

Mapping Pollution Exposure: **Quantified Personal Space**

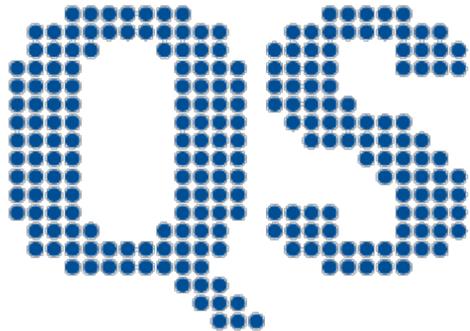
Jonny Huck
Duncan Whyatt
Paul Coulton
Adrian Gradinar

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QUANTIFIED SELF

Quantified Self

- 'Self Trackers'
- 2007: Single blog by Gary Wolf
- 2014: Research-driven applications
- Introverted
- Miniaturisation and reduction in cost of sensors



Quantified Self
self knowledge through numbers

YOU ARE JUST A NUMBER

Can you make yourself healthier and happier by logging every snore, step and mood swing? As a Californian trend for obsessional data-tracking makes its way over here, **Tim Chester** covers his body in gadgets to find out if self-knowledge is power. Photograph by Paul Stuart

Today I have climbed the equivalent of a tall giraffe. Coffee is my most frequent food. On average, I walk 11,726 steps a day, burning 3,089 calories, over 2.4 hours of activity. I sleep for 6 hours and 9 minutes a night. This week, my sleep efficiency is 72% and my food is 77% healthy. My BMI of 23.5 is 14 percentage points below the median for men my age, and my average daily Met score is 1.71, although I have no idea what a Met score is.

I am, it seems, nothing more than a bundle of numbers and milestones, spurred on by LEDs and chided by pop-up messages. A wireless accessory for the iPhone; perhaps its most sophisticated yet.

My arms are covered in bands, my pockets augmented with accelerometers, my eyes numb from all the charts, my heart pumping to the beat of a heart-rate monitor and forcing its ventricles to keep up with the national average. My head is about to implode from all the positive affirmation and gentle nudging, but it's OK because my memories are being saved to my hard drive and my mood swings are earning me "hugs" from strangers.

I am producing, analysing and socially sharing personal data. I am becoming fitter, happier, and more productive. I am staying motivated by earning badges. I have become a Quantified Self (QS).

The QS movement that I've temporarily joined began, as these things tend to do, in San Francisco's Bay Area in 2007. Two Wired magazine editors, Gary Wolf and Kevin



369 MINS
Sleep per night

73
bpm heart rate

3,324
Nike FuelBand score

582
photos logged

11,726
steps walked

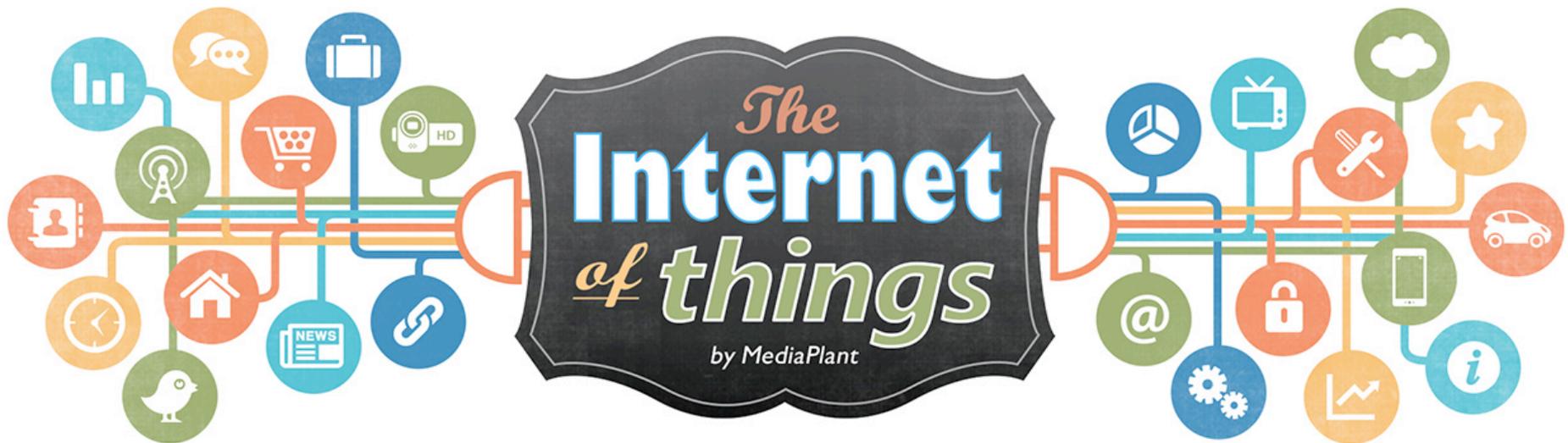
3,089
Calories burnt

24
Hours of
nonstop video

INTERNET OF THINGS

The Internet of Things (IoT)

- Everyday existing objects
- Interaction with the Physical World
- Miniaturisation and cost reduction of sensors



More than just a text from washing machine...

