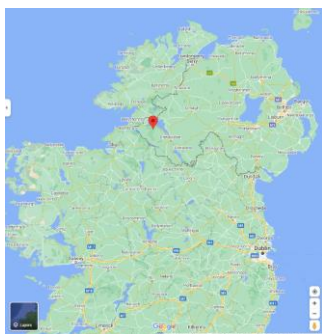# Creating a pathway towards the new WHO guidelines – what are the evidence gaps?

The updated World Health Organisation air quality guideline values are substantially lower than previous levels.

For fine particulate matter (PM$_{2.5}$), the new guideline value of 5 µg m^{-3} was exceeded in 2018 all AURN monitoring sites, with the exception of Lough Navar (Northern Ireland).

New WHO Global Air Quality Guidelines aim to save millions of lives from air pollution

Air pollution is one of the biggest environmental threats to human health, alongside climate change.

Table 0.1. Recommended AQG levels and interim targets

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
PM$_{2.5}$, µg/m³	Annual	35	25	15	10	5
	24-hour[a]	75	50	37.5	25	15
PM$_{10}$, µg/m³	Annual	70	50	30	20	15
	24-hour[a]	150	100	75	50	45
O$_3$, µg/m³	Peak season[b]	100	70	–	–	60
	8-hour[a]	160	120	–	–	100
NO$_2$, µg/m³	Annual	40	30	20	–	10
	24-hour[a]	120	50	–	–	25
SO$_2$, µg/m³	24-hour[a]	125	50	–	–	40
CO, mg/m³	24-hour[a]	7	–	–	–	4

[a] 99th percentile (i.e. 3–4 exceedance days per year).
[b] Average of daily maximum 8-hour mean O$_3$ concentration in the six consecutive months with the highest six-month running-average O$_3$ concentration.

The more we understand about the mechanisms from exposure to air pollution to adverse health effects, impacts are found even at levels (far) below current legal limit values

Long-term time series – from emissions to concentrations

- Cohort studies cover long time windows, with relevance of 'historic' exposures prior to the 1970s.
- Consistent, long-term air pollutant concentration datasets for epidemiological studies.

Carnell E, Vieno M, Vardoulakis S, Beck R, Heaviside C, Tomlinson S, Dragosits U, Heal M, Reis S (2019) Modelling public health improvements as a result of air pollution control policies in the UK over four decades – 1970 to 2010. *Environ Res Let* 14 074001, https://doi.org/10.1088/1748-9326/ab1542
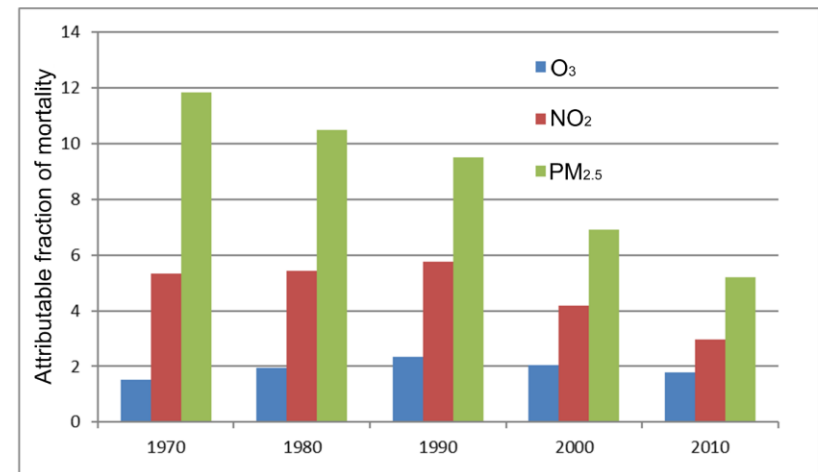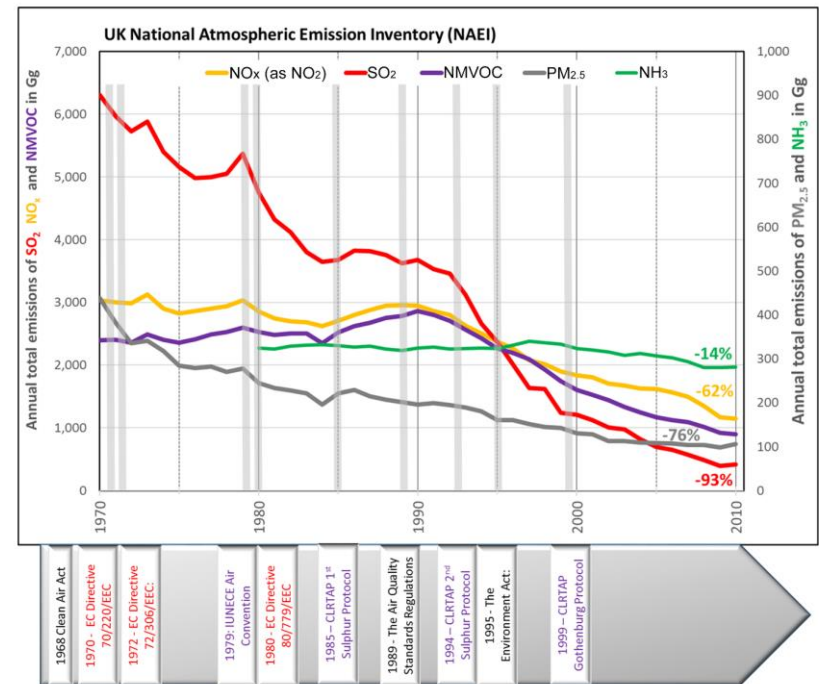
Evidence gaps regarding the role of atmospheric composition change, e.g.:

- Impacts of emission control scenarios on future inorganic secondary aerosol formation.

- Changes in the role of long-range transboundary air pollution in Europe/on UK air quality.

- Hemispheric atmospheric composition change and its influence on background levels of tropospheric ozone.

- Impacts of domestic NO_x/NMVOC emission reductions and UK tropospheric ozone formation under future climate scenarios.

- Contribution of natural/biogenic emissions to relevant AQ limit values in the view of further declining anthropogenic emissions.

Vieno M, Heal M, Twigg M, MacKenzie I, Braban C, Lingard J, Ritchie S, Beck R, Móring A, Ots R, Di Marco C, Nemitz E, Sutton MA, Reis S (2016) The UK particulate matter air pollution episode of March-April 2014: more than Saharan dust. Env Res Let 11(4)

Vieno M, Heal MR, Hallsworth S, Famulari D, Doherty RM, Dore AJ, Tang YS, Braban CF, Leaver D, Sutton MA, Reis S (2014) The role of long-range transport and domestic emissions in determining atmospheric secondary inorganic particle concentrations across the UK, Atmos Chem Phys 14, 8435-8447, https://doi.org/10.5194/acp-14-8435-2014.

