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Our future climate - living with fires now and into the future...

Understanding the science of fires in Australia and celebrating the spirit of renewal and recovery

THIRD

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Check against delivery

Good evening ladies and gentlemen, volunteers, fellow scientists and distinguished guests. My thanks to the Hon Robert Tickner, Secretary General of the Australian Red Cross, for inviting me to speak at this annual oration and Professor Lawrence Cram for that kind introduction.

Firstly, I would like to acknowledge the traditional owners of the land on which we meet and pay my respects to their elders past and present. I understand the traditional owners have lived with and used fire as an important tool in this country for millennia. There is evidence in their oral tradition of using astronomical, seasonal and biological observations to guide and assist in their survival.

The myriad generations of the traditional people that inhabited this land must have lived through significant changes of climate. Some of their ancestors must have experienced the end of the last ice age. Others have had to cope with extreme drought.

As we face a future of dramatic and global climate change, we may be able to learn from the adaptations that Indigenous cultures have developed in response to these intergenerational changes.

But it is also important to remember that our world society of nearly 7 billion people has new challenges.

Today, we know our own activities are responsible for the majority of climate change over the last two hundred years and pace with which that change is quickening. Today, tens of millions of people live in low-lying coastal regions that are at risk for continual flooding due to climate related sea level rise. Today, it is estimated that nearly one billion people are already hungry and malnourished. The effects and speed of climate change on agricultural practices will increase the difficulty we already have in feeding them.

Today, many parts of the world, Australia in particular, are facing a future of increasing destructive threat to population centres from massive firestorms.

Today, however, we also have new scientific tools with which to understand what is likely to lie ahead, and to adjust our activities in order to reduce and adapt to climate change.

Science tells us that more and larger fires are in our future if we do not change the current trajectory of global warming. February 2009 was found to be the ninth warmest since records began in 1880. This finding was based on the combined global land and ocean surface average temperature analysed by the US National Oceans and Atmospheric Administration (NOAA) National Climatic Data Centre[1]. Globally 13 of the 14 warmest years on record occurred between 1995 and 2008[2]. This trend is also evident in Australia, which has experienced warmer-than-average annual temperatures in 17 of the past 19 years, from 1990 to 2008.[3]

Unfortunately these dry facts and global findings can have very immediate, personal, even heart rendering consequences. As most of you probably already know, the recent Victorian bushfires resulted in the tragic loss of 173 lives - with many more seriously injured. 78 communities felt the impact, and 430,000 hectares of land in forests, crops and pasture were affected or completely burnt[4]. Before I go on, I want to express my sincerest sympathy to all those who lost family members or friends and all who have suffered through this disaster.

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[1] http://www.sciencedaily.com/releases/2009/03/090315092035.htm
[2] Climatic Research Unit, University of East Anglia and Meteorological Office Hadley Centre, UK.
[3] Bureau of Meteorology, Australia.
[4] http://www.wewillrebuild.vic.gov.au/images/stories/documents/100_day_report.pdf

Science and evidence-based approaches for communities of all scales --- from rural stations to megacenttres --- will be able to help us reduce the scale of such tragedies in the future.

And although climate science may seem complex and remote to many of us, it is about the things that have deep and pervasive effects on human life – temperature patterns, rainfall, severe storms, the conditions of the land and ocean from which we draw our food, and yes, the frequency of weather conditions that nourish massive fire storms.

Bushfires like those we experience in Australia are being repeated around the world in Spain, California, Canada, Siberia, Indonesia and, most recently, in Greece. Science can increase our understanding of and ability to live with fires as we adapt to climate change. And, if we use it wisely, can help us work towards the futures we prefer and help us avoid the ones we don't.

Tonight in the third National Red Cross oration, I would like to speak to you about the practical understanding of the science of fires in Australia and celebrate the spirit of renewal and recovery. I will also touch briefly on my role as Chief Scientist for Australia.

