Air pollution in schools

Research into indoor and outdoor air quality in a city primary school is providing valuable information that will be used to improve future building design and ventilation.

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WARMER, DRIER HEALTHIER BUILDINGS is a BRANZ-funded programme. As part of this, researchers from the University of Otago, Massey University and GNS Science are investigating air pollution sources in school classrooms. This includes monitoring the admittance of traffic pollution and the ability of ventilation and design to mitigate health hazards associated with the air pollution.

Air pollution impacts on health

These questions are important to answer, as earlier work has shown that exposure to indoor air pollution has significant negative short-term and long-term health effects.

Air pollution in classrooms is of great concern, as levels two to five times higher than outdoor have previously been recorded, much of this attributable to poor ventilation.

Children are also more sensitive to the negative health effects of air pollution. They breathe more rapidly than adults and do not have fully developed respiratory systems, and around one-quarter suffer from asthma.

Outdoor air quality monitoring unit at Newtown School.

Measurements at case study school

The project measured levels of indoor and outdoor air pollution over a 3-week period in October 2016 at Newtown School. This primary school is located in Wellington at a busy intersection, where air pollution levels are often elevated well above World Health Organization (WHO) guidelines.

The school operates out of typical school prefabricated buildings that are poorly insulated, ventilated and not designed to minimise exposure to air pollution or noise.

Measurements of air pollution indicators were taken inside and outside two prefabricated classrooms - one directly beside the road and one further away (see Figure 1).

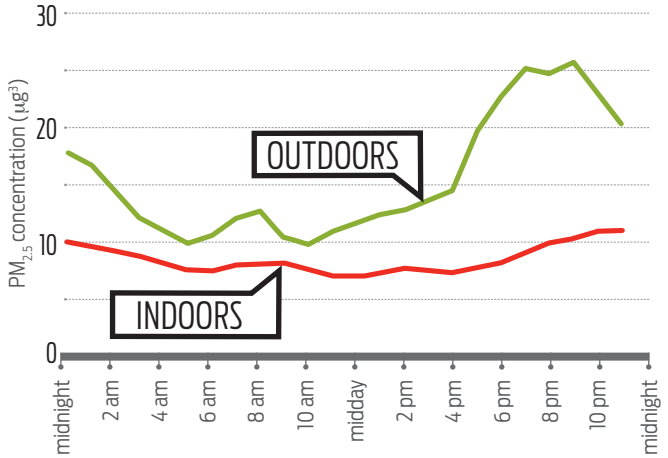

Figure 1: Diurnal plot of $PM_{2.5}$ levels from Newtown School (May–July 2016).

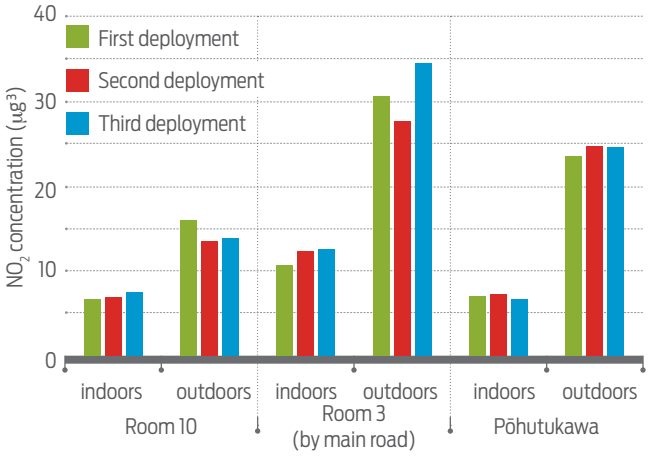

Figure 2: Two-week mean NO_2 concentrations.

Included in the measurements were particulates less than 2.5 ($PM_{2.5}$) or 10 micrometres (PM_{10}), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), volatile organic compounds (VOCs), temperature and humidity. Dust samples from the floor were collected in both classrooms to investigate the connection between airborne and dustborne pollutants. The results are currently being analysed.

Air quality system needed

As a precursor to this larger project, a pilot study measured traffic-related air pollution indicators at Newtown School over a 6-week period from May-July 2016.

It was important to gather data then, as Newtown School is being rebuilt from early 2017. Findings from the pilot study were instrumental in providing evidence on air quality, which supported the case for an air quality system to ensure the health of the school's students and staff.

Concerning outdoor particulate levels

Figure 1 shows a diurnal plot of $PM_{2.5}$ data taken during the pilot study. The average hourly $PM_{2.5}$ concentration is shown against the hour of the day. This shows the outdoor $PM_{2.5}$ levels increasing from around 5 am until around 8 am.

At 8 am, the levels drop down again for 2 hours before rising around 10 am. This rise continues until around 3 pm when the levels increase sharply until around 6.30 pm. It then takes the remainder of the night for the levels to drop back down to an average baseline level of 9.63 µg/m³.

The outside mean $PM_{2.5}$ was 15.7 µg/m³ (range 0.0-137.0 µg/m³). The WHO guideline recommends levels below 25 µg/m³, so average levels were well within the recommended range but the 137 µg/m³ peak was concerning.

Similar pattern of indoor $PM_{2.5}$ levels

The 6-week mean indoor $PM_{2.5}$ level was 8.3 µg/m³ (range 0.0-10.1 µg/m³). The indoor $PM_{2.5}$ levels follow a similar pattern to the outdoor levels. However there is a delay of about 1 hour between the outdoor levels rising and the indoor levels rising.

The windows in the classroom were not opened during the 6-week measurement period since it was winter and the temperatures were too cold.

NO_2 highest near bus stop

The highest concentrations of NO_2 were located outside the classroom beside the intersection/bus stop (6-week mean 30.9 µg/m³). The WHO recommended annual NO_2 level is below 40 µg/m³.

Classroom 10, located approximately 50 m from the main arterial road, had significantly lower levels of outdoor NO_2 than classroom 3, which sits beside the main road (6-week mean 11.9 µg/m³) - see Figure 2.

Classroom air pollution dynamics

The BRANZ-funded study will enable a more detailed investigation to confirm the sources of the pollution. It will fill knowledge gaps about how outdoor air pollution interacts with the indoor environment in poorly built buildings situated near busy roads.

Collecting hourly indoor and outdoor air pollution samples will allow us to explore the dynamic of indoor-outdoor air pollution in prefabricated buildings in high-risk areas. The infiltration of outdoor sources into classrooms and the expulsion of these pollutants from the children's environment is particularly important to explore.

Used to improve classroom design

Knowledge about the risks from air pollution to children's health and the dynamics of its outdoor-indoor flow will be used to suggest ventilation and design measures that improve the indoor environment.

The social costs associated with air pollution in New Zealand are estimated to be $4.28 billion per year or $1,061 per person. Collecting both indoor and outdoor air pollution data supports the development of policies to protect people from the effects of air pollution.

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