
# Understanding Behavioural Exposure for LAQM

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# Outline

What is ‘relevant exposure’?

What are limit values and objectives?

Current LAQM Approach

What is ‘Big Data’?

What does this mean for LAQM?

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# Air Quality Introduction

– This talk is concerned with **Outdoor or Ambient** air quality

– There are **legally binding limits** to certain pollutants based on their impact on health

– Governed at **EU, National** and **Local** level

– Our **exposure** to air pollution is dependent on what we do and where we do it

– Big impacts on human health, WHO estimate 9 out of 10 people worldwide breathe ‘polluted’ air

– The guidance and legislation we use and follow to undertake air quality studies is based on static approaches that don’t benefit from the complex datasets and tools currently available

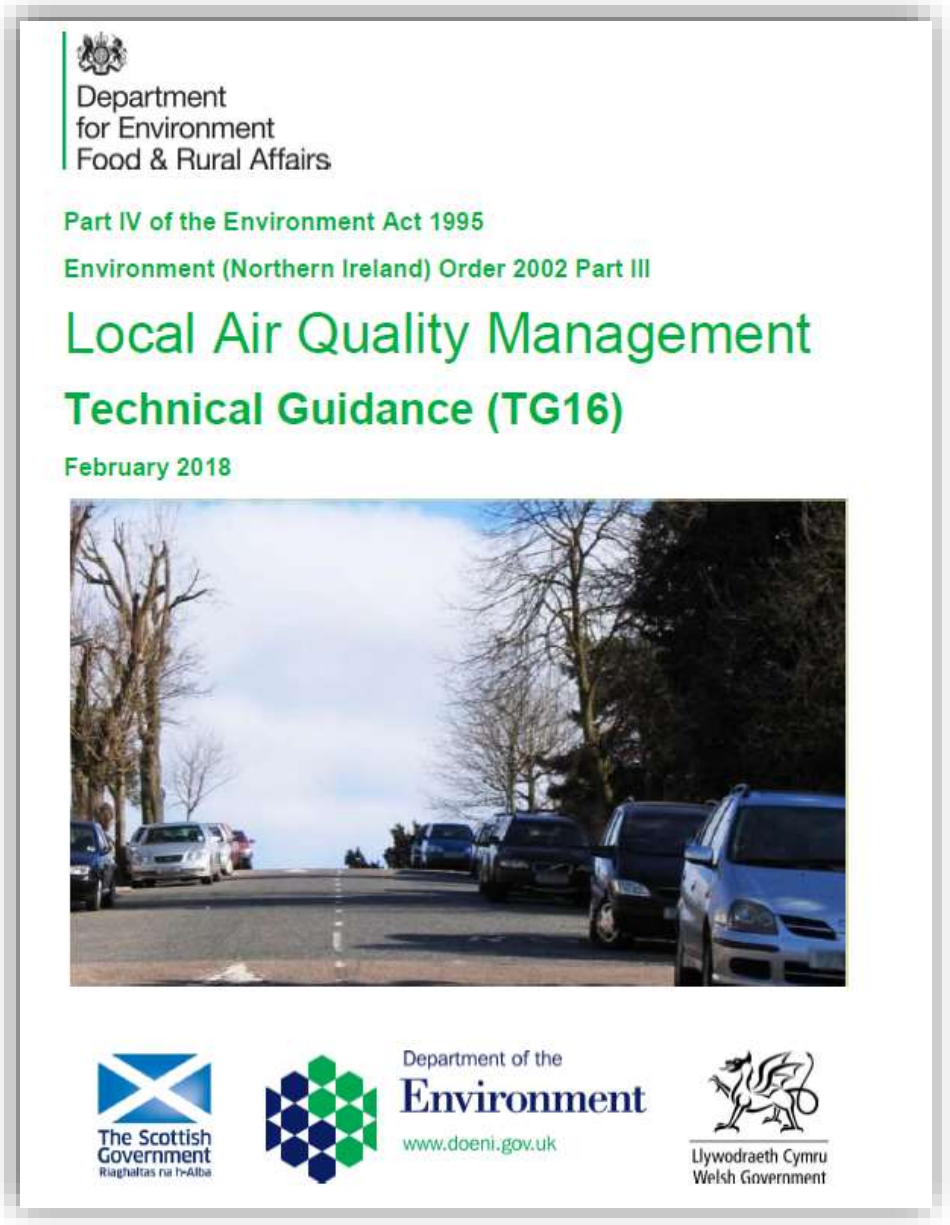
# Definition of ‘relevant exposure’:

LAQM.TG(16) states:

“For the purposes of LAQM, regulations state that exceedances of the objectives should be assessed in relation to “the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present”.”

