Background briefings on emerging issues for fire managers from AFAC and Bushfire CRC.

bushfire CRC

AUSTRALASIAN FIRE AUTHORITIES COUNCIL

FIRE NOTE

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CLIMATE CHANGE AND ITS IMPACT ON THE MANAGEMENT OF BUSHFIRE

One of the more difficult issues facing those involved in the management of bushfires is assessing the likely impact of climate change on the bushfire threat.

The combination of climate, topography and vegetation in many areas of Australia, and in parts of New Zealand, combine to produce one of the most severe fire environments in the world.

Conversely, fire has been part of most of these environments for millions of years, largely shaping the composition and distribution of the native plants, animals and ecosystems that survive today. Indeed, a significant proportion of Australia's unique biota has become largely dependent on fire and the attendant variety of fire regimes for its continued existence and development.

Any possibility that conditions in current bushfire-prone areas may become hotter, drier, and/or windier or that such areas may experience more frequent extreme 'fire weather' days, must be factored into future planning by fire authorities, land managers and the community.

The fire and land management agencies who are partners in the Bushfire CRC and members of the Australasian Fire Authorities Council have identified the issue of possible climate change as one of the most important strategic issues confronting bushfire managers in Australia and New Zealand.

BACKGROUND

There is considerable evidence that global and regional climates are in a fairly constant state of change. The time-scales involved range from months to millions of years. Factors influencing these changes range from those internal to the climate system (such as the El Niño – La Niña cycle) and those external to it (such as fluctuations in radiant energy output from the Sun).

There is a growing consensus, within the international scientific community, that aspects of current changes to global climate are due, in significant part, to increasing concentrations of greenhouse gases in the atmosphere.

For millions of years the greenhouse effect has operated on Earth. Without it, the planet would be too cold for human habitation. Prior to the Industrial Revolution, in the late eighteenth century, human activity had little effect on atmospheric carbon dioxide concentrations. The increasing use of fossil fuels since that time however has seen increasing amounts of carbon dioxide, methane, and nitrous oxide released into the atmosphere. Concurrently, land clearing for agricultural purposes, and for the expansion of cities and towns, has resulted in less vegetation being available to take up carbon dioxide from the atmosphere.

The level of atmospheric carbon dioxide, which is regarded as a key driver of climate warming, has increased from a pre-industrial value of 270 parts per million (ppm) to about 360 ppm at present, and is projected to rise to more than 500 ppm during this century.

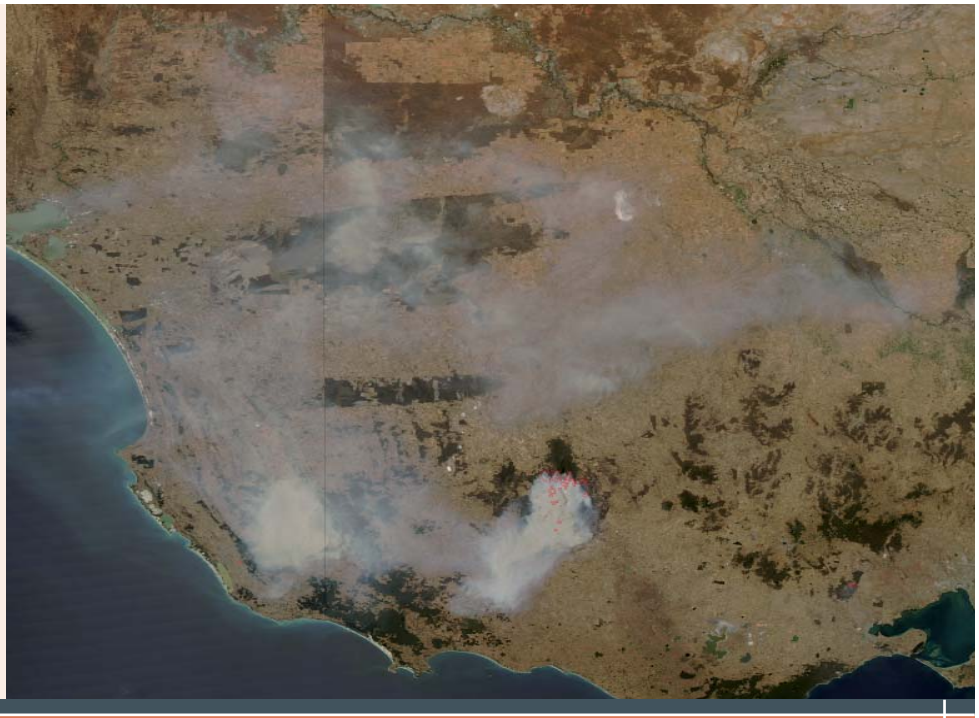
SUMMARY

Changes in global climate have the potential to significantly impact on the bushfire threat in Australia and New Zealand.

