ACT State of the Environment Report 2011

THEME: Air

Indicator cluster: Indoor air quality

The indicators for this cluster are:

- Indoor air quality (C) - includes carbon monoxide, nitrogen dioxide, lead, particles, volatile organic compounds, formaldehyde and benzene;
- Indoor air quality health impacts (I) - health impacts from indoor air emissions; and
- Indoor air quality management (R) - effectiveness of indoor air quality management.

Condition indicators (C) present data that tell us the state of the environment at any particular time.

Pressure indicators (P) present data for the main human activities that could potentially adversely affect the condition of the environment.

Impact indicators (I) present data on the effect that environmental changes have on environmental or human health.

Response indicators (R) present data about the main things we are doing to alleviate pressures, or to improve the condition of the environment.

Summary

There is a wide range of potential sources of indoor air pollution, but there are few quantitative data available on indoor air quality in the ACT.

Australians are estimated to spend 90% of their time indoors, yet the long-term health impacts of exposure to indoor air pollutants are not well understood.

With information about indoor air quality management in the ACT and Australia currently limited, it is difficult to determine the effectiveness of indoor air quality management, policy, legislation and education. Greater knowledge and management of indoor air pollution would be valuable.

Introduction

Indoor air can be polluted by a wide range of sources, including materials and activities indoors and also entry of outdoor air from the immediate surrounds. The main pollutants that have been studied are environmental tobacco smoke, nitrogen dioxide, carbon monoxide and volatile organic compounds. Bacteria, fungi and particulate matter[1] are also known pollutants of indoor air. A number of health effects, particularly respiratory, have been associated with indoor air pollutants.

[1] Two sizes of airborne particles are measured: less than 10 micrometres (microns), and less than 2.5 microns in diameter - known as PM10 and PM2.5 respectively.

Condition indicators

Indoor air quality

Indoor air quality can be affected by (AIHW 2011):

- outdoor air entering and being distributed around the building;
- emissions from processes and equipment in the building (e.g. cleaning substances, furniture, printers);
- emissions from occupants (e.g. environmental tobacco smoke); and
- emissions from construction and finishing materials (e.g. foam insulation, asbestos).

Whether a pollution source affects indoor air quality will depend on the nature of the pollutant, the ventilation of the area and the rate at which the pollutant is emitted (AIHW 2011). A wide range of potential indoor air pollutants have been identified, of which the main pollutants studied are (AIHW 2011):

- environmental tobacco smoke (ETS), sometimes called second-hand smoke - a mixture of around 3800 chemicals including carbon monoxide, nicotine, formaldehyde and ammonia, which results from tobacco smoking;
- nitrogen dioxide - produced during combustion, such as in gas stoves, ovens and heaters;
- carbon monoxide - produced during wood burning and in the exhaust of internal combustion engines such as idling cars; and
- volatile organic compounds (VOC) - a collective term for a range of chemicals from sources including paint, pesticides, building construction materials and office equipment. The most commonly studied VOC is formaldehyde which is found in a range of items including carpets, foam insulation, plywood and upholstery fabrics.

Bacteria, fungi and particulate matter[2] are also known pollutants of indoor air quality.

[2] Two sizes of airborne particles are measured: less than 10 micrometres (microns), and less than 2.5 microns in diameter - known as PM10 and PM2.5 respectively.

Table 1: Sources of some indoor air pollutants

Pollutant	Sources
Environmental tobacco smoke	Cigarette smoke
Carbon monoxide	The burning of kerosene, gas and solid fuel; car engines idling; cigarette smoke
Nitrogen dioxide	Gas combustion
Volatile organic compounds	New building products, cleaning products, office equipment, consumer products
Formaldehyde	Pressed wood products, laminates, consumer products (hobbies, crafts)
House dust mite allergens	Dust mites in bedding, carpets, furniture
Mould spores	Bathrooms, damp rooms, window sills, indoor plants, poorly ventilated areas

Source: DHA 2008

Data on indoor air quality in the ACT and elsewhere are limited. The Australian Government recently commissioned a study by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to provide information on the indoor air quality of the 'average' private dwelling in Australia. This study identified the following information (DEWHA 2010):

- carbon dioxide, carbon monoxide, nitrogen dioxide, formaldehyde, and some other chemicals[3] have higher concentrations indoors than outdoors;
- bacteria, fungi and particulate matter occur in similar concentrations both indoors and outdoors;
- ozone concentrations are lower indoors than outdoors (this was expected, because there are not large sources of ozone indoors in Australian dwellings, and indoor surface materials are very effective in removing ozone from the air);
- nitrogen dioxide was present in higher concentrations in dwellings near busy roads; its concentrations varied with season, being higher indoors in winter/spring and higher outdoors in summer/autumn, consistent with the use of heating through unflued chimneys;

[3] Other carbonyls, total volatile organic compounds, benzene, toluene, ethylbenzene and the three isomers of xylene.

- relatively old dwellings had increased air flow even when doors and windows were closed, tending to reduce the indoor concentrations of certain chemicals[4] that have indoor sources;
- garages attached to dwellings increased the concentrations of some chemicals associated with vehicle exhausts[5];
- opening of doors and windows during the week reduced carbon dioxide and formaldehyde (which have indoor sources) and increase ozone (which has outdoor sources);
- in houses that had renovations, painting, new flooring surfaces and new furniture, temperatures and concentrations of particulate matter were higher in winter/spring but not in summer/autumn - possibly because of reduced ventilation and more efficient heating and insulation during winter/spring;
- use of solvents increased the indoor concentrations of volatile organic compounds; and
- carbon dioxide, nitrogen dioxide and particulate matter all increased with more people in the dwelling. The major source of carbon dioxide in dwellings is human breath. Particles of size PM10 can be resuspended by human movements, and nitrogen dioxide is associated with unflued combustion.