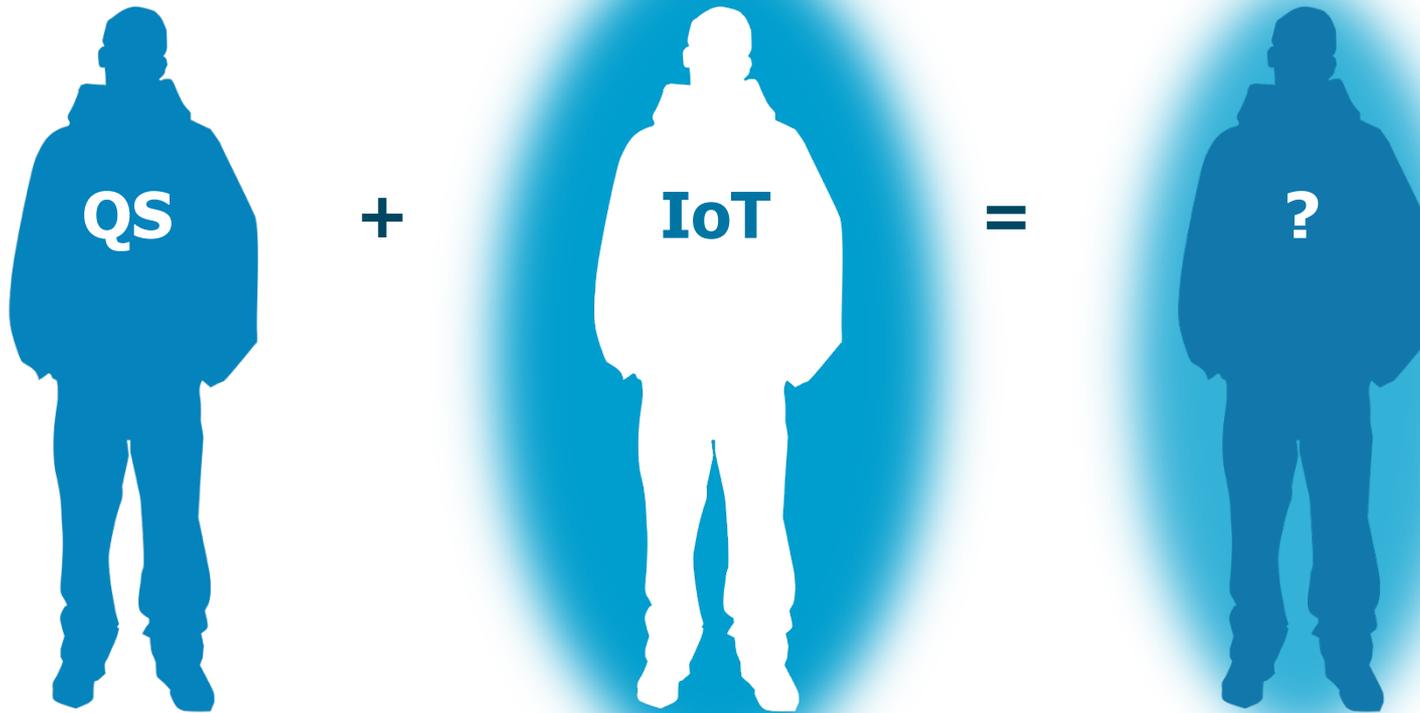
- Proximity
- Vibration
- Noise
- Weather
- Fire
- Gases
- Water Quality
- Soil Quality
- Smart Metering
- Smart Nappy...



<http://iotlist.co/>

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Combination of Technologies...



QUANTIFIED PERSONAL SPACE

AIR POLLUTION

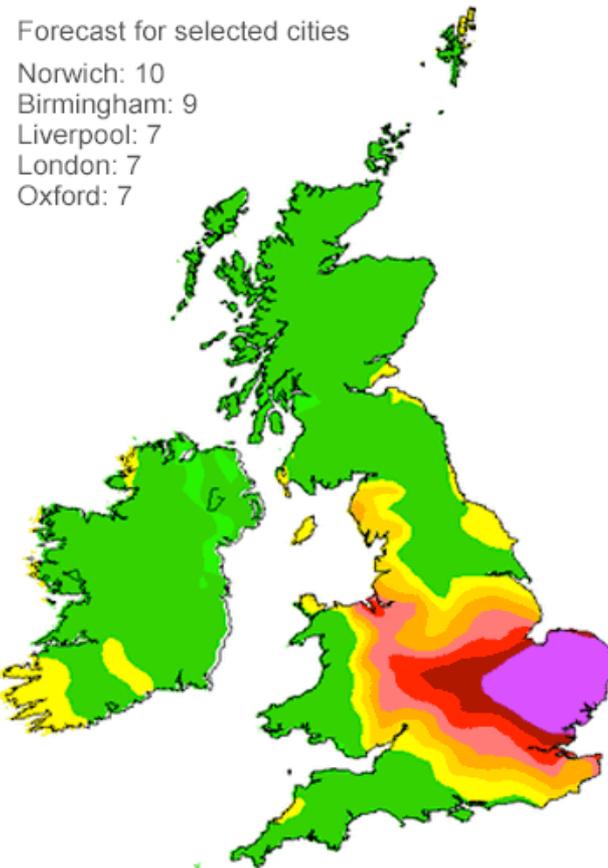
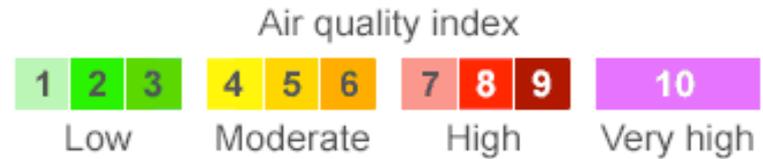
Air Pollution