EPUK / IAQM planning guidance states:

“The population exposure in many assessments will be evaluated by describing the impacts at individual receptors. Often, these will be chosen to represent groups of residential properties”



# Examples of where the Objectives Apply

| Averaging Period | Objectives should apply at: | Objectives should generally not apply at: |
|---|---|---|
| Annual mean | All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc. | Building façades of offices or other places of work where members of the public do not have regular access.<br>Hotels, unless people live there as their permanent residence.<br>Gardens of residential properties.<br>Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term. |
| 24-hour mean and 8-hour mean | All locations where the annual mean objective would apply, together with hotels.<br>Gardens of residential properties[10]. | Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term. |
| 1-hour mean | All locations where the annual mean and:<br>24 and 8-hour mean objectives apply.<br>Kerbside sites (for example, pavements of busy shopping streets).<br>Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more.<br>Any outdoor locations where members of the public might reasonably expected to spend one hour or longer. | Kerbside sites where the public would not be expected to have regular access. |
| 15-min mean | All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer. | |

LAQM TG16, 2018



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# Current Issues With Exposure Consideration

– **We do not have a holistic view** of the effect of air pollutants on the population; we treat people differently when they are at work, compared with when they are at home, shopping or elsewhere

– We do little to consider air quality in conjunction with factors such as health, poverty, social mobility and education

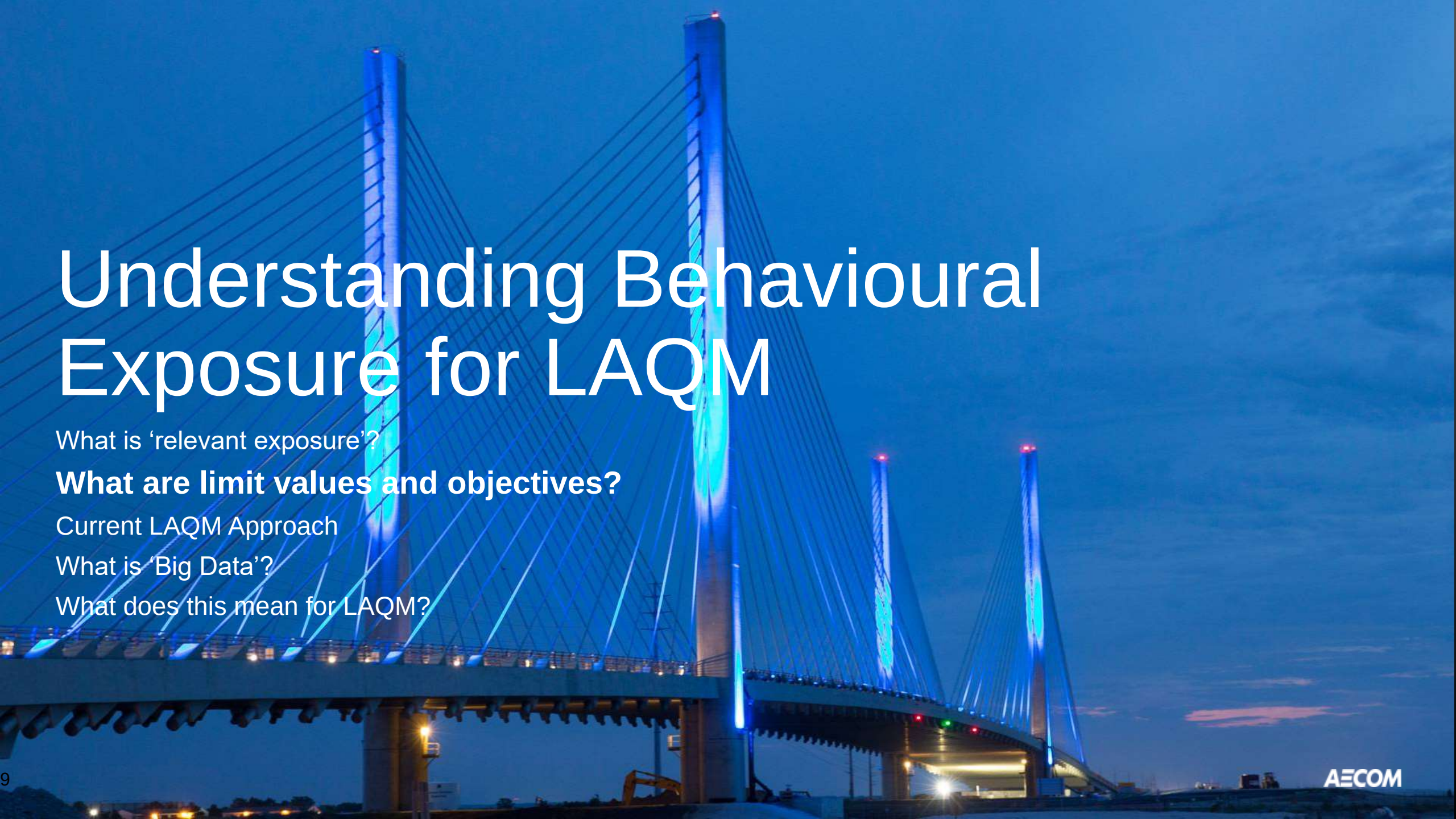
– We do little to understand the implication of time spent in different locations

