WP6 Health impacts

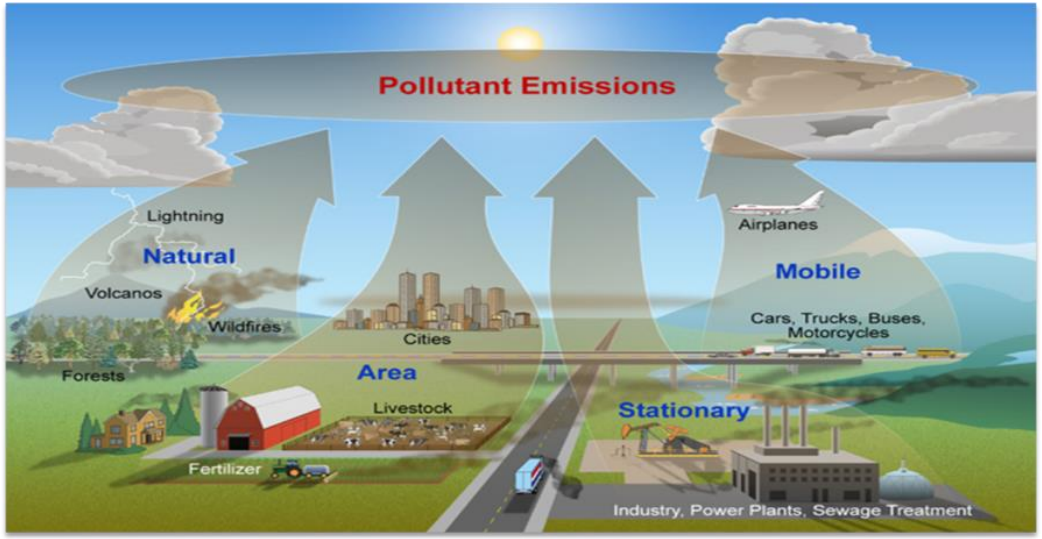
RAPTOR kick-off meeting November 18th 2019 Paris

Content

- General introduction air pollution and health
- Oxidative potential
- WP6 Health impacts objective, tasks, deliverables
- Questions

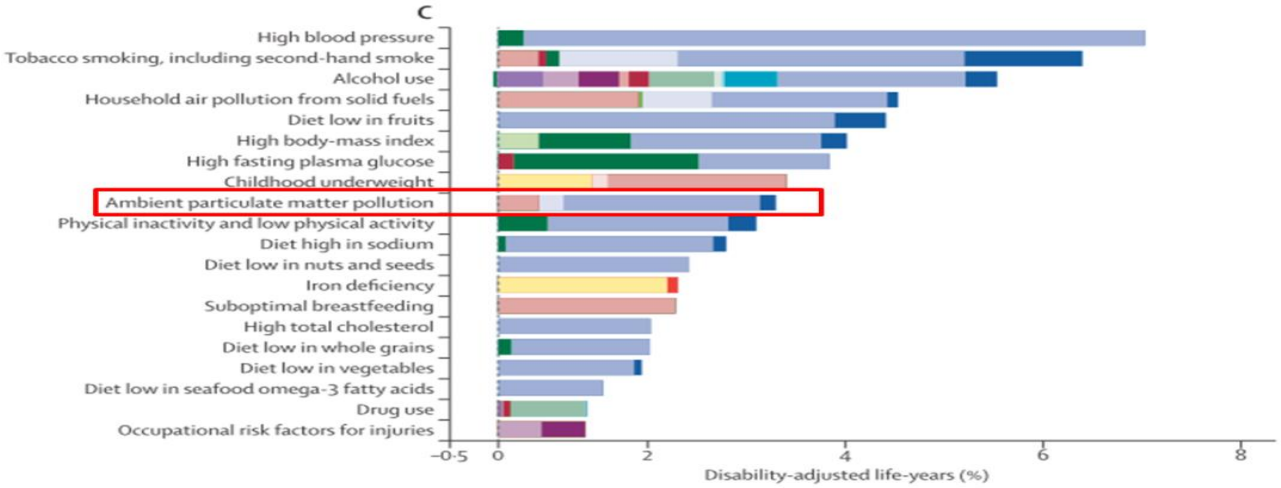
This project has received funding from the Clean Sky 2 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 863969.

