Modelling the effects of land use and urban forestry on air pollution across a cityscape

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The Urban Environment

▶ 56% of the world's population already live in urban areas (UN 2021)

▶ Urban areas are expanding faster than any other land-use type (Chen *et al.* 2020; Seto *et al.* 2010)

▶ 70% of world's population will be living in urbanised areas by 2050 (UN 2023)

Ashley NJ Douglas 2018

No More Green Means…

▶ Increased air pollution

▶ Elevated levels of noise pollution

▶ Loss of biodiversity

▶ Urban heat island effect

▶ 2021 - 99% of urban populations lived in areas that exceeded the new WHO air quality guidelines
(WHO 2023)

Ashley NJ Douglas 2018

The Not So Obvious Impacts

▶ 2019 - Ambient air pollution was associated in 4.2 million deaths

▶ 2016 – 11% of deaths in NZ was associated with anthropogenic air pollution

▶ 2015 – Cost of premature deaths globally from outdoor air pollution was estimated to be $3.5 trillion USD

▶ 2016 – Costs associated with air pollution was estimated to be $15.6 billion NZD

BBC 2019; Perth Now 2018
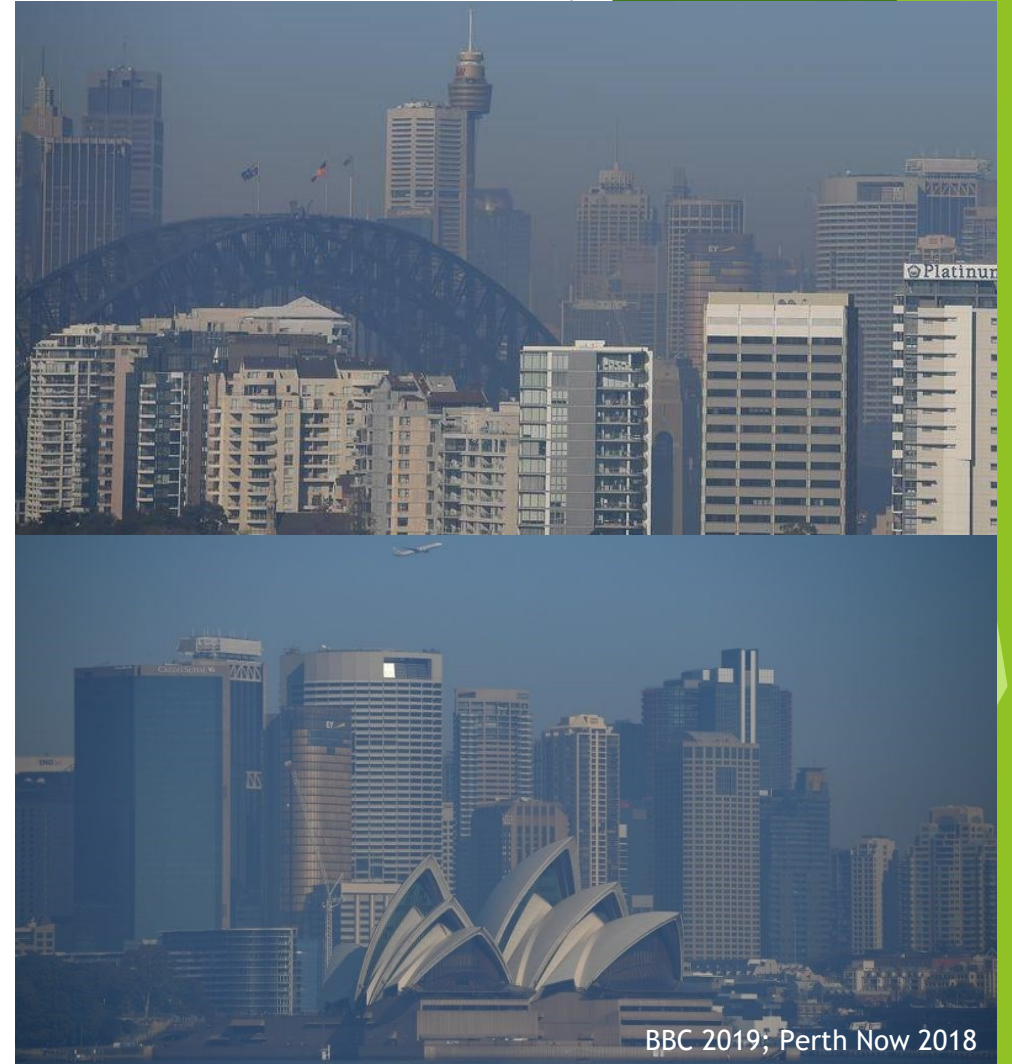
The Not So Obvious Impacts

