La ville, un risque pour la santé ? Respirer l'air de la ville

Bruno Housset

CHI de Créteil

CENTRE HOSPITALIER INTERCOMMUNAL CRETEIL

UPEC UNIVERSITÉ PARIS EST CRÉTEIL | FACULTÉ DE MÉDECINE

Déclaration liens d'intérêts

SUBVENTIONS À TITRE COLLECTIF	RÉMUNÉRATION ET AVANTAGES À TITRE PERSONNEL
Fondation du souffle FFP OREP	AstraZeneca, Mundipharma, Boehringer Ingelheim, Pfizer, Nycomed/Altana, Chiesi, GlaxoSmithKline, Novartis.

La ville, un risque pour la santé ? Respirer l'air de la ville

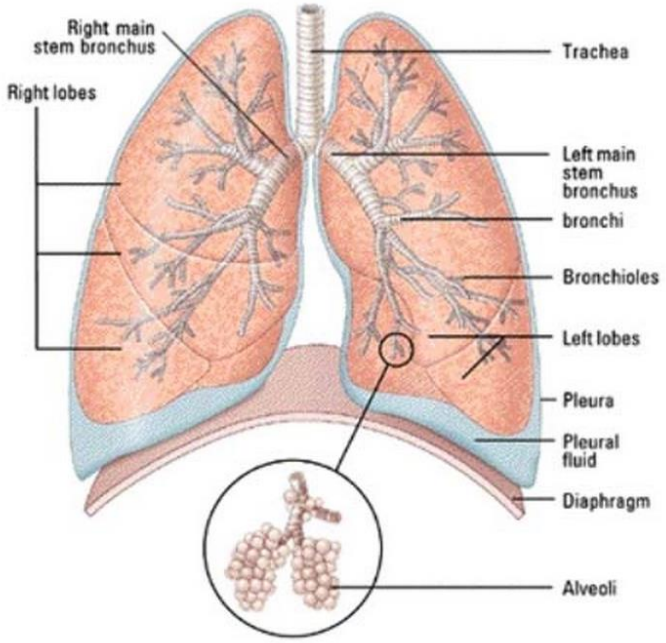
Bruno Housset

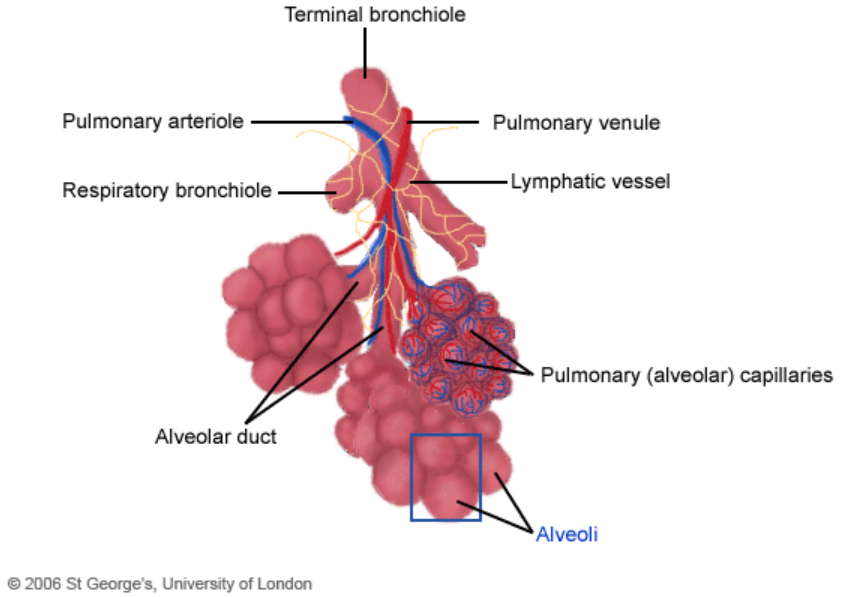
CHI de Créteil

CENTRE HOSPITALIER INTERCOMMUNAL CRETEIL

UPEC UNIVERSITÉ PARIS EST CRÉTEIL | FACULTÉ DE MÉDECINE

Le système ventilatoire

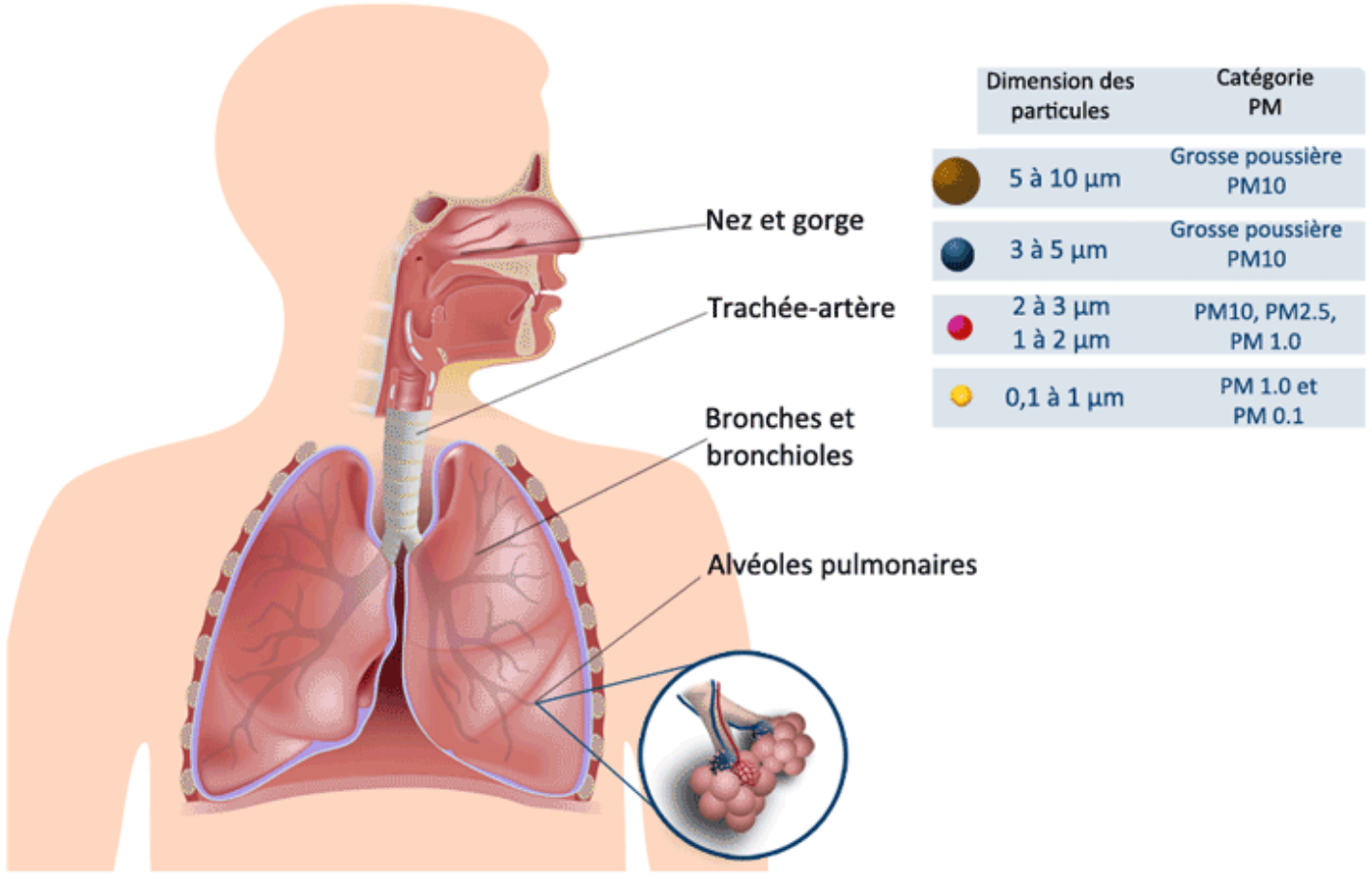




<u>15 000</u> litres d'air par jour (et davantage à l'exercice)

Surface alvéolaire= 100 m^2 - étendu mais fragile !

Pénétration des particules



Dimension des particules	Catégorie PM
5 à 10 µm	Grosse poussière PM10
3 à 5 µm	Grosse poussière PM10
2 à 3 µm 1 à 2 µm	PM10, PM2.5, PM 1.0
0,1 à 1 µm	PM 1.0 et PM 0.1

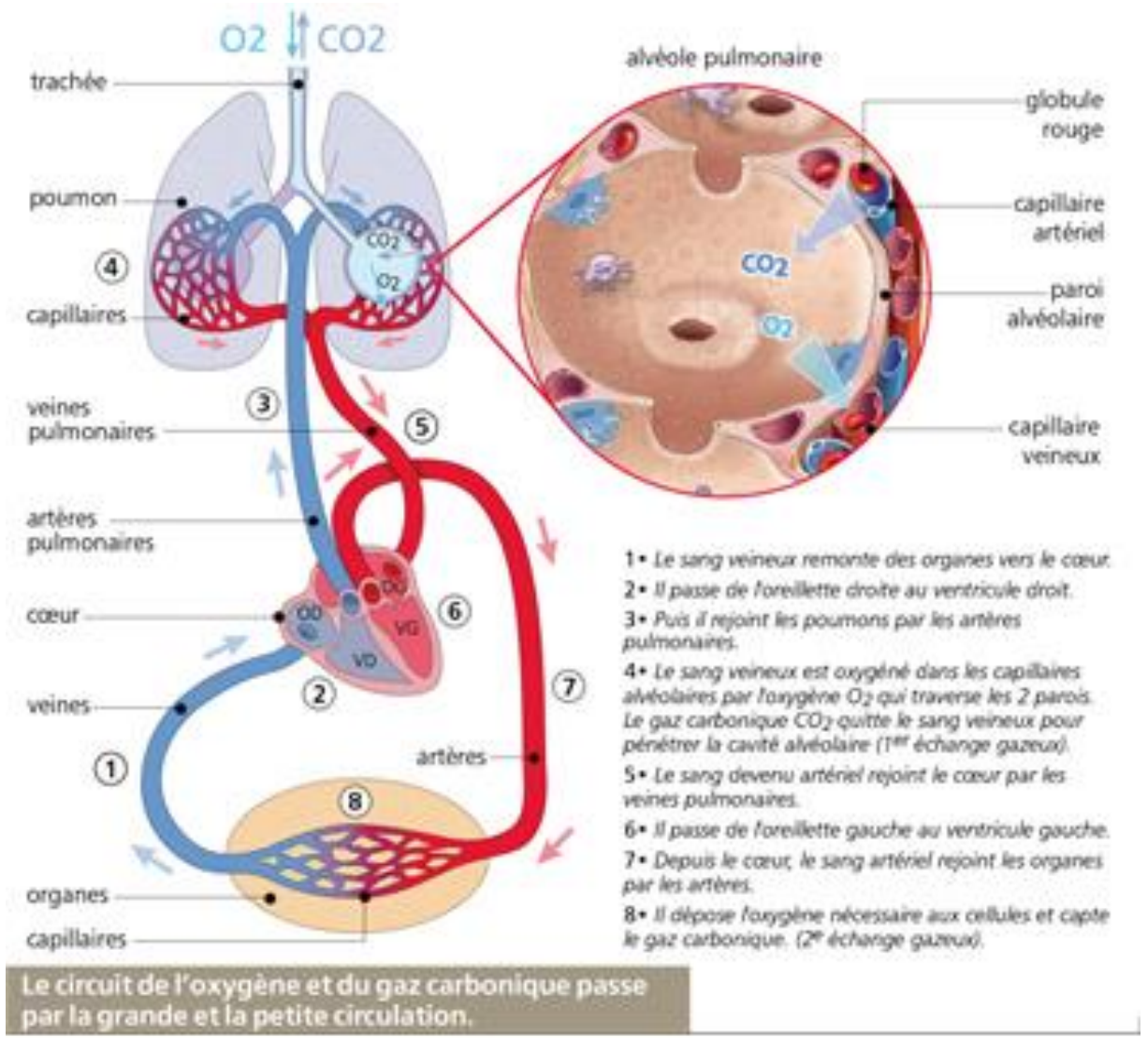
Organes respiratoires exposés aux poussières fines: plus les particules sont petites, plus elles pénètrent profondément dans l'appareil pulmonaire.