Vieno M, Dore AJ, Stevenson DS, Doherty R, Heal MR, Reis S, Hallsworth S, Tarrason L, Wind P, Fowler D, Simpson D and Sutton MA (2010) Modelling surface ozone during the 2003 heat-wave in the UK, Atmos Chem Phys 10 7963-7978, https://doi.org/10.5194/acp-10-7963-2010.

UK Centre for Ecology & Hydrology

AQ evidence gaps beyond WHO targets?

- Multi-pollutant multi-effect assessments of health effects from air pollutant exposures.

- Emerging health impacts, e.g. cognitive/brain health.

- Airborne transmission of microplastics and other materials (e.g. AMR, metals, POPS, pathogens, …)

- Integrating human and ecosystem health impact assessment of atmospheric threats – considering consistently whole-environment impacts vs. siloed approaches for human health and other impacts?

- Air pollution and climate change interactions, in particular in relation to human health and well-being *(incl. socio-economics, inequalities)* – highly spatially and temporally variable

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Ecology & Hydrology
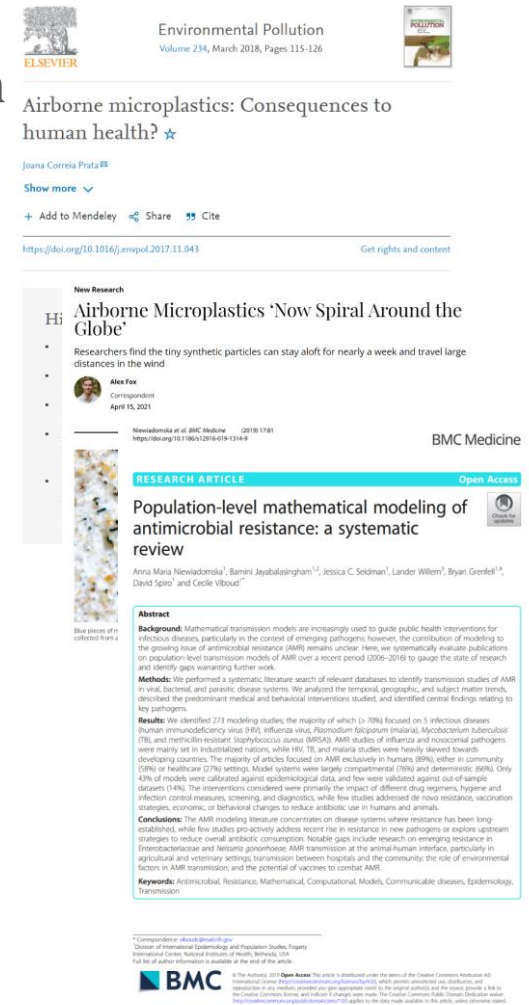
James Allan

University of Manchester & National Centre for Atmospheric Science

How do we measure PM$_{2.5}$ anyway?

- There are 4 MCERTS 'equivalent' PM$_{2.5}$ measurements:
  - FDMS TEOM
  - Beta attenuation
  - FIDAS (optical)
  - Gravimetric analysis of filters (reference method)
- The certification process is designed around getting concentrations below 25 μg m^{-3} – agreement is less good at lower concentrations!
- Semivolatile material (e.g. ammonium nitrate) is sometimes difficult to measure, especially by the reference method!
- Other particle types difficult to measure (e.g. small particles in FIDAS)
- Challenge for the instrumentation and metrology communities

Secondary organic aerosols

- Major topic of research for over 20 years, still not solved
- Can form around half of $PM_{2.5}$ but formed from a mix of biogenic and anthropogenic precursors
- Predictive capability is better than it was but still not perfect

- How will yields be affected by reductions in NO_x? (less peroxy termination)
- What about SOA from household products?
- How will biogenic emissions be affected under climate change?

Cooking

- Known to be a significant contribution to urban PM, but poorly represented in models

- Where are the sources and how strong are they?

- How long do cooking aerosols persist in the atmosphere given components (e.g. oleic acid) are semivolatile and/or chemically reactive?

Non exhaust emissions

- Brake wear, tyre wear and road dust resuspension are becoming the major primary particulate emissions from vehicles
- Poorly constrained in terms of measurements and models

- What size are the particles ($PM_{2.5}$ vs PM_{10} vs TSP)?
- How do we best measure them?
- Can we mitigate these through technical developments?

Wood stoves

- Single biggest source of primary $PM_{2.5}$ in the UK
- Emissions highly variable and uncertain
- Could be producing SOA, but again uncertain

- How much of a difference did the adoption of Ecodesign stoves and kiln dried wood make?
- How much emissions are caused by user behaviour, e.g. burning wet or waste wood, not operating the stove correctly, etc.?
- What emissions can we expect from novel manufactured fuels?
- Can technical developments continue to improve emissions?

Towards WHO guidelines

➢ Measurement challenge

➢ Mitigation challenge

➢ Equity challenge

➢ Prioritisation challenge

Environment Agency

EPUK @ The Clean Air Futures Group,
Creating a pathway towards the new WHO guidelines, 20/1/22

About EPUK: Environmental Protection UK is a national charity, with a vision for _a cleaner, healthier and more tranquil environment for all in the UK_.

Our membership is mostly drawn from environmental professionals, bringing together policy-makers, business, local authorities, third sector groups and academics, to foster partnerships for environmental action.

We provide expert policy analysis and information, including guidance, briefing notes and leaflets, on air quality, land quality and noise. We share best practice and support our members to deliver effective environmental protection.

Our current work includes a project on Air Quality & Climate Change interactions, focussing on the need for a coordinated approach and options for practical actions by local authorities and others; this project complements the recent & ongoing top-down work on air quality impacts of Net Zero.

Other work includes lobbying for effective environmental legislation and implementation, a robust Local Air Quality Management system, and supporting our Air Quality & Development Control planning guidance (produced with IAQM).

www.environmental-protection.org.uk
secretariat@environmental-protection.org.uk

EPUK @ The Clean Air Futures Group,
Creating a pathway towards the new WHO guidelines, 20/1/22

- We welcome the new WHO Guidelines for air quality. They show the urgent need for ambitious action to protect health, and should help drive this.

