CLEAN AIR forum 2004

Proceedings of the NSW Clean Air Forum 2004

Powerhouse Museum, Sydney
17 November 2004

New South Wales Government

Action for Air

Published by:
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Email: info@environment.nsw.gov.au
ISBN 1 74137 261 5
DEC 2005/88
March 2005
Printed on recycled paper.

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Opening address

The Hon Bob Carr MP
Premier of NSW

The Rt Hon Stephen Byers, Chair, International Climate Change Taskforce, other distinguished guests, ladies and gentlemen.

There is an exhibition of photographs currently showing at the Museum of Sydney—photographs by the father and son Max and Rex Dupain.

Max Dupain's photos are of Sydney back in the 20s, 30s and 40s, his son's of Sydney in contemporary times. Max Dupain's photos of old Sydney show a city encased in smoke. Everywhere you look there are chimneys belching smoke—it's a smelly, polluted city. The photographs of his son, Rex, show the much cleaner Sydney we take for granted today.

Now that shows the possibilities before us. But the fact is there is a devastating radical pollution taking place now that we don't see. It's disguised by the apparently clean air we enjoy, compared with that of industrial era Sydney. And that is the most radical environmental challenge we face—that of global warming.

Put simply, the air we breathe, the air you take from the highest mountain on earth, is chemically different from the air that would have been breathed a generation ago, and the air you'd extract from the highest mountain on earth 50 years ago.

Part of the human experiment with the planet is to chemically change the air that surrounds us. We've done that by emitting unprecedented quantities of carbon dioxide to the point where it is changing our climate. That is the biggest challenge human kind faces.

Sir David King, the UK's Chief Scientist, described climate change as "more serious even than the threat of terrorism". And he's right.

We are honoured over the last two days to have the International Climate Change Taskforce meeting in Sydney, and I thank members of that Taskforce for staying on for this Clean Air Forum and sharing with you their perception of global warming—as I said, the most fundamental and most radical change in our circumstances as human beings, and the most radical, fundamental pollution threat we face.

We've got a number of specific challenges. As the old-fashioned air pollution is conquered and banished, we are left with more tricky air pollution to deal with. We got rid of a lot of those heavy particles hanging in the atmosphere when old-fashioned industry was forced to upgrade and when a lot of it closed. That was one generation of air pollution that we got on top of and we solved.

But as that was happening, the population of Sydney was continuing to mount—1,000 people a week entering the Sydney basin, and the density of car ownership in the Sydney basin has increased. So as we tackle one generation of air pollution problems, we face others.

So let me come to a pretty brisk overview of some of the issues involved here. One is a very specific one. That is the pollution we cop as a result of the savage fires that surround Sydney during bushfire seasons.

Remember we used to have very heavy pollution in the air after still weekends because of the prevalence in our garden city of backyard burning. Back in the early 1980s we banned backyard burning, and we got rid a lot of our air pollution that was there on still, cloudy days.

But we still cop serious air pollution as a result of bushfires over the Christmas season.

Inquiry into bushfire risk

I'm pleased to announce that we are initiating cooperation with the Commonwealth into the bushfire risk and, in particular, comparing the current frequency of low to extreme fire danger days with projections for 2030 and 2070 for eight locations where we've got high-quality weather data: Coffs Harbour, Cobar, Richmond, Williamtown, Richmond, Sydney, Nowra, Wagga Wagga, Bourke and Cabramurra.

This will be completed in June next year. We will use it to guide our response to fire and its consequent air quality implications. I thank the Australian Greenhouse Office for their funding and support for this project.

Air pollution health alerts

Related to that there is an initiative I want to talk about—air pollution health alerts—such as those caused by bushfires. They can affect everyone's health but in particular those of that very high proportion of the Sydney population that suffers from asthma.

Asthma suffers can tell you it is painful to go outdoors when we're surrounded by fires or on other days of heavy pollution. We have developed a new air pollution health alert system that will provide the community with better information on the effect of air pollution on their health.

Public warnings will be issued by the Chief Health Officer once air quality reaches levels that may exacerbate conditions like asthma. This system, which has been trialled in Europe and the US, will be the most comprehensive of its kind in Australia. So, as well as media alerts, people will be able to ring a free-call help line or look online for the latest information on air pollution forecasts. So, a warning system for those citizens who are particularly susceptible to days of heavy pollution.

Motor vehicle emissions

I come to motor vehicle emissions, the most serious source of air pollution. The Bureau of Transport and Regional Economics estimates that health problems caused by motor traffic pollution in Sydney costs $1.5 billion a year.

We have taken huge steps towards reducing emissions through cleaner fuels and improved technology. There's been a $150 million upgrade at Caltex's Kurnell refinery, and that's going to continue to dramatically reduce the benzene content of petrol and the sulfur content of diesel.

Given that that plant produces about 60% of NSW's transport fuel, those cleaner fuels will have a significant impact and a beneficial impact on air quality.

Improvements like this, however, are being outweighed by the continued growth in vehicle use.

Cleaner Vehicles Action Plan—update

At the last Clean Air Forum, I announced the Cleaner Vehicles Action Plan—a package of measures to put more clean cars on the road, reward innovation by carmakers, and encourage consumers and businesses to take the green option.

Today I want to report on how we are delivering those commitments.

In 2002 we established environmental performance ratings for light vehicles—the Clean Car Benchmarks. These paved the way for the Federal Government's Green Vehicle Guide, which helps car buyers make their purchase a green purchase.

Our voluntary Clean Fleet Program recognises private fleet operators who adopt environmentally friendly practices. The Roads and Traffic Authority has also commenced a Voluntary Clean Fleet Program for heavy vehicle fleets. More than 80 private and council fleets have signed up for the program.

No government can talk about emission reductions without looking at its own fleet, and we are leading by example. Our fleet has purchased 133 hybrid vehicles, increased our use of cleaner models, and developed fleet management guidelines.

Cleaner government fleet

Today, I'm pleased to announce new tough but achievable targets to build on these measures and reduce the environmental impact of the NSW Government's light vehicle fleet.

I can also announce that from now on, V8 engines will no longer be purchased on NSW Government contract. V8s emit almost twice as much carbon dioxide as four cylinder models, and a third more than their equivalent V6 models. They also have much higher running costs.

Over the next three and a half years, these new policies will:

- reduce greenhouse emissions by over 55,000 tonnes
- reduce noxious emissions by over 80,000 kilograms, and
- save the Government around $50 million in lease and fuel costs.

Every government agency will be asked to develop performance indicators that comply with Clean Car Benchmarks and to monitor and report on their Fleet Improvement Plan.

Expansion of ratings to heavy vehicles

Heavy vehicles are one of the most significant and fastest growing sources of vehicle emissions.

The Government is looking at ways to reduce emissions from this sector and to encourage the uptake of cleaner heavy vehicles. But first we need to be able to measure the performance of heavy vehicles.

Building on the success of our Clean Car Benchmarks, NSW will establish an environmental rating system for heavy vehicles. We will also investigate options for providing incentives to switch to cleaner heavy vehicles.

After-treatment diesel vehicles exhaust traps

Emissions from diesel vehicles are another major source of particle pollution. In fact, the Department of Environment and Conservation estimates that 60% of fine particle emissions from motor vehicles in the greater metropolitan region still come from diesel vehicles. Today, I can announce an initiative that could greatly reduce harmful emissions by targeting these old, diesel workhorses.

The Government is providing $175,000 from the Environmental Trust's Clean Air Fund to evaluate the effectiveness of pollution reduction devices that can be retrofitted to diesel vehicle exhausts.

Overseas trials show reductions in particle emissions of between 25 and 90%. The Department of Environment and Conservation and the Roads and Traffic Authority will trial this new technology on 50 trucks, buses and off-road vehicles.

With strong industry involvement, a report on the trial's outcomes is expected in mid-2006. If successful, we can work with industry to achieve these retrofits, expanding the use of these devices across NSW's diesel fleet.

Biodiesel fuel trial

The use of diesel fuel is, of course, not restricted to our roads. I'm pleased to announce an initiative that would result in a cleaner public transport system—a trial of biodiesel fuel on Sydney Ferries.

Biodiesel is a renewable bio-based fuel that is bio-degradable and non-toxic. Sydney Ferries Corporation is talking to the biodiesel industry to finalise details prior to commencing a trial on selected vessels.

Consumer action—green wheels

Even if we all drive clean cars, there are simple things we can do to minimise emissions and make our cars as efficient as possible.

For instance, regular servicing, keeping tyres pumped to optimum pressure and avoiding unnecessary short trips. Trips of just one kilometre currently account for more than 50% of private car travel.

Getting out of our cars and walking, cycling or taking public transport is the best way to reduce emissions. These alternatives will also increase our fitness and save money.

I'm proud to announce the new Green Wheels Program to encourage the public to consider such positive transport options. It will include:

- sending out tips for cleaner driving with registration renewal papers
- a voluntary green registration program to encourage drivers to offset car emissions by planting trees, and
- a commitment from individual citizens to plant sufficient trees to absorb the carbon dioxide their vehicle trips are responsible for.

Conclusion

The challenge of air quality management increases with every degree of global warming.

The good news is that the steps we take towards cleaner air will lead to lower greenhouse emissions. The environmental decisions of the early 1980s, such as banning lead in petrol, showed we could make the hard choices and we benefit from those decisions today.

I'm optimistic about the ability of the people of the State to respond to the dual challenge of global warming and clean air. It's only by working together that we will protect our health, our economy and our environment.

I declare the 2004 Clean Air Forum open, and I thank you, especially our international visitors, for your attendance.

Why climate change is a priority for the UK

Rt Hon Stephen Byers MP (UK)
Chair of the International Climate Change Taskforce

This morning I will address three key issues:

- why clean air, climate change and the environment are becoming a political priority in the UK and internationally
- the UK experience in this area, specifically clean air, and
- the importance of 2005 for international debate and consideration of climate change and what we can do as an international community to tackle global warming.

Firstly, why have clean air and climate change become a political priority at this particular time? If we look back 200 years, the UK had an industrial revolution which was followed throughout most of the developed world. This saw a move from rural to urban, farm to factory, and an agricultural to industrial base in our economy, with great impacts on our quality of life and the way in which we lead our lives. In the developed world, this meant greater prosperity and higher standards of living, but it came at a cost and the heaviest burden was probably faced by the environment.

People today in the developed world have the opportunities to get more out of life than just the hand-to-mouth existence of the industrial revolution era. As their prosperity grows, they have the freedom to think about wider issues concerning their family and the communities they live in. Consequently, the public is more aware of the environment around them and is demanding politicians do something to protect it.

Political leaders therefore now have an opportunity to develop a strategy with environmental initiatives that can be taken at a government level. There is also a role that individual citizens can play in partnership with government. Young people in particular, who in Western Europe are disconnected from the political process and democracy, can be engaged by governments through issues like the environment as many of them have deep passionate concerns, real convictions and real commitments towards it.

So what then should be the government's response, specifically regarding clean air and climate change? In the UK, clean air is a good example of how a new government reflected on what was happening and the concerns of the people.

Tony Blair's government was elected in 1997. The environment and quality of life issues didn't really appear in the election campaign, so on taking office there was a view that these matters weren't as important as getting the economy straight and investing in schools, hospitals and transport. As we made progress on those big ticket issues though, it became very clear there were other quality of life issues that would make a difference in terms of how people felt about themselves and the progress that the new government was making. The environment was one of those issues.

We have created two million more jobs in the UK economy since 1997 which is good news if you're one of the two million people back into work, but the consequence of this is that there are two million more journeys to work every morning and two million more journeys back home in the evening. This has an effect on environmental quality and we found very quickly that, even though we had many very good measures in place, air quality was being adversely affected.

We commissioned some work on the effect of air quality on public health in 1998 that looked at the correlation between air quality, pollutants in the atmosphere and their impacts on the health of the population. The conclusion that came out in 1999 was startling. There were 11,600 premature deaths in the UK in 1998 primarily due to air quality factors. There were 117,700 hospital admissions that would not have taken place apart from the poor quality of the air that we were breathing. Those were figures that no responsible government could ignore, so we developed an Air Quality Strategy in January 2000 that stated our objectives, our targets for improving air quality and how they could be achieved.

However, within the UK structure, although the central government has the responsibility for laying down the national targets and objectives, local government is

responsible for delivering or tackling pollutants in our air—so there are divided responsibilities. The four main aims of the strategy were:

- social progress which meets the needs of everyone
- effective protection of the environment
- prudent use of natural resources, and
- maintenance of high and stable levels of economic growth and employment.

This is a classic example of politicians wanting to be all things to all people. We very quickly realised, as we tried to put the policy in place, that these were soft words that didn't really make any progress.

This combination of an 'all things to all people' approach and divided responsibility among hundreds of local councils for tackling air pollution posed a real problem—no one would be responsible for failure to meet the targets (the buck could be passed between central and local governments), and perhaps even more importantly for politicians, no one would get the credit if things went well.

There are important lessons to be learned from this—there have to be clear lines of responsibility and accountability with people being held to account if things go wrong, but also being applauded if they do a good job and actually meet the targets which have been set. Secondly, there have to be targets where the people responsible for implementation have ownership of them.

The third issue I want to touch on is that of climate change and why 2005 is going to be a very important year in this area. Tony Blair has made it very clear that he regards climate change as being one of the most pressing issues facing the world at this time. Next year the UK has the chairmanship of the G8 group of major industrialised economies. In the latter half of next year the UK also takes over the presidency of the European Union.

The good news for those of us concerned about the environment is that, in terms of the UK's chairmanship of the G8, there are two issues Prime Minister Blair has identified as being top priorities:

- a commission on Africa looking at data aid and tackling poverty and famine, and
- climate change and international measures to tackle global warming.

In response to this, three think tanks—the Institute of Public Policy Research in the UK, the Centre for American Progress in the United States and the Australia Institute in Canberra—got together and sponsored the International Climate Change Taskforce which I am responsible for chairing. The Taskforce's purpose is to develop proposals that build on the outcomes of the Kyoto Protocol to help ensure climate change is addressed effectively, and internationally, over the longer term.

The reason why this is important is that, in Europe, ten of the last 14 years have been the warmest on record. In the 1960s, floods affected seven million people. It's now 150 million people. In 2002 we had severe floods in Europe which cost $16 billion. In 2003 in Europe we had a heat wave which led to 26,000 premature deaths and a cost of $13.5 billion.

Things are happening to our economy and people are telling governments to act. The difficulty with climate change is that, unlike the old air quality issues where individual towns could take steps and you could see a result pretty quickly, there is a mismatch between the political decisions that you take now and when you see the benefit of them. If we make decisions now affecting car use and the way we live our lives, we are not going to see a benefit in terms of climate change for a decade or two.

No country operating on its own can tackle global warming. It is a global issue and there needs to be a global consensus and a global initiative if we are going to be successful. One of the things that the Taskforce has been considering over the last two days here in Sydney is whether we can come up with a set of proposals which will inform the debate at the G8 next year. Our recommendations will be published towards the end of January 2005, at the beginning of the UK's presidency and chairmanship of the G8.

It will be a challenging program that we put forward to the world leaders, but if they have the courage to adopt it they will make a very real difference, not just to their individual nations, but to the world in which we all live. We are living through a period of prosperity—more jobs, a better quality of life for many people in the developed world. For developing countries however, climate change has disastrous outcomes—more famine, more floods, more people dying because of the extremes of climate conditions we are now experiencing.

We have an opportunity provided by Tony Blair in 2005 to make a real difference, and I am confident that the benefits will be felt by our children and our grandchildren.

Climate change—the state of knowledge

Dr Rajendra K Pachauri
Chairman of the Intergovernmental Panel on Climate Change
Director General, The Energy Resources Institute (India)

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organisation and United Nations Environment Program, and currently has a membership of 192 governments.

The IPCC has issued three climate change assessment reports, the last one being published in 2001. We are now working actively on the fourth assessment report which will be published in 2007. This fourth report will hopefully reduce some of the uncertainties surrounding climate change and fill in some of the knowledge gaps that existed in the earlier reports.

The temperature of the earth

Over the past 1,000 years, the average surface temperature of the earth (in the northern hemisphere) did not vary significantly from the average recorded for the period 1961 to 1990. Since the start of the industrial revolution however, it has deviated sharply upward and today we remain well above that average.

What has kept the earth in a balance and temperatures at levels that have allowed all species to survive is the re-radiation back from the earth of part of the vast amount of solar radiation it receives. The increase in concentration of greenhouse gases associated with climate change means that part of the radiation which would have gone back into outer space remains trapped in the earth's atmosphere with the consequent effect of warming of the earth.

This process of warming is not a linear or steady change or trend. Once the balance of nature is disturbed, all kinds of non-linear or abrupt changes can take place, meaning a greater likelihood of much more severe and frequent climate-related impacts and events.

Indicators of a warming earth

Key indicators that the earth is becoming warmer include:

- an increase in global mean surface temperature estimated at 0.6 degrees Celsius since the beginning of industrialisation
- a decrease in the Arctic Sea ice extent by 10% to 15% and its thickness by 40%. The recently released Arctic Assessment Report raises some alarm as it now appears that climate change in the Arctic region is perhaps much faster than what was anticipated earlier. This could have very serious implications for the rest of the earth.
- a decrease in snow cover area by 10% since observations started in 1960
- bleaching of coral reefs, in some cases beyond any possibility of a reversal
- worldwide, the 1990s have been the warmest decade in the millennium
- an increase up to 1999 in the atmospheric concentration of carbon dioxide, the most important greenhouse gas, by 31%. Today's concentration has not been exceeded perhaps during the past 420,000 years, nor likely the past 20 million years. The average rate of increase since 1980 has been 0.4% annually, though recent evidence indicates this has accelerated in the last five years.
- an increase since 1750 of nitrous oxide concentrations by about 16%. Since 1980, these have been increasing at around 0.25% annually.

The IPCC's third assessment report concluded that there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities. We also now know that emissions of carbon dioxide from fossil fuel burning are virtually certain to be the dominant influence on the trends in atmospheric carbon dioxide concentrations during this century. If we want to bring about a change and somehow stabilise the earth's climate, we therefore need to reduce levels of carbon dioxide and other greenhouse gases.

Impacts of climate change

An increase in temperature, changes in precipitation and sea level rise are key impacts. Human health is also likely to be affected—vector borne diseases would increase as would weather-related mortality and air quality respiratory illnesses. The yields of crops would likely go down and there would be greater demands for water as a result of increased temperatures, with serious consequences in terms of greater water scarcity in different parts of the world and a worsening of water quality.

Coastal areas are particularly vulnerable. Small island states don't necessarily have to be inundated by sea level rise before people start moving away as environmental refugees. Storm surges, cyclones and other extreme weather events would make it very difficult for people to remain there because of the huge threat to life and property.

There is also a danger for species and natural areas. An IPCC technical paper on climate change and biodiversity indicates the threat to biodiversity has already reached a point of grave concern.

The inertia of the climate system means that some impacts of anthropogenic climate change may be slow to become apparent, and some could be irreversible if climate change is not limited in both rate and magnitude before associated thresholds, whose positions may be poorly known, are crossed. It is possible that we are already very close to those thresholds and the resultant impacts of crossing them could be extreme, abrupt, harmful and irreversible.

The most important issue is the impact on sea level rise. There are two factors which lead to this:

- temperature increases which lead to expansion of the oceans, and
- melting of the large ice bodies.

These and other impacts of climate change could continue for centuries if not millennia, that is, long after emissions are reduced, which highlights the importance of taking early action. We may have committed to a certain level of impacts already, but these impacts will become more severe and frequent such that the extent of danger to life and property would become increasingly more serious.

