Enhancing urban health with satellite data

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CWARE

CURE

Introduction to me and CWare

I am an economist, PhD in Corporate Strategy, worked at Joint Research Center/Space Institute, Gallileo Programme, COWI as Chief Project Manager, now founder and partner in Cware, Copenhagen.

CWare is research and consultancy start-up specialised in circular-economy, economic and environmental feasibility assessment, market strategic exploitation. We are currently involved in H2020 projects related to urban resilience.

www.cware.eu

CWARE

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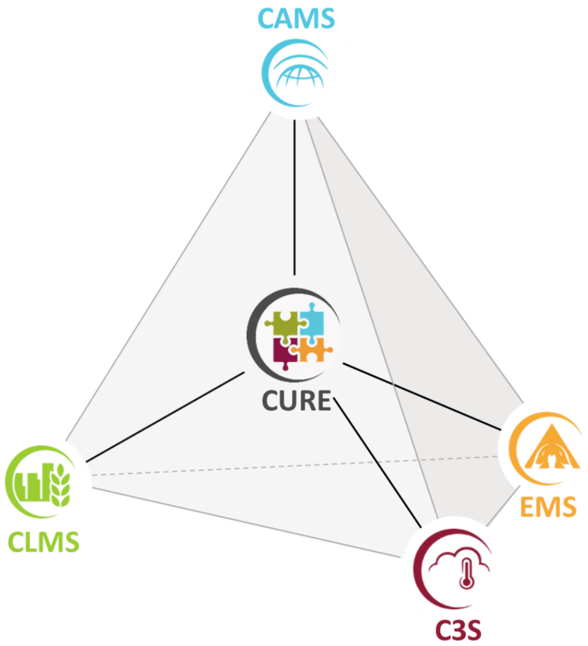
Outline

1. The CURE project
2. The user's perspective, David Ludlow/UWE - Bristol
3. Urban health
4. CURE APP07 Air Quality
5. CURE APP11 Health impact
6. Visions for future urban health services

The CURE Concept

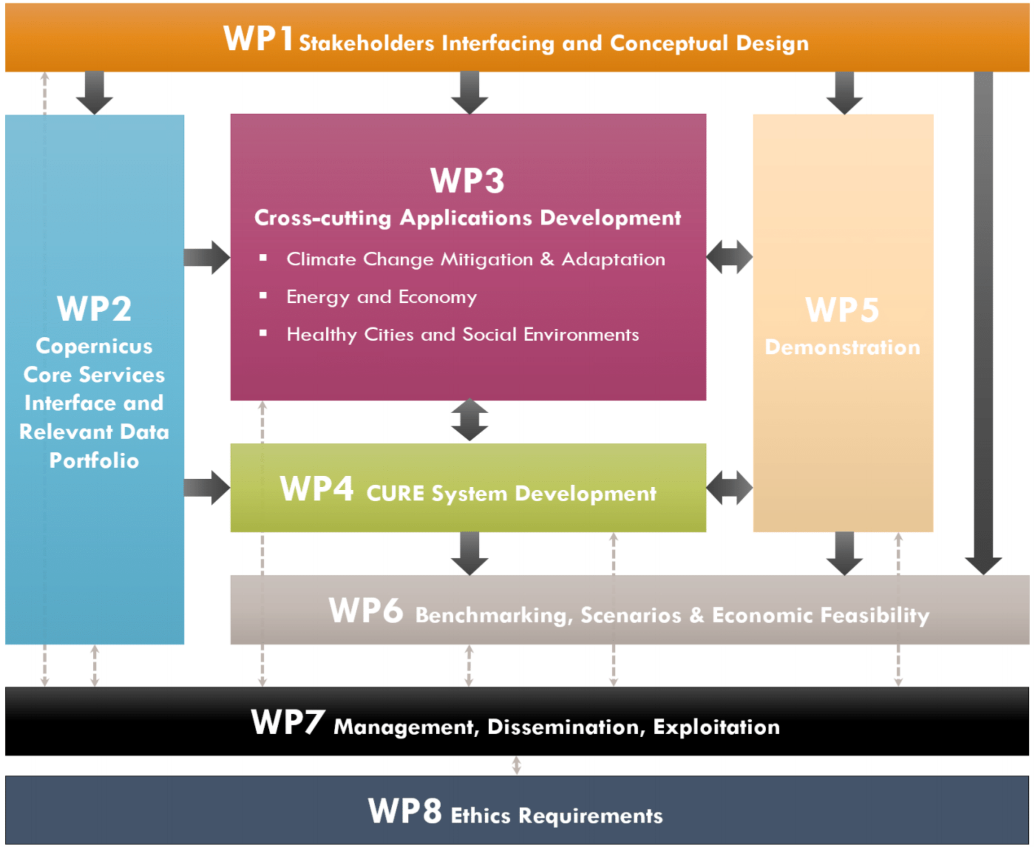
- Provide the means to cope with the EO data under-exploitation in the domain of **sustainable and resilient urbanization**, by combining products from from CAMS, CLMS, C3S and EMS.
- Introduce novel ideas on how to develop applications across Copernicus Core Services in the domains:
  - climate change adaptation & mitigation
  - healthy cities and social environments
  - energy and economy