Air pollution research - sources and health



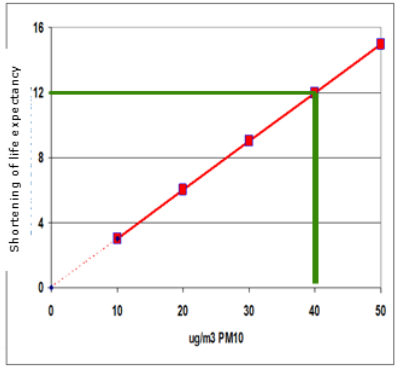
From nps.gov/subjects/air/sources.htm

Risk factor for global burden of disease



Lim et al. LANCET (2012)

Emission mixture particles and gaseous



PM10 standard 40 µg/m³

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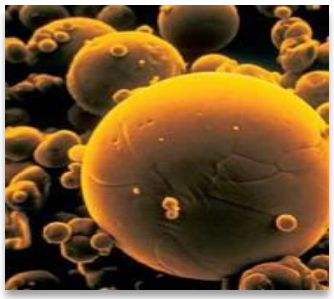
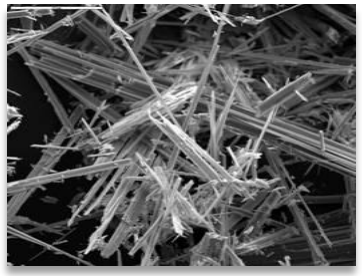
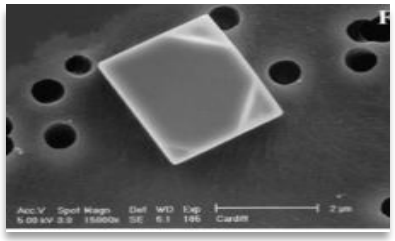
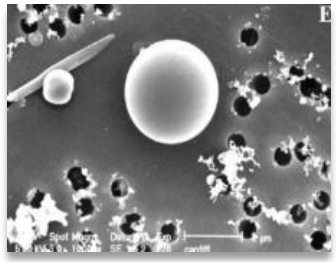
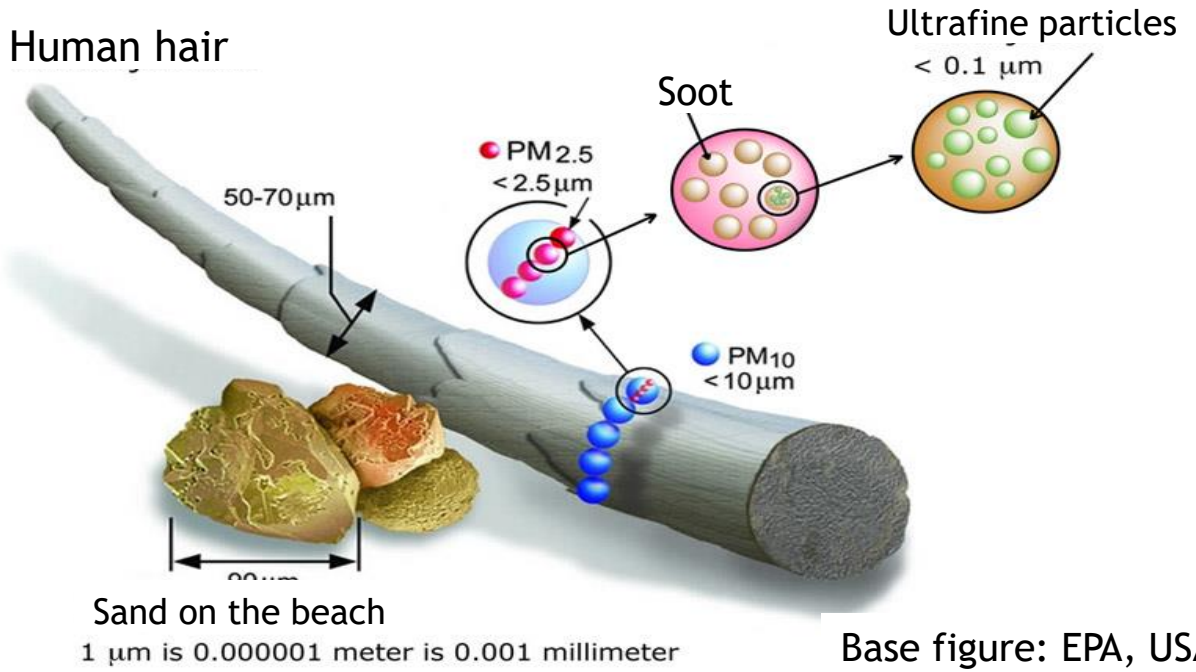
Particulate matter



