Health Organisation* 47, 47-8; Bobak and Leon, 'Air pollution and infant mortality; the effects are specific for respiratory causes in the postneonatal period' (1998) *Epidemiology* 9:S58;
Woodruff, Grillo and Shoendorf 'The relationship between selected causes of postneonatal infant mortality and particulate air pollution in the United States' (1997) 105 *Environmental Health Perspectives* 679, 679.

[105] Ritz *et al*., 'Effect of air pollution on preterm birth among children born in Southern California between 1989 and 1993' (2000) 11 Epidemiology 502, 511.

[106] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 11.

0.6% and 1% per 10 μg/m^3, however, this can vary considerably depending on local conditions.[107]

Far less is known about the health impacts of $PM_{2.5}$, but it is clear that it is far more deleterious than the coarser PM_{10}.[108] This is because $PM_{2.5}$ particles are much finer and are therefore capable of penetrating deeper into the terminal regions of lung tissue.[109] Unlike PM_{10}, $PM_{2.5}$ has the capacity to penetrate into the indoor, home environment.[110] Despite this greater health risk, $PM_{2.5}$ is far less frequently monitored in Australia.[111]

$PM_{2.5}$ is also associated with elevated mortality (Fig 1&2), however, even very short periods of exposure , as short as a few hours, can trigger an increase the populations' risk of hospital admissions for cardiovascular and respiratory issues by approximately 1.28% per 10μg/m^3 increase in $PM_{2.5}$.[112] Meta-analyses show that every 10 μg/m^3 increase in $PM_{2.5}$ is associated with a 4% increase in overall mortality, a 6% increase in cardiopulmonary mortality and an 8% increase in lung cancer mortality.[113] Conversely, reductions in exposure to $PM_{2.5}$ pollution in the United States resulted in significant improvements in life expectancy.[114] Exposure for a few months can reduce

---

[107] Ibid 9.
[108] Dominici *et al.,* 'Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases' (2006) 295 *Journal of the American Medical Association* 1127, 1127**;** Mallory Barnes, interview with Prof. Krassi Rumchev (conducted via telephone between Canberra and Perth at 12.00pm AESD on 12 September 2012).
[109] Dominici *et al.,* 'Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases' (2006) 295 *Journal of the American Medical Association* 1127, 1127.
[110] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 2.
[111] Ibid.
[112] Dominici *et al.,* 'Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases' (2006) 295 *Journal of the American Medical Association* 1127, 1127; Brook et al 'Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association' (2010) 10 *Circulation* 2231, 2231.
[113] Pope, 'Epideimiology of fine particulate air pollution and human health: biological mechanisms and who's at risk?' (2000) 108 *Environmental Health Perspectives* 713, 723.
[114] Pope, Ezzati, and Dockery, 'Fine-Particulate Air Pollution and Life Expectancy in the United

life expectancy by years. Pope *et al*. has suggested that the 24µg/m3 difference in $PM_{2.5}$ concentration

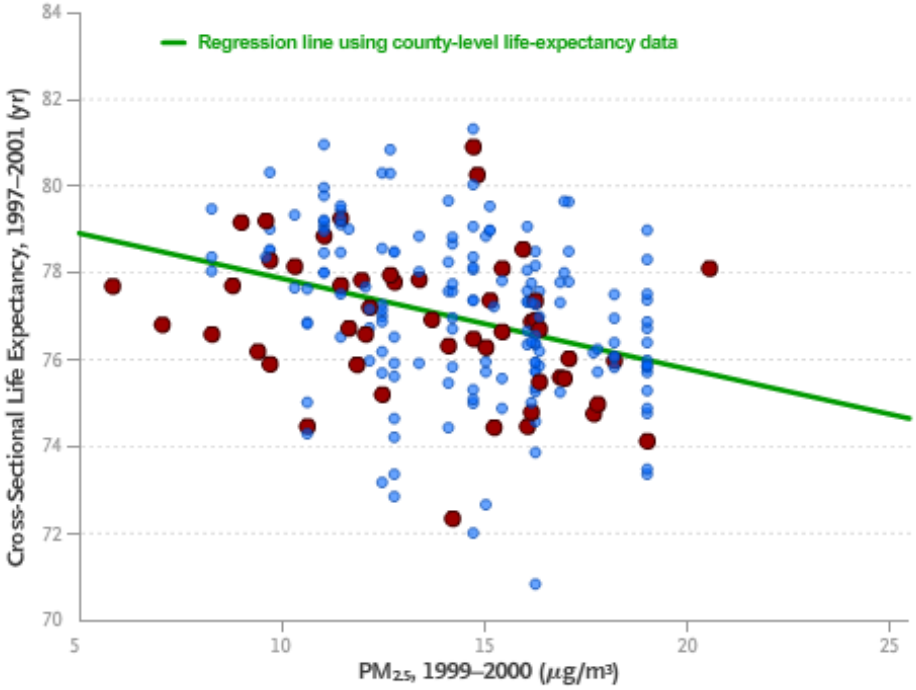

Figure 1 Changes in life expectancy in the United States. [115]

States' (2009) 360 *New England Journal of Medicine* 376, 376.

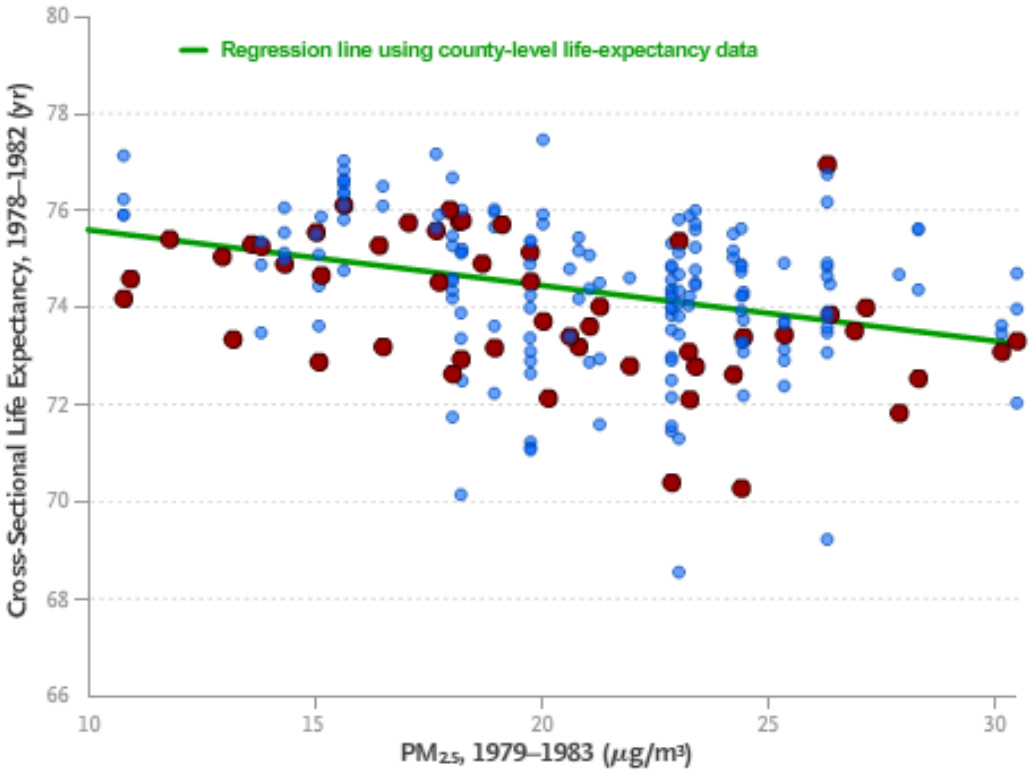

Figure 2 Decrease in life expectancy in the United States.[116]

between the dirtiest and cleanest cities results in life expectancy differential of 1.5 years (Fig. 3).[117]

[115] Pope, Ezzati, and Dockery, 'Fine-Particulate Air Pollution and Life Expectancy in the United States' (2009) 360 *New England Journal of Medicine* 376, 376.

[116] Pope, Ezzati, and Dockery, 'Fine-Particulate Air Pollution and Life Expectancy in the United States' (2009) 360 *New England Journal of Medicine* 376, 376.

[117] Pope, 'Epideimiology of fine particulate air pollution and human health: biological mechanisms and who's at risk?' (2000) 108 *Environmental Health Perspectives* 713, 723.

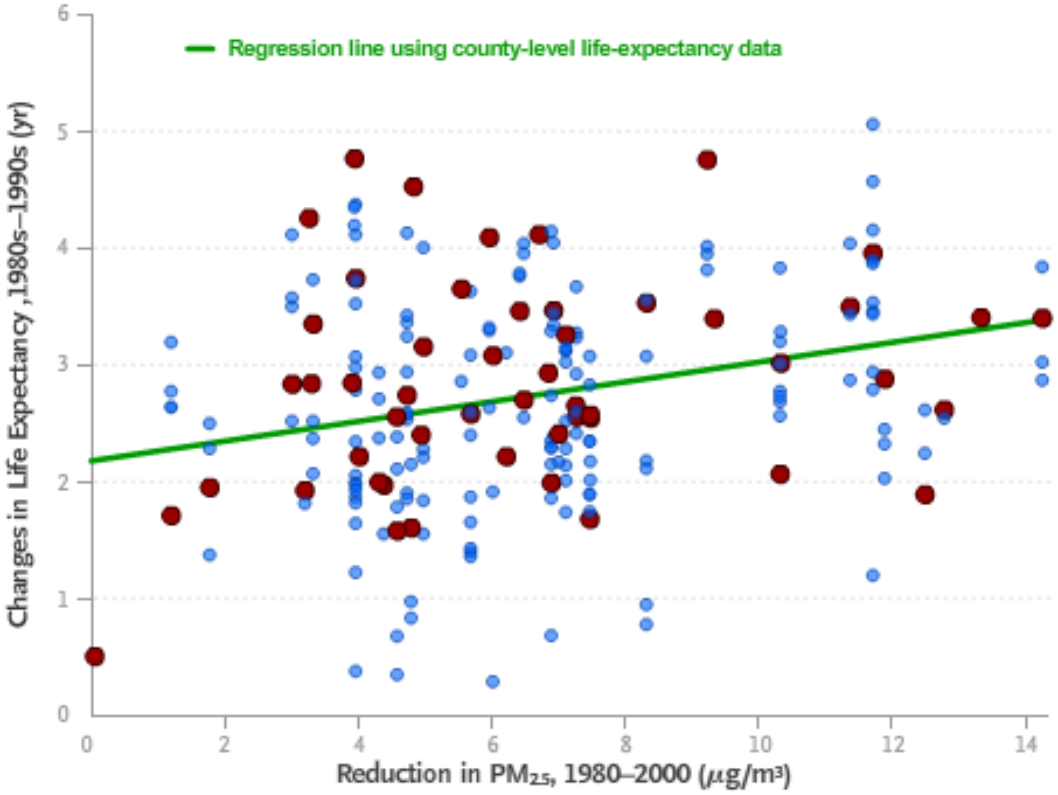

Figure 3 Increased life expectancy resulting from reductions in PM2.5 in the United States.[118]

External Public Health Cost

The NSW government website admits that research suggest that 2.3% of all deaths in Australia may be attributable to air pollution. In the Sydney Greater Metropolitan region alone, air pollution is estimated to be responsible for between 640 and 1400 premature deaths a year, and nearly 2000 hospitalisations.[119] This is called a negative externality, and it is when a cost that is not reflected in the market price of something, but is transferred to people uninvolved in the transaction. It is estimated that the burden of air pollution on the NSW public health system is approximately $4.7 billion

[118] Pope, Ezzati, and Dockery, 'Fine-Particulate Air Pollution and Life Expectancy in the United States' (2009) 360 *New England Journal of Medicine* 376, 376.
[119] Ibid.

per year.[120] Conservative estimates of the national health burden of coal operations are around $2.6 billion per annum.[121] If the price of coal were adjusted to reflect this, it would cost between $42-54/MWh.[122] If this negative externality were recovered through taxes, coal would be the most expensive form of energy.[123]

Individuals at risk

People react differently to air pollution depending on their health status and age.[124] There are some subsets of the population that are especially vulnerable to increased concentrations of air pollution, namely: the very old,[125] the very young and those who are already predisposed to cardiovascular or respiratory illness.[126] A US study found that while the whole population was morme prone to hospital admissions with elevated PM, those above the age of 75 had a far greater risk than those younger.[127] In a study of air pollution in 10 major American cities, individuals aged over 65 had approximately double the risk of mortality with every $10\mu g/m_3$ increase in PM_{10} compared to the general population.[128] Furthermore, children aged under 5-years are far more likely to suffer from mortality due to acute respiratory infections with an increased PM_{10}.[129] Individuals who already suffer from COPD are also at greater risk

---

[120] Anon., *Air Pollution* (2012) NSW Health <http://www0.health.nsw.gov.au/publichealth/environment/air/air_pollution.asp> at 2 October 2012.
[121] Castelden, Shearman, Crisp and Finch 'The mining and burning of coal: effects on health and the environment' (2011) 195 *Medical Journal of Australia* 333, 334.
[122] Ibid.
[123] Ibid.
[124] Ibid.
[125] Simpson et al, 'Effects of ambient particle pollution on daily mortality in Melbourne, 1991-1996' (2000) 10 *Journal of Expusre Analysis and Environmental Epidemiology* 488, 488.
[126] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 16.
[127] Dominici *et al.,* 'Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases' (2006) 295 *Journal of the American Medical Association* 1127, 1134.
[128] Schwartz, 'The distributed lag between air pollution and daily deaths' (2000) 11 *Epidemiology* 320, 326.
[129] Loomis *et al.,* 'Air pollution and infant mortality in Mexico City (1999) 10 *Epidemiology* 128, 128.

increased morbidity and mortality from elevated PM.[130] However, instances where air pollution is at extremely high concentrations for prolonged periods, everyone's health is likely to be adversely affected.[131] Importantly, people living in close proximity to the source of pollutants have a greater risk of poor health outcomes compared to the general population.[132]

Communities at Risk

The public health burden of PM will be greater in regions that are in close proximity to coal mining operations and coal combustion.[133] Very little research has been done into these kinds of communities.[134] The Upper Hunter Valley in NSW is one such community because of the extraordinarily high PM loads to which it is subject due to coal operations.[135] The only research that has been done into the public health implications of coal operations in the Upper Hunter is that conducted by the local Singleton GP, Dr Tuan Au, who became concerned about large number of child patients presenting with low respiratory function.[136] After a number fruitless community campaigns imploring NSW Health to commission an independent report