But first I would like to share my deepest admiration for the work of the International Federations of the Red Cross and Red Crescent societies for helping so many in their hour of need during major and minor disasters that confront us all the world over. Their collective efforts are to be congratulated for the great recovery work they do in times of disaster and tragedy. In the last five years alone they have been there helping, healing and supporting the victims of the Canberra 2003 bushfires, the 2005 Boxing Day Tsunami affecting almost a quarter of our Earth,

tropical Cyclones Larry and Monica in 2006, the Great Sichuan Earthquake in 2008 in Western China and, earlier this year, somehow, almost miraculously, coping simultaneously with both the 2009 Victorian bushfires and with the Queensland floods.

So I applaud the work of the Red Cross Society and hope to touch upon it later in my speech. But first I would like to give you a brief overview of my own work as Chief Scientist.

Some of you will know that the position of Chief Scientist was established in April 1989 by the then Prime Minister Bob Hawke. I am the first full-time Chief Scientist for Australia for some time. My primary task as Chief Scientist is to advise the government in an independent manner on all things related to science and innovation. I am also a strong advocate for evidence based decision-making, and Ambassador for Australian science on the global stage.

One of my most prominent roles involves working with some of Australia's top scientific and business leaders to examine key issues of national importance in science, engineering and innovation. This I do as the executive officer of the Prime Minister's Science Engineering and Innovation Council, or PMSEIC for short, which makes twice-yearly reports and recommendations to the Prime Minister and Government.

This advice includes issues related to Australia's economy, public good, education, future industries and employment, security, and sustainable development in a modern world. In addition, PMSEIC also advises on the adequacy and effectiveness of Australia's resources and infrastructure for supporting science, technology and its innovative use for the benefit of Australia.

Since becoming chair of the PMSEIC Standing Committee, I have encouraged the council to take a long-term view and engage in “foresighting” (over-the-horizon) activities. The idea is to identify a set of plausible futures that lie 10 to 50 years ahead of us, draw a line between where we are now and each of those futures, and ask the following questions:

- What are the problems and opportunities for Australia that intersect that line that involve science?
- Are their gaps in our current knowledge that prevent us from appropriately formulating good policy for those possible challenges and opportunities?
- If so, we need to know what those gaps are, and fill them.

Foresighting is not forecasting or predicting the future. Rather it involves considering a multitude of plausible transformational long-term futures for Australia based on the best evidence and trends, and then examining possible pathways to and through these futures.

PMSEIC has now been charged formally with a key foresighting role. It will be anticipating and reporting upon likely or plausible Australian needs, threats and opportunities that may benefit from a response grounded in scientific evidence or technological innovation.

Foresighting is only limited only by the human imagination. But this in itself can be a problem if the unimaginable happens. Returning to the main theme of this oration, that of bushfires: few would have dared predict or imagined the horrendous destruction that was wrought on Victoria earlier this year. And yet, this is precisely the kind of situation we must plan for in Australia.

Since these terrible fires, there has been discussion of whether or not they were caused by climate change. What

we know is that however they began, the speed and severity of the fires was worsened by conditions that are likely to be more common in a future of rapid climate change.

Any discussion about living with fires now and into the future, should draw upon knowledge derived from monitoring and modelling, to the best of our ability, present and future climate change. Projections indicate that even if we stopped emitting greenhouse gases now, past emissions, that we as humans have already produced, have accumulated in the atmosphere and locked us into more global warming, nearly twice as much, as we have already experienced.

So it is important to not only talk about *mitigation* but also *adaptation* and the science that we need to inform it. We need to focus on the climate's influence on the frequency, severity and extent of fires in the future and work out how we can adapt to these changes.

Australia is one of the driest continents with most of its populations living on or near the coastal fringes, many adjacent to dry sclerophyll or eucalypt forests and drying wet forests. It stands to reason that Bushfires are a regular occurrence here, especially in south-east Australia. I do not need to remind you of previous disastrous fires such as Black Friday, 13 January 1939 and Ash Wednesday, 16 February 1983, both of which led to significant losses of life and property.

The management of fire to protect human life, conserve biodiversity and protect assets has become a major challenge for Australian forest and fire managers, particularly on the east coast and those living on urban fringes or in bushland settings.