Case Studies

Cross-cutting applications	Berlin	Copenhagen	Sofia	Heraklion
Local Scale Surface Temperature Dynamics	●	●	●	●
Surface Urban Heat Island Assessment	●	●	●	●
Urban Heat Emissions Monitoring				●
Urban CO_2 Emissions Monitoring				●
Urban Flood Risk		●		
Urban Subsidence, Movements and Deformation Risk			●	
Urban Air Quality			●	
Urban Thermal Comfort		●	●	
Urban Heat Storage Monitoring				●
Nature Based Solutions		●		
Health Impacts (socioeconomic perspective)		●	●	

Implementation



http://cure-copernicus.eu

The User’s perspective -1

- CURE – Policy Drivers

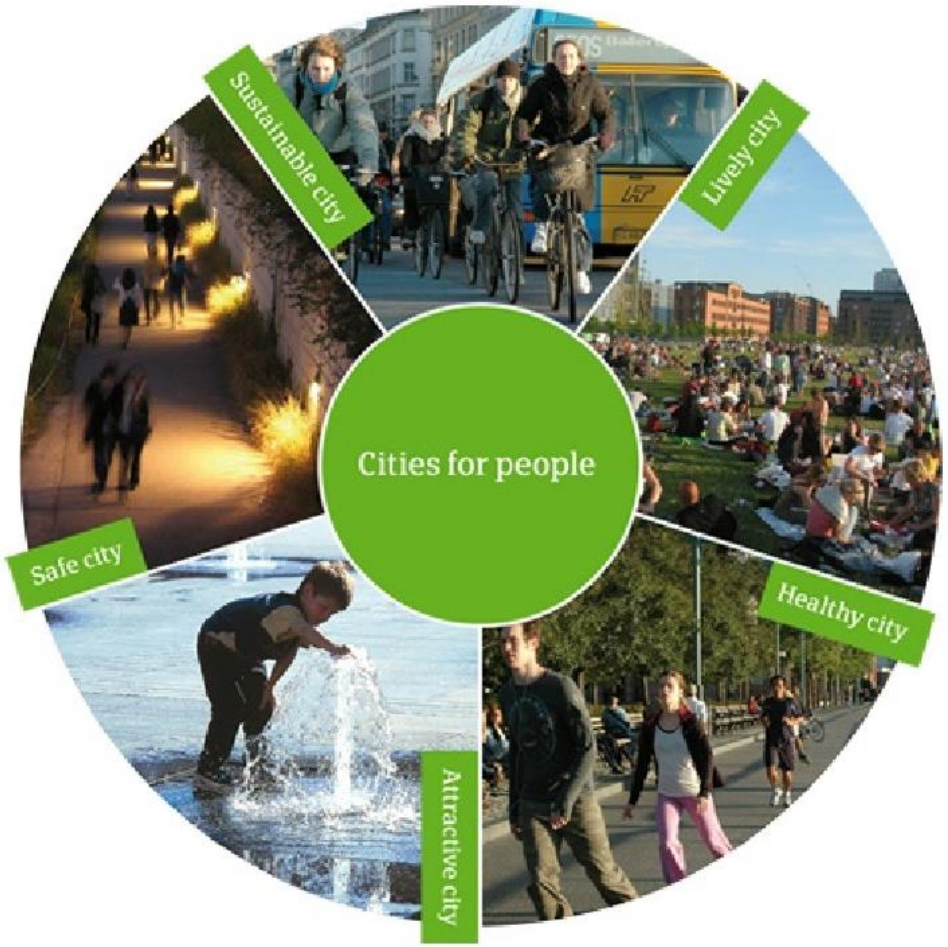
- Cities policy drive for transitions to carbon neutral, healthy and sustainable cities – supported by pan-European (Urban Agenda) and global (SDGs) policy commitments
- Policy objectives targeted by land use planning in management of the city-region to address these key political concerns of cities globally
- Management specified in policy strategies including mitigation and adaptation actions that enhance the resilience of cities:
- Policies targeting climate resilience, compact cities and enhancing urban quality of life seeking major climate co-benefits e.g. improving air quality by reducing fossil fuel emissions creating accompanying positive health as well as environmental impacts;
- Policies targeting the creation of healthy cities, where air quality remains below critical levels and where health promoting aspects, such as walkability, bike-ability and access to green areas are prioritised in urban planning