- Irritation to the eyes, nose and throat
- Nausea
- Respiratory problems
- Death



Air Pollution

- First week of April 2014
- Dangerously high pollution levels
- Meteorological coincidence
- Can occur 5 times per year
- Danger to people with respiratory problems
- 30,000 people in the UK die prematurely due to pollution
- 7 million globally



<http://www.bbc.co.uk/news/uk-26856285>

<http://www.bbc.co.uk/news/uk-26863228>

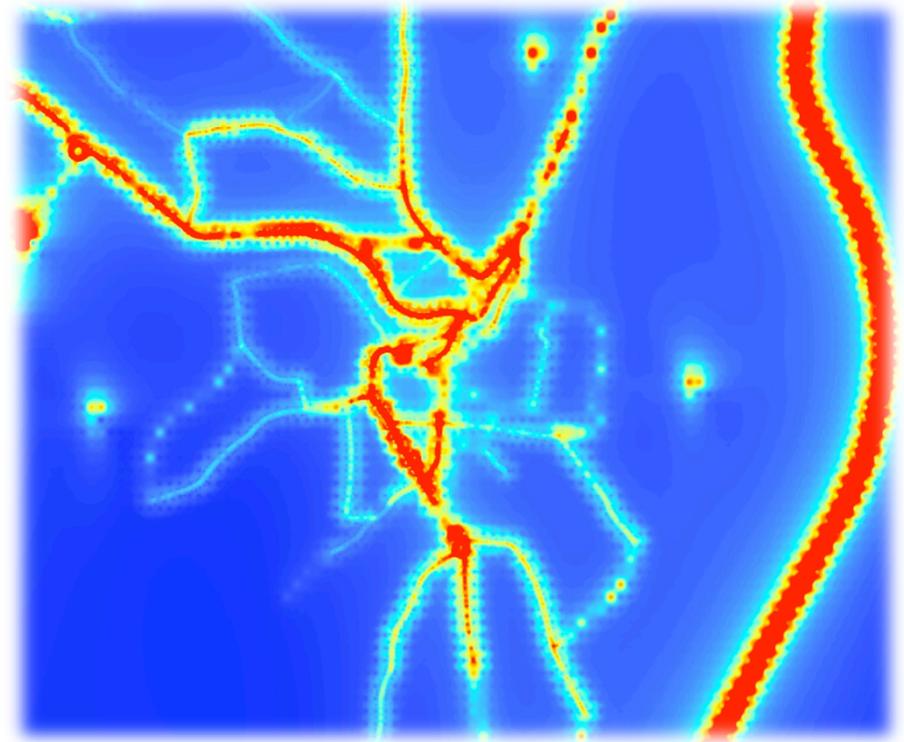
Pollution Monitoring

- Large automatic monitoring stations
- Very expensive
- Static
- Low density (7 in Glasgow)
- Non-automatic monitoring stations
- "Diffusion tubes"
- Replaced in 2005...



Pollution Modeling

- Reliance upon modeling
- Nice spatial pattern
- Estimate based upon Traffic count & composition data
- Misapplication – false confidence