Système Circulatoire

Tout le sang passe par les poumons

Toxiques inhalés peuvent passer dans le sang

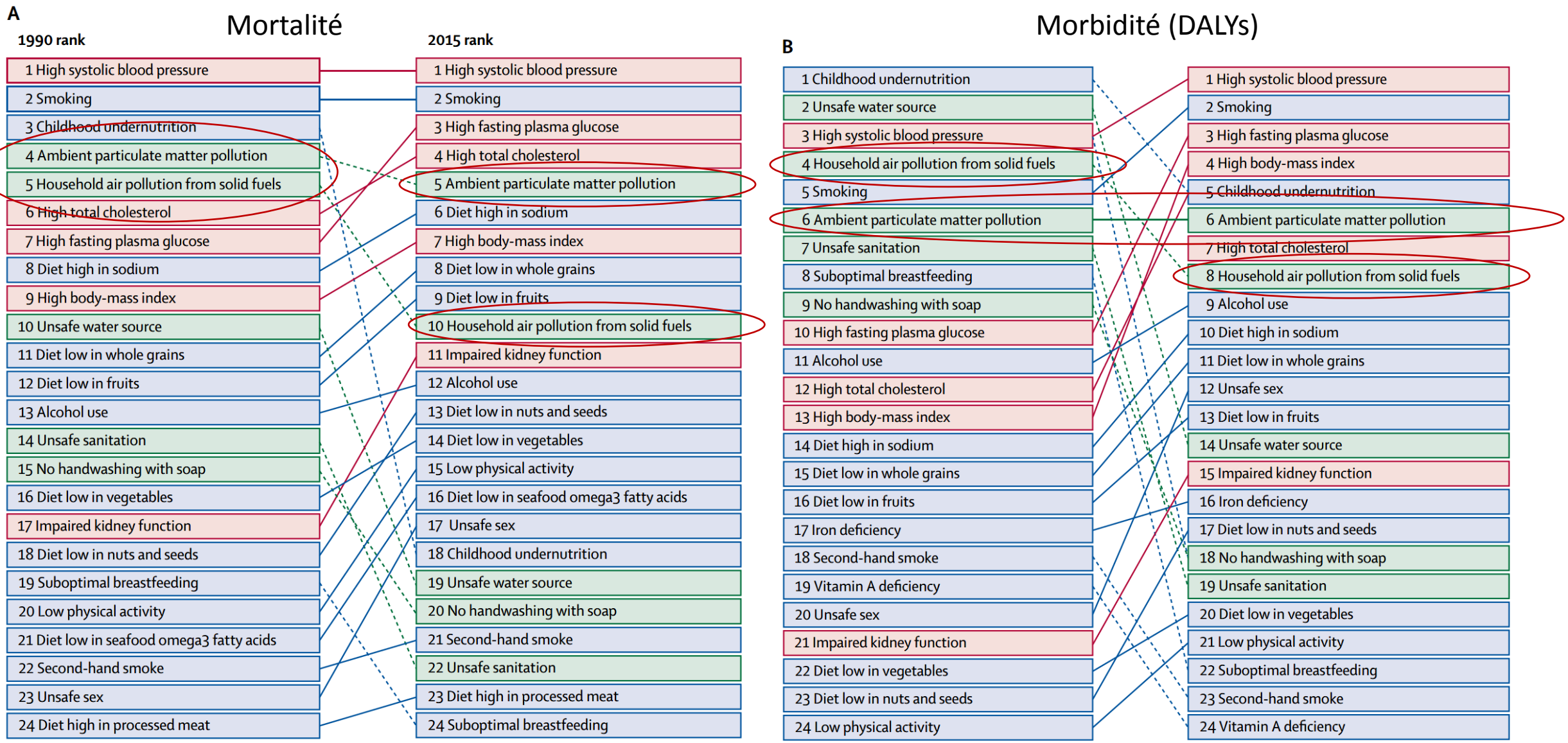
Toxiques peuvent aussi passer par le tube digestif



Le circuit de l'oxygène et du gaz carbonique passe par la grande et la petite circulation.

Difficile de choisir l’air que l’on respire

- La peau est étanche
- Nous pouvons choisir notre alimentation
- Il est plus difficile de choisir la qualité de l’air inspiré
  - Gaz
  - Fumées (tabac, échappements, feux)
  - Particules (amiante, silice, nanoparticules)
  - Allergènes
  - Germes
- Mesurable mais pour la plus grande partie invisible
- Et il est impossible de s’arrêter bien longtemps de respirer !



Cohen AJ *et al.* Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The Lancet* Published Online April 10, 2017. DOI : http://dx.doi.org/10.1016/S0140-6736(17)30505-6

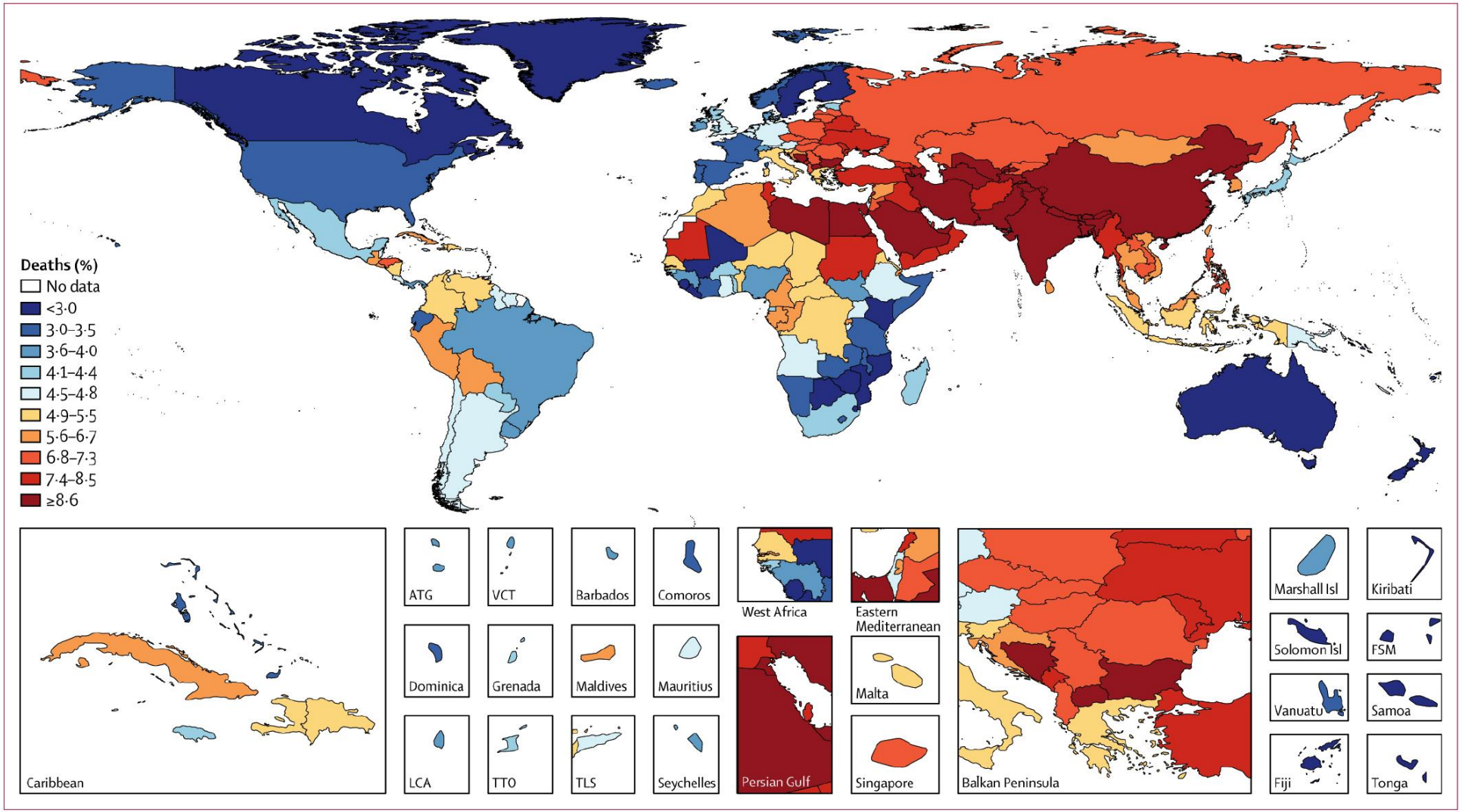


Figure 5: **Deaths attributable to ambient particulate matter pollution in 2015**

ATG=Antigua and Barbuda. FSM=Federated States of Micronesia. Isl=Island. LCA=Saint Lucia. TLS=Timor-Leste. TTO=Trinidad and Tobago. VCT=Saint Vincent and the Grenadines.