The User's perspective - 2

- **CURE – Copernicus Cross-Disciplinary Data**
- Policy strategies and associated decision-making based on sound understanding and quantification of the drivers of urban transition
- CURE responds to these challenges by exploiting the under-utilized Copernicus cross-disciplinary data originating from different Core Copernicus services
- Data helps assess the efficacy of policy actions and implementation co-benefits. Tools allow local authorities to test 'what if' scenarios e.g. concerning the reduction of air pollution to estimate the health cost savings of low-carbon transport policies
- Similar tools for other co-benefits assessment can aid the incorporation of co-benefit considerations in the decision making process e.g. tools to quantify the estimated health benefits and savings associated with active travel and nature based solutions

Urban health

- The enhancement of human health and the increase of human resilience through improved city planning are key challenges
- Substantial health economic benefits can be achieved by creating healthy cities, where air quality remains below critical levels and health promoting aspects (such as walkability, bikeability and access to green areas) are prioritised in urban planning
- Evidence shows that poor air pollution and heat stress during the summer leads to premature deaths and loss of productivity (e.g. 4800 premature deaths due to poor air quality reported for Denmark in 2018)
- In Europe, 74% of the populations live in cities – air pollution, increasing temperatures and increasing populations in cities will have a huge health impact and socio-economic cost



Architect Arne Gehl

Urban built environment and human behavior and health

Physical Qualities →

- Traffic volumes
- Building height
- Number of people
- Commuting distance
- Green corridors
- Km of cycle path per inhabitant
- Distance to green areas

Urban Climate Qualities →

- Thermal Comfort
- Air Quality
- General comfort (wind, rain)
- Sense of safety
- Esthetic interest

Human Behaviour →

- Method of transportation
- Life quality
- Outdoor physical activities
- Outdoor social activities

Human Health →

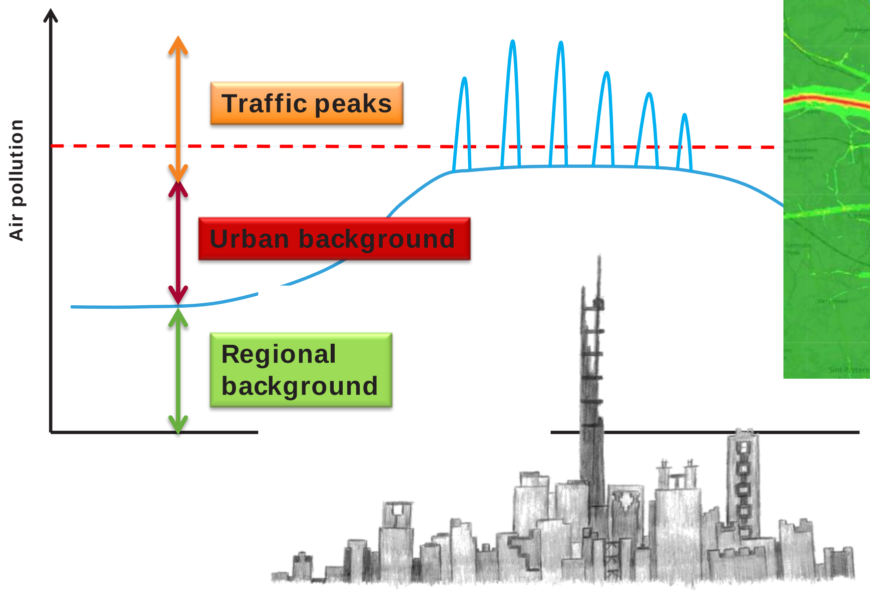
- Frequency of doctor visits/hospital admissions
- Number of sickness days
- Early retirement due to bad health
- Premature deaths

