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FIRE NOTE

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BUSHFIRE SMOKE AND PUBLIC HEALTH

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This work was completed by Rachel Tham as part of the Victorian Public Health Training Scheme administered by the Victorian Department of Human Services

ABOUT THIS FIRE NOTE

This Fire Note is not intended to be used as advice for the general public.

It is a summary of a report that collated the information available to the general public concerning health issues associated with bushfire smoke.

It draws on interviews with relevant agencies, published scientific literature and an assortment of information materials available to the general public, including pamphlets, websites and phone helplines.

ABOUT THE PROJECT

Smoke composition from prescribed and wildfires and health (Project B 2.2)

This project is applying new and existing techniques to measure the contribution of prescribed burns and wildfires to particulate matter, classical pollutants, dioxins, irritants and carcinogens, greenhouse gases, photochemically active gases and ozone-depleting chemicals in smoke emissions.

The project will answer key questions about ecological and environmental aspects of bushfire smoke - What contribution do prescribed burning and wildfires make to greenhouse gases in the atmosphere? What is the extent of loss of nutrients through oxidation of carbon, nitrogen and sulphur?

And, is there a 'good' side to smoke for regeneration of vegetation, for example in the promotion of germination of seeds?

The Project Leader is Dr Tina Bell, from the School of Forest and Ecosystem Science at the University of Melbourne.

Bushfires produce copious quantities of smoke that often disperses over long distances depending on the climatic conditions, topography and vegetation sources.

As a result, smoke may affect human communities that are not directly threatened by bushfire or impacted by prescribed burning.

The presence of greater numbers of people living in or near the bush has increased the size of the at-risk population in the event of a bushfire.

The population health impacts associated with smoke from bushfires are not well defined but are thought to have possible adverse effects on respiratory and cardiovascular systems and are therefore important considerations for public health, and for emergency and environmental agencies.

SMOKE COMPOSITION

Smoke produced during bushfires or prescribed burning contains a complex mixture of particulate matter, water vapour and gases, many of which are known to be air pollutants or greenhouse gases.

Particulate matter results from incomplete combustion of vegetation and varies in concentration, composition and size distribution.

The gaseous components of smoke include carbon monoxide, carbon dioxide, methane, ammonia, oxides of nitrogen, sulphur dioxide, volatile organic compounds (e.g. alcohols, esters, carbonyls, benzenes and acids) and polycyclic aromatic hydrocarbons (e.g. fluorene, anthracene, pyrene, perylene and coronene). Gases and particulate matter may be considered to be 'primary' if they are emitted at the source and remain unchanged or 'secondary' if they are formed from gaseous precursors by various oxidation pathways (e.g. ozone).

The composition and quantity of smoke produced during a fire will differ depending on the chemistry and condition of the fuel, the amount and arrangement of fuel layers and the behaviour of the fire and weather conditions. Many of the gaseous aerosols produced in smoke can exist in the atmosphere for variable lengths of time ranging from days to months and can travel considerable distances.

Particulate matter is not as long lived as gaseous products and generally only remain in the atmosphere for periods of hours to weeks, depending on their size. Most particulate matter emitted by combustion of vegetation consists of elemental and organic carbon and can be categorised according to their aerodynamic diameter: coarse particles are between 2.5–10 µm (PM_{10}), fine particles are 0.1–2.5 µm ($PM_{2.5}$) and ultrafine particles are less than 0.1 µm.

The coarsest particles in smoke generally settle out from the atmosphere by gravity close to the source within hours, the smaller particles can be dispersed further before settling.

All particles with an aerodynamic diameter of less than 10 µm can enter the human respiratory tract, but those particles that are smaller than 2.5 µm are of particular concern as they are small enough to penetrate deep into the lungs then enter the blood stream and be transported to other tissues.

EFFECT OF BUSHFIRE SMOKE ON HUMAN HEALTH

Smoke has been demonstrated to have significant negative effects on human health from studies investigating the impact of tobacco smoke, smoke from indoor wood fires and ovens (called indoor biomass smoke) and industrial smoke in urban centres (smog). In these studies, exposure to smoke is usually investigated at a known concentration and for a specified duration.

In contrast, bushfires and prescribed burning activities episodically expose humans to high levels of pollutants and for short periods of time. The cause-effect relationship of bushfire smoke is therefore more difficult to investigate. The association between respiratory illness and community exposure to smoke from bushfires or prescribed burning has been made in a number of Australian epidemiological studies but a causal link is yet to be established.