▶ Increased energy consumption

▶ Cities occupy approximately 3% of the Earth's land cover (UN 2023)

▶ 80% of the world's energy consumption (UN 2023)

▶ 75% of world's carbon emissions (UN 2023)

Ashley NJ Douglas 2020

The New Global Focus

SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

15 LIFE ON LAND

The Green Goal

▶ Greenery benefits include:

- ▶ Reduction in the urban heat island effect
- ▶ Enhanced air quality
- ▶ Increased biodiversity
- ▶ Improved storm water management
- ▶ Reduce noise pollution
- ▶ Urban food production
- ▶ Social, psychological and biophilic satisfaction

▶ Despite these benefits, green infrastructure is in competition with other land uses or socioeconomic priorities

So Why Research?

▶ Addressing gaps in our knowledge reduces our barriers to implementation

▶ Scarcity of research across a citywide scale

▶ Differences with:

    ▶ Temperature

    ▶ Rainfall

    ▶ Suitable vegetation

    ▶ Climatic zones

▶ Negative impacts of air pollution in the urban environment continues to increase
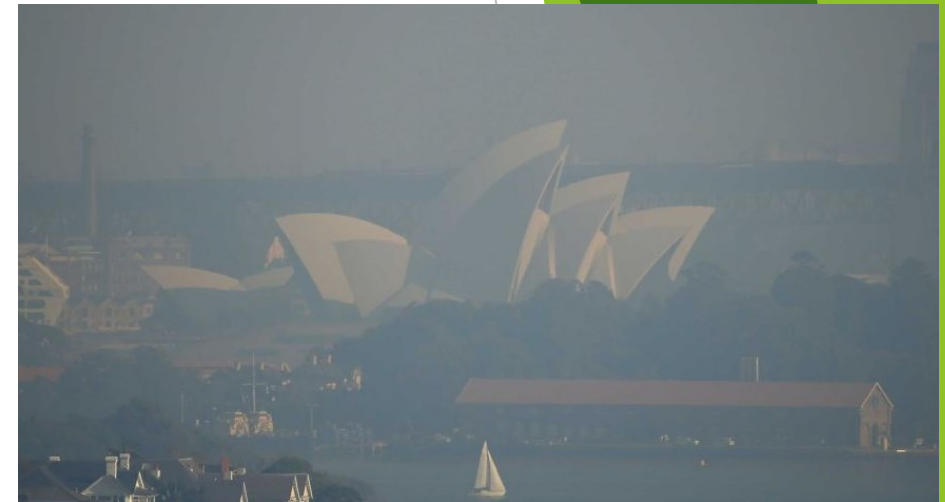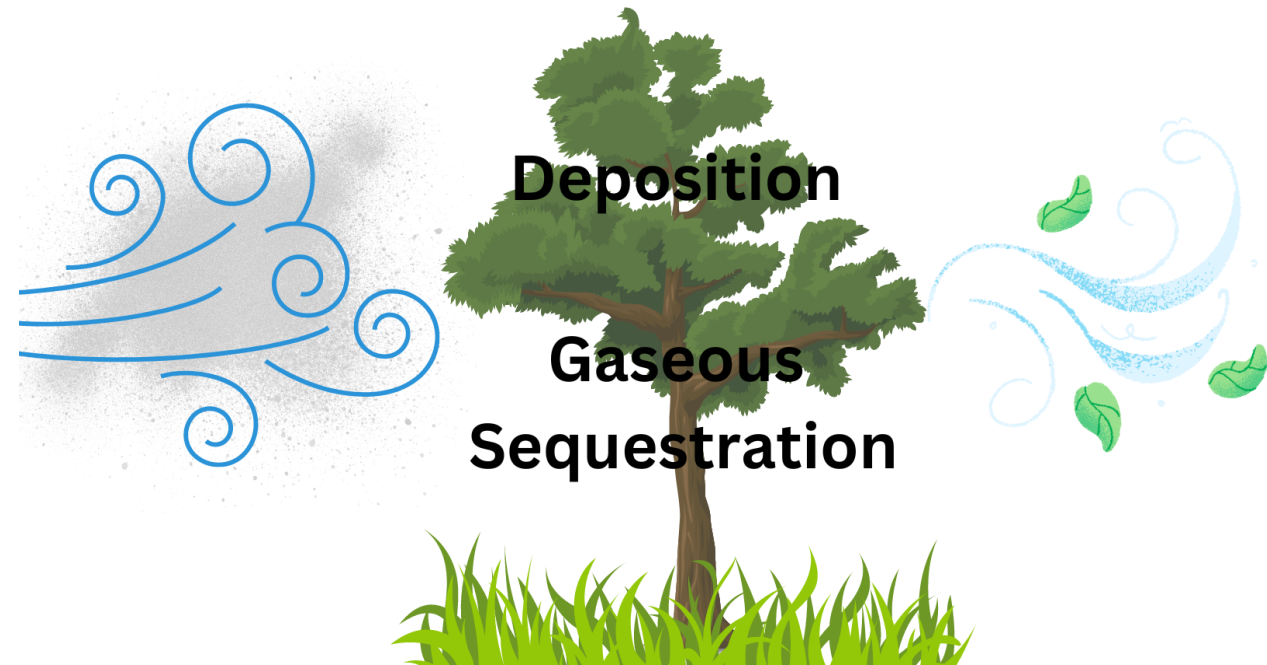
Location in Question