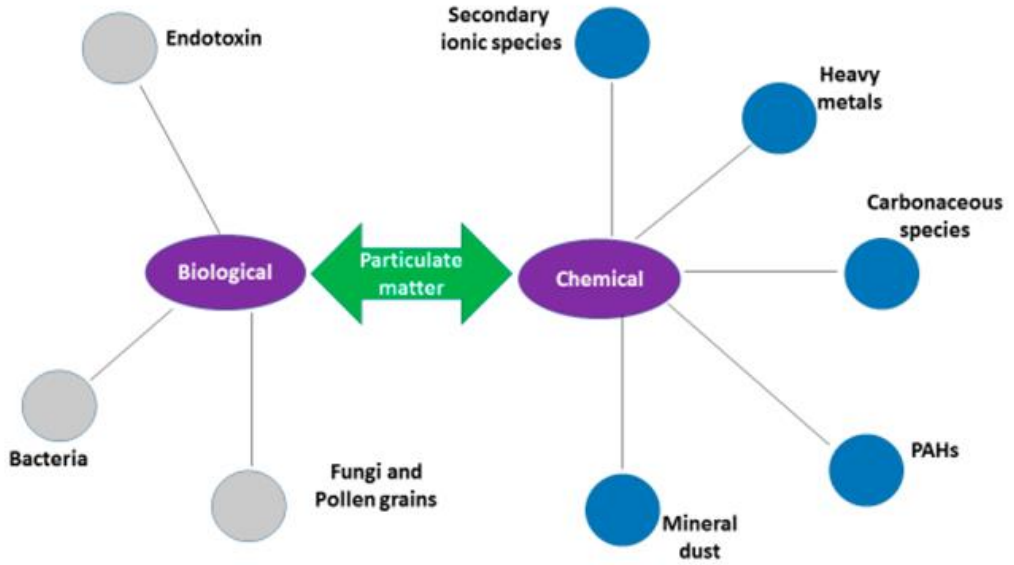








Base figure: EPA, USA



Morakinyo et al. 2016 Int J Environ Res Public Health

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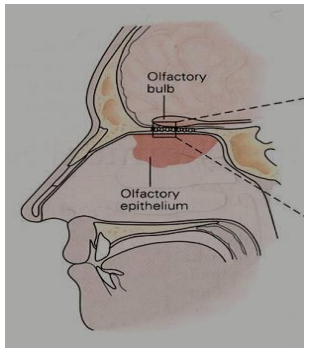
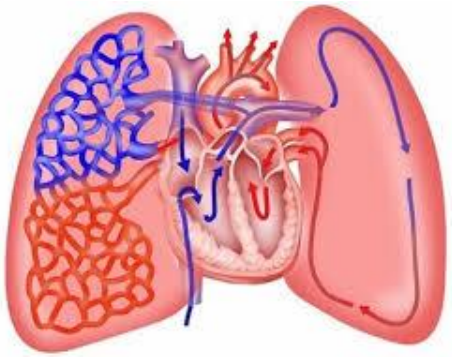
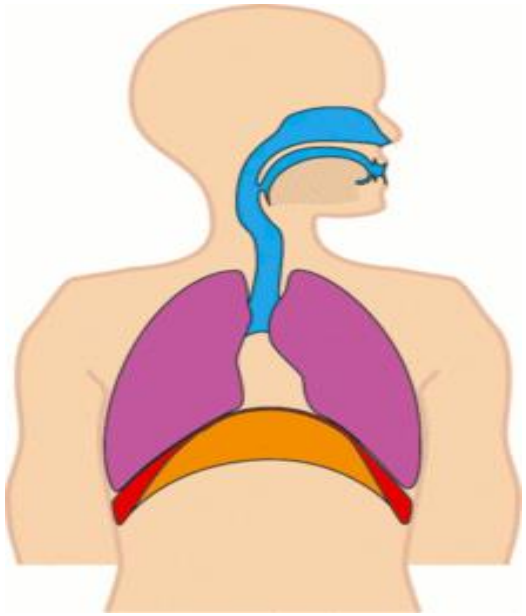
Health effects of particles