Predicting the impacts of climate change in specific regions continues to be very complex scientifically. Current projections suggest that for south-eastern Australia there could be an increase in the frequency of very high and extreme fire danger days, especially in inland areas, and that periods suitable for prescribed burning are likely to move toward winter. In northern Australia, current predictions suggest the frequency of floods and droughts could increase, with some ecosystems becoming more arid.

Lightning strikes might also increase in the north.

Several current Bushfire CRC research projects are assisting agencies to understand and prepare for the possibility of future climate change. As the understanding of the probable impacts of climate change at regional levels becomes more certain, there will be a need for more targeted Bushfire CRC research projects.



In its 2005 *Annual Australian Climate Statement*, the Bureau of Meteorology announced that Australia had officially recorded its warmest year on record. The statement advised that "…the nation's annual mean temperature for 2005 was 1.09°C above the standard 1961-90 average, making it the warmest year since reliable, widespread temperature observations became available in 1910…" The statement went on to advise that the previous record of +0.84°C was set in 1998, noting that "While these temperature departures may seem relatively small, a 1°C increase in mean temperatures is equivalent to many southern Australian towns shifting northwards by about 100 km."

This observed temperature increase is not unique to Australia. The World Meteorological Organisation (a specialised agency of the United Nations) in a *Statement on the Status of the Global Climate* in 2005 announced that the global mean surface temperature in 2005 was 0.47°C to 0.58°C above the 1961-1990 annual average of 14°C. The statement advised that 2005 was "…one of the two warmest years on record since 1850." (The year 1998 had annual surface temperatures averaging 0.52°C above the same 30-year mean).

The WMO statement went on to observe that "The large-scale climate phenomenon El Niño can contribute to above-average warmth, as was the case with extremely strong 1997/1998 episode..." The WMO notes however that "The record warmth in 2005 is notable as there was little influence of the El Niño event on the 2005 global temperatures…"

In a report released by the Federal Minister for the Environment and Heritage, in February 2006, titled *Climate change impacts on fire-weather in south-east Australia*, the CSIRO suggests: "The south-east region of Australia is particularly vulnerable to bushfire – along with southern California and southern France it is identified as one of the three most fire-prone areas in the world. It is therefore critical that we prepare for the potential of increased fire risk associated with the hotter and drier years we may experience in the future…"

Meanwhile, in northern Australia, the Tropical Savannas CRC has reported that "…there has been a general increase in heavy rainfall over the past century…" The CRC notes that: "This trend is consistent with the predictions from climate models under enhanced greenhouse conditions." The CRC also suggests "…the frequency of extreme events such as floods and droughts will probably increase." with the possibility that north Australian ecosystems could become more arid.

CLIMATE CHANGE AND BUSHFIRE MANAGEMENT

The danger posed from bushfire is directly related to the chances of a fire starting, its subsequent rate of spread, intensity and difficulty of successfully suppressing it. The difficulty of successful bushfire suppression is variously related to the nature and arrangement of the available fuel, the temperature, relative humidity, wind speed and both long and short term drought effects.

Bushfire seasons are obviously related to the prevailing regional weather patterns. Currently, most of southern Australia, and New Zealand experience their fire danger period in summer and autumn. New South Wales and southern Queensland experience peak risk in spring and early summer. Northern Australia experiences most of its fires in winter and spring.

Not all years are the same in terms of fire risk and activity. Widespread bushfire damage can occur in some years (for example, the Canberra and alpine fires in January, 2003); while in other years large bushfires are rare. Fire, and park and forest management agencies, and indeed vulnerable communities need to understand this variability and its relation to climate. It has direct relevance to how fires will behave in a given area and to the nature of planning of both agencies and the community.

The climate change debate is clearly a complex one and, in the context of bushfires, must also be viewed in conjunction with the nature of much of Australia's, and some of New Zealand's native vegetation. Much of this vegetation has a complex evolutionary and dependent relationship with fire. Fire has been part of these environments for tens of thousands of years and much native flora and fauna remains dependent on it in various ways.