<http://www.citi-sense.eu/>

www.imagination.lancaster.ac.uk

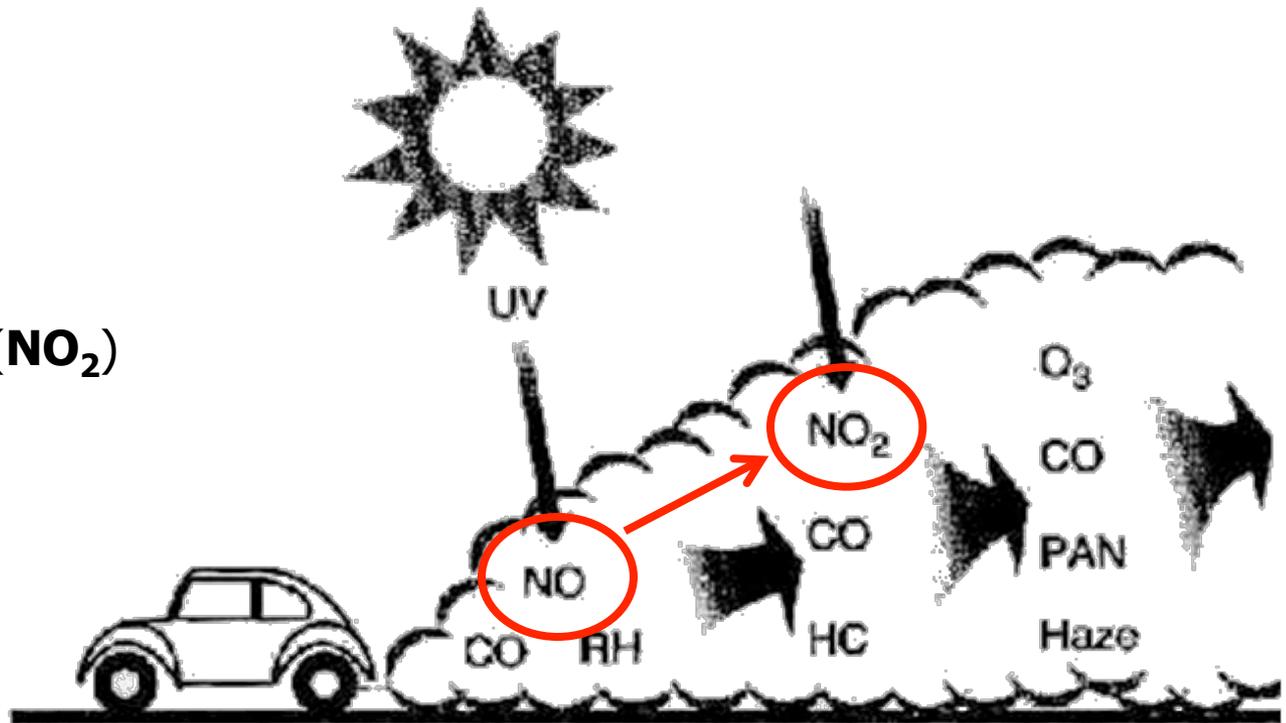
Exposure...

- Pollution concentration in the air
 - **Measured**
 - **Modeled**
- Volume of air inhaled
 - **Physiology**
 - **Terrain**
 - **Weather**
 - **etc...**



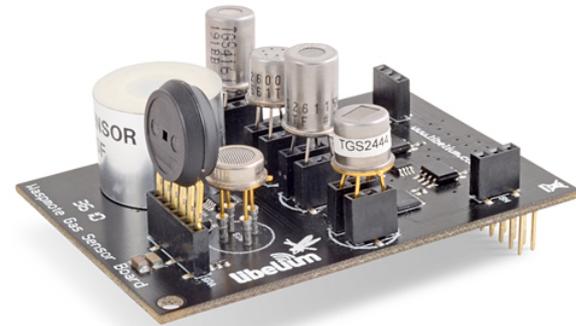
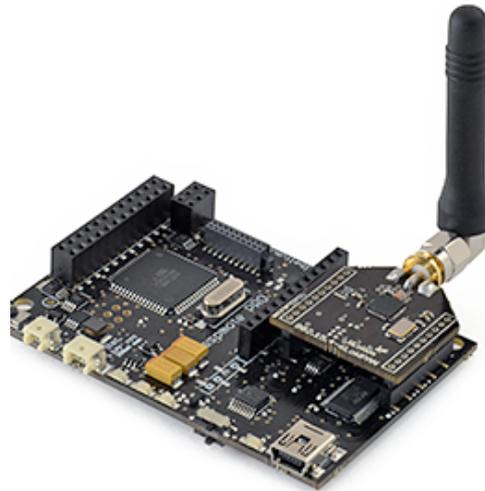
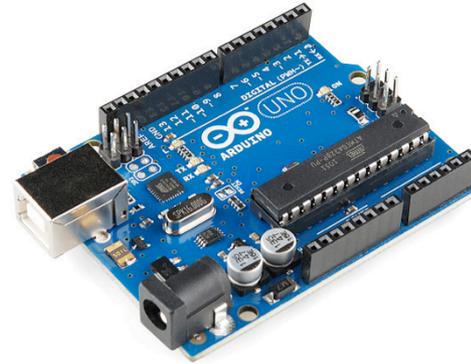
The plan...

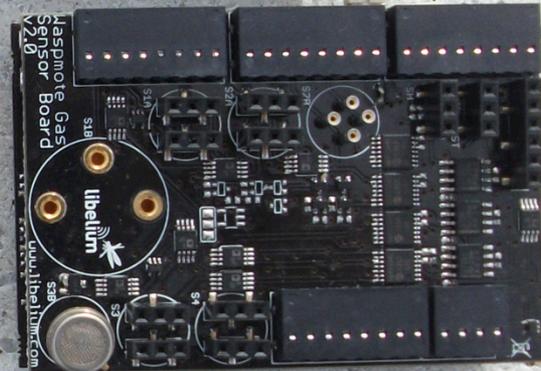
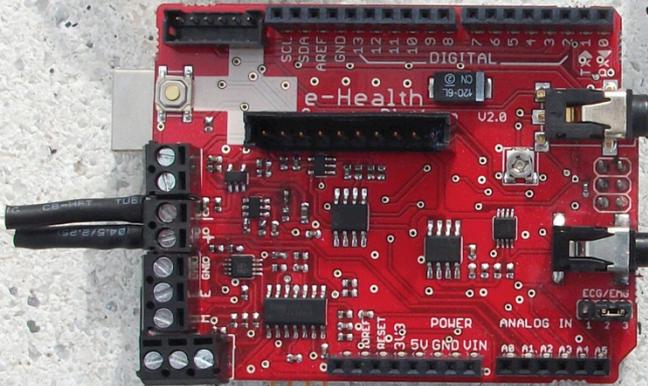
- Quantified Personal Space: **Air Pollution Exposure**
- Direct sensing
 - Air Pollution
 - Nasal Airflow
- Nitrogen Dioxide (**NO₂**)