The Blue Mountains, West of Sydney, is one bushland area settled by Europeans. In a study of fire history conducted in the Blue Mountains region in 1983 using oral histories and written fire reports over a period of about 80 years, it was found that about one in four of the fires were caused by lightning strikes. The remaining three out of four fires were started by humans, either by accident with escaped campfires, or deliberately for hazard reduction, or illegally by arsonists[5].

However, while the weather may not have directly caused any of these fires, it affected their severity and frequency and magnified the consequences. Dry storms with lightning in drier seasons naturally lead to broader areas of vegetation being burned.

Seasonal and short-term variations in weather can follow longer-term trends that indicate broader underlying causes. So it is important that we begin by making the distinction between climate and weather. Weather can be unpredictable and chaotic which means no matter how good the meteorological scientists are at predicting the weather over the next few days there will be times when they get it wrong. When one averages out this chaotic weather over time, one arrives at the long-term climate. If the climate is stable, the averages are relatively constant, even if the weather from day to day is highly variable. If the averages are changing over years, that is, if the long-term climate is changing, then we talk about climate change. And if change is taken place the world over in connected patterns, we talk of global climate change.

Some broad features of the weather are easier to predict than details. We may be able to predict the path of large storm clouds, for example, but cannot predict exactly where the clouds will drop rain, or if they will drop any

[5] http://www.ecogis.com.au/Ecos_fire/Fire%20Articles/FireHist_Bms.html

rain at all. We know that winter is cooler than summer although we can't predict the weather for any given day. This is because the science behind the path of large storm clouds, or the science of summer and winter, is well understood.

Similarly, scientists are continually improving their ability to predict climate change with their growing knowledge of the main physical and biological drivers of long-term global climate. However, some short-term changes like volcanic eruptions or changes in wind and ocean circulation patterns, such as El Nino, are more difficult to predict, and this can produce small discrepancies with models on timescales of one to a few years. Nevertheless, the long term climate trend is clear.

While long-term climate change may not directly start bushfires, what it does do is make short-term *seasonal bushfire weather* more likely. The Bushfire CRC here in Australia have reviewed reliable modelling that shows average summer temperature is expected to increase in a way that will lead to an increase in the frequency of very high and extreme fire danger days, especially in inland areas. It is predicted that the frequency would increase by 4-25% by 2020 and by 15-70% by 2050, if the model projections are correct[6]. These changes are considered likely to be greatest in the inland, and relatively less along the coast and in Tasmania.

The situation regarding rainfall levels is less clear at present. Current fire models indicate that increased rainfall might actually produce larger fires, mostly as a consequence of higher fuel load and fuel continuity, which increases fire spread[7]. There is also strong agreement amongst climate models that recent rainfall declines over

[6] http://www.bushfirecrc.com/news/releases/weather.html

[7] http://knowledgeweb.afac.com.au/__data/assets/pdf_file/0005/19463/Cary_G_Abs-60.pdf

Southern Australia are likely to worsen throughout the century if world continues to emit high levels of greenhouse gases. The higher temperatures will result in increased evaporation and this will exacerbate the effect of this reduced rainfall on river flows and the weather conditions associated with high fire danger.

Moving on from rainfall, even less is currently known about changes in wind speeds, relative humidity and lightning activity that may result from global warming. This means that there is much work to do to continue to improve our knowledge of the effects of climate change on detailed aspects of the earth system.

Nonetheless, our current state of knowledge indicates that it would be prudent for relevant agencies to begin preparing for a higher frequency of unplanned and more intense fires.

Reconstruction and renewal

Fire plays two roles in nature: that of destruction, yes, but also that of reconstruction. Let me now focus now on a second theme, one of rejuvenation and renewal in the Australian bush.

Bushfires are a natural part of the Australian environment with many native species in Australia depending on them for their propagation and rejuvenation.

Many native plants have adapted to bushfires occurring under particular climatic conditions and frequencies. The most fire-sensitive plants may not survive increased fire frequencies, and may be seriously reduced in future Australian plant communities. These plants require special attention in any fire management regime that focuses on

environmental recovery in order to enhance their survival rates[8].