- We note that achieving the guidelines will be difficult. (Also that the existing limit values and objectives based on health and achievability are still exceeded)

- We need a narrative that strongly encourages action, without the guidelines seeming alienatingly impossible. This will be a find line to tread. Air quality research will be key here.

- Looking forward to CAF/Imperial work and Defra work on pathways to achieving compliance with 2005 guidelines.

- Further query around whether the new guidelines (and any standards based on them) will change the priorities for action, and if so how? Are there measures (current or proposed) which we should or shouldn't pursue?

- There are opportunities to capture co-benefits (and optimise) for air quality with climate change action.

Sarah Legge, Chair of the Air Quality Committee, sarah@slhenvironmental.co.uk

Creating a pathway towards the new WHO guidelines – what are the evidence gaps?
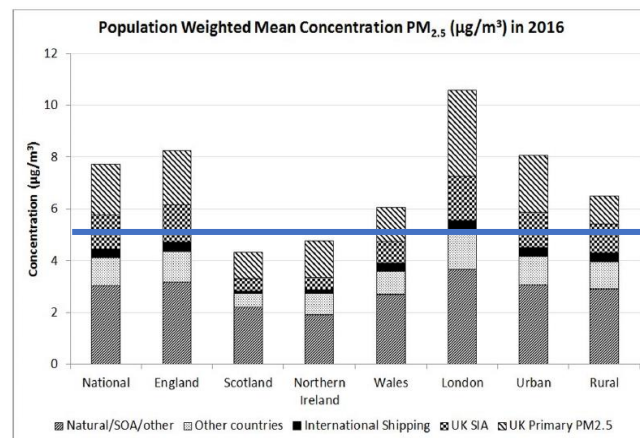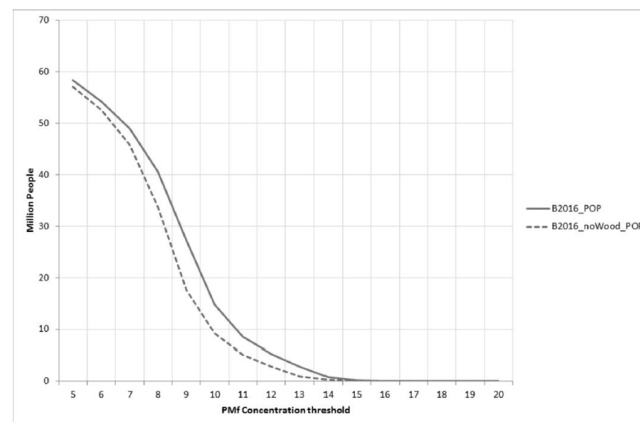
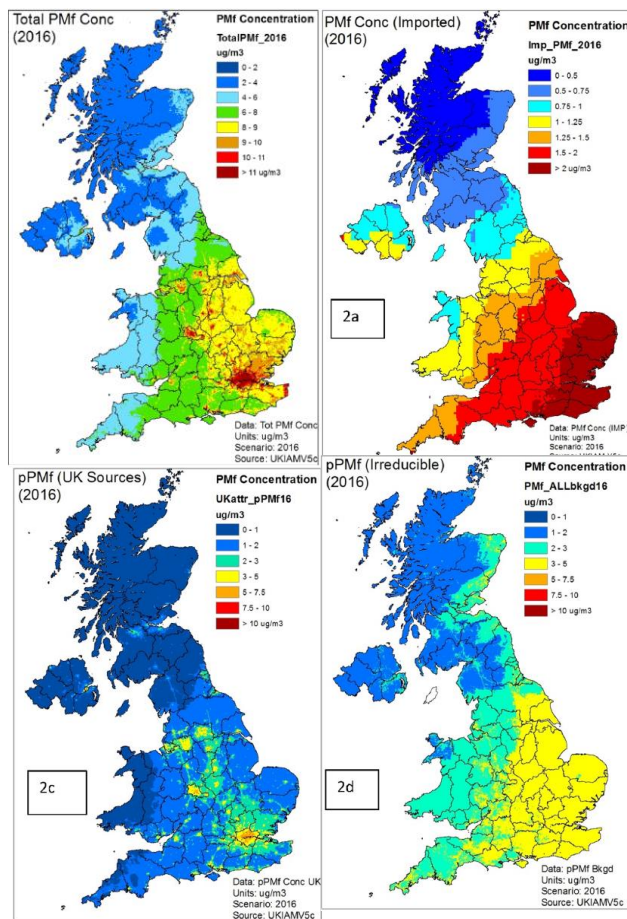**Dr Matt Loxham**