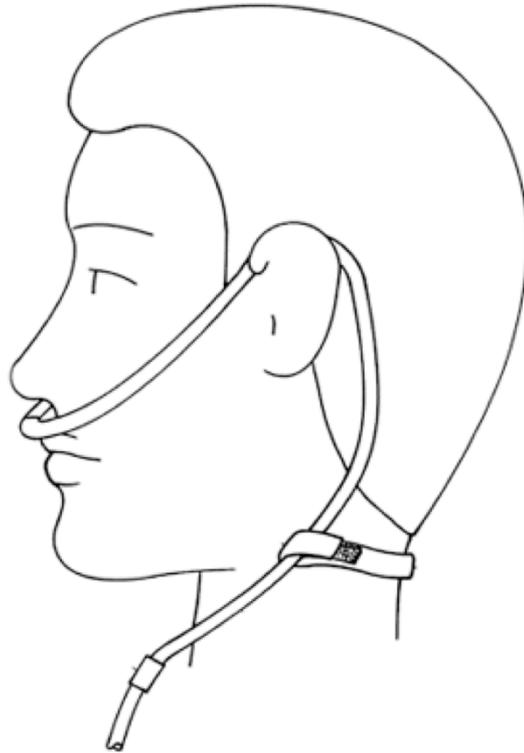
QPS: Air Pollution

- Arduino 'Uno' Board
- Cooking Hacks 'e-Health' Shield
- Wasmote 'mote'
- Wasmote 'Gases Board' Shield
- Android Mobile Phone