Ashley NJ Douglas 2023

The Investigation: Urban Forestry and Air Pollution

- Two main mechanisms:
  - Gaseous sequestration
  - Deposition

- Investigates the relationship between:
  - Land cover and air pollution
  - Land use and air pollution
  - Vegetation type and air pollution

- Pollutants:
  - NO_2
  - SO_2
 - PM_{10}

Deposition

Gaseous Sequestration

Variables

- Pink squares represent the NSW Government's Department of Planning and Environment air quality monitoring stations
  - Ambient air pollutant concentrations

- Blue triangles represent the National Pollutant Inventory polluting facilities
  - Industrial air pollutant concentrations

- Green circles represent the Roads and Maritime Services traffic count sites
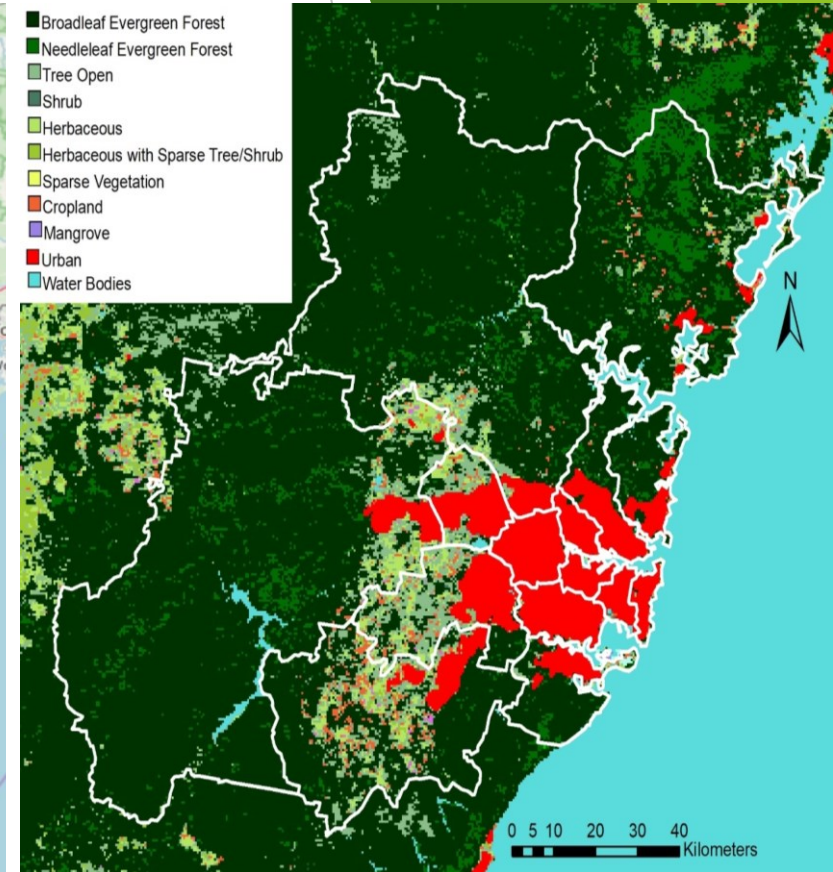 - Daily traffic count
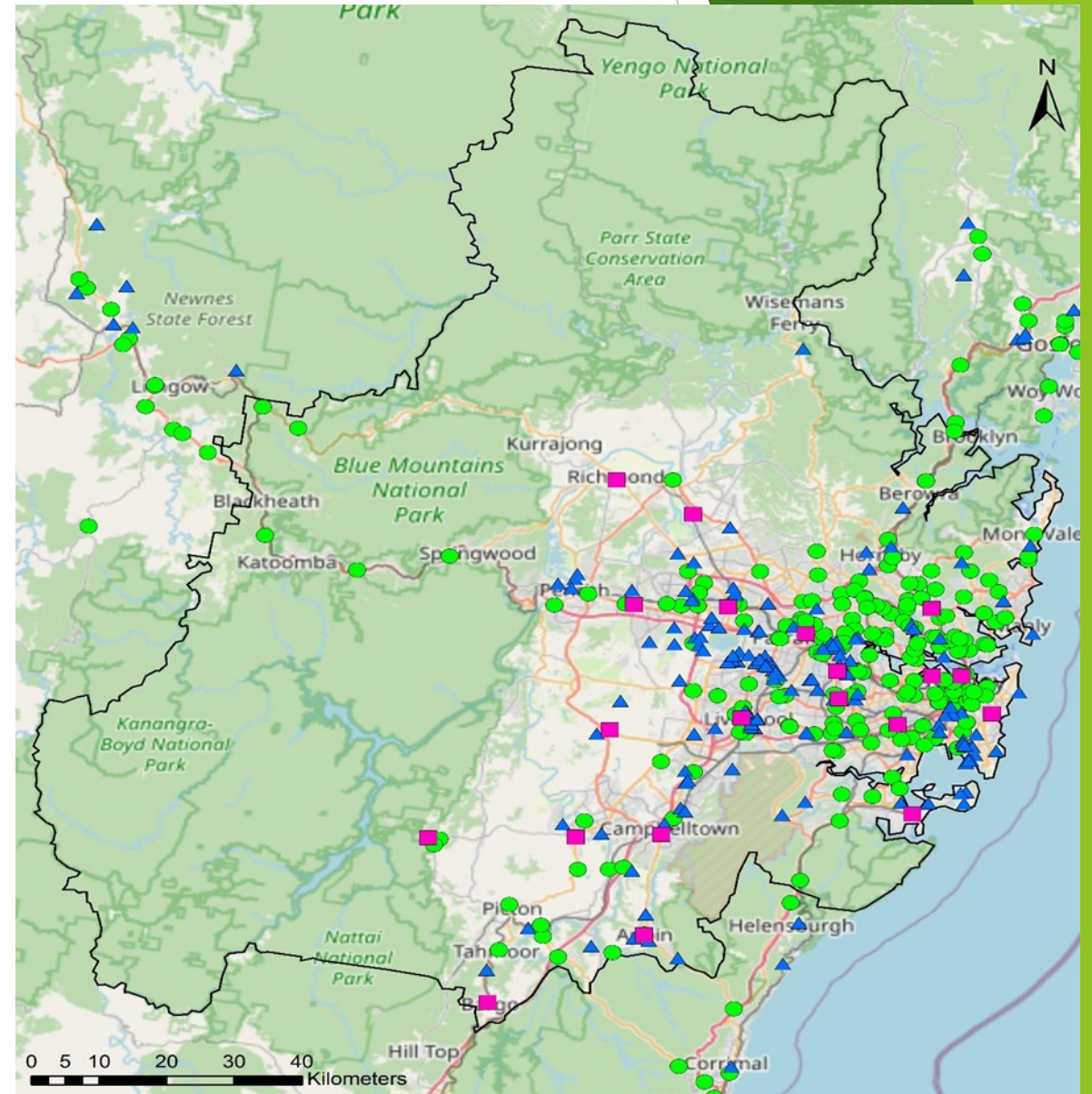
Variables
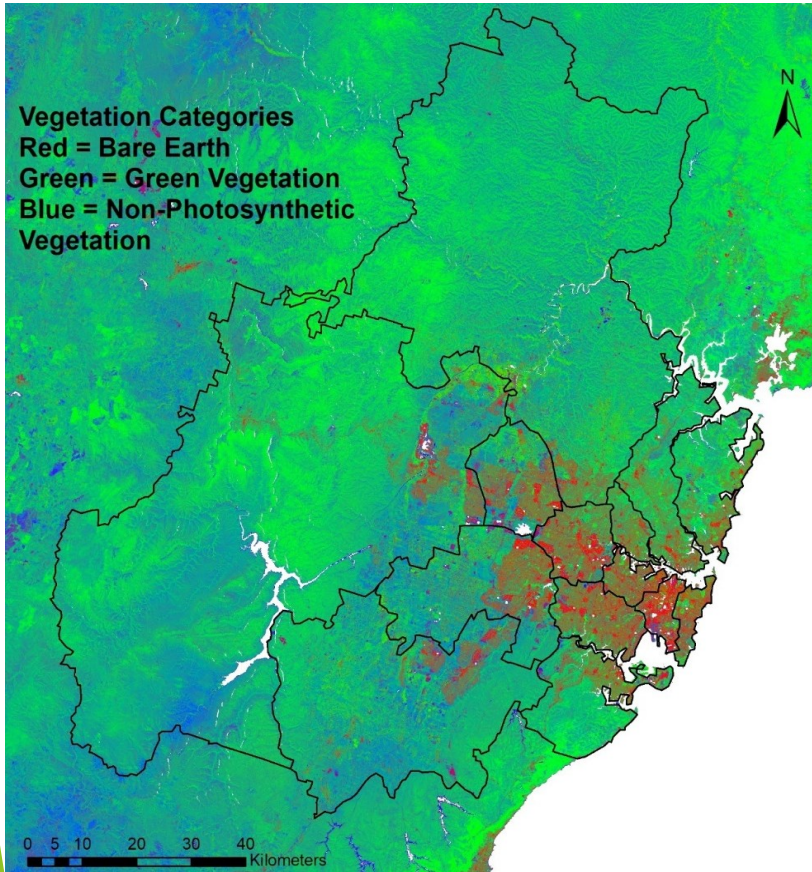
Land cover types derived from Landsat 7 images from Geoscience Australia.