The impacts of climate change will also fall disproportionately upon developing countries and poor persons within all countries, thereby exacerbating inequities in health status and access to adequate food, clean water and other resources.

The threat to food security is of particular concern. Populations are increasing, especially in Asia. By 2050 for instance, 42% of the world's population will be concentrated in India and China. Climatic variability and change over this period will seriously endanger sustained agricultural production in Asia. China could therefore become a major importer of food and food grains which will have impacts for food security throughout the region.

Adapting to and mitigating climate change

Given the inertia of the climate system and the nature and extent of impacts that are likely to take place, the world will have to adapt to climate change. There are two types of adaptation measures: planned and anticipatory, and autonomous and reactive. Societies and governments have to decide to take the first set of measures. In the case of agriculture for instance, we need much greater research and development on drought prone crops and species, and greater effort in managing water resources. This requires a long term strategy whereby investments can be made in actions and programs that would have desirable outcomes over a period of time.

As for mitigating greenhouse gases, it is commonly believed that the cost of taking action would be too heavy for many countries. The cost of inaction however, will also be unaffordable. The IPCC has estimated that by the year 2050, to stabilise carbon dioxide emissions at 450 parts per million, the reduction in GDP would at most be about 4% in that particular year, based on our knowledge of existing technologies. Technological development often outstrips human imagination though, so with greater human effort, it is likely that the costs will be much lower.

Carbon dioxide emissions are the product of the GDP of a country, the energy intensity of the country, and the carbon intensity of the energy that is used. If you reduce energy intensity you reduce end-use demand and increase efficiency in the use of energy. To reduce the carbon intensity, you have to move to low carbon intense sources of energy. This means moving away from conventional fuels to renewables. Australia has enormous capabilities in this area.

Integrating climate change concerns in larger development plans is also critically important. Transport and energy generation are two areas that we need to focus on. The share of transport in global oil demand is increasing, which is a concern. The demand for oil is growing at a rate which would require only a small number of countries in the Middle East to meet that additional demand, and that has geopolitical considerations that we need to take into account. There is therefore a coincidence between objectives related to climate change and ensuring energy security.

The vehicle stock is going to change substantially with the big increase in car ownership taking place in non-OECD countries. It is therefore important to develop transport systems that rely essentially on public transport technologies so that people have options other than using passenger cars.

If China, India and other developing countries were to follow the pattern of per capita oil use for transport of OECD countries, the earth would be polluted to a point where we could be facing disaster. The transport sector is therefore one particular area where we need a global approach of investing in public transport systems that would provide options to various regions of the world.

We need to emphasise the fact that actions that require mitigation of climate change also have substantial local benefits. With public transport for instance, these include eased congestion and lower air pollution. There are many key linkages between mitigation and development that need to be highlighted. Given the large social benefits, some of these actions require intervention and progressive policies by the State.

Climate change also has major linkages with sustainable development. If we address the problem of climate change we would also be promoting a pattern of sustainable development. Mahatma Gandhi said, "if you really want to see change in the world then you've got to be the change you want to see in the world".

Climate change—the future challenges

Dr Clive Hamilton
Executive Director, The Australia Institute

The debate about climate change is spreading to new areas. Recently attention has focused on the security implications of global climate change. Earlier this year *The Observer* newspaper in London reported a leaked report titled 'An abrupt climate change scenario and its implications for United States National Security'. Surprisingly it was commissioned by the Pentagon and it painted a picture far scarier than even the most rabid environmentalists would dare. The plausible scenario outlined by the report's authors considers a world dramatically affected by climate change with large changes in average temperatures, rainfall patterns and the incidence of drought and storms. It focuses particularly on food security and the implications for countries like Australia if crops persistently fail in developing countries leading to famine and mass migration.

The Pentagon report paints a bleak picture of a humanity reverting to constant warfare over diminishing resources. It canvasses the possibility of persistent conflict in South East Asia, India and China including border wars, nuclear brinkmanship and civil unrest. Instability in the region may lead Japan to re-arm and the USA to strengthen border protection to hold back waves of 'unwanted starving immigrants'.

For Australia, the most startling claim of the Pentagon report is that we, along with the United States, may find ourselves building 'defensive fortresses' around our country to protect our resources from desperate outsiders and aggressive states created by rapid and unpredictable climate change.

Action on climate change has always been driven by scientific research and there is little doubt that the science will only move in one direction—making more refined, more accurate and more alarming warnings about the effects of human-induced climate change. The recent interest in abrupt climate change is particularly worrying.

On the policy and political front, there have been three big developments recently in the international climate change regime, each with profound implications for Australia.

Firstly, on 1 January 2005, the European Union (EU) will implement a cap and trade emissions reduction program. It will be the biggest and boldest pollution trading scheme ever conceived and its success is critical to the future of international efforts to tackle climate change. The first or 'warm up' phase, applying to the new EU complement of 25 countries, will run until the end of 2007. The second phase will begin in 2008 and end in 2012, coinciding with the first commitment period of the Kyoto Protocol.

Under the EU's emissions trading directive, member states are required to set an emissions cap for all installations covered by the scheme and it is estimated that 12,000 installations, accounting for 46% of total EU CO_2 emissions will be covered. The implementation of the scheme will transform the business environment in Europe and provide tremendous momentum for continued action on climate change.

Secondly, the Bush administration in the US remains in the grip of the more recalcitrant elements of the fossil fuel lobby and seems at times at least to be ideologically opposed to taking action on climate change. When asked in 2001 if the President would be urging Americans to restrain their energy use, Bush spokesman Ari Fleischer replied, "That's a big no." He went on to declare, "The President believes that it's an American way of life, that it should be the goal of policy makers to protect the American way of life. The American way of life is a blessed one. The President considers that America's heavy use of energy is a reflection of the strength of our economy, of the way of life that the American people have come to enjoy."

Fortunately President Bush's fundamentalism on this issue is out of step with mainstream opinion in the US, and that opinion is likely to be translated into serious domestic action to reduce emissions.

Last October a group of powerful Republican Democrat senators introduced the McCain-Lieberman Bill to the US Senate as an amendment to the Climate Stewardship Act. This would have required major emitters in the US to adhere to mandatory economy-wide emission caps, and the fact that it was introduced at all represents a

radical break from the view that the US is irredeemably opposed to tackling the problem of climate change. The Bill would have introduced a cap and trade system across the US, beginning in 2010 in the first instance, and proposed to cap emissions at year 2000 levels over the period 2010 to 2016. In subsequent years they would be reduced to 1990 levels. The proposed program would have covered more than 70% of US CO_2 emissions and other industrial greenhouse gases.

The Senate vote on the McCain-Lieberman Bill was lost 43 to 55. All observers were astonished at how narrowly it was lost and how close the US came to having a far reaching bipartisan mandatory program to cut greenhouse gas emissions. Some senators who voted against the Bill nevertheless spoke in favour of it. They made it very clear that they knew the US had to act soon and they didn't want to be the ones to go down in history as the law-makers who stopped action on this huge global problem.

The closeness of the vote reflected the sharp change in views on climate change in the US, which indicates that the Bush administration's hostility is out of step with the rest of the community. Washington observers believe that a similar Bill will be introduced again in the next three or four years, and there is a strong likelihood that it will become law.

The third recent big development is Russia's ratification of the Kyoto Protocol. When the Protocol enters into force in early 2005, everything will shift. The stakes will suddenly be much higher, especially for those who remain outside of the international system. There is no way that Japanese and European firms are going to allow Australian and American firms that have a competitive advantage arising from the absence of any obligation to cut their emissions, to undercut them in markets at home and abroad. With the Kyoto Protocol coming into effect, the desire, both internationally and at home, to find a way for the US and Australia to become part of the system will therefore increase. Where will the Kyoto system and more broadly international efforts go? There are a few key structural issues that any development of future climate change regimes must consider. Driven by the climate science, the international community is increasingly concerned about the need to set a long-term emissions reduction target and develop long-term strategies so as to prevent (some of the) dangerous climate change. Among the long-term targets being discussed is limiting emissions so that the global mean temperature doesn't increase by more than two degrees Celsius. Another proposal is to limit increases in carbon dioxide concentrations in the atmosphere to 450 or 550 parts per million.

A second issue which is of increasing concern is how to deal with uncertainty. Any effective climate regime must accommodate the uncertainty associated with human-induced climate change. It must be sufficiently flexible to allow for changes in scientific understanding and for sudden and unexpected changes in global climate. There is an increasingly strong case to build into any future regime the ability for an emergency response to catastrophic climate change, including the abrupt climate changes now attracting the attention of scientists.

The issue of fairness is the perennial and most difficult one in climate change negotiations. The refusal of Australia and the US to ratify the Kyoto Protocol has been justified by arguments that the Protocol is unfair, although those arguments carry little force elsewhere in the world. But within the international debate, various, often conflicting, notions of fairness have dominated discussions. Fairness in international climate change regimes has been taken by various parties to reflect any one of a number of considerations: historical responsibility for emissions, current emissions per capita, perceptions of the right to development, capacity to pay, special national circumstances and, of course, inter-generational equity.

The final point that has to be acknowledged is the very wide differences in political influence among nations engaged in the negotiations. Developing countries are particularly disadvantaged due to their weaker economic power and the difficulties that many have in providing the expertise and resources to participate effectively and reflect their interest.

As for the Australian government's position on climate change, it claims a major reason for refusing to ratify the Kyoto Protocol is that our fossil fuel dependence makes it harder and more expensive for us to cut our emissions. A little thought reveals that in fact the opposite is more likely to be the case. The cost of reducing emissions by say 10% depends not on how much fossil fuel you burn, but how efficiently you burn it. If a country burns fossil fuels inefficiently, then it will be much cheaper to reduce its consumption of fossil fuels. Exploiting such opportunities actually provides us with a tremendous financial opportunity through an international emissions trading system.

The government argues that Kyoto is not in our economic interests. After the negotiations to refine the Protocol at Marrakech in November 2001, the government commissioned new economic modelling of the expected economic impacts of Australian ratification. The modelling, conducted by ANU economist Warwick McKibbin, concluded that the economic cost of the Kyoto Protocol will be higher if Australia does not ratify the treaty than if it does.

It concluded that by 2010 Australia's GNP would decline by 0.4% if Australia stays out of Kyoto, but only by 0.33% if we actually ratify. This is because actions by other countries, such as Japan reducing its coal imports from Australia, will have negative economic consequences. If accurate, these results completely demolish the rationale for Australia staying out.

Modelling through to 2020 concluded that if Australia refuses to ratify we would be economically better off with our real GNP falling by 0.3%, compared to a 0.5% fall if we do ratify. This 0.2% difference in GNP by 2020 however, is a disappearingly small amount that will be outweighed several times over by the statistical error in measuring GNP.

According to McKibbin's modelling results, under business as usual, Australia's real GNP will exactly double on the 1 December 2020—it will rise from US $402 billion to US $806 billion. If we ratify the Kyoto Protocol, then with existing policies, our GNP would double at the end of January 2021, a delay of eight weeks. It is this eight week delay to become twice as rich that is the basis for the repeated stories about the huge economic cost that we face by participating in these international efforts.

The Australian government also claims we will meet our Kyoto target without ratifying. The fact is that the rapid increase in Australia's greenhouse gas emissions from stationary energy and transport have been exactly offset by the decline in carbon dioxide emissions from land clearing. This has nothing to do with Federal Government policies to cut emissions from stationary energy and transportation.

The government further argues that Australian ratification wouldn't make any difference, as we contribute only a small percentage of total greenhouse gas emissions, though we should note that Australia does have the highest per capita greenhouse gas emissions of any industrialised country, 25% higher than the US. Australia's total greenhouse gas emissions are actually almost the same as those of Italy and France, and not much lower than those of the UK and Canada. If Australia's emissions are too small to make any difference and we therefore shouldn't ratify, then nor should Italy, France, UK or Canada bother to reduce their greenhouse gas emissions.

Australia really is missing out on a unique opportunity to participate in this global process of de-carbonising the world economy and we are going to suffer grievously from our unwillingness to participate in this process. The realisation that we will suffer, particularly the business and environmental implications, will compel the Federal government to resume negotiations so that Australia too can play its part in tackling this most serious environmental problem.

Climate change and bushfire incidence

Dr Geoff Cary
School of Resources, Environment and Society
Australian National University

This presentation describes the relationship between climate change and bushfire incidence, including the implications for air quality.

Bushfires and emissions

The complete combustion of vegetation comprised of pure cellulose would release only carbon dioxide, water vapour and thermal energy. Vegetation is not comprised purely of cellulose however, and its combustion is almost never complete. Every fire that you see has a smoke plume, which is the emission of particulate matter, or the incomplete products of combustion, into the atmosphere.

Smoke particles have a life of hours to weeks and they generally become adhered to surfaces or are intercepted by rainfall. Fire emission rates are affected by fire behaviour and the amount of fuel being burnt. Head fires (particularly fast moving fires burning heavy fuel loads) might emit up to 1% of the fuel load as particulate matter to the atmosphere. Bushfires therefore clearly have a significant effect on air quality. Given this relationship between bushfires and air quality, we need to know how fire regimes will change with time and with climate change.

Climate change and bushfire danger

The forest fire danger index (FFDI), which was developed in the mid 1960s, is a measure of the likelihood of a fire starting, its rate of spread and its difficulty of suppression on any particular day.

Beer & Williams (1995) analysed the likely changes in the annual sum of the FFDI between a current carbon dioxide concentration climate (1 x CO_2) and that where the carbon dioxide concentration doubles (2 x CO_2). They found an increase in the annual sum of FFDI across much of Australia, particularly in the South East (Figure 1).

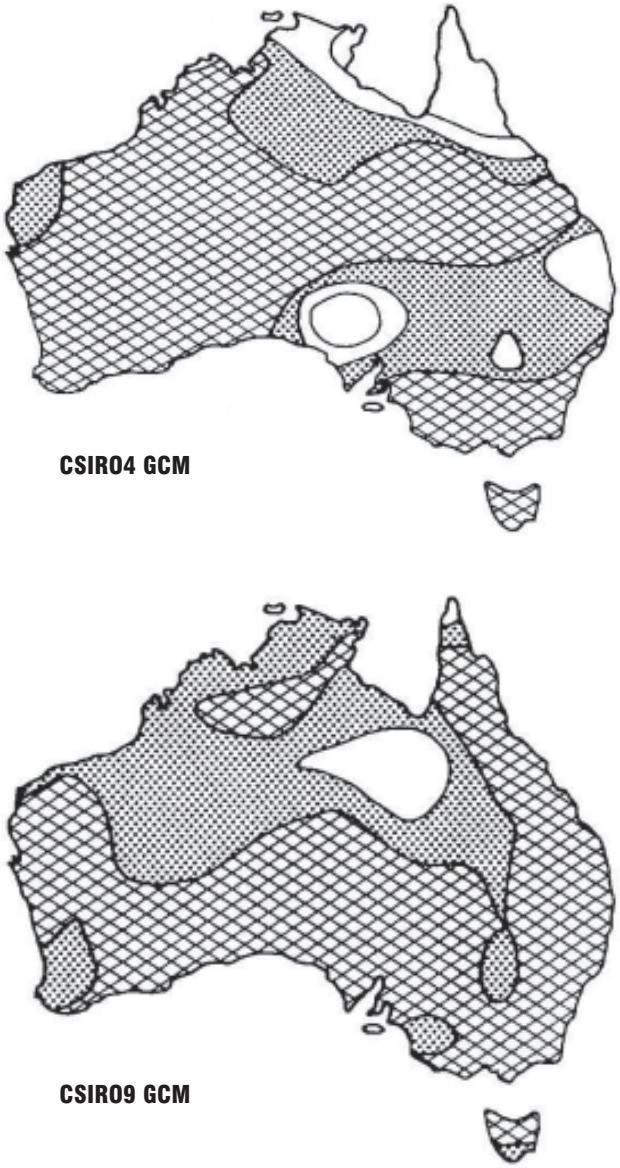

Figure 1: Changes in the annual sum of FFDI: 1 x CO_2 to 2 x CO_2 (Beer & Williams 1995)

Cross-hatched areas indicate an increase in expected annual sum FFDI of greater than 10%

Dotted areas indicate a likely increase of up to 10%

Blank areas indicate a decrease

Williams et al. (2001) also looked at the distributions of fire danger rating days for a range of specific sites in southern and northern Australia and found a general trend towards a decreasing frequency of low and moderate fire danger rating days, but an increasing frequency of very high and in some cases extreme fire danger days.

The FFDI can be used to predict the likelihood of having destructive events. Bradstock & Gill (2001), for example, studied 40 years of newspaper records from 1955 to 1995 and found that the probability of a house being destroyed by bushfire in the Sydney region rises to 100% once the forest fire index reaches 40.

Knowing the FFDI will not enable us to predict the effects of bushfire on everything we value, including biodiversity and vegetation. *Banksia ericifolia* for example, which is a common species in the vegetation around the Sydney region, will survive under a particular suite of favourable fire regimes (i.e. frequency, intensity, seasonality of fire occurrence), whereas other (adverse) fire regimes may lead to the loss of the species from a site.

Air quality and fire regimes

Air quality and the way that we respond to it should be thought of in the terms of the fire regime—how frequently will there be bad air quality days because of bushfires and how intense will the impact on air quality be?

We can use simulation models (e.g. FIRESCAPE) to do this. Data including terrain type, empirical models of lightning fire and other fire locations, fuel dynamics, well-accepted algorithms of fire behaviour, and weather dynamics are inputs used to simulate the spread of fires across landscapes.

Fires are ignited in the landscape, they spread and become a discrete fire event that burns faster when the fire danger index increases, and slower when the fire danger index decreases. Fires also respond to wind direction, terrain slope, and fuel load and availability. They will eventually extinguish. These fire events can be overlaid through time to gain an understanding of likely spatial patterns of fire frequency, fire intensity and season of fire occurrence. Figure 2 is an example from a FIRESCAPE simulation for the ACT region. The warmer colours indicate intervals between fires of less than 20 years while the cooler colours indicate longer intervals of greater than 70 or up to 100 years.

Model output can be evaluated against things like dendrochronology studies and what we know about forest fire behaviour, to try and validate and generate confidence in these output predictions. We can also use these simulation models to consider the effect of climate change scenarios on bushfires.

In collaboration with CSIRO Division of Atmospheric Research, I analysed 1 x CO_2 and 2 x CO_2 climate scenarios for the ACT region in terms of monthly changes in temperature, daily wind speed, precipitation and humidity. Our conclusions were that we are expecting a warmer climate, and a decline in precipitation over the summer months and late autumn, but an increase in precipitation in spring and early summer. We are also going to see a decrease in non-relative humidity. Wind speed and wind direction remain largely unchanged. These are all factors that affect fire behaviour, fire danger and subsequently fire regimes in the landscape.

We next developed four climate change scenarios—no change in climate and small, moderate and large changes in climate—using maximum temperature increases of +0, +0.6, +2.0 and +3.4 degrees Celsius respectively. Minimum temperature, precipitation and relative humidity were scaled equivalently to the scaling of maximum temperature, and wind speed and direction remained unchanged.

Running the model with our current climate (i.e. from the 1980s up to 2000) to parameterise the climate and the weather generator in the model, we saw a particular pattern in fire intervals (Figure 2).

We can then change the weather parameters on a monthly basis according to the predicted changes in monthly climate averages for the moderate change in climate, and re-run the model holding all other parameters constant (Figure 3).