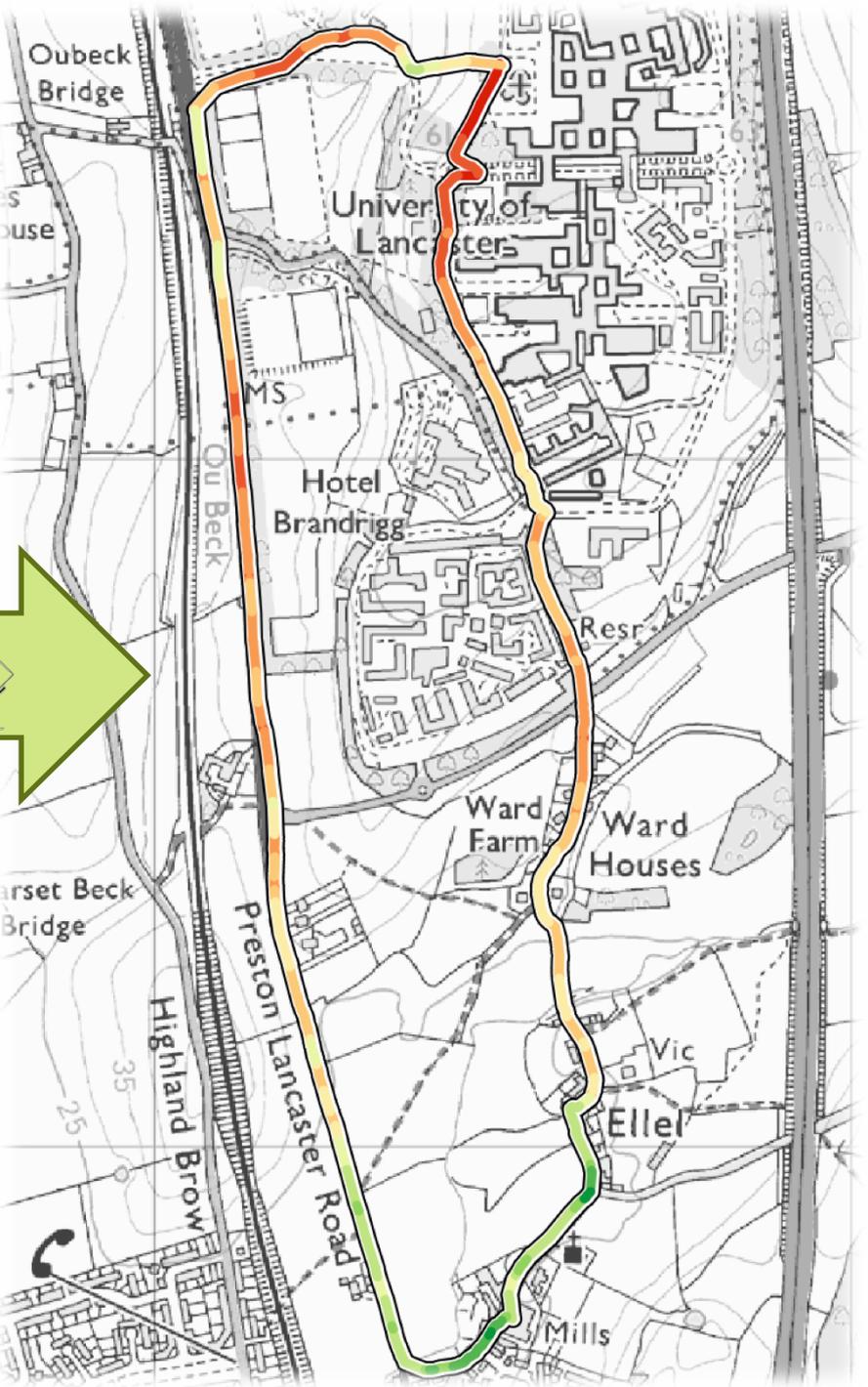




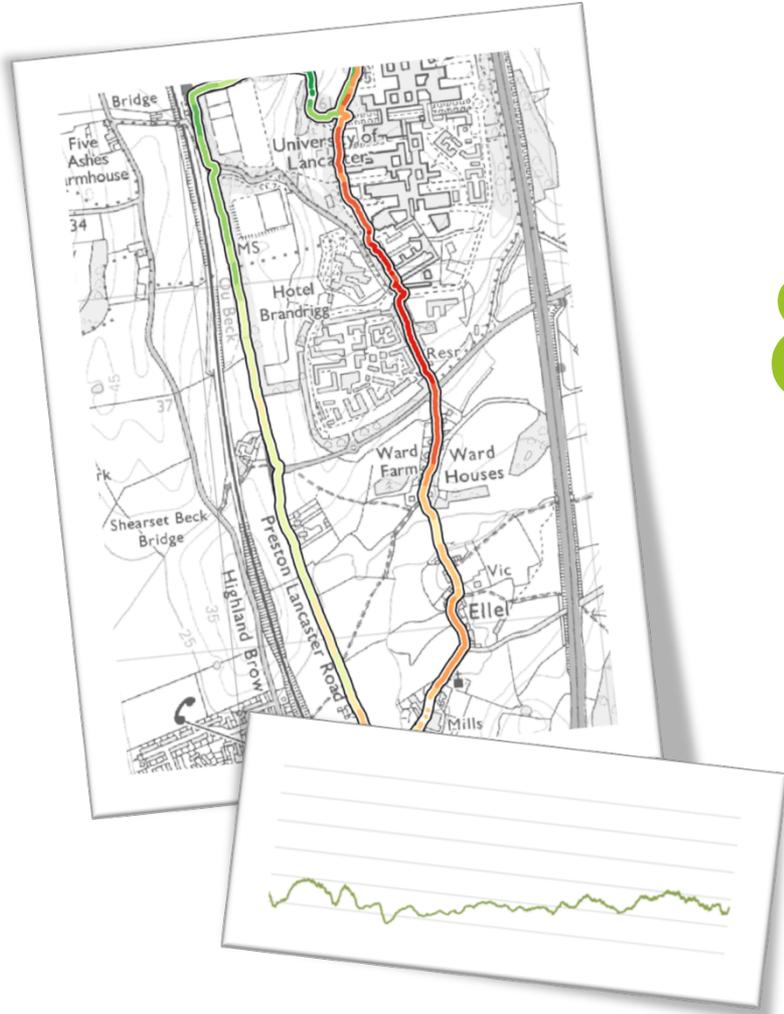
Airflow Monitor



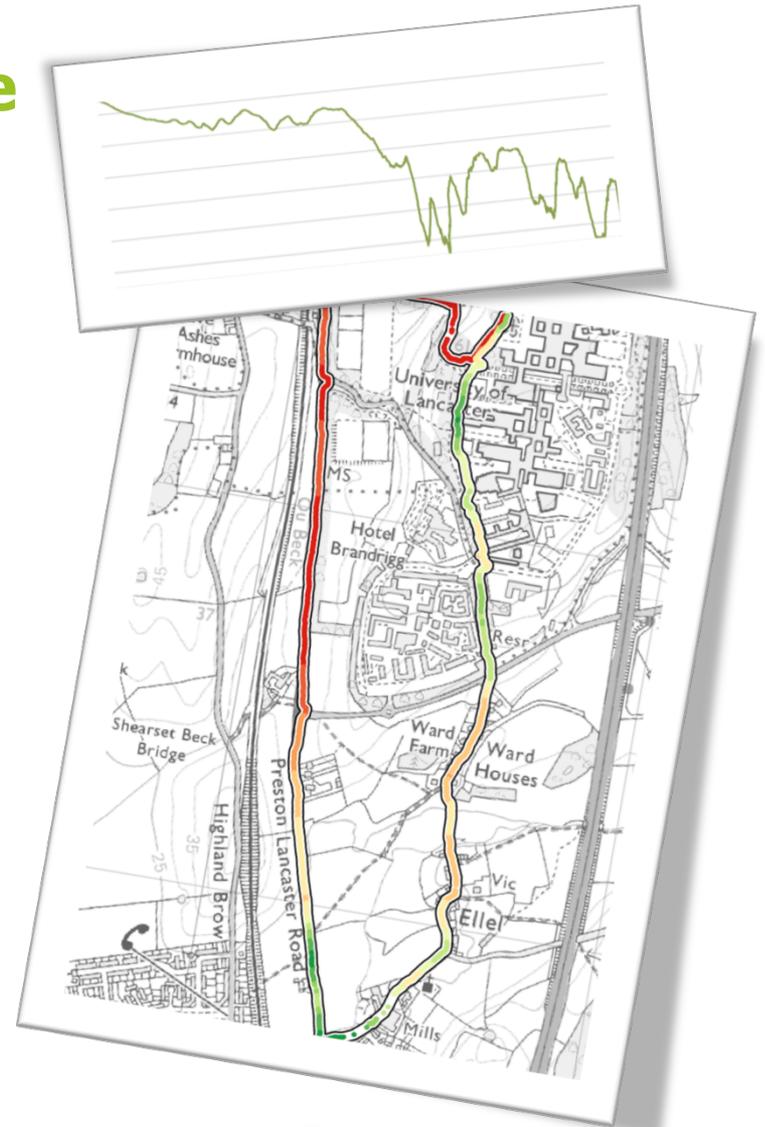
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Calculating Relative Exposure



