Air Quality and Public Health Challenges

GLOBAL CENTRE FOR CLEAN AIR RESEARCH

UNIVERSITY OF SURREY

Professor Prashant Kumar

Chair in Air Quality and Health
Founding Director, Global Centre for Clean Air Research (GCARE)
Department of Civil & Environmental Engineering
University of Surrey, United Kingdom

Adjunct Professor, Trinity College Dublin, Ireland

@AirPollSurrey @pk_shishodia

Outline

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

GCARE: Team & Research

COVID-19 Context & RAMP T7

Air Quality Trends

Summary

GCARE....thanks to team/collaborators

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

GCARE team

@AirPollSurrey @pk_shishodia @GuildfordLL

Visit Website

surrey.ac.uk/gcare

Acknowledgements

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

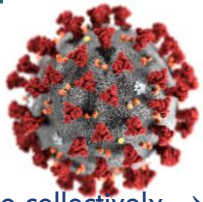
Thanks to our research sponsors, GCARE team and research collaborators…

ESRC Economic & Social Research Council
EPSRC Engineering and Physical Sciences Research Council
NERC
FAPESP São Paulo Research Foundation
Santander
Qatar National Research Fund Member of Qatar Foundation
UGPN
NWO Netherlands Organisation for Scientific Research
Kuwait Institute for Scientific Research
European Commission
Newton-Bhabha Fund
Commonwealth Scholarships
British Council

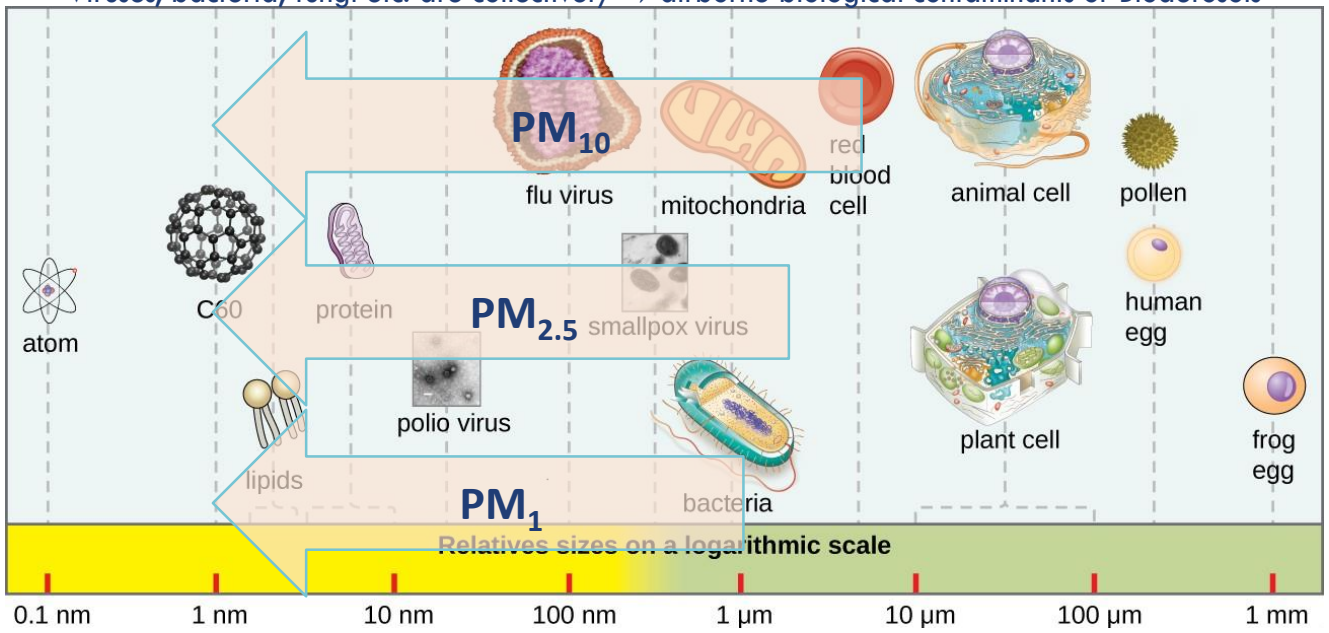
UKRI Innovate UK — Pollution Guardian & Global Home
UKRI Engineering and Physical Sciences Research Council — INHALE — COVAIR & CO-TRACE
UKRI Natural Environment Research Council — ASAP-Delhi
UKRI UK Research and Innovation — GCRF — NOTS & CArE-Cities
UGPN — SCAN
OPERANDUM
iSCAPE