Cohen AJ *et al.* Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The Lancet* Published Online April 10, 2017. DOI : http://dx.doi.org/10.1016/S0140-6736(17)30505-6

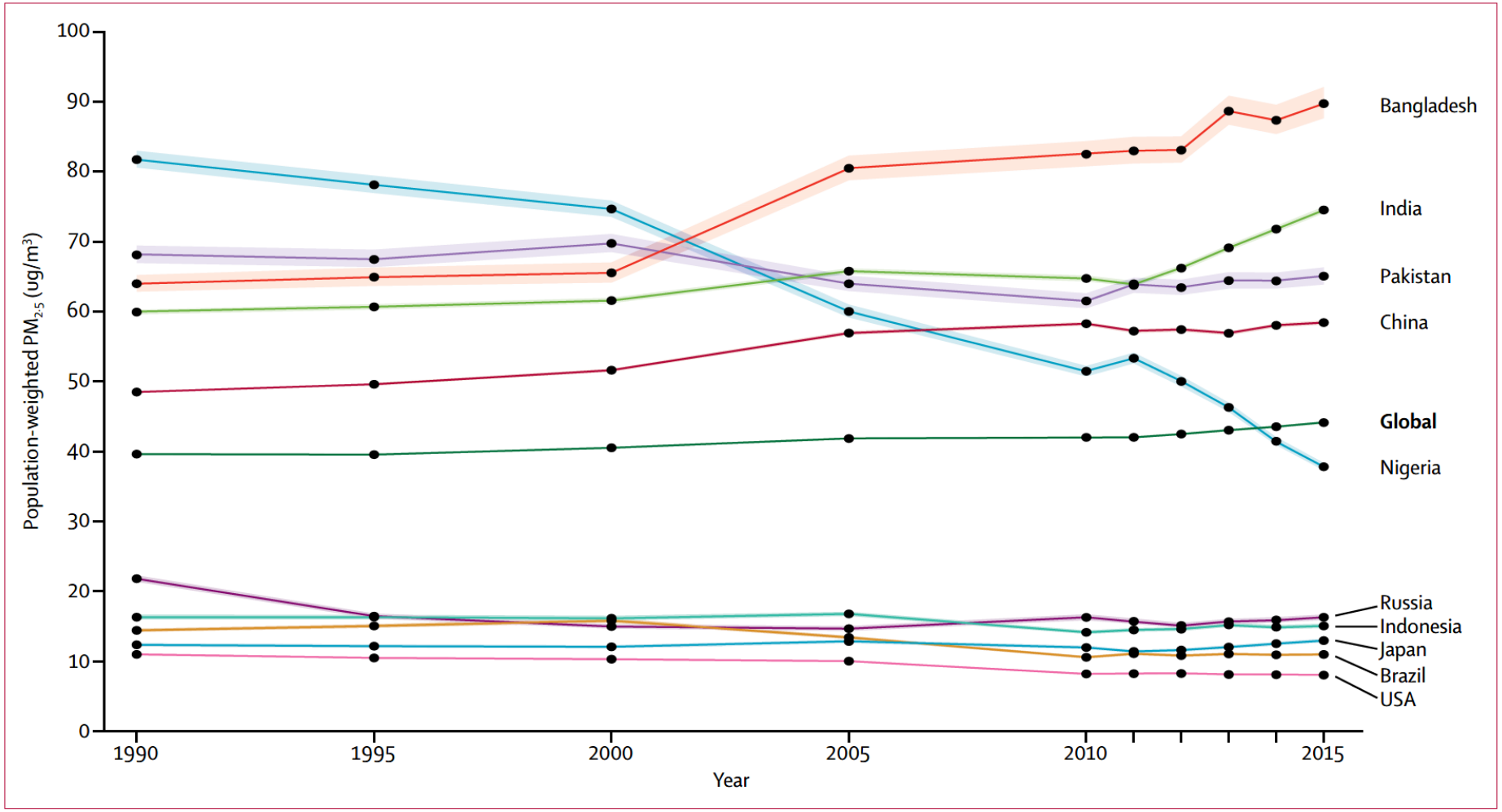


Figure 2: **Trends in population-weighted mean concentrations of particle mass with aerodynamic diameter less than 2·5 µm**
Global data and data from the ten most populous countries are shown. Shaded areas are 95% uncertainty intervals. $PM_{2·5}$=particle mass with aerodynamic diameter less than 2·5 µm.

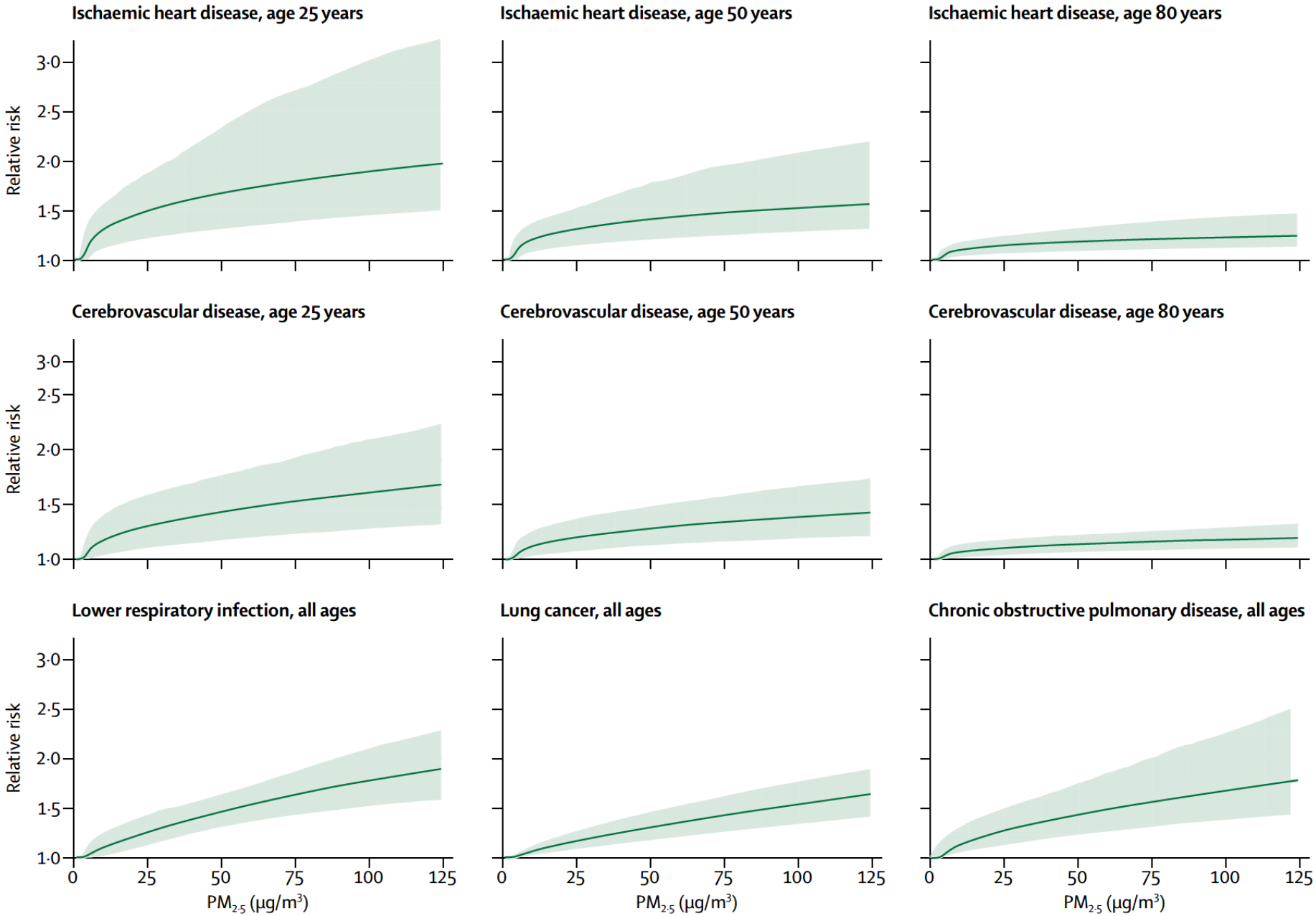
Cohen AJ *et al.* Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The Lancet* Published Online April 10, 2017. DOI : http://dx.doi.org/10.1016/S0140-6736(17)30505-6

Effets sur la santé de l'air que l'on respire

- Respiratoires
  - BPCO
  - Asthme
  - Cancer
  - Infections (grippe, tuberculose, pneumonies)

  = 90% des maladies respiratoires sont liées à l'environnement

- Non respiratoires
  - Infarctus du myocarde
  - Accidents vasculaires
  - Thrombose veineuse