Land use data derived from the Australian Bureau of Statistics.

Vegetation types that cover in the form of urban forestry cover types.

Analysis

ANCOVAs were performed. **Air pollutant data was source corrected with the traffic and industry emissions covariables:**
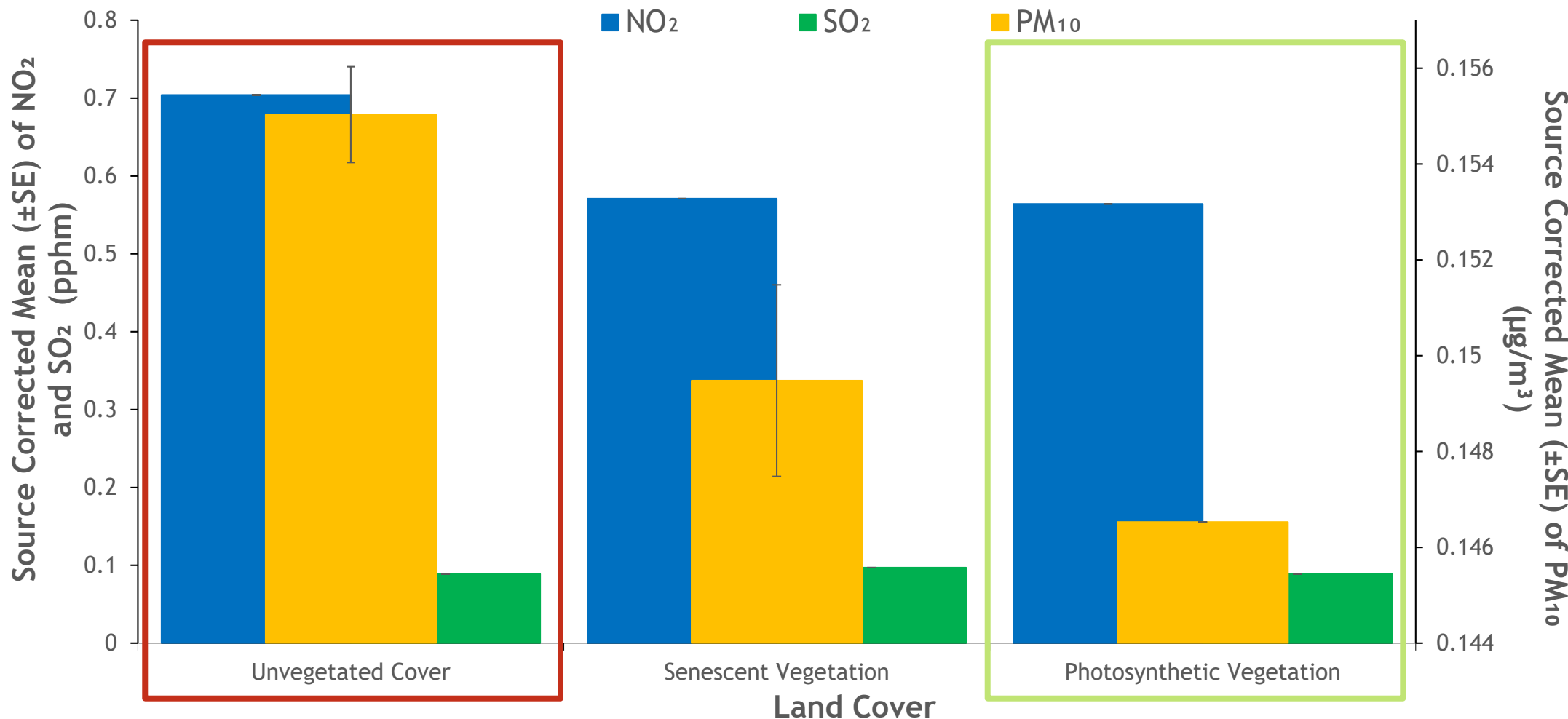   -Land cover and air pollution
      -Land use and air pollution
      -Vegetation type and air pollution

Bonferroni's pairwise comparisons were made

Estimated marginal means (EMMs) were derived from the ANCOVAs

All comparisons were confirmed through the absence of overlap with the 95% confidence interval

Relationship between land cover and air pollution

Source corrected means for all three air pollutants and the land cover types across Sydney. All ANCOVAs were statistically significant.