Viruses and aerosol particles…

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY



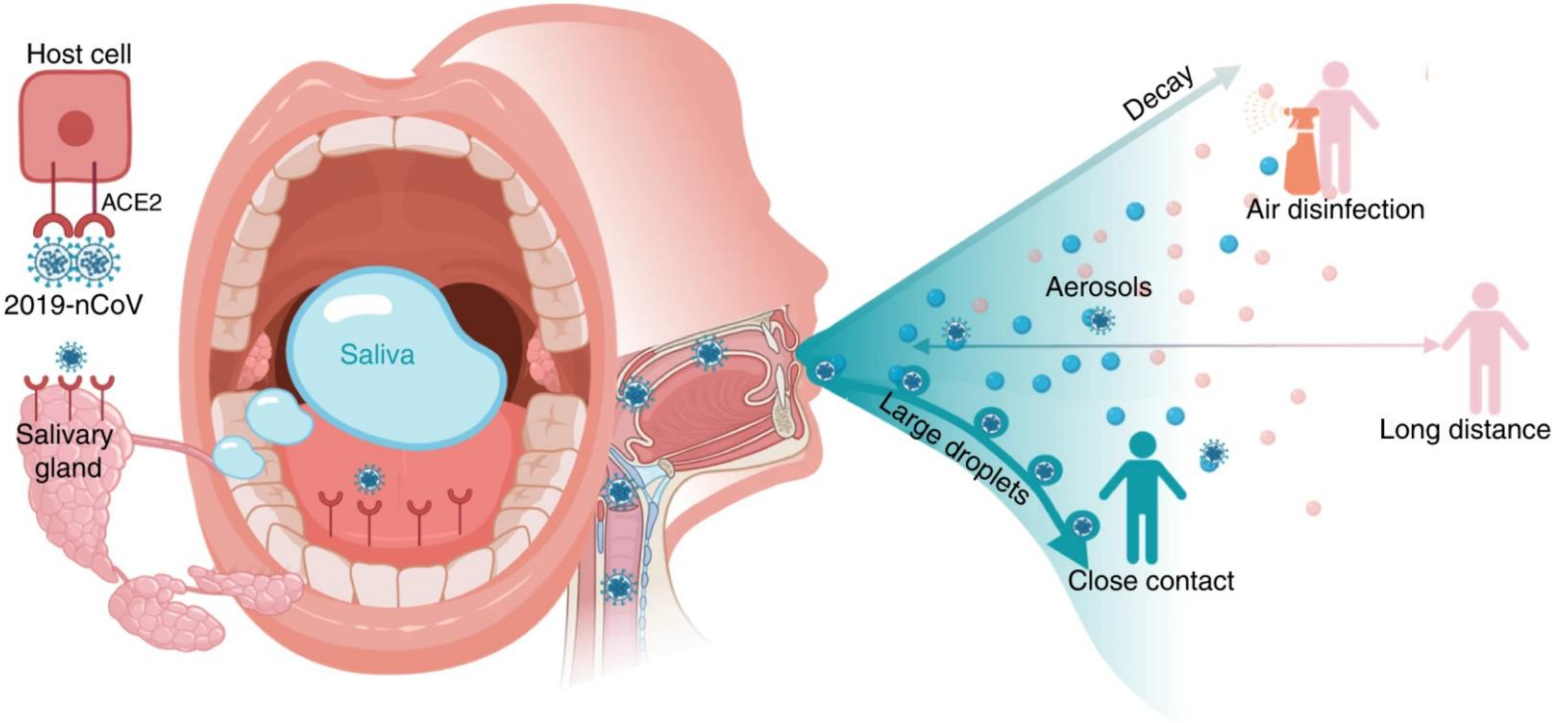
Viruses, bacteria, fungi etc. are collectively → airborne biological contaminants or Bioaerosols



Source: https://courses.lumenlearning.com/microbiology/chapter/viruses/

Pathways.....

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY



Source: https://www.nature.com/articles/s41368-020-0080-z/figures/1

Droplet v/s Bio/aerosols…..

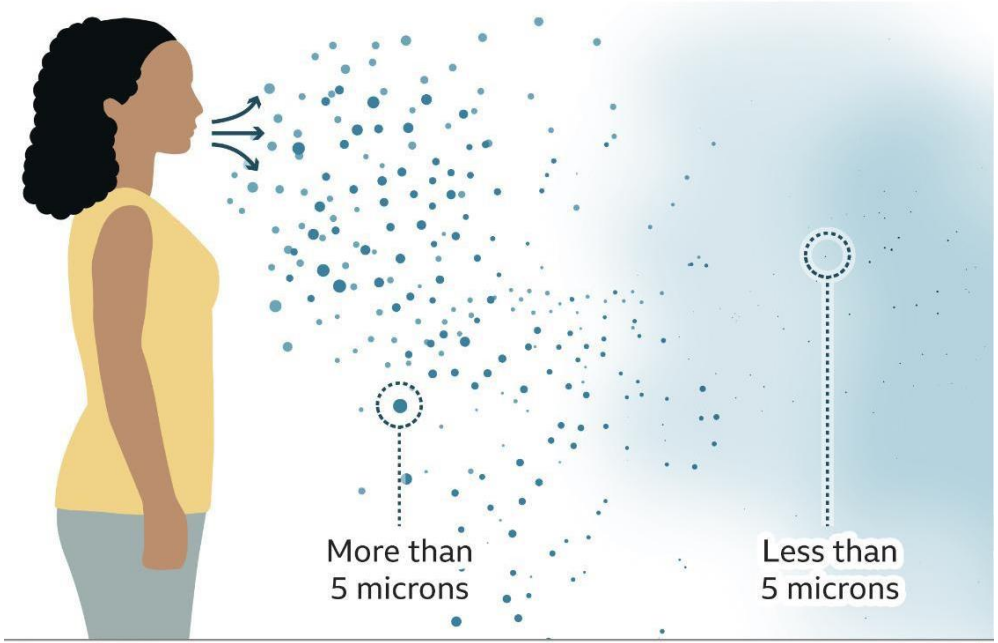
GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

Droplet transmission

When droplets of saliva or mucus from coughing and sneezing reach someone else's eyes, nose or mouth

Airborne transmission

Tiny particles suspended in the air for longer, travel further and can be breathed in by someone else



Airborne transmission was not recognised..

