

# Citizen Science and Participatory Research on air pollution



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# Outline

- Personal pollution monitors
- Environmental science and participation
- Case 1: Air pollution monitoring in Uppsala, Sweden
- Social perspectives on air pollution
- Case 2: Household energy choice and air pollution in coal towns of central India

# Personal pollution monitors

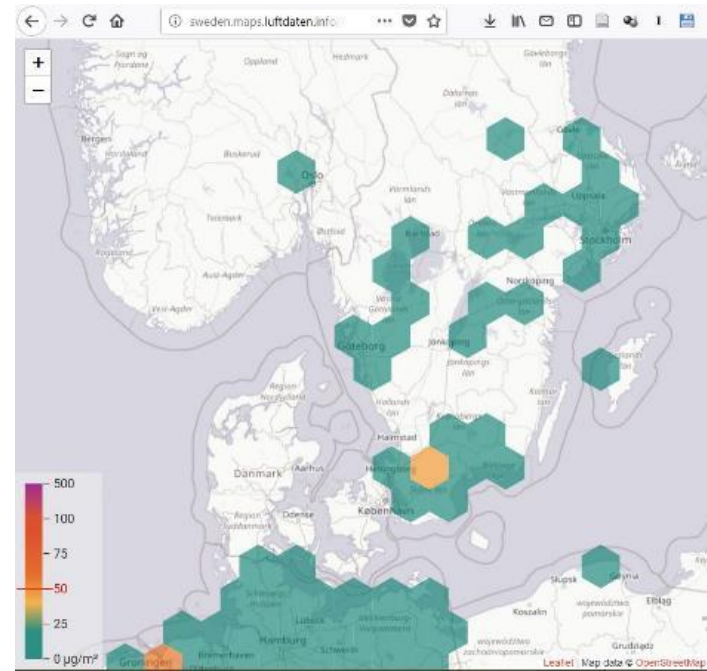
- New set of PM2.5 (Particulate Matter) monitors since early 2010s:
  - Speck monitor developed to examine 1000s of fracking wells in Pennsylvania, United States
- Rapid development of pollution monitors:
  - Lower cost (<200 USD)
  - Improved accuracy (about 15% deviation to reference)
  - New features (GPS, new pollutants like NO2 and Ozone, apps to track and visualise data)
  - Build your own open source monitor (Luftdaten, HackAir)





# DIY Air Pollution

- <https://luftdaten.info/>
- <http://luftdata.se/>



# Citizen monitoring and environmental justice

- The bucket brigade (Ottinger 2010a) or filters to capture pollution (Narayan and Scandrett 2014)
  - Benefit: Scientifically valid. Can go to court using results
  - Drawback: Expensive and time-consuming. Needs to be analysed in lab.
- Shared citizen-company monitoring (Ottinger 2010b)
  - Many companies and cities public readings as part of transparency

Ottinger, G. (2010a). Buckets of Resistance: Standards and the Effectiveness of Citizen Science. *Science, Technology & Human Values*, 35(2), 244–270.

Ottinger, G. (2010b). Epistemic Fencelines: Air Monitoring Instruments and Expert-Resident Boundaries. *Spontaneous Generations: A Journal for the History and Philosophy of Science*, 3(1), 55–67.



# Air pollution and public health

- Pollution is the largest environmental cause of disease and premature death in the world (larger than e.g. tobacco, AIDS, malaria) (Landrigan 2017).
- Particulate Matter are particles of 2.5 or less micrometre in diameter measured as PM2.5.
  - PM2.5 is “identified as the air pollutant with largest impacts on premature mortality and morbidity” (Amann, Klimont, & Wagner, 2013, p. 33).

Amann, M., Klimont, Z., & Wagner, F. (2013). Regional and Global Emissions of Air Pollutants: Recent Trends and Future Scenarios. *Annual Review of Environment and Resources*, 38(1), 31–55.

Landrigan, P. J. (2017). Air pollution and health. *The Lancet Public Health*, 2(1), e4–e5.

# Environmental science and participation

- The state is legally mandated to uphold environmental quality
  - This not happening at the moment in many places (but environmental quality is also improving on many indicators)
  - Leads to distrust of the state?
  - And distrust of environmental experts?
- Environmental science is well-established discipline with specific ways of measuring, estimating consequences on public health and environmental quality

# Environmental science and participation

- Who has expertise and knowledge on the environment?
- How do we build trust between experts and citizens?
- Deliberative participation is ... recognized as the way to build trust in an environment of uncertainty” (Fischer 2000: 220)
  - Trust in the government
  - Trust in experts
  - Trust between citizens and groups in wider society

Fischer, F. (2000). *Citizens, Experts, and the Environment: The Politics of Local Knowledge*. Durham, NC: Duke University Press Books.