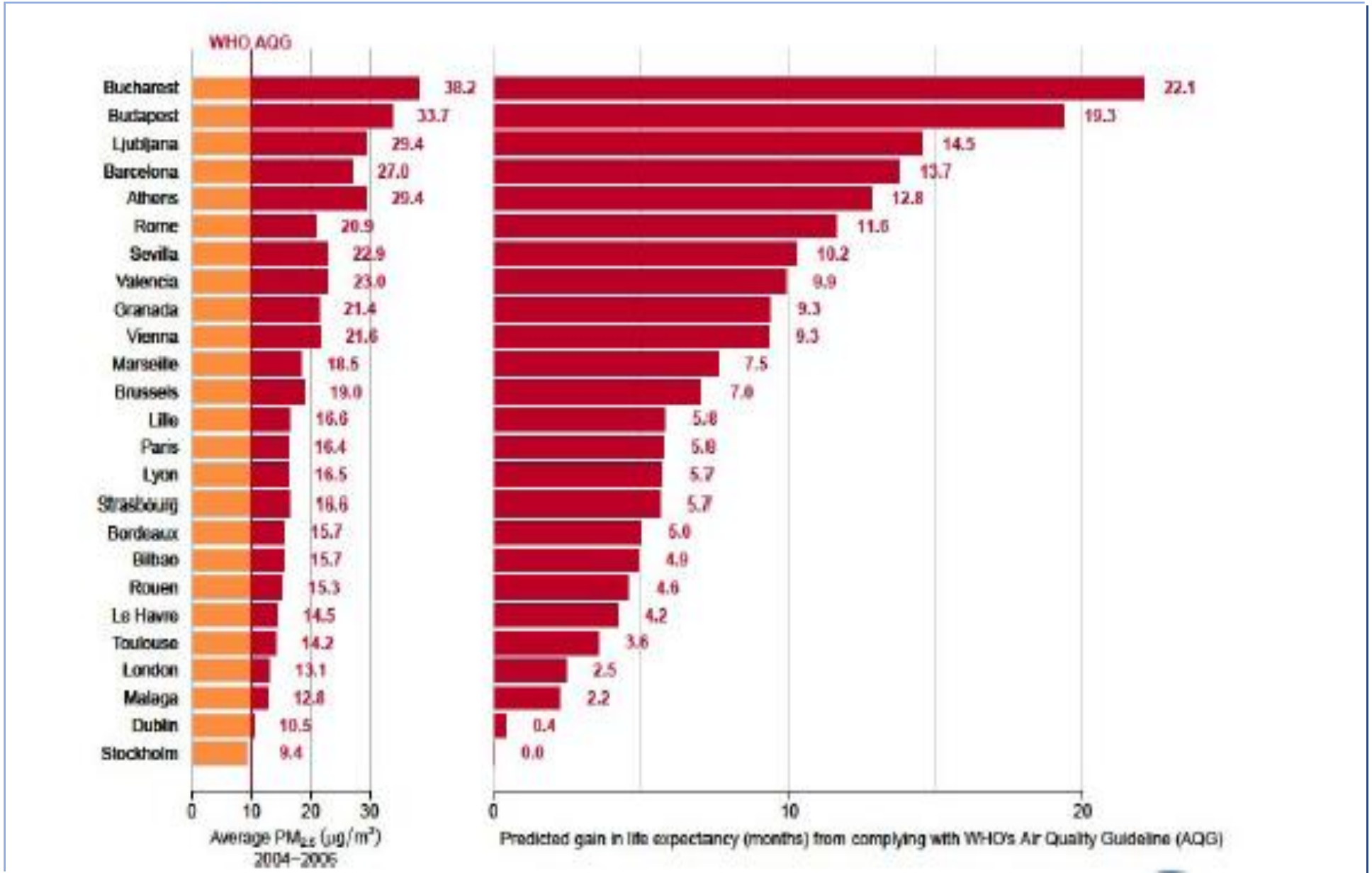
Curves show the central estimate of the integrated exposure–response (solid lines) and their 95% uncertainty intervals (shaded areas). The relative risk equals 1 for $PM_{2·5}$ concentrations of 0–2·4 µg/m³ (ie, lower bound of the theoretical minimum risk exposure level uncertainty distribution). Additional details are provided in the appendix (pp 7–15). $PM_{2·5}$=particle mass with aerodynamic diameter less than 2·5 µm.

Cohen AJ *et al.* Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The Lancet* Published Online April 10, 2017. DOI : http://dx.doi.org/10.1016/S0140-6736(17)30505-6

Pollution

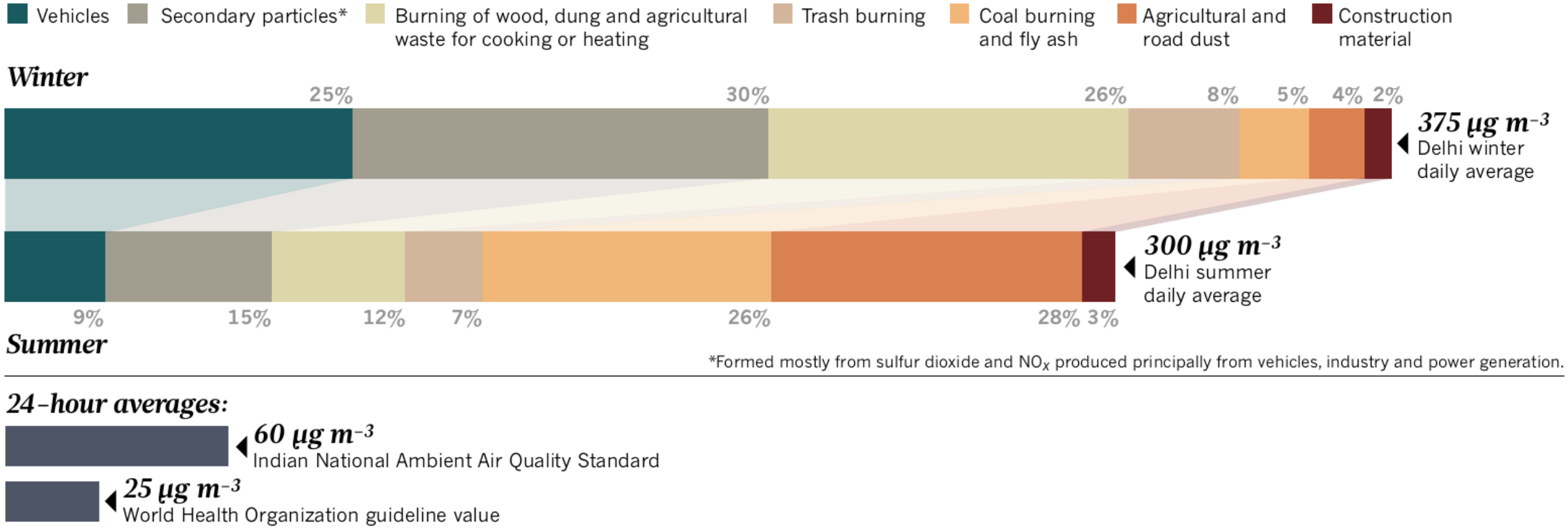
- Soupe de polluants
- Effets respiratoires plus marqués
  - Sur un poumon en développement (enfants)
  - En cas d'atteinte pré-existante (asthme/BPCO)
  - Chez le sujet âgé
- Extérieure (atmosphérique) ou intérieure (domestique)
- Grande variabilité temporelle et spatiale

Gain d'espérance de vie (mois) si les niveaux moyens de PM 2.5 étaient à 10µg/m3 (valeur guide OMS)



Poison stew

Delhi has the highest particulate air-pollution readings of any megacity. A study released this year by the Indian Institute of Technology Kanpur[4] found that different sources dominate in winter and summer for particles smaller than 2.5 micrometres, known as $PM_{2.5}$.

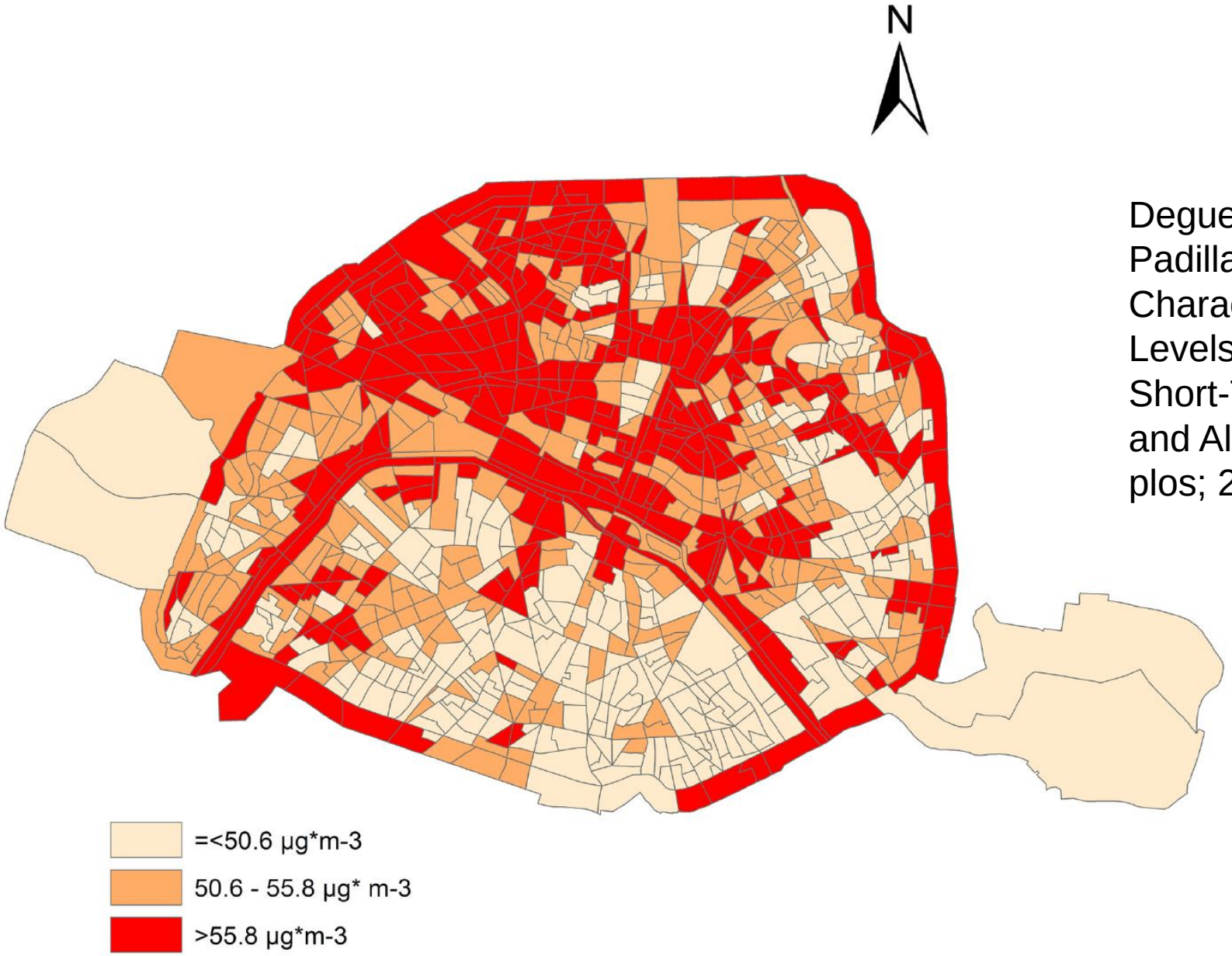


Subramanian M. Can Delhi save itself from its toxic air? Nat News. nature; 2016;534(7606):166.