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

April 2020

City and Environment Interactions 4 (2019) 100033

Contents lists available at ScienceDirect

City and Environment Interactions

journal homepage: www.elsevier.com/locate/cacint

Research Article

Could fighting airborne transmission be the next line of defence against COVID-19 spread?

Prashant Kumar [a,*], Lidia Morawska [b]

[a] Global Centre for Clean Air Research (GCARE), Department of Civil and Environmental Engineering, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford GU2 7XH, United Kingdom
[b] International Laboratory for Air Quality and Health (ILAQH), School of Earth of Atmospheric Sciences, Queensland University of Technology, Brisbane, Queensland 4001, Australia

06 July 2020

ACCEPTED MANUSCRIPT

It is Time to Address Airborne Transmission of COVID-19

Lidia Morawska, Donald K Milton

Clinical Infectious Diseases, ciaa939, https://doi.org/10.1093/cid/ciaa939
Published: 06 July 2020 **Article history**

WHO acknowledges airborne transmission of coronavirus in closed settings, and asymptomatic spread

JULY 10, 2020

10 July 2020

Questions [RAMP T7, Case Studies]

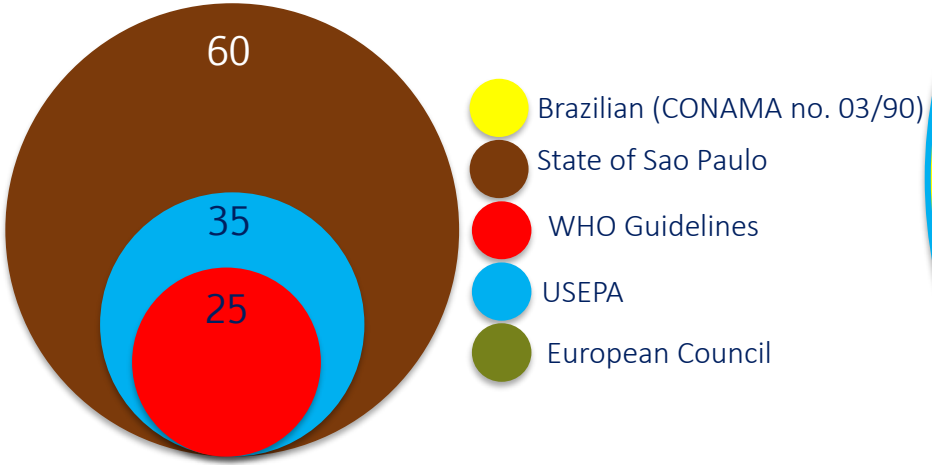
GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

- **How important is airborne transmissions in built spaces? The smaller-sized particles will remain suspended in air for longer time and a lack of adequate ventilation may increase vulnerability of exposure to virus-liaden particles.**
- **What is intensity of aerosol versus non-aerosol (e.g. surfaces) spread?**
- **Is partitioning rooms/office spaces/restaurants effective in reducing spread?**
- **Does the specific locations (e.g., queuing outside/inside) increase the vulnerability of exposure?**
- **Are people more vulnerable to spread in trains compared with platforms?**
- **Social distancing rule outdated and varied – 1m, 1m+, 2m – they cannot offer >20-30% usage of space; are there ways to increase the capacity (e.g., reduced distance, increased ventilation, germicides and masks etc).**
- **Supermarkets are diverse layouts – approaches for modelling people, flow and aerosol dispersion that can allow some generalisation?**
- **What full scale experiments can be done for generalisation of results in enclosed spaces, e.g. supermarkets/trains?**