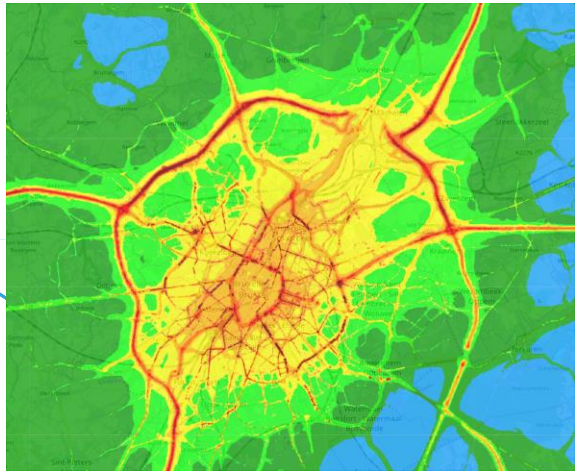
Health cost

- Mortality
- Morbidity
- Hospital admission costs
- Cost of medicine
- Sickness days

CURE APP07 Urban Air Quality (VITO)

- Urban air quality: multiscale problem

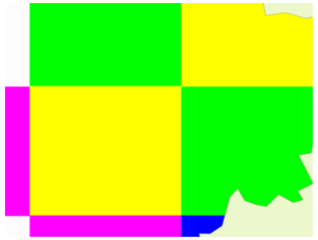




Methodology: ATMO-STREET

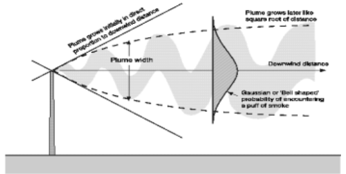
CAMS

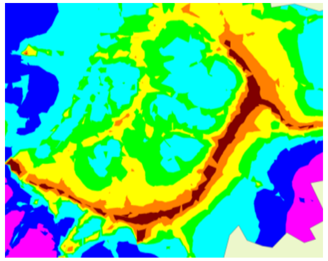
Background concentrations
Chemical transport model



IFDM

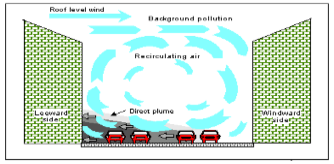
Gaussian plume model
Open street concentrations due to traffic and point sources

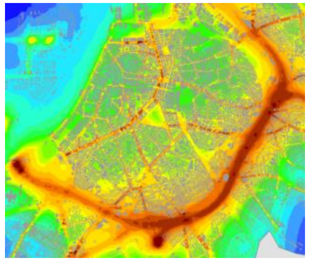




OSPM

Street-canyon module
Street canyon increment





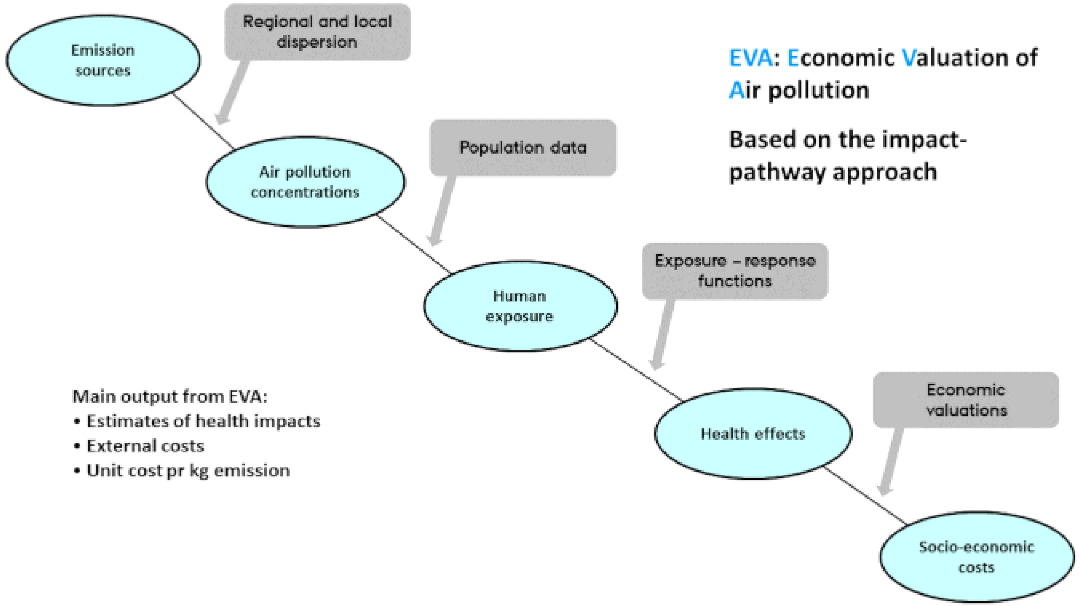
Pollutant	EU reference value (ᵃ)	Urban population exposure (%)	WHO AQG (ᵃ)	Exposure estimate (%)
PM_{10}	Day (50)	13-19	Year (20)	42-52
$PM_{2.5}$	Year (25)	6-8	Year (10)	74-81
O_3	8-hour (120)	12-29	8-hour (100)	95-98
NO_2	Year (40)	7-8	Year (40)	7-8
BaP	Year (1)	17-20	Year (0.12) RL	83-90
SO_2	Day (125)	< 1	Day (20)	21-31