The frequency of fire is predicted to increase across all of the study landscape. This not an entirely unexpected result given that for warmer, drier fire seasons we would expect a larger area burned and a reduction in inter-fire interval.

Perhaps the most interesting result is the mechanism responsible for this increase in fire frequency. It is not the high-intensity fires that burn across the landscape, but the very low-intensity fires that are no longer as easy to suppress or self extinguish naturally because of the change in the fire weather over time with climate change.

Empirical evidence also supports these hypotheses. Ross Bradstock (unpublished data) looked at the relationship between soil dryness index on the day of ignition of a fire and the cumulative area burnt in the Blue Mountains between 1960 and 2003.

The soil dryness index is a measure of soil dryness and tells you how much soaking rain is needed to bring the

soil back to field saturation. It can also be considered a measure of the severity of a drought and can be related to the flammability of live vegetation, coarse woody debris and deep litter beds.

In the Blue Mountains study, a phase change was detected between a soil dryness index of about 60 and 70. We know from our own observations going back many decades that larger fires occur when droughts are more severe, but Bradstock's study quantifies what we might expect under climate change. The climate change scenarios for southern Australia are mostly increasing the soil dryness index, raising the question of how often will it increase above a threshold of larger fires given the particular climate change scenarios?

Bushfire emissions and management

Karen King (unpublished data), from the Bushfire Cooperative Research Centre, is studying the sensitivity of fire regimes to management and climate change in a mix of vegetation types across Tasmania. Some of these, like button grass moorland, are highly flammable while others, like rain forest, are relatively non-flammable.

An initial part of King's analysis is to use simulation models to investigate the relationship between the percentage of the button grass moorland subject to annual prescribed burning, as a management practice to reduce the area of unplanned fires, and the area of unplanned fires that actually occur. With increased fire management in the landscape there is a reduction in the area of unplanned fire.

When the 2070 climate is used in the model, the same basic relationship between management and area of unplanned fire is observed (i.e. the more you burn the landscape the lower the area of the unplanned fire). However, to maintain the same level of unplanned fire in 2070 as in 1980–2000, you need to burn more of the landscape with prescribed fire. The interaction between climate change and the amount of required fire management is therefore very important.

Management burning will also contribute to particulate emissions, possibly more than the bush fires that you are trying to prevent. Air quality is, therefore, affected by unplanned bushfires, and by the smoke from planned fires which are designed to try and reduce the risk of those higher intensity unplanned fires.

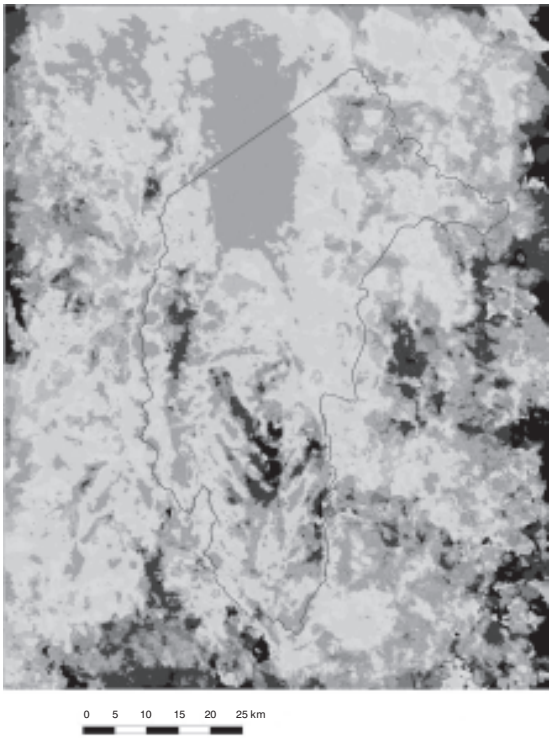

Figure 2: Average inter-fire interval from 500 year FIRESCAPE simulation assuming current climate from the Australian Capital Territory Region (Cary 2002)

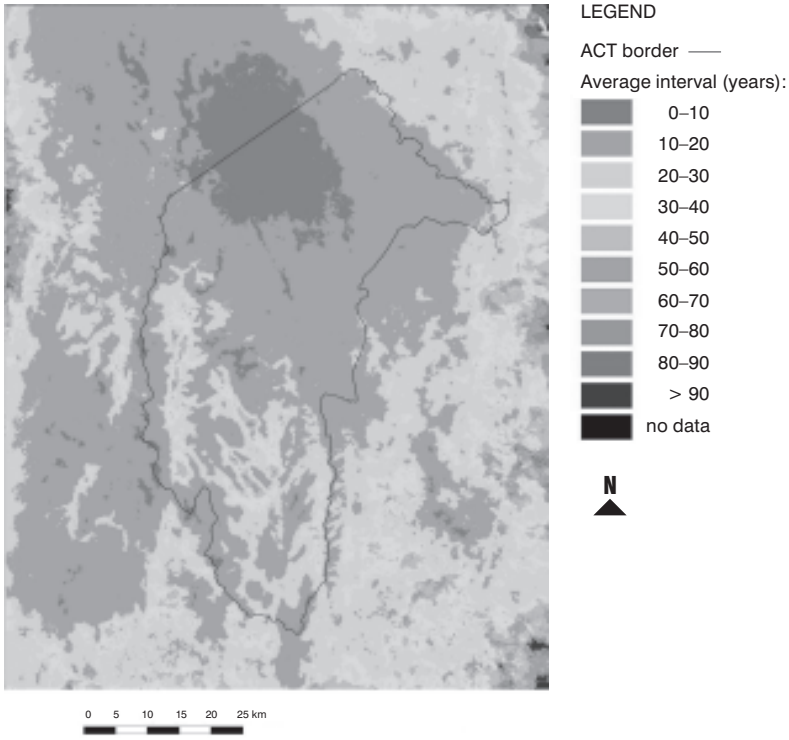

Figure 3: Average inter-fire interval from 500 year FIRESCAPE simulation assuming a moderate change in climate from the Australian Capital Territory Region (Cary 2002)

Optimal fire management research

The Bushfire Cooperative Research Centre, which is a joint venture between the Department of Environment and Conservation (NSW), the Australian National University and the University of NSW, is undertaking a seven year research project on managing bush fire risk in a changing world. The study areas—the Sydney region, the NSW southern tablelands, south-west Tasmania and central or arid Australia—give a range of climates and, importantly, a range of different values at risk, and different management solutions that might be applied to the fire management problem.

In the Sydney region there are many things we value and wish to protect—including people and property, water yield and quality, air quality and biodiversity to name a few. Fire management options include prescribed burning and fire suppression, and alternative suppression tactics, and interface management.

Our knowledge of simulation models is growing and is matched by parallel research in the US, Canada and Europe. We have an evermore sophisticated understanding of the potential impacts of increased CO_2 and other greenhouse gases on the world's climate. We also have knowledge on particulate emission rates from bushfires and models for the transport of air pollutants across large air sheds like the Sydney basin. In the near future we will be able to develop scenarios for air quality in the Sydney region with respect to fire management in the context of the broader things that need to be managed—people and property, biodiversity, water quality and yield—and given the influence of a changing climate.

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Climate change and health: impacts—and significance

Professor Tony McMichael
Director, National Centre for Epidemiology and Population Health
Australian National University

We have been concerned over the last 15 years about the impacts of climate change on the economy, recreational amenity and biodiversity. More belatedly we have become aware that there are very serious issues for the wellbeing and health of human populations, particularly those that are vulnerable in the poorer regions of the world.

It is no longer disputed by mainstream science that average climatic conditions in the world are going to change. The consensus view is that we have begun to see human-induced change in recent years. Climate variability will very probably change, and in varying degrees around the world. We must also expect discontinuity in the form of abrupt climatic shifts and abrupt environmental consequences. This poses an unfamiliar, serious and increasing risk to population health.

Our existing knowledge, which is still incomplete, enables us to estimate at least some of the health impacts of model scenarios of future climate. These will vary in type and severity, reflecting local vulnerability as a function of geography, socio-economic circumstances and demographic characteristics.

Climate change health impacts have a particular significance—they signify that we are on a non-sustainable path of disruption to earth's life-supporting systems. This is a very different environmental concern from our conventional environmental health hazards of local air pollution as a toxic hazard, the release of ionising radiation into the local environment, or pesticide residues in food that we consume. These we can study, directly estimate their effects, and take direct action to intervene and remedy them.

When we are talking about a change to the world's climate system though, we are talking about something that is operating on a different scale and through a different type of medium that involves the disruption of very complex processes and a range of consequences.

Global warming in Australia

The Australian Climate Group (2004), which is a group of eight scientists and several representatives from the insurance industry and environmental movement, reported in 2004 that, based on 50 years of Bureau of Meteorology data, there has been a decline in average annual rainfall in the eastern and south-eastern regions of Australia, and particularly in the south-west, where there has been a 25% decline over the last 25 years. This is believed to be due to a shifting of the rainfall regime to higher latitudes to the south such that much of the rain that previously fell on the land is now falling on the ocean. This trend is expected to continue, which is why Western Australia is now taking extraordinary measures to ensure their fresh water supply over the coming decades.

Looking to the future, CSIRO Atmospheric Research modelling predicts an increase in temperature across most of the country. For example, it is estimated that by 2030 the north-east coast of Australia (Cairns region) would be around 0.5 to 1.5 degrees warmer, and a further one and a half degrees warmer by 2070 (McMichael et al. 2003).

A collaborative report, by ANU, CSIRO Atmospheric Research, the Bureau of Meteorology Research Centre and several New Zealand colleagues for the Commonwealth Department of Health and Ageing, estimates how those likely climate futures in Australia would impinge on human health. We intend to build on this work by modelling not just changes in average conditions in the future, but also the changing variability of climatic conditions in Australia. This is important for identifying where and when we might pass critical climatic thresholds.

Impact pathways

There is a range of pathways by which a change in climatic conditions can affect elements of human exposures that would then bear either directly on human health, or indirectly via perturbations of various environmental systems, ecological processes and social

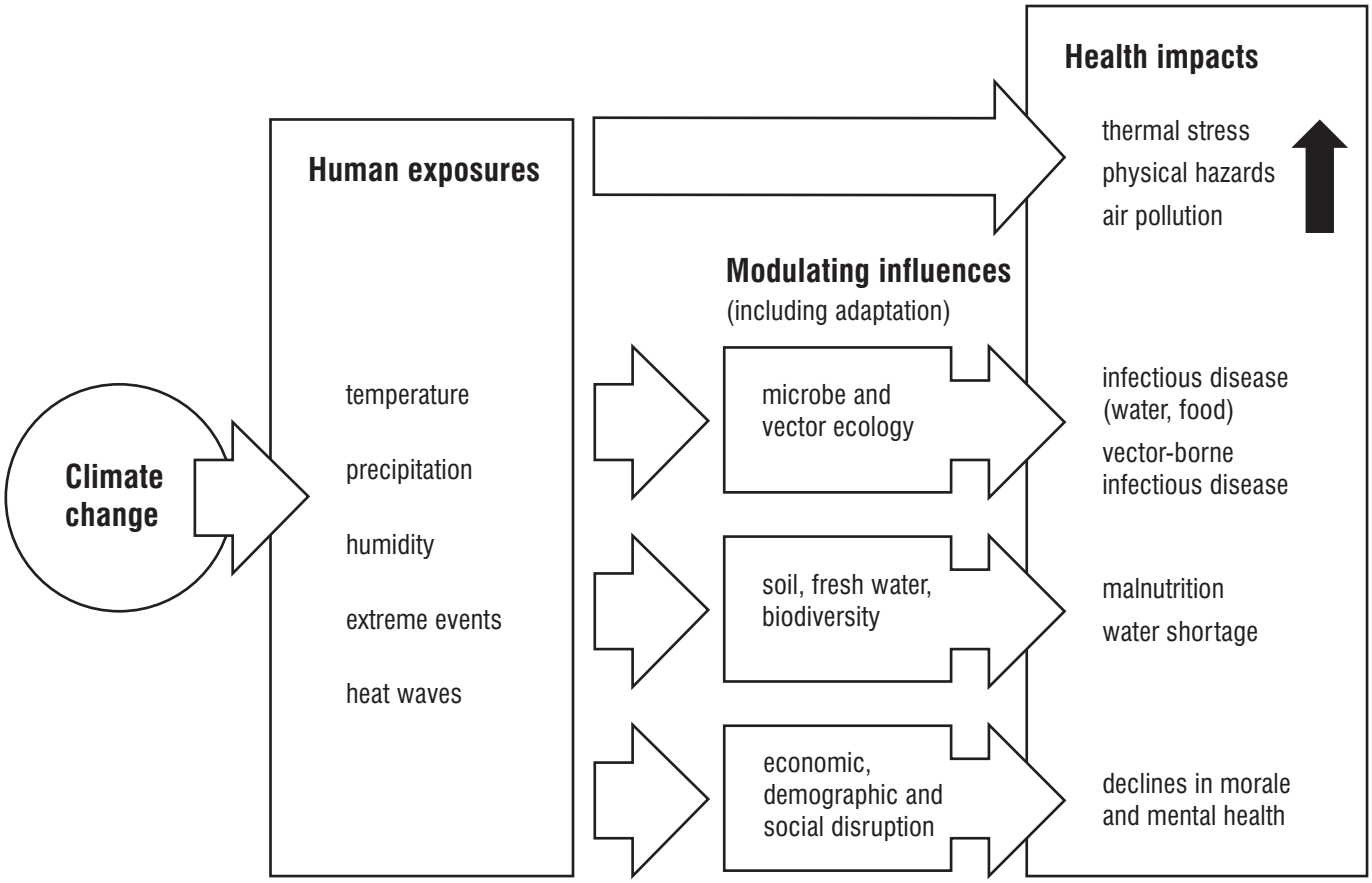

Figure 1: Pathways for climate change impacts

and demographic conditions (Figure 1). This includes disruption to regional food and water supplies, destabilisation of social and economic conditions in some parts of the world, and increased conflict situations and refugee flows with resultant adverse health consequences for both refugee and host populations.

Very many of these pathways are mediated by more complex disturbances which make quantification of the impacts difficult.

An actual example of climate change health impacts is the 2003 summer heat wave in Europe which led to around 26,000 excess deaths across the continent over a two-week period. France bore the brunt and Paris in particular, where there were an estimated 11,000 excess deaths. During this time, there was a quite marked increase in the maximum daily temperature, and importantly, the night time (minimum) temperatures, indicating lack of physiological relief overnight.

Most of the deaths were from heart attacks, strokes or respiratory failure. As always happens in heat waves, it tended to be the elderly and people with pre-existing cardiovascular or chronic respiratory diseases that were affected.

Empirical studies

Epidemiologists have three options in terms of understanding climate-related health risks better and for trying to foresee future risks: learning from the past; detecting the present; and predicting the future.

Learning from the past

We need to learn more about the relationship between climatic conditions and health. We are at the brink now of looking seriously for evidence of initial effects in at least some vulnerable populations around the world and we will use the information that we gain from these empirical studies to strengthen our capacity to predict the impact of future climate scenarios on human health.

As an example, we have modelled data from 1991 to 2001 of summer food poisoning from salmonellosis in Australia's capital cities and found a clear relationship

of a two- to three-fold increase in the risk of food poisoning at the high end of the temperature range compared to the low end (D'Souza et al. 2003).

We have also learnt in recent times how death rates respond to heat waves, how vector-borne infectious diseases like malaria, dengue fever and Ross River virus in Australia respond to temperature increases, and about the impacts of extreme weather events like floods, storms and cyclones which depend greatly on the vulnerability of the population and their location.

An interesting overseas study is that of the International Rice Research Institute on the impact of temperature changes on rice productivity, which found that yields fell by 10% for every one degree Celsius rise in mean night time minimum temperature (Peng et al. 2004). Such a diminution of food production and nutritional status is a concern as it has a range of adverse health consequences.

Detecting the present

It is perhaps a little early to detect any evidence of change in health patterns around the world, but there is indication that we are starting to see a change in the pattern of heat wave-related deaths. A better, more systematic multi-country study is needed to confirm this. Extreme weather events data are starting to look persuasive in terms of infectious disease spread:

- malaria is rising to higher altitudes in parts of eastern Africa
- warmer winters over the last 15 years in Sweden are associated with a progressive spread of tick populations and increase in the rates and intensity of tick-borne encephalitis
- there has been an intensification of the relationship between cholera outbreaks and the El Nino system in coastal Bangladesh.

Modelling future impacts

With respect to thermal stress, we can repeat in Australia analyses like those of heat-related deaths in Paris and, using CSIRO model projections of climatic conditions to 2050, estimate the annual heat-related deaths attributable to temperature rises per se, and to ageing enhanced susceptibility. It amounts to an extra 4,000 deaths on top of today's approximately 1,100 deaths per year attributed to heat stress (McMichael et al. 2003).

For vector-borne diseases like Dengue fever, climate change is important, but there are many other environmental and social changes that impinge on the breeding, behaviour and survival of the mosquito vector and therefore the risk of this disease.

Social changes include:

- post-1970 cessation of insecticide spraying
- decline in the public health system
- urbanisation and configuration of surface water
- intercontinental shipment of used tyres and other items containing mosquito eggs.

Environmental changes include:

- biodiversity loss, in particular, mosquito predators (e.g. birds, frogs)
- land use and forest clearing.

We are building up from a simple base towards having a better capacity to undertake fuller multi-varied modelling, but we are starting to get good estimates of how at least the climate factor will affect the transmissibility of dengue. In Australia, the disease could be transmitted by the vector mosquito, *Aedes Aegypti,* in the northern region of the country under current climatic conditions. Looking to the future for medium and high greenhouse gas emission scenarios, the region of potential spread of the disease would be increased (Figure 2, see next page).

Similarly with malaria, a one and a half degree Celsius rise in climatic conditions would increase the transmissibility of malaria around the world. In Zimbabwe alone, as we move to 2025, warmer conditions and changes in rainfall will see the spread of malaria into the central highlands, which are currently malaria-free, and by 2050 most of the country will be at risk. This will mean either a lot of disease, or a high cost to a tiny economy to control the disease.

Because of complex human culture and our limited capacity to buffer against change, few climate change-attributable health impacts are yet apparent, but impacts will inevitably increase over coming decades, especially in vulnerable groups. Health is the real bottom line of sustainability. If social, economic and environmental trends impair population health and survival, then we are on a non-sustainable trajectory.