– Current definition of relevant exposure in air quality studies does little to differentiate those who are **more sensitive to the health effects of pollution** to make the LAQM process more relevant

# Examples

Assessing new houses to be built alongside a polluted road, versus offices and shops which can be built along the same road with less concern for the effect of the pollution on the employee.

Due to a disparity between environmental and occupational regulation the customer buying a coffee in a railway station concourse is subject to a far lower pollution threshold than the barista serving the coffee.



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# EU Limit Values

| *Pollutant* | *Concentration* | *Averaging period* | *Legal nature* | *Permitted exceedences each year* |
|---|---|---|---|---|
| Fine particles (PM2.5) | 25 µg/m3*** | 1 year | Target value to be met as of 1.1.2010<br>Limit value to be met as of 1.1.2015 | n/a |
| Sulphur dioxide (SO2) | 350 µg/m3 | 1 hour | Limit value to be met as of 1.1.2005 | 24 |
| | 125 µg/m3 | 24 hours | Limit value to be met as of 1.1.2005 | 3 |
| Nitrogen dioxide (NO2) | 200 µg/m3 | 1 hour | Limit value to be met as of 1.1.2010 | 18 |
| | 40 µg/m3 | 1 year | Limit value to be met as of 1.1.2010 * | n/a |
| PM10 | 50 µg/m3 | 24 hours | Limit value to be met as of 1.1.2005 ** | 35 |
| | 40 µg/m3 | 1 year | Limit value to be met as of 1.1.2005 ** | n/a |

| *Title* | *Metric* | *Averaging period* | *Legal nature* | *Permitted exceedences each year* |
|---|---|---|---|---|
| PM2.5 Exposure concentration obligation | 20 µg/m3 (AEI) | Based on 3 year average | Legally binding in 2015 (years 2013,2014,2015) | n/a |
| PM2.5 Exposure reduction target | Percentage reduction* + all measures to reach 18 µg/m3 (AEI) | Based on 3 year average | Reduction to be attained where possible in 2020, determined on the basis of the value of exposure indicator in 2010 | n/a |

