MONASH University
Medicine, Nursing and Health Sciences

VICBiostat

Health effects of disasters

Rory Wolfe

Acknowledgments: Sam Brilleman, Theodore J Iwashyna, Goma Khatri, Michael Abramson

Monash University

Victorian Centre for Biostatistics

Hazelwood HEALTH STUDY

What is a disaster?

- any unfortunate event, especially a sudden or great misfortune

- an event, as a flood, fire, explosion, etc., which devastates a community and is beyond the scope of the community's own resources to manage, requiring assistance on a national scale to restore safe conditions, functioning communications and a continuing livelihood for the people

MACQUARIE DICTIONARY


AMBULANCE

Studying health effects of disasters

- Disasters are typically unanticipated
  - Exposure to disaster can’t be randomised! Observational studies…

- Different types of disaster will impact on different aspects of health

- In advance, we don’t know when to measure, what to measure, who to measure, or where to measure

Retrospective studies

Measure health in exposed community

Retrospective studies – limited but can be useful

- Many limitations, eg
  - difficulty identifying members of the exposed community,
  - Incomplete outcome (case) ascertainment,
  - unclear whether health outcome is relatively poor and if so whether that can be attributed to disaster

- A tumor registry was organized in Hiroshima in 1957 and in Nagasaki in 1958

- Exposure to ionizing radiation increases the incidence of breast cancer in women
  - Evidence base includes follow·up studies of atomic bomb survivors and of patients treated with X·ray for acute postpartum mastitis.

- McGregor et al. “Breast Cancer Incidence Among Atomic Bomb Survivors, Hiroshima and Nagasaki, 1950-69” J Natl Cancer Inst (1977) 59 (3): 799-811

Analysis of post-disaster studies

- Disease occurrence measure for affected community
  - Eg % with disease in a 1-month period post-disaster
- Rate in community versus rate in population
  - Comparability of community and population?
- Community-level data
  - Indirect standardization using population rates of the disease in strata defined by variables, eg sex and age, whose distributions are known in the affected community
  - how does the number of disease cases in affected community compare with the number that would be expected (SMR)
- Individual-level data
  - Direct standardization (post-stratification) – how does a weighted sum of strata-specific disease rates in the community compare with the population disease rate?

Post-stratification for many variables?

- Many strata – use a multilevel model to borrow strength across cells
- Xbox gamer sample of voting intentions
  - "Disease" is the intention to vote for Romney rather than Obama in 2012 US election
  - 176,256 cells - all combinations of sex (2 categories), race (4 categories), age (4 categories), education (4 categories), state (51 categories), party ID (3 categories), ideology (3 categories) and 2008 vote (3 categories)
- Multilevel regression and post-stratification
  - $\text{logit}[P(Y_i=1)]=\beta+b^{\text{age}}_{j[i]}+b^{\text{sex}}_{j[i]}+ b^{\text{race}}_{j[i]}+\ldots$
  - Population weights came from 2008 exit poll sample – this survey has the necessary stratification variables (which are highly predictive of 2012 intention)
- For disasters, need population distribution by disease-predictive variables that are available in community sample

Wang et al 2014 "Forecasting elections with non-representative elections" International J Forecasting

Prospective studies?

→ Measure health before disaster

→ Measure health after disaster

Before-after comparisons

- Requires pre-disaster measures of disease
- Ecological, eg
  - After April 2015 earthquake in Nepal
  - “Number of severely malnourished children in the district was 78 for the year ending April 2015, an increase from 41 for the preceding 12 month period”
  - Time series, e.g. weekly number of presentations to Emergency Departments for respiratory problems before, during and after major bushfire events
- Person-specific
  - Linkage of post-disaster status with pre-disaster health measures (ie measured before disaster, not retrospective assessment)
  - Measures at individual level unlikely…..
  - Unless population-wide ongoing surveillance of individuals’ health?
  - Eg Pharmaceutical Benefits Scheme information on asthma medication

Comparison – internal? or other community?

