The impacts on health of air quality in Australia

Near Stratford Vic. Smoke from remote fires, 2/2/2011

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Rural Air Stinks

I believe that health effects of air quality are a major problem for rural people, although poor air quality is often thought of, as an urban issue. Rural residents are frequently subject to unhealthy air conditions from bush fires and also the fuel reduction burns, designed to protect them from fire danger. In Gippsland many people live in, or down wind of, the Latrobe Valley coal mines and power stations. Furthermore, many rural households burn wood for winter heating. Unsurfaced roads and agricultural activities may also, in windy conditions, lead to significant dust issues.In addition rural communities often see significant truck movements from mining, forestry and agriculture, with inherent dust and diesel particulate releases.

At Esso Longford, (below) the processing of Bass Strait gas provides black smoke and flaring as intermittent but troublesome hazards for neighbours. If unconventional gas development follows the pattern witnessed in Northern parts of the country, then further dust, methane and flaring can be anticipated here as well.

(a) Particulate matter, its sources and effects;
1 - coal mining and burning
2 - household wood fires
3 - forest fires
4 - fuel reduction burning
5 - peat fires
6 - gas industry

Coal fired power stations:
These create health hazards at numerous levels: firstly from the coal mining and related dust release, and potential diesel pollution from heavy equipment as well as water pumps used in the mine. There are also intermittent fires within the coal as well as the combustion products from the power stations. As well as soot with potentially, adsorbed toxins, power stations also release elements such as chlorine, fluorine, lead, mercury, zinc, organic compounds such as Polycyclic Aromatic Hydrocarbon (PAH's) and oxides of sulphur and nitrogen.

looking SW towards Hazelwood, Morwell, February 17th 2013

Wood Fires:
Space heating by burning wood releases Sodium, Potassium, Iron, Bromine, Chlorine, oxides of Sulphur and Nitrogen, as well as various PAH's attached to soot which can act as a signature for different fuel types.

Many rural families find electric and gas heating too expensive when they can obtain free wood for burning. The air quality in a town like Sale, even though it has mains gas, can be quite putrid,

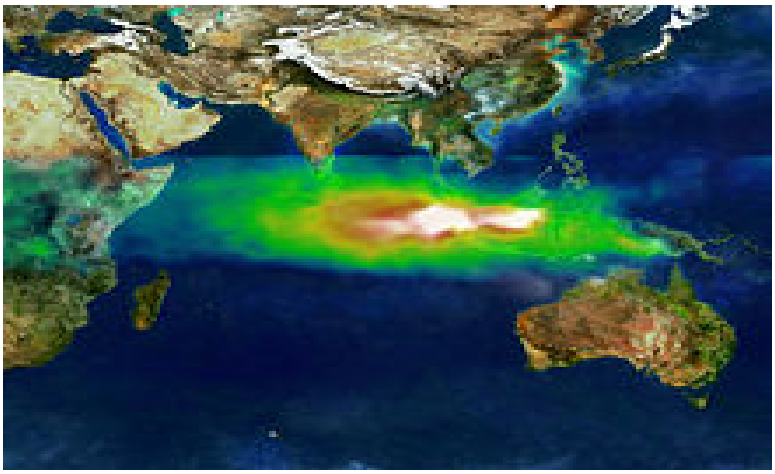
on still winter nights. A brown smog layer sitting over the town may be visible from high points a sufficient distance away. Burning off is also a rural tradition, whereby cleared scrub and other waste is heaped up and burnt.

Peat fires:

Peat is partially decomposed vegetable matter, (half way to becoming brown coal, if you like), and contains carbon, sulphur and nitrogen in various compounds as well as variable moisture content. It burns at relatively low temperatures and may smoulder underground for years in relatively anaerobic conditions. This produces incomplete combustion with much higher levels of gases and particulates.