---

[130] Amiot *et al.,* 'Consequences of atmospheric pollution fluctuations in patients with COPD' (2010) 27 *Rev Mal Resp* 907, 907.
[131] *Air Pollution* (2012) NSW Health <http://www0.health.nsw.gov.au/publichealth/environment/air/air_pollution.asp> at 2 October 2012.
[132] Australian Broadcasting Corporation 'A Dirty Business', *Four Corners* 12 April 2010 http://www.abc.net.au/4corners/content/2010/s2867659.htm at 20 October 2012.
[133] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 2.
[134] Castelden *et al.,* 'The mining and burning of coal: effects on health and the environment' (2011) 195 Medical Journal of Australia 333, 333-5.
[135] Higginbotham *et al*., 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.
[136] Australian Broadcasting Corporation 'A Dirty Business', *Four Corners* 12 April 2010 http://www.abc.net.au/4corners/content/2010/s2867659.htm at 20 October 2012; Lee Rhiannon, *Blog: Hunter coal – dirty, dusty and dodgy* (2012) Lee Rihannon's Blog <http://lee-rhiannon.greensmps.org.au/content/blog/blog-hunter-coal---dirty-dusty-and-dodgy> at 20 October 2012.

into the public health implications of coal operations in the Upper Hunter, Dr Au decided to conduct research himself.[137] It must be noted that Carmel Tebut, the then NSW Health Minister, refused to conduct a study based on the spurious reasoning that the sample size was too small for epidemiological research, despite that the upper Hunter community at the time exceeding 40 000 individuals.[138]

Since 2008, Dr Au has been visiting local schools in the Upper Hunter region and surveying children's' respiratory functions. His provisional results show that one in six children in the Singleton area have low lung function, while the national average is one in nine.[139] The anecdotal evidence that voices community anxiety cannot be ignored. Ethnographic investigation found that residents complain of chronic dermatitis, difficulty breathing headaches and mental-health symptoms.[140] Parents who take their children on holiday outside the Upper Hunter find that their children's respiratory symptoms disappear for the duration of the holiday, only to return within a few days upon their arrival.[141] More alarmingly, some parts of the Upper Hunter Valley are reported to have mortality rates 37% greater than the national average.[142] Despite this compelling evidence indicating the urgent need for further investigation,

---

[137] Australian Broadcasting Corporation 'A Dirty Business', *Four Corners* 12 April 2010 http://www.abc.net.au/4corners/content/2010/s2867659.htm at 20 October 2012.
[138] Ibid.
[139] Ibid.
[140] Albrecht *et al., .Solastalgia: The Distress Caused by Environmental Change* (Paper presented at RANZCP Social and Cultural Psychiatry Conference, Cairns, 4-7 Sept 2006).
[141]Australian Broadcasting Corporation 'A Dirty Business', *Four Corners* 12 April 2010 http://www.abc.net.au/4corners/content/2010/s2867659.htm at 20 October 2012; Lee Rhiannon, *Blog: Hunter coal – dirty, dusty and dodgy* (2012) Lee Rihannon's Blog <http://lee-rhiannon.greensmps.org.au/content/blog/blog-hunter-coal-–-dirty-dusty-and-dodgy> at 20 October 2012.
[142] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

the NSW Education Department has actively frustrated Dr Au's independent research by banning him from entering schools in the Hunter Valley.[143]

So to did a 1998 study into the Latrobe Valley in Victoria - which produces 85% of the State's energy through coal combustion[144] - show that there was a significant association between hospital admissions for respiratory morbidity and increased PM.[145] Even the low levels of PM experienced in 1998 resulted in elevated hospital admissions for COPD.

A 1993 study comparing a two coastal Australian towns – one with two coal-powered generators and one without coal-generation at all – found that heavy exposure to PM, in the town with the coal-fired power stations had a higher prevalence of 'wheeze' and asthma like symptoms in children.[146] This risk of elevated morbidity from exposure to coal industry pollutants is not just limited to the Upper Hunter and Latrobe. Every community in Australia that is in close proximity to coal operations has a higher probability of being exposed to elevated levels of pollutants that have been shown to be very harmful to public health. The communities at risk include those near rail lines that transport coal as well as coal loaders.[147]

---

[143] Lee Rhiannon, *Blog: Hunter coal – dirty, dusty and dodgy* (2012) Lee Rihannon's Blog <http://lee-rhiannon.greensmps.org.au/content/blog/blog-hunter-coal-–-dirty-dusty-and-dodgy> at 20 October 2012.

[144] Darrell White, *Inquiry into Greenfields Mineral Exploration and Project Development in Victoria Hearing Councillor Darrell White* (2011) Latrobe City Council *<http://www.parliament.vic.gov.au/images/stories/committees/edic/greenfields_mineral_exploration/hearings/20111107_-_Latrobe_presentation.pdf> at 20 October 2012.*

[145] Voigt, Bailey and Abramson, 'Air pollution in the Latrobe Valley and its impact upon respiratory morbidity' (1998) 22 *Australian and New Zealand Journal of Public Health* 556, 556.

[146] Halliday *et al.,* 'Increased wheeze but not bronchial hyper-reactivity near power stations' (1993) 47 *Journal of Epidemioly, Community and Health* 282, 286.

[147] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

International studies corroborate these domestic concerns, The Appalachian counties of West Virginia in the United States that have a high density of mountaintop coal mining also have serious associated public health concerns. For instance, communities in close proximity to Mountaintop coal-mining activities had an increased risk of all forms of cancer.[148] Living close to these coal mining areas was also associated with an increased risk of cardiopulmonary disease, chronic obstructive pulmonary disease, hypertension, lung and kidney disease.[149] Studies show that lung related mortality is greater in the high coal mining areas of the Appalachia compared to the rest of the United States.[150] In fact, mortality was higher for all causes in areas of the Appalachia that were subject to the heavy coal mining.[151] Between 1999 and 2004 there were 1607 excess annual deaths in these areas.[152] All results were adjusted for ages, sex, smoking, occupational history, education, family history and socio-economic background. Similarly, in the UK, proximity to open-cut coal mines was associated with a higher rate of childhood respiratory consultations.[153] However, this study did not find an increased prevalence of respiratory morbidity in the children.[154]

If the burden of disease from PM exposure on the world's cities is large,[155] the burden on Australia's regional communities in proximity to coal operations is tremendous. Today, air-pollution is considered to account for 1.4% of total mortality and 2% of

---

[148] Hendryx *et al.,* 'Self-reported cancer rates in two rural areas of West Virginia with and without mountaintop coal mining' (2012) 37 *Journal of Community Health* 320, 327.
[149] Hendryx and Ahern, 'Relations between health indicators and residential proximity to coal mining in West Virginia' (2008) 98 *American Journal of Public Health* 669, 671.
[150] Hendryx, O'Donnell and Horn, 'Lung cancer mortality is elevated in coal-mining areas of Appalachia' (2008) 62 Lung Cancer 1, 1.
[151] Hendryx and Ahern, 'Mortality Rates in Appalachian Coal Mining Counties: 24 Years Behind the Nation' (2009) 124 *Public Health Reports* 541, 550.
[152] Ibid.
[153] Pless-Mulloli et al, 'Living near opencast coal mining sites and children's respiratory health' (1999) 57 *Occupational Environmental Medicine* 145, 145.
[154] Ibid.
[155] Cohen *et al*., 'Comparative Quantification of Health Crises: Urban Air Pollution' (2004) *World Health Organisation* 1353.

cardiopulmonary disease,[156] but the burden does not appear to be shared equally across Australia.

[156] Ostro 'Outdoor air pollution: Assessing the environmental burden of disease at national and local levels' (2004) 7; Cohen et al 'Mortality impacts of urban air pollution. In: Ezzati, Lopez, Rodgersand Murray eds. Comparativ quanitification of health risks: global and regional burden of disease attributable to selected major risk factors ' (2004) Geneva, World Health Organisation Vol 2; Ezzati, at al 'Selected major risk factors and global and regional burden of disease' (2002) 360 *Lancet* 1347, 1360.

Chapter III

Regional Air pollution Concentrations

Regional communities that are geographically proximate to coal operations have consistently high PM loads, often much higher than PM in major urban centres. This pattern occurs in the four case study areas: Mackay (Qld), Moranbah (Qld) the Upper Hunter Valley (NSW) and La Trobe Valley (Vic). Although the PM loads were often greater than in major urban centres, ambient PM levels tended to be well within the national PM standards set by the Australian Government's Ambient Air Quality National Environmental Protection Measure (AAQNEPM), aside from sporadic exceedence events. The following section will investigate the PM concentrations in the four regional community case studies and then assess the pollution threshold standards. Differences in the standard of monitoring between States makes consistent comparison difficult.

The Institutional framework

Air quality is regulated by the National Environmental Protection Council (NEPC), an inter-governmental panel that harmonises State and Federal environmental protection approaches[157] using National Environmental Protection Measures (NEPMs).[158] The council is composed of ministers from each State or Territory, and chaired by the Federal Environment Minister.[159] The AAQNEPM was created in 1998,[160] and established a uniform national threshold standards for six key air pollutants (criteria

[157] *National Environmental Protection Council Act 1994 (Commonwealth)* s 12; National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 2.
[158] *National Environmental Protection Council Act 1994 (Commonwealth)* Division 2.
[159] *National Environmental Protection Council Act 1994 (Commonwealth)* s 9(1).
[160] *National Environmental Protection Council Act 1994 (Commonwealth)* s 2.

pollutants) including carbon monoxide, particulate matter (the NEPM was varied on 2003 to include PM_{10} and $PM_{2.5}$ s[161] ozone, sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and lead. The AAQNEPM provides for a nationally consistent framework for monitoring and reporting on air quality.[162] The national standards for PM_{10} and $PM_{2.5}$ this outlined in Table 3.

Pollutant	Averaging period	Maximum concentration	Goal within 10 years maximum allowable exceedences
Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
Particles as PM_{10}	1 day	50 µg/m^3	5 days a year
Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3	Goal is to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards.

Table 3[163] National pollution standards. Note the absence of a $PM_{2.5}$ goal.[164]

The Upper Hunter Valley

The Upper Hunter is the largest coalfield in NSW and wins the majority of NSW mining royalties.[165] On-top of the mining burden, both Singleton and Muswellbrook, the major population centres of the region, lie in the emissions drop-zones of three major coal-fired generators, exposing the community to extremely high pollution loads.[166]Since at least 2008, the community has consistently implored the NSW Government to install pollution monitoring devices and commission an independent

[161] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 2.
[162] Ibid.
[163] Ibid 8.
[164] Ibid 9.
[165] Higginbotham *et al.,* 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 260.
[166] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

report into the public health implications of coal operations due to the observed high morbidity levels.[167] Despite this prolonged community entreaty, pollution-monitoring devices were only installed and made operational in the Upper Hunter on 31 August 2011.[168]

PM_{10} and $PM_{2.5}$ are measured against the national benchmark 24-hour averages of 50 $\mu g/m^3$ and 25 $\mu g/m^3$ respectively.[169] A NSW Government report between 2010 and 2011 states that Singleton and Muswellbrook were both 'on track' to meet PM_{10} emissions benchmarks, while Muswellbrook was reported to have some 'issues' with $PM_{2.5}$ that required further investigation,[170] yet a closer inspection of the data reveals more alarming results. Although PM concentrations were consistently below the threshold level,[171] there were 11 days in which the PM_{10} levels in the Upper Hunter exceeded the nationally prescribed benchmark. The $PM_{2.5}$ standard was exceeded on four days.[172] Using self-generated graphs from the NSW Environment Office website, it's discovered that the Upper Hunter has consistently and significantly higher monthly maximum[173] and mean PM_{10} concentrations than the largest city in Australia; Sydney (fig 4). The exact same pattern is followed for $PM_{2.5}$ (Fig 5).

---

[167] Ibid.
[168] *Upper Hunter Air Quality Monitoring Network (UHAQMN) Interim Performance Report: December 2010 – August 2011* (2011) NSW office of Environment and Heritage <http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf> at 20 October 2012, 12.
[169] Ibid.
[170] Ibid 27.
[171]Ibid.
[172] Ibid 6.
[173] *Search Air Quality Data* (2012) NSW Environment and Heritage <http://www.environment.nsw.gov.au/aqms/search.htm>at 20 October 2012.

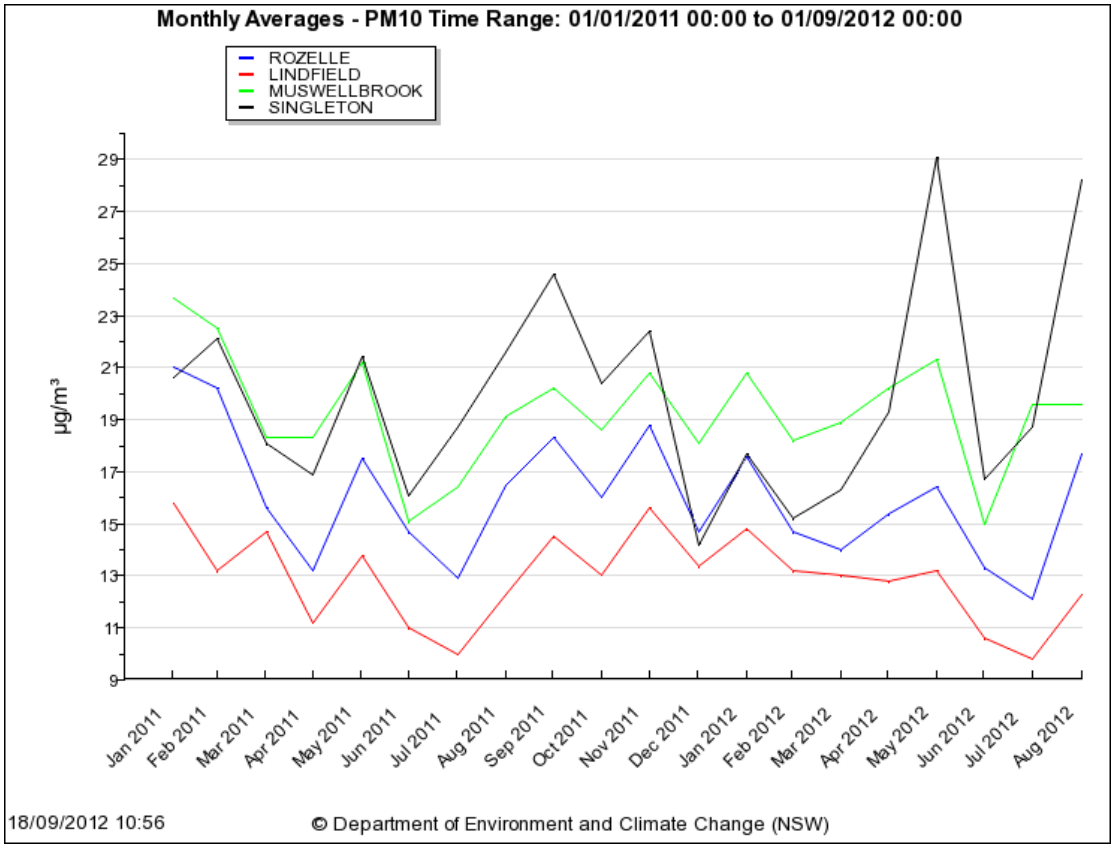

Figure 4[174] **The Upper Hunter has a consistently higher monthly average PM_{10} concentration than Sydney central-east.**

[174] Ibid.