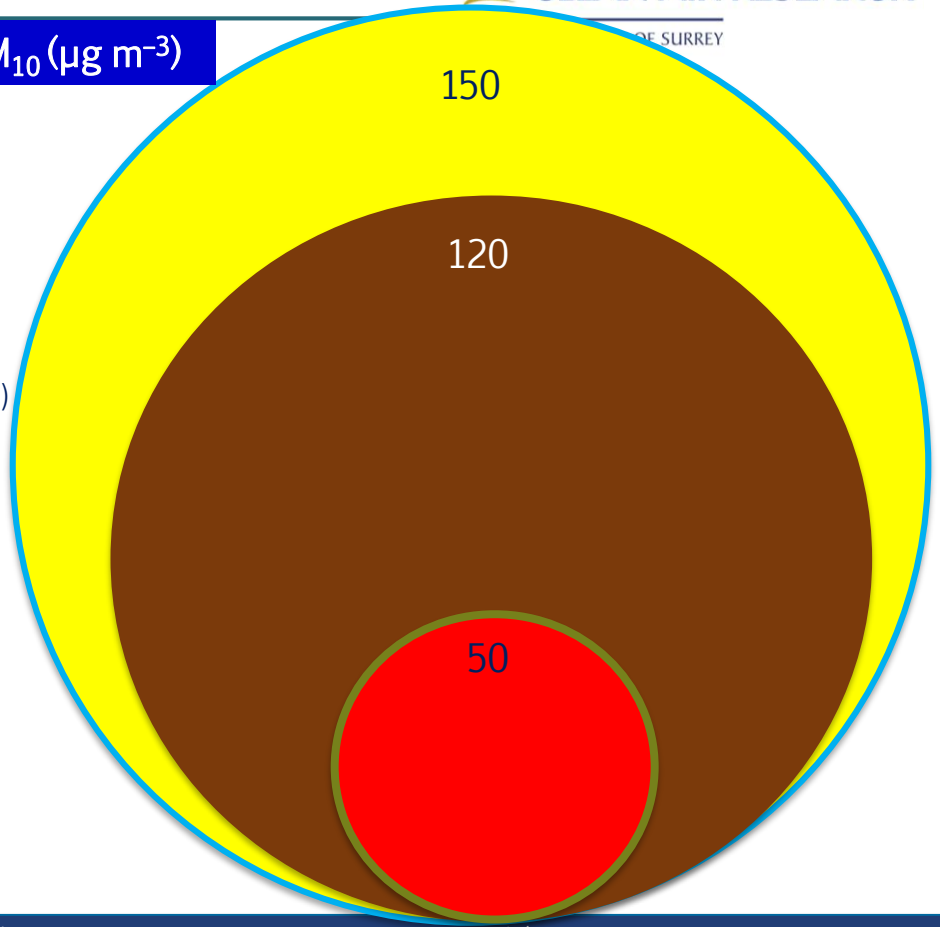
Limit values

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
OF SURREY

24-h $PM_{2.5}$ (µg m^{-3})



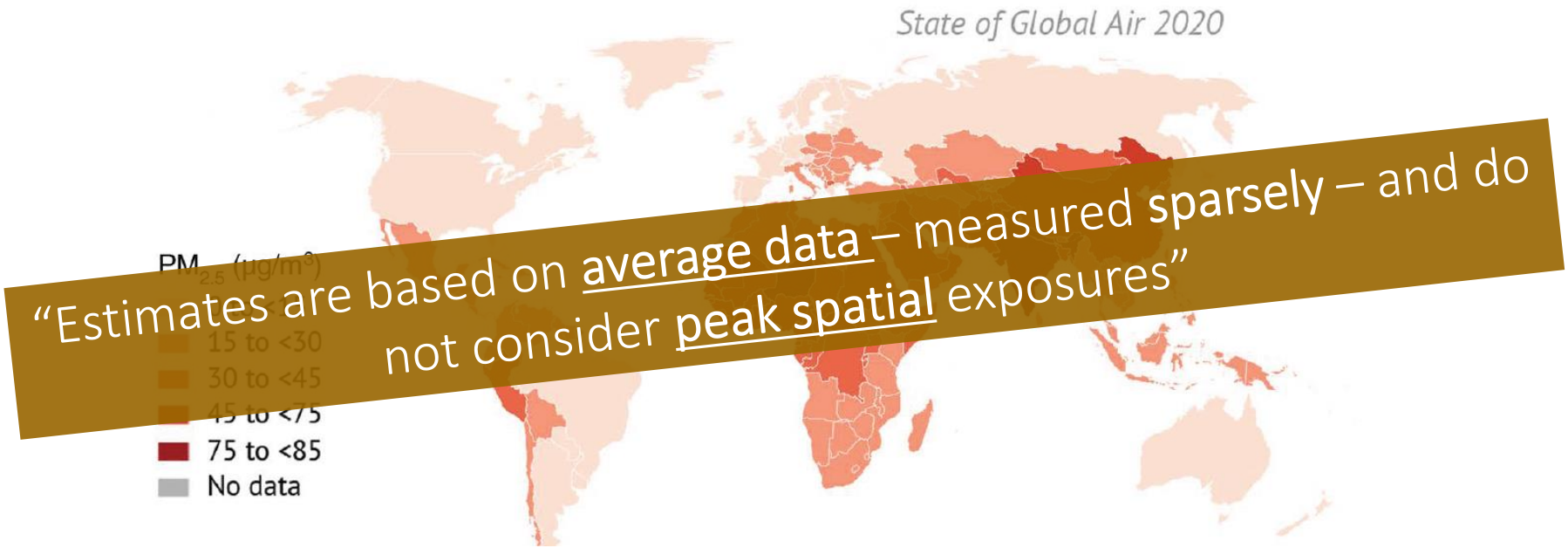
24-h PM_{10} (µg m^{-3})



Pollution distribution….

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

FIGURE 2 Global map of population-weighted annual average $PM_{2.5}$ concentrations in 2019.



"Estimates are based on average data – measured sparsely – and do not consider peak spatial exposures"

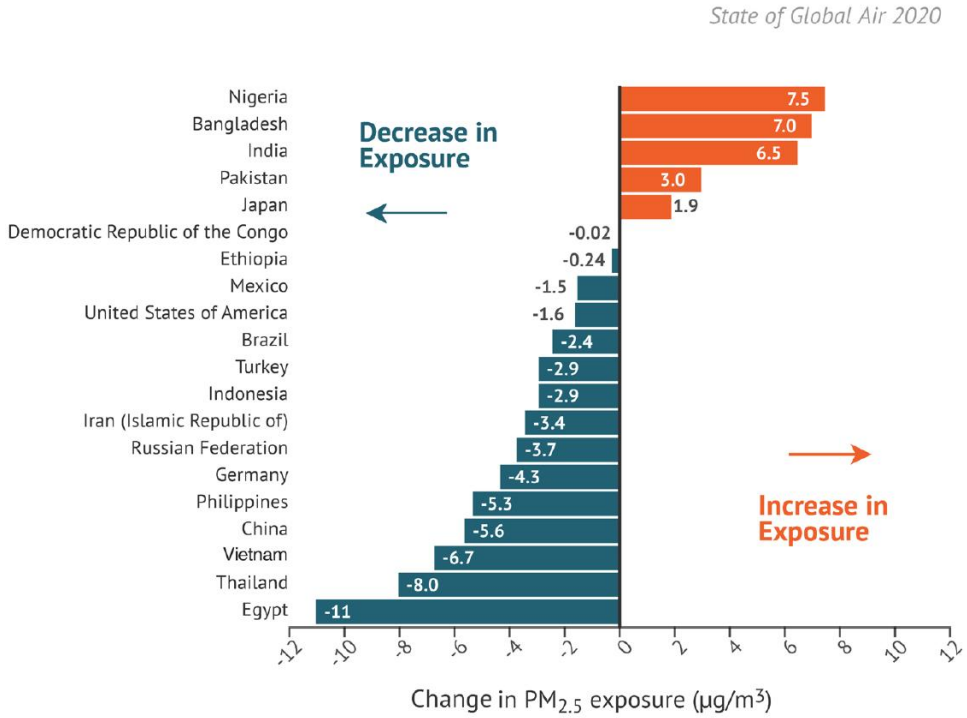
"Over 90% of population in 2019 live in areas where outdoor **fine particulate matter** concentrations exceed the **World Health Organization's Air Quality Guideline** of 10 µg/m^3"