Respiratory effects

- asthma
- inflammation
- impaired lung function

Health effects beyond the lung

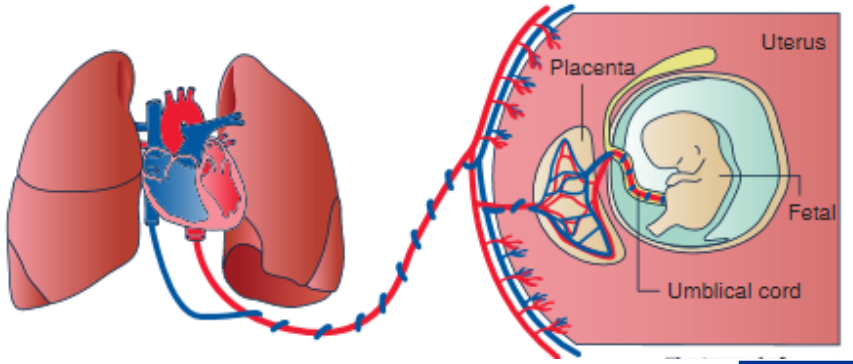
Cardiovascular system

- impairment of vascular function
- vasoconstriction

Brain

- neuroinflammation
- Neurodegeneration

Reproductive system



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Research health effects - epidemiology

- Study of disease patterns in the population related to environmental factors (air pollution, noise)
  - questionnaire
  - health measurements (e.g. lung function)
  - use of datasets

- Data entire population on e.g. mortality, medication, birth weight, address, education

- Connect health outcomes to environmental factors (associations)

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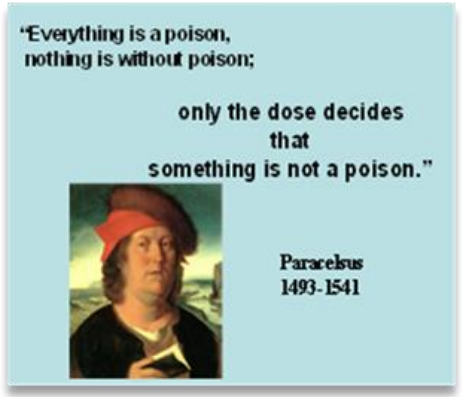
Toxicological research

Toxicity of components and the mechanisms (causal)

Risk = hazard x exposure



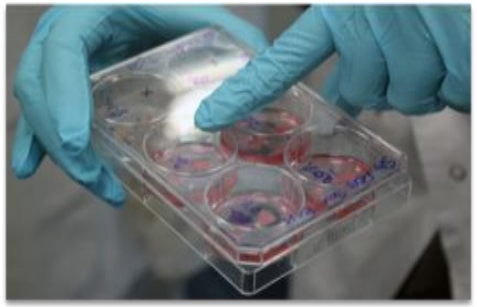
SUSCEPTIBILITY
age
disease

RISK
type/severity
health effects

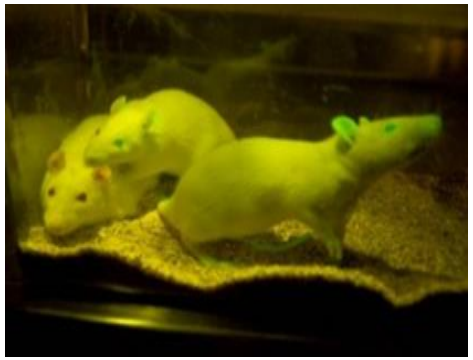
HAZARD
PM size
PM composition

EXPOSURE
level
duration

in vitro (cells)