→ Measure health in exposed community: gradient of exposure

? Similar sociodemographics
Negligible exposure
Appropriate size and location

→ Measure health in unexposed community

→ Measure health before disaster

→ Measure health after disaster; gradient of exposure

? Unexposed community → Measure health before disaster

? Unexposed community → Measure health after disaster

Examples from current work

- Hazelwood mine fire long-term health effects study
- Effect of natural disasters in the US on physical disability in older adults
- Mediation of Nepal 2015 earthquake effect on postpartum outcomes (birthweight) through perinatal factors (maternal depression)

Hazelwood mine fire

- February 9 2014: open cut brown coal mine adjacent to the Hazelwood power station in the Latrobe Valley caught fire.
- In Morwell, a few hundred metres from the mine, residents exposed to plumes of acrid smoke over a period of 6-7 weeks.
- Concern about health effects – state government commissioned a study of medium and long-term effects
- High-profile analysis of mortality rate time series
  - subject of a re-opened Public Inquiry

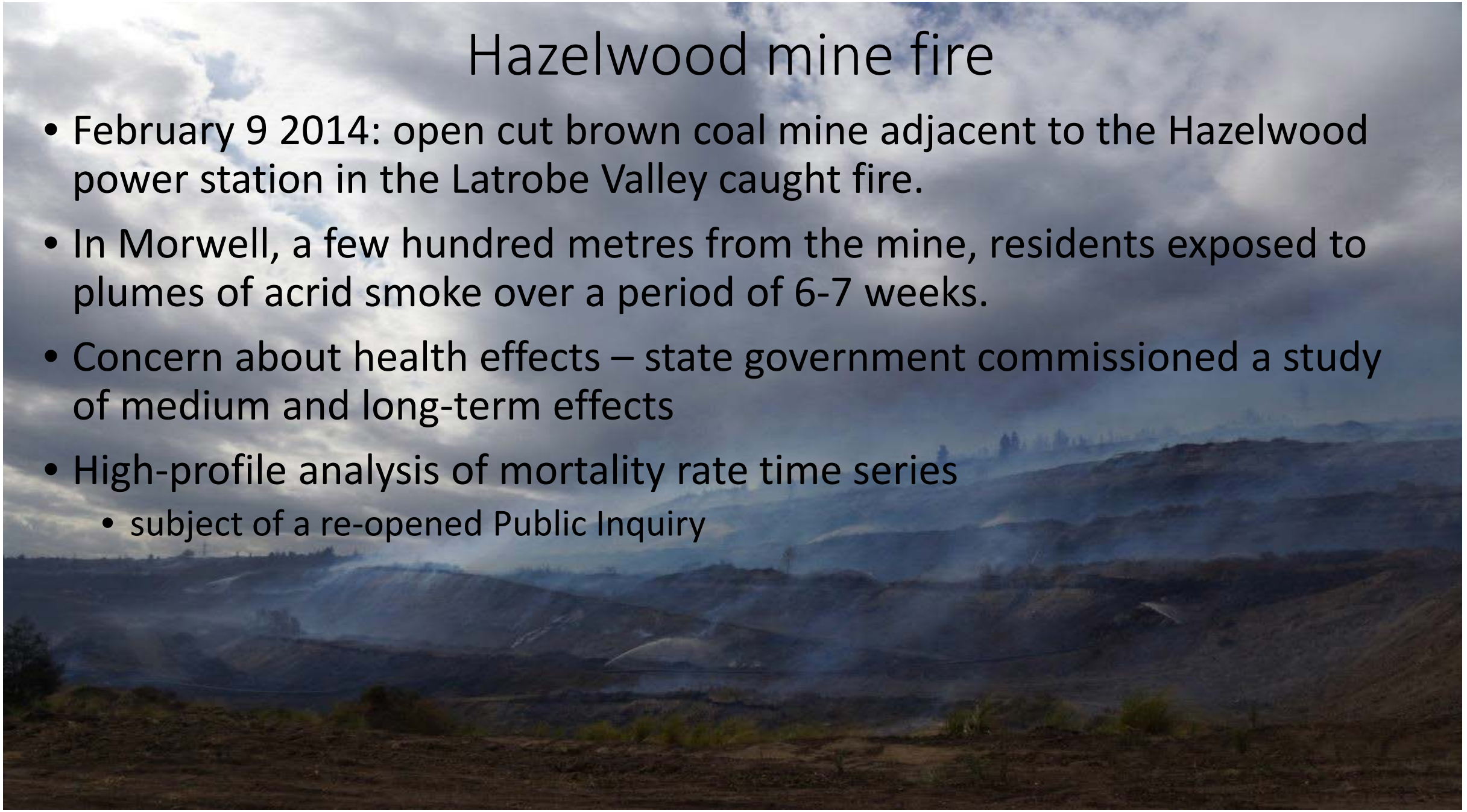
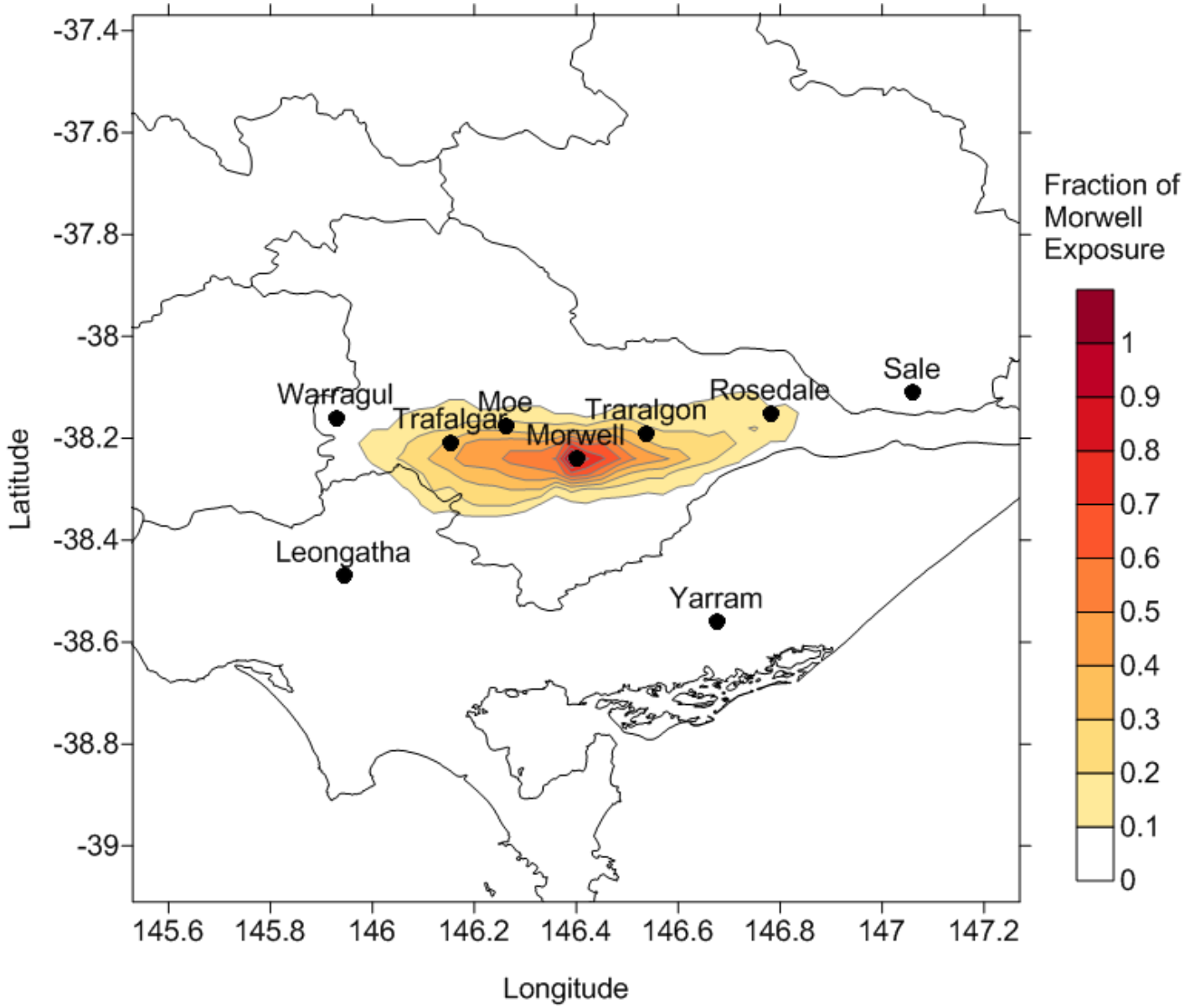
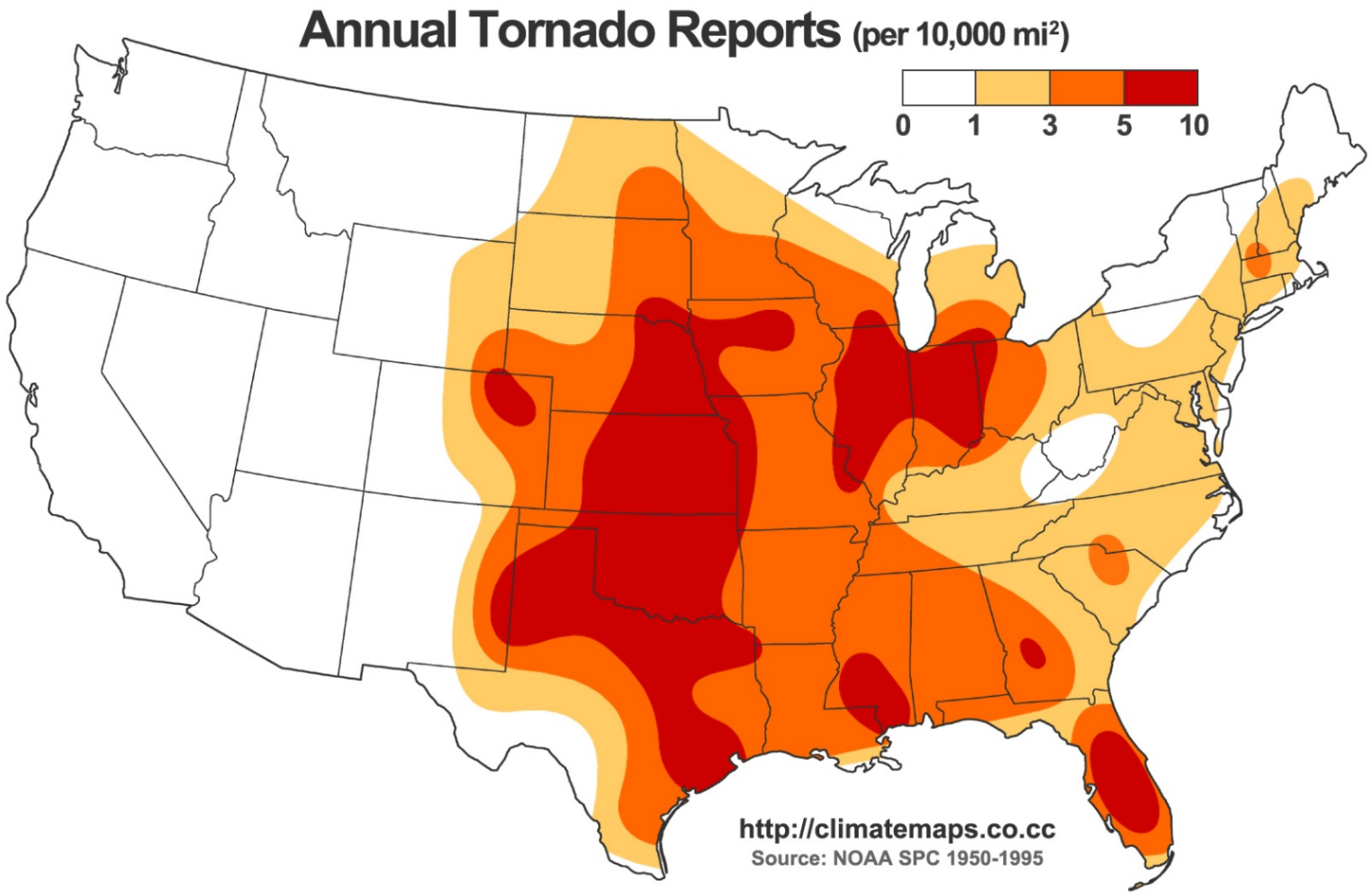


Photo courtesy of Keith Pakenham, CFA



Smoke exposure (relative to exposure across Morwell) in Latrobe Valley; estimated by CSIRO with a preliminary model.

US natural disasters



US natural disaster exposure linked to ongoing longitudinal study of individuals

- Survey participants every 2 years
- Assess physical disability trajectory
- Mortality status identified
- Intersected by ongoing exposure to range of natural disasters

- Sophisticated research questions
- Joint modelling of disability trajectory and time to death – how is this bivariate outcome impacted upon by disasters?
- To implement – alignment of disaster exposure timing with biennial disability measures, relevant “exposure window”? Disaster severity?

Summary

- Disasters can impact on a community's health
  - Immediate risk
  - Ongoing exposure to toxicity may be triggered by disaster event
  - Access to adequate health care may be difficult in a disaster's aftermath
  - Upheaval and disaster management requirements may impose their own toll on health

- Studying health effects can require a wide array of study design and data analysis methods
- Opportunities for novel methods to be applied