Expérience londonienne

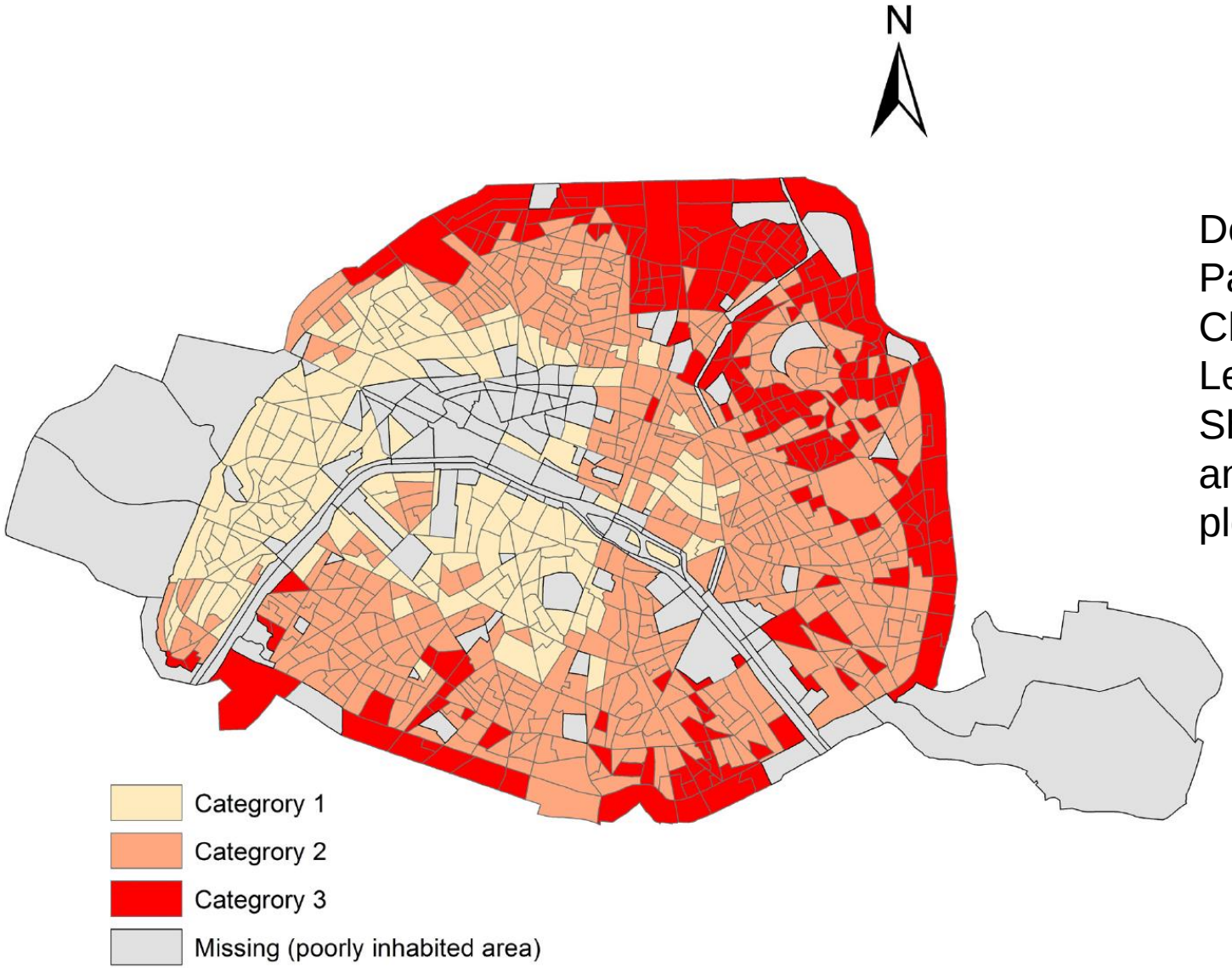
- **Comparaison des effets respiratoires d'une sortie de 2 heures à 3 semaines d'intervalle :**
  - Oxford Street (section réservée bus et taxis)
    PM 2,5 : 28,3 µg/m^3 – Nano : 63,7 10^3/cm^3 - NO2 : 142 µg/m^3
  - Hyde Park (interdit aux voitures)
    PM 2,5 : 11,9 µg/m^3 – Nano : 18,3 10^3/cm^3 - NO2 : 21,7 µg/m^3
- **2 groupes d'asthmatiques légers(31) et modérés (29)**
  - Dégradation significative de la fonction respiratoire
  - Marqueurs biologiques d'inflammation broncho-pulmonaire

McCreanor, J., et al., Respiratory Effects of Exposure to Diesel Traffic in Persons with Asthma. N Engl J Med, 2007. 357(23): p. 2348-2358.



NO_2 concentrations from 2002 to 2009, in census block areas within Paris.

Deguen S, Petit C, Delbarre A, Kihal W, Padilla C, Benmarhnia T, et al. Neighbourhood Characteristics and Long-Term Air Pollution Levels Modify the Association between the Short-Term Nitrogen Dioxide Concentrations and All-Cause Mortality in Paris. Plos One. plos; 2015;10(7):e0131463.



Deguen S, Petit C, Delbarre A, Kihal W, Padilla C, Benmarhnia T, et al. Neighbourhood Characteristics and Long-Term Air Pollution Levels Modify the Association between the Short-Term Nitrogen Dioxide Concentrations and All-Cause Mortality in Paris. Plos One. plos; 2015;10(7):e0131463.

Socioeconomic categories in census block areas in Paris.

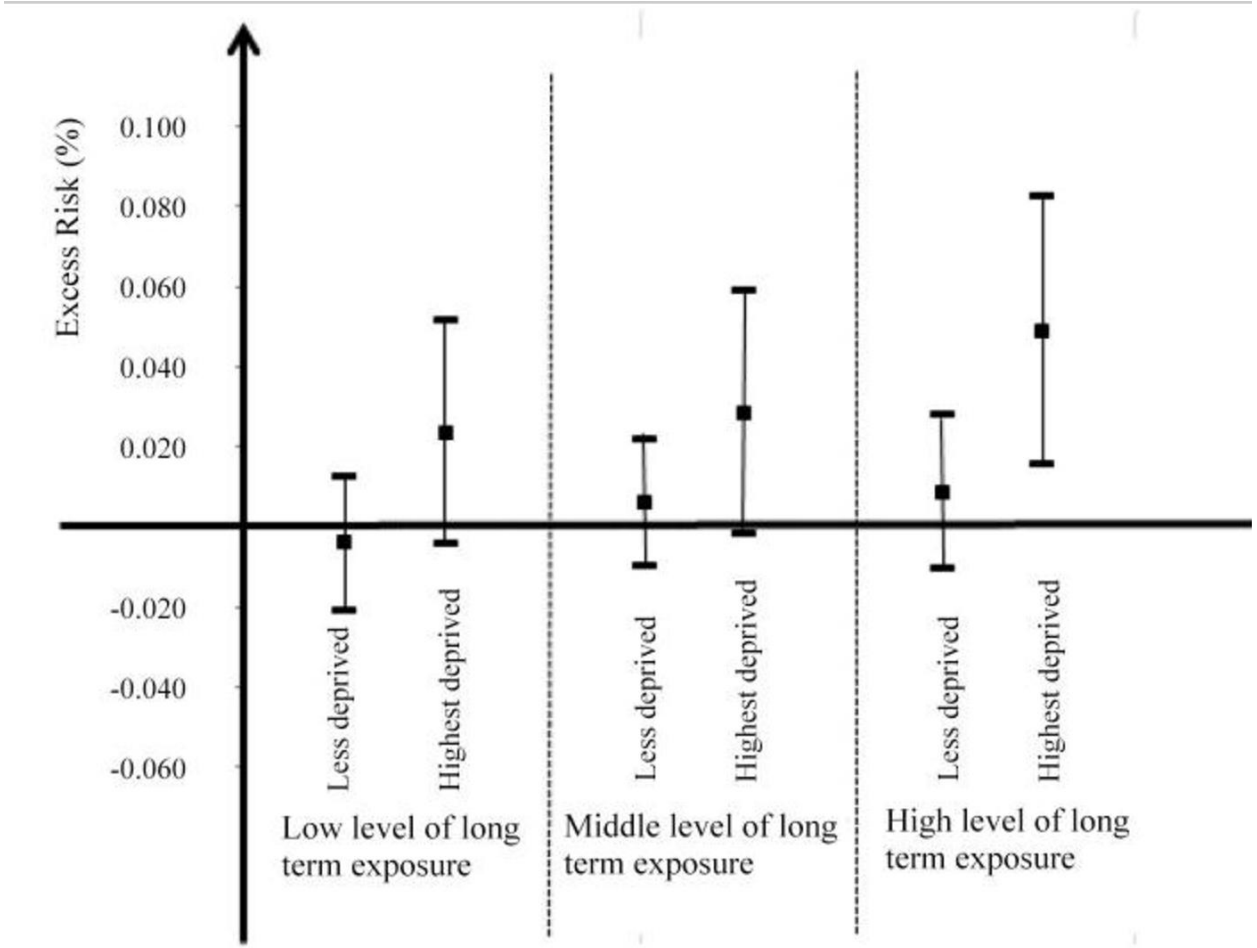
Table 1. Descriptive statistics of NO_2 concentrations (short and long term) across the study period (2004–2009).

Short term concentrations	Mean [CV%†]	Long term concentrations	Mean [CV%‡]
All blocks	52.59 [26.47%]	All blocks	53.21 [11.43%]
Least deprived blocks	52.78[25.29%]	Least exposed blocks	47.48 [4.76%]
Intermediate blocks	52.33 [26.66%]	Intermediate blocks	53.15 [2.92%]
Most deprived blocks	53.01 [26.99%]	Most exposed blocks	60.61 [7.18%]

†: expressed in $\mu g/m^3$

‡CV% = coefficient of variation in %

Deguen S, Petit C, Delbarre A, Kihal W, Padilla C, Benmarhnia T, et al. Neighbourhood Characteristics and Long-Term Air Pollution Levels Modify the Association between the Short-Term Nitrogen Dioxide Concentrations and All-Cause Mortality in Paris. Plos One. plos; 2015;10(7):e0131463.