Key				
Key	< 5 %	5-50 %	50-75 %	> 75 %

CURE 11 Health Impact

RESULTS OF THE AIR QUALITY (SOFIA)

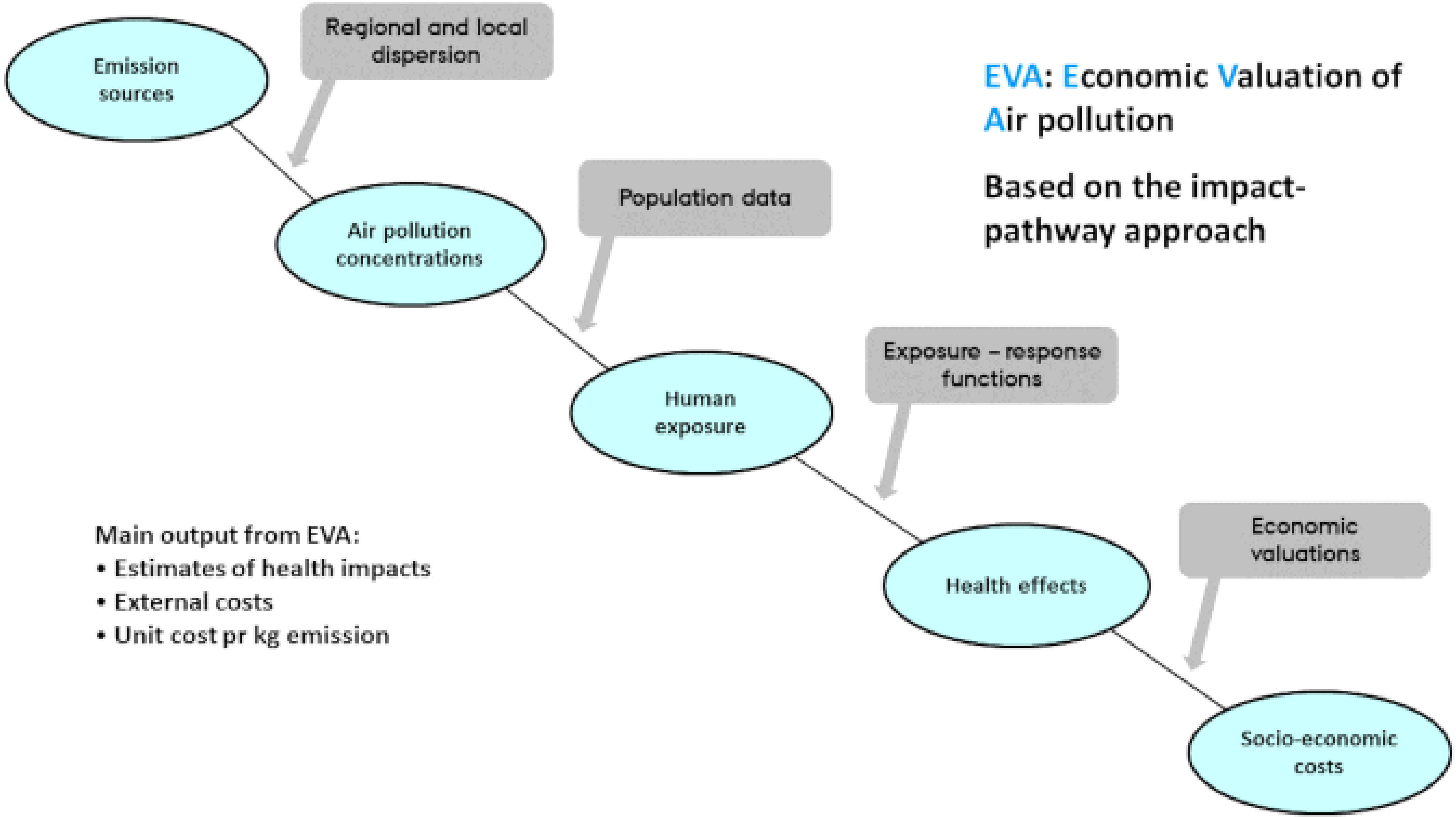
EVA MODEL



Questions to be answered:

1. How is the Air Quality in my City (SOFIA)?
2. How does this compare to EU thresshold values?
3. What are the main sources impacting AQ?
4. What are the health impacts and accosiated health costs of air pollution?