From a scientific viewpoint climate change needs to be understood at a both a global and regional level. This is clearly a complex task, and many questions remain. In the February 2006 report referred to earlier (*Climate change impacts on fire-weather in south-east Australia*), the CSIRO concluded that should the average summer temperature increase then "…there will be an increase in the frequency of very high and extreme fire danger days, especially in inland areas". The report concluded that frequency would increase by 4-25% by 2020 and by 15-70% by 2050 if the model projections are correct. The changes were considered likely to be greatest in the inland, and relatively less along the coast and in Tasmania. The report went on to suggest that "…in most places an increase in fire danger in spring, summer and autumn is also likely, which will move the periods suitable for prescribed burning toward winter".

The situation regarding future rainfall levels is less clear at present. Current future fire regime scenarios incorporating increased rainfall yield larger fires, mostly as a consequence of higher fuel load and fuel continuity, which increases fire spread (Cary 2002). Lightning strikes are also predicted to increase in frequency (Goldhamer and Price 1998) for tropical Australia, while the trend for southern Australia remains unclear.

While simulated climate futures vary considerably in their predictions of rainfall, even less can currently be predicted about how current levels of wind speeds, relative humidity and lightning activity may change. Nonetheless, it would seem prudent for relevant agencies

RIGHT: SMOKE PLUMES FROM 2003 ALPINE FIRES IN VICTORIA

COVER IMAGE: GRAMPIANS SMOKE PLUME AND ASH, JANUARY 2006

ALL PHOTOS IN THIS FIRE NOTE COURTESY OF BUSHFIRE CRC PARTNER AGENCIES.

ABOVE: BUSHFIRE CRC RESEARCH IN NEW ZEALAND, JANUARY 2005.

to begin planning for a higher frequency of unplanned fires.

In its report to the Council of Australian Governments in March 2004, the *National Inquiry on Bushfire Mitigation and Management* concluded:

"Depending on future international and Australian arrangements for greenhouse mitigation, there may be economic benefits associated with reducing greenhouse gas emissions associated with fire or in sequestering carbon through vegetation sinks. Realising either of these economic benefits would depend on managing the impacts of bushfires.

"In summary, the implications of climate change for bushfires are likely to create substantial economic, social and environmental costs. For these reasons fire and land management agencies are already exploring measures and arrangements that might mitigate the impacts of bushfires under altered climatic regimes and might capitalise on opportunities that mitigation arrangements present. Because of the significance of northern savanna fires to greenhouse emissions and the potential for landowners to benefit from mitigation arrangements, these options have been most fully explored to date in northern Australia."

BUSHFIRE CRC RESEARCH

The Bushfire CRC is playing a key role in improving understanding of climate change and climate variability and is currently focussing on six aspects

- Weather and climate associated with past major fire events;
- A detailed accurate fire weather data set 1957-2003;
- Improved seasonal climate outlooks;
- Composition and health impacts of smoke;
- Links between climate, fuels and the carbon and water cycles, especially in alpine country.

It is important that we keep in mind that a single major fire event, such as the 2003 fires, can have far greater consequences than small changes in temperature or rainfall over a period of decades. Similarly, the year-to-year and seasonal variations can be far greater than the small gradual changes of long-term climate change.

The work in the Bureau of Meteorology's Research Centre on the weather and climate conditions surrounding major fire events in the past and CRC funded efforts on building an accurate, reliable fire weather data base back to 1957 will be important tools in managing climate variability in the future.

The recent Bushfire CRC/Bureau of Meteorology workshop on developing a seasonal fire weather outlook is likely to lead to a valuable national tool in preparing for fire seasons.

Major research challenges for the future will be to gain a better understanding of the links between fire as a land management tool and the management of critically important resources such as water and forests.

The Bushfire CRC project A2.1 *Fire Weather – Fire Danger* is establishing relationships between global circulation anomalies and Australian regional seasonal weather. It is focusing on the number of high hazard episodes as well as 'mean' weather behaviour, with a view to assisting fire agencies in their strategic planning.

At the 'applied science' level, smoke from bushfires, and more particularly smoke from the use of prescribed fire, is increasingly viewed in some quarters as further adding carbon dioxide, and other greenhouse gases to the atmosphere, and as such further contributing to global warming.