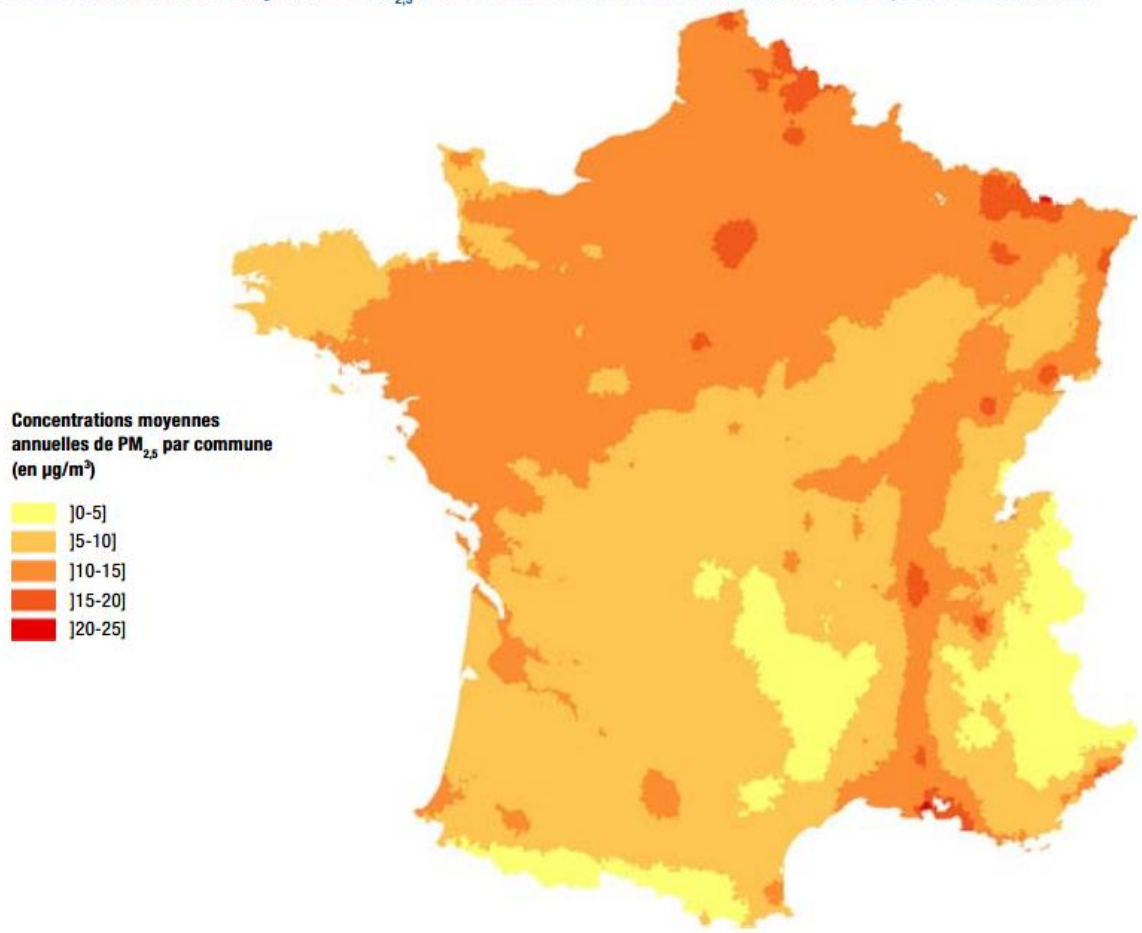
Excess risk of mortality associated with a 10-µg/m3 short-term NO2 increase and 95% confidence Interval, stratified by SES and long-term NO2 concentrations- Paris, France, 2004–2009

Deguen S, Petit C, Delbarre A, Kihal W, Padilla C, Benmarhnia T, et al. Neighbourhood Characteristics and Long-Term Air Pollution Levels Modify the Association between the Short-Term Nitrogen Dioxide Concentrations and All-Cause Mortality in Paris. Plos One. plos; 2015;10(7):e0131463.

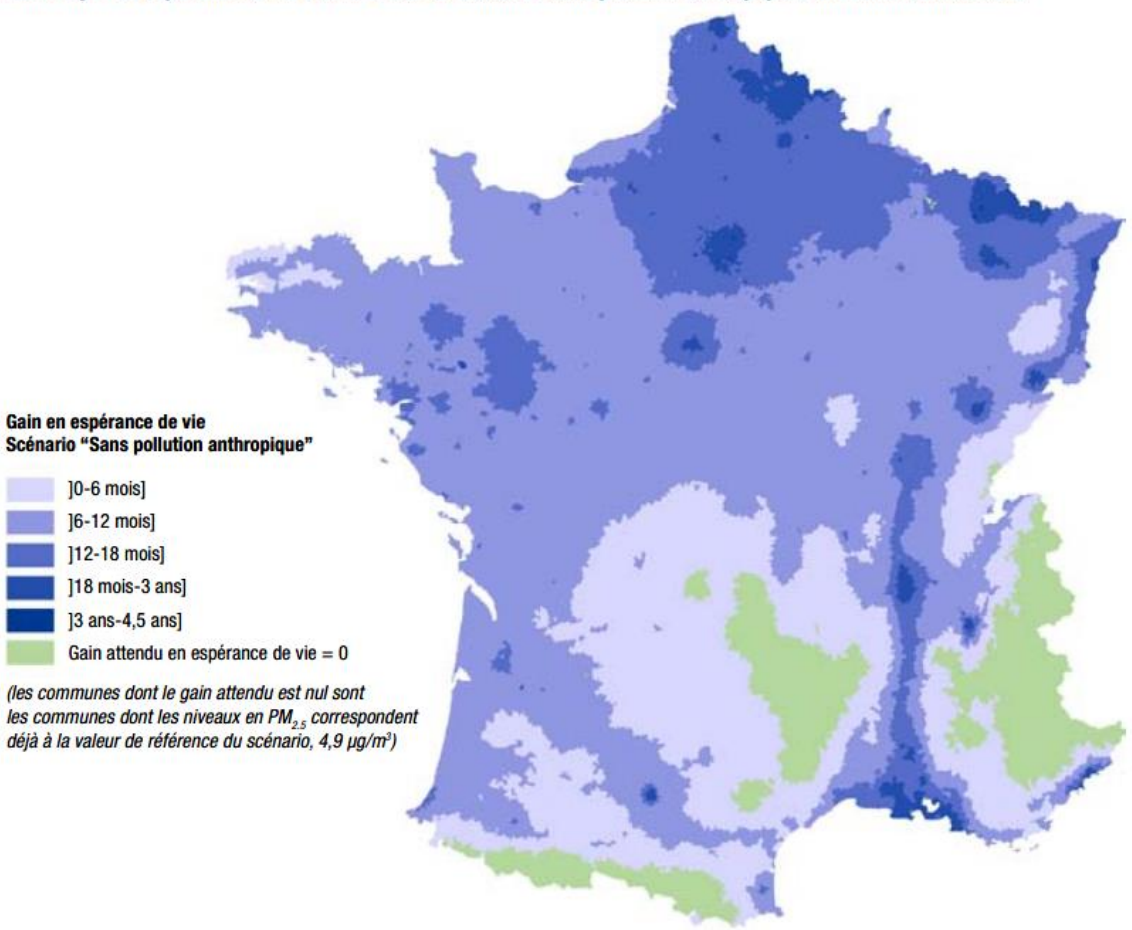
Gain en espérance de vie - PM 2,5 < 5µg/m^3

Pascal M, de Crouy Chanel P, Wagner V, Corso M, Tillier C, Bentayeb M, et al. Analyse des gains en santé de plusieurs scénarios d'amélioration de la qualité de l'air en France continentale. Bull Epidémiol Hebd. 2016;(26-27):430-7. http://invs. santepubliquefrance.fr/beh/2016/26-27/2016_26-27_1.html

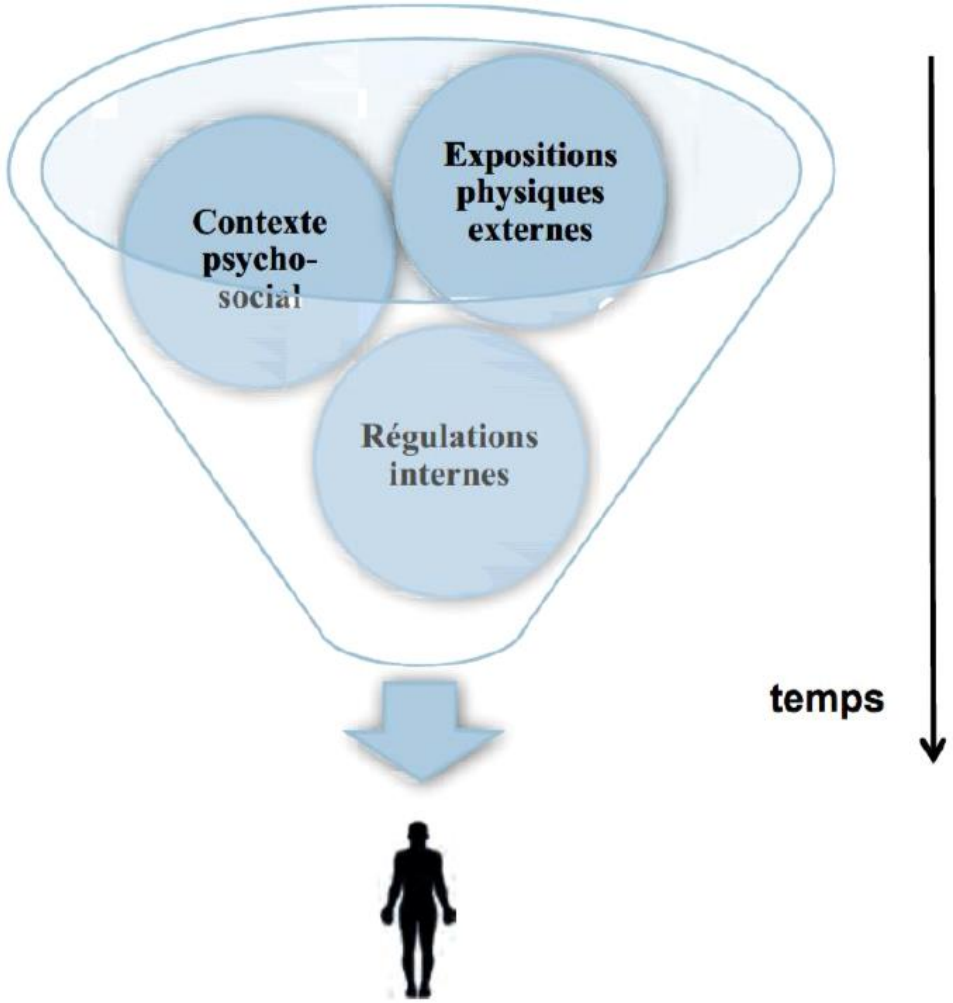
Concentrations annuelles moyennes de $PM_{2,5}$ utilisées dans l'EQIS. Modèle Gazel-Air 2007-2008, France continentale