Socio-economic costs of air pollution



EVA: Economic Valuation of Air pollution

Based on the impact-pathway approach

Main output from EVA:
- Estimates of health impacts
- External costs
- Unit cost pr kg emission

The EVA model is developed by University of Aarhus, Jorgen Brandt

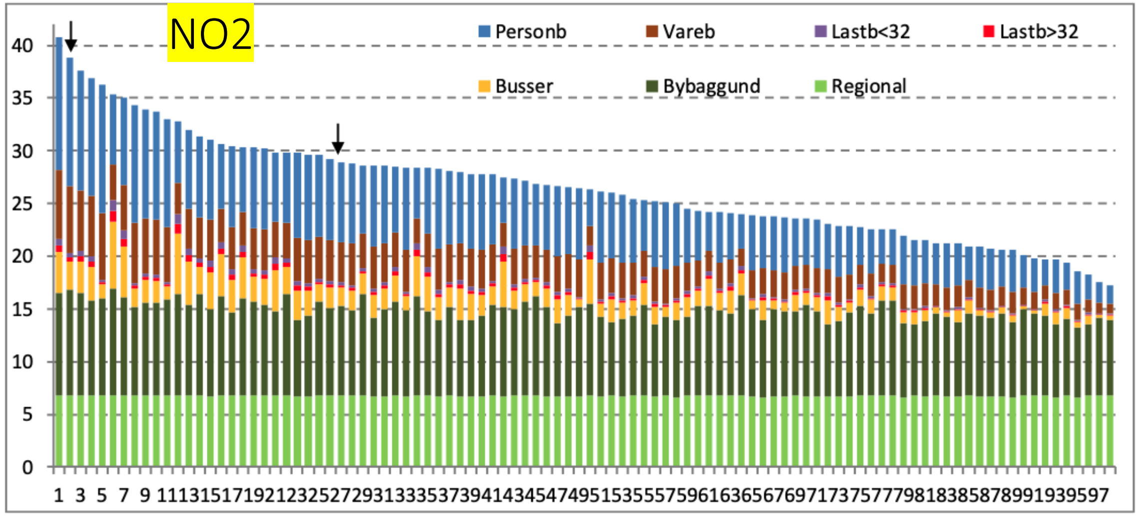
Results from Copenhagen

https://dce2.au.dk/pub/SR348.pdf

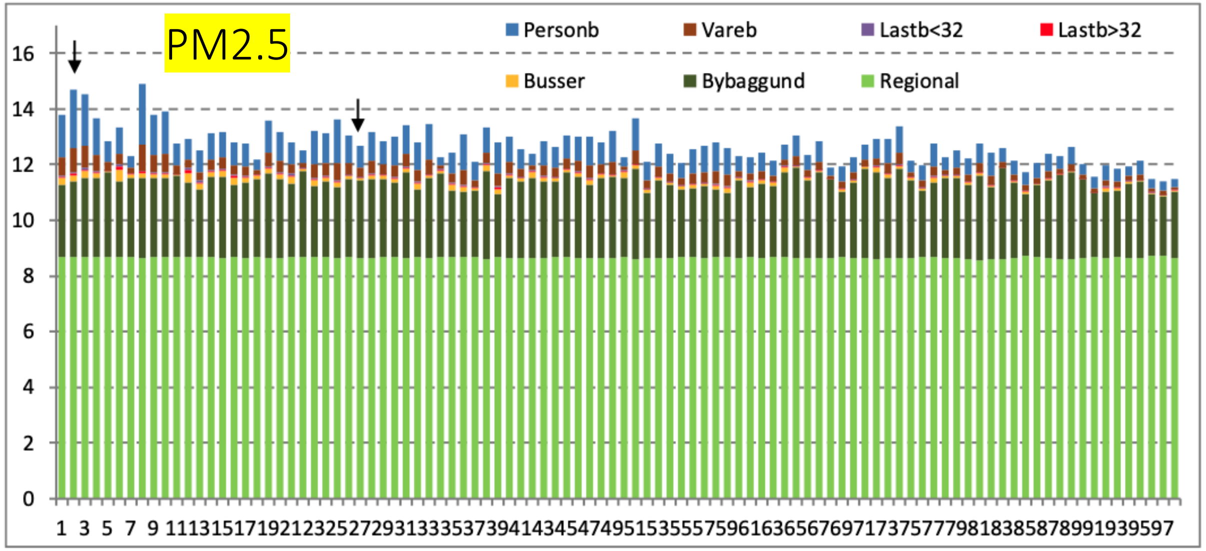
- Population 600.000: 110.000 children, 450.000 (between 19-65 years, 65.00 above 65 years
- In 2017 460 people died prematurely due to poor air quality (=12% of all deaths), the majority due to PM2,5
- 440.000 days of sickness days
- The largest individual sources to air polution are road transport and wood stoves
- The toal socio-economic costs of air polution in Copenhagen in 2017 amounted to 8,8 billion DKK (1,2 billion EUR)

Tabel 3.1. Sammenligning mellem EU-grænseværdier og WHO-retningslinjer og målte koncentrationer i København i 2018. Grøn betyder overholdelse og rød betyder overskridelse af EU grænseværdi eller retningslinjer.