BBSRC David Phillips Fellow

University of Southampton

20th January 2022
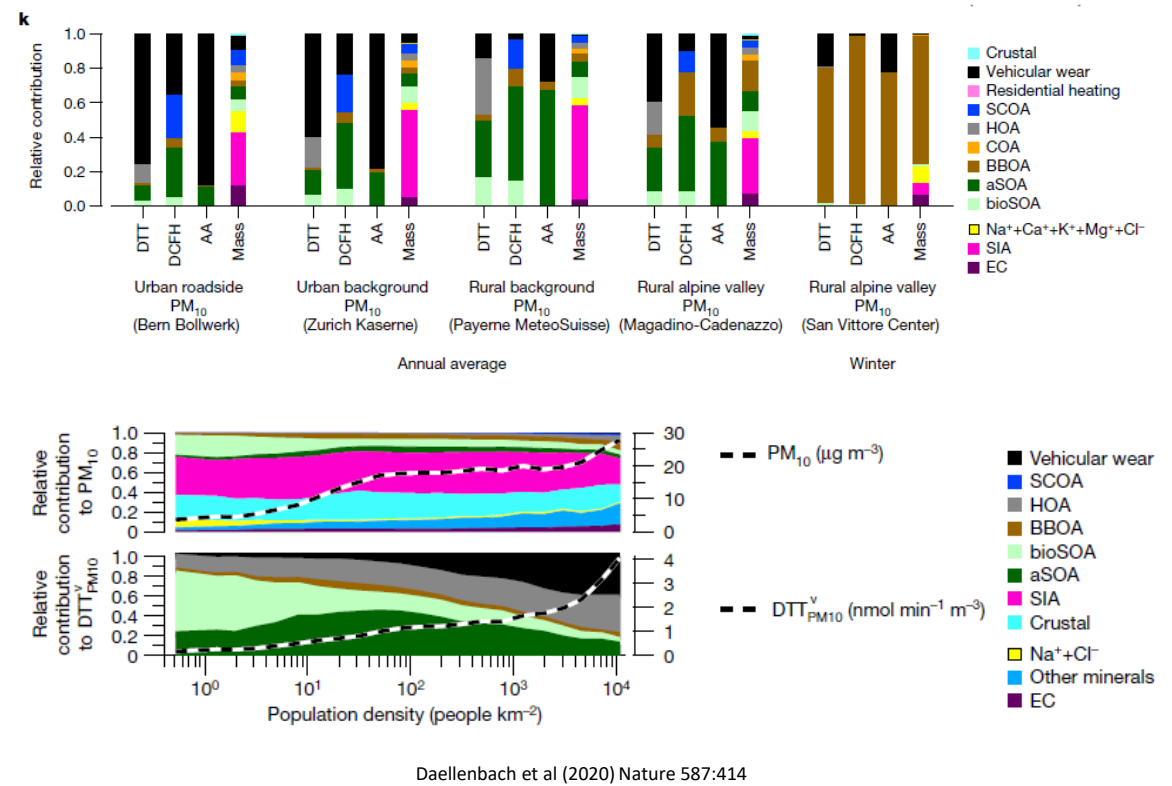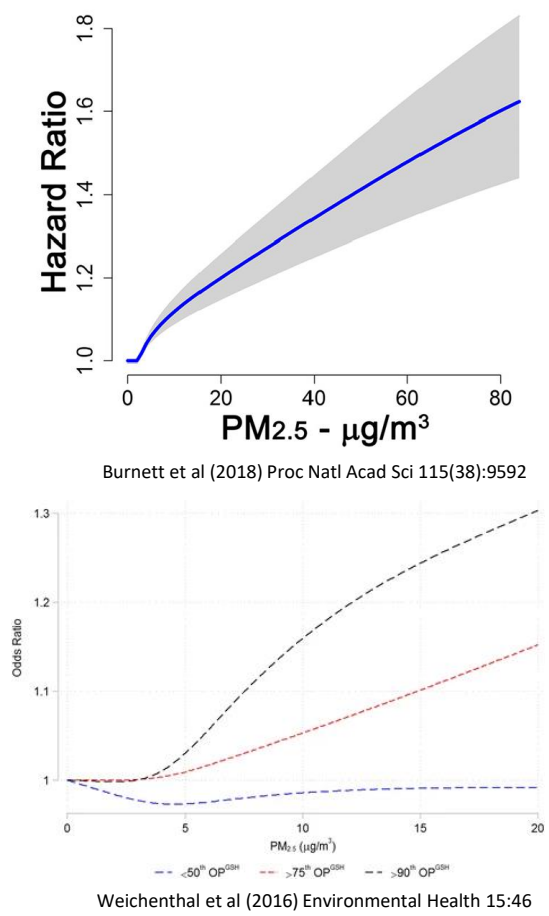
Where does PM come from?

**UK
Integrated
Assessment
Model
(UKIAM)**

ApSimon et al (2021)
Environment International
153:106515

**The majority of the UK population are exposed to PM2.5 > new WHO guidelines, but a significant portion of this not from UK primary sources.**

Is PM mass the most appropriate metric?

Burnett et al (2018) Proc Natl Acad Sci 115(38):9592

Weichenthal et al (2016) Environmental Health 15:46

Daellenbach et al (2020) Nature 587:414

Contributors to PM10 mass and PM10 oxidative potential can be quite different

Specific source considerations

PM2.5

PM10

From Diesel to:
BEV 0% regen
BEV 90% regen
BEV 100% regen
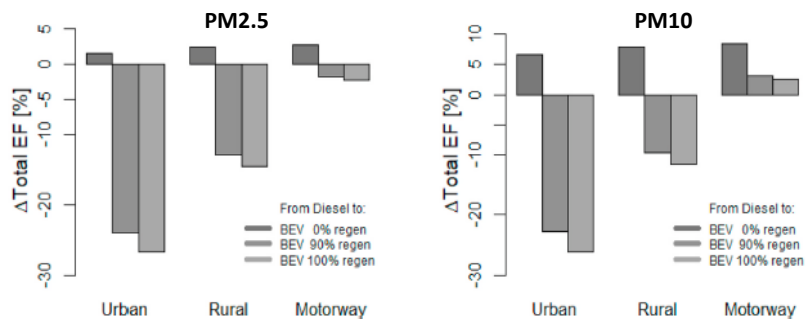
Beddows and Harrison (2021) Atmos Environ 244:117886

Anthropogenic PM → traffic-related PM → non-exhaust PM → brakewear PM → specific brakepad type
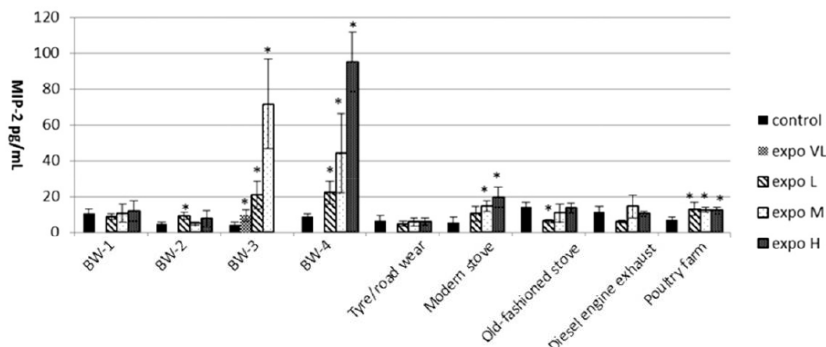
Gerlofs-Nijland et al (2019) Inhalation Toxicology 31(3):89