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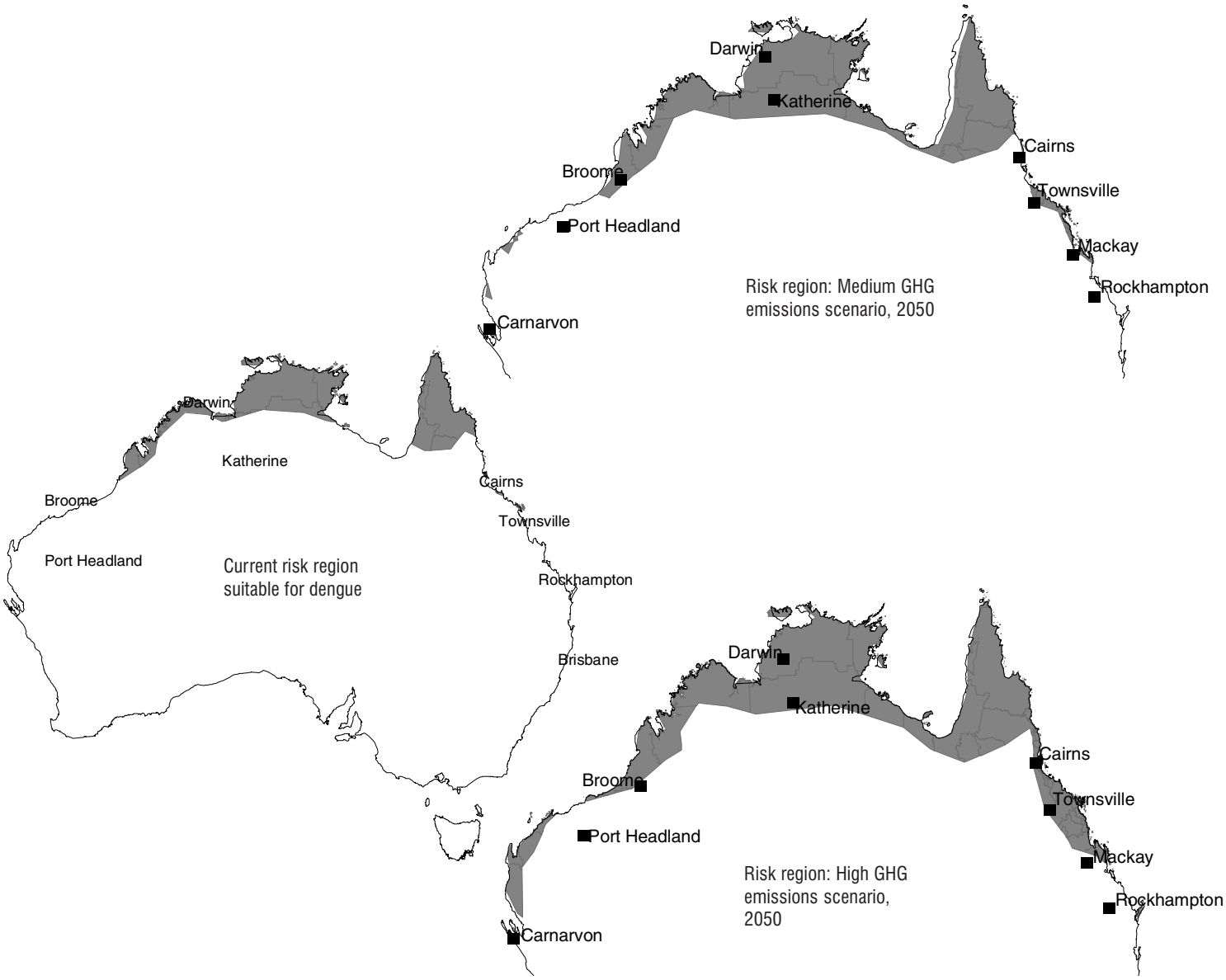


Figure 2: Estimated geographic region suitable for dengue vector—different climate scenarios at 2050 (McMichael et al. 2003)

Panel discussion

Panel members

Chair: Mr Martijn Wilder

Rt Hon Stephen Byers

Dr Clive Hamilton

Dr Geoff Cary

Professor Tony McMichael

Mr Roger Wilkins, Director General, NSW Cabinet Office

Mr Martijn Wilder: The UK is now a major player in emissions trading and the Kyoto Protocol, and Prime Minister Blair is heavily committed to these things. What will be the UK Government's approach to dealing with countries like Australia and the US who have not just said they are not going to ratify Kyoto, but who are trying to push Kyoto aside and look for alternatives?

Rt Hon Stephen Byers: The importance of Tony Blair having climate change at the top of the G8 agenda is that it will force the Bush administration to address the issue. Both the United States and Australia have had elections, and climate change and the environment were not big issues in either of those election campaigns. This means newly elected governments standing on a clear platform of not endorsing Kyoto, and begs the question of 'how do you engage these countries in the global challenge of climate change?'.

The International Climate Change Taskforce has been looking at what a new global framework which builds on Kyoto might look like. If Kyoto does go ahead because of Russia's ratification, the United States, which is responsible for 25% of all carbon emissions, and Australia will not be playing a part. Large developing countries like China and India are also not involved. We therefore need a new global framework which will involve everyone.

There is no point criticising Australia and the US for not ratifying Kyoto because they have taken a decision that has been endorsed by the electorate through their governments' re-election. We have to find a new avenue to try and re-engage them—this is the big challenge that lies ahead.

The UK and the European Union, by taking actions like introducing the emissions trading scheme from January 2005, are beginning to show that there is no economic case against such measures, that emissions trading does not adversely affect the competitive position of British or European businesses. We now need to get major multi-national companies like BP, Du Pont and Boeing in the United States, who are all very mindful of the importance of this issue, to begin to be strong and powerful advocates for measures to tackle global warming.

The insurance sector and financial institutions in America are beginning to bring political pressure to bear because they are paying a heavy cost for the extreme weather conditions now being experienced in the US. The hurricanes which hit Florida and Louisiana in September for example, have cost the insurance sector an estimated US $45 billion.

Mr Martijn Wilder: The Australian Environment Minister recently said that Australia needs up to a 60% cut in emissions but he hasn't said how this will be achieved. What needs to be done to achieve these reductions in a fairly rapid timeframe?

Dr Clive Hamilton: There is a view that, sooner or later, if we invest enough in new technologies like geo-sequestration we will be able to solve the problem. But we have the technologies now to make huge reductions

in emissions through energy efficiency and the use of renewables and more highly efficient gas. What we lack is the vision and the will.

Mr Martijn Wilder: So how will we actually achieve a 60% cut by 2050?

Dr Clive Hamilton: The modelling broadly shows that we can offset the emissions increase that will inevitably occur in our energy use through energy efficiency. To cut emissions by 60%, we need to take advantage of the range of renewable and low-emission technologies that are currently available—extending solar energy and wind power, and much wider use of gas and biofuels. The political problem is that people who are concerned about the environment still don't understand climate change and therefore object to things like the installation of wind farms. Although we will have to suffer some environmental pain in the form of landscape alteration, the analysis has shown that this is achievable with some effort—even without new technologies. These should make the task much easier, and will emerge onto the market in the next 10 to 20 years.

Mr Martijn Wilder: In NSW two of the major sources of greenhouse gas emissions are the transport and energy sectors. What is the best way to manage the increased demand for energy and transport and at the same time, also manage the increased emissions that come from these sectors?

Mr Roger Wilkins: In international negotiations we are often tied up in a range of arguments between two different but non-exclusive schools of thought:

- emissions trading as part of a strategic approach to using economic instruments—this would set a policy context where the market responds to problems if given the right incentives and where externalities are built into the prices, and
- a set of policies and measures for reducing emissions over the longer term.

The first approach would be better as an overall strategic position—this is what we are seeing in Europe. Ideally, an emissions trading scheme should emerge at a national level in Australia, but allow the States room to deal with problems concerning possible variations between them (mainly in relation to compliance). This would also enable us to take advantage of the trading opportunities offered by Kyoto, if we signed up.

Nevertheless, in the absence of a national approach by the Australian Government, NSW through a cooperative effort with the States is trying to develop a State-based emissions trading scheme. Integrating it with energy policy is a significant challenge but should be possible. The big issues for the Premiers will be creating a constituency for change.

There is emerging demand from business—insurance companies, banks and people wanting to invest in a whole range of undertakings—for certainty in the regulatory framework. They need this to continue doing business and make investments.

Mr Martijn Wilder: Many people take the view that emissions trading is the main policy tool to deal with reductions in greenhouse gases. However, in the EU scheme, the emissions trading scheme only covers 45% of emissions, so a range of other policy measures do need to be adopted.

It has been said by sceptics that a warm climate is better for human health and that in the past the earth's climate has been warmer. They also argue that statements that Kyoto harms ecology and health are actually propaganda. Health is a significant impact of climate change. How do we get the public and the public sector to recognise this and take it into account?

Professor Tony McMichael: I would say the residue of public sceptics with respect to climate change in Australia, at least those that are quoted a lot in the media, tend disproportionately to be people that don't understand natural systems like eco-systems and climate systems. They tend to be economists and statisticians and this Russian guy is a good example of this. He says it's all propaganda, he says that climate change science itself is propaganda and so I'm not surprised that he says that ideas about adverse health impacts are also propaganda.

Those of us aged over 35 or 40 came through educational systems that paid no attention to ecological systems in the natural world. We think mechanistically and are unable to imagine that a change in the world's climate and in dependent ecological systems would then have impacts on the provision of goods and services upon which human health and survival is predicated. Food does not grow in supermarkets and good health does not come from doctors. These things are a function of the environmental and ecological conditions that are available to us in the medium to long term. Somehow we have to gradually get this message out so that people will talk this language and understand it. To date this has been difficult and human health has only been a later element in the public discourse on climate change.

Mr Martijn Wilder: Part of the challenge is that often the climate sceptics get as much media exposure as everybody else. Politics appears much greener in Europe than other parts of the world with leaders like Tony Blair being seen to make a difference. Is this the difference between the European and Australian and US approaches to climate change?

Rt Hon Stephen Byers: There are no green representatives in the UK House of Commons or House of Lords. Climate change is therefore largely below headline political priorities like the economy, immigration, the health service or the school system. But it is a factor in people's minds regarding their quality of life. Europe is very highly and densely populated with different cultures living very close to each other. There is therefore probably a different perspective on climate change because of this compared to the United States and Australia.

Dr Clive Hamilton: The media gives an ear to the fossil fuel lobby and conservatives who are opposed to Kyoto and so promotes the views and gives credibility to a handful of sceptics without any scientific credibility. They have effectively created the impression that the scientists are divided, but they are not. There is the most extraordinary process through the IPCC which accommodates all credible views and pieces of analysis to reach a consensus view, and this view is very worrying.

The media love sceptics because they generate debate. It is profoundly irresponsible of the press to focus on an apparent 'good' stoush amongst scientists because it trivialises the real problem. You could still find in the 1970s credible medical specialists who would claim there is no connection between smoking and lung cancer. Eventually the evidence proved otherwise and anyone who said this now would be regarded as a crank. In 10 years time the same will apply in climate change science.

Mr Martijn Wilder: To what extent are people equating the Canberra bushfires with climate change?

Dr Geoff Cary: There has been a lot of debate on this. The major drought associated with the January 2003 fires in south-eastern Australia was the warmest and windiest on record. There has been a shift from what we understand regular fire weather to be, going back hundreds of years, into a new domain. Some have tried to use the fires to argue about prescribed burning and suppression strategies, but this recent drought and weather were somewhat unprecedented and may be indicative of the future.

People have a reasonable understanding of this. In Canberra they are bombarded with fire information almost every day, which has meant a growing understanding that there is a residual risk associated with bushfires and that you cannot prevent all bushfires. We also will never be able to put enough money into an engineering-type solution. You are seeing this understanding reflected in some of the reports that are now coming out.

The extent to which the 2003 fires were related to climate change cannot be determined. Climate change is a transient thing—you don't go from a 1 x CO_2 type atmosphere to a 2 x CO_2 overnight. Changes will be very small but incremental.

Mr Harold Scuby, Pedestrian Council of Australia:

- Four wheel drives come into this country at 5% tariff and much cleaner, smaller cars come in at 15%. What can NSW do to reverse this tariff position?
- The fringe benefits tax system encourages motorists to drive further to lower the tax and many middle and upper management people are being offered cars as part of their tax package. What can NSW do to reverse this trend?
- Hundreds of cities around the world have a car-free day yet not one capital city in Australia has even started talking about it. What can we do to get Sydney to have the first car-free day in Australia?

Mr Roger Wilkins: Regarding tariffs, all a State government can do is bring in better targets and greener fleets. There is not much we can do in terms of private motorists. As for the FBT issue, the Government is showing leadership in the way it handles its own fleet of cars. Some people will need four wheel drives—National Parks and Forestry staff—but generally they should not get through the type of rating that we have for progressively bringing in green vehicles.

Rt Hon Stephen Byers: Authorities like the State government can lead by example. The difficulty with a tax regime is that people often see it as a way of raising revenue, not a means of influencing the way they do things.

For example, speed cameras in the UK have been introduced to stop people driving too quickly and killing other people, particularly children. Via the media, speed cameras are just seen to be a way of raising revenue—a stealth tax on drivers. So even though they are saving lives everyday, the public is against them. Now the government is having to remove speed cameras from certain areas because of the public outcry against them. Candidates are even winning seats in local government on campaigns against speed cameras.

If the government leads by example though, and introduces various measures in its own fleet of vehicles, it will be in a stronger position to make the case.

In terms of car-free days, you need to convince people it is worthwhile. In London we go car-free in particular localities (e.g. Trafalgar Square, Parliament Square), but not the whole city. This works pretty well because although people may have to avoid certain areas, they can still use their cars. People are also encouraged to use

public transport, for example, by offering cut price fares on the Underground system. People need to be engaged, and made aware of why the government is doing certain things, and leading by example is particularly important for this.

Dr Clive Hamilton: The 5% import tax concession on four wheel drives will be phased out in the next few years. We have to recognise however, that the purchase of four wheel drives is not very price sensitive. Marketing analyses carried out by four wheel drive manufacturers show that purchasers of these vehicles tend to be insecure and self-centred people, and the manufacturers market four wheel drives specifically to appeal to those characteristics of those people.

The issue is not so much price differences, but imposing special licences on people who drive four wheel drives. These are specialised, dangerous vehicles and you should pass an advanced driving test in order to be able to drive one. We also need a public vilification campaign of people who drive four wheel drives. Eventually they will not be seen to be free, independent spirits but people who make pathetic attempts to cover up their own inadequacies.

Mr David Butcher, Greening Australia: Is it probable that plant and livestock diseases are a significant part of future climate change impacts, not only for those particular plants and animals, but also for humans in terms of nutrition and health?

Professor Tony McMichael: This is a long and complex causal sequence and its impact could be quite great. The work that has been done so far in looking at how climate change would affect, for example, crop production, has been limited to factors affecting the physiology of the plant—temperature, soil moisture— and therefore photosynthetic activity and production.

It leaves out those things that are much less straightforward and linear and which have stochastic characteristics such as the likely effect of a change in climatic conditions on patterns of pests and diseases. We know that those probabilities will change, they just can't be modelled. If they do change we also know that they could be catastrophic. The science is currently working more with shifts in mean conditions than with changes in variability, and is not taking account of abrupt changes and the stochastic consequences, like those for plants and livestock.

Climate change and air quality: implications for NSW

Dr Tom Beer Coordinator, CSIRO Environmental Risk Network

Introduction

The term 'climate change' refers to the possible impacts, including global warming, arising from the increase of greenhouse gases in the atmosphere. This presentation examines one impact—air quality—and how it relates to NSW and to Sydney in particular.

The structure for the presentation is based on an environmental risk framework (Beer 2003) known as the Budapest Manifesto framework (www.iugg.org/budapest.pdf) which contributes to decision-making. The manifesto suggests the following steps to examine technical and social issues related to sustainability:

- anticipating man-made and natural risks through widespread **consultation**
- determining **concerns** by using risk assessment techniques for various scenarios
- identifying the **consequences** by systematically cataloguing hazards
- undertaking **calculations** with appropriate models
- evaluating the **certainties**, uncertainties, and the probabilities involved in the calculations of the vulnerability and of the exposure
- **comparing with criteria** to assess the need for further action
- determining and acting on options to **control**, mitigate and adapt to the risk
- **communicating** the results to those who need to know
- promoting and guiding **monitoring** systems to collect, assimilate and archive data relevant to the determination of sustainability and risk, now and in the future
- integrating the knowledge and understanding from all relevant disciplines to provide society with the tools to **review** the sustainability and the risks of proposed policies and plans.

Context

The context can be found in the various *State of the Environment* reports produced by the NSW (Environment Protection Authority 2003) and the Federal (Manins et al. 2001) governments—as well as in many other publications such as the various studies of alternative fuels that CSIRO has carried out (Beer et al. 2001, 2003, 2004).

Concerns

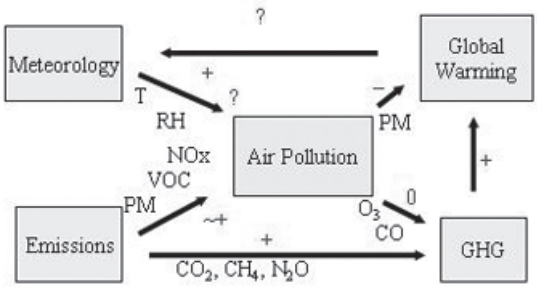
The concerns are that an increase in greenhouse gases leads to a greenhouse effect that manifests itself through global warming which leads to climate change and this climate change, by affecting the meteorology, has air quality impacts. In addition, we need to be aware that air quality can also influence the greenhouse effect directly through the emissions of greenhouse gases, and indirectly through the role of aerosols.

Consequences

The consequences that Hennessy et al. (2003) examined are: smog, bushfires, particulate matter, pollen and asthma. This presentation will concentrate on greenhouse gases and smog issues. The two determinants of air pollution are emissions, and the local meteorology. Figure 1 illustrates this by showing meteorology and emissions as boxes on the left with arrows leading into the box marked 'Air Pollution'.

Calculations

Figure 1: Interaction between air pollution and global warming



The '+', '-', '0' and '?' represent whether the link exacerbates (+), mitigates (-), is neutral (0) or unknown (?). The relevant gases or meteorological variables are also shown adjacent to each link. See the glossary at the end for explanation of abbreviations.

The emissions of the criteria pollutants, particulate matter (PM), volatile organic compounds (VOC) and oxides of nitrogen (NO_x) in general exacerbate air pollution. Because there is a complex chemical reaction that converts VOC and NO_x to ozone, the major constituent of photochemical smog, the arrow in Figure 1 shows '~+' meaning that in general an increase in these emissions leads to more air pollution. Because chemical reactions proceed more quickly in high temperatures (T), higher temperatures also exacerbate air pollution (which is why the '+' sign is linked to the 'T' in the upper left arrow). It is not clear whether changes in relative humidity (RH) affect air pollution (which is why the '?' sign is linked to the RH in the upper left arrow).

When we consider the interaction with greenhouse gases and global warming then there is generally a positive feedback, as shown by the '+' signs next to the bottom arrow and the right hand arrow of Figure 1. However, particulate matter reduces the greenhouse effect (Houghton et al. 2001, Ch.5) so that the upper right diagonal arrow has a minus sign linked to PM. The most complex interaction is that between global warming and meteorology. The question mark on the upper arrow indicates that the link between global warming and meteorology is uncertain because it will depend on the details of how global warming takes place, and the meteorological effects will vary spatially and temporally. GCMs, which can stand for 'General Circulation Models' or 'Global Climate Models', are computer models that work out such interactions.

In the case of Sydney, the results from the CSIRO Climate Change Projections for Australia (http://www.dar.csiro.au/impacts/future.html) indicate that by 2030 there is a likelihood of a 1 degree Celsius rise in mean annual temperature, and by 2070 there is a likelihood of a 3.5 degree Celsius rise in mean annual temperature. The rainfall is expected to decline.

Monitoring

Ozone is the pollutant that is used to measure smog. In examining the number of days that readings from measurement stations in Sydney exceed the ozone standard of 10 ppm (Figure 2), it appears that in Sydney the El Nino cycle plays a strong role, with El Nino years such as 1983, 2001 showing more ozone exceedences than in years such as 1989.

Comparison with criteria

Recent work examined the expected ozone in US cities as a result of global warming (Lashof et al. 2004). In every case the number of days with low ozone concentrations go down, and unhealthy days, namely those with high ozone concentrations, go up.