Source: https://www.stateofglobalair.org/

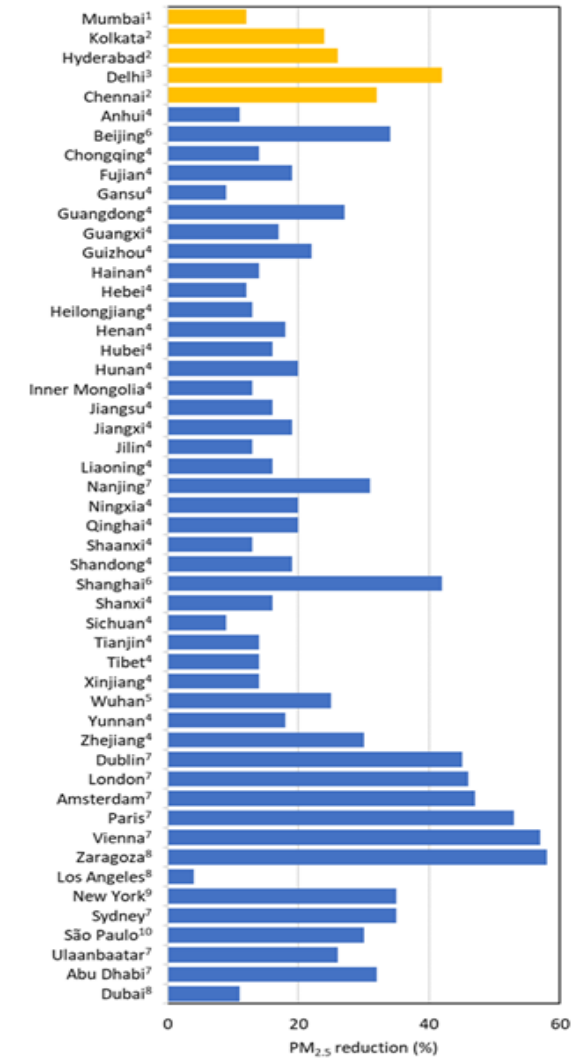
Exposure trend....

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

FIGURE 4 Change in population-weighted annual average $PM_{2.5}$ exposure in the 20 most populous countries, 2010–2019.