Gain moyen en espérance de vie à 30 ans sous le scénario « sans pollution anthropique » en France continentale



Exposome



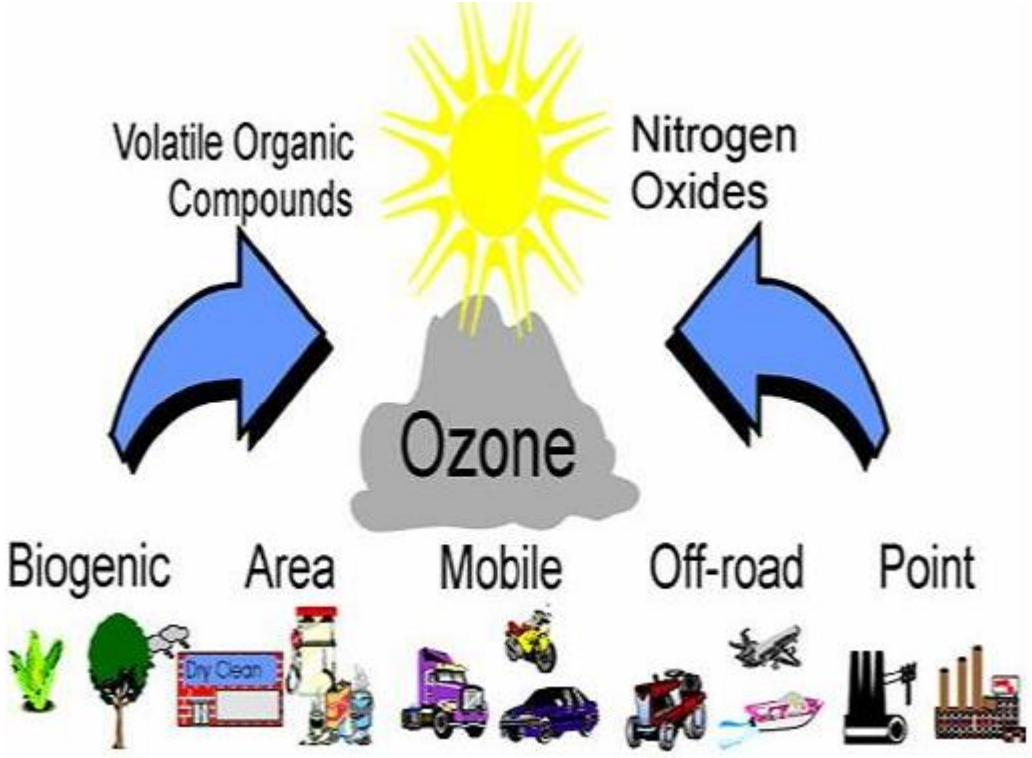
D'après :
Environnement et santé : la combinatoire des expositions
Robert Barouki
Questions de Santé Publique
N° 26 – Septembre 2014

http://www.iresp.net/communication/publication-dun-bulletin-trimestriel-de-4-pages/

http://humanexposomeproject.com/

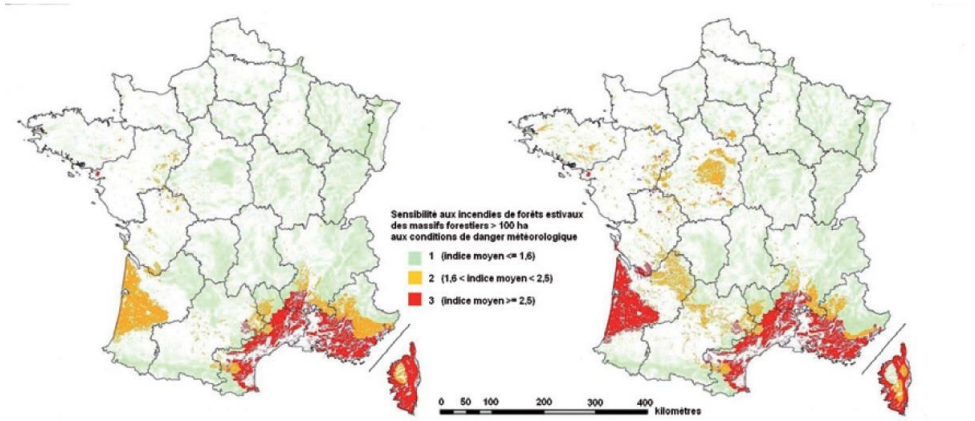
Interactions
Réchauffement Climatique - Pollution

Génération d'ozone



Génération de PM 10 et PM 2,5

- Remise en suspension de poussières
- Feux de forêts
- Tempêtes
- Orages



Note : Les deux cartes ci-dessus indiquent pour les massifs de plus de 100 ha le degré de sensibilité actuel et à l'horizon 2040.
Le niveau le plus élevé est en rouge, le niveau moyen en orange, et le niveau faible en vert. En blanc figurent les zones sans massif forestier supérieur à 100 ha ou à sensibilité très faible.

Source : D'après le rapport de la mission interministérielle « Changement climatique et extension des zones sensibles aux feux de forêt », juillet 2010.

Pollens - Ambroisie

- Croissance plus rapide et en plus grand nombre
- Augmentation de la production de pollen / plante
- Davantage de protéines allergéniques dans le pollen
- Précocité et allongement de la période pollinique
- Modification de la distribution géospatiale du pollen

Chaleur + CO2 ?

2000
-
2010

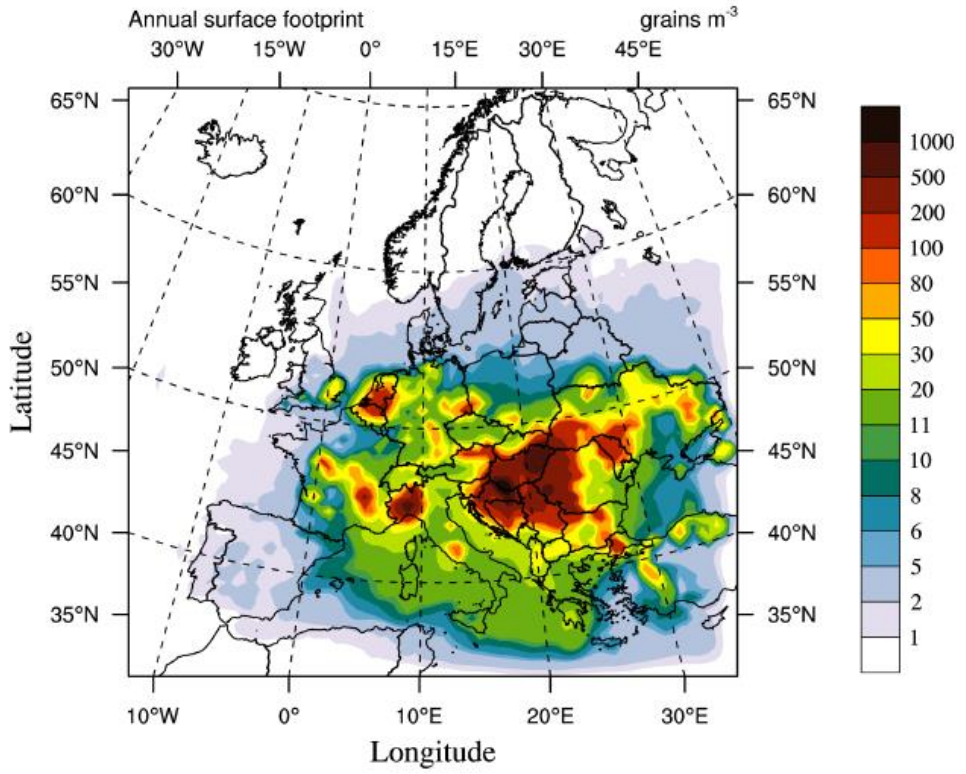


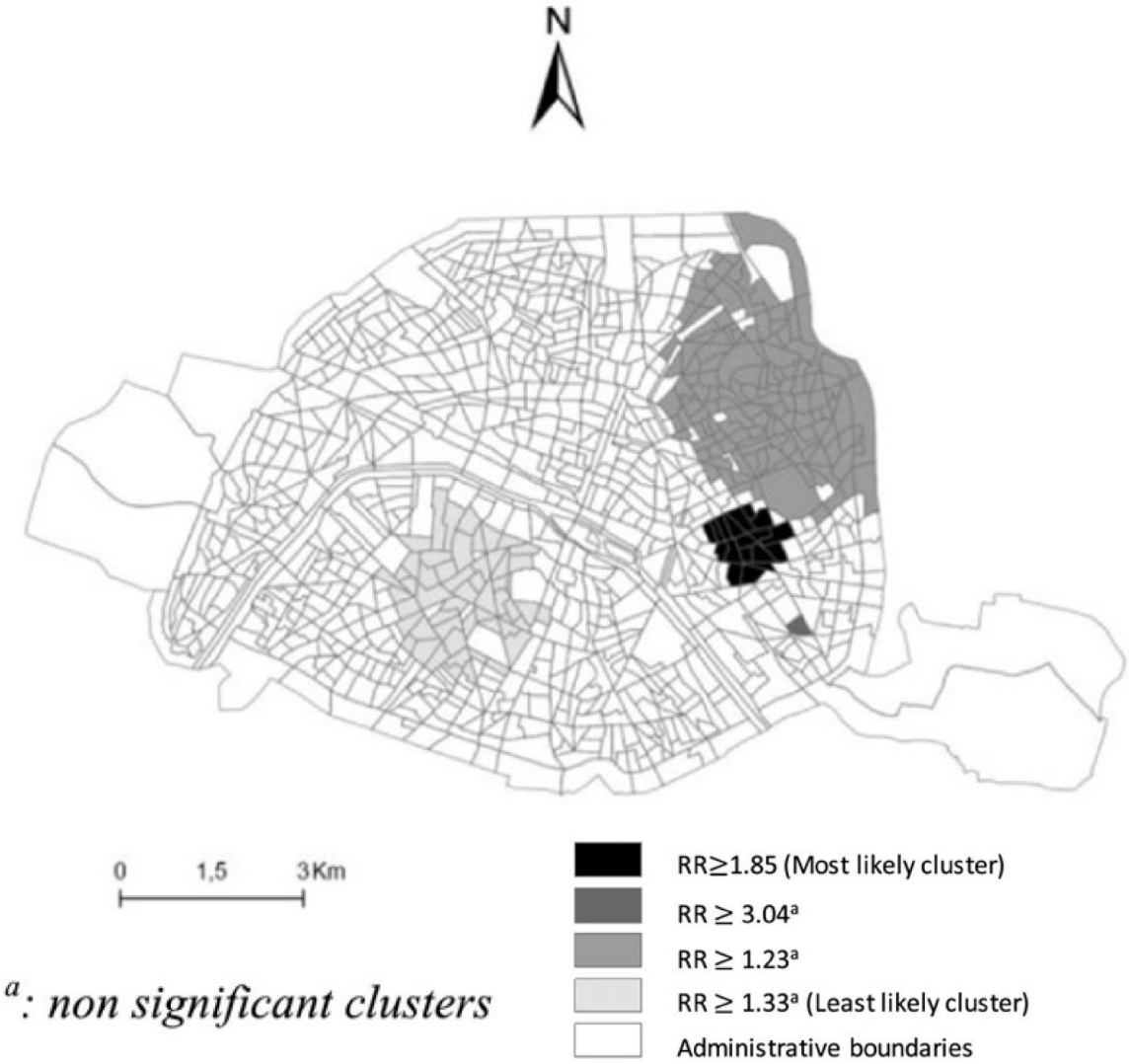
Figure 12. Annual footprint of ragweed pollen at the surface, obtained by selecting the maximum from daily averaged concentrations during the whole pollen season.

les concentrations dans l'air du pollen de l'ambroisie à feuille d'armoise pourraient **quadrupler** en 2050, le changement climatique expliquant les deux tiers de cette augmentation.