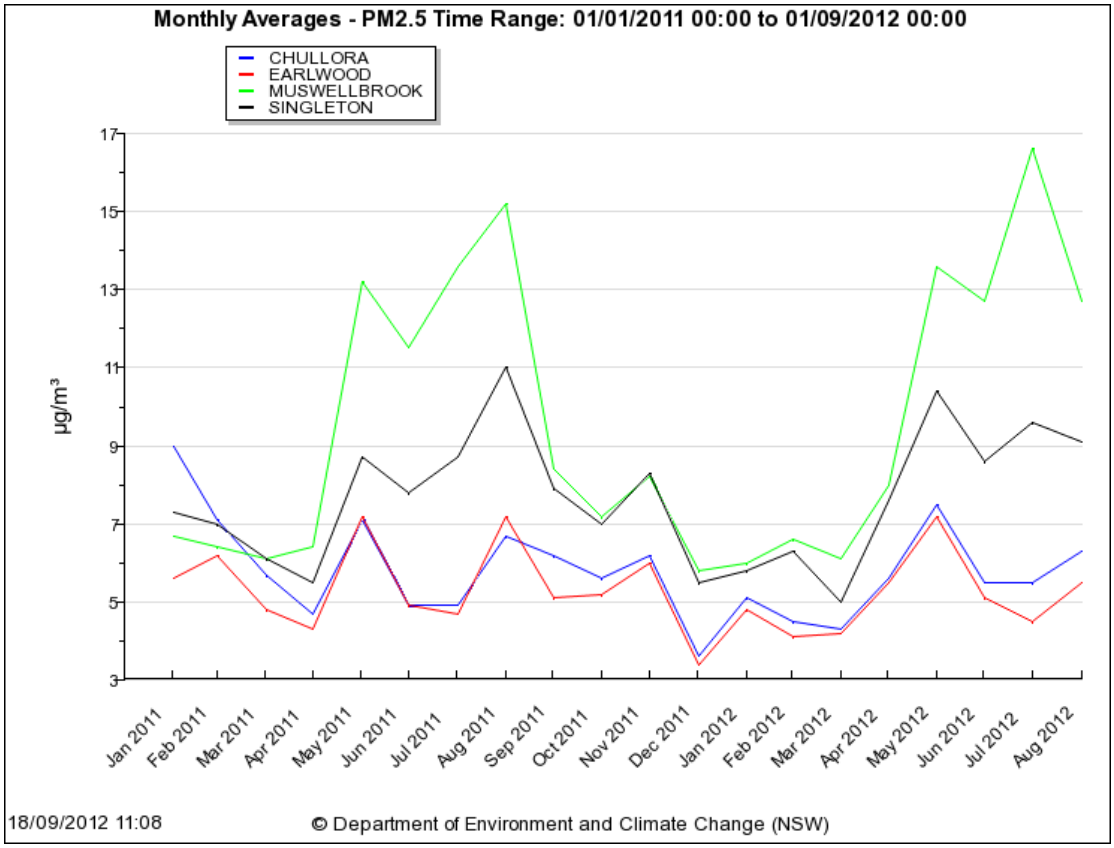

Figure 5 [175] **The Upper Hunter has a consistently higher monthly average $PM_{2.5}$ concentration than Sydney central-east.**

An analysis of wind conditions during exceedences reveals that elevated PM levels in the Upper Hunter are almost indisputably caused by coal operations. Singleton is to the southeast of the major open-cut coal-production areas,[176] and almost all of Singleton's PM_{10} readings greater than 50 µg/m^3 are associated with northwest winds (Fig 6) while every reading greater than 75 µg/m^3 occurs during north-westerly winds (Fig 7). Furthermore, north-westerly winds are more common in Winter while south-westerlies are more common in Summer, and accordingly PM_{10} levels in Singleton tend to be higher in Winter.[177] The opposite occurs for Muswellbrook which is to the

[175] Ibid.

[176] *Upper Hunter Air Quality Monitoring Network (UHAQMN) Interim Performance Report: December 2010 – August 2011* (2011) NSW office of Environment and Heritage <http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf> at 20 October 2012, 12.

northwest of the nearest coal operations.[178] Its highest $PM_{2.5}$ concentrations were associated with south-westerly winds and cold times of day and year (Fig 8). There tends to be higher pollution loads during cool periods (daily and seasonally) because the heavier air accumulates in the valley, disrupting dispersion[179]. The pollution concentrations for PM (and also NO_2) have been steadily growing since 1999 (Fig 9), however, interestingly, SO_2 levels have dropped due to strict diesel standards for machinery. Furthermore, it should be noted that, the pollution levels recorded by the companies as a condition of their license agreements give substantially higher readings than the government monitoring stations, yet this data is in a format that makes it publicly inaccessible.[180] NSW is by far the most progressive State for pollution monitoring.

[177] Ibid.
[178] Ibid.
[179] Ibid 25.
[180] *Compendium of Upper Hunter Ambient Air Quality Monitoring Data* (2011) NSW Environment and Heritage <www.environment.nsw.gov.au/.../air/UpperHunterAirQualityData.pdf> at 20 October 2012.

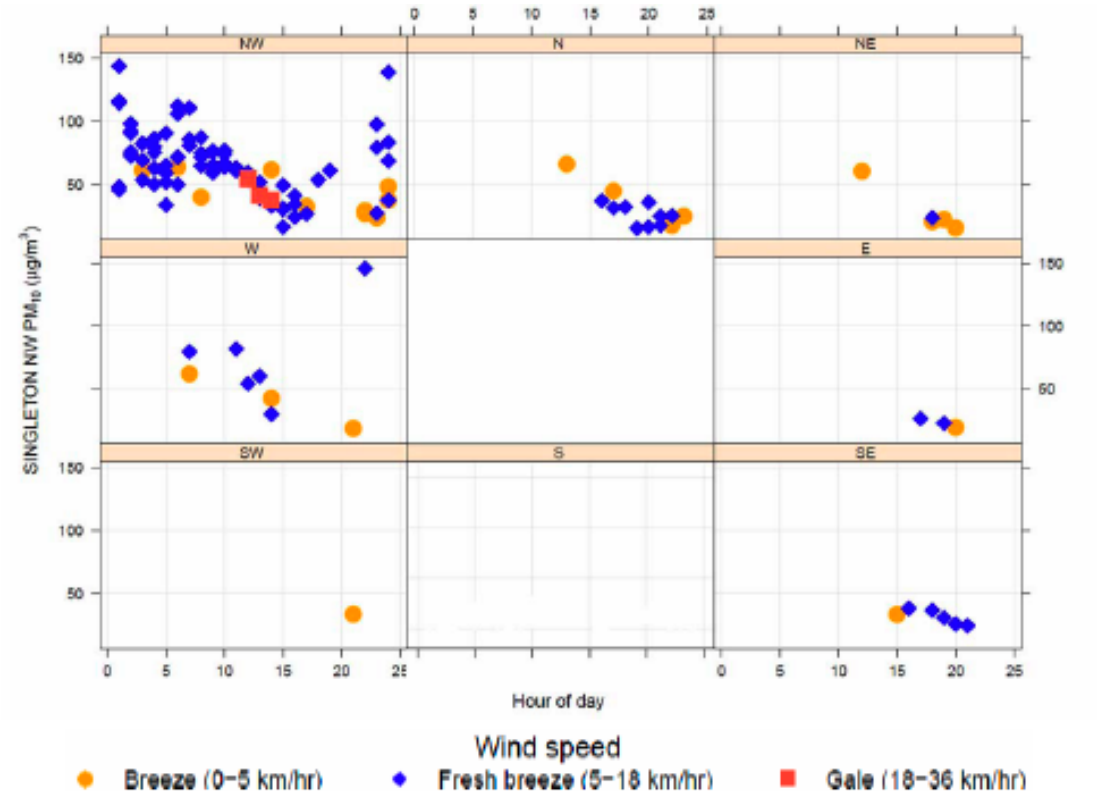

Figure 6 PM_{10} concentrations greater than 50µg/m^3 in Singleton as a function of wind direction.[181]

[181] *Upper Hunter Air Quality Monitoring Network (UHAQMN) Interim Performance Report: December 2010 – August 2011* (2011) NSW office of Environment and Heritage <http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf> at 20 October 2012, 19.

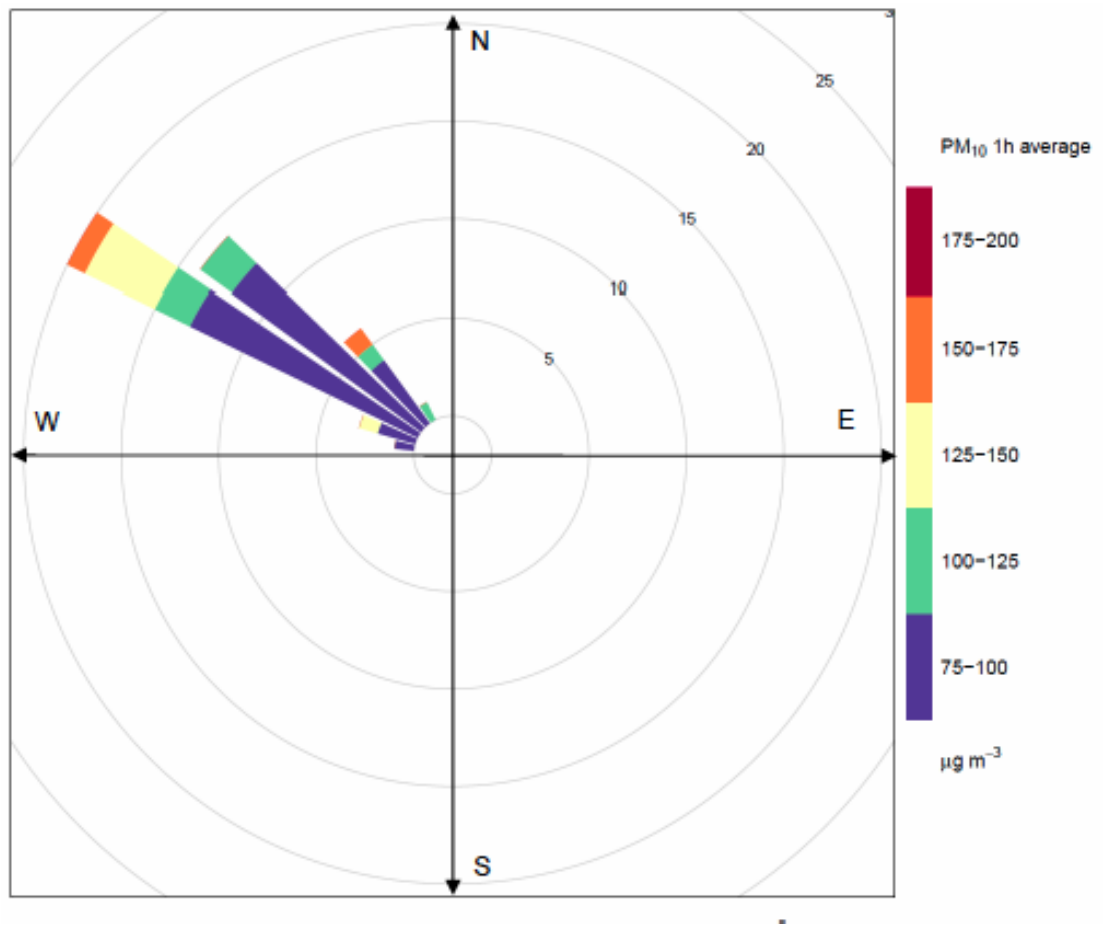

Figure 7 All PM_{10} in Singleton readings greater than 75 µg/m^3 are associated with north-westerly winds.[182]

[182] Ibid, 20.

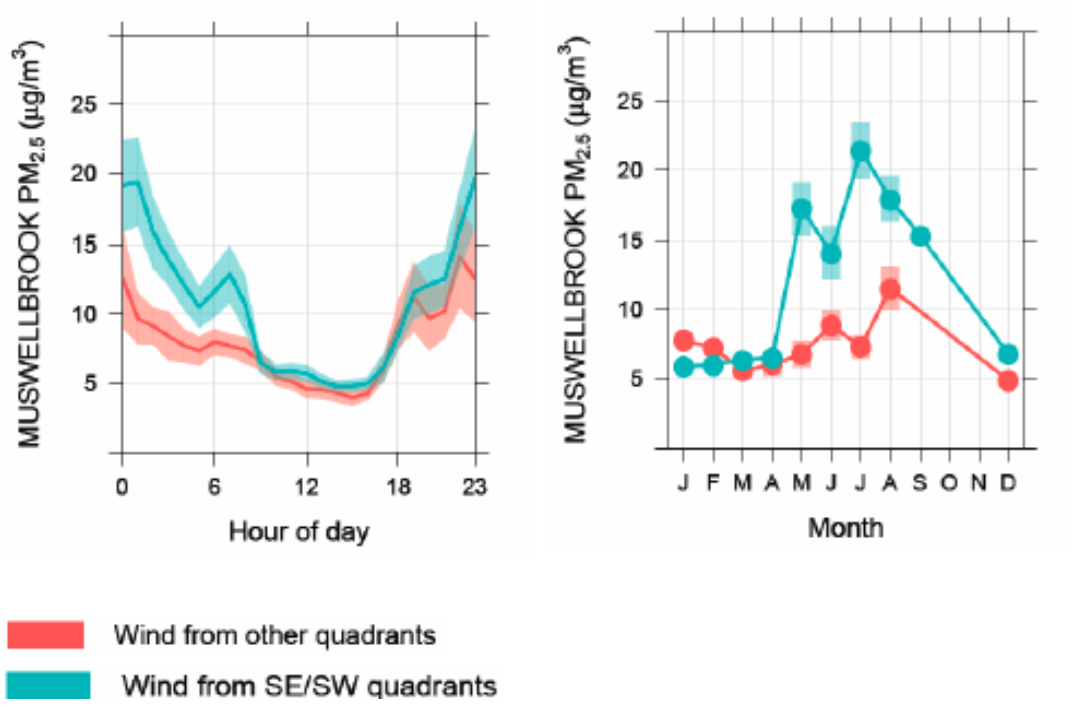

Figure 8[183] **Musswelbrook daily and yearly $PM_{2.5}$ concentrations**.