A drying climate with more ground water extraction is leading to more risk of peat fires, around the world. The 2010 fires across Russia included inumerable peat fires. The air quality was dramatically affected with pictures of Red Square veiled in smoke. The peat fires in Borneo and Kalimantan in 1997, are estimated to have led to a 30% increase in hospital attendance in Singapore and the economic costs of the event are estimated to have been upto US$ 4.5 billion in economic costs, across South East Asia. Children and the elderly or those with pre-existing cardiovascular

disease were most affected.



NASA picture of 1997 SE Asia peat fires

The Department Of Health in Western Australia has put out specific guidelines for communities affected by Peat Fires, recognizing that the threat is increased by climate change, and therefore it is important to have policy in this area - http://www.public.health.wa.gov.au/cproot/1415/2/Minimising_the_Impacts_of_Peat_Smoke.pdf.
Despite several recent peat fires in Victoria, that state has no policy, nor clear chain of command to deal with health effects.
When I was living across the road from a peat fire, in December 2010, I asked EPA to set up temporary air quality monitoring. They took a month to respond, seemed unaware of the problem in Gippsland and suggested I take it up with CFA, because they had no monitoring equipment available. A year later, when the fire was still burning, despite 700mm of flooding rain, over the intervening winter, the Departments of Primary Industry, as well as Sustanability and Environment and CFA became concerned. Over a million dollars was spent building protection lines between the fire and The Gas Plant at Esso, Longford. If the Peat Fire broke out on a Northerly wind day, setting alight scrub country and heading for the coast, they would have three cleared roadsides to fight the fire from. It was deemed impossible to put the fire out and it was known from infra red surveys that the temperature at the centre of the smouldering peat was upto 240^0 C . Peat underlies much of that country so it was felt problematic to use fire as a tool to clear roadsides, in case it extended the area of peat involved.
It is clear that the Government recognises the threat to Victoria's gas supply but perhaps not the threat to human health. Not monitoring, may be disguising the possible causative agent for

lung etc. damage.

Peat smog from our front verandah, December 2010, Longford, Vic.

Forest fires:

Forest fires occur when forests are very dry and the weather conditions are conducive. Dry Eucalypt forest may burn ferociously when Eucalyptus oils, vaporize and ignite, on days of low humidity and high temperature such as was experienced on Black Saturday. Different vegetation types will burn with some differences in chemical composition dependent on heat of fire as well as the vegetation substrate but there are recurrent themes, with soot, oxides of nitrogen and Phenolic compounds and, both in US conifer forests, and Northern territory rangelands, isocyanide compounds, similar to components of diesel combustion and cigarette smoke.
Isocanides may be toxic to human tissues at concentrations of one part per Billion. Because fires also release oxides of nitrogen, some of which increase blood flow through human lungs, some other toxics may gain access to the blood stream and thence to other part of the body, in even greater concentrations. The additive effects may be far worse than would be the case if

only one type of gas was present in the absence of the other.

The other emerging issue is that we now see increasing global frequency, of Mega Fires, defined as fires in which the burn cannot be controlled by human means, and is not extinguished until more favorable weather conditions such as heavy rain, finally occur. Such longterm and largescale fires also cause long-lasting environmental, economic, social, physical and mental health effects.

The emotional effects are very significant. There is no word to describe the feeling of walking out of your office at 3 pm, in mid summer, to find that the world has gone dark. The picture above shows what it was like. The faint white blobs across the picture, are reflections of the camera flash, off falling carbonised gum leaves and other forest debris. This fire was 35 km away, from Sale but darkened the sky from Rosedale to Lakes Entrance over the coming hours. Later on, a black rain fell and covered roof tops, cars etc. Warnings were issued on the ABC for people to block off their tanks to avoid contamination of drinking water. The same happened again after the black Saturday fires: in this case the pall of smoke came over at 5 pm, the sky darkened and

again the black rain fell.

Fuel Reduction Burning

Fuel reduction, one of 4 fires visible near Rosedale ,that day.