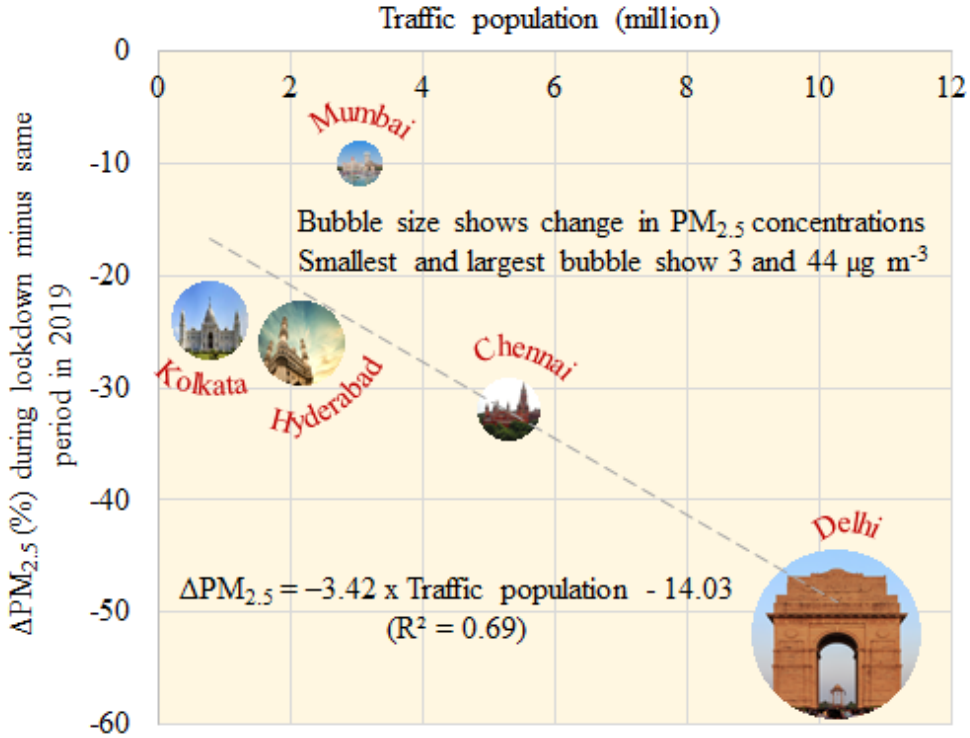


Source: https://www.stateofglobalair.org/



Aerosols & COVID-19

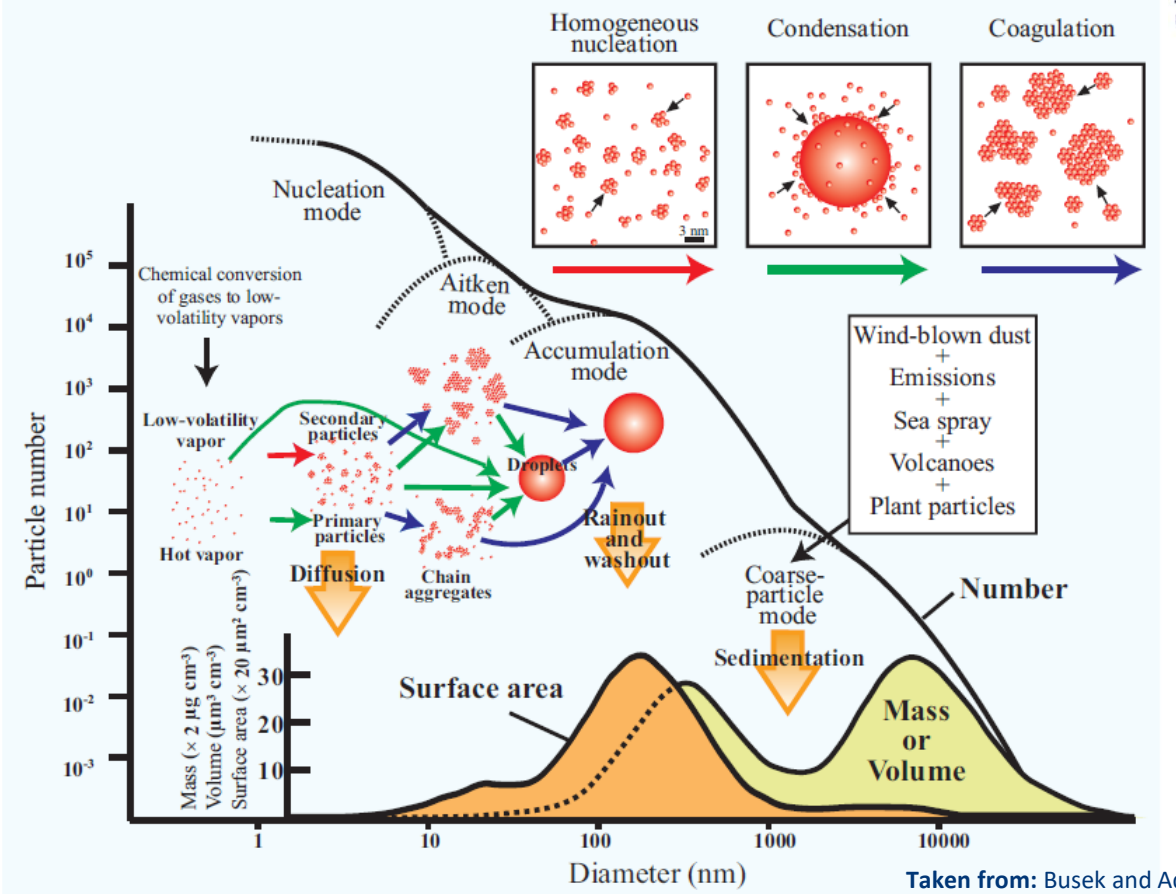
GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY



Source: Kumar et al., 2020. SCS. 62, 102382.

Complexity: modes, processes..

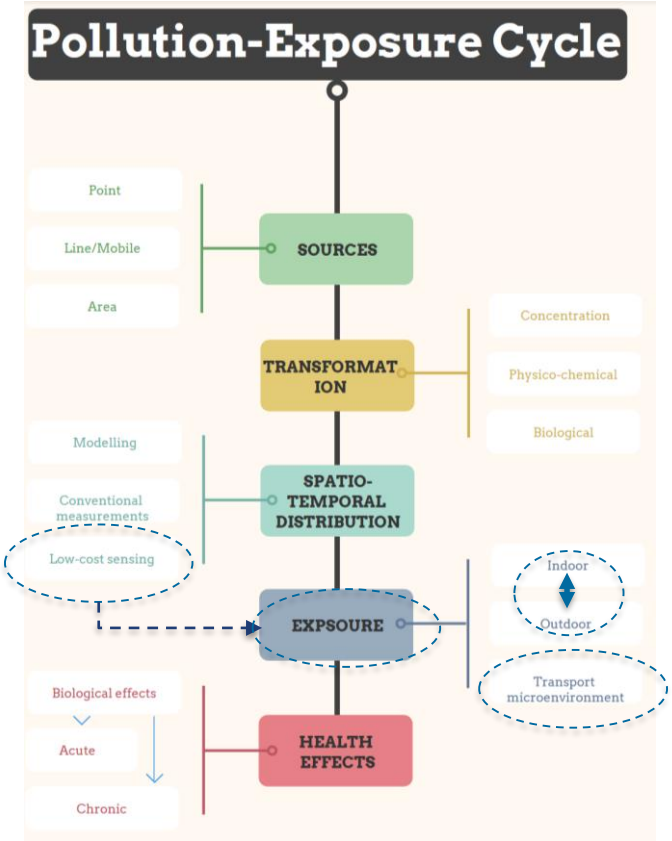
GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY



Taken from: Busek and Adachi, 2008. Elements 4, 389-394.