Shipping Movements
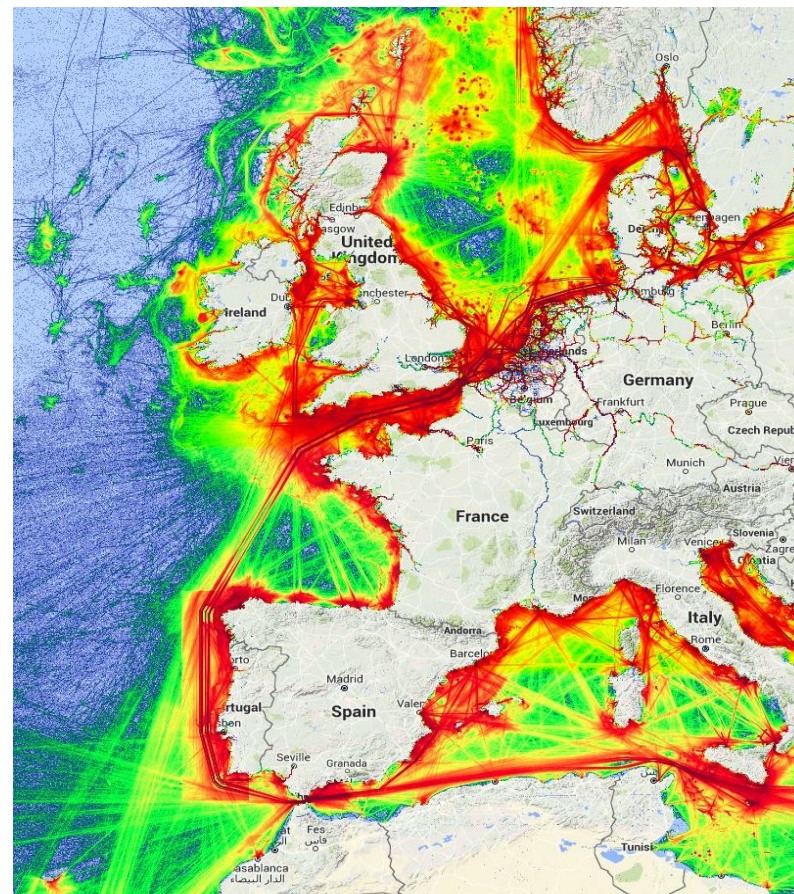
"Transboundary" impacts
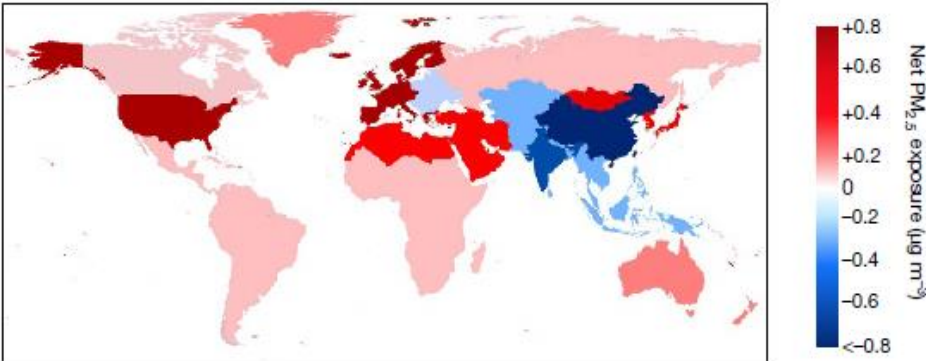
Zhang et al (2017) Nature 543:705

Air pollution can travel across borders (transboundary) but can also be "imported" and "exported" through differential locations of production and consumption of goods

A local perspective

Question 1a. To what extent do you think air quality is a problem in Southampton?

5%
18%
2%
32%
44%

- 22% Not much or not a problem
- 2% Don't know
- 75% A fairly or very big problem
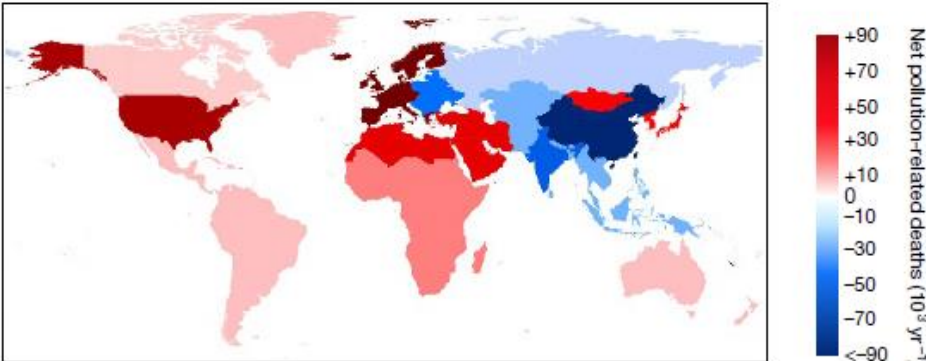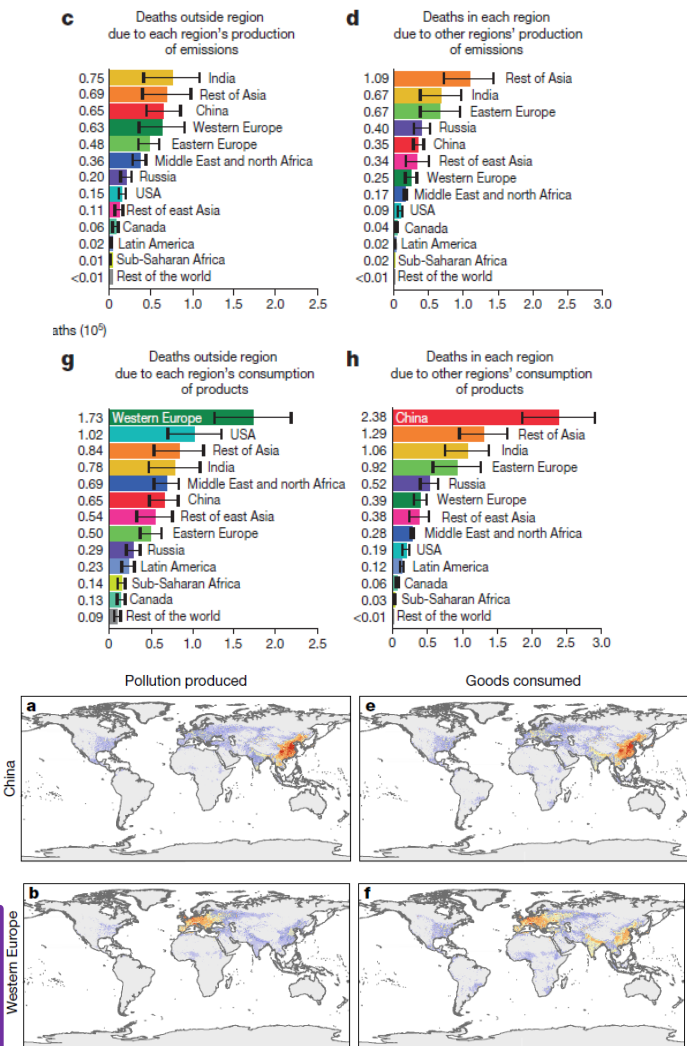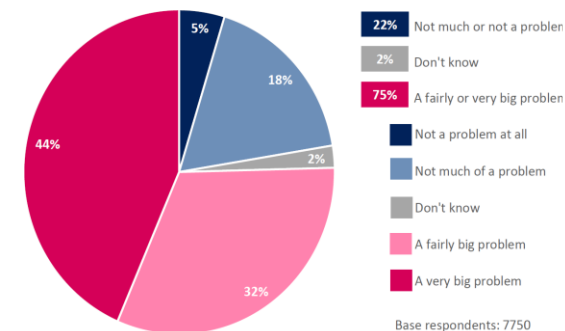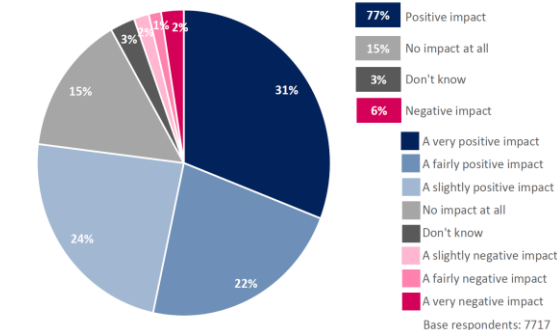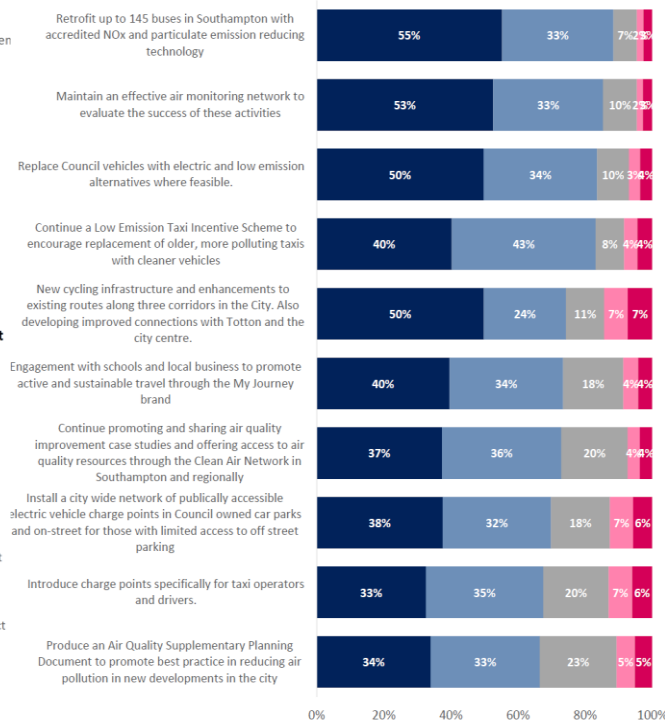- Not a problem at all
- Not much of a problem
- Don't know
- A fairly big problem
- A very big problem