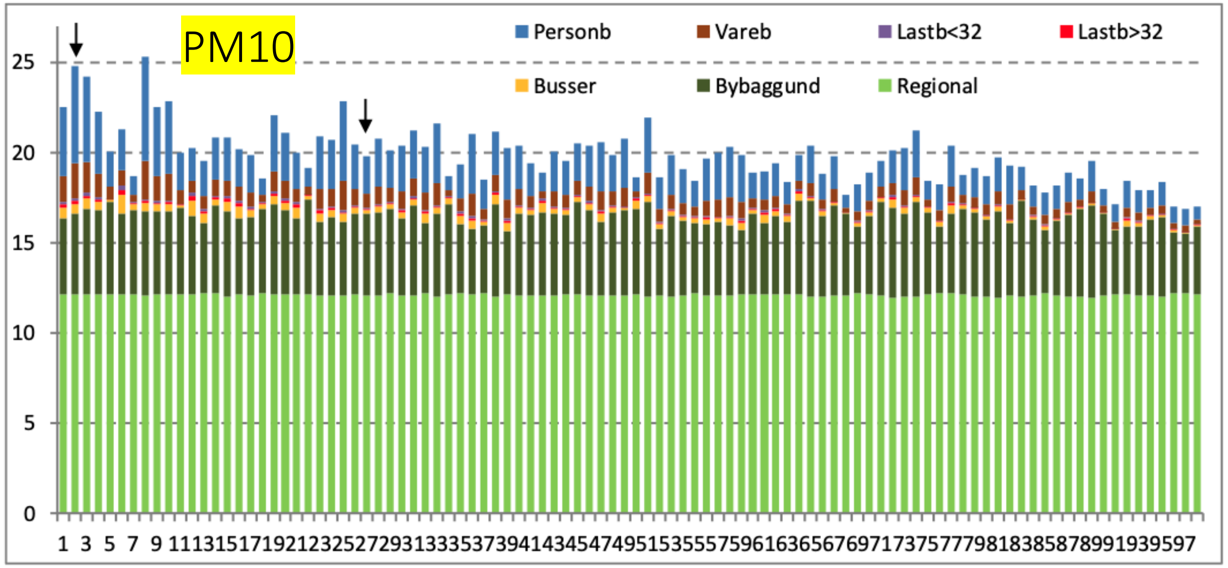
Stof	EU-grænseværdi ($\mu g/m^3$)	WHO-retningslinjer ($\mu g/m^3$)	Målt på målestationer i 2018 ($\mu g/m^3$)		
			Trafikerede gader	Bybaggrund (hustag)	Landområder
$PM_{2,5}$	Årsmiddel (25)	Årsmiddel (10)	14-16	12-13	12
PM_{10}	Årsmiddel (40)	Årsmiddel (20)	25-31	18	17-18
NO_2	Årsmiddel (40)	Årsmiddel (40)	30-39	12-13	8



Figur 4.2. Kildebidrag til NO_2-koncentrationen fordelt på køretøjskategorier for 98 gader i København i 2018. Pile markerer målestationer. Anden højeste koncentration er ved målestationen på H.C. Andersens Boulevard. Den anden målestation er på Jagtvej, som har den 27. højeste koncentration ud af de 98 gader. Enhed µg/m³.



Figur 4.4. Kildebidrag til $PM_{2,5}$-koncentrationen fordelt på køretøjskategorier for 98 gader i København i 2018. Pile markerer målestationer. Vist i samme rækkefølge som for NO_2. Enhed µg/m³.



Figur 4.5. Kildebidrag til PM_{10}-koncentrationen fordelt på køretøjskategorier for 98 gader i København i 2018. Pile markerer målestationer. Vist i samme rækkefølge som for NO_2. Enhed µg/m³.

Health impacts

Number of incidents

Tabel 5.1. Helbredseffekter i Københavns Kommune pga. den totale luftforurening, dvs. både danske og udenlandske kilder i 2017. Total er summen af helbredseffekter af SO_2, O_3, NO_2 og $PM_{2,5}$.