An indicative guide to the likely effects that meteorology may have on air pollution consists of the number of days that the temperature exceeds 31 degrees Celsius. The monthly distribution of such days in Sydney is the same as the monthly distribution of smog days—namely from October to March. This indicates that if the temperature were to rise by three degrees then the number of days of ozone exceedence (smog days) would go up from 12 days per year (on average) now to 15 days per year in 2030, and 30 days per year in 2070. This is based on the meteorology alone, and assumes that nothing further is done to control emissions.

Control, communication and review

In terms of reducing greenhouse gases, policy options are directed towards abatement of emissions in the energy

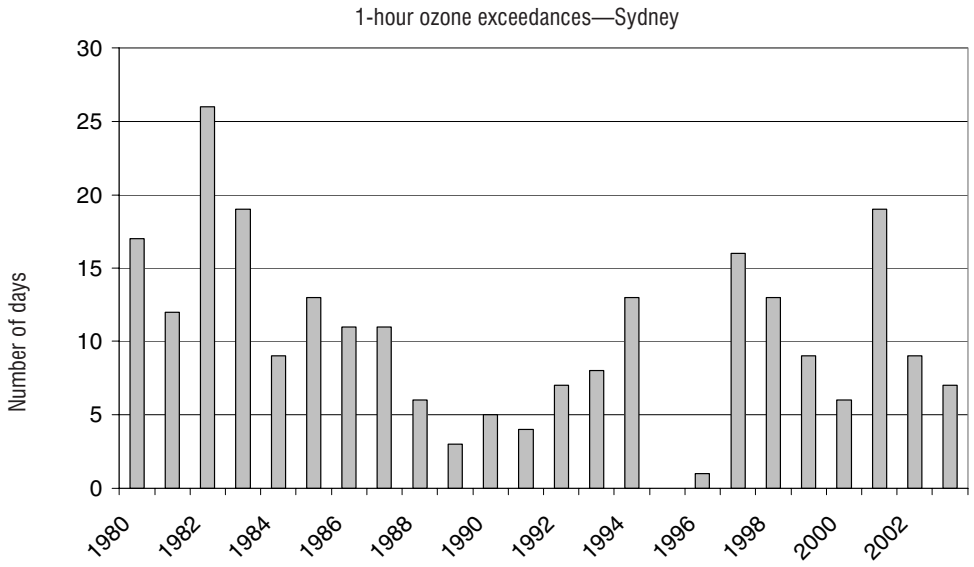


Figure 2: The number of days in NSW that exceed the one-hour ozone standard appears to be strongly influenced by the cycle of El-Nino events

sector, which produces 68% of Australian greenhouse gas emissions. Such energy policy options can be divided into four groups: supply-side changes, demand-side changes, fuel switching and pollutant capture.

In general, measures to reduce greenhouse gases will reduce air pollution (and vice versa) but this is not always the case and one needs to examine possible policy options to ensure whether they are positive (they reduce both greenhouse gases and air pollution) or perverse (they increase one or both of greenhouse gases or air pollutants).

Diagrammatically, we can show this using a four-division quadrant with air quality and greenhouse gas options divided into good and bad options. Most greenhouse gas abatement options and air quality improvement options are good in terms of both greenhouse gases and air quality. But some policy options are not as clear cut.

For example, is the option of 10% ethanol in petrol in Sydney a positive or a perverse policy option? There are some important imponderables that make it difficult to provide a clear answer.

The first imponderable is whether the greenhouse gas emissions are better, worse, or the same. Greenhouse gas accounting rules say that a 100% renewable fuel may be treated as emitting zero greenhouse gases from the tailpipe. The fuel when burnt emits carbon dioxide but the carbon dioxide is not counted as a greenhouse gas because it is not fossil carbon dioxide. One way to think of this is to envisage red carbon dioxide and green carbon dioxide coming out of the tailpipe of a car, with the green carbon dioxide not being counted as a greenhouse gas.

On the basis of the NSW ethanol trials that were run in 1997, 10% ethanol in petrol leads to a 7% decrease in tailpipe greenhouse gases. When the whole life cycle is taken into account (Beer et al. 2003) then the greenhouse gas savings from renewable fuels range from 1.7% (from wheat) to 5.1% (from molasses, using co-generated power).

A second imponderable is that adding 10% ethanol to petrol increases the octane number—which is desirable, but also increases the vapour pressure, which is generally undesirable. NSW wishes to control the vapour pressure of petrol, even though the NSW long-term goal of 57 kPa for the Reid vapour pressure is higher than the present Californian standard of 48.3 kPa.

The reason for controlling vapour pressure is to try to control smog formation. Addition of 10% ethanol to petrol will increase the volatile organic compounds being evaporated and those being emitted from the tailpipe, by 45% and 7% respectively.

But these increases in VOCs turn out to produce only slight increases in ozone. Modelling work by Cope et al. (2003) indicates that the overall trend is towards ozone reduction—though this is very dependent on the meteorology.

Overall, the results from studies on ethanol are variable. There are positive greenhouse gas (GHG) and air quality (AQ) benefits, but in each case there is a 25% probability that the benefits may not materialise. This may be shown diagrammatically (Figure 3) by drawing quadrants of possible policy options and placing the 10% ethanol in petrol option (denoted by E10) in a circle, displaced from the centre such that the displacement is towards the improved GHG and improved AQ quadrant.

Figure 3: Diagrammatic representation of the uncertainties associated with the policy option of introducing petrol containing 10% ethanol

Overall the option may be expected to be positive, but there is a finite probability of a perverse outcome.

Some policy options that are good for greenhouse gases may be bad for air quality. Producing electricity in the Hunter valley and sending it to Sydney through transmission lines is wasteful because of the transmission losses. Putting small scale distributed power stations where they are needed will save greenhouse gases, but the emissions from those generators may worsen air quality.

Cars being driven around a city also constitutes an example of many, small-scale, distributed power generators. We know that they are bad for air quality. However, hybrid electric vehicles use only half the petrol of an ordinary petrol car when used in the city. This means that their use will reduce both air pollution and greenhouse gas emissions, provided that one does not try to charge the electric car using the grid-generated electricity, in which case the greenhouse gas advantages are lost. Thus, in the policy options diagram (Figure 4), distributed power is a perverse policy option being good for greenhouse gases but bad for air quality. Nevertheless, the policy option does have a chance of being positive if the noxious emissions can be properly controlled.

A policy option that is good for air quality but may be bad for greenhouse gases is the use of selective catalyst reduction on trucks so that they can meet Euro4 diesel standards (Coffey, 2004). This particular technology requires urea—a nitrogen-based fertiliser—to be added to the catalyst. This is going to produce nitrous oxide, N_2O, which is a greenhouse gas. Thus, in the policy options diagram (Figure 4), on the basis of our present knowledge, selective catalyst reduction (SCR) is a perverse policy option.

Similarly, the idea of using hydrogen-powered buses and cars is very good for air quality but the greenhouse gas situation is more complicated. If the hydrogen supply is from natural gas reformulation then, on a life-cycle basis, there is no greenhouse gas advantage to using hydrogen fuel (Beer et al. 2001). However, there is a substantial advantage in terms of low emissions of urban pollutants. This is because the combustion of hydrogen produces only water vapour as its emission.

However, if hydrogen is produced from renewable sources such as wind, solar or tidal power then there could be both reduced urban pollution and greenhouse benefits. The same would be true of the carbon dioxide emissions where it can be sequestered. Thus in the policy options diagram of Figure 4, hydrogen vehicles can also be viewed as a perverse policy option—though it has the possibility of being positive if properly implemented.

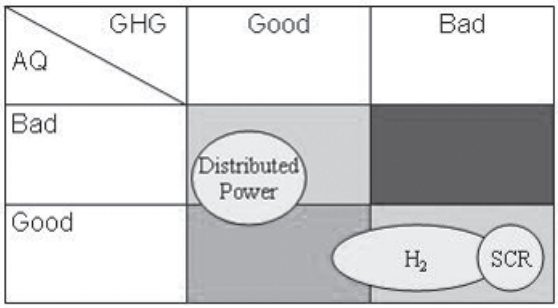


Figure 4: Policy options diagram for distributed power generation and for the use of hydrogen as a transport fuel

Issues such as these are being examined by the Energy Transformed Flagship, which is one of the CSIRO major flagship programs. The Energy Flagship has four major themes:

- energy futures
- low-emissions electricity
- low-emissions transport, and
- low-emissions distributed energy.

Further information is available at: www.energytransformed.csiro.au

Consultation and acknowledgements

In preparing for this presentation I have been greatly helped by my colleagues Ian Smith, Kevin Hennessy, Martin Cope and Penny Whetton.

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Glossary

Symbol	Name	Meteorological variable	Greenhouse gas	Air pollutant
CH_4	Methane		X	
CO	Carbon monoxide			X
CO_2	Carbon dioxide		X	
N_2O	Nitrous oxide		X	
NO_x($NO + NO_2$)	Oxides of nitrogen			X
O_3	Ozone			X
PM	Particulate matter			X
RH	Relative humidity	X		
T	Temperature	X		
VOC	Volatile organic compounds			X

Health impacts of air quality

Associate Professor Guy Marks
Head of Epidemiology, Woolcock Institute of Medical Research

I will discuss some of the ways in which air pollutants can affect health, including both naturally occurring phenomena and man-made pollutants.

Health effects of air pollutants

Health effects attributable to air pollution are generally divided into two categories:

- acute effects, which occur due to short-term variation in pollution exposure. These are manifest as symptoms and variations in bodily functions, principally respiratory and cardiac functions, and include exacerbations of pre-existing illness. Severe effects may result in either admission to hospital or the emergency department, and in extreme cases, death.
- longer-term effects, which are cumulative effects of exposure to air pollutants. These are often difficult to measure. Cumulative effects on lung function, for example, might manifest as impaired growth in lung function in children, which would have lifelong effects on the child's respiratory health. An accelerated rate of decline in lung function among adults may also occur, causing respiratory insufficiency in later life. This, and other long term effects of air pollution on physiological processes, may result in either the initial manifestations of new illnesses, such as chronic lung disease, or the persistence of pre-existing illnesses.

Naturally occurring air quality problems

Naturally occurring phenomena can adversely affect health.

In Wagga Wagga on 30 October 1997, such an event occurred resulting in a five to twelve-fold increase in pollen grains. Within a few hours, 215 people attended the emergency department at Wagga hospital for exacerbations of asthma. Of these, 41 were admitted and two were incubated in intensive care (Girgis et al. 2000). This event was due to a thunderstorm outflow sweeping across surrounding fields of grass, concentrating grass pollen grains in a narrow band of air near ground level. This is not a particularly rare event. We have found that approximately 50% of epidemics of asthma exacerbations in rural NSW that occur during spring and early summer could be attributed to this thunderstorm outflow-pollen phenomenon (Marks et al. 2001).

Bushfires are another natural phenomenon associated with changes in air quality. The evidence about the adverse health effects of bushfires is more difficult to interpret (Cooper et al. 1994; Jalaludin et al. 2000). Respiratory admissions probably do increase, but to a relatively small extent compared to the magnitude of the increase in particulate pollution.

Man-made air quality problems

Ozone

Ozone is a naturally occurring pollutant but it is the increased levels of ozone as a result of human activity that is the real concern. Ozone forms as result of a slow reaction between oxides of nitrogen and volatile organic hydrocarbons in the presence of sunlight and, consequently, reaches its highest levels on summer afternoons. It is a highly reactive oxidant and is relatively insoluble, meaning it can be inhaled deep into the lungs where it has its effect in the small airways and air sacs (alveoli) of the lungs.

Human experimental studies using exposure chambers have largely clarified the acute effects of ozone on humans. Symptoms attributable to ozone exposure include cough, pain on deep inspiration, and chest tightness. There is a measurable reduction in the capacity to take in a deep breath, which is often associated with some decrease in a person's ability to exercise. This is most problematic in people who exercise intensely, such as athletes. There is some evidence that ozone might be linked to enhanced responses to allergen, a key feature of asthma.

There are three features of ozone exposure that predict the magnitude of the response (McDonnell et al. 1995):

- ozone concentration
- duration of exposure
- intensity of exercise or amount of breathing while exposed.

However, there is also inter-individual variability in people's sensitivity to ozone, which is not particularly related to whether or not they have asthma.

Data on hospitalisation and death rates related to asthma are mixed. Australian studies show that in some cities there is an effect on association between ozone and increased risk of hospitalisations (Melbourne, Perth) (Denison et al. 2001; Department of Environment WA 2003), and an association with increased risk of mortality (Sydney, Melbourne, Brisbane) (Simpson et al. 1997; Morgan et al. 1998; Simpson et al. 2000). A European study conducted in 23 cities also showed a significantly increased risk of death with an increase in ozone, but there is variability among cities (Gryparis et al. 2004). On average, for a 5 ppb increase in ozone concentration, there is a 0.33% increase in risk of death due to all causes, an increase in risk of death due to cardiovascular disease of about the same magnitude, and a slightly higher increase in risk of death due to respiratory causes (Gryparis et al. 2004).

This and other studies also show that the relationship between the level of ozone exposure and the predicted increase in risk of deaths does not have a lower limit. In other words, there is no threshold level below which ozone does not have an impact.

Romieu et al. (2002) studied children with moderate to severe asthma in Mexico City, where ozone levels are very high. In children given a placebo vitamin supplement, lung function was observed to be lower on days when ozone levels were higher. This observation had been made many times previously. However, among children who received anti-oxidant vitamin supplements (vitamins C and E), this adverse effect of ozone was completely abolished. There was no fall in lung function associated with increases in ozone. This confirms that the action of ozone in causing reduction in lung function is probably mediated by the oxidant effect.

Nitrogen dioxide

Nitrogen dioxide is the oxidant pollutant generated from fossil fuel combustion. Its main site of action in the lungs is the small airways. Unlike ozone, the adverse effects of nitrogen dioxide are principally observed in people with asthma (Koenig et al. 1988). There is some evidence that nitrogen dioxide increases responses to allergen (Devalia et al. 1994). However, the epidemiological evidence linking variations in nitrogen dioxide levels with variations in asthma symptoms and risks of hospitalisation for asthma and respiratory disease is not conclusive.

Chauhau et al. (2003) followed children with asthma over a period of time and noted the occasions on which they developed a cold (i.e. viral respiratory tract infection). Amongst children who developed colds they found a relationship between the children's nitrogen dioxide exposure before they got a cold and the severity of their colds. In other words, the effect of a virus might be more severe in children who are exposed to high levels of nitrogen dioxide than it is to children who are exposed to lower levels.

There is more evidence about the adverse effects of indoor exposure to nitrogen dioxide. Pilotto et al. (2004) studied children attending Adelaide schools that were fitted with unflued gas heaters. Half the schools in the study replaced their heaters with either flued gas heaters or electric heaters, thereby reducing indoor nitrogen dioxide levels. During the following winter children with asthma attending those schools had much lower rates of breathing difficulty during both the day and night and lower rates of chest tightness than children with asthma who attended schools that continued to use unflued gas heaters. This suggests that intervention to change heaters and reduce nitrogen dioxide exposure has beneficial effects on respiratory health.

Particulates

Particulates are non-gaseous airborne pollutants that vary greatly in both size and composition. Larger particles (more than 10 µm in diameter) tend to be filtered out in the nose. Particles between about 10 and 2.5 µm deposit in the respiratory tract, and the very small particles (less than 2.5 µm) penetrate deep into the small airways and alveoli. Studies of people with asthma show that particulates are associated with an increase in symptoms and a decrease in lung function (Pope & Dockery 1992). However, particles generated by bushfires do not seem to have as big an effect as those from other sources.

Evidence from the US and Europe indicates that high levels of particulate pollution are associated with an increased risk of mortality on any given day. There is substantial inter-city variability, but overall, for a 10 µg/m^3 increase in particulates, there is a 0.6% increase in all cause mortality (Katsouyanni et al. 2001). This effect is partly attributable to nitrogen dioxide because the levels of nitrogen dioxide in the atmosphere tend to be correlated with the levels of particulates.

There is also evidence of an increased risk of admission to hospital, both for respiratory disease (Atkinson et al. 2001) and for cardiac disease (Le Tertre et al. 2002) associated with increases in particulate pollution. Particulate effects may extend beyond the lungs. This is thought to be a result of the release of inflammatory and other mediators from the lungs into the systemic circulation.

Motor vehicle pollution, in general

There is a body of evidence that relates adverse health effects directly to exposure sources. Vehicular traffic is one such (major) source, and there have been many studies showing an association between adverse health outcomes and the intensity of exposure to vehicular traffic.

For example:

- intensity of truck traffic, but not cars, has been related to a risk of asthma and wheeze in the Netherlands (Janssen et al. 2003)
- high traffic counts within 50 metres of home are associated with an increased risk of current asthma, wheeze and cough in German children (Nicolai et al. 2003).

Controlling air quality

The current approach to controlling air quality is based on setting thresholds for criterion pollutants, monitoring adherence and directing action at preventing exceedences of those thresholds. A problem with this approach is that there is no evidence that there actually is a threshold in the dose response relationship. Another problem is that health effects seem to vary between cities and this is yet to be explained. This means that evidence gleaned from some cities may not be relevant to the exposure-response relationship in other cities. Thirdly, pollutant measurements may not adequately reflect the hazard arising from the environmental source. We may be measuring the wrong thing. For example, it may not be nitrogen dioxide from gas heaters that is a problem, but other environmental effects of gas heaters may mediate the adverse effect. This requires further elucidation. Finally, levels of exposure to various pollutants tend to be correlated, which makes it difficult to attribute adverse effects to any specific pollutant.

We need to focus on identifying and ameliorating hazardous environments and sources. This will require research to further identify what they are and to quantify the nature of the hazards. We should also consider air quality as a continuum that exists both outdoors and indoors, whether this be a workplace, the school environment or in the home.

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Sydney's Metropolitan Strategy—towards a sustainable city

Mr Evan Jones
Executive Director Metro Strategy Division
NSW Department of Infrastructure, Planning and Natural Resources

Metropolitan Strategy

The Metropolitan Strategy is a vision for the kind of city we want to live in. We have been talking extensively to the community about this, and the directions and strategies for managing growth and change over the next 30 years. We have also talked about implementation issues including governance, finance and other tools we need to bring about a shift in urban form and transportation in the metropolitan region.

The end result will be a framework that supports sustainable growth, provides practical guidance for land use decisions, makes liveable places, balances the needs of the people and the environment, and conserves regional assets.

The strategy has grown out of planning reforms designed to simplify the planning system and make it more effective. These included:

- appointing Minister Knowles as the Minister for Planning and Infrastructure, with whole of government responsibility for coordinating planning with infrastructure
- creating the Department of Infrastructure, Planning and Natural Resources (DIPNR), a single agency responsible for natural resource management, land use planning, infrastructure coordination and transport planning
- creating a Cabinet Standing Committee on Infrastructure and Planning to bring all the relevant ministers together to make important decisions and trade-offs while adhering to the priorities that are established in the Metropolitan Strategy.

Planning challenges

Key planning challenges that we face include:

- population growth—Sydney will have a sustained period of population growth for at least the next 30 years
- people and housing—the average number of people per dwelling has dropped due to taxation policies and other things while their houses are getting bigger
- ageing population
- travel behaviour—people are spending on average one hour and 20 minutes travelling each day. They are also making lots of small trips—51% of trips are less than five kilometres in length and most trips are for activities like education, recreation and shopping; travelling to and from work accounts for only 25% of trips
- car use—car growth is increasing faster than population growth and vehicle kilometres travelled (VKT) is increasing faster than car growth.