https://ec.europa.eu/environment/air/quality/standards.htm, 2019

# UK Air Quality Objectives

**Table 1.1 – UK Air Quality Objectives and Pollutants - LAQM**

| Pollutant | Objective | Averaging Period | Obligation |
|---|---|---|---|
| Nitrogen dioxide ($NO_2$) | 200µg/m³ not to be exceeded more than 18 times a year | 1-hour mean | All local authorities |
| | 40µg/m³ | Annual mean | All local authorities |
| Particulate Matter ($PM_{10}$) | 50µg/m³ not to be exceeded more than 35 times a year | 24-hour mean | All local authorities |
| | 50µg/m³ not to be exceeded more than 7 times a year | 24-hour mean | Scotland only |
| | 40µg/m³ | Annual mean | All local authorities |
| | 18µg/m³ | Annual mean | Scotland only |
| Particulate Matter ($PM_{2.5}$) | Work towards reducing emissions/concentrations of fine particulate matter ($PM_{2.5}$) | Annual mean | England only (encouraged in Wales) |
| | 10µg/m³ | Annual mean | Scotland only |

LAQM TG16, 2018

# Health Effects

Estimates of health impact are many, complex and varied

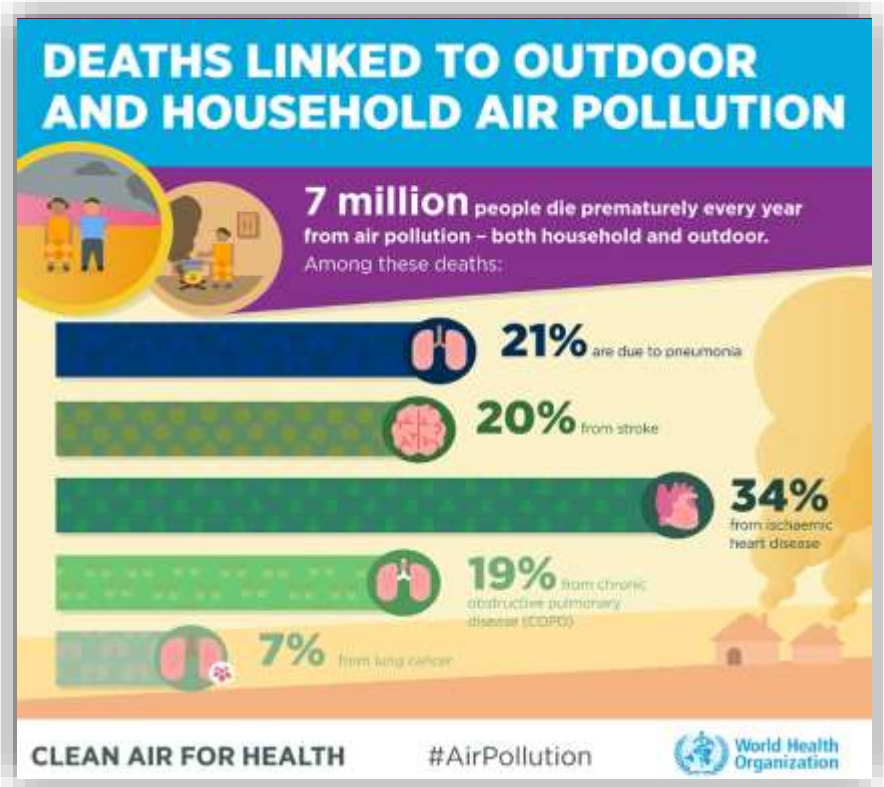
Research indicates:

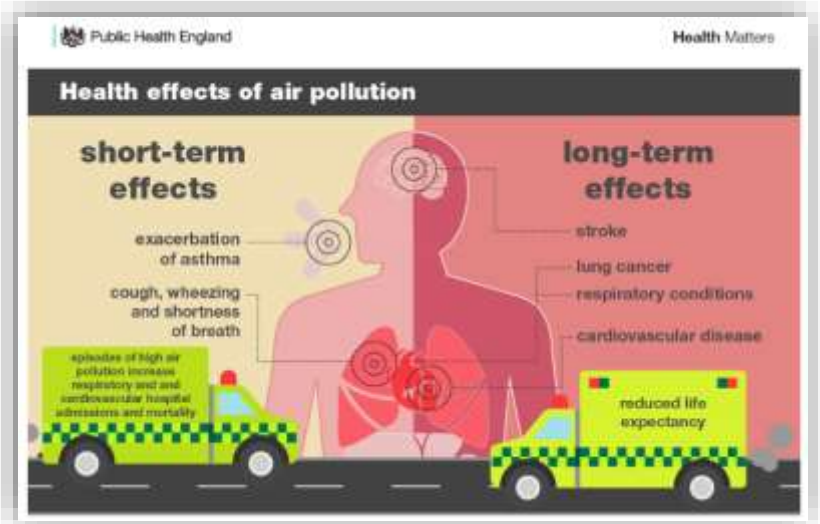
-The 3 main conditions associated with air pollution are respiratory conditions (such as asthma), cardiovascular disease (CVD), and lung cancer.

-There is emerging evidence for associations with low birth weight and Type 2 diabetes.

-Emerging evidence suggests that air pollution may also affect the brain and is possibly linked to dementia and cognitive decline.

(Source: Public Heath England)



# What Are The Issues?

- In the UK, principally;
- Nitrogen Dioxide (**$NO_2$**)

- acidic gas, high levels $NO_2$ causes **inflammation of the airways**. Long term exposure may affect lung function. Enhances the response to allergens in sensitive individuals.

- exceeding **EU** and **UK** limits in many areas in UK (mainly urban)

- Particulate Matter (**PM**)

- Small, differently sized (**$PM_{10}$** and **$PM_{2.5}$**) dust, dirt, soot, smoke particles.
The smaller the particle the further it can penetrate the airways, and therefore the more damage it does.

- Eye irritation, Bronchitius, Cardiovascular, **Carcinogens**

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# Current LAQM Approach

- Modelling how emissions from source will disperse and how this will affect places of interest (usually residential).
- We are currently focusing our efforts on improving air quality on rigidly defined locations, such as the facades of residential properties.
- We typically consider population sensitivity to air pollution based on static data sets, such as address point data.
- It is rarely taken into account who lives there and where they actually spend their time.

- Are we best utilizing the information available to us?

# Examples of Research

- Many studies have shown differences between concentrations at residential addresses and personal exposure concentrations.
- Nazelle et. al. 2013 found using smartphone technology could substantially alter exposure estimates.
- Use of low cost, personal air pollution sensors to improve exposure estimates across different modes of transport (walking, cycling etc.)
- Bike courier studies
- “activity-weighted” approaches to estimating pollutant exposure (as alternatives to traditional “population-weighted” approaches)
- Online maps showing air pollution levels at roads or other locations such as green spaces across cities.

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# Big Data

Millions of data points

Multidimensional data

Too large/complex to utilize using traditional techniques

Variety of forms e.g. emails, photos, videos, social media posts

Data generated/growth very quick

# Big Data Examples

Mobile phone apps

Fitness wearables

Remote monitoring

Social Media

Home connection devices

Anonymously tracking individuals – routinely used to inform transport policy based on journey origin, destination and travel mode

# Big Data Challenges

Access to data sets

Ability to process / significant post processing

Data growth and change both rapid

Validation of data / reliability

Variation in data quality

Possibility of bias (e.g. socio economic)

