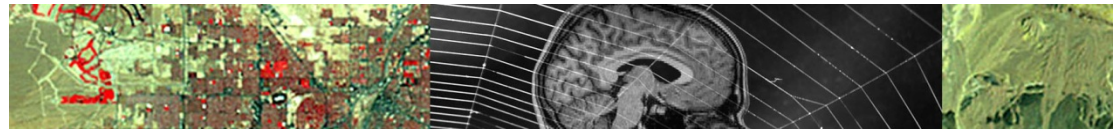


Sensing in Space and Time

Michael F. Goodchild
University of California
Santa Barbara



GPS/GNSS

- Trivial to add location and time to a point record
 - not so trivial at all to add location to a place

Lake Superior / Coordinates

47.7231° N, 86.9407° W



People also search for



Great Lakes

45.0522° N,
82.4846° W



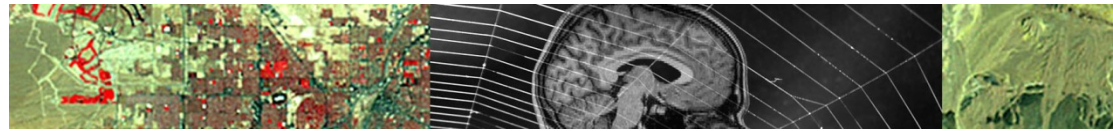
Lake Huron

45.0522° N,
82.4851° W



Lake Michigan

43.4501° N,
87.2220° W



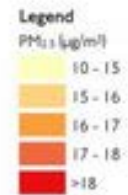
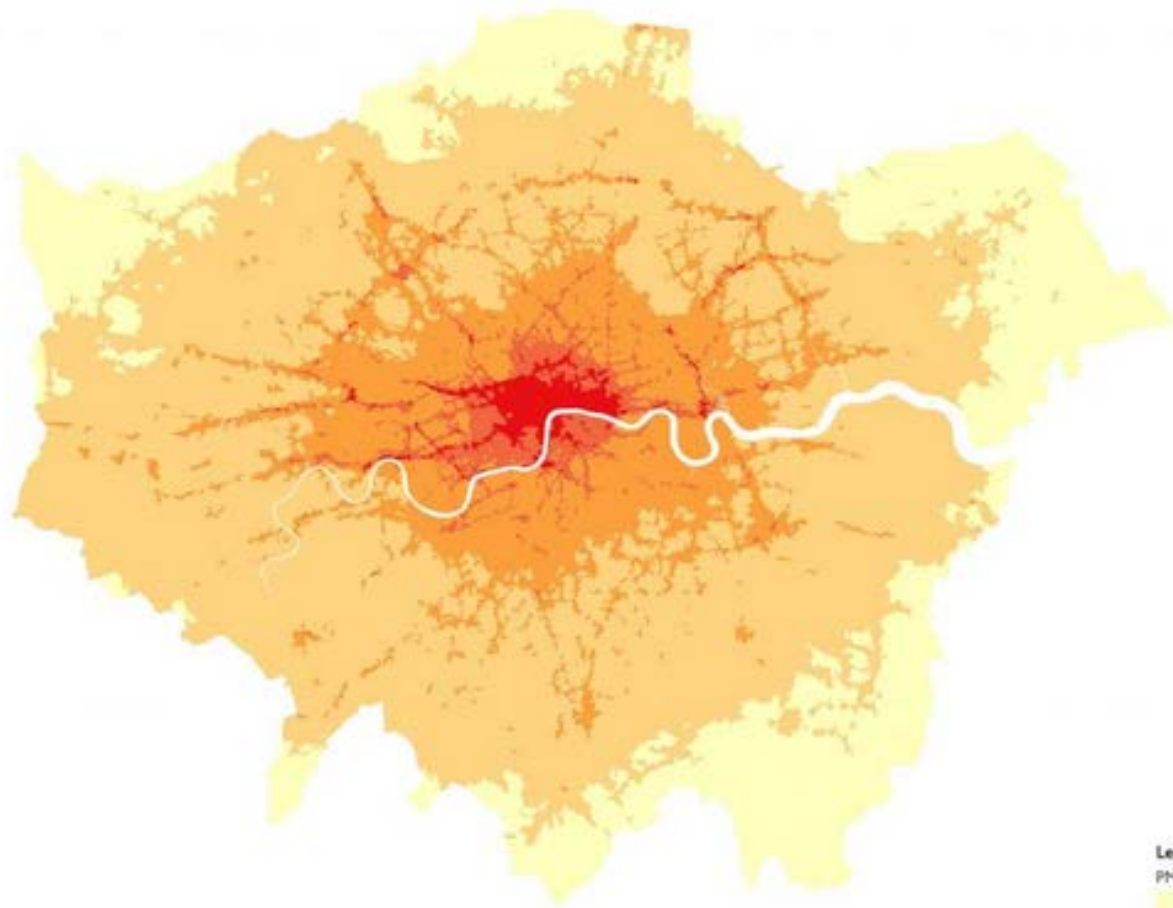
What is sensing *for*?