The knee jerk reaction to the fear generated by Mega Fires, is to burn forest to make it less flammable. However evidence is accumulating that this approach may have unforeseen effects. Many Mega fires "were fueled in part by overzealous fire suppression or practices that favoured there growth of more fire-resistant natural vegetation and therefore allowed fuels to accumulate. As this summer has demonstrated, with yet another Mega Fire in Gippsland, recently burnt forest is not always easier to manage. It is time for a complete re think on fuel reduction and new research that looks at the new normal with a changing climate. It appears possible, that the understory of forest recovering from fire, in dry conditions, may be more, rather than less flammable.

The smoke generated by fuel reduction burning may carry its own heath hazards. Studies in the Northern Territory detected

isocyanides in air quality monitors, set up during burning off. They also correlated measured, poor air quality, with hospital attendances. This showed that indigenous people were admitted in numbers significantly greater than would normally be the case, upto 3 days after exposure, to demonstrably poor air quality. The authors, Johnston et al, felt that other socio economic factors and pre-existing ill health, increased their vulnerability.

In Gippsland the air quality is often terrible in March and April, which is peak burning season for fuel reduction. On one occasion in Bairnsdale, hospital staff complained of head aches, and sore throats and eyes, having woken to markedly reduced visibility and evident significant smoke. Anecdotally, I recall an April weekend, where the Emergency Department in Sale noted a spike of migraine over a still two days, during which we experienced visibly poor air quality.
Reinhardt and Ottmar measured formaldehyde, acrolein, benzene, CO, and respirable PM (PM3.5) in Rondonia, Brazil, during the peak of the 1996 biomass burning season. Noting that forest fire smoke can be unpredictable, depending on wind direction, fire intensity, humidity or precipitation and terrain. The human health effects are also quite difficult to predict and plan around, and depend on individual factors as much as fire related variables.
The increased intensity and longevity of Megafires and extended fuel reduction seasons, will inevitably lead to more inhalation of harmful substances which spread further and go on for longer, increasing the cumulative risk.

Gas Exploration and Production

Bass Strait Oil and Gas have been processed at Esso Longford since the 1960's. Additional processing facilities have been added incrementally. There is currently a process investigating building a so called "Conditioning" Plant to extract CO2 and Mercury from the incoming gas. The unwanted gas is to be vented to atmosphere and the mercury scavenged and managed as a separate waste stream. This has become necessary because the remaining gas in the depleted field, is becoming progressively worse in quality. In some senses, this is desperation gas mining, flogging the field for every last drop, because the infrastructure is there and because, as yet there is no transition to on shore

gas. There have been a number of unplanned outages with flaring, grass fires and billowing black smoke, in February and March this year. in November 2012, there was an accidental loss of 2 million litres of crude oil, apparently from corroded pipes. It seems that maintenance of ageing infrastructure is a significant problem. For the neighbours, they are concerned that they may have been exposed to harmful levels of benzene which may increase their long term risk of cancer. They are also frequently subjected to black smoke of unknown quality, but with evident black "creosote-like" material on rooves and cars of near neighbours and employees respectively. Car dealers are said to be able to pick that you live near Esso by the pitting of the duco on cars. There is very often a red glow in the night sky over Longford. If longterm exposure to airborne Esso residues, eats through car duco, it begs the question, is it harmful to inhale this same air?

White car, black rain after Black Saturday fires 2009

Right now, with Gippsland a patchwork of mining and petrol and gas tenements, the proximity of the existing Infrastructure (processing plants and pipelines) is being touted to potential investors, and spun to local landholders as a symbol of the inevitability of the area becoming a major hub for on-shore, unconventional gas exploration and hydrological fracturing (Fracking). Logically, the next additional threat to the health of Gippslanders, is from the gas industry drilling, fracking and flaring its way across our major agriculture, fishing and tourism region. If the air quality is poor and toxics are precipitated across the food basket, we may live to regret the poisoning of the food chain, or at least the next generation may.
At this stage the risks are modelled and said, by industry, to be manageable. We clearly need, substantive, baseline data, collected before any further pollution of our air and water begins.