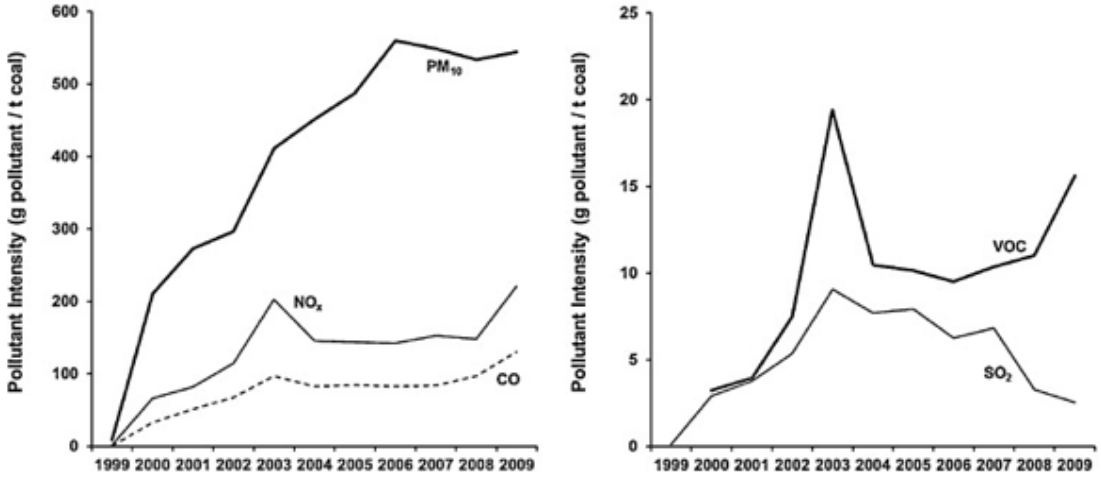

Figure 9[184] **long-term pollution increase the Hunter valley.**

[183] Ibid, 25.

[184] Weng *et al.,* 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 89.

Mackay

The Bowen Basin coalfields – representing 85% of the Queensland coal industry - sit in the hinterlands of West Mackay. The average PM_{10} concentrations for Mackay in 2011 were greater than in the Brisbane CBD. For instance, the annual average 24-hour PM_{10} maximum between February 2011 and January 2012 in Mackay was 33.05 µg/m^3.[185] Although this is below the air quality standard, it was significantly greater than Brisbane's 27.36 µg/m^3 average.[186] Thus, Mackay's PM_{10} concentrations were 20.7% greater than Brisbane. The air quality standard was breached in October 2011 in Mackay, with the monthly maximum 24-hour average PM_{10} concentration recording 65.8 µg/m^3 of PM_{10}. In all other months the PM_{10} was well within the air quality standard (Table 4).[187] It's clear from this data that although the PM_{10} concentrations in Mackay are within the nationally prescribed limit, they are much worse than in Brisbane. Alarmingly, $PM_{2.5}$ was not monitored in Mackay.[188] Why is unclear.

Site	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Mackay												
West Mackay												
Maximum 24-hour	29.4	23.9	23.7	25.2	28.0	31.1	39.2	41.8	65.8	36.8	29.6	22.2
% I.A.	95	90	97	91	93	97	94	85	99	99	95	96

% I.A. indicates instrument availability. - indicates less than two-thirds of the data are available.

n.d. indicates no data are available.

The *National Environment Protection (Ambient Air Quality) Measure* air quality standard for PM_{10} is a 24-hour average of 50µg/m^3 (not to be exceeded on more than five days per year).

Table 4[189] Monthly PM_{10} concentrations in Mackay.

[185] *Air Quality Bulletin Central Queensland* (January 2012) Queensland Department of Environment and Resource Management <http://www.ehp.qld.gov.au/air/documents/air-bulletins/cq12jan.pdf> at 20 October 2012, 18.

[186] Ibid 16.

[187] Ibid 18.

[188] Ibid 1.

[189] Ibid 18.

Moranbah

Moranbah also sits in Queensland's Bowen Basin. Like Mackay, the average PM_{10} concentrations for Moranbah in 2011 were greater than Brisbane's CBD, however the margin of difference was far greater. The annual average 24-hour PM_{10} maximum between February 2011 and January 2012 in Moranbah was 41.75 $\mu g/m^3$.[190] This, again, is below the national standard, however, it is 14.36 $\mu g/m^3$, or 52% greater than the Brisbane CBD's average over the same period.[191] Furthermore, in October, November, December 2011 and January 2012, the monthly maximum 24-hour average concentrations of PM_{10} in Moranbah exceeded the national air quality standard (see Table 5),[192] while for the same period in the Brisbane CBD, it was only exceeded once.[193] Again, $PM_{2.5,}$ was not monitored at Moranbah.[194]

Site	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Moranbah												
Moranbah‡												
Maximum 24-hour	n.d.	-	17.4	23.1	25.1	24.6	32.2	43.9	67.6	55.1	53.0	75.5
% I.A.	0	59	99	96	94	95	93	100	100	99	99	97

% I.A. indicates instrument availability. - indicates less than two-thirds of the data are available.
n.d. indicates no data are available.

‡ PM_{10} monitoring at Moranbah commenced in March 2011.

The *National Environment Protection (Ambient Air Quality) Measure* air quality standard for PM_{10} is a 24-hour average of 50$\mu g/m^3$ (not to be exceeded on more than five days per year).

Table 5[195] PM_{10} concentrations in Moranbah.

[190] Ibid 20.
[191] *Air Quality Bulletin Central Queensland* (January 2012) Queensland Department of Environment and Resource Management <http://www.ehp.qld.gov.au/air/documents/air-bulletins/cq12jan.pdf> at 20 October 2012, 16.
[192] Ibid 20.
[193] Ibid 16.
[194] Ibid 1.
[195] Ibid 20

Latrobe Valley

Latrobe valley provides more than 90% of Victoria's electrical power requirements with its coal-fired power stations.[196]It also has a number of open cut coal-mines.[197] Despite this, there is only one monitoring station in Latrobe Valley, positioned in Traralgon. The concentrations of PM_{10} in Latrobe Valley exceed the national benchmark on a number of days in 2011 (the exact number of days is not revealed in the public reporting).[198] Despite these exceedences, Latrobe met its annual NEPM goal in 2011 of no more than 5 exceedence days per year above 50 $\mu g/m^3$. Yet, in the years 2003, 2006, 2007, 2008 and 2009, it failed to meet this goal.[199] Latrobe Valley thus has the worst history of PM_{10} air pollution in Victoria.[200] In 2010, the PM_{10} concentration in Traralgon was exceeded on three days, however it was also exceeded four imes on Footscray.[201] Furthermore, Latrobe Valley recorded the highest maximum 24-hour PM_{10} concentration of any site in Victoria in 2010.[202] Yet, the inferred cause this was bushfire.[203] Despite the exceedences, compliance with the NEPM goals was met at Latrobe in 2010.[204] Alarmingly, $PM_{2.5}$ was again not measured in the Latrobe valley at all.

---

[196] P 113 GHD Pty Ltd. *Latrobe Valley 2100 Coal Resources Project* (2005) Department of Primary Industries<http://www.ret.gov.au/resources/Documents/Industry%20Consultation/Regional%20Minerals%20Program/Latrobe%20Valley%202100%20Coal%20Resources%20Project/RMP_Latrobe_Valley_2100_Coal_Resources.pdf> at 20 October 2012, 113.

[197] Ibid.

[198] *Air monitoring report 2011 – Compliance with the National Environment Protection (Ambient Air Quality) Measure* (2011) Environmental Protection Agency Victoria <http://epanote2.epa.vic.gov.au/EPA/publications.nsf/2f1c2625731746aa4a256ce90001cbb5/785bd9d0eb1f0b1cca2579fe0013c3bd/$FILE/1483.pdf> at October 2012, 12.

[199] Ibid 10.

[200]Ibid.

[201] Ibid.

[202] Ibid.

[203] Ibid 16.

[204] Ibid 10.

It is important to note that in Latrobe valley there is only one monitoring station at Traralgon, and its data is used to generalise air quality for the entire region. There are no monitoring stations in the towns that are arguably at greater risk from air pollution due to their closer proximity open-cut coal mines such as Yallourn, Morwell and Newborough.

Review of the Pollution Standards

PM is a non-threshold pollutant because there is no safe level of exposure,[205] thus, it requires management that achieves the lowest possible exposure practicable.[206]The correlation between PM and mortality occurs at concentrations that are below the current ambient air quality standards.[207] So even exposure to what is considered low concentrations of PM is, are fact, quite deleterious. This comes as surprise considering that the primary objective for setting the pollution threshold standards is to *'prevent adverse health impacts from air pollution, and to provide adequate protection for all Australians.'*[208]

A 13 ½-year study into mortality from extreme PM_{10} concentrations due to bushfire smoke and dust storms events in Sydney, found that the 99th percentile of daily PM_{10} concentration between 1994 and 2007 was 47.3 µg/m^3 and above (Fig. 10).[209] This 99th percentile of data distribution was correlated with a 5% increase in mortality

---

[205] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 1.
[206] John Todd, *Submission on the AQ NEPM Discussion Paper* (2010) Coag Standing Council on Environment and Water http://www.scew.gov.au/archive/air/pubs/aaqnepm/submissions/submission_aaq__j_todd.pdf at 20 October 2012.
[207] Valberg, 'Is PM more toxic than the sum of its parts? Risk-assessment toxicity factors vs. PM-mortality "effect function' (2004) 16 *Inhal Toxicol* 19, 19.
[208] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 4.
[209] Johnston *et al.,* 'Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994 – 2007' (2011) 111 *Environmental Research* 811, 811.

following smoke events and a 15% increase in mortality following dust events.[210] This suggests that the current threshold standard for PM_{10} is so high that it includes extreme pollution events within the ample boundaries of what the government considers safe. Put more simply, what Johnston *et al.* consider 'extreme,'[211] State and Territory Governments consider 'good'[212] and the Federal Government considers below the *'maximum acceptable concentration.'*[213] No elevated mortality was associated with PM_{10} concentrations in the 95th percentile, or 32.0 µg/m^3.[214]

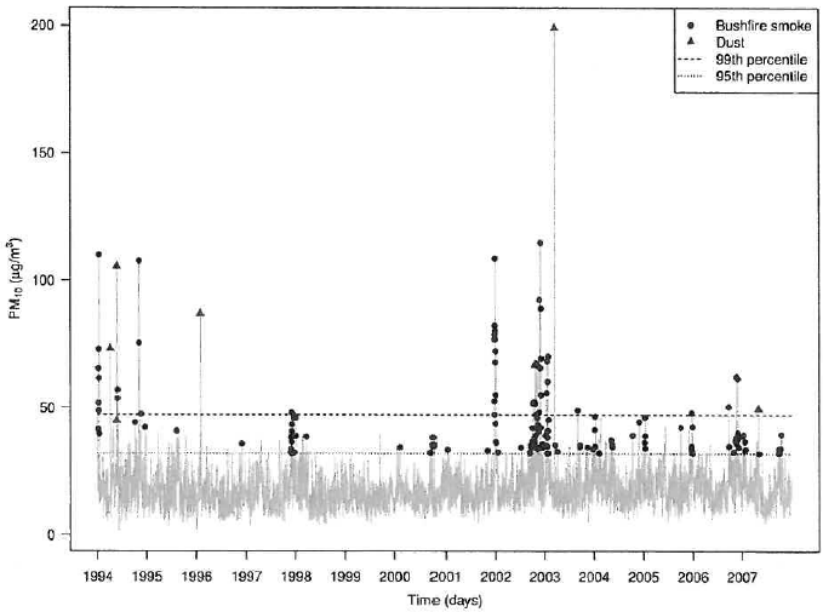

Figure 10 Sydney's maximum PM_{10} concentrations between 1994 and 2007.[215]

---

[210] Ibid.

[211] Ibid.

[212] *EPA Air Quality Hourly Update* (2012) Victorian Environmental Protection Agency <http://www.epa.vic.gov.au/Air/Bulletins/aqbhour.asp> at 20 October 2012; *Search Air Quality Data* (2012) NSW Environment and Heritage <http://www.environment.nsw.gov.au/aqms/search.htm>at 20 October 2012; *Queensland Air Quality Index* (2012) Queensland Government Department of Environment and Heritage Protection <*http://www.ehp.qld.gov.au/air/monitoring/measuring/air-quality-index.html*> at 20 October 2012.

[213] *Queensland Air Quality Index* (2012) Queensland Government Department of Environment and Heritage Protection <*http://www.ehp.qld.gov.au/air/monitoring/measuring/air-quality-index.html*> at 20 October 2012.

[214] Johnston *et al.,* 'Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994 – 2007' (2011) 111 *Environmental Research* 811, 815

[215] Johnston *et al.,* 'Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994 – 2007' (2011) 111 *Environmental Research* 811, 813.

Some argue that the national PM_{10} threshold is appropriate, but the allowable number of annual exceedences should reflect only natural exceedences from bushfires.[216] A review of historical bushfire data will tell us if five annual exceedences are excessive.[217] However, allowing for natural exceedences can create room for misuse of the terminology.[218] It is also argued that only having 24-hour standards for PM_{10} is unacceptable, and an annual standard needs to be included into the NEPM, otherwise populations are at risk of unacceptable long-term exposures, which are more harmful than short term exposures.[219] Furthermore, as the health impacts of $PM_{2.5}$ are much worse than PM_{10},[220] there is an exigency to transition to both a short and long-term *compliance* standard, rather than the present *advisory* standard.

Some researchers argue the positive correlation between $PM_{2.5}$ and elevated mortality is weak, and findings are extrapolated to all forms of $PM_{2.5}$, failing to account for the 'remarkably diverse' composition of particles within the $PM_{2.5}$ class.[221] Buringh impugns the association between $PM_{2.5}$ and poor health, arguing that current US standards for ambient $PM_{2.5}$ (higher than Australian standards) are adequate.[222] Interestingly, he doesn't question the relationship between PM_{10} and mortality; probably because PM_{10} has been know to science for longer so more research

---

[216] John Todd, *Submission on the AQ NEPM Discussion Paper* (2010) COAG Standing Council on Environment and Water http://www.scew.gov.au/archive/air/pubs/aaqnepm/submissions/submission_aaq__j_todd.pdf at 20 October 2012.
[217] Ibid.
[218] Ibid.
[219] Ibid
[220] John Todd, *Submission on the AQ NEPM Discussion Paper* (2010) Coag Standing Council on Environment and Water http://www.scew.gov.au/archive/air/pubs/aaqnepm/submissions/submission_aaq__j_todd.pdf at 20 October 2012; Mallory Barnes, interview with Prof. Krassi Rumchev (conducted via telephone between Canberra and Perth at 12.00pm AESD on 12 September 2012).
[221] Buringh and Opperhuizen 'What'sWrong with the NationalAmbientAirQualityStandard (NAAQS) for FineParticulateMatter ($PM_{2.5}$)?' (2002) 37 *Regul Toxicol Pharmacol.* 411, 411.
[222] Ibid.

supports the relationship. However, there is still strong support for the association between elevated $PM_{2.5}$ and acute and chronic cardiovascular and lung cancer mortality.[223] Importantly, it has been shown by Laden *et al.* that reduced $PM_{2.5}$ concentrations result in reduced mortality; a 0.73% decrease in mortality for every 10 $\mu g/m^3$ decrease in $PM_{2.5}$. The biggest decreases in mortality in this multi-city study were in cities with the largest reduction in $PM_{2.5}$.[224]

The World Health Organisation bases its air quality standards entirely on health considerations and does not take into account social and economic issues.[225] Previously, WHO encouraged countries to take such matters into consideration when setting their own standards,[226] however, recently it has been urging nations to reduce their PM_{10} standards to 20 $\mu g/m^3$ to avoid poor public health outcomes.[227] This is 60% lower than the Australian standard. The Australian methodology to setting air quality standards considerers matters extraneous to human health concerns, including technical, economic, political and cultural issues.[228] Given this plethora of concerns that NEPC can take into account in setting pollution standards, it is likely that the publics' need for a purely health-based, and therefore conservative PM standard, is obfuscated by the need to consider scattered and diverse interests.