The Mountain Ash forest of Victoria is one example of a plants species that can cope with bushfires but not if they occur too frequently. If the intensity of the fire is high enough, the Mountain Ash trees are killed. But they regenerate from seeds stored in their crowns. This new generation of trees will also be killed if another fire comes along that scorches the crowns. In fact, if two crown-scorching fires occur within the time taken to produce seeds on the trees -- say 20 years -- than the species becomes locally extinct. So it is not just the fire, it is the frequency of fires that impact on a plant specie's ability to survive.

Other plants such as the Banksia and Hakea that have adapted to bushfires are expected to flourish under the projected climate models. They tend to survive in fires by re-sprouting quickly or having well-protected seeds.

After the immediate crisis of a bush fire has passed, the inevitable aftermath lingers. The landscape remains blackened and bare for many weeks. However, suddenly it seems green shoots are sprinkled over the charred remains. Some plant communities sensitive to fires can be supplemented by short-lived opportunist species immediately after the fires.

In the days and weeks that follow, the fire damaged vegetation starts to re-sprout from seeds and roots where these have survived in the soil without being sterilised or consumed by the heat or flames. Some may have been stored underground by ants as part of their organic stores for food production for the nest. Other regrowth springs

[8] http://www.climatechange.gov.au/impacts/pubs/biodiversity-vulnerability-assessment.pdf p14

from lignotubers at the base of the stems or on certain roots in the soil.

Epicormic buds also quickly reshoot from under the bark of some species to allow moderately fire-damaged trees to survive and seemingly spring back to life from where life had not been seen.

Sometimes we may need to intervene in the landscape in order to maintain species within a safe fire regime. Ways of doing this can include ecological engineering, such as expanding natural fuel breaks, or buffers in the landscape, such as effectively widening wet gullies[9].

After the fires, wildlife such as spiders, ants, native rodents, mice, wombats and snakes that sought refuge in tunnels underground begin to return home seeking water and food. But in a fire damaged wilderness, this will not be easy unless the fire has been followed by rain or dew, and the vegetation has not been completely consumed. Furthermore, if another fire reoccurs too quickly over too large an area, grains may not set the seeds eaten by some species of bird only capable of flying a certain distance for food.

Scientists are finding that most native animal species survive a fire event to various degrees. The challenge is to discover which species are most susceptible to extinction in present and future fire regimes, and to mitigate against this. To this end, documentation of the extent and severity of all fires, including prescribed fires is now being undertaken. Establishing the tolerances of species to fire regimes is important and there is a great deal of work currently being done in Australia on this.

[9] http://www.climatechange.gov.au/impacts/pubs/summary-policy-makers.pdf

Human beings can help with this natural recovery. After most bushfires in Australia, wildlife rescuers scour the countryside searching for animals that need help and disposing of the remains of any that did not survive.

Human recovery

It is not only the bush that is healing its scars after a fire. Like the resurgent foliage, humans are also recovering. They are putting down fresh roots, rebuilding homes and lives, demonstrating once again the courage, wisdom and resilience they displayed when flames threatened their homes and the smoke hung thick in the air.

As people came to terms with the loss of their loved ones, their land, their pets, houses, cars and other property, science can help them transform their grief into positive outcomes of recovery and renewal.
Bushfire recovery science begins making an impact immediately after the fires have passed, with initial mopping up operations by fire crews to minimise the extent of damage from fires relighting and putting out any residual fires still burning.

Since the cleanup after the Victorian bushfires began in early March, more than 400,000 tonnes of bushfire affected material had been transported to appropriate landfills around the state by around 600 workers, with 150 crews working at the height of the operation[10].

Scientists also turn their attention to the health impacts on fire-fighters, the public returning to their properties, and livestock and wildlife. All can be affected by the fumes and smoke that remain as the temperatures of the fires drop and smouldering embers remain. Carbon monoxide and

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[10] http://www.wewillrebuild.vic.gov.au/about-us.html

particulates have been identified as major toxins in bushfire smoke that can produce respiratory hazards[11].