# Citizen science

- Citizen science offers the chance for common people to:
  - Demystify science
  - Take control of measurements
  - Learn about the environment and your personal health
  - Potentially take action
- Can citizens generate ‘good enough data’ (Gabrys et al 2016) to build bridges between citizens and experts?

Gabrys, J., Pritchard, H., & Barratt, B. (2016). Just good enough data: Figuring data citizenships through air pollution sensing and data stories. *Big Data & Society*, 3(2).  
<https://doi.org/10.1177/2053951716679677>

# Air pollution and energy poverty

- Energy and air pollution are closely related:
  - Poor choice/use of fuel (transport: diesel over petrol, petrol over natural gas; homes: coal/wood over gas/electricity)
  - Old or badly maintained engines
  - Waste management (including road dust)
  - Lacking public transport
  - Inadequate heating systems (including poor insulation in homes)
- But non-energy sources of air pollution also exist:
  - Desertification, forest fires, agricultural fires

# Example: Unexpected air pollution problems in Uppsala, Sweden



- There is only one air pollution monitor in Uppsala placed on a central road
- Construction forced the monitor to be relocated about 250 m
  - >Uppsala is breaking EU regulations!



# Environmental science and air pollution

- The Uppsala case is typical for environmental science approaches to air quality
  - A few expensive monitors in each city
  - Pollution modelling to extrapolate values for wider area
- This approach is showing limitations in most cities of the world:
  - Air quality is difficult to model in cities where the wind direction might change in unexpected ways
  - Bad air tends to get trapped in city settings (urban canyons)
  - Air pollution can vary significantly from one block to the next.
  - Professional monitors cost above 20,000 Euro per unit
- Lots of emerging work on distributed and/or participatory air pollution monitoring



# Connecting pollution data to social settings

- Are the people in the picture affected by industrial or household energy poverty?



# Towards a socio-environmental science on air pollution

- Nightingale (2016): Different starting points lead us to ask different questions about society and the environment
  - Leads to different research designs and questions
- Potential starting points:
  - Is air pollution about not exceeding certain threshold limits? If yes, carry out scientific measurements
  - Is air pollution about poverty? If yes, consider ways to explore differences in energy use or pollution loads.

Nightingale, A. J. (2016). Adaptive scholarship and situated knowledges? Hybrid methodologies and plural epistemologies in climate change adaptation research. *Area*, 48(1), 41–47. <https://doi.org/10.1111/area.12195>

- “... how does the experience and experiment of air pollution and air quality data become a site of political, as well as potentially affective, engagement (Gabrys 2016:161)”?

# Different approaches to pollution

- Effective pollution research:
  - Environmental science closely related to the governance of pollution
  - Can citizens measure pollution to generate reliable numbers?<sup>1</sup>
- Affective pollution research:
  - How can pollution numbers connect to personal and family health challenges?
  - Personal health and the wider political economy

1) Low cost monitors are increasingly shown to be more accurate than previously believed:

Zheng, T., ... Carlson, D. E. (2018). Field evaluation of low-cost particulate matter sensors in high and low concentration environments. *Atmos. Meas. Tech. Discuss.*, 2018, 1–40. <https://doi.org/10.5194/amt-2018-111>