For example, increased levels of particulates (PM_{10}) in smoke produced by vegetation burning during the dry season in northern Australia caused an increase in hospital visits for asthma (1) but the same effects were not found in a study undertaken after a large bushfire event in New South Wales (2).

Another study did not find any reduction in lung function in symptomatic asthmatic children during the same fires in New South Wales (3).

A recent study conducted in Brisbane has shown that daily respiratory hospital admission rates consistently increased with increasing levels of PM_{10} for both bushfire and non-bushfire periods over a three year period. The findings were also suggestive that bushfire smoke was significantly associated with increased risk of respiratory hospital admissions (4).

Elsewhere in the world, smoke from the 1997-1998 forest fires in Indonesia resulted in substantially reduced air quality over Malaysia, Singapore, Brunei, southern Thailand and parts of the Philippines for a number of months (5, 6). This haze was associated with a significant increase in the number of people requiring clinic and hospital treatment for smoke-related symptoms in some studies (7) but not in others (8). In the United States, smoke from large forest fires have resulted in increased hospital visits according to at least three studies (9-11).

SENSITIVE POPULATIONS

Most healthy adults and children will recover quickly from acute smoke exposure and not suffer from any long-term adverse consequences. However, there are some sensitive populations that may experience more severe short- and long-term effects from exposure to smoke.

Sensitive populations include:

- individuals with asthma and other respiratory diseases, such as chronic obstructive pulmonary disease;
- individuals with cardiovascular disease including high blood pressure, coronary artery disease, congestive heart failure or angina;
- the elderly as they tend to have pre-existing respiratory and cardiovascular diseases and reduced immune defence systems against the particulate matter;
- children inhale more air per kilogram of body weight and as their lungs are still developing, they are more susceptible to the effects of air pollution.

BUSHFIRE SMOKE RESEARCH

Other CRC projects are researching aspects of bushfire smoke.

Behaviour of smoke plumes and hazes from rural or urban fires (Project B 2.1)

This project is enhancing models of smoke movement and integrating them with other meteorological tools, including the Smoke Dispersion Forecasting Service, which is available through the Bureau of Meteorology.

Air Toxics Exposure and measurement (Project D 2.2)

This project is advancing the knowledge of firefighters' exposure to such toxic air pollutants as carbon monoxide, respirable particles, polyaromatic hydrocarbons and dioxins.

It is identifying key toxic pollutants, evaluating their concentration and providing tools to measure, evaluate and control the exposure of firefighters and communities to these substances. The study is monitoring on the fireground at prescribed burns and wildfires.

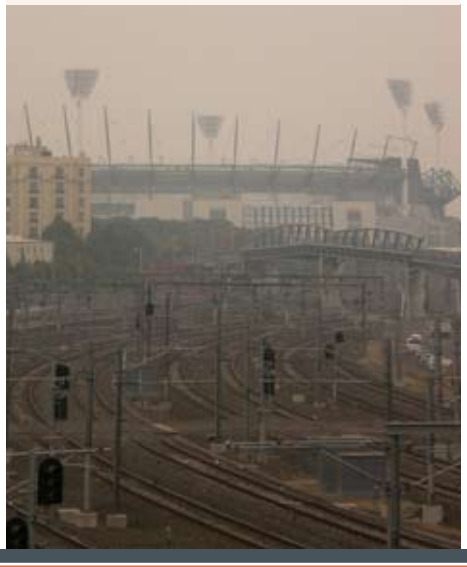
Respiratory Health of Firefighters (Project D 4)

This project, now complete, investigated the respiratory effects of combustion products as well as the efficacy of the standard issue smoke masks.

Three types of masks were tested. One mask is designed to protect from particulates only, and the other two from both particulates and organic volatiles.

More information on these projects at: www.bushfirecrc.com

See also:
FireNote 3, Smoke and the Control of Bushfires.
FireNote 12, Firefighter's Exposure to Air Toxics During Prescribed Burns.



The main component of smoke that affects these sensitive populations is particulate matter; however there is limited evidence as to whether particulate matter produced by bushfires affects susceptible populations differently from particulate matter produced by indoor air pollution, tobacco smoke or smog.

THE SYMPTOMS OF SMOKE EFFECTS

Fine particles and gases can accumulate in the eyes, nose and lungs and cause a number of health problems including burning or itchy eyes, runny nose, sore throat, headache and general coughing.