Working towards a sustainable city

Sustainability is about living within our means. To do this we must look after natural resources and the environment, support a competitive economy and create better places to live and work. We must also find ways to do these things simultaneously rather than trade between them.

There are a number of directions we can go to balance growth and strengthen regions.

- Plan for balanced growth in the Greater Metropolitan Region (GMR) within natural resource constraints—this is a very important starting step for the Metropolitan Strategy. We need to better balance urban renewal in existing centres and corridors with some new, staged greenfields land release.
- Strengthen the regions—we must manage ongoing pressures on the Central Coast and ensure the Illawarra and Lower Hunter grow and maintain at least their current share of total GMR population. Regional strategies therefore need to be developed for these regions in 2004 and 2005,

which also explain how these regions link and work with Sydney.

- Manage growth and value non-urban areas—we need to limit urban sprawl and direct new greenfields growth into specific growth centres so as to protect rural land, parks and conservation areas.
- Build liveable new communities—new greenfields communities will be planned in a significantly different way than in the past. They will have local jobs, access to safe and reliable public transport, local schools, shops and parks and a variety of housing. We are currently finalising investigations for the north west and south west sectors of Sydney and will be imposing strict criteria for the delivery of these things.
- Renew existing areas—about 70% of Sydney's population will have to be accommodated in existing areas. By concentrating on centres and corridors that we have already announced for renewal (e.g. Parramatta Road) or which have this potential (e.g. Airport–CBD, Canterbury Road, Hume Highway), we will have a good framework for ensuring these people can live where there already is transport infrastructure, services and jobs.
- Strengthen employment and existing precincts—we need to bring together activities in the major industrial areas and along corridors to create both the wealth and jobs that will underpin Sydney's economy. This includes activities at the airport, ports and existing business precincts, and major new industrial areas such as Huntingwood West and the former Wonderland site.
- Connect centres with the transport network—the Government is tackling transport problems by investing in the rail network through borrowings (e.g. Rail Clearways project), in bus transitways and through reforms identified in the Unsworth Bus Review that ensure we have buses in logical places around centres and going directly to major centres in Western Sydney. There is also the Epping to Chatswood rail line, the Western Sydney Orbital and the Cross Sydney Tunnel. However, we must get the balance right between provision of transport infrastructure, demand management and location of land uses to relieve congestion and get the city to work more optimally.
- Target infrastructure—the Metropolitan Strategy will be a key budget tool to target where infrastructure needs to be. We must also look at new technologies for delivering the infrastructure.
- Use appropriate funding and governance arrangements—we need new funding sources to deliver the infrastructure. In new land release areas for example, we are looking at significant development contributions to assist with infrastructure given the nexus between the benefits the developers are creating for communities and the prices they obtain in these areas. We are also considering new governance options such as a development corporation to make sure the infrastructure is established. Local government will lead implementation of aspects of the Metropolitan Strategy where appropriate.

Integrating land use and transport planning

There are two things we can do to influence air quality and build a better city:

- Manage land use demand within the natural resource limits for the Sydney region. This also means managing urban form and guiding the development of sustainable new communities.
- Better manage transport demand. Though politically difficult to achieve, community support for this is growing. Key policy elements include reducing (short) car trip proliferation, determining infrastructure priorities, demand management pricing, and influencing travel choices—destinations, modes and travel times.

The traditional neighbourhood design, where you have mixed land uses and an inter-connected network of streets, has significant effects on reducing the greenhouse gas emissions from urban sprawl to a more sustainable level. A study of energy use and greenhouse gas emissions in Perth confirmed this by finding energy use and greenhouse gas emissions were noticeably lower in traditional areas with their higher resident and worker densities, higher levels of connectivity, and proximity to other places. These factors both reduce the need to travel and make alternatives such as public transport more viable. This is what we are now attempting at Sydney's urban fringe.

By way of comparison, in Clovelly in Sydney's eastern suburbs 59% of homes are within 400 metres of shops. This is what we call a pedestrian shed—you can walk 400 metres and get to a shop. In newer areas like Green Valley in Sydney's south west, only 13% of the homes are within 400 metres of a shop, so it is unlikely many people will walk to that shop.

As another example, Burwood in Sydney's inner west has a range of land uses—residential, commercial/retail, light industry, community, parks—and there are a lot of workers living in this mix. In Green Valley, there is a shop and housing and therefore no context for walkability. Everyone is car dependent.

Additionally, in Burwood there is a range of people living there on a range of different lot sizes, meaning there is a range of housing to accommodate the needs of an ageing population. Green Valley however, is almost mono-cultural in terms of lot sizes and very unrobust for the population that will live there in the future. This 'inbuilt redundancy' for our future communities will be very difficult to change.

The Metropolitan Strategy therefore looks at the fundamental building blocks for a sustainable Sydney.

- Neighbourhoods (e.g. Flemington, Concord North)—one to ten shops, a child care centre, primary school, home offices and access to small parks. Houses are detached and up to two storeys high.
- Small urban villages (e.g. Summer Hill, Haberfield) —10 to 50 shops, a small supermarket, child care, primary school, etc. (i.e. some mixed land use), as well as a mix of housing (town houses and up to four-storey flats) to support the vibrancy of the centre.
- Larger urban villages (e.g. Strathfield, Ashfield)—two to three supermarkets, more than 50 shops, a range of housing including mid-rise apartment blocks up to six storeys high, and civic and cultural facilities (banks, medical centres, library, small civic square).
- Major urban centres (e.g. Liverpool, Bankstown, Blacktown)—major retail shopping centres, government offices and regional headquarters, and a range of services (medical, fire, police, library, community arts) so you don't need to drive out of your local region, or you can at least catch one of the new buses to access these facilities. Residential density would be mid to high rise (i.e. six to 20 storeys).
- Primary urban centres or CBDs (e.g. Parramatta, Sydney)—major concentration of retail, civic and cultural services as well as professional, educational and medical facilities (court houses, universities, TAFE, hospitals), and high density living (20+ storeys). These centres typically are the focus of the fixed transport network. They also are and will continue to be engine drivers of the economy and we need to continue to focus transport and other infrastructure investment here as well as make them as liveable as possible.

Thus, in new communities in particular, air quality will be addressed by a strong commitment to reducing car dependency via the structure of land use and urban design. As well as local employment opportunities (and economic development) in new light industrial areas and shopping centres, there will be local walking and cycle facilities built from the start to discourage short car trips. There will also be new rail links and dedicated bus routes to move people between centres.

Metropolitan Strategy timeframe

We have held two Futures Forums and a number of community forums which have involved people from across the greater metropolitan region (e.g. Parramatta, Gosford, Wollongong, Ryde). We are also working with local government, non-government organisations and others to flesh out the Strategy's concepts and ensure we have the governance arrangements and other tools needed to bring this to bear.

When asked at these forums, 'what do you like about the area in which you live?' and, 'what could be done to improve Sydney by 2030?' people have commonly answered 'good air quality'. This is one of the things we are seeking to achieve with the Metro Strategy.

Panel discussion

Panel members

Chair: Mr Brian Elton

Dr Tom Beer

Associate Professor Guy Marks

Mr Evan Jones

Mr Jeff Angel

Ms Lisa Corbyn

Dr Greg Stewart, Chief Health Officer, NSW Department of Health

Dr Steve Corbett, Western Sydney Area Health Service: How will land use and transport conflicts be managed, particularly air quality issues which are important in terms of human health outcomes?

Ms Lisa Corbyn: It is a big challenge but there are a number of things we can incorporate into the design of cities that will help. For example, how we design the residences people live in and whether they have the right control measures to deal with the exposures people might have to motor vehicle pollutants. Strong initiatives are also needed to ensure we have cleaner fuels and cleaner vehicles so as to reduce motor vehicle emissions. Similar challenges exist in other areas like co-generation and the trade-offs we must make in respect of various energy sources.

Mr Jeff Angel: Increased density could potentially increase traffic in small concentrated areas. New greenfields sites should be able to be developed properly—there won't be no traffic, but compared to similar sprawling situations, there will be relatively less. With existing urban areas, density increases will occur in places that were not particularly designed for more people. This is an issue because you are overlaying more people on an almost deterministic urban structure and people behave the way the access to shops or the access to transport demands. We therefore need filters for the types of increases in density in established areas.

If you look at the share of car trips in urban sprawl areas compared to more densely settled areas like the eastern suburbs and the western centre around Parramatta, it is about 20% to 30% lower in the densely settled areas. These places are working—there is a lot more walking, and this is the sort of Sydney urban ideal that we should be aiming for.

Mr Evan Jones: If we took 20% of the cars out of western Sydney, it would be the equivalent of taking all cars out of the inner suburbs. This is the kind of problem we currently face. So far we have put resources into getting the greenfields areas right because they are new. We will have to be very specific in our criteria for existing areas though. In both cases, we have some very hard choices to make regarding natural resources and air quality limits.

Ms Chloe Mason, NSW Council of Social Services and Bicycle NSW: What can the Air Quality Management Plan process do to assist in replacing diesel fuel buses with cleaner alternatives under the new service level agreements in the forthcoming bus contracts that will be signed under new NSW legislation?

Ms Lisa Corbyn: One of the issues we have to look at more clearly is the linkage of the Air Quality Management Plan and *Action for Air* to the overall public transport system. In particular, how does the government make criteria for and decisions about the sorts of public transport programs for Sydney and specifically for buses, how they work, what kind of buses, and what fuel they might run on.

The Air Quality Management Plan is a policy framework, not a regulatory instrument, so has a broad

context of being able to link the air quality issues with other government initiatives. Cleaner buses and trucks is one of the many strategies in the Air Quality Management Plan. We do have some research work in progress aimed at providing better information for decision makers on the air quality impacts of different fuels that might be used in buses and other vehicles, as well as different vehicle technologies.

Dr Tim O'Meara, Woolcock Institute of Medical Research: Has much consideration been given to the impact of greenfields areas on the city as a whole, and conversely, the impact of the city on those greenfields areas? The DEC is saying areas like Bringelly have the highest level of ozone in Sydney and NSW Health is saying ozone is bad for asthmatics. What is the mechanism for getting input from the various government departments into the Metro Strategy, and how are those sorts of issues dealt with?

Mr Evan Jones: Firstly with land release, we set up both inter-agency and council steering committees from day one and went out to Western Sydney to gather input from stakeholders. We started with first principles— what is the environmental footprint, the urban footprint and the urban structure, and how do transport and employment overlays work?

As for air quality issues in Western Sydney, we worked with DEC on modelling forward 15 and 30 years. This showed those areas were not the best places to put urban development given the impact of the types of designs and the transport networks we are planning, but they are the only places left to do it. It will be a government decision whether those issues will balance out the right way, but overall there won't be harmful impacts on air quality— just a couple more exceedences than the rest of Sydney.

Ms Lisa Corbyn: It is also important to get the timing and sequencing of the development right using various transport and urban development assumptions, including those in the broader context such as the availability of cleaner fuels. We also need to have an adaptive management approach of continual reassessment of the assumptions built into the modelling so that we can react as we move forward.

The concerns about air quality are not only the numbers of days there might be exceedences, but also peak levels, particularly for ozone, and what the population exposure might be. The modelling will provide these correlations.

Dr Greg Stewart: NSW Health has long been involved in health aspects of air pollution. The new planning framework and the Metropolitan Strategy have allowed even broader involvement, not just about air pollution or hospital planning, but also issues like walkability, how transport will affect physical activity and therefore the health of the population through being overweight and obese.

Urban reforms of 150 years ago around hygiene were primarily driven by infectious disease spread. From a health perspective, the way we build our urban environment and the way we move people around is just as critical now as infectious diseases were then, because 25% of NSW children are now overweight and obese, as are 50% of adult females and 60% of adult males.

Dr Tom Beer: The speed at which vehicles travel also influences air quality. If traffic is moving too slowly it causes air quality problems, but similarly, vehicles travelling at high speeds have a lot of air resistance and high emissions. There is therefore an optimal speed at which vehicles should travel to minimise vehicle-related air pollution. Residential urban design, how the roads themselves are constructed, and what obstructions or non-obstructions are put in the way of traffic therefore become very important.

Mr Frank Muller, Institute of Environmental Studies, UNSW: The targets in *Action for Air* to slow down and then arrest the growth in VKT are very ambitious and a lot of people don't believe they are achievable. When Kyoto targets for Australia are considered, a dramatically lower VKT target would be needed for transport in Sydney. Although we have not ratified Kyoto, it is inevitable that there will be a cap on Australia's emissions. If transport in Sydney doesn't pull its weight, there are real costs elsewhere in the (national) economy. To what extent have these hard economic issues been quantified and presented?

Mr Evan Jones: The evidence about the costs to the economy is out there and we believe this will help to make policy makers serious about the changes, particularly the step changes, we need to make.

Ms Lisa Corbyn: We know that we are not achieving the VKT targets but they remain very important. One of the challenges we face is trying to engage people on the climate change interactions with VKT targets because there wasn't as much discussion about climate change and global warming issues when *Action for Air* was being developed. It therefore focused primarily on regional issues.

If you do set targets that people won't or can't achieve, they become meaningless. This is one of the things we will look at as we move forward with *Action for Air*— how do people engage with VKT targets and are they realistic? If they're not realistic, how do we make people think they are and enable them to take actions to achieve them?

Mr Jeff Angel: The *Action for Air* VKT targets are a bit like the first commitment period of Kyoto—the achievement was to actually get VKT targets, while for Kyoto it was getting a regulatory system. As the Metro Strategy goes through its processes and is tested for its congestion, urban air quality and greenhouse impacts, a second commitment period will arise.

Audience member: Targeting VKT can be one way to reduce greenhouse gas emissions. Targeting individual vehicles is the other way. Australians increasingly want to drive heavier vehicles fitted with luxuries which means that any savings achieved through VKT reduction are negated by individual vehicles. This can be overcome by using totally renewable fuels and driving small light vehicles or hybrids.

Ms Lisa Corbyn: Governments leading by example, and in particular, changing the way the NSW fleet is managed, is a very significant step forward. It will send out strong signals about achieving both greenhouse and noxious emissions targets.

Mr Bob Gordon, Renewable Fuels Australia: How much attention needs to be paid in Sydney to uncombusted particulate emissions from diesel and petrol vehicles—PM_{10} and particularly, light and fine and ultra fine particles which carry toxics from these fuels deep into the body and have significant impacts?

Associate Professor Guy Marks: A lot of work has been done, both epidemiological and studies in humans and animals, which suggests there are particular adverse effects associated with very fine particles. Effects on cardiovascular function, the risk of heart attacks and other cardiac events, and the risk of developing or increasing allergic responses have all been observed. Metals within the particles may act as a catalyst that mediates the development of allergic responses.

Both the size and the nature of the particles are relevant. The size determines where the particles get to in the lung. We know less about the effects of particle composition—bushfire particles, for example, don't have the magnitude of adverse health effects that we would expect. There do seem to be particular problems with diesel exhaust particulates and metals, and with some organic and biological materials. We need a lot more knowledge about these.

Ms Lisa Corbyn: The National Environment Protection Measure process is looking at getting better information about $PM_{2.5}$. We have established a process for monitoring and reporting on $PM_{2.5}$—it is an advisory reporting standard rather than a compliance standard (as we have for PM_{10}) because we don't yet have good information about what levels to set. The $PM_{2.5}$ reporting process will collect this information—but the value against which we will report is conservative. A reporting process for ultra fine particles has also been discussed but is yet to be progressed.

Mr Andrew Doig, Australian Environment Business Network: We have heard today that ozone is a health issue and we can predict when we are likely to have high ozone days. Can we invoke a strategy to target these high ozone days—for example, car-free days or offering cheaper public transport to encourage the public to leave their car at home? Other sectors could also take actions—power generators for example, could load shed on these days. This targeted approach, instead of generic limits that apply across the year irrespective of conditions, could reduce the number of exceedences of the ozone standards.

Ms Lisa Corbyn: This is an excellent idea and we do actually have some of these reactive management strategies built into licence conditions of some industries (e.g. power industries, particularly in Western Sydney). Industry is not particularly positive about this however, because of the lack of certainty.

The air pollution health alerts generally can only be issued one day ahead because they depend on the meteorology and the pollution that has occurred the day before. We start to predict in the afternoon what will happen the next day and this presents challenges in how do people stop operating the next day when given such short notice.

Dr Greg Stewart: The health alerts have formalised the advice that we can give to individual people to enable them to take action at an individual level. For example, the alert will say that if the Regional Pollution Index gets to a certain level, and if you have asthma, you need to make sure you are taking your preventive medicine. We have been providing this simple advice for years, but we now have a mechanism for doing it in a systematic way.

Dr Tom Beer: The health alerts actually increase modelling complexity. Up until now air quality modelling has been a bit like meteorological forecasting—the publication of the forecast has no bearing on what subsequently happens to the weather. If the publication of the forecast then changes society's behaviour, you have changed the emissions and therefore the forecast itself is going to be in error. To this extent air quality modelling is starting to exhibit some of the characteristics of economic modelling.

Mr Jeff Angel: Trigger levels for a health alert will tend to become politicised if reactive or adaptation strategies are implemented, as opposed to just solving the problems so they don't come up in the first place. There will be inconvenience or perceived economic costs to the people who have to adjust fairly quickly. More debate is needed around this.

Community stakeholder perspectives on air quality

Mr Jeff Angel
Director, Total Environment Centre

4.5 out of 10—Review of *Action for Air* for the 2004 Clean Air Forum

Action for Air is the NSW Government's 25-year plan to improve air quality in the Greater Metropolitan Region (GMR) of Sydney, the Illawarra and the Lower Hunter. Launched in 1998 it provides a framework for measures to be implemented by a number of government agencies.

In the lead up to the 2001 Clean Air Forum the Total Environment Centre (TEC) conducted a comprehensive review of progress in implementing *Action for* Air. The review concluded that *Action for Air* faced very significant challenges with poor air quality results, particularly for ozone, a continuing problem.

Of particular concern was the failure to implement foundation policies in *Action for Air*. Two areas in particular stand out—continuing rapid growth in vehicle kilometres travelled (VKT) and poor progress in implementing *Action for Air* commitments to i mprove public transport, local air quality and greenhouse emissions.

TEC assessed progress in implementing *Action for Air* at 4/10 and concluded that a major overhaul of *Action for Air* was needed to improve progress in meeting commitments and reaching air quality goals.

In the lead up to the 2004 Clean Air Forum TEC has again undertaken a review of the implementation of *Action for Air*. Rather than seeking to replicate the work of the 2001 review this review has focussed on areas where changes have occurred since the last Clean Air Forum. In particular we have sought to highlight any areas where performance has improved or declined.

Objective 1: Integrate air quality goals and urban transport planning

A major development since the last forum is the NSW Government's Metropolitan Planning Strategy. A key objective of the strategy is to ensure that transport planning is integrated with land use planning. Since the last forum the Department of Infrastructure, Planning and Natural Resources was created to better integrate transport and planning while the Minister for Infrastructure, Planning and Natural Resources has a key role in transport infrastructure decisions. These arrangements are relatively new and as yet untested.

A major concern is the virtually unchanged pattern in VKT figures and continued road building as indicated by the construction of the Western Orbital.

Objective 2: Provide more and better transport choices

Significant progress has been achieved toward improving bus services with the opening of the Liverpool to Parramatta Transitway (T-Way), progress toward the North-West T-way, reform to private bus contract arrangements under the Unsworth review process and moves toward equalisation of private and government bus fares.