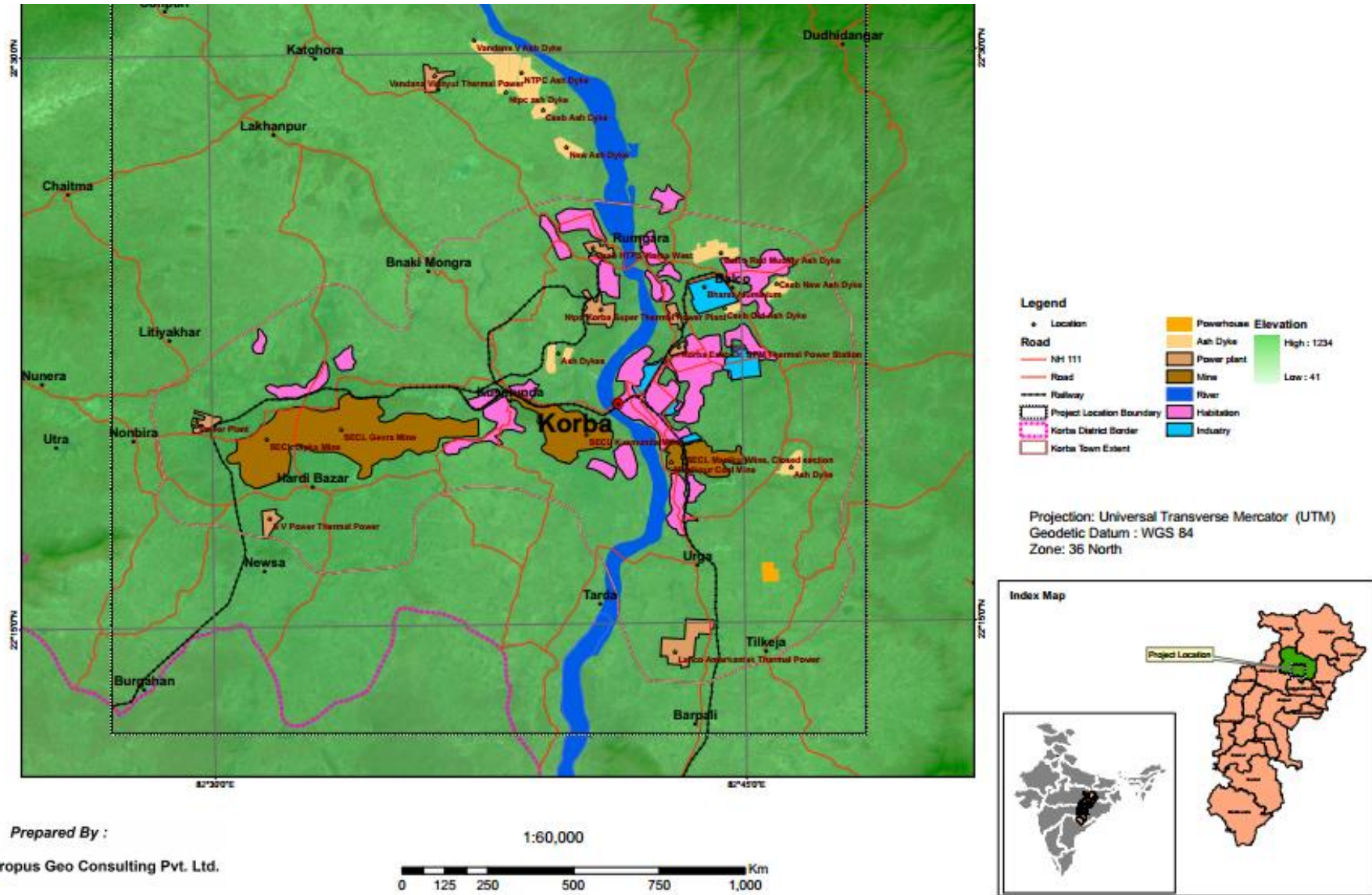
Bulot, F. M. J., ... Loxham, M. (2019). Long-term field comparison of multiple low-cost particulate matter sensors in an outdoor urban environment. *Scientific Reports*, 9(1), 7497. <https://doi.org/10.1038/s41598-019-43716-3>

# Social questions around emissions

- Political questions around decision-making, voice, power and inequality
- Gender: Who makes decisions in the household?
- Behavioural questions: Monitors changing behaviours by making the unseen seen
- Health experiences like asthma connected to pollution exposure
- Cultural questions: What is pollution? Is it dust, ritual impurity, chemically-defined pollutants or something else?



## Example 2: Household energy choice and air pollution in coal towns of central India



## Example 2: Household energy choice and air pollution in coal towns of central India

- All of rural India (and many in urban areas) rely on solid fuels like firewood, biomass or coal for cooking (about 800 million people)
- Especially damaging for the health of women and children in the home





- Household energy choice and air pollution in coal towns of central India





# The coal laddu of Raipur, India

- Coal dust from iron-making units become coal cakes (laddus) when mixed with saw dust and cow dung
- An entire energy poverty supply chain created to make coal laddus (although gas cooking is increasing) with serious health ramifications



- Lack of energy security leads households to rely on 3-4 different cooking fuels
- Natural gas and electricity both appear as possibilities
- Well-known problem remarkably lacking in action
- The role of air pollution monitoring will be discussed in the next hour