---

[223] Laden *et al.,* 'Reduction in Fine Particulate Air Pollution and Mortality Extended Follow-up of the Harvard Six Cities Study' (2006) 173 *Am. J. Respir. Crit. Care Med* 667, 669.
[224] Ibid.
[225] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 7.
[226] Ibid.
[227] World Health Organisation 'WHO challenges world to improve air quality' (Press Rlease, 2006) <http://www.who.int/mediacentre/news/releases/2006/pr52/en/index.html> at 20 October 2012.
[228] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 10-11.

There is strong evidence for a revised standard for PM pollution aimed exclusively at reducing population exposure to improve health outcomes. A review of 13 Australian studies on the public health impacts of air pollution found that:

> *'The weight of Australian studies reviewed indicated that air pollutants {including PM), even at levels lower than the current national standards, were associated with an increase in respiratory and cardiovascular mortality and hospital admissions.'*[229]

The CSIRO also concludes that:

> *'At present, a large body of evidence demonstrates that air pollution, even at concentrations below the current air quality standards, is associated with adverse health effects in humans.'*

NEPC should heed the number one recommendation of the 2011 Review Report of the AAQNEPM which stated the goal is to *'minimise the risk from adverse health impacts from exposure to air pollution for all people wherever they may live.'*[230] This includes those regional Australians who, by virtue of living in close proximity to coal-operations, disproportionately bear the health burden of higher PM exposures. In establishing threshold standards, NEPC is required to have regard to the Intergovernmental Agreement on the Environment (IGAE),[231] and the objective of the IGAE is that *all* people are protected *equally* from pollution.[232] In Australia, the

---

[229] Howie *et al.* 'Air Pollution and Cardiopulmonary Diseases in Australia: A Review of Epidemiological Evidence' (2005) 5 *Environmental Health* 23, 23.
[230] *National Environment Protection (Ambient Air Quality) Measure Review* (2011) National Environmental Protection Council <http://www.ephc.gov.au/sites/default/files/AAQ%20NEPM%20review%20report_0.pdf> at 20 October 2012, 2.
[231] *National Environmental Protection Council Act 1994 (Commonwealth)* s 64.
[232] Intergovernmental Agreement on the Environment; and *National Environment Protection (Ambient*

largest sources of pollution are outside of capital city airsheds,[233] in places like Latrobe, Valley, the Hunter Valley and Bowen Basin. These places make up only a small fraction of our population but incur an enormous cost in reduced health. A significantly lower standard, at least in line with the WHO standard, must be set if we are to protect our *entire* population from the adverse health affects of air pollution. NEPC must enact this reduction urgently, as the mortality effect of PM concentrations is reversible over time periods as short as a year.[234]

Summary

PM concentrations are significantly higher in Mackay, Moranbah, the Upper Hunter Valley and Latrobe Valley compared to major Australian urban centres. It is highly likely this is because of their proximity to coal operations. But despite being exposed to much higher pollution loads, the concentrations are consistently below the national threshold standards. However, there is strong evidence that the below-threshold-levels to which these regional communities exposed, are still very harmful. There is an urgent need to lower the national PM_{10} threshold, and to set a $PM_{2.5}$ compliance standard. There is also an alarming absence of $PM_{2.5}$ monitoring in many of the communities and the quality of monitoring and reporting appears to vary considerably between States, with NSW having the highest standard. These differences in reporting, and the lack of a centralised database, make comparing regions in different States very challenging.

Air Quality) Measure Review (2011) National Environmental Protection Council <http://www.ephc.gov.au/sites/default/files/AAQ%20NEPM%20review%20report_0.pdf> at 20 October 2012, 2.

[233] Dennekamp and Carey 'Air quality and chronic disease: why action on climat e change is also good for health' (2010) 21 *NSW Public Health Bulletin*, 115, 115.

[234] Laden *et al.,* 'Reduction in Fine Particulate Air Pollution and Mortality Extended Follow-up of the Harvard Six Cities Study' (2006) 173 *Am. J. Respir. Crit. Care Med* 667, 667.

Chapter IV

This chapter aims to outline a spectrum of possible solutions to the problem of high PM exposures in communities proximal to coal operations. PM pollution is unique because the size of the benefit gained from abatements is disproportionately large, and the costs can be relatively low. However the biggest obstacle to PM reductions are in the economic interdependence of the coal industry and State Governments.

Recommendations

Current initiatives to limit pollution are inadequate. In NSW, the most progressive state, all coal operations in the Upper Hunter are required to prepare a report comparing their practice with international best practice, report on the practicability of implementing these practices and prepare a timetable for the implementation of practicable measures.[235] This essentially leaves pollution control to the unabated discretion of the polluters. This policy is so impotent and tokenistic that it's insulting. Furthermore, requiring mining companies to purchase areas affected by pollution, as suggested by the NSW Government,[236] is clearly not a viable option as - in the case of the Upper Hunter - it would require purchasing entire shires such as Muswellbrook and Singleton.

Unsurprisingly, these ineffective policies have allowed an increase in pollution load with every tonne of coal produced.[237] Obviously, more substantial measures need to

---

[235] *Upper Hunter Air Quality Monitoring Network (UHAQMN) Interim Performance Report: December 2010 – August 2011* (2011) NSW office of Environment and Heritage <http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf> at 20 October 2012, 12, 27.

[236] *Draft Strategic Regional Land Use Plan* (2012) NSW Government <haveyoursay.nsw.gov.au/document/show/192> at 20 October 2012.

[237] Weng, Mudd, Martin and Boyle, 'Pollutant loads from coal mining in Australia: Discerning trends

be taken. The AAQNEPM does not provide any mechanism for reducing exposure levels. The following is a brief list of 16 potential initiatives that could be implemented to drive down PM concentrations arising from coal operations and thus ameliorate the burden of PM exposure. These initiatives range from small, technical and regulatory modifications, to fundamental, economy-wide transitions; the latter options exacting increasing amounts of political will in order to materialize, but will likely have the greatest public utility:

1. **Cover coal rail wagons, as a large amount of emissions exposure occurs during transportation.**[238]

2. **Degraded land must be rehabilitated swiftly.**[239]

3. **Coal-power generators must not double as incinerators.** Power stations such as Liddell in the Upper Hunter incinerate hazardous waste despite that they don't operate at the requisite temperatures required to break the waste down waste safely.[240]

---

from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 78.

[238] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

[239] *Draft Strategic Regional Land Use Plan* (2012) NSW Government <haveyoursay.nsw.gov.au/document/show/192> at 20 October 2012.

[240] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

4. **Monitor $PM_{2.5}$ more thoroughly.** The Australian monitoring system is criticized for it's 'deadly uselessness' because it focuses on PM_{10} rather than more lethal PM $_{2.5}$.[241] This is surprising considering that $PM_{2.5}$ is the only pollutant under AAQNEPM to have an advisory standard instead of a compliance standard. [242] This advisory reporting standard provides a threshold against which health risks to the population arising from exposure to the less known $PM_{2.5}$ can be assessed,[243] so that enough information can be gathered to inform the setting of a $PM_{2.5}$ compliance standard.[244] PM 2.5 has been at the advisory reporting standard stage since the inception of the AAQNEPM in 1998. We now know much more about $PM_{2.5}$ than we did in 1998 but we still don't know enough to set compliance standard. More extensive monitoring of $PM_{2.5}$ would facilitate this step.

5. **NEPC should alter the AAQNEPM to mandate that State and Territory Governments install a high density of monitoring stations in communities that are at higher risk of exposure to PM due to their close proximity to coal operations.** The AAQNEPM promotes a monitoring system that is focused on the total amount of pollution rather than the cause,[245] and the size of the population at risk rather than size of the pollution concentration.[246] Thus, the existing monitoring sites may not be representative of the elevated exposures experienced in close proximity to coal operations.[247] Furthermore, the monitoring commitment

---

[241] Ibid.
[242] National Environmental Protection Council 'Methodology for setting air quality standards in Australia' (2011)Part A, 3.
[243] Ibid.
[244] Ibid.
[245] Weng, Mudd, Martin and Boyle, 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 78.
[246] National Environment Protection (Ambient Air Quality) Measure (1998) cl 14.
[247] *National Environment Protection (Ambient Air Quality) Measure Review* (2011) National Environmental Protection Council <http://www.ephc.gov.au/sites/default/files/AAQ%20NEPM%20review%20report_0.pdf> at 20

can vary considerably depending on the resources and the willingness of the jurisdiction.[248] The 14 additional pollution-monitoring stations in the Upper Hunter that the NSW Government were compelled to install due to community pressure, rather than being obliged by the AAQNEPM, have provided invaluable data about the sources of pollution and the higher exposure levels.

6. **Include point source data into the public databases on each State or Territory monitoring website.** Coalmines and coal-powered generators are obliged to monitor their own emissions as a condition of their licenses,[249] yet this point-source data is not incorporated because the AAQNEPM stipulates that only areas representative of the general air quality experienced by the population will be subject to monitoring.[250] However, in regional communities that are proximal to coal operations, the driver of pollution levels is almost always the coal operations[251] so the public deserves to be informed.

7. **NEPC must commission an independent, Australia-wide study into the public health risks associated with living in proximity to coal operations.** Residents

October 2012, 2, 32 -33.

[248] National Environment Protection (Ambient Air Quality) Measure (1998) Schedule 4 cl 2.

[249] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.

[250] National Environment Protection (Ambient Air Quality) Measure (1998)cl 13(2); Mallory Barnes, interview with the Department of Sustainability, Environment, Water, Population and Community (Interview in the office of Senator Larissa Waters at Australian Parliament House, Canberra conducted on 19 September 2012).

[251] *Upper Hunter Air Quality Monitoring Network (UHAQMN) Interim Performance Report: December 2010 – August 2011* (2011) NSW office of Environment and Heritage <http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf> at 20 October 2012, 12.

in these exposed communities perennially articulate their general experience of poor health, but their concerns are quashed when placed against the might of 'State-sponsored science' that aims to obfuscate the connection between the coal industry and poor health.[252] A thorough and independent study of the communities would remedy this knowledge imbalance.

8. **An independent assessment into the health impacts of any proposed coal operation must occur as a condition of approval.[253]**

9. **Considering that these regional communities overwhelmingly bear the health costs arising from coal operations, they are entitled to a greater level of procedural involvement in the decision-making processes.** This could be affected by requiring community consultation before the approval stage, such as including a community vote as a condition of approval on new coal operation.

10. **Lower the ambient air quality benchmark for PM_{10} to 20 µg/m^3.**

11. **An independent watchdog should be created to monitor the industry's emissions and disincentivise breaches of pollution conditions attached to**

[252] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.
[253] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).
[253] *Draft Strategic Regional Land Use Plan* (2012) NSW Government <haveyoursay.nsw.gov.au/document/show/192> at 20 October 2012.

mining licenses. This watchdog should have the power to temporarily suspend operations, or impose punitive monetary sanctions.[254] Between 2000-2008 there were over 3000 license breaches in NSW and only six cases went to court.[255] In the Upper Hunter, 27 coalmines made 1041 license breaches between 2000-2006.[256] This can occur because the AAQNEPM stipulates that State Governments can only monitor ambient air pollution that is representative of the general community experience, not peak sources,[257] while peak sources are monitored by the emitters themselves. This creates a dangerous knowledge imbalance where those who are responsible for imposing a negative externality possess a monopoly on information about it.

12. Lower the point source pollution limits for coalmines and coal-powered generators in their licensing conditions to avoid pollution exceedences in surrounding communities.

13. Only approve underground coalmines and place a moratorium on open-cut coal mining as it generates significantly higher pollution loads.[258]

14. Include in mining license agreements a requirement that companies are liable

---

[254] Cronshaw, 'Air pollution and you' (2009) *Herald,* 2 January, 3.
[255] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.
[256] Ibid.
[257] National Environment Protection (Ambient Air Quality) Measure (1998) cl 14.
[258] Weng, Mudd, Martin and Boyle, 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 86.

to compensate individuals for disease arising from the operation of mining activities. Or, alternatively, put a levy on all coal operations to compensate the public for the increased burden on its public health facilities.

