Spatio-Temporal Analysis Using Earth Observation Data to Identify Adverse Health Effects of Landscape Fires

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Background and Aim

- Landscape fires (LF - bush/wild fires and planned burns) create smoke that can affect health

- Understanding true effects is limited by exposure assessment

- 'Exposure' assessed by;
    - Ground level monitoring of criteria air pollutants (esp. particulate matter - PM)
    - Fire v non-fire periods
    - Area burnt
    - Remote sensing observations

STUDY AIM

To develop an exposure model for LF smoke related PM$_{2.5}$ using earth observation data.

- Apply to health (time-series) study of smoke-related PM$_{2.5}$ and
    - Hospitalisation
    - ED visit
    - Ambulance call-out

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Satellite Image Analysis

- Tracings of smoke plumes were made using hourly true-colour imagery from Himawari 8 satellite image

- Hourly tracings collated for single 24-hr shape file

- Rasterized to 1.5 km x 1.5 km grids (for PM model calculation)

- Develop a smoke plume mask (SPM) for geographical units (Statistical Areas - SA2), ie whether plume covered centroid of SA2.
 - SA2 is the geographical unit used for the health study

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Smoke-related PM2.5 Model*

Model inputs (for 1.5 x 1.5km grids)

- PM2.5 lag1 – Previous days PM2.5 (interpolated using Inverse Distance Weighting from Perth air quality monitoring sites)

- SPM – Smoke Plume Mask (manual process)

- FRP – Fire Radiation Power (from Geoscience Australia)

- AOD – Aerosol Optical Depth (derived form MODIS data)

- FDR – Fire Danger Rating (from Bureau of Meteorology)

- VI – Venting Index (from Bureau of Meteorology)

$$PMlag0 \sim PMlag1 + SPM + FRP + AOD + FDR + VI$$

We calculated the median of PM2.5 values from the gridded cells corresponding to a specific SA2
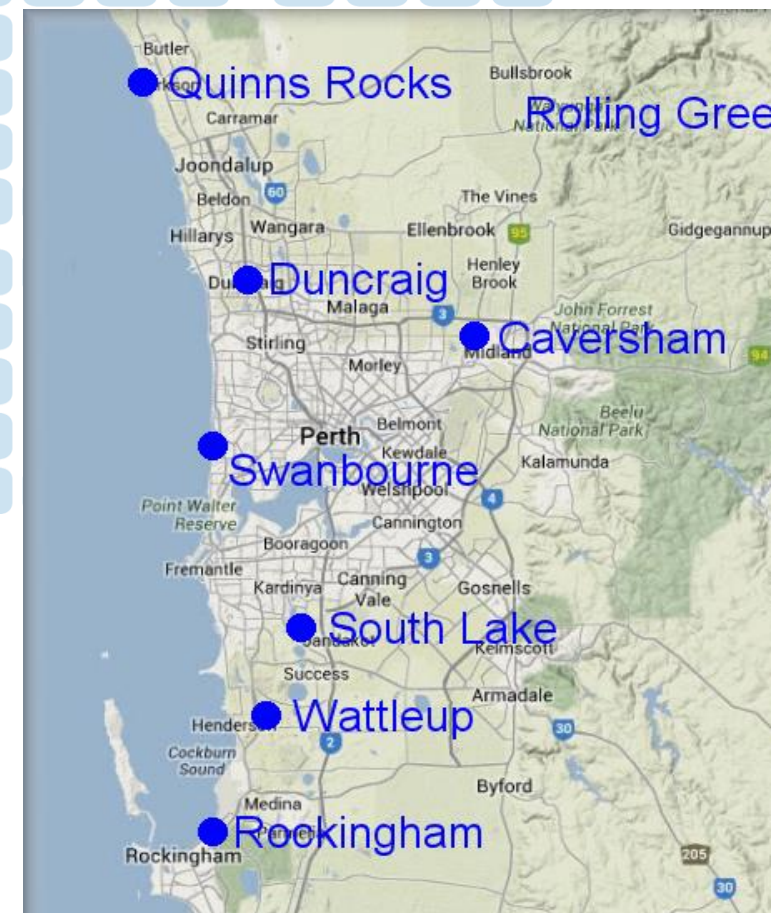
*Based on model developed by Yao and Henderson (J Exp Sci Environ Epidemiol 2014; 24: 328)

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Application – Health study

- PM2.5 categorised: ≤95th percentile, 96th – 98th %ile, ≥99th %ile
  - To delineate between 'background' and 'smoke-related' PM2.5

- **General Findings**:
  - ↑ ED visits and hospitalisations for all-cause, respiratory and CV conditions, but no ↑ in ambulance call-outs

- **Specific Findings**:
  - 3 – 10% ↑ in asthma ED presentations and 2 – 18% in ↑ asthma hospitalisations (NS)
  - 8 – 19% ↑ in ED presentations for ALRTI
  - 2 – 7% ↑ in general cardiovascular ED presentations
  - Up to 25% ↑ in ED presentations for transient ischeamic attack
  - Vulnerable groups: Increased risks for; people aged 60 years and above, people from low socioeconomic status, and those with heart or lung problems.

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Future work

- Addition of data, eg chemical transport models, to improve exposure estimation

- Fine resolution prediction model of smoke trajectory

  – Early/real-time warning systems
  – Manual tracings of plumes – time intensive. Automation is required.

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