Base respondents: 7750

Question 10. To what extent do you agree or disagree that the following additional proposed activity will improve air quality in Southampton?

Activity					
Retrofit up to 145 buses in Southampton with accredited NOx and particulate emission reducing technology	55%	33%	7%	2%	2%
Maintain an effective air monitoring network to evaluate the success of these activities	53%	33%	10%	2%	2%
Replace Council vehicles with electric and low emission alternatives where feasible.	50%	34%	10%	3%	4%
Continue a Low Emission Taxi Incentive Scheme to encourage replacement of older, more polluting taxis with cleaner vehicles	40%	43%	8%	4%	4%
New cycling infrastructure and enhancements to existing routes along three corridors in the City. Also developing improved connections with Totton and the city centre.	50%	24%	11%	7%	7%
Engagement with schools and local business to promote active and sustainable travel through the My Journey brand	40%	34%	18%	4%	4%
Continue promoting and sharing air quality improvement case studies and offering access to air quality resources through the Clean Air Network in Southampton and regionally	37%	36%	20%	4%	4%
Install a city wide network of publically accessible electric vehicle charge points in Council owned car parks and on-street for those with limited access to off street parking	38%	32%	18%	7%	6%
Introduce charge points specifically for taxi operators and drivers.	33%	35%	20%	7%	6%
Produce an Air Quality Supplementary Planning Document to promote best practice in reducing air pollution in new developments in the city	34%	33%	23%	5%	5%

0%   20%   40%   60%   80%   100%

Question 6. What do you think about the proposed daily charges for non-compliant Heavy Goods Vehicles?

6%
8%
39%
14%
17%
16%

- 14% Slightly or far too low
- 39% The right amount
- 47% Slightly or far too high or there should be no charge
- Far too low
- Slightly too low
- The right amount
- Slightly too high
- Far too high
- There should be no charge

Base respondents: 7624

Question 11. What impact do you feel the preferred option for a Clean Air Zone might have on the following? Health impacts

31%
22%
24%
15%
3%
2% 1% 1% 2%
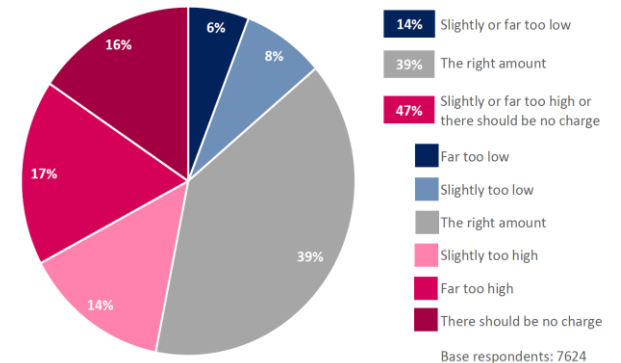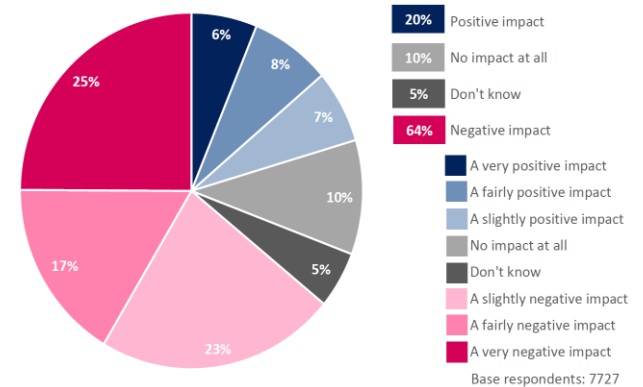
- 77% Positive impact
- 15% No impact at all
- 3% Don't know
- 6% Negative impact
- A very positive impact
- A fairly positive impact
- A slightly positive impact
- No impact at all
- Don't know
- A slightly negative impact
- A fairly negative impact
- A very negative impact