There are some indoor air measurements undertaken by private organisations in the ACT. It is uncertain if these assessments are in response to specific issues (which is most likely) or broader assessments of overall indoor air quality.

Pressure indicators

There are no pressure indicators for the *Indoor air quality* indicator cluster. As identified above, indoor air can be polluted by a large range of sources, and it is affected by the flow of air in the building, the activities of the occupants and the materials within the building.

The design and construction materials used in buildings can affect the air quality of ACT indoor environments. Modern buildings are often better sealed than older buildings and therefore have less air exchange between indoors and outdoors. Air or heat exchanges can improve indoor air quality, but there are currently no minimum air-flow standards.

[4] Formaldehyde, other carbonyls, total volatile organic compounds and several of the aromatic compounds.
[5] PM10, benzene and m-xylene

Impact indicators

Health impacts

In 1998, the CSIRO estimated that the economic cost of poor indoor air quality amounted to $12 billion a year. This was mostly due to ill health and lost production (AIHW 2011).

However, the long-term health impacts of exposure to indoor air pollutants are not well understood: exposure is often subtle and the symptoms can be complex. Individuals vary greatly in their sensitivity to pollutants in air. A concentration that may cause symptoms in one person may have no discernible effect on another (AIHW 2011). Nonetheless, a number of health effects have been associated with indoor air pollutants (Table 2).

Table 2. Potential health impacts of some indoor air pollutants

Pollutant	Potential health impacts
Environmental tobacco smoke	• Developmental effects including low birth rate, sudden infant death syndrome and poor foetal growth • Respiratory effects including reduced lung function in children, asthma induction and exacerbation in children and adults, and chronic respiratory symptoms in children • Carcinogenic effects including lung cancer, nasal sinus cancer and breast cancer (in relatively young women) • Cardiovascular effects including altered vascular properties and acute and chronic heart disease
Carbon monoxide	• Aggravation of cardiovascular disease • Poor foetal development
Nitrogen dioxide	• Respiratory effects in children, including asthma and breathing difficulties
Volatile organic compounds	• Respiratory effects including inflammation and episodes of bronchial obstruction • An increased risk of pulmonary infections in infants aged six weeks has been observed in circumstances where painting (in restoration work) had occurred during pregnancy and where relatively high concentrations of styrene had been used (e.g. in flooring)
Formaldehyde	• In low concentrations, irritations of eyes, skin or airways • At higher concentrations, throat spasms and a build-up of fluid in the lungs, leading to death • In the long-term, workers with high exposure have shown an tendency to contract cancers, including nasopharyngeal cancer and leukaemia
House dust mite allergens	• Aggravation of asthma, nasal inflammation, eczema
Mould spores	• Aggravation of asthma, nasal irritation and inflammation

Source: Compiled from AIHW 2011 and DHA 2008

Response indicators

Indoor air quality management

It is estimated that Australians spend 90% of their time indoors, which makes it important to have an understanding of indoor air pollution and its implications (AIHW 2011).

Improved monitoring of indoor air quality has been recommended in several previous ACT State of the Environment Reports. However, there is still little information on indoor air quality or indoor air quality management in the ACT and Australia. It is therefore difficult to determine the effectiveness of indoor air quality management.

The *2007-08 ACT State of the Environment Report* reported that legislation banning smoking in public buildings and licensed premises in the ACT has greatly improved indoor air quality for many people. Smoking is now banned in any enclosed public place, which can be anywhere to which the public or a section of the public has access. In December 2010, the *Smoking (Prohibition in Enclosed Public Places) Amendment Regulation 2010* (ACT Government 2010) was finalised. This regulation extends the ban on smoking to all outdoor eating and drinking areas across the ACT.

To guide the management of asbestos in buildings in ACT, there is now policy, as well as legislation and education (ACT Government 2011).

Indoor air quality at workplaces is managed under occupational health and safety legislation, but there is no equivalent legislation to address indoor air pollution in private homes.

In 2008, the Australian Government Department of Health and Ageing published *Healthy Homes: A guide to indoor air quality in the home for buyers, builders and renovators* (DHA 2008). That booklet informs householders, home-buyers, builders and renovators about air pollutants that may be found inside the home. It also advises on actions that can be taken to protect health and make better-informed decisions about health and indoor air quality issues when undertaking maintenance or renovation activities.

As recommended in previous ACT State of the Environment Reports, given the number of sources of indoor air pollution and the amount of time spent inside, improved knowledge and management of indoor air pollution would be beneficial. Options could include a national focus on reducing emissions of potential air pollutants, either by removing the sources or by minimising emissions from sources. National standards may have to be developed to apply this option. Another option is to educate people to open windows and doors more often to increase ventilation - actions that are likely to result in improved indoor air quality.

References

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DEWHA 2010. *Indoor Air Project Part 1: Main Report, Indoor Air in Typical Australian Dwelling.* The Centre for Australian Weather and Climate Research. Report to the Air Quality Section – Environment Standards Branch. Department of the Environment, Water, Heritage and the Arts. Australian Government. Canberra. http://www.environment.gov.au/atmosphere/airquality/publications/pubs/indoor-air-project-dwellings.pdf (accessed 26/5/11)

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Other data sources

In addition to these published reports, data for this paper were also sourced from:

Environment Protection Authority, Department of the Environment, Climate Change, Energy and Water (DECCEW) - now Environment and Sustainable Development Directorate (ESDD)