in vivo animals



human volunteers

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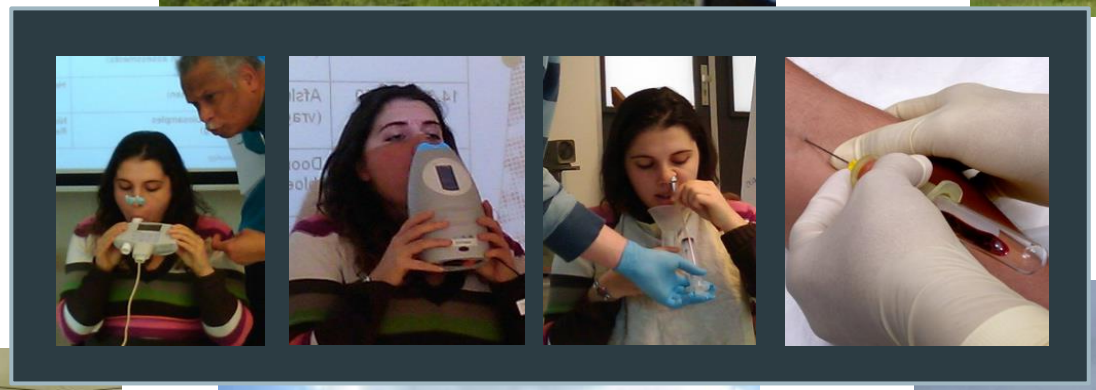
On site exposure

Trucks

Airport

Freeway



Underground railway

Pig farm

Shipping

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PM composition

Free Radical Biology and Medicine 117 (2018) 202–217

Contents lists available at ScienceDirect

Free Radical Biology and Medicine

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

Review article

A critical review of assays for hazardous components of air pollution

Henry Jay Forman[a,c,*], Caleb Ellicott Finch[a,b]

International Journal of *Environmental Research and Public Health*

MDPI

Review

Health Outcomes of Exposure to Biological and Chemical Components of Inhalable and Respirable Particulate Matter

Oyewale Mayowa Morakinyo *, Matlou Ingrid Mokgobu, Murembiwa Stanley Mukhola and Raymond Paul Hunter

Journal of the Air & Waste Management Association

Taylor & Francis

ISSN: 1096-2247 (Print) 2162-2906 (Online) Journal homepage: http://www.tandfonline.com/loi/uawm20

Long-term particulate matter exposure: Attributing health effects to individual PM components

R.E. Wyzga & A.C. Rohr

Differential Proinflammatory Responses Induced by Diesel Exhaust Particles with Contrasting PAH and Metal Content

Annike I. Totlandsdal ,[1] Marit Låg,[1] Edel Lilleaas,[1] Flemming Cassee,[2] Per Schwarze[1]

RAPTOR

Clean Sky 2

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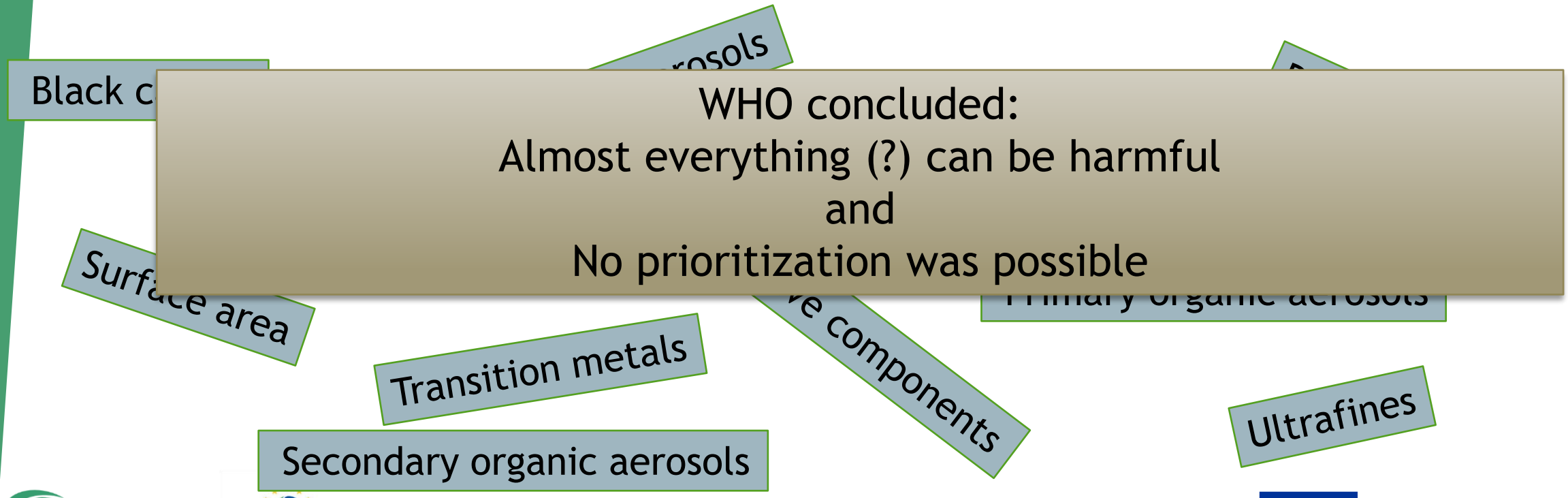
What are the most toxic parts of PM?