Data may only represent fraction of population

Spatial accuracy of mobile data is limited

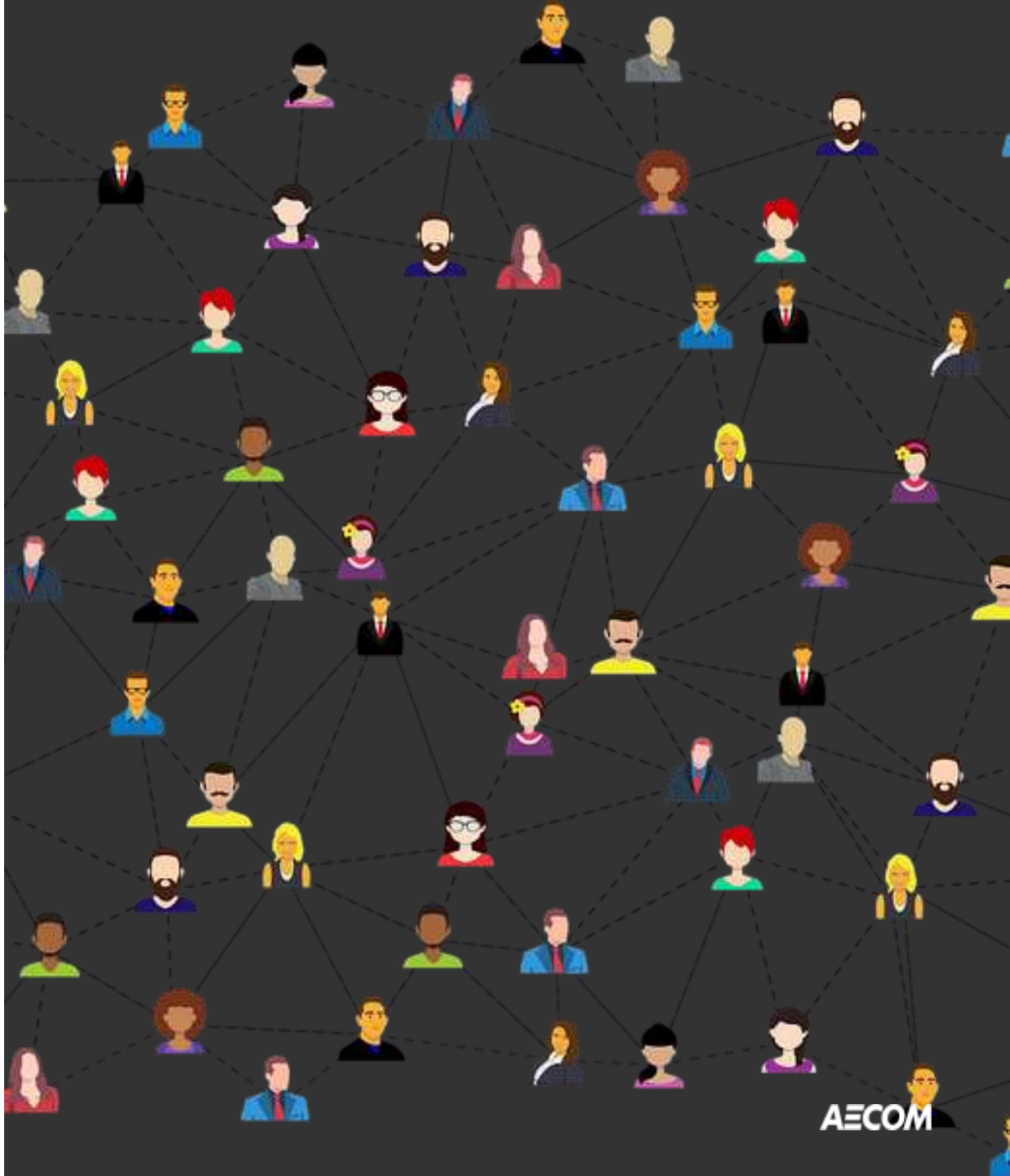
# Opportunities /Scalable Data

Mapping data already used (e.g. queuing)

Manually assign exposure bias; e.g. 9-hours at school in term, varying for land-use type.

Use of mobile phone data to fill in for missing transport information

Define links to sensitivity and socio-economic indices



# Opportunities/ Dream Big…

Apply individual data points to a population

Combine different indices

Ability to use multiple dimensions

Sensitivity tests that feedback into multiple factors e.g assessment of measures aimed at improving air quality

# Applications

WebTAG:

- Assigning exposure bias to land use may shift scores away from residences and towards commercial areas.