15. **Implement an Emissions Trading Scheme (ETS) applying exclusively to coal operations, similar to the US model for SO_2.** Companies would purchase the right to emit a specific amount of PM, and if they exceed their allocation, they would have to purchase permits from companies that abate their emissions.[259] The US ETS of 1990 was, and continues to be, extremely successful in limiting and reducing the burden of SO_2 and Acid rain in America.[260] So successful was the program that SO_2 emissions were reduced by 50% of the 1980 levels faster than expected and below forecast costs.[261] The SO_2 market is now worth about $4 billion a year.[262]

It must be remembered that public health impact of particular coal operation will be substantially affected by its climatic context.[263] Thus, similar operations in different climates may generate vastly different amounts of dust.[264] In order to maximize efficiency of a pollution abatement strategy, it must be designed to match the specific climatic conditions in which it operates. It also mustn't be forgotten that small, low-

[259] Richrd Eckard, *Emissions Trading – a challenge or opportunity for the Dairy Industry?* (2008) University of Melbourne http://www.greenhouse.unimelb.edu.au/pdf_files/ADC08EmissionsTrading.pdf at 20 October 2012.
[260] Ibid.
[261] Acid Rain Program 2007 Progress Report (2009) *Clean Air Markets - Air & Radiation US EPA* *http://www.epa.gov/airmarkt/progress/arp07.html* at 20 October 2012
[262] Richrd Eckard, *Emissions Trading – a challenge or opportunity for the Dairy Industry?* (2008) University of Melbourne http://www.greenhouse.unimelb.edu.au/pdf_files/ADC08EmissionsTrading.pdf at 20 October 2012.
[263] Fact Sheet: Dust Monitoring, Sources and Types of dust from mining (2012) Environmnetal Defender's Office http://www.edo.org.au/edonsw/site/factsh/fs04_7.php at 20 October 2012.
[264] Ibid.

cost changes in practice can make disproportionate changes in pollution levels. For instance, increasingly stringent diesel fuel standards have brought about dramatic decreases in national SO_2 levels.[265]

By far, the biggest barrier to an adequate solution is the economic interdependence of State Governments and coal corporations, resulting in a lack of political will to risk endangering the economic benefits they reap.[266] This is similar to the issue described by Bourdiue, in which the community struggles against corporations and governments over who should bear the cost of the health risks arising from air pollution.[267] This sentiment was echoed by a leaked NSW DECC draft document which stated that while the NSW Coal industry reaped $8.5 billion between 2005-6, the social and environmental costs should not be shifted onto the taxpaying community.[268] Furthermore, the majority of the $1.3 billion in NSW government royalties in 2009-10 was generated from just two, small shires: Muswellbrook and Singleton.[269] A similar disparity occurs in Victoria with Latrobe Valley, and Queensland, with the Bowen Basin. This disparity in the distribution of costs was lamented in the Herald:

> *'Cynics in the Hunter have often wondered if the Government – which benefits to the tune of several hundred million dollars a year from coalmining – may not want to examine the subject too closely. Calls for a health study of those*

[265] Weng, Mudd, Martin and Boyle, 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 89.
[266] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.
[267] Bourdieu, 'Practical Reason: On the Theory of Action' (1989) *Stanford University Press, Stanford.*
[268] Cronshaw, 'Air pollution and you' (2009) *Herald,* 2 January, 3.
[269] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.

affected by the immense dust output of the Hunter mines have been ignored. So have requests for an Upper Hunter office of the Environment Protection Authority…The Government doesn't argue against these calls: it just ignores them and keeps banking its royalty cheque.'[270]

Or as Steenis pithily stated:

'Levers of corporate and political power are positioned against the interest of the people'[271]

Thus, there is a utilitarian dilemma whereby the economic benefit of the majority precedes the need to remedy the corollary health risk that economic activity has on a small minority. This is also called distributive environmental injustice: when a small subset of the population is impacted disproportionately by environmental problems.[272] Should this large health risk to these pollution exposed communities outweigh the marginal economic benefit enjoyed by the rest? Is it fair to allow these electorally insignificant communities to become 'sacrifice zones' for the larger population?[273]

These regional communities also suffer from procedural injustice, whereby they are isolated from the decision-making processes that affect them.[274] As has been

[270] Herald (editorial). 'What about an honest try: Stopping the spin' (2008b) *Herald,* 2 August, p. 18.
[271] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).
[272] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.
[273] Lloyd-Smith, Bell (2003) 'Toxic disputes and the rise of environmental justice in Australia.' (2003) 9 *International Journal of Occupational and Environmental Health*
14, 21-3.

demonstrated, a common theme in these disproportionately affected regional communities is that State Governments systematically ignore their attempts to have their concerns acknowledged.[275] The benchmark of a successful strategy to remedy pollution issues faced by these regional communities will be if *both* forms of injustice are eliminated.

Ultimately, the solution lies is in shattering the political intransigence that perennially preferences the short-term economic benefits generated by the coal industry royalties, over the long-term health of the regional communities surrounding the industry.[276] There is strong political support for the coal industry in Australia because of the export revenues it generates and the reliance of the population on coal-fired power.[277] Thus, a legitimate solution to this emerging public health crisis is unlikely if we fail to make the fundamental shift to renewable, emissions-free, energy sources.

Conclusion

It has become clear that PM exposure from coal operations is 'an assault on public health.' In Australia, it is those communities who live closest to coal mining operations and coal-powered generators who are exposed to the highest levels of PM pollution. In order to achieve the maximum health benefit, reduction initiatives should be prioritized to these communities.

[274] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.
[275] Ibid.
[276] Ibid.
[277] Weng et al, 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 78.

Studies have shown that because there is no safe level of PM exposure, any reductions in PM exposure will significantly reduce population morbidity and mortality.[278] Therefore, COAG must enact some of the aforementioned initiatives because, relative to the tremendous social benefit gained from PM reductions, the cost is low and the implementation painless. Furthermore, these reductions in PM will not only ameliorate the burden of chronic disease and mortality, they will also have the added benefit of reducing the risk of climate change.[279]

The economic value of coal is vastly altered when one takes into account the negative external costs of reduced public health that the coal industry silently invoices to the public. The interdependence of State Governments and coal corporations - whereby Governments rely on mining royalties, and the coal industry on access to minerals – operates to disenfranchise those communities that are most heavily oppressed by the toxic relationship. It will take strong political will to realize that all *'people have the fundamental right to be protected from air-pollution'*[280] including the minorities living nearest to the source of emissions.

This paper has looked exclusively at the public health impacts of air pollution caused by coal operations. It hasn't taken into account the health impacts of coal mining from water contamination or psychological damage. Studies have shown that water

---

[278] Dr Nick van Steenis, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012; Dr Nick van Steenis, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

[279] Dennekamp and Carey 'Air quality and chronic disease: why action on climat e change is also good for health' (2010) 21 *NSW Public Health Bulletin*, 115, 114.

[280] Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259, 266.

contamination from coal mining in is associated with cancer.[281] Little study has been done about this in Australia.[282] Even less is understood about the psychological impact of coal mining due to dramatic landscape modification. Recently, the term *solastalgia* was coined to describe the psychological distress experienced when someone's home environment undergoes environmental damage.[283] The term describes the nexus between ecological health and human psychological health, but still not enough is known about the connection between environmental change and clinical conditions such as depression and anxiety related diseases.[284] These are important areas for future research.

8769 words.

[281] Hitt and Hendryx 'Ecological integrity of streams related to human cancer mortality rates' (2010) 7 *Ecohealth* 91, 104.
[282] Weng *et al.,* 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78, 89.
[283] Albrecht *et al.,* 'Solastalgia: the distress caused by environmental change;Environmental Change and Human Health in Upper Hunter Communities of New South Wales, Australia' (2007) 15 *Australas Psychiatry* 95, 95.
[284] Connor *et al.* 'Environmental Change and Human Health in Upper Hunter Communities of New South Wales, Australia' (2004) 1 *Eco Health* 47, 47.

Acknowledgements

Thank you to Caroline Nordang and Senator Larissa Waters for hosting me for 11 weeks. Thank you to Prof Krassi Rumchev and the Department of Sustainability, Environment, Water, Population and Community for answering my questions. Thank you to Elizabeth Beaumont for proof reading my essay.

Bibliography

Articles

Albrecht, Connor, Higginbotham and Sartore, *Solastalgia: The Distress Caused by Environmental Change* (Paper presented at RANZCP Social and Cultural Psychiatry Conference, Cairns, 4-7 Sept 2006).

Albrecht, Sartore, Connor, Higginbotham, Freeman, Kelly, Stain, Tonna and Pollard, 'Solastalgia: the distress caused by environmental change; Environmental Change and Human Health in Upper Hunter Communities of New South Wales, Australia' (2007) 15 *Australas Psychiatry* 95.

Amiot, Tillon, Vaicroze, Aouine and Muir 'Consequences of atmospheric pollution fluctuations in patients with COPD' (2010) 27 *Rev Mal Resp* 907.

Bobak and Leon, 'Air pollution and infant mortality; the effects are specific for respiratory causes in the postneonatal period' (1998) *Epidemiology* 9:S58.

Bourdieu, 'Practical Reason: On the Theory of Action' (1989) *Stanford University Press, Stanford.*

Brook, Rajagopalan, Pope III, Brook, Bhatnagar, Diez-Roux, Holguin, Hong, Luepker, Mittleman, Peters, Siscovick, Smith Jr, Whitsel and Kaufman, 'Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association' (2010) 10 *Circulation* 2231.

Buringh and Opperhuizen ‘What's Wrong with the National Ambient Air Quality Standard (NAAQS) for Fine Particulate Matter ($PM_{2.5}$)?’ (2002) 37 *Regul Toxicol Pharmacol.* 411.

Castelden, Shearman, Crisp and Finch ‘The mining and burning of coal: effects on health and the environment’ (2011) 195 *Medical Journal of Australia* 333, 335.

Castillejos, Borja-Aburto, Dockery, Gold, Loomis, ‘Airborne course particles and mortality’ (2000) 12 *Inhalation Toxicology* 62, 72.

Chi Chen and Lippmann, ‘Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health’ (2009) 21 *Inhalation Toxicology* 1.

Coggon and Taylor ‘Coal mining and chronic obstructive pulmonary disease: a review of the evidence’ (1998) 53 *Thorax* 398.

Cohen, Anderson, Ostro, Pandey, Kryzanowski, Kunzli, Gutschmidt, Pope, Romieu, Samet and Smith ‘Comparative Quantification of Health Crises: Urban Air Pollution’ (2004) *World Health Organisation* 1353.

___, ‘The global burden of disease due to outdoor air pollution’ (2005) 68 *Journal of Toxicology and Environmental Health* 1.

___, ‘Mortality impacts of urban air pollution. In: Ezzati, Lopez, Rodgersand Murray eds. Comparativ quanitification of health risks: global and regional burden of disease attributable to selected major risk factors ’ (2004) Geneva, World Health Organisation Vol 2.

Connor, Albrecht, Higginbotham, Freeman and Smith 'Environmental Change and Human Health in Upper Hunter Communities of New South Wales, Australia' (2004) 1 *Eco Health* 47.

Cronshaw, 'Air pollution and you' (2009) *Herald,* 2 January.

Dennekamp and Carey 'Air quality and chronic disease: why action on climate change is also good for health' (2010) 21 *NSW Public Health Bulletin*, 115.

Dockery and Pope 'Acute respiratory effects of particulate air pollution' (1994) 15 Annual Review of Public Health 107.

Dominici, McDermott, Zerger and Samet, 'On the use of generalized additive models in time-series of air pollution and health'(2002) 159 *American Journal of Epidemiology* 193.

Dominici, Peng, Bell, Pham, McDermott, Zeger and Samet 'Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases' (2006) 295 *Journal of the American Medical Association* 1127.

Van Steenis, Nick, 'Untitled' (Speech delivered at an Experts Forum Hosted by Lock the Gate Alliance, Sydney, 9 March 2011).

Englert, 'Fine particles and human health— a review of epidemiological studies' (2004) 149 *European Congress of Toxicology* 235.

Ezzati, Lopez, Rodgers, Vander Hoorn, Murray and the Comparative Risk Assessment Collaborating Group 'Selected major risk factors and global and regional burden of disease' (2002) 350 Lancet 1347.

GHD Pty Ltd. *Latrobe Valley 2100 Coal*

Halliday, Henry, Hankin and Hensley, 'Increased wheeze but not bronchial hyper-reactivity near power stations' (1993) 47 *Journal of Epidemiology, Community and Health* 282.

Hanninen, Salonen, Koistinen, Berregard and Jantunen, 'Population exposure to fine particles and estimated excess mortality in Finland from an East European wildfire episode' (2008) 19 *J Expo Sci Environ Epidemiol.* 414..

Hendryx and Ahern, 'Mortality Rates in Appalachian Coal Mining Counties: 24 Years Behind the Nation' (2009) 124 *Public Health Reports* 541.

___, 'Relations between health indicators and residential proximity to coal mining in West Virginia' (2008) 98 *American Journal of Public Health* 669.

Hendryx, O'Donnell and Horn, 'Lung cancer mortality is elevated in coal-mining areas of Appalachia' (2008) 62 Lung Cancer 1..

Hendryx, Wolf, Luo and Webb, 'Self-reported cancer rates in two rural areas of West Virginia with and without mountaintop coal mining' (2012) 37 *Journal of Community Health* 320.

Higginbotham, Freeman, Connor, Albrecht, 'Environmental Injustice and Air Pollution in the Hunter Environmental Injustice and Air Pollution in Coal Affected Communities, Hunter Valley, Australia' (2010) 16 *Health & Place* 259.

Hitt and Hendryx 'Ecological integrity of streams related to human cancer mortality rates' (2010) 7 *Ecohealth* 91.

Hoek, Brunekreef, Goldbohm, Fischer and van den Brandt 'Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study' (2002) 360 *Lancet* 1203.

Hong, Leem, Ha and Christiani 'PM10 exposure, gaseous pollutants, in Inchon South Korea' (1999) 107 *Environmental Health Perspectives* 873.

Howie, Tong, Verral, Gerber and Rodney, 'Air Pollution and Cardiopulmonary Diseases in Australia: A Review of Epidemiological Evidence' (2005) 5 *Environmental Health* 23.

Johnston, et al., 'Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994 – 2007' (2011) 111 *Environmental Research* 811.

Katsouyanni, et al., 'Confounding and effect modification in the short-term effects of ambient particles on the total mortality: results from 29 European cities within the APHEA2 project' (2001) 12 *Epidemiology* 521.

Kleinerman et al., 'Lung cancer and indoor exposure to coal and biomass in rural China' (2002) 44 *Journal of Occupational Environmental Medicine* 338.

Krewski et al., 'Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of particulate air pollution and mortality: a special report of the institute's Particle Epidemiology Reanalysis Project' (2000) *Health Effects Institute* 11 – 31.

Kwon, Cho, Chun, Lagarde, Pershagen, 'Effects of the Asian dust events on daily mortality in Seoul, Korea' (2002) 90 *Environmental Research* 1.

Laden, Schwartz, Speizer and Dockery ‘Reduction in Fine Particulate Air Pollution and Mortality Extended Follow-up of the Harvard Six Cities Study’ (2006) 173 *Am. J. Respir. Crit. Care Med* 667.

Laney, Wolfe, Petsonk and Halldin, ‘Pneumoconiosis and advanced occupational lung disease among surface coal miners - 16 states, 2010-2011’ (2012) 16 *MMWR* 431.

Lave and Seskin ‘An analysis of the of the association between US mortality and air pollution’ (1973) 62 *Journal of American Statistical Association* 342.

Li *et al*., ‘Temperature Modifies the Effects of Particulate Matter on Non-Accidental Mortality: A Comparative Study of Beijing, China and Brisbane, Australia’ (2012) 2 *Public Health Research* 21.

Lissowska *et al*., ‘Lung Cancer and Indoor Pollution from Heating and Cooking with Solid Fuels’ (2005) 162 *American Journal of Epidemiology* 326.

Loomis *et al*., ’Air pollution and infant mortality in Mexico City (1999) 10 *Epidemiology* 128.

Morgan, Corbet, Wlodarczyk and Lewis, ‘Air pollution and daily mortality in Sydney, Australia, 1989 through 1993’ (1998) 88 *American Journal of Public Health* 759.