Base respondents: 7717

Question 11. What impact do you feel the preferred option for a Clean Air Zone might have on the following? Economic impact on the port or city

6%
8%
7%
10%
5%
23%
17%
25%

- 20% Positive impact
- 10% No impact at all
- 5% Don't know
- 64% Negative impact
- A very positive impact
- A fairly positive impact
- A slightly positive impact
- No impact at all
- Don't know
- A slightly negative impact
- A fairly negative impact
- A very negative impact

Base respondents: 7727

Southampton City Council (2018) Consultation feedback on proposals for a Clean Air Zone in Southampton

InSPIRE

Innovating UK clean air policies
to prevent cognitive disorders

InSPIRE's vision is for everyone in the UK to be able to breathe clean air that promotes a healthy brain and cognitive life regardless of where they live.

Headline News!

3 | The impact of air quality on brain health

Reviewed 69 epidemiological studies – 2006 to 2019

Current evidence suggests:

- Air pollution is causally associated with cognitive impairment and dementia.

- A biological gradient most likely exists.

- The magnitude of exposure-response is often small but significant.

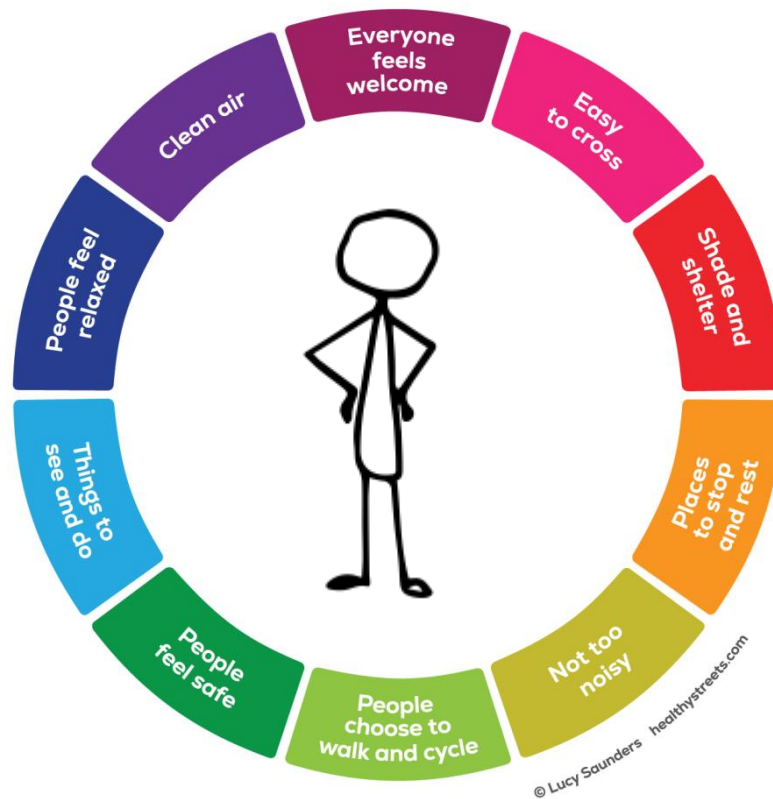# Taking a Healthy Streets Approach

Lucy Saunders

lucysaunders@healthystreets.com

The 10 Healthy Streets Indicators

Everyone feels welcome

Easy to cross

Shade and shelter

Places to stop and rest

Not too noisy

People choose to walk and cycle

People feel safe

Things to see and do

People feel relaxed

Clean air

GREENGROCER

CAFE

PLUMBERS

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Healthy Streets®

All these factors influence how people feel

Everyone feels welcome · Easy to cross · Shade and shelter · Places to stop and rest · Not too noisy · People choose to walk and cycle · People feel safe · Things to see and do · People feel relaxed · Clean air

© Lucy Saunders healthystreets.com

Healthy Streets®

The big health impacts of urban transport

Clean air

Easy to cross

People feel safe

Not too noisy

© Lucy Saunders   healthystreets.com
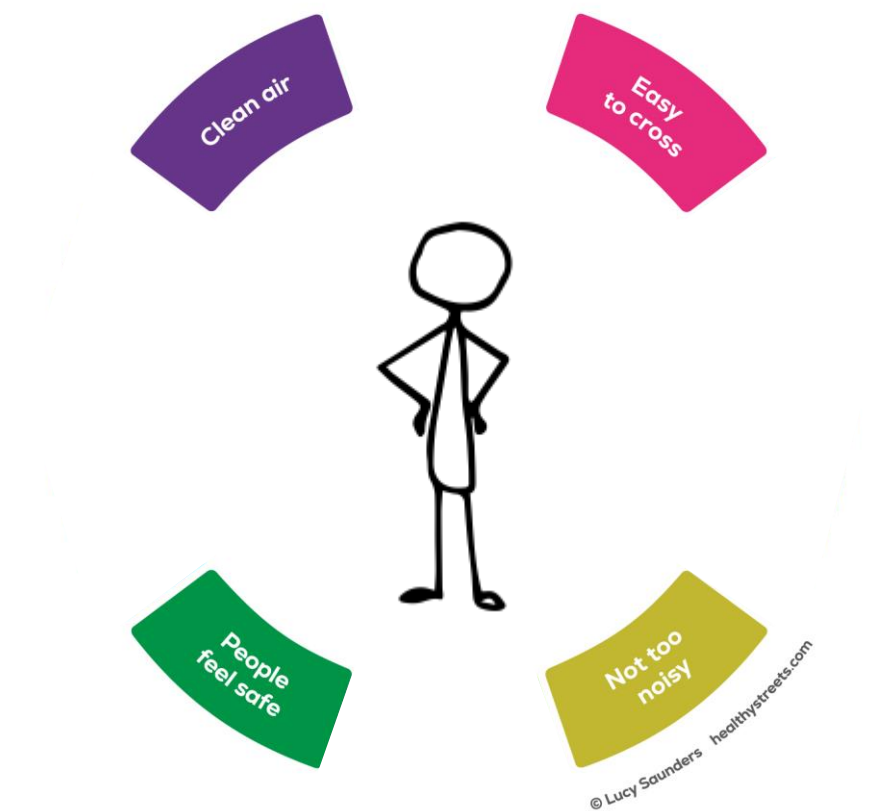
Healthy Streets®