LAQM:

- Addition of social score

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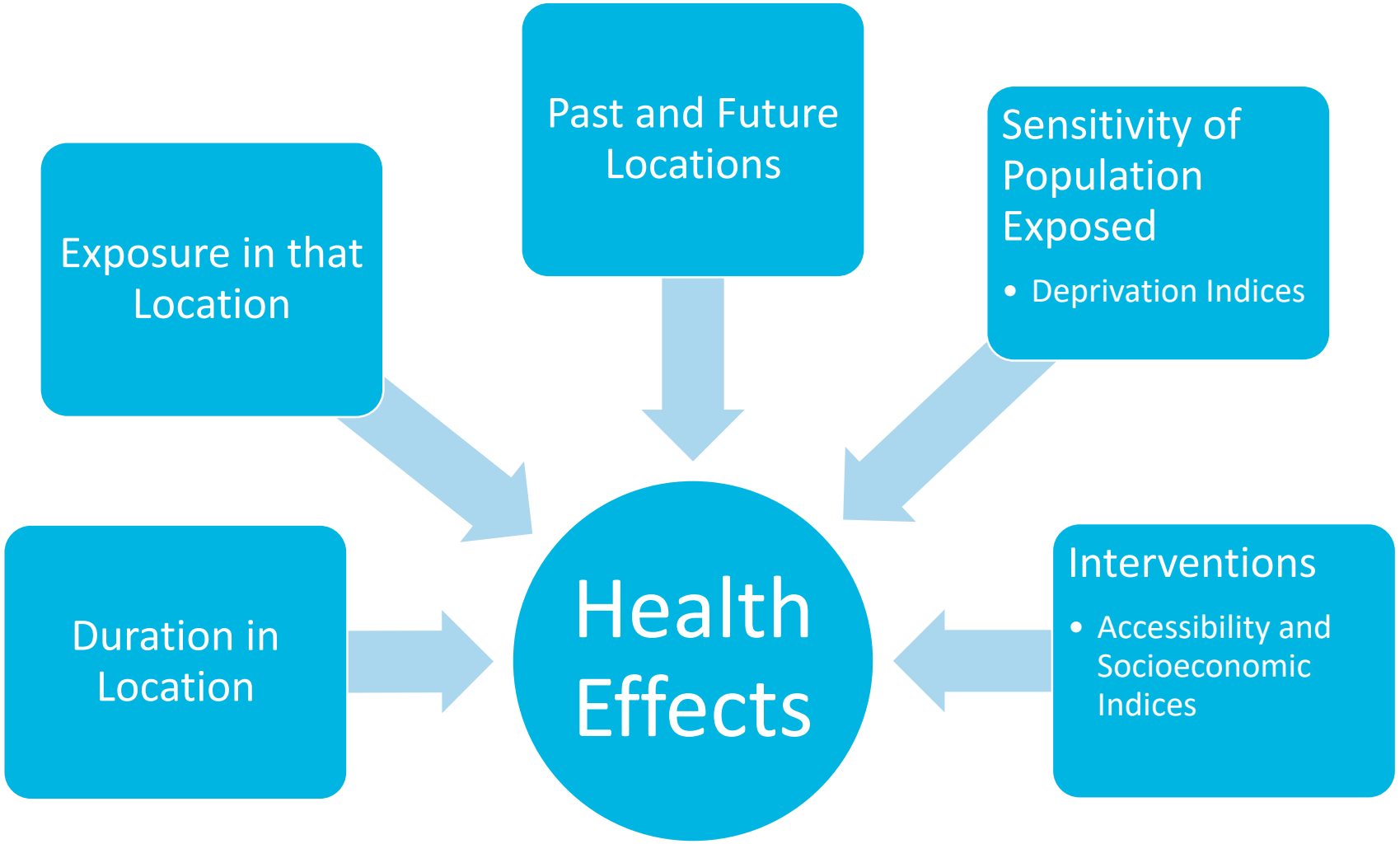
# How Can We More Accurately Represent Exposure?