National Environmental Protection Council, *Methodolog for setting air quality standards in Australia* (2011)Part A.

Ostro ‘Outdoor air pollution: Assessing the environmental burden of disease at national and local levels’ (2004).

___, ‘The association of air pollution and mortality: examining the case for inference’ (1993) 48 Archives of Environmental Health 336, 342.

Ostro, Chestnut, Vachit Vadakan and Laixuthai ‘Air pollution and the impact of particulate matter on daily mortality in Bangkok, Thailand’ (1999) 49 *Waste Management Association* 100.

Ostro, Eskeland, Sanchez and Feyzioglu, ‘Air pollution and health effects: a study of medical visits among children in Santiago, Chile.’ (1999) 107 *Environmental Health Perspectives* 69.

Penna and Duchiade, ‘Air pollution and infant mortality from pneumonia in the Rio di Janero metropolitan area’ (1991) 25 *Bulletin of the Pan American Health Organisation* 47.

Perez *et al*., ‘Coarse particles from Saharan dust and mortality’ (2008) 19 *Epidemiology* 800.

Pless-Mulloli *et al.,* ‘Living near opencast coal mining sites and children's respiratory health’ (1999) 57 *Occupational Environmental Medicine* 145.

Pope, ‘Epidemiology of fine particulate air pollution and human health: biological mechanisms and who’s at risk?’ (2000) 108 *Environmental Health Perspectives* 713.

Pope, Ezzati, and Dockery, ‘Fine-Particulate Air Pollution and Life Expectancy in the United States’ (2009) 360 *New England Journal of Medicine* 376.

Pope *et al.,* ‘Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults’ (1995) 151 *American Journal of Respiratory and Critical Care Medicine* 669-74.

Ritz, Yu, Chapa and Fruin 'Effect of air pollution on preterm birth among children born in Southern California between 1989 and 1993' (2000) 11 *Epidemiology* 502.

Samet *et al*., 'Fine particle air pollution and mortality in 20 US cities, 1987-1994' (2000) 343 *New England Journal Medicine* 1742.

Samet, *et al*., 'The national morbidity and mortality air pollution. Part II: Morbidity and mortality from air pollution in the United States' (2000) 94 *Health Effects Institute* 5.

Sastry, 'Forest fires, air pollution and mortality in south east asia' (2002) 39 *Demography* 1.

Schwartz 'Assessing confounding, effect modification, and thresholds in the association between ambient particles and daily deaths' (2000) 108 *Environmental Health Perspectives* 563.

___, 'The distributed lag between air pollution and daily deaths' (2000) 11 *Epidemiology* 320.

Selvey, Linda 'The inextricable links between the health of the environment and human health.' Lock the Gate Alliance,' (Speech delivered at the Forum on Human Health Impacts of Open Cut Coal Mining and Coal Seam Gas Mining, Sydney, 9 March 2011).

Simpson *et al*., 'Effects of ambient particle pollution on daily mortality in Melbourne, 1991-1996' (2000) 10 *Journal of Exposure Analysis and Environmental Epidemiology* 488.

Simpson, *et al*., 'Association between outdoor air pollution and daily mortality in Brisbane, Australia' (1997) 52 *Archives of Environmental Health* 442.

Valberg, 'Is PM more toxic than the sum of its parts? Risk-assessment toxicity factors vs. PM-mortality "effect function' (2004) 16 *Inhal Toxicol* 19.

Vallyathan *et al*., 'The influence of dust standards on the prevalence and severity of coal worker's pneumoconiosis at autopsy in the United States of America' (2011) 135 *Arch Pathol Lab Med* 1550.

Voigt, Bailey and Abramson, 'Air pollution in the Latrobe Valley and its impact upon respiratory morbidity' (1998) 22 *Australian and New Zealand Journal of Public Health* 556.

Weng, Mudd, Martin and Boyle, 'Pollutant loads from coal mining in Australia: Discerning trends from the National Pollutant Inventory (NPI)' (2012) 19 *Environmental Science & Policy* 78.

Woodruff, Grillo and Shoendorf 'The relationship between selected causes of postnatal infant mortality and particulate air pollution in the United States' (1997) 105 *Environmental Health Perspectives* 679.

WP Logan, 'Mortality in London fog incident,' (1952) 14 *Lancet* 336.

Xu, Yu, Ling and Xu 'Air pollution and daily mortality in Shenyang, China' (2000) 55 *Archives of Environmental Health* 115.

Internet Resources

Acid Rain Program 2007 Progress Report (2009) *Clean Air Markets - Air & Radiation US EPA* http://www.epa.gov/airmarkt/progress/arp07.html at 20 October 2012

Air monitoring report 2011 – Compliance with the National Environment Protection (Ambient Air Quality) Measure (2011) Environmental Protection Agency Victoria <http://epanote2.epa.vic.gov.au/EPA/publications.nsf/2f1c2625731746aa4a256ce90001cbb5/785bd9d0eb1f0b1cca2579fe0013c3bd/$FILE/1483.pdf> at October 2012.

Air Pollution (2012) NSW Health (<http://www0.health.nsw.gov.au/publichealth/environment/air/air_pollution.asp> at 2 October 2012.

Air pollution & cardiovascular disease (2011) The National Institute of Environmental and Health Sciences <http://www.niehs.nih.gov/about/congress/impacts/cardiovascular> at 20 October 2012.

Air Pollution Economics: Health Costs of Air Pollution in the Greater Sydney Metropolitan Region (2005) Department of Environment and Conservation NSW <http://www.environment.nsw.gov.au/resources/aqms/airpollution05623.pdf> at 20 October 2012.

Air Quality Bulletin Central Queensland (January 2012) Queensland Department of Environment and Resource Management <http://www.ehp.qld.gov.au/air/documents/air-bulletins/cq12jan.pdf> at 20 October 2012.

Australian Broadcasting Corporation 'A Dirty Business', *Four Corners* 12 April 2010 http://www.abc.net.au/4corners/content/2010/s2867659.htm at 20 October 2012.

COAG Standing Council for Environment and Water: Public Statement on the Development of the National Plan for Clean Air (2012) Environmental Protection and Heritage Council <http://www.scew.gov.au/publications/pubs/air/national-plan-for-clean-air-public-statement.pdf> at 20 October 2012.

Compendium of Upper Hunter Ambient Air Quality Monitoring Data (2011) NSW Environment and Heritage <www.environment.nsw.gov.au/.../air/UpperHunterAirQualityData.pdf> at 20 October 2012.

Council Expansion of the Multi-City mortality and morbidity study: Final Report (2010) Environmental Protection and Heritage http://www.scew.gov.au/archive/air/pubs/aq_rsch__multi-city__mm_executive_summary_sept__final_201009.pdf at 20 October 2012.

Darrell White, *Inquiry into Greenfields Mineral Exploration and Project Development in Victoria Hearing Councilor Darrell White* (2011) Latrobe City Council *<http://www.parliament.vic.gov.au/images/stories/committees/edic/greenfields_mineral_exploration/hearings/20111107_-_Latrobe_presentation.pdf> at 20 October 2012.*

Draft strategic Regional Land Use Plan (2012) NSW Government <haveyoursay.nsw.gov.au/document/show/192> at 20 October 2012.

Eckard, Richrd*, Emissions Trading – a challenge or opportunity for the Dairy Industry?* (2008) University of Melbourne

http://www.greenhouse.unimelb.edu.au/pdf_files/ADC08EmissionsTrading.pdf at 20 October 2012.

EPA Air Quality Hourly Update (2012) Victorian Environmental Protection Agency <http://www.epa.vic.gov.au/Air/Bulletins/aqbhour.asp> at 20 October 2012.

Exports, Energy and Construction (2012) Australian Coal Association <http://www.australiancoal.com.au> at 20 October 2012.

Hardening of the arteries (2004) The National Institute of Environmental Health Sciences <http://www.niehs.nih.gov/research/supported/sep/2004/hardarts/index.cfm> at 20 October 2012.

Inflammation & Alzheimer's-like damage caused by severe air pollution(2007) The National Institute of Environmental Health Sciences <http://www.niehs.nih.gov/research/supported/sep/2004/inflam/index.cfm> at 20 October 2012.

Intergovernmental Agreement on the Environment http://www.environment.gov.au/about/esd/publications/igae/index.html at 20 October 2012.

National Environment Protection (Ambient Air Quality) Measure (1998) cl 14.Richrd Eckard, *Emissions Trading – a challenge or opportunity for the Dairy Industry?* (2008) University of Melbourne http://www.greenhouse.unimelb.edu.au/pdf_files/ADC08EmissionsTrading.pdf at 20 October 2012.

National Environment Protection (Ambient Air Quality) Measure Review (2011) National Environmental Protection Council <http://www.ephc.gov.au/sites/default/files/AAQ%20NEPM%20review%20report_0.pdf> at 20 October 2012, 2.

Queensland Air Quality Index (2012) Queensland Government Department of Environment and Heritage Protection <*http://www.ehp.qld.gov.au/air/monitoring/measuring/air-quality-index.html*> at 20 October 2012.

Resources Project (2005) Department of Primary Industries <http://www.ret.gov.au/resources/Documents/Industry%20Consultation/Regional%20Minerals%20Program/Latrobe%20Valley%202100%20Coal%20Resources%20Project/RMP_Latrobe_Valley_2100_Coal_Resources.pdf> at 20 October 2012.

Rhiannon, Lee *Blog: Hunter coal – dirty, dusty and dodgy* (2012) Lee Rihannon's Blog <http://leerhiannon.greensmps.org.au/content/blog/blog-hunter-coal-–-dirty-dusty-and-dodgy> at 20 October 2012.

Schwartz, '*The health effects of air pollution* (2006) The John Locke Foundation<http://jlfadmin.info/acrobat/policyReports/airpollutioneffects-schwartz.pdf> at 20 October 2012.

Search Air Quality Data (2012) NSW Environment and Heritage <http://www.environment.nsw.gov.au/aqms/search.htm>at 20 October 2012.

Todd, John, *Submission on the AQ NEPM Discussion Paper* (2010) COAG Standing Council on Environment and Water

http://www.scew.gov.au/archive/air/pubs/aaqnepm/submissions/submission_aaq__j_todd.pdf at 20 October 2012.

Upper Hunter Air Quality Monitoring Network (UHAQMN) Interim Performance Report: December 2010 – August 2011 (2011) NSW office of Environment and Heritage <http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf> at 20 October 2012, 12.

Van Stennis, Nick, *Urgent Reform of Coal Industry operating standards required* Observations by Dr Nick van Steenis <http://wag.org.au/documents/doc-119-dvs-coaldust-rev.pdf> at 20 October 2012.

Interviews

Mallory Barnes, interview with Prof. Krassi Rumchev (conducted via telephone between Canberra and Perth at 12.00pm AESD on 12 September 2012).

Mallory Barnes, interview with the Department of Sustainability, Environment, Water, Population and Community (Interview in the office of Senator Larissa Waters at Australian Parliament House, Vanberra conducted on 19 September 2012).

Legislation

National Environmental Protection Council Act 1994 (Commonwealth).

Abbreviations

1. AAQNEPM – Ambient Air Quality National Environmental Protection Measure.
2. COAG – Council of Australian Governments
3. COPD – Chronic Obstructive Pulmonary Disease
4. EPHC –Environment Protection and Heritage Council
5. NO_2 – Nitrogen dioxide.
6. NEPM – National Environmental Measure.
7. PM – Particulate matter.
8. PM_{10} – Particulate matter with an aerodynamic diameter of between 2.5μm and 10μm.
9. $PM_{2.5}$ – Particulate matter with an aerodynamic diameter less than 2.5μm.
10. SO_2 - Sulfur dioxide

NB: the term 'coal operations' is used throughout to refer to coal mining activities, including transportation, as well as coal combustion for electricity generation.

Appendix A

AIR QUALITY BRIEF

OFFICE OF SENATOR LARISSA WATERS

Relevant Federal body

- Department of Sustainability, Environment, Water, Population and Communities.
- The National Environmental Protection Council or NEPC (an intergovernmental panel).
- The Hon Tony Burke MP is the Chair of the NEPC.

Regulatory Responsibility

- The NEPC consists of a single Federal Environment Minister and Ministers from each participating State and Territory.[285]
- The purpose of the council is to:
    i. Create National Environmental Protection Measures (NEPM), which become law once created.[286]
    ii. Assesses and reports on the effectiveness of implementation of NEPMs.
    iii. Deliver COAG's strategic themes by pursuing and monitoring issues of 'national significance' with respect to environment and water issues.[287]

What is an NEPM?

[285] *Ibid (c)*. http://www.austlii.edu.au/au/legis/cth/consol_act/nepca1994432/s9.html
[286] *Ibid* s 12(a). http://www.austlii.edu.au/au/legis/cth/consol_act/nepca1994432/s12.html; http://www.scew.gov.au/about/nepc.html.
[287] http://www.ephc.gov.au/nepms

They are an outline of agreed national objectives for protecting and managing the environment.[288] An NEPM sets out environmental monitoring and reporting requirements, goals, standards protocols and guidelines. [289]

All states and territories agree to implement the measures set out in the NEPM.[290]

In making NEPMs, the NEPC *must* consider:

i. The Intergovernmental Agreement on the Environment;[291]
ii. Environmental, economic and **social impacts;**[292] and
iii. International agreements.[293]

States' role - Each minister on the NEPC is required by the *Nation Environmental Protection Council Act 1994* (Cth) (*NEPC Act*) to report to the Council annually on the implementation of National Environmental Protection Measures.[294]

NEPM for Ambient Air Quality – Commonwealth Monitoring Plan (created in 26 June 1998) (hereafter referred to as the 'AAQ NEPM')

This NEPM Establishes a set of standards and goals for **6 major air pollutants** and the methods by which they are to be monitored, assessed and reported. The pollutants are:

ii. Nitrogen dioxide

[288] http://portal.environment.wa.gov.au/pls/portal/docs/PAGE/DOE_ADMIN/POLICY_REPOSITORY/TAB1144266/NEPMS%20_2_.PDF
[289] http://portal.environment.wa.gov.au/pls/portal/docs/PAGE/DOE_ADMIN/POLICY_REPOSITORY/TAB1144266/NEPMS%20_2_.PDF
[290] *Ibid (b)*. http://www.austlii.edu.au/au/legis/cth/consol_act/nepca1994432/s12.html; http://www.scew.gov.au/about/nepc.html.
[291] *Nation Environmental Protection Council Act 1994* (Cth) s 9(1)(a). http://www.austlii.edu.au/au/legis/cth/consol_act/nepca1994432/s15.html
[292] *Ibid* s 15(b). http://www.austlii.edu.au/au/legis/cth/consol_act/nepca1994432/s15.html
[293] *Ibid* (a). http://www.austlii.edu.au/au/legis/cth/consol_act/nepca1994432/s15.html
[294] http://www.ephc.gov.au/nepms

iii. Ozone

iv. Lead

v. Sulfphur dioxide

vi. Carbon monoxide

vii. Respirible particles (PM 10 and PM 2.5)

The AAQ NEPM requires monitoring, sets air quality standards and air quality goals as well as maximum exceedence events.[295]

No Commonwealth region requires direct monitoring under the NEPM (eg Cocos Island, Norfolk Island etc) because they do not meet the threshold requirement under Clause 14(1) of the NEPM.