&



PERSONAL EXPOSURE MAP



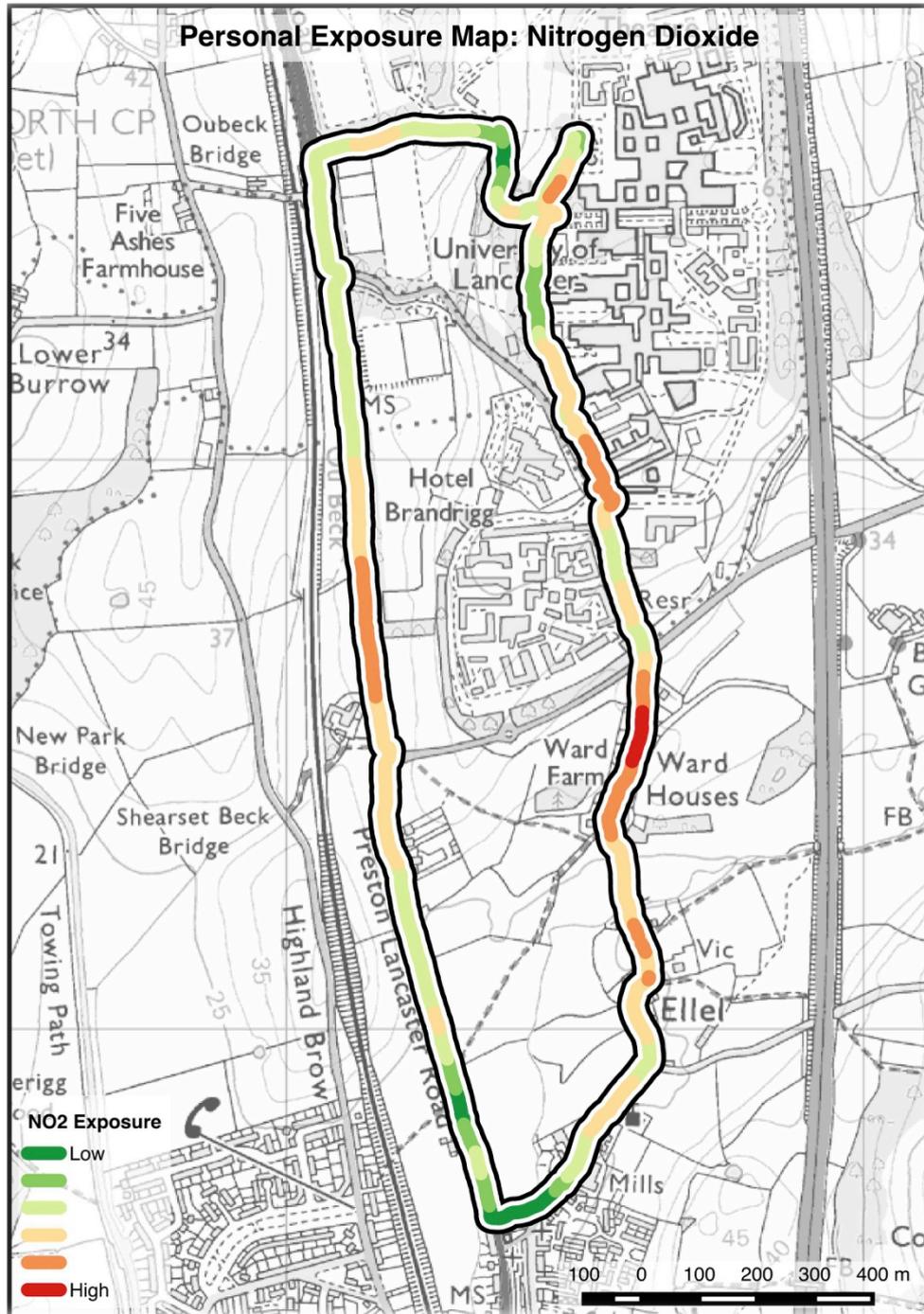
Car Park



Traffic on drive



Busy A road



Back on campus



A bit hilly...