= augmentation de la prévalence asthme et rhinite.
Une allergie respiratoire pourrait concerner plus de 50% de la population en 2050

Liu L, Solmon F, Vautard R, Hamaoui-Laguel L, Torma CZ, Giorgi F. Estimates of common ragweed pollen emission and dispersion over Europe using RegCM-pollen model. Biogeosciences Discussions. 3 nov 2015;12(21):17595-641.

Ilots de chaleur



Spatial distribution of relative risk (RR) for death (among old people ≥65 years) during the heat wave period (Definition A) in Paris (2004–2009). The grey census blocks show the areas with increased RR.

Table 3
Meta-regression model investigating the predictors of the log [relative risks] for Definition A.

Independent variable	Beta coefficients	(95% CI)
Annual mean PM_{10} concentration ($\mu g/m^3$)	0.023	0.001; 0.045
Annual mean $PM_{2.5}$ Concentration ($\mu g/m^3$)	0.032	−0.001; 0.064
Annual mean NO_2 concentration ($\mu g/m^3$)	0.004	−0.003; 0.010
Social deprivation index (Tercile)	0.027	−0.024; 0.079
Social deprivation index (Quintile)	0.008	−0.022; 0.038
Proportion of foreign people (%)	0.614	0.010; 1.218
Proportion of unemployed people (%)	0.638	−0.401; 1.678
Proportion of People with no diploma (%)	0.137	−0.484; 0.759
Proportion of people with a higher educational degree in the 15 years old and more (%)	−0.124	−0.504; 0.255
Proportion of non-owners (%)	67.71%	−0.217; 0.372
Proportion of people living in low-income housing (%)	−0.082	−0.252; 0.0877
Proportion of people with stable jobs (%)	−0.202	−0.619; 0.214
Proportion of blue collar workers (%)	1.280	0.211; 2.348
Proportion of people over the age of 65 in the total population (%)	−1.640	−2.404; −0.876
Median income per consumption unit (in euros per year)	−0.007	−0.021; 0.007
Green-space proportion in each census block (%)	−0.005	−0.011; −0.0001
Density of constructed feature in each census block (%)	0.0041	0.001; 0.008

CI: Confidence interval.

Benmarhnia T, Kihal-Talantikite W, Ragettli M, Deguen S. Small-area spatiotemporal analysis of heatwave impacts on elderly mortality in Paris: A cluster analysis approach. Sci Total Environ. sciencedirect; 2017;592:288–94.

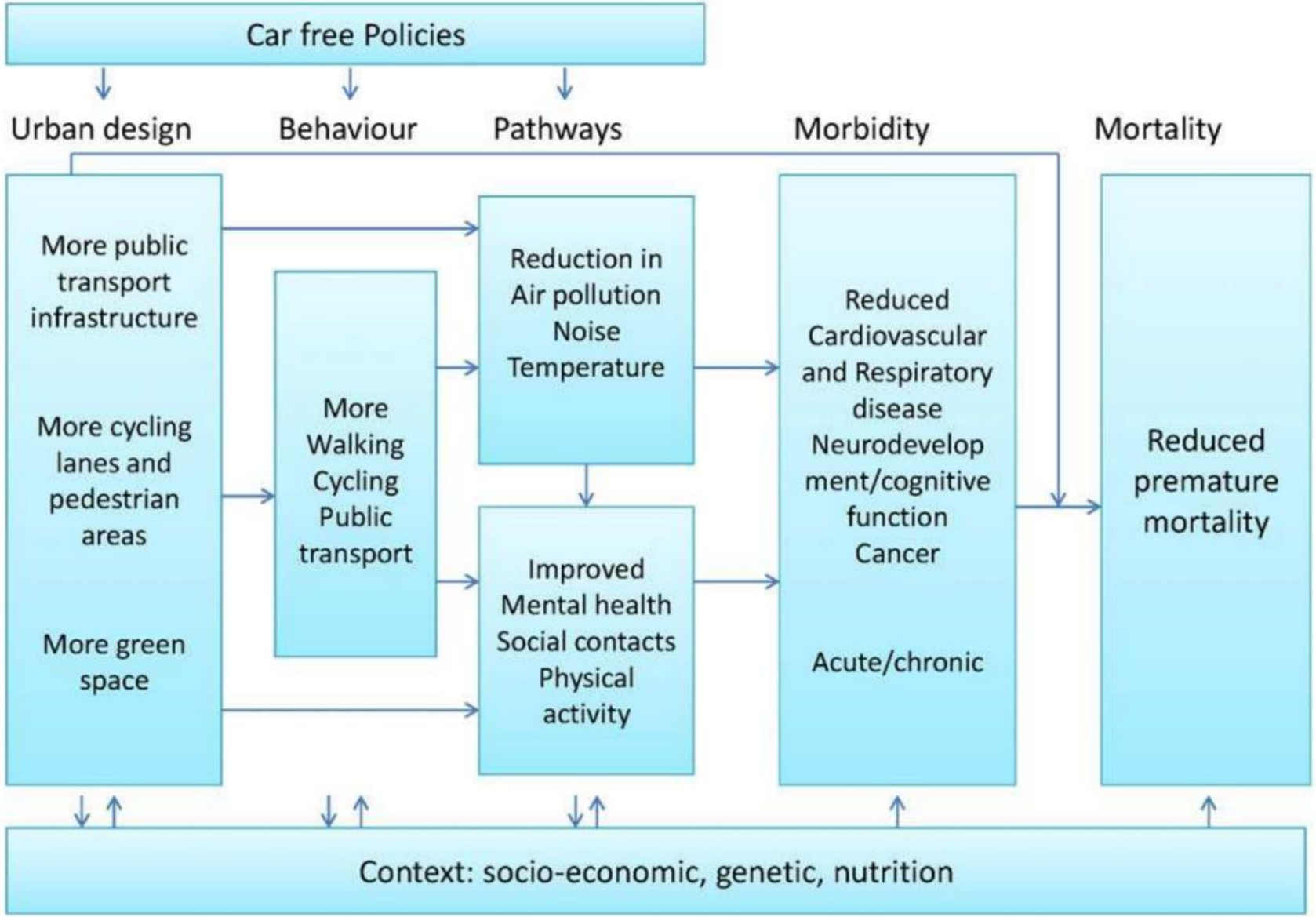


Fig. 1. Linkage between urban and transport planning, environmental exposures, physical activity and health.

Nieuwenhuijsen MJ, Khreis H. Car free cities: Pathway to healthy urban living. Environment International. Environment International; 2016;94:251–62.

FLOW FEATURES

360° air intake

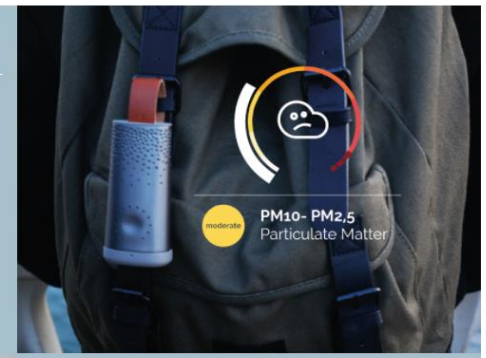
Versatile leather strap

Glanceable LED interface

TRACK

OUTDOOR & INDOOR POLLUTION

- **PM2.5:** Particulate Matter and Dust
- **NOx:** Exhaust Fumes
- **Ozone:** Irritating Gas
- **VOCs:** Household Chemicals
- **Temperature**
- **Humidity**



MONITOR

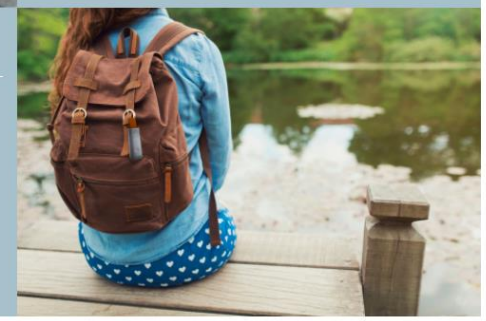
AND REDUCE YOUR EXPOSURE

- Receive **tailored air quality alerts**.
- Discover easy ways to **escape pollution**.
- Find the **ideal moment** for an outdoor activity.

IMPROVE

BE PART OF A GLOBAL MOVEMENT

- **Build better routines** while mapping your city to find clean air hotspots.
- Join a **community of citizens** helping make the air we breathe more transparent.



https://plumelabs.com/en/products/flow

“Il aspira une bouffée de brise humide matinale, inhalant azote, oxygène, argon, xénon et radon, vapeur d'eau, monoxyde de carbone, dioxyde d'azote, tétra éthyle de plomb, benzène, particules de carbonates et de silicates, quelques spores de champignons, une escadrille de bactéries, un poil d'origine inconnue, un ectoparasite de pigeon, des pollens anémophiles, une goutte d'anhydride sulfureux échappée d'une lointaine usine et un grain de sable en provenance de Tevtikiye (Nord-Ouest de la Turquie) transporté par le sirocco de la nuit.

Bref, il respira l'air de la ville.”

Actes Sud – Février 2009