Announcement of developer levies to fund public transport infrastructure in urban release areas is also a welcome step forward for clean air and better public transport.

Against these positive steps is the dismal performance in relation to rail services. While construction of the Bondi Junction turnaround loop will provide a significant increase in the capacity of the Illawarra line and the rail clearways project will also improve services throughout the network, elsewhere the picture is far from encouraging with the abandonment of the Parramatta to Epping section of the Parramatta to Chatswood rail link, and no discernible progress to development of other badly needed rail links. Poor reliability and on time running coupled with cuts to off-peak services are also providing commuters with little incentive to choose public transport over the private car.

CityRail's own performance data indicates that on 1 November 2004, 0% of peak hour trains ran on time. (http://www.cityrail.info/aboutus/our_performance/perform_1.jsp)

In August 2004, Transport Services Minister Michael Costa, said those experiencing delays on the train system can "buy a car". Mr Costa has made clear his belief

that a car is a viable alternative to public transport. "The Minister said you can buy a car very cheaply," a spokesperson for Mr Costa said. "Even allowing for depreciation, it makes it very competitive." This statement will make the public question the government's commitment to public transport.

The spokesperson said that while the frequency of services had been cut to free up drivers for peak-hour rosters, extra carriages had been added to weekend trains to accommodate the crowds. The spokesperson also said, "People need to remember the rail network cannot be all things to all people … It's designed to move a large number of people in small amounts of time when demand is greatest. People do have other options." (Sydney's *Inner West Courier*, 17 August 2004).

Given that most complaints are for peak hour services, when the system must perform, it is ludicrous to suggest replacing train trips with a car trip.

Objective 3: Make, cars, trucks and buses cleaner

Good progress has been made in relation to vehicle emission and fuel standards with the implementation of national emissions standards under the Commonwealth *Motor Vehicle Standards Act 1989* and the *Fuel Quality Standards Act 2000*.

Of particular concern however, is the decision by NSW State Transit to end its commitment to purchase CNG buses. State Transit will return to purchasing diesel engines as they are now marginally cheaper to run due to Federal changes in fuel excise.

This is a significant step backwards which—in the first stage of its implementation—is likely to cost the community at least $4.4 million in health costs from particulate matter alone, with oxides of nitrogen costing an additional $1.3 million.

Continued failure to undertake phase 2 of the inspection and maintenance program for in-service vehicles allows 371 tonnes of pollution to enter Sydney's air every day.

Finally, the Government has continued its failure to implement higher stamp duties for the more polluting, fuel-inefficient vehicles.

Objective 4: Promote cleaner business

There is relatively little change to report in relation to this objective with most initiatives having been implemented prior to the last Clean Air Forum. We are not aware of cleaner production having been mainstreamed. Boutique projects will not suffice and we should be mobilising the planning approval and pollution licensing process.

Objective 5: Promote cleaner homes

The major change in this area has been the introduction in July 2004 of *BASIX— the Building Sustainability Index*. BASIX is a web-based planning tool for assessing the performance of new homes against a range of sustainability indices: landscape, stormwater, water, thermal comfort and energy.

The first stage of BASIX is focussed on reducing water and energy use. New residential development in nominated local government areas must be designed and built to use 40% less drinking-quality water and produce 25% less greenhouse gas emissions (40% by 2006) than average NSW homes of the same type. This is a positive step forward in designing sustainable, energy-efficient homes.

Objective 6: Manage the impact of open burning

There is relatively little change to report in relation to this objective with most initiatives having been implemented prior to the last Clean Air Forum.

Objective 7: Monitor, report and review air quality

In October 2004 it was revealed DEC monitoring stations at Earlwood and George Street in the CBD have been closed. The station at Earlwood was crucial for monitoring pollution from the M5 East tunnel stack.

Pollutant monitoring has also stopped at Rozelle, St Marys, Newcastle and Illawarra. In 2004, the metropolitan air quality network dropped its sampling levels from 1500 to 450.

Closure of stations and cutbacks on monitoring significantly compromises the collection of long-term scientific data sets, and the capacity of the DEC to monitor and improve air quality. It may also limit their capacity to bring about a successful prosecution due to limited evidence.

Daily reports of the Regional Pollution Index (RPI) are still available on the DEC NSW website. The RPI is issued twice daily. The morning report at 9:30 am covers the period from 3 pm the previous afternoon to 6 am that morning. The afternoon report at 4 pm covers the period 6 am to 3 pm.

Conclusion

While there have been improvements in some areas, continued high VKT and poor performance in relation to rail services and infrastructure is continuing to limit the success of *Action for Air*. Major investment in new infrastructure and improved services is urgently required.

The full TEC report on its Review of *Action for Air* for the 2004 Clean Air Forum can be found on www.tec.org.au—under 'Clean Air Campaign'.

Future directions for air quality management in NSW

Ms Lisa Corbyn
Director General, Department of Environment and Conservation (NSW)

One of the great challenges in managing air quality is that there are so many contributing sources and variables, and things are constantly changing. What we know now about climate change and air quality clearly sets a different challenge than we saw back in the mid 1990s when we started *Action for Air*. Never in my wildest dreams could I have imagined in 1998 that we would have low-sulfur fuel actually starting to be available, as it is now.

It would be impossible to capture everyone's concerns and good ideas in a one day forum. That's why we have also been holding workshops with different sectors over the last year to generate new ideas and to help us set the directions for air quality management in the future. And it's why we have clearly linked the air quality work we are doing with the Sydney Futures Forum, plotting the course for the Metro Strategy.

This afternoon I will paint a quick picture of Sydney's air quality as it is now, and report back on the directions that stakeholder workshops have been pointing us.

We are still thinking about the main sources and potential controls in four categories:

- commercial and domestic
- land use and transport planning
- motor vehicles and fuel, and
- industry.

We must also still consider open burning and fire management.

All of this sets the context for the next update of *Action for Air*, after its first six years.

Air quality in the Greater Sydney Metropolitan Region

How is NSW really tracking against the national air quality standards under the National Environment Protection Measure? Not too bad but we have some looming issues. Our results are based on the Department's monitoring network which is the most extensive air monitoring network of any city in Australia. We are working now to modernise it so we continue to have good data and modelling for future planning.

Our monitoring has shown real improvements in a number of areas:

- a dramatic reduction in lead over the last 20 years
- ambient levels of carbon monoxide are low
- since 1994 we've rarely had exceedences of the national standard for nitrogen dioxide
- sulfur dioxide concentrations are also well below the national standard, even in Wollongong and Newcastle.

But the two looming challenges are ozone and particles.

Ozone

In 2000, 2001, 2002 and moving into 2003 there were a number of days when the ozone standard was exceeded in Sydney (Figure 1). This is ground level ozone or photochemical smog, the white haze we see in summer. Some of these days were affected by bushfires, but even without the fires we would have exceeded the four-hour ozone concentration standard.

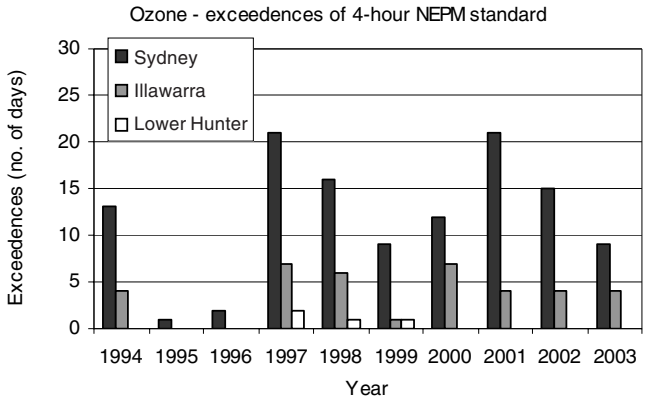


Figure 1: Ozone standard exceedences (excluding bushfire effects)

We also know from overseas work that because of health linkages, ozone standards may become even more stringent. We will therefore need to bring down emissions of volatile organic compounds (VOCs) and

oxides of nitrogen (NOx) in all sectors, including motor vehicles and in the commercial/domestic sector which makes up almost half of the VOC emissions. The biggest player in NOx is industry—which contributes almost 60% of NOx emissions—so industry will also need to play its part.

Particles

Turning to particles, Figure 2 which plots the 24-hour particle measurements shows the maximum levels and the 95th percentile, measured against the standard of 50 µg/m^3 right now. In Sydney we would generally meet the goal for particles of less than 10 micrometres in diameter (PM_{10}) but in years with significant fire and dust storms which are often caused by drought such as 2002 and 2003, we clearly are not meeting the goals.

One of the developments since the last Clean Air Forum is the introduction in 2003 of a national advisory standard, for monitoring and reporting purposes only, for fine particles of less than 2.5 micrometres ($PM_{2.5}$) (Figure 3). We know that concern is growing about the

Figure 2: Particle exceedences related to weather and other events

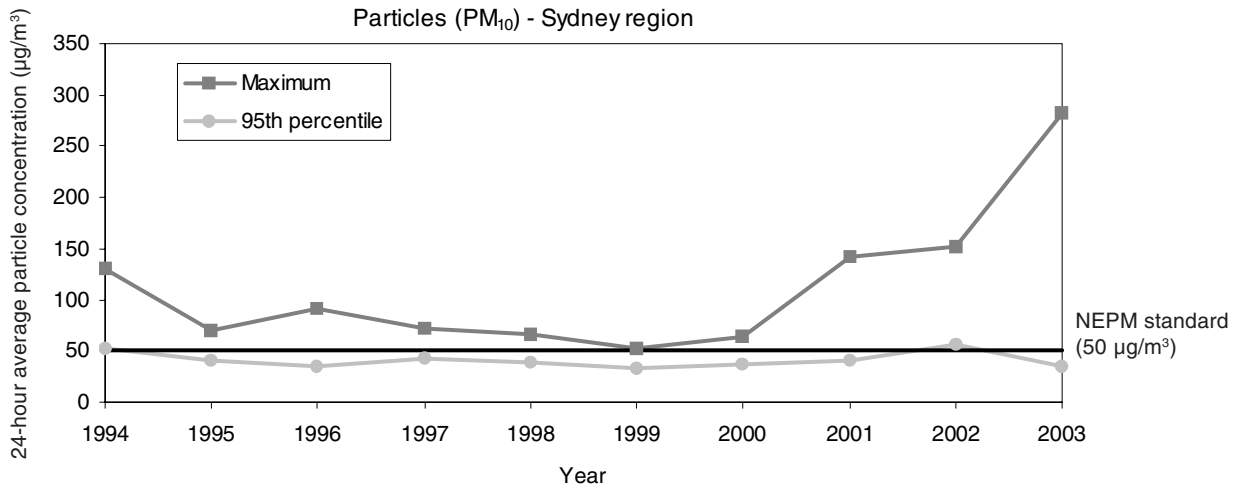
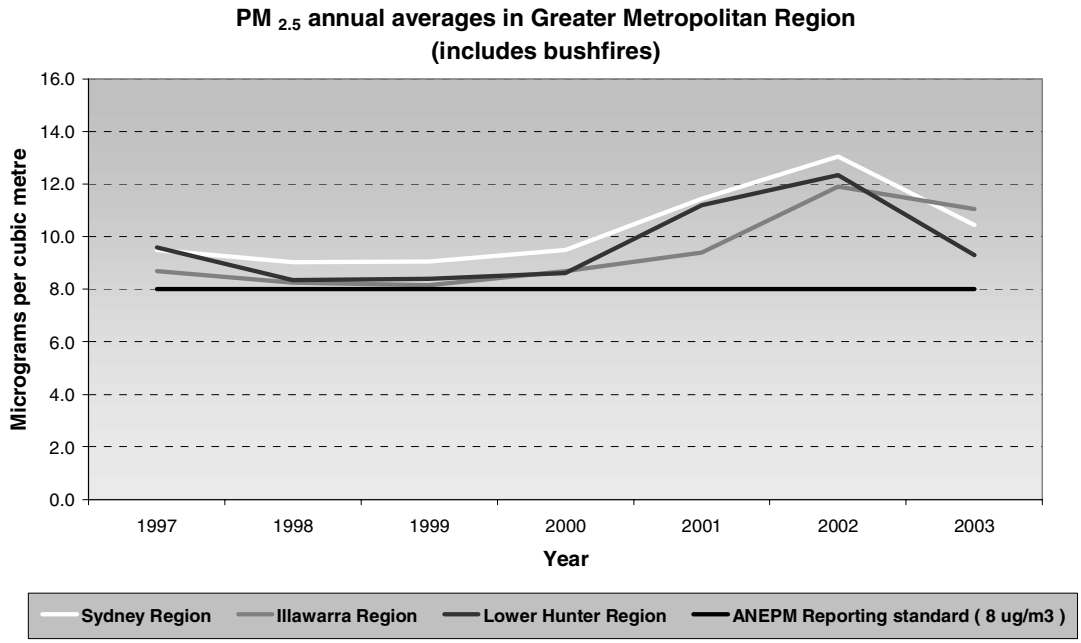


Figure 3: Ambient air quality trends—$PM_{2.5}$



health risks associated with the finer fractions of particles. At this point, the new reporting standard is not a compliance level but has been designed to collect information to inform future decisions.

Given the potential for fine particles to impact on health, we are taking a conservative approach and the reporting standard has been set at a very tight level by world standards. Again weather has influenced the most recent years but when we discount the effect of bushfires and drought, we still have concerns, so we need to be doing some serious thinking now about more ways to reduce our particle levels in the future.

The sources of particle emissions are interesting (Figure 4). The mobile sector continues to be well represented with just under 20% of particles coming from this sector in Sydney in 2003. This would appear to be a marked change from the previous inventory published as part of the 1992–1995 Metropolitan Air Quality Study. However, since those estimates were made in the early 1990s we have better information on which to base our road transport estimates thanks to the research studies that underpinned the Diesel NEPM.

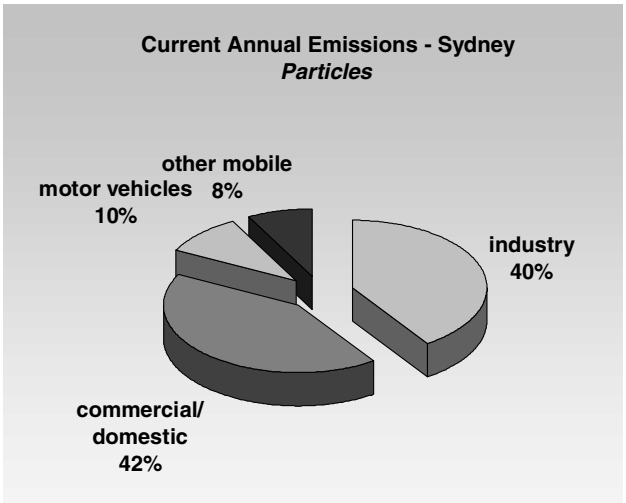


Figure 4: Sydney's particle sources (2003)

In the Greater Metropolitan Region, the mobile sources' contribution is much less due to the dominance of major industry (e.g. power stations) in this larger region (14% of total GMR particle emissions in 1992 to approx 12% in 2003).

We can see the combined impact of population growth and improvements in motor vehicle emissions over the recent past with the increasing proportion of both particle and VOC emissions coming from the commercial-domestic sector. These shifts highlight the need to look at all areas and sources of emissions.

Air toxics

Another change since 2001 is the introduction of a monitoring and reporting standard for some air toxics. NSW has already undertaken an air toxics study as part of our commitment under *Action for Air*. It showed that the ambient levels of most air toxics in NSW were low and well below current international standards and benchmarks.

Nevertheless, we have put the spotlight on three areas to make sure they do not become a problem in the future:

- polycyclic aromatic hydrocarbons (PAHs), which can be linked to solid fuel heaters; this type of heating is commonly used in some NSW country towns
- 1,3 butadiene, which is produced by motor vehicles, and
- benzene, although we expect levels to decrease with the changes to fuel standards.

We will be conducting further analysis of hot spots and population exposure to air toxics to make sure we don't have problems in the future.

Next steps

In the workshops, stakeholders have told us they want better, more up-to-date information about the changing sources of emissions and about how to deal with them, and we agree. We have a number of projects underway to improve our tools to do just this—particularly concentrating on emissions inventories and community information.

Emissions inventory

Reliable and current information on emissions is needed to underpin our programs both at a State and local government level. We are undertaking a major update of our inventory of pollution sources so that we have the best information available on which to make decisions.

The emissions inventory project will:

- improve information and data from over 1,100 licensed industrial sources
- expand the number of pollutants we have information about, building on the National Pollutant Inventory which includes up to 90 pollutants
- provide access for local government to the database and offer training to assist in their planning and prioritising sources and pollutants
- give us information on smaller sources like two-stroke engines from boats and off-road mobile sources that individually may not be such a

problem but can add to the cumulative total of emissions.

The results will be available in the second half of 2005. The new information will allow us to refine our programs to prioritise those high-risk industry sources that have the highest environmental risks.

Health alerts

As the Premier mentioned, we have also designed a new health alert system that will provide better forecasts on days when we think pollution levels may be of concern, particularly for sensitive populations.

Industry

It is important to recognise that industry is making improvements to their emissions controls under pollution reduction programs, but we need to modernise our regulatory approach, some of which was designed over 30 years ago.

In the past five years industry has spent approximately $58 million on air pollution reduction measures. On top of this, BHP alone spent $95 million to reduce emissions from its sinter plant in Wollongong.

The incentives are wrong in the old regulation however, because after 30 years of giving the benefit of more lax standards to old plant and equipment there is no real incentive for upgrades. We are therefore having a fundamental rethink and are currently revising the key Regulation which provides the framework for the management of air pollution from licensed industrial premises.

We had a round of stakeholder consultation on the development of the Regulation late last year and a second round of consultation on the details of the draft Regulation is about to start. It will consider:

- tighter emissions standards for new industry
- new requirements for some older industries to assess health impacts and
- the introduction of more modern emissions limits, if needed.

We expect the consultation period on the draft revised Regulation to go from November to mid-February 2005.

Local government air quality toolkit

Another of our challenges in looking to the future for air quality is to realise we need actions at the global, regional and local levels. It is a very big jigsaw, a complex matrix. Air pollutants at the local level can create hotspots, cause significant local community aggravation and, depending on the pollutant, may have health effects. We are developing a toolkit which aims to increase the knowledge, confidence and expertise of council officers to better manage air pollution. It will focus on premises regulated by local government such as:

- food outlets and small scale food processing
- construction sites
- spray painters, and
- intensive animal industries.

The toolkit will assist councils to identify projects that will improve local air quality and expand the technical capacity of officers to promote clean air. The toolkit and training will be available in the second half of 2005.

Commercial and domestic sector

As other sources are cleaned up, the commercial and domestic sector is making relatively increasing contributions to emissions for both ozone and particles. The Government has provided almost $2.5 million over three years to reduce emissions from small businesses and light commercial businesses. Local councils have been and will continue to be an important part of this program.

Wood smoke

One of our biggest challenges in the commercial and domestic sector is smoke from wood heaters. It causes high levels of particle pollution in winter, not only in Sydney, but also in some of the State's regional areas.

To address this problem the Government has operated the Wood Smoke Reduction Program over the last three winters which includes education, enforcement and incentives to encourage cleaner heating. We have also been working with the Commonwealth to examine national standards for heaters. We now have a good alliance at the national, state and local level in tackling wood smoke and will be evaluating the program to look at what additional strategies are needed to reduce the contribution that wood heaters make to the growing concern with particle pollution.