- The exposome
 - individual exposures to potentially harmful pollutants
- PM2.5
 - particulate matter that passes through a 2.5-micron filter
 - high-quality sensors are expensive
 - PM2.5 concentration varies rapidly in space and time
 - in 4D

Map A1: Air Quality Index (AQI) Monitoring Sites Across Ontario in 2014

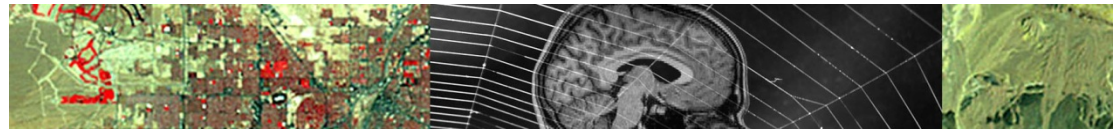


<https://www.ontario.ca/page/air-quality-ontario-2014-report>



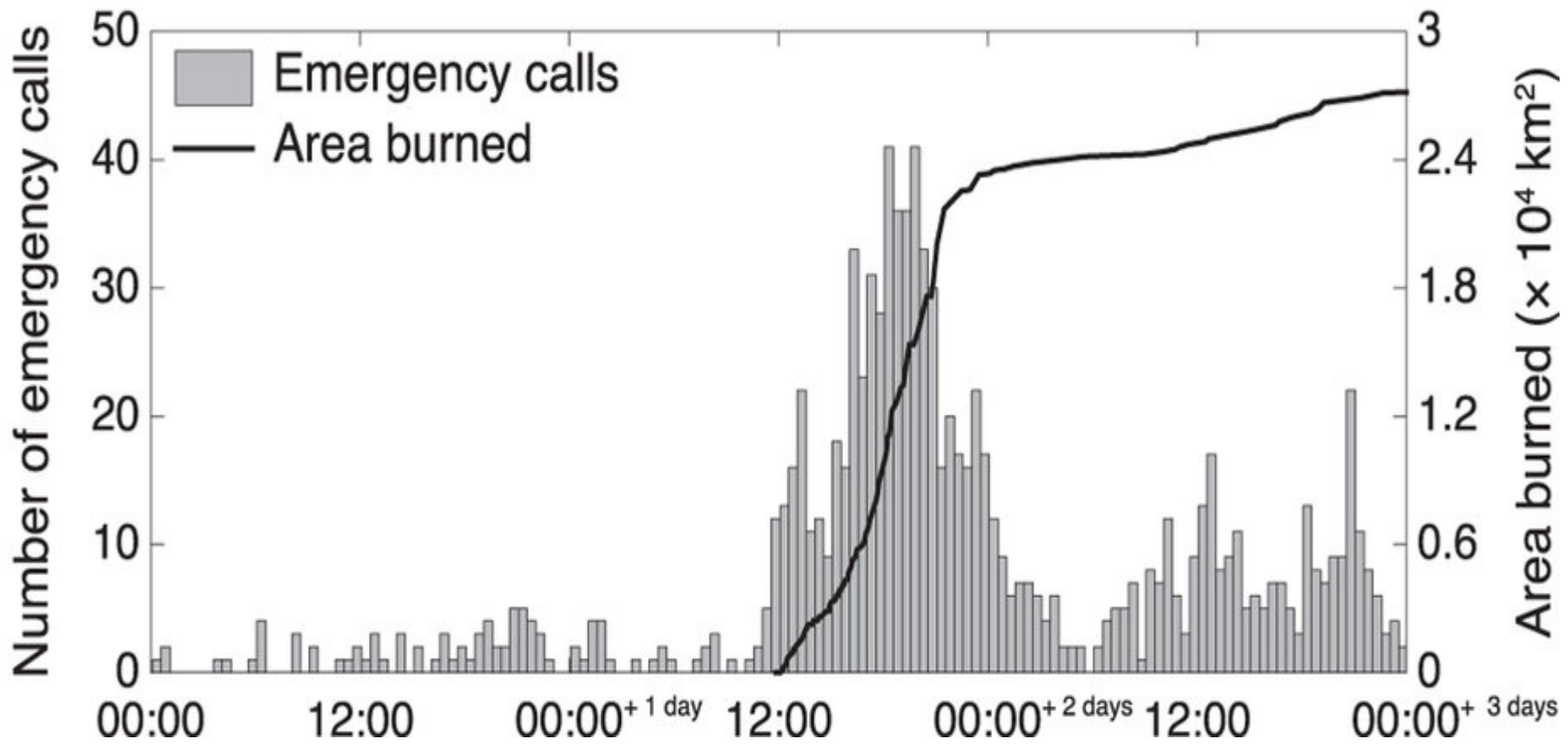
2013 LAEI Update - Annual mean PM_{2.5} concentrations
based on average within Output Areas