Primary focus: Health

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

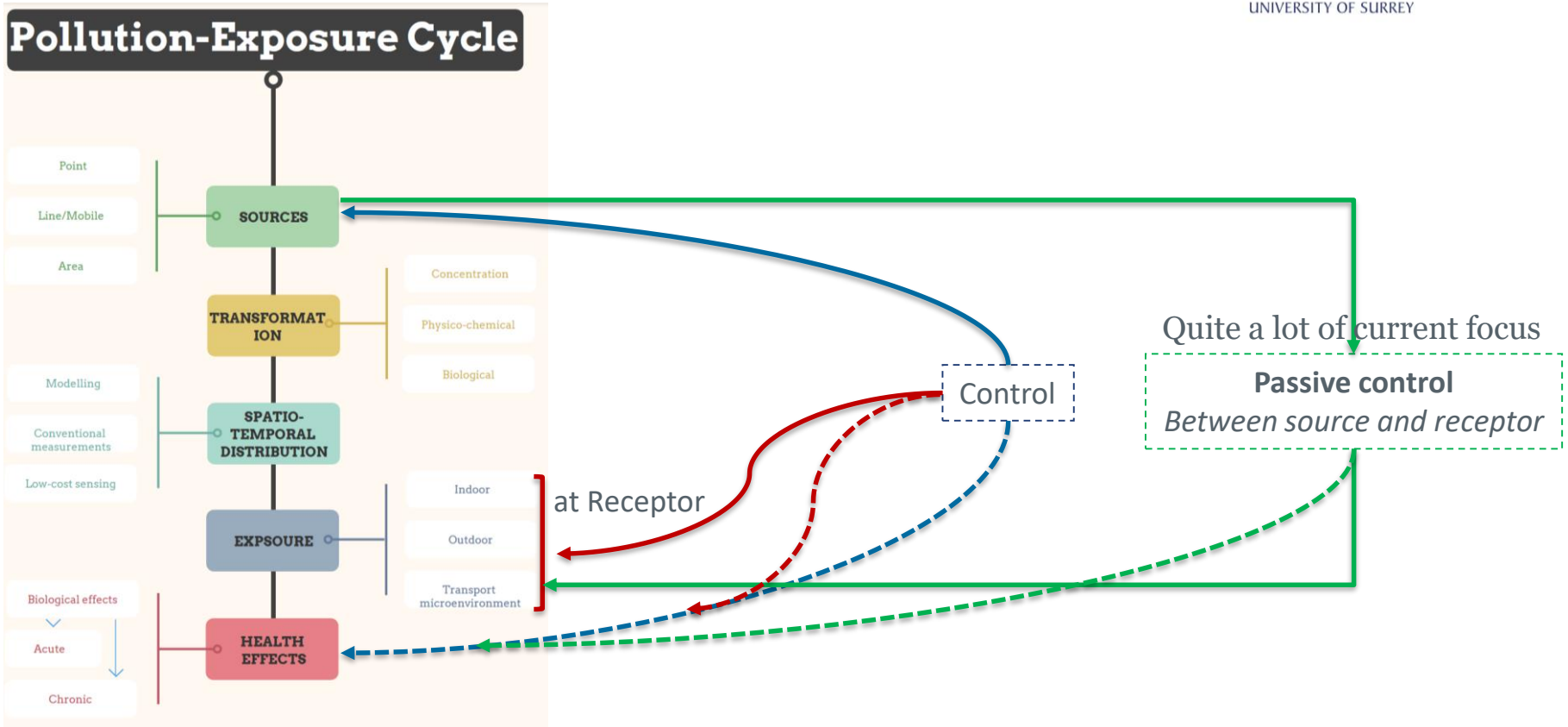


Quite a lot of focus in recent past on….