AAQ NEPM NSW annual compliance report

The NSW government, for example, issued an annual NEPM compliance report in 2010.

There was a total of 10 calendar days where there were exceedences above PM_{10} standards (7 days in rural areas) – purportedly due to bushfires and dust storms, not coal mining operations.

National Plan for Clean Air (2011)

2011 COAG meeting identified air quality as a *Priority Issue of National Significance* and agreed that the COAG Standing Council on Environment and Water would

[295] http://www.ephc.gov.au/sites/default/files/AAQ%202010%20Report_%20NSW.pdf

develop a National Plan for Clean Air in order to *'improve air quality, and community health and well-being'* to be delivered by the end of 2014.[296]

Aims of the National Plan for Clean Air

- Unite all State and Federal Governments to reduce the health risk of air pollution[297]
- Reduce pollution and pollution exposure
- Modernise standards and respond to the latest science by introducing an exposure reduction framework for pollutants which have no safe threshold;
- Prioritise measures that achieve a net benefit to the community

Initial focus of National Plan for Clean Air is on particulate matter because of size of benefit gained, current levels of population exposure and low cost of available actions to address particles.

What will the first stage of the Plan involve?

- Health risk assessment of all major particles, ozone, sulfur dioxide and nitrogen dioxide.
- Develop options to reduce particle pollution including implementation of national product standards to control emissions from a range of products and equipment.
- Cost benefit analysis for different particle standards

What will the National Plan for Clean air deliver by 2014?

- New air quality standards and an exposure reduction framework
- Proposals for laws, regulations, incentives, guidance, partnerships or other actions for implementing emission and exposure reduction actions;

[296] http://www.scew.gov.au/publications/pubs/air/national-plan-for-clean-air-public-statement.pdf
[297] Ibid.

- Improved monitoring and reporting; and
- An agreed jurisdiction action list for ongoing implementation;

Suggested questions to the Department -

1. What does the NEPC consider to be the primary source of particulate matter in places such as the Upper Hunter Valley? Why are the PM levels so much higher in the Upper Hunter compared to the Lower Hunter?
    a. Background: Government websites acknowledge that there are many sources of PM. Some are natural while others are generated by human activity. Natural sources include bushfires, dust storms, pollens and sea spray. Particles generated by human activity can be emitted from sources such as motor vehicles, power plants, mining and materials handling, residential wood burning, agricultural burning, and some industrial processes. We are keen to find out more re which sources contribute the most?

Coal is the biggest source of PM_{10}. Coal dust and non-road diesel vehicles produce a lot of $PM_{2.5}$. PM is more of a problem in drought years.

2. Why did it take until 13 August 2011 to have the 14 monitoring stations operational in NSW? Why did the NEPC allow the NSW Minister to establish monitoring technology in the Upper Hunter so late when we have known for so long that the residents there are subject to significantly higher PM_{10} and $PM_{2.5}$ levels than the rest of the population?
    a. Background: Between 2007-8 the PM_{10} emissions for the Upper Hunter Shires of Singleton and Muswellbrook was 39 000 and 18000 tonnes

respectively, while the neighboring Lower Hunter areas of Newcastle and Maitland were subject to 920 and 260 tonnes of PM_{10} respectively. In the Lower Hunter there are no power stations and only a few small open cut mines.[298] While the federal government isn't directly responsible for the monitoring, the NEPC approves the annual reports each year, so the feds should have the opportunity to ask questions of their state colleagues and push for better monitoring.

Speaking to Jane, Lee and Tim:

NSW Government initiative to install 14 monitoring stations in the Upper Hunter. They were going beyond their obligations in the NEPM. It was a State decision. In terms of NEPC reviewing the States' choices of where to place monitoring stations, Jane said that the only scope that the Commonwealth has to review the States' is through the annual reporting to the NEPC and review of the NEPM.

3. What has the NEPC done to ensure that NSW meets the benchmark PM_{10} and $PM_{2.5}$ levels in the Upper Hunter Region where there were 11 exceedence days for PM_{10} and 4 exceedence days for $PM_{2.5}$ between December 2010 and August 2011?[299]

As above. So long as NSW or any other participating states meet their obligations under the NEPM then the Commonwealth has no scope to call on the States pick up their act.

Look at the exposure reduction framework and Economic Analysis for the National Plan for Clean Air. Look at the CLASANZ website. Standards set with a working

[298] http://www.ncbi.nlm.nih.gov/pubmed/19884036

[299] http://www.environment.nsw.gov.au/resources/aqms/120164uhaqmnintrepdecaug.pdf (Table 1)

group way back in 1998. Look at the NEPC site. Details of the CBA for standards will be on NEPC site.

4. Why is there no maximum exceedence limit (# of days/year exceeding daily limit) for $PM_{2.5}$ set out in the AAQ NEPM, yet there is for PM_{10}? How did the NEPC arrive at the decision to set the maximum exceedence goal for PM10 set at 5 days/year?
    a. Background: The Benchmark air quality standards are set by AAQ NEPM which is set by the NEPC. The standard for PM_{10} is 50 $\mu g/m^3$ over a 24 hour averaging period with a maximum exceedence of 5 days per year. The benchmark for $PM_{2.5}$ is 25 $\mu g/m^3$ over a 24 hour averaging period with no limit for exceedence days or 8 $\mu g/m^3$ over a 1 year averaging period also with no limit on exceedence days.

There are many uncertainties surrounding $PM_{2.5}$. For instance, the measuring tools used for monitoring $PM_{2.5}$ are completely reliable. So there are questions asound what is the best method for collecting data. Look at the NPFCA and the ambient air quality review by the NEPC for a more detailed answer.

Risk framework may pick up the 25 000 issue. No work from us about the 25 000 threshold. Not obliged to monitor small towns but he still do.

5. There are two averaging periods for $PM_{2.5}$, why hasn't been adopted for PM10?
    a. Background: There seems to be two averaging periods: Annual one is 8 micrograms/ m3; 24 hour is 25 micrograms/ m3. Yet PM10 only has 50 micrograms/ m3 every 24 hours.

Look at the NEPM review.

6. What, if any, reviews are being conducted into the threshold number of allowable exceedence days for $PM_{2.5}$? Is the department aware that PM 2.5 is considered more dangerous than PM_{10}, even for short periods of exposure (ie hours)?
7. Why isn't PM_1 monitored?
8. What auditing does the Commonwealth or the NEPC undertake to ensure the adequacy of monitoring?

Not much. States and Territories report annually to the NEPC.

9. How does NEPC ensure that monitoring sites are placed in the most appropriate places?

It doesn't

10. Why does Clause 14(1) of the NEPM stipulate that 25 000 is the threshold population level needed to justify monitoring of a region? Why isn't annual pollution load rather than just minimum population used as a criteria for selecting sites?

Risk framework may pick uo the 25 000 issue. No work from the department about the 25 000 threshold. Not obliged under the NEPM to monitor small towns but NSW still do by their own accord.

11. Has there been any assessment of how many people are subject to air that is not monitored and at risk of pollution exposure? (any findings..?)

Not NEPC responsibility, not Department's responsibility.

12. What cost benefit analysis did the NEPC conduct before adopting the WHO's benchmark standards for air pollution (eg the maximum concentration of PM_{10} stipulated by the AAQ NEPM over an averaging period of one day is 50µg/m^3) ? Why is the standard above zero if the National Pollution Inventory accepts that there is no threshold level at which health effects do not occur from exposure to $PM_{2.5}$ and PM_{10} [300]?

When adopting the WHO's standards, the Council considered the need to find consensus that everyone can work with and establish a standard that people can work to. However, they did not just adopt the WHO standards holus bolus.

13. The National Plan for Clean Air (2011) stipulates that the first stage of the plan will include a cost benefit analysis of the different PM standards. Will the analysis consider:
    a. the National Pollution Inventory accepts that there is no threshold level at which health effects do not occur from exposure to PM_{10}?
    b. that every 10 µg/m^3 increase in PM_{10} increase mortality by approximately 1%?
    c. Dr Tuan Au's independent epidemiological research in the Upper Hunter Valley which indicates a significantly higher prevalence of low childhood respiratory function relative to the broader Australian community?

[300] http://www.environment.nsw.gov.au/AQMS/aboutaqi.htm#goal

14. Can the Department inform us of their progress with the Cost Benefit Analysis of different PM standards?
15. Apparently the National Plan for Clean Air prioritized PM reduction over other pollutants because of the "size of benefit gained, current levels of population exposure and low cost of available actions to address particles".

    Can you talk me through the research that underpins this statement? Ie what are the benefits of focusing on PM? Has the Dept got any estimates on the current costs to society of particulate pollution?

The Department believes that they can make easy cuts to PM pollution with small things such as regulating surface coating operations or wood heaters. This is a more strategic way to go.

16. What if any assessments has NEPC (or member jurisdictions) done into the current levels of population exposure to PM?
17. What are the available actions to reducing PM and what is their cost relative to the available actions for reducing other pollutants?
18. Why doesn't the NEPM require the monitoring of the *composition* of PM, not just the size class considering that penetration of particles is also partly determined by chemical composition?

Not enough information. There is a Macquarie university report that looks into it. Review of ambient air quality NEPM. But the department is not interested in commissioning any reviews

19. What assessment has the NEPC conducted into the different health risks associated with PM of the same size but differing elemental composition (eg. coal

dust v silica dust)? Is there a need/ any commitments to further research here? Timeframes?

As above. NB - PM 2.5 is from combustion of diesel engines. PM 2.5 is almost smoke.

20. What assessment has the NEPC conducted into the different health risks associated with PM of the same size but differing shape? (eg asbestos is dangerous cos of its shape)

As above.

21. Why doesn't the NEPM require the monitoring of whether the PM carries carcinogenic components like benzopyrenes?
22. The NEPM is focused on monitoring average air quality, rather than major point sources and peak concentrations. How does the NEPM distinguish between point sources of pollution and areas which give an average representation of general air quality? What if the point sources of pollution are near residential areas? What's NEPC's role here?
    a. Background - NEPM regulations do not apply to the 'major point sources' of pollution or 'peak concentrations,' while they do apply to and sites which give an 'average representation of general air quality and of population exposure.'[301]

Point source pollution does not feed into state and territory monitoring.

[301] http://www.ephc.gov.au/sites/default/files/AAQ_DiscPpr__Review_of_the_AAQ_NEPM_Discussion_Paper_AQ_Standards_Final_201007.pdf at p 12.

23. What assessments, if any, are being conducted into the public health implications of communities in proximity to coal mining operations?

None. They suggested overseas literature.

Wednesday morning (10 am for meeting, 12 pm)

Appendix B

Questions for Prof Shannon Friel questions – Prof. at the ANU in the Centre for Epidemiology and Public Health

Interview conducted over the phone on 12 September 2012 between approximately 12.00 pm and 12.25pm (Eastern Standard Time)

1. *What is the safe level of PM_{10}, $PM_{2.5}$ and PM_1 in the atmosphere?*
    a. The National Environmental Protection Council (NEPC) set the standards for ambient concentrations of PM. The maximum concentration of PM_{10} over an averaging period of one day is 50 $\mu g/m^3$. The maximum concentration of $PM_{2.5}$ over an averaging period of 1 year is 8 $\mu g/m^3$ and 25 $\mu g/m^3$ over an averaging period of 1 day.
    b. *Are these standards safe?*

PROF. RUMCHEV: WHO guidelines published in 2010 set standards for particulate matter. The WHO standard for $PM_{2.5}$ over a 24 hour period is 10 $\mu g/m^3$. So the Australian standard is actually more conservative than the International standard $PM_{2.5}$. Most countries adopt the WHO standards. Before these standards were published there was no pre-existing standard. Standards are well considered. A great deal of academic literature was reviewed before setting the standard however sensitive people with predisposing medical conditions and children may still be considered vulnerable from exposure to these levels. *Why are there two averaging periods for $PM_{2.5}$*

c. *Why is the averaging period of $PM_{2.5}$ so long?*

2. The government has set the maximum number of exceedence days for the benchmark PM_{10} standard at 5 and the while there is no limit on the number of exeedences of the PM2.5 standard?

a. *Is it safe to have 5 exceeedence days for PM_{10}?*

PROF. RUMCHEV: Unclear why the exceedence days are set as they are. Some people, such as adults, may be safe being exposed to PM 10 and PM 2.5 levels above the benchmark set by the government. You will have a greater chance of suffering from adverse health impacts from exposure to PM if you are already pre-disposed to medical conditions such as low respiratory function (eg asthma) or heart disease.

b. *Why might there be no $PM_{2.5}$ limit?*

PROF. RUMCHEV: There are guideline values for 24h and I year mean exposures to PM2.5 However less is known about PM_1 and there is no guidelines on PM_1. $PM_{2.5}$ is more dangerous than PM_{10} because it is smaller while PM10 is coarser.

3. *If someone is exposed to PM, do the chemical properties of that PM have any bearing on the impact it has on the person's health, or is it simply a matter of particle size? I.e. does it make a difference whether the particulate matter that someone is exposed to is coal dust or other particulate matter*

PROF. RUMCHEV: Elemental composition of particles is VERY important. Not only size determines the health impact but also the elemental composition of the particle. Coal dust particles = respiratory problems.

4. Some studies I've read have shown a correlation between low respiratory function and geographical proximity to mines, while others have shown no correlation at all. *Why might there be this discrepancy? In your opinion, is geographical proximity to mine sites a risk factor for low respiratory function?*

PROF. RUMCHEV: Yes. Communities closer to coal mines are more likely to be exposed to higher levels of coal dust and therefore affected with respiratory illnesses. There are very limited studies in Australia on affects of coal mines on public health.

5. The NSW Government refused to undertake epidemiological studies into public health implications of coal mining in Singleton despite community overwhelming community demand. Their reason for not undertaking a study was that the sample size was not large enough. However, the community at the time had a population of well over 40 000. *Is a sample size of 40 000 individuals large enough to generate reliable, epidemiological data for conditions such as low respiratory function, asthma, dermatitis or cancer?*

PROF. RUMCHEV: The size of the sample group is determined by the question you are asking and the illness that you are dealing with. The exact size of the sample group should be determined by statisticians. In my opinion, 40 000 sounds like an adequate sample size to do a prevalence study into respiratory function.