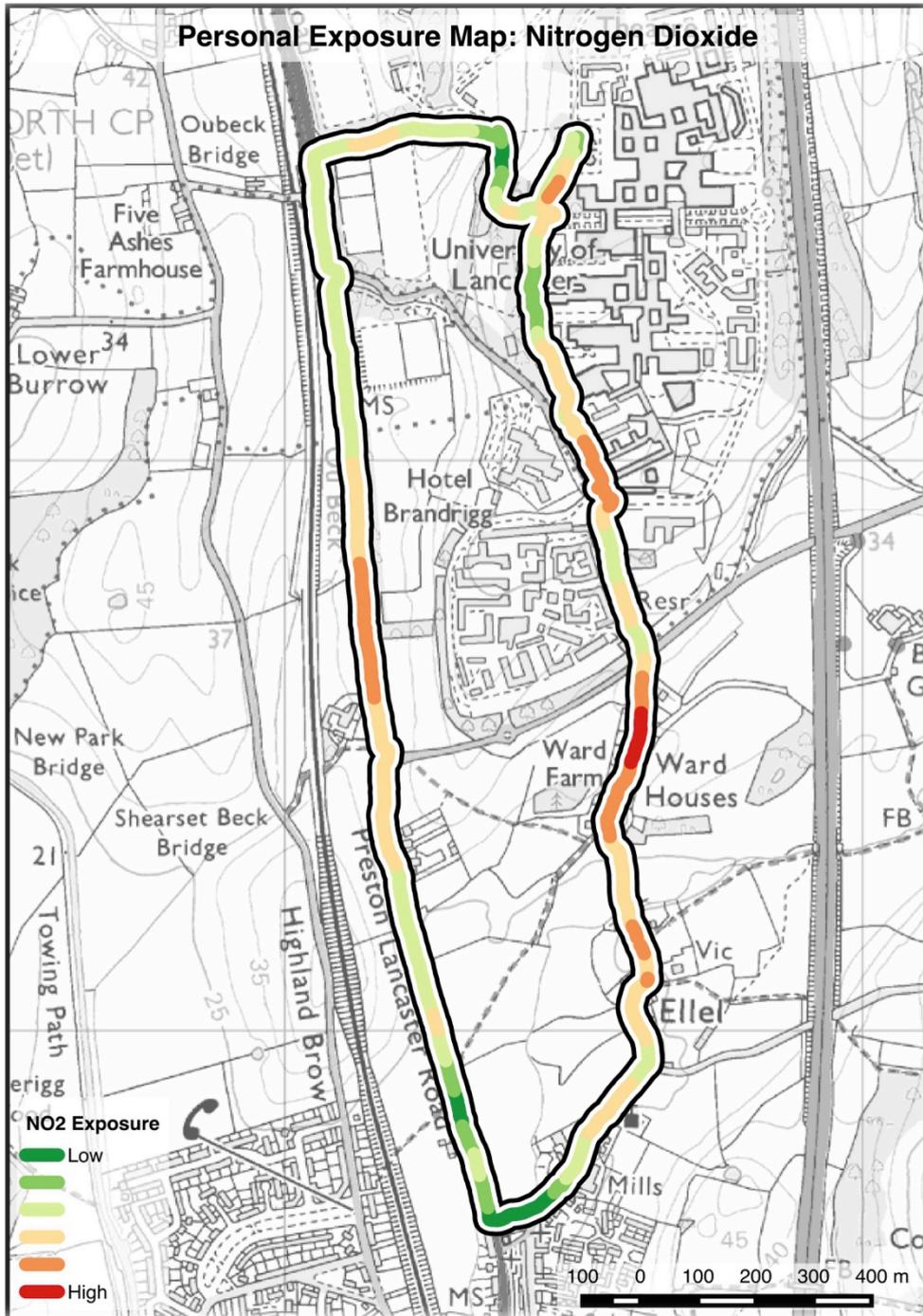


Leafy green village

NO₂



Personal Exposure Map: Nitrogen Dioxide



Airflow



Ready for Prime Time?

- Asking a lot!
 - Real-time
- Quality of sensors
 - Un-calibrated
 - Relatively noisy
 - A bit of lag
 - A bit invasive...
- But this will change
 - Calibrated Versions
 - Early Stages of development...



But...

- Portable
- High spatial and temporal resolution
- Accounts for the individual physiology of the user
- Real time feedback
- Low cost (c £400 and falling)
- Networked...



Scalability

- Cheaply and easily deploy a network of devices on people, bikes, trains, cars etc.



Explore our personal space in new ways...

- Explore the effect of knowledge upon behaviour
- Explore the effect of real-time feedback upon behaviour
- Explore perceived verses actual pollution levels
- Validation of pollution models
- Applications far beyond pollution...



QUANTIFIED PERSONAL SPACE