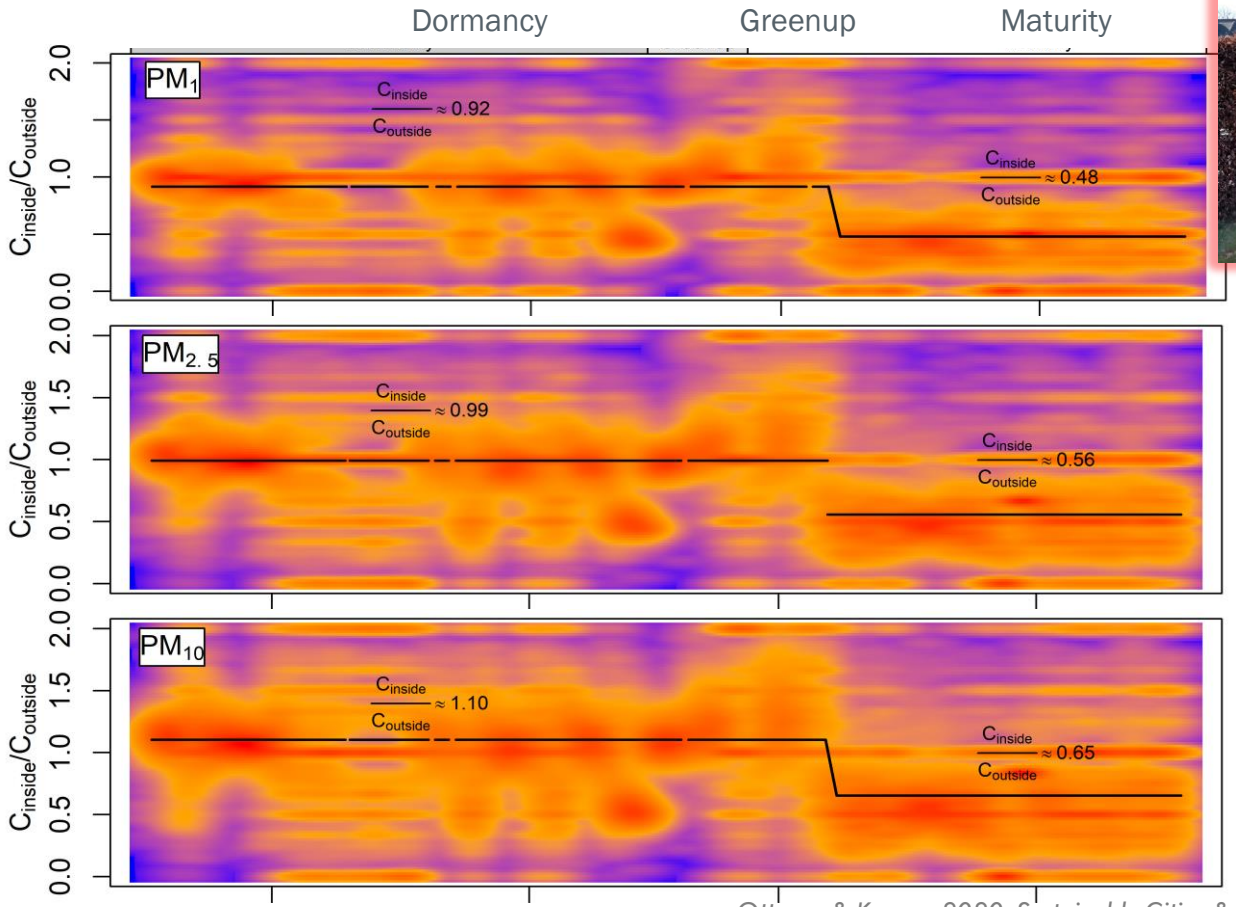
- **Exposure-centric approach**
  - Exposure is not always proportional to air quality
  - Peaks close to sources not captured
  - Unregulated pollutants (BC, UFP,..)
- **Evolution of low-cost sensing**
  - Less accurate but high resolution
  - Access to many
  - Citizen Science opportunity
  - Multidisciplinary (IOT, data science, social science,…)
  - ….
- **Indoor/outdoor interactions**
  - Not new but getting more and more important (>90% time indoors)
  - Pollutant ingress for diverse building stock
  - ….
- **Transport microenvironment**
  - Cars, buses, trains
  - Physically active (cycle, walk)

Pollution control for ‘health’

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY



Nature-based solutions: a hedge between a park and a busy road



LAI <2.9
Dormancy

LAI > 2.93
Greenup

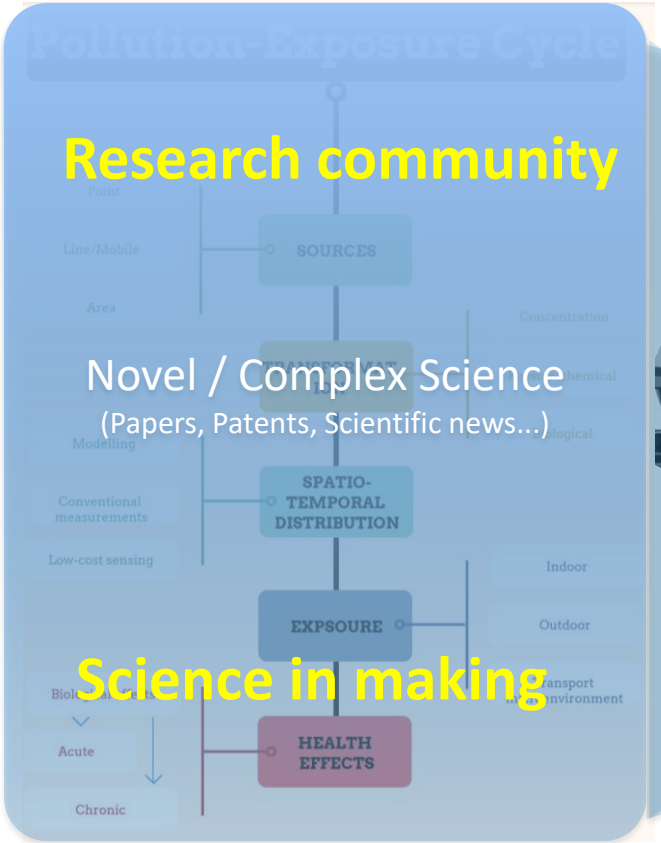
LAI ~7-8
Greenup

Ottosen & Kumar, 2020. Sustainable Cities & Society, 53, 101919.

Real difference.. a weak link?

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

Research community



Novel / Complex Science
(Papers, Patents, Scientific news…)

Science in making

- Stakeholder engagement
- Special allowance
- Endpoint requirements
- Multidisciplinary
- …

Public community

Evidence-based Solutions
(Engagement, guidance,..)

Science in practise

…not thinly pointed but widely penetrating!

Thank you!

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY

Guildford Living Lab

.. a platform for researchers, community & stakeholders for co-creating & co-designing air pollution and climate change mitigation solutions

Contact

Professor Prashant Kumar
Email: P.Kumar@surrey.ac.uk

@AirPollSurrey @pk_shishodia @GuildfordLL

Visit Website

surrey.ac.uk/gcare