<https://data.london.gov.uk/dataset/pm2-5-map-and-exposure-data>



How to densify?

- Large number of cheap/inaccurate sensors
 - carried by humans, on vehicles
- Integration of hard/rare and soft/dense data
 - co-Kriging
- Modeling using covariates
 - traffic, TRI, GDP, etc.
- Remote sensing



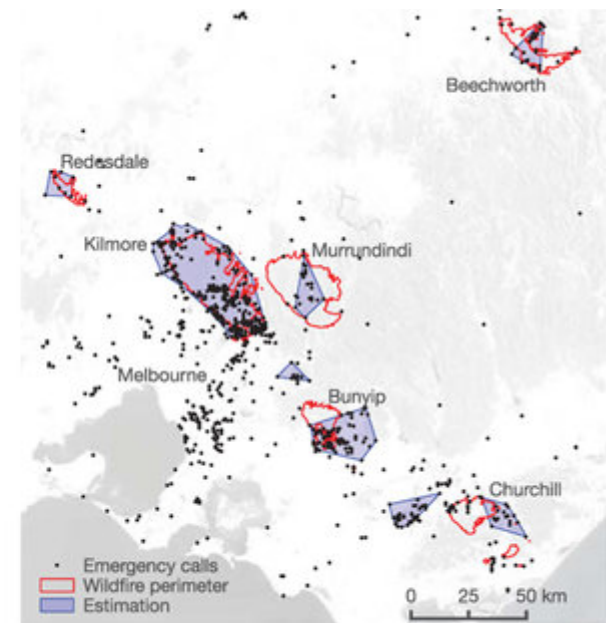
Xu Zhong, Matt Duckham, Derek Chong, and Kevin Tolhurst,
Real-time estimation of wildfire perimeters from curated crowdsourcing.
Scientific Reports **6**, Article number: 24206 (2016)
doi:10.1038/srep24206



17:00, 7th February, 2009

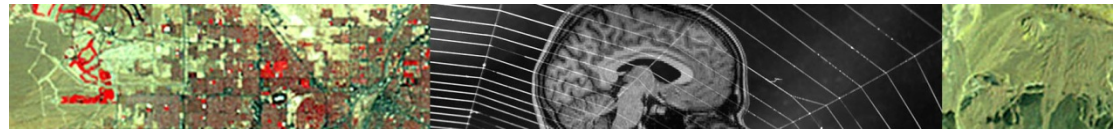


20:20, 7th February, 2009



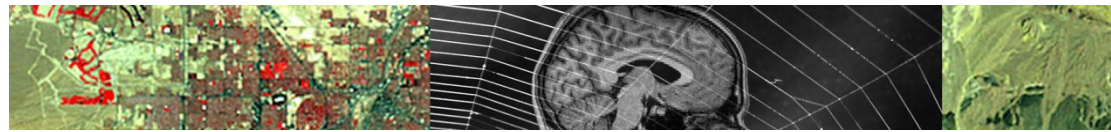
23:50, 8th February, 2009

Xu Zhong, Matt Duckham, Derek Chong, and Kevin Tolhurst,
Real-time estimation of wildfire perimeters from curated crowdsourcing.
Scientific Reports **6**, Article number: 24206 (2016)
doi:10.1038/srep24206



Uncertainty

- Measurement error in the sensor data
- Additional uncertainty introduced by interpolation, densification
 - how to propagate through the various stages
- How to communicate uncertainty
 - in the context of a use case



Research questions

- How to densify in space and time
- Where to put the next sensor?
 - to give the greatest increment to knowledge
 - to solve the most immediate practical problems
 - subject to numerous constraints
- How to integrate dense/soft data with rare/hard data
- How to estimate and visualize uncertainty in interpolated estimates