Infrastructure

Science can also help with the recovery of infrastructure in new and innovative ways. An initiative that was recently presented to a Rural Research & Development Committee seminar on Bioenergy at CSIRO in Canberra, addresses both the power failures that can follow a fire and the problem of cleaning up the debris that fire leaves behind. How? The Bioenergy plan for villages near Marysville proposes initially using fire damaged wood to generate bioenergy[12].
Using charred wood residues to create regional renewable energy is indeed a striking symbol of a resourceful and resilient community rising from the ashes, creating an opportunity from adversity.

Rebuilding and reconstruction, planning and zoning authorities are also considering how the landscape might help them fight the fires. Recently the ACT Government announced its Strategic Bushfire Management Plan to minimise the likelihood of bushfires and their negative consequences. It now includes special ember attack zones with particular strategies for homeowners to consider with known bushfire causes and risk assessment[13].

Building standards are also undergoing active review and implementation across Australia. Many scientists, planners and legislators are looking at the effect of bushfires and experiences after Black Saturday to determine what standards need to be in place so we can live with fires. It is vitally important that the best science becomes the

[11] http://www.bushfirecrc.com/publications/D_Reisen.pdf
[12] http://www.treepower.com.au/FFWFv3.pdf
[13] http://www.esa.act.gov.au/ESAWebsite/content_esa/fire_safety/bushfire_management_plan_page/bushfire_management_plan.html

foundation of such a review of standards. I note that the CSIRO is working with many others towards a safer and sustainable building code for Australia. The CSIRO has been looking at bushfire-proof housing since at least Ash Wednesday in 1983.

It has a large test facility that includes huge sheds with furnaces and radiators to test the response of different materials to extreme temperatures. Their research is pointing to simple changes in design and construction that can make a huge difference. It has also identified that many of the features that improve environmental performance also make houses more bushfire-resistant too[14].

Infrastructure damage and recovery are vitally important for communications and essential services. Part of the recovery process is rebuilding this infrastructure so it is less prone to fires in the future. Overhead powerlines for example, are vulnerable to fires and can themselves cause fires in high dry winds. So placing some of these wires underground can help fireproof this infrastructure in the future.

Another idea put forward for bushfire prone areas is the placement of high speed optical broadband inside existing underground sewer pipes. The optic fibres would be enclosed inside a small pipe hanging from the roof of these pipes[15].

Ecological engineering can also assist in suburban settings. Local governments are making strategic decisions about which broad strips and blocks of grass to keep green. Recycled water can be used to keep up the moisture content of soil and vegetation of these buffer

[14] T. Wakefield, Y. He and V.P. Dowling, 2009, An experimental study of solid timber external wall performance under simulated bushfire attack, University of Western Sydney, Australia CSIRO, Australia
[15] http://news.bbc.co.uk/2/hi/technology/7104011.stm; http://www.allbusiness.com/electronics/telecommunications-equipment/6026044-1.html

strips. When a fire front reaches this green strip the moisture in the soil and grass instantly evaporate, immediately lowering the temperature and the intensity of the fire, sometimes putting it out altogether. These buffer strips can be aesthetically pleasing and an added urban environmental amenity, yet still act as fire barriers.

Many Local Councils are also rethinking landscape design in their suburbs, utilising the natural fire resistance of many native plants species. They are planting them in ways that retard the progress of fires, as well as act as physical barriers to deflect ember attack and radiant heat. They are also encouraging the use of bushfire resistant native species in gardens.

An example of this could be seen in 2003, after the fires in Canberra, when the Government provided for a number of plant nurseries to give away recommended fire-resistant-and-retardant native plants indigenous to the ACT region. These were given to people whose properties were affected by the fires.

Trauma recovery – physical

Treatment of burns is of course an important part of recovery after major bushfires like those we saw in Victoria at the beginning of this year.

Bushfires can cause burns in human and animal victims from direct heat. These can be incredibly damaging and painful. In fact, radiant direct heat is considered far worse than chemical burns or even chemical explosions because generally larger areas of the body are affected more severely. Elderly citizens affected by burns require particular attention as do those with diabetes and other existing conditions[16].