Everyone needs an accessible environment to be active everyday

The environment needs to be pleasant too

People feel relaxed

Things to see and do

Shade and shelter

Places to stop and rest
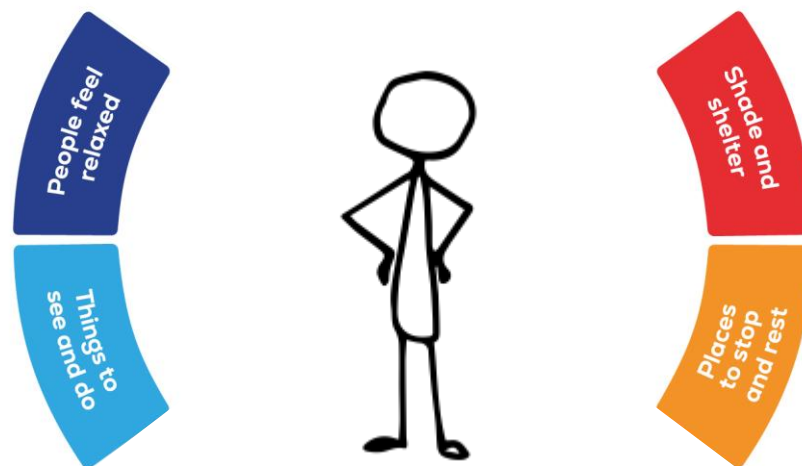
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Healthy Streets®

Welcoming & accessible for all

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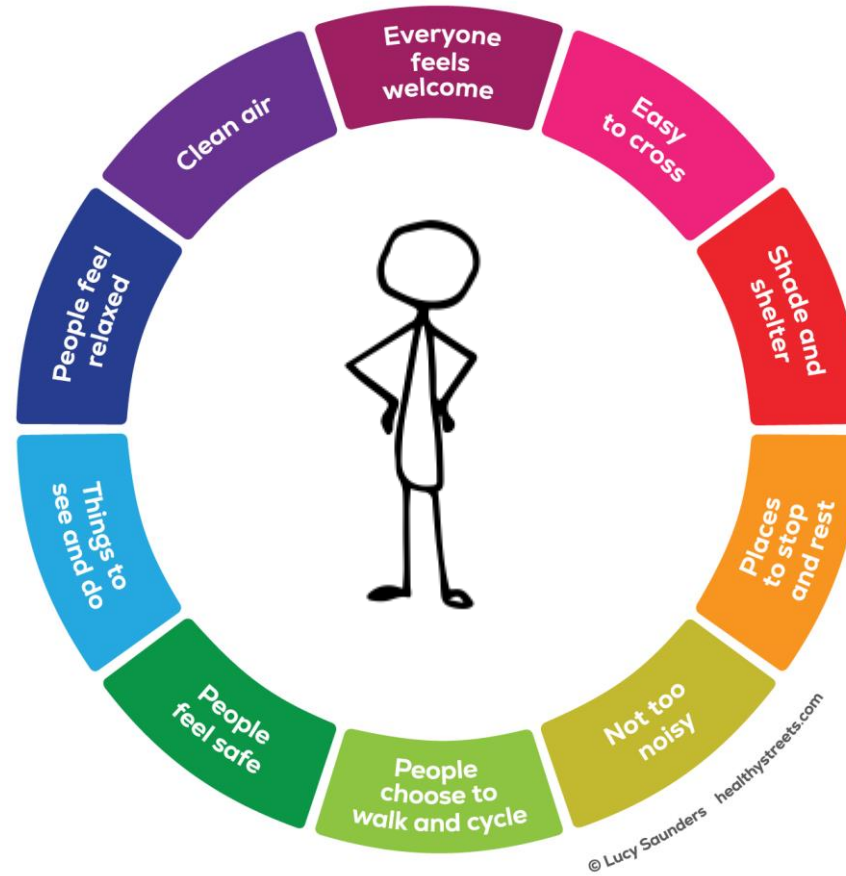
The 10 Indicators are interdependent

Source: Lucy Saunders

Healthy Streets®

The 10 Healthy Streets Indicators
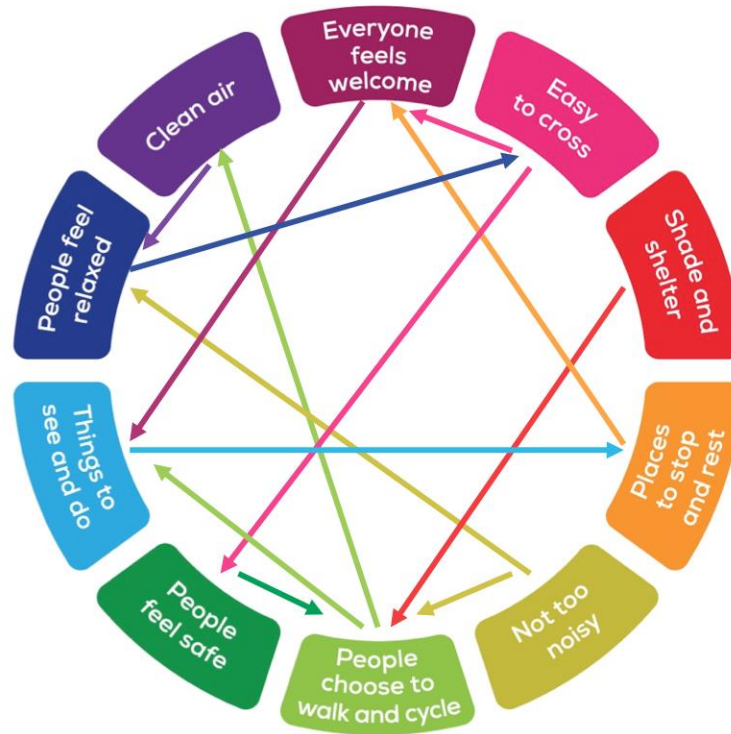
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Thanks

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www.healthystreets.com

Creating a pathway towards the new WHO guidelines
What are the evidence gaps

Ruth Calderwood
Air Quality Manager, City of London Corporation

cityair@cityoflondon.gov.uk
@_CityAir

Some evidence gaps

- Detailed source apportionment - localised
- PM characterisation / speciation eg metals, black carbon, nitrates
- Who has the levers to control emissions
- Where are the gaps in the above
- Where will net zero take us and when
- Are current $PM_{2.5}$ analysers accurate enough to measure $5\mu g/m^3$
- How are the biggest health benefits obtained
- How will lower NO_2 impact on urban O_3