- Health effects related to (groups of) chemical and physical properties

World Health Organization – REVIHAAP project

Cassee FR, Héroux ME, Gerlofs-Nijland ME, Kelly FJ., Inhal Tox 2013



WHO concluded:
Almost everything (?) can be harmful
and
No prioritization was possible

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Different source specific PM2.5

Gerlofs-Nijland et al., 2019, Inhalation Toxicology

Table 1. Sources used to collect PM2.5 and PM2.5 suspension sample code.

PM source	PM2.5 suspension sample code
ECE low-metallic brake pads including copper	BW-1 or brake wear 1
Semi-metallic brake pads without copper	BW-2 or brake wear 2
Non-asbestos organic (NAO) brake pads	BW-3 or brake wear 3
ECE-NAO hybrid brake pads	BW-4 or brake wear 4
Studded winter tires and asphalt concrete pavement	Tire/road wear
Modern wood stove with efficient combustion conditions	Modern stove
Old-fashioned wood stove with efficient combustion conditions	Old-fashioned stove
Diesel engine exhaust from EURO-III engine	Diesel engine exhaust
Poultry farm	Poultry farm

- Brake wear - 4 types of brake pads, realistic driving conditions
- Wood combustion – modern and old-fashioned stove
- Diesel combustion – stationary HD engine (Euro III compliant settings)
- Poultry farm (± 70,000 animals)
- Tire/road wear – studded tires, asphalt concrete pavement

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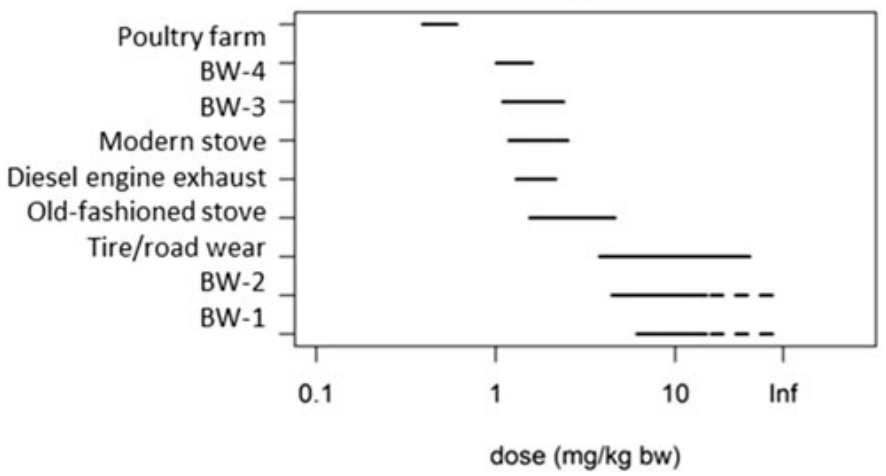
Hazard identification

Pulmonary inflammation

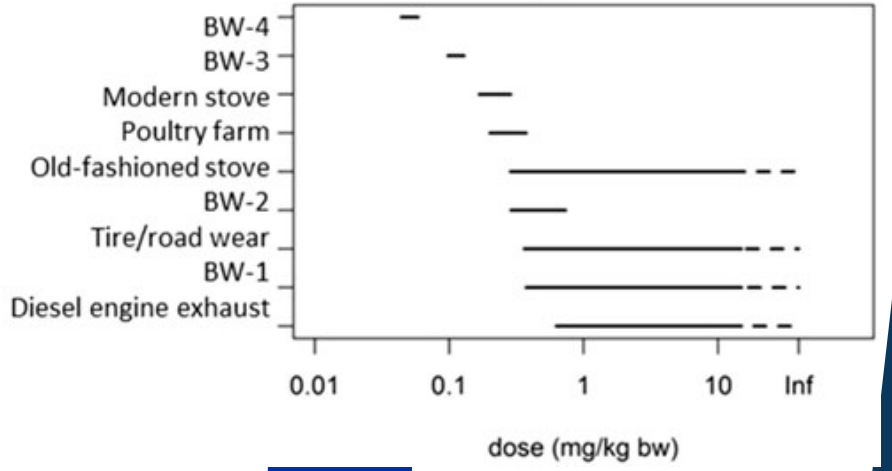
- BMD approach to assess the differences in potency for each parameter
- The lower the PM dose needed to observe this effect the more hazardous the PM material is
- Overlapping BMD ranges implies that no difference in the potency of the different samples tested can be observed