[16] http://www.aussmc.org/Victorian_bushfires.php

You may have heard of the world-leading research in the treatment of burns that Professor Fiona Wood developed with a spray-on skin product after the Bali bombings. Following this original breakthrough, in which techniques of skin culturing needed 21 days to produce enough cells to cover a major burn area, this research has now been advanced and requires only five days. This has the potential of greatly reducing scarring for burns[17]. Advancements in medical science are resulting in higher survival rates from physical injuries. Medical science is also turning its attention to the broader well-being of survivors. Psychological problems still show in about 25 per cent of people following traumatic injury such as those suffered in bushfires.

Trauma recovery – mental

Human recovery takes many forms. People affected by fires respond differently, with some slipping into panic, others oblivious to the dangers or entering into a form of denial, and still other exhibiting stoicism or sheer heroism.

Some of you may know of my own experience of the Canberra bush fires in 2003, when I was Director of the ANU's Research School of Astronomy and Astrophysics at Mt Stromlo.

The Mount Stromlo facility has rebounded remarkably well following the fires, though not without pain, struggle and uncertainty. I believe that the good aspects of that story are largely due to the strength and resilience of the people at Mt Stromlo and the larger community in which they operate, and the ways they worked together to heal physical and psychological scars.

[17] http://www.ausbiotech.org/data/downloads/MR_AusDay0109Final.pdf

In response to disasters, mental health science has found that people usually need practical support rather than psychological support and counselling in the immediate aftermath. The emotional impact of these events is generally longer term and can last for years.

A study after the Ash Wednesday bush fires looked at the time it took for people to begin to seek help from their GPs for their health-related problems, depression and post traumatic stress disorder. Many people, particularly fire-fighters and emergency relief workers felt that they were tough and didn't need psychological support. Like many survivors of major trauma they believed that they could cope with their distress and that "time heals all things." The study revealed that the time it takes for people to realise things are not getting better and to seek out help varies, but actually peaks a full two years after the initial trauma[18].

One of the immediate mental health issues after such a tragic event as we experienced in Victoria this year is that survivors may suffer "survivor guilt." While this reaction may be understandable, it can become dangerous if it is not dealt with adequately by facilitating its discussion with sufferers. Some people can become obsessed by "what if" scenarios, imagining what they might have done differently. The full psychological impact of the unnecessary guilt can take years to be worked through properly[19].

Research into better mental health care for all trauma patients can help bushfire survivors. Scientific bodies such as the National Medical Health and Research Council are researching the treatment of adults with acute stress disorder and post traumatic stress disorder. The Australian Centre for Posttraumatic Mental Health's Traumatic Injury

[18] http://www.aussmc.org/Victorian_bushfires.php
[19] http://www.defence.gov.au/opEx/global/opvicfire/trauma/InformationForPartners.doc

Research program is also investigating ways to help injured Australians.

A notable response across Australia to recent bushfires has been a rise of volunteerism and philanthropy. For some people who survived the firestorms joining a volunteer community fire unit was a means to post-fire-trauma treatment and comfort. Immediately after the Canberra 2003 fires, community initiatives supported by the ACT Government saw the formation of volunteer Community Fire Units. These have grown since 2004 to become the fastest growing volunteer group in ACT. With more than 1,000 trained volunteers and close to 40 units positioned along parts of the most fire prone western urban fringes of Canberra they have become a necessary adjunct to the ACT Urban Fire Brigades.

The spirit of renewal and recovery was also clearly illustrated by the unprecedented contributions that so many made despite a global financial meltdown affecting families across Australia. The Victorian Bushfire Appeal raised more than $375 million. Australians made personal sacrifices of money, clothing, food and hands-on support to help those affected by the bushfires.

The level of commitment following the Victorian Bush fires earlier this year saw an unprecedented level of cooperation and community mindedness. If we begin now with the same concentrated collaborative effort, we can meet the fires that this coming summer will almost certainly bring with more confidence. Further ahead, in a climate in which fires may be more frequent and more ferocious - we need science to meet the fires in our future with even more wisdom.

Together we, as individuals and communities, as citizens and governments, informed by science, motivated by

compassion, and girded with resilience, can meet the challenges of current and future fires as we renew our custodianship of the land we call home.

I would now be happy to open the floor to questions.

Thank you.