As with much of the science associated with climate change however, the story is more complex. New vegetation that establishes following a fire is invariably vigorous, growth-wise, generally 'locking up' considerable quantities of carbon. Similarly, any contributions to global warming that might result from prescribed fires must be balanced against the global warming impacts of more frequent and more intense bushfires that will occur in the absence of the strategic use of prescribed fire.

UNDERSTANDING THE TERMS

The Greenhouse Effect: The Sun's energy, which is mainly short wavelength radiation, passes through the atmosphere and warms the Earth's surface. The Earth's surface re-radiates this heat energy at longer wavelengths. The so-called 'greenhouse gases' strongly absorb this heat energy in the lower atmosphere. They act like a blanket in preventing heat loss. The principal greenhouse gases are: water vapour, carbon dioxide ($C0^2$), methane (CH^4), nitrous oxide (N^2O), ozone (O^3), and chlorofluorocarbons (CFCs).

The El Niño-Southern Oscillation: The term El Niño was originally used to describe a warm water current which periodically flows along the coast of Ecuador and Peru. The term is now used to describe extensive warming of the central and eastern tropical Pacific Ocean that leads to a major shift in weather patterns across the Pacific. In Australia, and particularly in eastern Australia, El Niño events are associated with an increased probability of drier conditions. The opposite effect, extensive cooling of the central and eastern Pacific Ocean, is known as the La Niña phenomenon. It is associated with the probability of wetter conditions in eastern Australia. El Niño and La Niña are extreme phases of a naturally occurring climate cycle. They result from interaction between the surface of the ocean and the atmosphere in the tropical Pacific Ocean. This coupled atmosphere-ocean phenomenon is collectively known as the El Niño-Southern Oscillation (ENSO). The system oscillates between warm (El Niño) to neutral (or cold La Niña) conditions on average every 3 to 5 years. Since 1975, La Niñas have been only half as frequent as El Niños, a shift being studied for its possible relationship to global climate change.

Project B2.2 *Smoke Composition from Prescribed and Wildfires and Health* is better quantifying the contribution of prescribed fires and wildfires to atmospheric particulate matter, classical pollutants, greenhouse gases, photo chemically active gases and ozone-depleting chemicals.

Project B6 *HighFire* has been designed to help better understand the dynamic interactions of climate, fuel, water and carbon in the 'high country' of south-eastern Australia. Using three sites, in Victoria, the ACT and New South Wales, researchers are working to quantify the possible impacts of climate change on water and carbon balances, and on fuel production, fuel loads and fuel moisture status. The future interactions of fire regimes and climate change are likely to present land managers of these remote parks and forests with significant strategic and operational challenges.

Several other Bushfire CRC projects (such as A4.1 *Fire Management Business Model*) will assist fire, park and forest management agencies to better prepare for climate related changes to fire regimes. The outcomes of Project A4.1 for example, will provide a better understanding of how changes in one aspect of bushfire management can affect other aspects of land and fire management.

In considering fire at the landscape level, the likely impact of climate change on the current distribution of flora and fauna is another key issue. Species invariably evolve in ways that enable them to survive in particular climates. Even small changes in climate will see some species unable to continue in some locations. This is likely to be more the case where climate change occurs rapidly and evolutionary adaptation is less achievable. As an example, it has been estimated that if present temperatures were to rise 2°C in southern Australia, the temperate rainforest tree *Nothofagus cunninghamii* (Myrtle Beech) would vacate significant parts of its present geographic range. Such an outcome (a retreat of cool temperate rainforest) would see considerable additional areas of forest become more flammable, more frequently.

Similarly, elevated levels of carbon dioxide in the atmosphere may do more than change fire regimes through weather effects. Greater carbon dioxide availability may also lead to changes in plant growth and decomposition rates, thereby changing fuel dynamics. Until the global impacts of climate change become further refined, regional and national consequences for particular ecosystems will remain somewhat elusive.

In the report to the Council of Australian Governments in March 2004, the *National Inquiry on Bushfire Mitigation and Management* concluded:

"Long-term strategic research, planning and investment are necessary if the Australian Government and state and territory governments are to prepare for the changes to bushfire regimes and events that will be caused by climate change."

AFAC, the Bushfire CRC, and their fire and land management partners remain committed to the need for an on-going strategic response to the possible impacts of climate change on bushfire regimes.

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AFAC is the peak representative body for fire, emergency services and land management agencies in the Australasia region. It was established in 1993 and has 26 full and 10 affiliate members.