Dødelighed /Mortality	**Total**	**SO_2**	**O_3**	**NO_2**	**$PM_{2,5}$**
For tidlige dødsfald fra korttidseksponering ($PM_{2,5}$, SO_2, NO_2, O_3)	138	1	3	50	83
For tidlige dødsfald fra langtidseksponering ($PM_{2,5}$, NO_2)	320	0	0	0	320
Dødsfald blandt spædbørn ($PM_{2,5}$)	0	0	0	0	0
Totalt antal for tidlige dødsfald ($PM_{2,5}$, SO_2, NO_2, O_3)	458	1	3	51	403
Sygelighed /Morbidity					
Hospitalsindlæggelser for luftvejslidelser ($PM_{2,5}$, NO_2, O_3)	420	0	3	240	177
Hospitalsindlæggelser for cerebro-vaskulære lidelser ($PM_{2,5}$, O_3)	102	0	9	0	124
Episoder med astma blandt børn ($PM_{2,5}$)	39	0	0	0	39
Episoder med bronkitis ($PM_{2,5}$)	368	0	0	0	368
Episoder med bronkitis børn ($PM_{2,5}$)	1.601	0	0	0	1.601
Dage med tabt arbejde ($PM_{2,5}$)	133	0	0	0	133
Dage med nedsat aktivitet (sygedage) ($PM_{2,5}$)	443.376	0	0	0	443.376
Dage med delvist nedsat aktivitet (O_3)	40	0	40	0	0
Lungecancer ($PM_{2,5}$)	6	0	0	0	6

Health costs

Tabel 6.1. Totale eksterne omkostninger pga. den totale luftforurening i Københavns Kommune pga. al luftforurening både fra danske og udenlandske emissionskilder i 2017 samt andelen forårsaget af emissioner i Københavns Kommune (mio. kr.).

Helbredseffekter	Total	SO_2	O_3	NO_2	$PPM_{2,5}$	SIA+SOA+SS
Dødelighed /Mortality	M DKK					
For tidlige dødsfald fra korttidseksponering ($PM_{2,5}$, SO_2, NO_2, O_3)	4.353	28	107	1581	608	2.029
For tidlige dødsfald fra langtidseksponering ($PM_{2,5}$, NO_2)	3.784	0	0	5	1.019	2.760
Dødsfald blandt spædbørn ($PM_{2,5}$)	9	0	0	0	2	7
Total antal tidlige dødsfald ($PM_{2,5}$, SO_2, NO_2, O_3)	8.146	28	107	1.586	1.629	4.796
Sygelighed /Morbidity						
Hospitalsindlæggelser for luftvejslidelser ($PM_{2,5}$, NO_2, O_3)	31	0	0	18	4	10
Hospitalsindlæggelser for cerebro-vaskulære lidelser ($PM_{2,5}$, O_3)	16	0	1	0	4	11
Episoder med astma blandt børn ($PM_{2,5}$)	0	0	0	0	0	0
Episoder med bronkitis ($PM_{2,5}$)	109	0	0	0	29	79
Episoder med bronkitis børn ($PM_{2,5}$)	0	0	0	0	0	0
Dage med tabt arbejde ($PM_{2,5}$)	489	0	0	0	132	357
Dage med nedsat aktivitet (sygedage) ($PM_{2,5}$)	0	0	0	0	0	0
Dage med delvist nedsat aktivitet (O_3)	3	0	0	0	1	2
Lungecancer ($PM_{2,5}$)	9	0	0	0	2	7
Total sygelighed	657	0	1	18	172	466
Total dødelighed og sygelighed 1,2 BEUR =	8.803	28	108	1.604	1.801	5.262
Københavns Kommune - alle kilder i kommunen	855	11	-17	388	468	0
%-andel pga. emissioner i Københavns Kommune	10%	38%	-16%	24%	26%	0%

partikler (nitrat, sulfat og ammonium, tilsammen kaldet **SIA**), sekundært dannede organiske partikler (**SOA**) og havsalt (**SS**)

Visions for future urban health services

- In CURE:
  - SOFIA to be completed
  - Replicability potential , incl. costs of service delivery for other cities depending on availability of city specific data (transport, demography etc)
- Modelling, forecasting and simulations – defining decision-making and driving behavioural change
- Cross thematic services – integrating health, environment and economy
- Interactive services – supporting open governance and stakeholder engagement
- Light versions – applicable to all cities globally
- Post-covid transitions - towards “new normal” healthy sustainable cities