Health effects generally:

Fine Particles are the current major concern to health professionals. Large particles above 10 micron do not get deep into the lungs because they are too big.

$PM_{2.5}$ and smaller appear to be the most dangerous. Nano to micron sized inspirable particles, are small enough to get in to the alveoli, or gas exchange, parts of the lungs. These are designed to provide many capillaries in close proximity to the inhaled air, to allow oxygen and carbon dioxide to diffuse in and out. Medication can also be rapidly absorbed into the circulation via the lungs, such as when inhaled ventolin causes a brief burst of more rapid heart rate, which some people experience as an unpleasant side effect. More obvious examples are inhaled anaesthetic gases, which quickly reach the brain via the circulation. Similarly, it is becoming more and more evident that toxins attached to fine particles of soot, may also gain access to the circulation. Debate continues as to whether tiny particles get into the brain via the circulation or possibly via the olfactory

bulb, where smell sensors are located in the nose with nerves leading back into the brain.

The effects on respiratory and cardiac function are fairly self evident, but the other effects which are now being recognised, are more counter-intuitive. Studies in animal models and from epidemiology are beginning to link life-time fine particle exposures with risk for neurodegeneerative diseases such as Parkinson's and Altzheimer's Diseases. These studies are also beginning to suggest damage done in early life, including during foetal life, may also affect bran development.
It is worrying to discover that multiple studies in different countries are linking air pollution to foetal growth. A recent study in China showed lower birth weights and elevated risk of brain and spinal chord malformations, linked to air quality during the pregnancy. This is really significant, since we know that lower birth weight is associated with greater risk for hypertension, diabetes and cardiovascular disease, leading to health costs and reduced life span.
The likely mechanism is that, based on studies in mice, ultrafine particles from exhaust fumes etc, can travel to the placenta, chorion and amniotic fluid and affect the growing foetus. Such particles are known to cause inflammation which is thought to be the mechanism for many of the observed effects including premature labour. Preliminary research suggests that PAH's may also have effects in the very early weeks of pregnancy when aberrant development, may go on to cause more profound or lethal defects or malformations. However this is an area requiring more substantive research and epidemiological studies.

Many studies have highlighted the greater vulnerabilities of infants and children. Children have incompletely developed lungs with relatively larger surface area compared to their body weight. They breathe more rapidly than adults and breathe 50% more air per kilogram of body weight. This leaves them open to increased exposure to toxins entering via the lungs and distributed over much smaller bodies, increasing the relative concentrations of toxins.

(c) the standards, monitoring and regulation of air quality at all levels of government;

The biggest problem, particularly in Victoria and more specifically Gippsland,

is the paucity of air quality monitoring stations. With no monitoring down wind of the Latrobe Valley, and none in the ranges, which are arguably our greatest bush smoke producers, we have no data on which to base scientific studies into potential health effects.
With adequate monitoring it would be possible to compare AEDI (Australian Early-childhood Developmental Index) figures with air quality. The AEDI data is compiled by pre school teachers, nationally, looking at developmental vulnerabilities in pre schoolers. Gippsalnd scores have been poorer than most of the other rural areas, in this state. While no causal relationship necessarily exists, it would be sensible to exclude air quality as a remediable factor, if it proves to be a likely cause. The time is ripe to do extensive monitoring at the time of potential closures of emitters like Hazelwood Power Station.

(d) any other related matters.

Based on the limited research conducted so far, public health officials generally consider children, older people, pregnant women, smokers, and people with chronic respiratory problems to be especially vulnerable to health effects from outdoor fires .The standards are irrelevant if there is no monitoring, but we need to be able to respond to the health needs of our most vulnerable populations. Detailed monitoring including significant periods of data collection in more sparsely inhabited areas are essential to our understanding of the effects of Australian Bush Fire Smoke, and more thoughtful fuel management.

Falling debris

Sale CBD, Aberfeldie fire January 2013.

Dr Joanna McCubbin