Gerlofs-Nijland et al., 2019, Inhalation Toxicology

Neutrophils



Pro-inflammation marker



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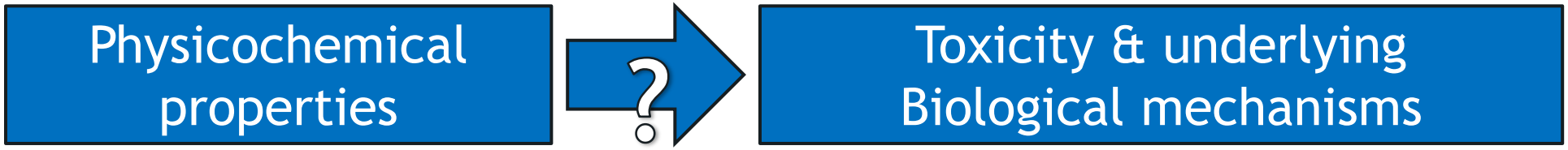
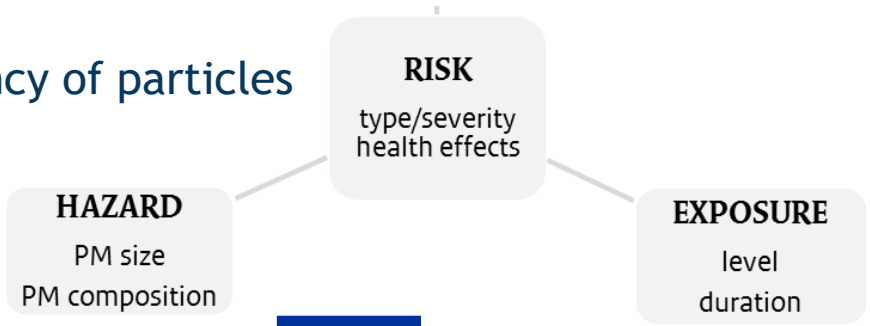
Considerations understanding toxicity



- Which components/characteristics are important
- PM composition differs per location due to different sources, therefore the hazard differs as well
- A mass based metric – PM concentration - is therefore not the best indicator of the health effects (hazard)
- Oxidative potential as a metric in assessing the toxicological potency of particles