People with heart disease might experience chest pain, palpitations, and shortness of breath or fatigue. People with lung disease may not be able to breathe easily, deeply or vigorously and may develop symptoms such as wheezing, coughing, phlegm and chest discomfort.

MITIGATION MEASURES

Current practices to reduce the impact of bushfire smoke on public health include pre-bushfire preventive measures such as prescribed burning and enhancing community education.

These information programs focus on fire prevention, management and general safety and adopting personal protective behaviours during a smoke episode. During a bushfire event the impact of smoke on local communities can be reduced by managing the smoke with fire suppression techniques and with models for predicting smoke plume activity.

The main recommendations to the general public, taken from a range of state jurisdictions, for behaviour during a smoke or haze event (but not a severe bushfire event, which has a separate set of recommendations that encompass the Prepare, Stay and Defend or Leave Early policy) include:

- Be prepared.
- Anyone with a lung or heart condition should ensure that they have at least five days supply of medication available and follow their treatment plan.
- People with asthma should adhere to their personal asthma plan.
- Minimise exercise and physical activity outdoors as the increased breathing depth and rate encourages more fine particles to be inhaled deeper into the lungs.
- Whilst indoors, close doors and windows to reduce the entry of smoke.
- If you have an air conditioner, turn it on to 'recycle' or 'recirculate' to reduce smoke being drawn indoors.
- Reduce other sources of indoor air pollution such as cigarette smoke, woodstove smoke, burning candles, using unflued gas appliances or stirring up fine dust with vacuuming or sweeping.
- If there is a break in the smoky conditions, take the opportunity to air out the house to improve indoor air quality.
- If you are in a vehicle, close the windows and use the air conditioner on recirculate mode.
- If your home gets too hot to be comfortable or is letting in a lot of smoke, try to take a break at a local building that is air-conditioned with filtered air; for example a library or a shopping centre.
- Monitor all people for signs of heat stress, especially in the very young, elderly or those who are unwell. These signs include: heavy sweating; paleness; muscle cramps; tiredness; weakness; headache; dizziness; confusion; nausea; fainting; poor co-ordination and restlessness.

DO MASKS HELP?

Ordinary dust masks, surgical masks, handkerchiefs or bandannas are not effective for filtering out fine particles or gases from bushfire smoke, and are therefore limited in the protection they can provide.

Special masks that have been designed to filter out fine particles in dust and smoke are readily available in hardware stores. They must be rated P1 or P2 and should fit well by sealing closely against the face to prevent leakage.

However, people with beards or small faces (children) cannot get a good fit. They are often hot and uncomfortable to wear and the filter system makes breathing more difficult, even with exhaust valves.

PUBLIC HEALTH INFORMATION AND LINKS

This project, part of Program B of the Bushfire CRC, aims to identify and collate the sources of information available to the general public concerning health issues associated with bushfire smoke.

This involved interviews with fire, land management, emergency and health agencies in Victoria, an extensive review of published scientific literature and gathering together of information available to the Australian public (for example, pamphlets, websites and information phone lines).

The following sources of information were found to be helpful:

Victorian Department of Human Services - Emergency Management
http://www.dhs.vic.gov.au/emergency/

Better Health Channel
http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/hc_environmental?open

South Australian Department of Health
http://www.dh.sa.gov.au/pehs/Alerts-&-Recalls/bushfire-smoke-11jan05.htm

New South Wales Department of Health
http://www.health.nsw.gov.au/pubs/2004/pdf/airpollution_public.pdf
http://www.health.nsw.gov.au/pubs/factsheet/pdf/bushfire_fs.pdf

Department of Health and Ageing
http://www.healthinsite.gov.au/topics/Fires_and_Fire_Safety

NSW Department of Environment and Conservation
www.environment.nsw.gov.au/airqual/aqupd.asp

United States Environmental Protection Agency
http://www.airnow.gov/index.cfm?action=smoke.smokecover
http://www.epa.gov/airnow//smoke/Smoke2003final.pdf

United States Centre for Disease Control
http://www.bt.cdc.gov/firesafety/wildfires/pdf/wildfiresfacts.pdf

Montana: Wildfire Smoke – A Guide for Public Health Officials
http://www.deq.state.mt.us/FireUpdates/WildfireSmokeGuide.pdf or
http://www.arb.ca.gov/smp/progdev/pubeduc/wfgv8.pdf or
http://www.epa.gov/ttnamti1/files/ambient/smoke/wildgd.pdf

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