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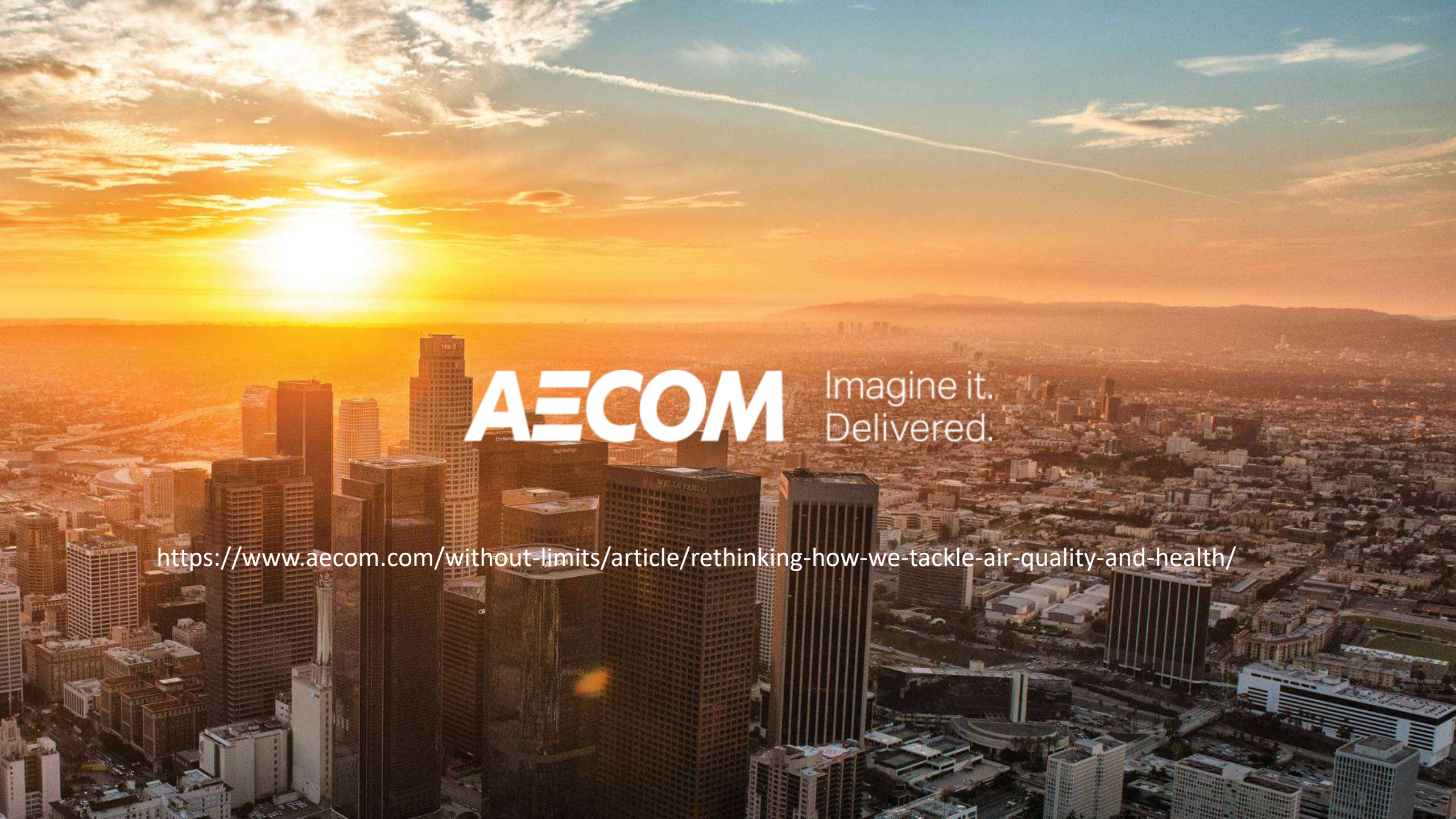
# What Should We Be Doing?

– As air quality professionals, we need to **re-focus on real-world human and environmental health responses** that are far more complex than mere compliance with statutory air quality limit values and thresholds.

– We know that exposure to pollutants varies with location and time, and that individual response is subject to multiple sociological factors. We also have **access to large data** sets and increasingly powerful computation which was barely conceivable just a few years ago.

– The combination of this knowledge and ability means we can really start to **change how the effects of air quality are appraised**, and subsequently how improvements can be prioritised.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