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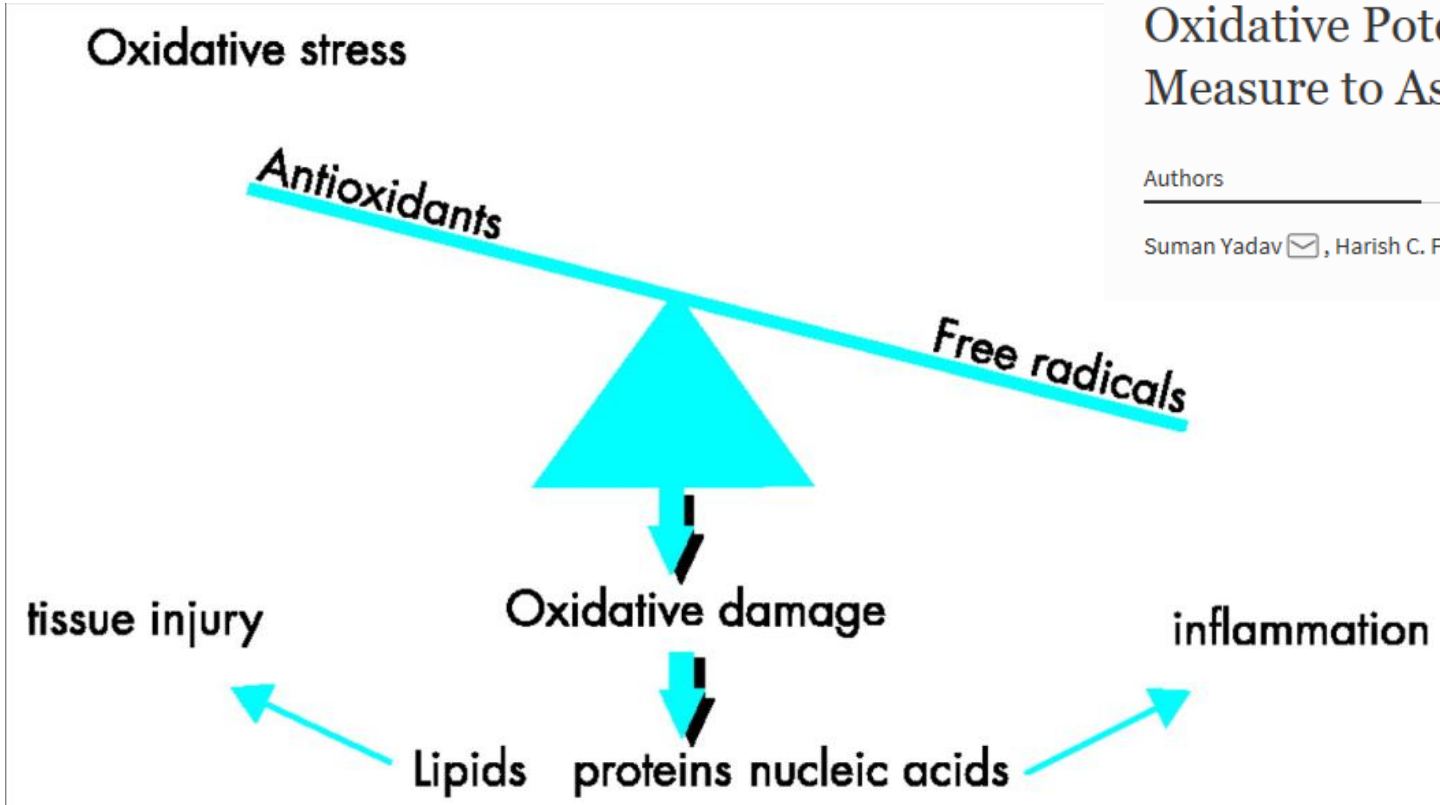
OP as a biological and health relevant PM metric

The capability of airborne particulate matter (PM) to generate reactive oxygen species (ROS), known as “oxidative potential” (OP) is suggested to be one of the most relevant indicators of PM toxicity



Measurement, Analysis and Remediation of Environmental Pollutants pp 333-356 | Cite as

Oxidative Potential of Particulate Matter: A Prospective Measure to Assess PM Toxicity

Authors | Authors and affiliations

Suman Yadav, Harish C. Phuleria

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Assays oxidative potential

- Electron spin resonance (**ESR**):free radicals

- Anti-oxidant depletion: sensitive for transition metals
- Dithiothreitol (**DTT**) assay, ability of the sample to generate ROS (organics, Cu)
- Etc…

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WP6 Health impact

- Objective
  - Determine and improve the understanding of the health impact of aviation emissions to serve regulation

- Task 6.1 Toxicological impacts review: literature survey current state of knowledge to assess critical factors for hazard. Focus on oxidative potential to assess toxicity

- Task 6.2 For estimation of hazard of full mixtures an extensive assessment is needed. In RAPTOR only small empirical work foreseen (oxidative potential on PM collected on filters). Relative ranking of emissions based on oxidative potential as an indicator for health effects

- Task 6.3 Identify the major gaps in knowledge that prevent a proper hazard and risk assessment. This task will not only summarize these gaps but also provide suggestions on to close these gaps for a toxicological point of view including research recommendations

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Deliverables WP6

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D6.1	Report Assessment of exhaust hazard	5 - RIVM	Report	Public	20
D6.2	Report on knowledge gaps and research needs regarding health effects of emission	5 - RIVM	Report	Public	22

Description of deliverables

D17 Report Assessment of exhaust hazard
D18 Report on knowledge gaps and research needs regarding health effects of emission

D6.1 : Report Assessment of exhaust hazard [20]

Report Assessment of exhaust hazard, and set of OPEN Data

D6.2 : Report on knowledge gaps and research needs regarding health effects of emission [22]

Report on knowledge gaps and research needs regarding health effects of emission

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Questions

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