Motor vehicles and fuel

Motor vehicles (and the roads they travel on) continue to be the major component of Sydney's air pollution and one of the hardest to get a handle on. Cars are an important part of people's lives and trucks are an essential element of many businesses. Feedback from stakeholders underlines the fact that reducing emissions and tackling congestion from the motor vehicle sector requires a range of policy approaches.

Stricter standards for petrol and diesel vehicles— We have already covered today the significant advances made in vehicle technologies and cleaner fuels. We have

also seen a positive response from consumers and businesses towards the new range of cleaner, less polluting cars and toward fleet maintenance programs which make sense—if only for their fuel efficiencies—but they also have added air quality benefits across particle pollution, greenhouse gases and air toxics. New technologies and new vehicle and fuel standards which will be introduced between 2005 and 2009 will make cars and trucks even cleaner.

Road tunnels—Since publication of *Action for Air* probably the most controversial issue in this sector has been emissions associated with road tunnels, both in-tunnel and from tunnel stacks and portals. There is work now underway by the RTA in both the design and operation of new and existing tunnels to reduce air emissions that may be harmful to people. Stakeholder workshops highlighted the need not only to respond to the technological issues but also to provide a clearer regulatory framework within government across the planning, environmental and health responsibilities.

One aspect we need to look at is behavioural change, but, as social scientists tell us, this is never straightforward. *Action for Air* contains VKT targets which currently are not being achieved although growth in travel appears to have stabilised up to 2001. The population is ageing and in the past, car use by the elderly as a group reduces. However, recent research suggests that as the baby boomers retire they will buck this trend (Rees & Lyth 2004). They are a cohort that has grown up with the car and, unlike the previous generation, women as well as men have always driven. Their cars provide them with a sense of security and independence as well as convenience. Our policy approaches need to take this into account.

Planning & public transport systems—Stakeholders also emphasised the importance of making improvements to the planning and public transport systems. We have to do this if we want to promote walking, reduce VKT and reduce our reliance on cars. These issues have already been discussed by Evan Jones in the context of the Metro Strategy.

Where to from here?

We need to keep our focus well and truly on ozone and particles, particularly in light of the emerging clarity about the impacts of climate change on air quality. And of course, future air quality gains for ozone and particles in Sydney will undoubtedly come at a cost, but not taking action also comes at a cost.

We must also understand what implications of extreme events, particularly increasing temperatures, will have on our overall air quality. This presents new challenges from those we faced when we developed *Action for Air* in 1998.

Hugh Mackay recently suggested that future generations are bound to criticise us for "our reckless, travel-obsessed disregard for the fragile ecology of the planet". He suggests that our children's children will be asking: "Why did people do all that endless travelling, burning up those fossil fuels and creating such damaging emissions from their cars and aircraft? Didn't they understand the consequences?"

There was a strong message from the stakeholder workshops including the one on motor vehicles and fuels that we shouldn't just focus our strategies on technological change—we also need to be sending the right economic signals. Economic instruments and incentive programs are not easy to design and are more often than not difficult to implement. They are either seen as subsidies which create a drain on tight budgets or as a new tax that is controversial with the community.

We will be continuing to examine the use of economic strategies to give us all the incentives to reduce our road travel. Since our last Clean Air Forum, London has introduced a congestion pricing scheme which has reduced congestion by 40%. The local government association recently voted in favour of having a similar scheme here. Of course, it's not just about cars. Waverley Council in Sydney has introduced a ban on the installation of wood heaters and open fireplaces. Christchurch in New Zealand is going further and phasing out the use of existing open fireplaces and old wood heaters as Denver Colorado did several years ago. But if technology improves do we need to deny people both the economic benefit and pleasure of such heating? These are the tough questions we must ask!

Our next set of strategies for *Action for Air* 'unplugged' will require adaptive management to balance those many competing needs. We look forward to everyone's ideas to keep the strategy delivering cleaner air.

References

Rees C & Lyth A 2004, 'Exploring the Future of Car Use for an Ageing Society: preliminary results from a Sydney study', *Proceedings of the 27th Australasian Transport Research Forum*, Adelaide, 29 September–1 October 2004

Closing address

The Hon Bob Debus MP
NSW Minister for the Environment

I'd like to thank all the speakers at today's forum. I'd also like to thank everyone in the audience for their participation today and for their input in the lead up to this year's Clean Air Forum.

As we've heard, we face some major challenges in managing air quality in NSW in the future.

There are many factors affecting the air we breathe:

- our weather
- our topography
- our expanding population and city sprawl
- our growing economy
- the types of industry we have, and
- our continuing love affair with cars and being busy.

Some of these factors we can influence and some we can't. Add climate change to that mix and it gets even more complex.

But it's not good enough to sit on our hands and wait to see if the Commonwealth Government, or even the Bush government for that matter, takes some action. We need to be firm and clear in our vision for air quality in Sydney, in NSW and throughout our great country.

My vision for Sydney is a challenging one. It is of a city where:

- every teenage boy in Rockdale can tell you which of the latest car models has the lowest emissions— as well as which one has the most power
- a family in Eastwood is responsible for producing the same amount of greenhouse gases as a family in East Timor, and
- smoky sinter stacks, smoky wood heaters and smoky whipper-snippers have been replaced by clean alternatives. They would be things you can only see at the Powerhouse Museum as historical relics.

I know some of you will think this can't happen in our lifetime. But 10 years ago few people thought hybrid cars, let alone those fueled by canola oil and other alternative fuels, could ever become mainstream.

But this change will only come about with a combined effort from government, business and the community. And we need to be taking action now and to be planning for the future.

Petrol volatility regulation

One of the actions that the NSW Government has been planning for some time and that came into effect this week is a regulation to reduce the volatility of petrol over summer.

Fuel vapour is one of the pollutants that contribute to smog over our city. In summer, fuel evaporates faster than in winter and Sydney's hot summers call for extra measures to address fuel volatility and reduce pollution.

Up until now oil companies have supplied lower volatility fuel over summer as part of a voluntary agreement. We consulted with stakeholders late last year and I'm pleased to say that every last one of them supported our proposal to make the summertime fuel mandatory.

The new requirements are expected to reduce fuel vapour in the Sydney Greater Metropolitan Region by almost 3,000 tonnes every year for the next three years. This is equivalent to the total volatile organic compound emissions of over 90,000 cars.

New pollution inventory research

While fuel vapour is a commonly known contributor to air emissions there is an increasing number of new and unexpected sources of pollution of which we have only a limited understanding. To best tackle air pollution head on we must continue to build up our knowledge of new and emerging causes.

I'm pleased to announce today a major new $500,000 research project that will see the development of a comprehensive inventory of sources of air pollution. This major research project will build on the range of established things that affect our air quality, like industrial, commercial and domestic sources. It will also look at the unusual and less well-known causes, like mobile and even biological sources. The project involves using the latest technology and sophisticated

software to test out policy scenarios, conduct emissions modelling, pollution forecasting, environmental reporting and data visualisation. It's a little bit like CSI-Sydney on air pollution.

Increasingly we're seeing air pollution from mobile sources like helicopters, planes and boats, as well as from minor items like lawnmowers and whipper-snippers. And biological air pollution comes from living organisms like gum trees which release volatile organic compounds. This can cause ground level ozone when combined with the right weather conditions and other chemicals—especially during summer.

These are the modern-day scenarios confronting the scientists and policy-makers who are working hard to ease the pressures on our air quality.

The project will run for more than 12 months and will involve up to 15 researchers working to build the most comprehensive inventory on air pollution Sydney has ever seen.

Its potential is really remarkable. Once the evidence is in we'll be able to model these scenarios, so our suburbs can be planned in a way to minimise our impact on air quality. This research is one of the scientific building blocks needed to ensure that the way Greater Sydney expands is both sustainable for our own well being and for our environment.

Links with greenhouse and air quality

Like many people present today, I was here at the first Clean Air Forum in 2001. One of the big changes for my portfolio since then has been the creation of the Department of Environment and Conservation. The former Environment Protection Authority, National Parks and Wildlife Service, Resource NSW and Botanic Gardens Trust are now all part of the one organisation working for improved environmental outcomes.

At first glance air quality doesn't seem to be linked with management of national parks or with conservation and biodiversity. But today's discussion about climate change shows how these issues are inextricably linked.

With climate change there is:

- the potential for more hot days, for more bushfires, for higher pollution levels and for heat-related health problems
- there is also an increased need to effectively suppress those fires in national parks and their impact on conservation of fragile ecosystems.

We need to understand the extent of climate change to manage our policy responses. We have to start looking at co-benefits for air quality and greenhouse when we:

- assess industry proposals
- consider the use of alternative fuels, or
- plan new suburban developments.

For instance, reducing traffic congestion and the number of trips can lead to reduced ozone and particle pollution and lower emissions of greenhouse gases. Managing demand for electricity will also reduce greenhouse gases and other pollutants by avoiding increased emissions from power plants.

We need overarching strategies like *Action for Air*, the Metro Strategy and the upcoming Greenhouse Strategy to address the environmental and economic impacts and the impacts on human health in an integrated way.

Next steps

What happens after today? Firstly, we want to make sure there is a record which captures the outcomes of the forum. You will all receive a summary of proceedings in the next few months.

We are also planning to bring out a revised *Action for Air* document in the middle of next year.

We will ensure that our air management strategy is aligned with the other major developments we have talked about today—that it is explicitly linked with the Metro Strategy and with new climate change and energy policies.

As I mentioned earlier, the Government will be releasing its draft Greenhouse Strategy shortly and seeking your input. Having a far reaching air quality and Greenhouse Strategy is important.

It's important to have rigorous standards and benchmarks so we can comprehensively monitor air quality and publicly report on the results. It's also important to participate in health studies on pollutants and to undertake scientific research on bushfires. However, on their own these things can't improve air quality or reduce greenhouse gases.

The choices we make as a community and as individuals every day are integral to determining our air quality. Every day, each of us holds that power in our hands when we make decisions about:

- whether to take the train or the car
- whether to buy energy-efficient appliances or standard ones, or
- whether to buy a V8 or a hybrid car.

I for example, have just changed to a hybrid vehicle for my ministerial car. Each of us has a part to play in determining the environment our children and grandchildren will live in.

I look forward to seeing you at the next Clean Air Forum in 2007 and looking back on the steps we've taken together since today to bring about a healthier and cleaner environment for our future.

List of attendees

Name	Organisation
Ms E Adamson	Roads and Traffic Authority
Mr S Alchin	Department of Infrastructure, Planning and Natural Resources
Mr J Angel	Total Environment Centre
Dr G Ayres	CSIRO Atmospheric Research
Dr M Azzi	CSIRO Energy Technology
Ms C Barlow	NSW Ministry of Transport
Mr C Bartlett	Air Quality Measurement
Mr G Bates	EPA Board
Dr T Beer	CSIRO Environmental Risk Network
Dr P Beggs	Macquarie University
Mr T Bertoia	Institute of Transport Studies, University of Sydney
Mr R Bluett	Department of Environment and Conservation
Mr J Booth	Department of Environment and Conservation
Dr R Bradstock	Department of Environment and Conservation
Ms K Brady	Department of Infrastructure, Planning and Natural Resources
Ms C Brindley	PricewaterhouseCoopers Legal
Ms J Broady	The University of Sydney
Mr W Brooks	Tomago Aluminium Company
Mr J Brown	NRMA Motoring and Services
Mr A Burnard	Department of Energy, Utilities and Sustainability
Mr D Butcher	Greening Australia NSW
Ms S Calvert	Department of Infrastructure, Planning and Natural Resources
Ms M Camamo	Roads and Traffic Authority
Ms M Campbell	Department of Primary Industries
Ms S Campbell	Institute of Sustainable Futures, University of Technology, Sydney
Ms E Carlsson	Sydney Gas Operations Pty Ltd
Mr R Carter	Department of Environment and Conservation
Mr S Charity	Society of Automotive Engineers – Australasia
Ms S Connolly	PricewaterhouseCoopers Legal
Mr M Conroy	Department of Infrastructure, Planning and Natural Resources
Mr T Coombe	Hydro Aluminium Kurri Kurri Pty Ltd
Dr S Corbett	Western Sydney Area Health Service
Ms L Corbyn	Department of Environment and Conservation
Mr B Corderoy	Delta Electricity
Mr M Cove	Shell Refining (Australia) Pty Ltd

Name	Organisation
Mr B Crocker	Department of Commerce
Ms A Crotty	Department of Environment and Conservation
Mr S Crumlin	Audit Office of NSW
Mr M Curran	Groups Against Polluting Stacks
Ms R Daniels	Department of Infrastructure, Planning and Natural Resources
Ms L Davidson	NSW Greenhouse Office
Mr M Davies	Alcoa Australia Pty Ltd
Mr J Dengate	Department of Environment and Conservation
Dr M Diesendorf	Sustainability Centre, University of NSW
Mr A Doig	Australian Environment Business Network
Mr B Dowdell	Roads and Traffic Authority
Ms S Dunford	NSW Greenhouse Office
Mr C Dunstan	Department of Energy, Utilities and Sustainability
Mr R Edwards	NSW Treasury
Mr J Egan	Toyota Motor Corporation Australia Limited
Mr C Eiser	Department of Environment and Conservation
Mr B Elton	Elton Consulting
Mr L Farago	Department of Energy, Utilities and Sustainability
Ms H Fitzgerald	NSW Ministry of Transport
Mr R Fowler	NSW Greenhouse Gas Abatement Scheme
Mr J Fry	Conservation Volunteers Australia
Mr D Fuller	Focus Press Pty Ltd
Ms A Gaffney	BP Australia Pty Ltd
Mr M Garrahy	Bluescope Steel
Ms M Gleeson	EcoTransit Sydney
Mr J Goddard	Outboard Engine Distributors Association
Ms A Gordon	NSW Greenhouse Office
Mr B Gordon	Renewable Fuels Australia
Mr N Gow	Australian Trucking Association
Dr S Greaves	Institute of Transport Studies, University of Sydney
Mr M Griffin	Environmental Manager Newsletter
Mr S Habbits	KPMG Risk Advisory Services
Mr P Haenke	Energetics Pty Ltd
Mr M Hambrook	The Australian Paint Manufacturers' Federation
Mrs H Hamilton	Healthy Cities Illawarra
Prof R Harding	Institute of Environmental Studies, University of NSW
Mr R Harman	Outdoor Power Equipment Association
Mr D Hemming	Department of Energy, Utilities and Sustainability

Name	Organisation
Mr A Hicks	Capitol Research Pty Ltd
Mr J Higgins	Australian Greenhouse Office
Ms C Hinde	Department of Primary Industries
Mr B Hoare	Greenchill Technology Association Inc
Mr M Holden	Composites Institute of Australia
Mr J Hopwood	Printing Industries Association of Australia
Mr B Isherwood	Xstrata Coal
Mr S Isles	Roads and Traffic Authority
Dr B Jalaludin	South Western Sydney Area Health
Mr P Johns	Drycleaning Institute of Australia
Mr D Johnson	Department of Environment and Conservation
Mr V Johnston	Toyota Motor Corporation Australia Limited
Ms A Jones	Commonwealth Department of Transport and Regional Services
Mr B Junor	EPA Board
Ms N Kanhoush	Department of Environment and Conservation
Dr R Kearney	Lane Cove Tunnel Action Group
Mr K Koop	Department of Environment and Conservation
Mr A Lake	Biodiesel Association of Australia
Ms L Lakshmi	Harris Community Centre
Mr C Lamberton	Department of Environment and Conservation
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Ms M Lyons	Climate Friendly Pty Ltd
Mr M Lyster	Ecos Corporation
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Mr E MacPherson	Australian Institute of Petroleum
Mr H Malfroy	Malfroy Environmental Strategies Pty Ltd
Mr G Marshall	Commonwealth Department of Environment and Heritage
Ms C Mason	NSW Council of Social Services, Bicycle NSW
Ms L Mason	EcoTransit Sydney
Mr A Mattes	Department of Environment and Conservation
Mr H McMaster	NSW Road Transport Association
Ms E Metzer	The Shell Company of Australia Pty Ltd
Mr F Mieszala	Eraring Energy
Mr R Miyazawa	Hino Australia
Mr M Molitor	Carbon Management Group
Prof F Muller	Institute of Environmental Studies, University of NSW
Prof P Nelson	Graduate School of the Environment, Macquarie University

Name	Organisation
Mr I Newbery	National Environment Protection Council
Mr B Noble	Hino Australia
Mr R North	Australian Liquefied Petroleum Gas Association
Mr H O'Clery	Greenfleet Australia
Dr T O'Meara	Woolcock Institute of Medical Research
Mr T Pennington	Truck Industry Council
Ms K Perini	Department of Environment and Conservation
Dr T Prasad	Department of Energy, Utilities and Sustainability
Mr P Prineas	EPA Board
Ms S Quigley	Department of Environment and Conservation
Ms K Reade	NSW Cabinet Office
Mr J Real	Commonwealth Department of Transport and Regional Services
Dr T Recsei	Save Our Suburbs (NSW) Inc.
Mr D Richards	Newcastle City Council
Mr P Ridgeway	Onesteel Ltd
Ms M Riley	Sydney Water
Mr D Roddis	Clean Air Society of Australia and New Zealand
Mr N Routh	Department of Environment and Conservation
Ms J Ryan	Roads and Traffic Authority
Mr N Ryan	The Wilderness Society
Mr D Rynne	Australian Trucking Association
Mr C Santin	Plastics and Chemicals Industries Association
Ms L Sayer-Roberts	Department of Environment and Conservation
Dr S Schuck	Bioenergy Australia
Mr K Schrader	Central Sydney Area Health Service
Mr H Scruby	Pedestrian Council of Australia
Mr R Seeley	Commonwealth Department of Environment and Heritage
Dr V Sheppeard	NSW Department of Health
Mr J Sherrard	Cambiar
Mr M Smith	The Shell Company of Australia Pty Ltd
Mr P Smith	NSW Minerals Council
Mr P Smith	Orica Australia Pty Ltd
Mr S Smith	Department of Environment and Conservation
Mr A Spencer	NSW Greenhouse Advisory Panel
Dr M Staff	NSW Department of Health
Dr G Stewart	NSW Department of Health
Mr R Steven	NSW Treasury
Mr C Swindells	Colpro Engineering (Australia) Pty Ltd

Name	Organisation
Ms N Thirkettle	Air Quality Community Consultative Committee
Mr G Thomson	Galvanisers Association of Australia
Mr P Tonitto	Victa
Mr F Topham	Caltex Australia Limited
Mr B Verhey	Local Government and Shires Association of NSW
Ms K Vinot	Visy Industries
Ms F Wain	Environment Business Australia
Mr F Wallner	Healthy Cities Illawarra
Mr M Warren	NSW Minerals Council
Mr J Wellsmore	Public Interest Advocacy Centre
Mr K Wentrup	Energy Supply Association of Australia
Ms K Whillock	Department of Environment and Conservation
Mr J White	Department of Environment and Conservation
Mr A Whitehead	Future Energy
Ms S Whittaker	Department of Environment and Conservation
Mr M Wilder	Baker and McKenzie
Mr R Wilkins	NSW Cabinet Office
Mr N Williams	Eraring Energy
Mr P Wild	TNT Express
Mr O Woldring	NSW Greenhouse Office
Mr I Woods	AMP Capital Investors
Mr P Woods	EPA Board
Mr J Woodward	Department of Environment and Conservation
Mr P Wright	NSW Greenhouse Office