Relationship between land use and air pollution
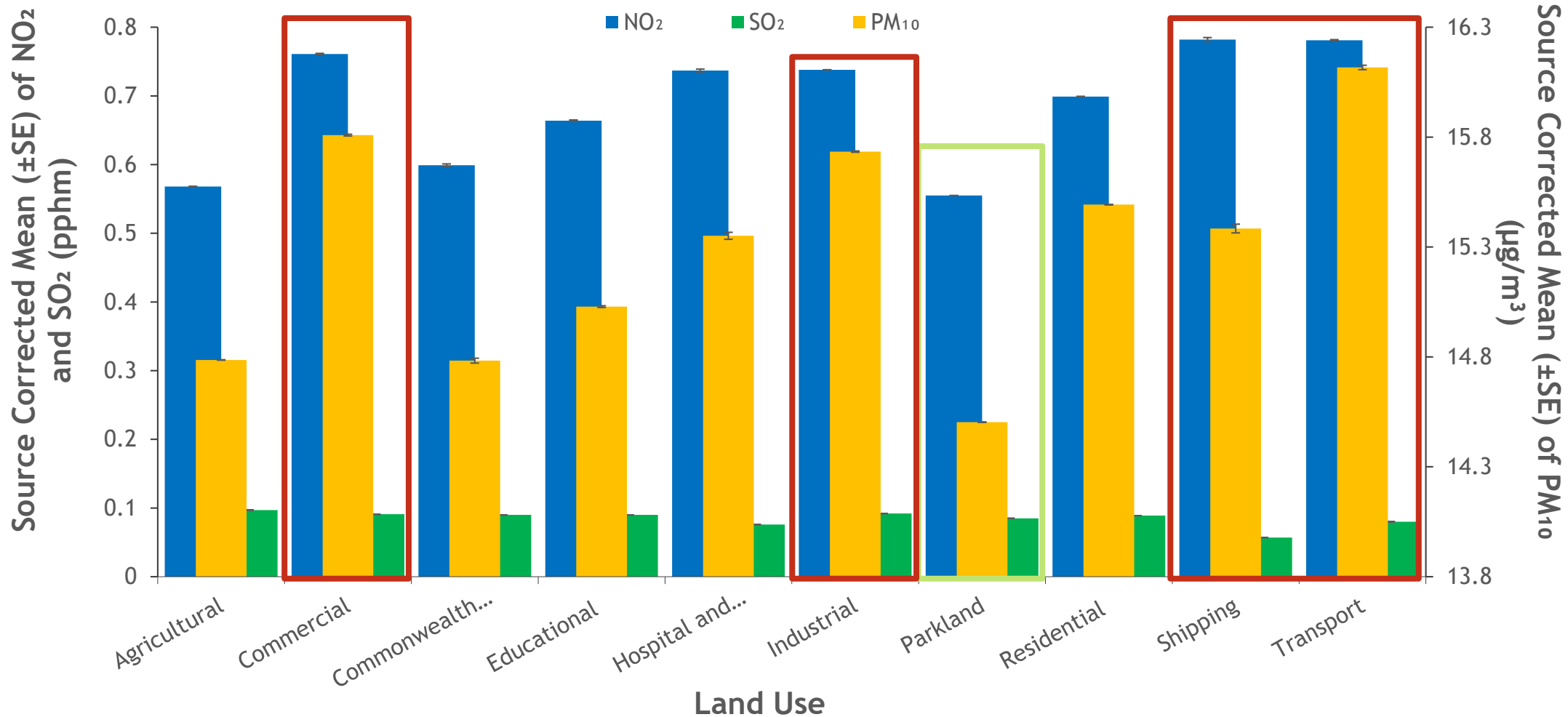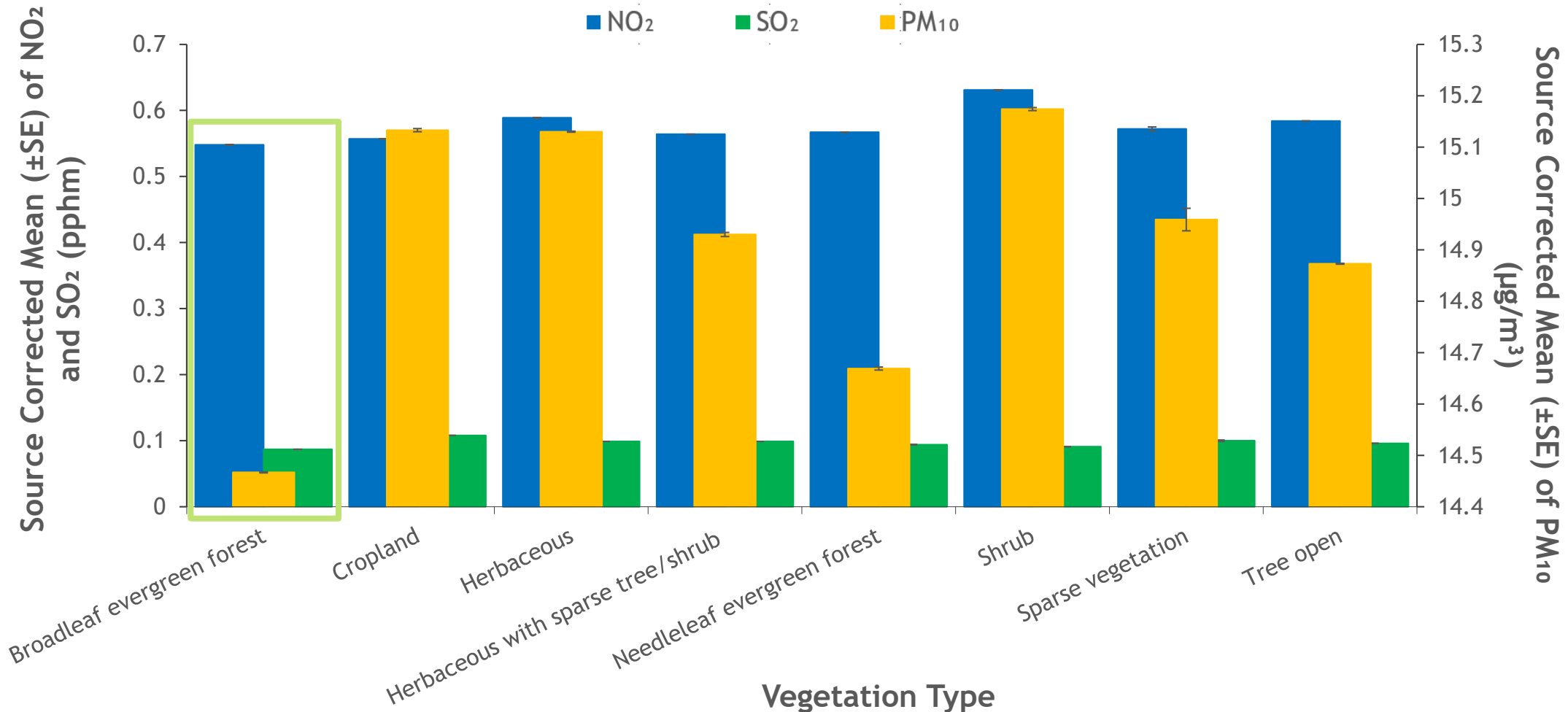

Source corrected means for all three air pollutants and the land use types across Sydney. All ANCOVAs were statistically significant.

Relationship between vegetation type and air pollution

Source corrected means for all three air pollutants and the vegetation types across Sydney. All ANCOVAs were statistically significant.

What's next?

- Urban forestry in the form of parklands is associated with decreased air pollutant concentrations

- Broad leaf evergreen forests were associated with lower pollutant concentrations

- Maximise the application of vegetation and increase urban forestry

- Used to develop and support planning policies and greening policies

- Allow for more tailored choices and focused efforts based on vegetation types

Ashley NJ Douglas 2022

A happy hiker looking over a patch of Sydney's broad leafed evergreen forests located in northern Sydney.

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