

Environment and Heart Disease

Pollution, hypertension, diabetes and obesity

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Why heart disease ?

- Framingham Heart Study 1948-2013

National Heart and Blood Institute / Harvard Medical School

- Tobacco
- Heredity
- Diabetes
- High cholesterol
- High blood pressure
- Sedentarity
- Obesity
- Stress

Did Framingham say
everything ?

Cardiovascular disease: Facts

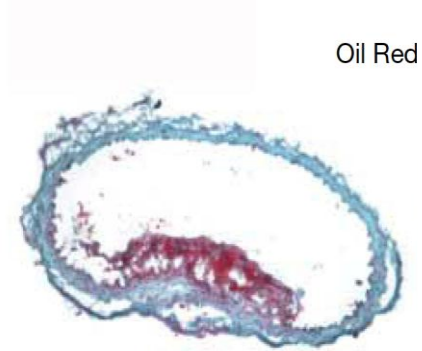
- Rare in animals
- Rare within humanity
 - before 1830
- Rare within humanity
 - living outside industrialized world

Cardiovascular disease: Facts

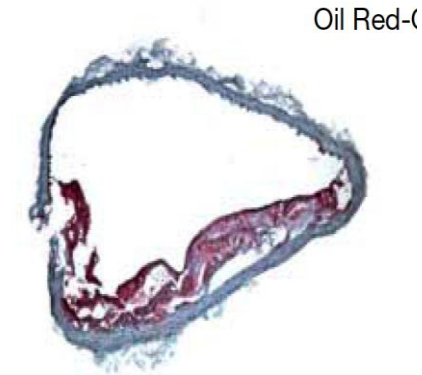
- Inducible in animals
 - Excellent medical bench test
- Dramatic increase of cardiac morbidity
 - Following traditional industrial revolution

Filtered air

Normal Chow



High-Fat Chow



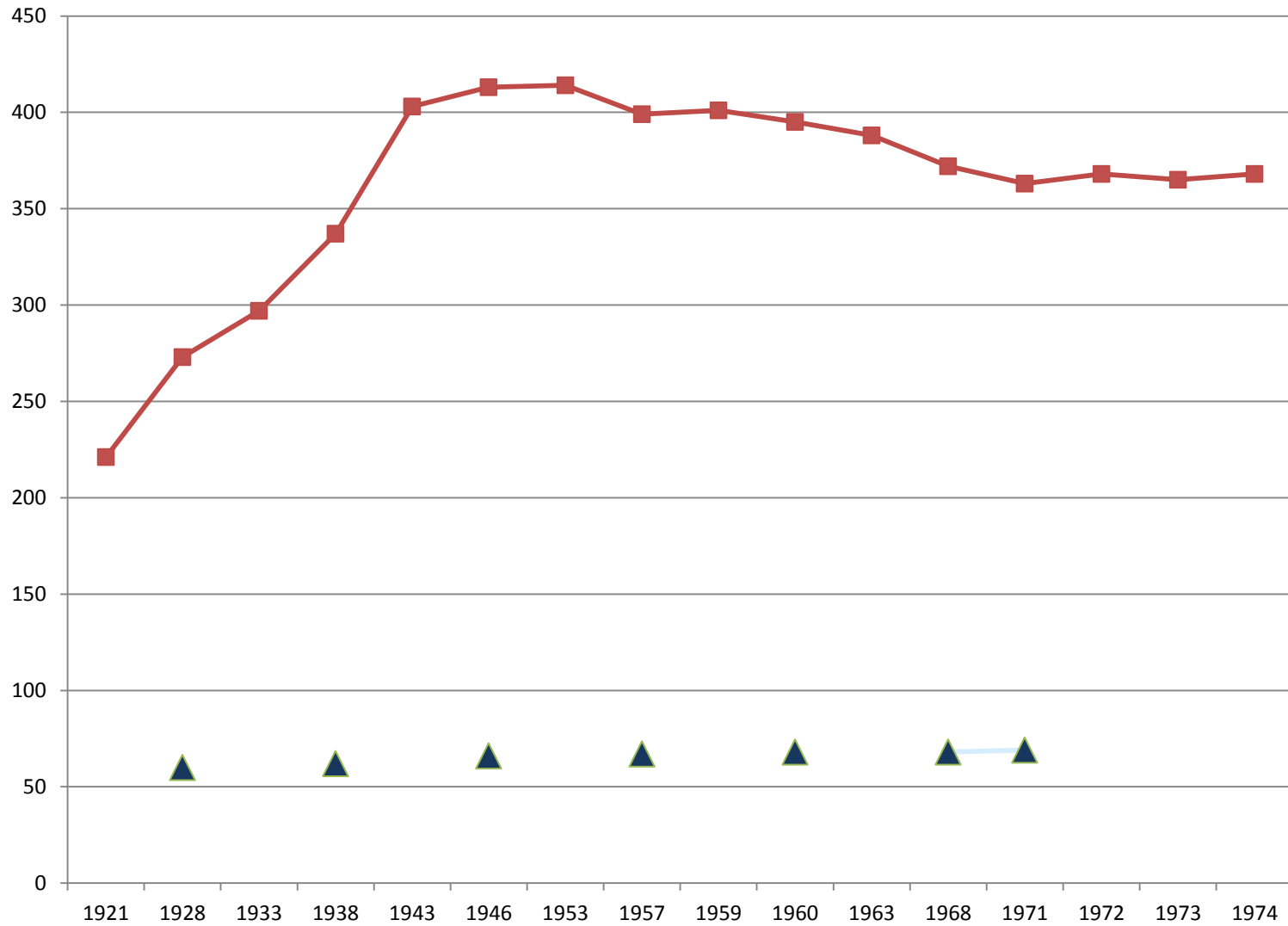
Long-term Air Pollution Exposure and Acceleration of Atherosclerosis and Vascular Inflammation in an Animal Model. JAMA 2005. 294: 3003-3010

Why heart disease ?
1948

The Framingham Heart Study

American epidemic

Rate of CV mortality / Canada 1920-1975



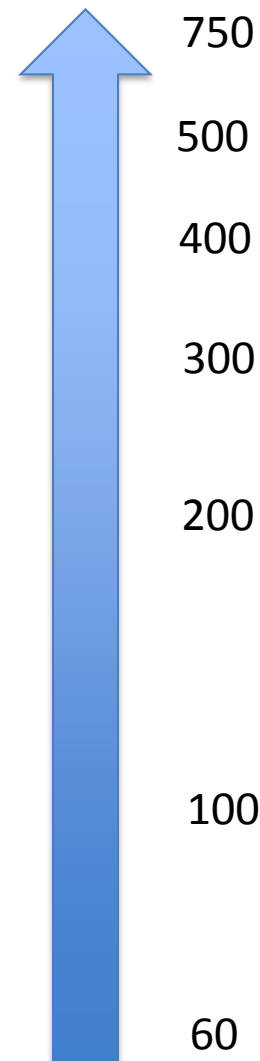
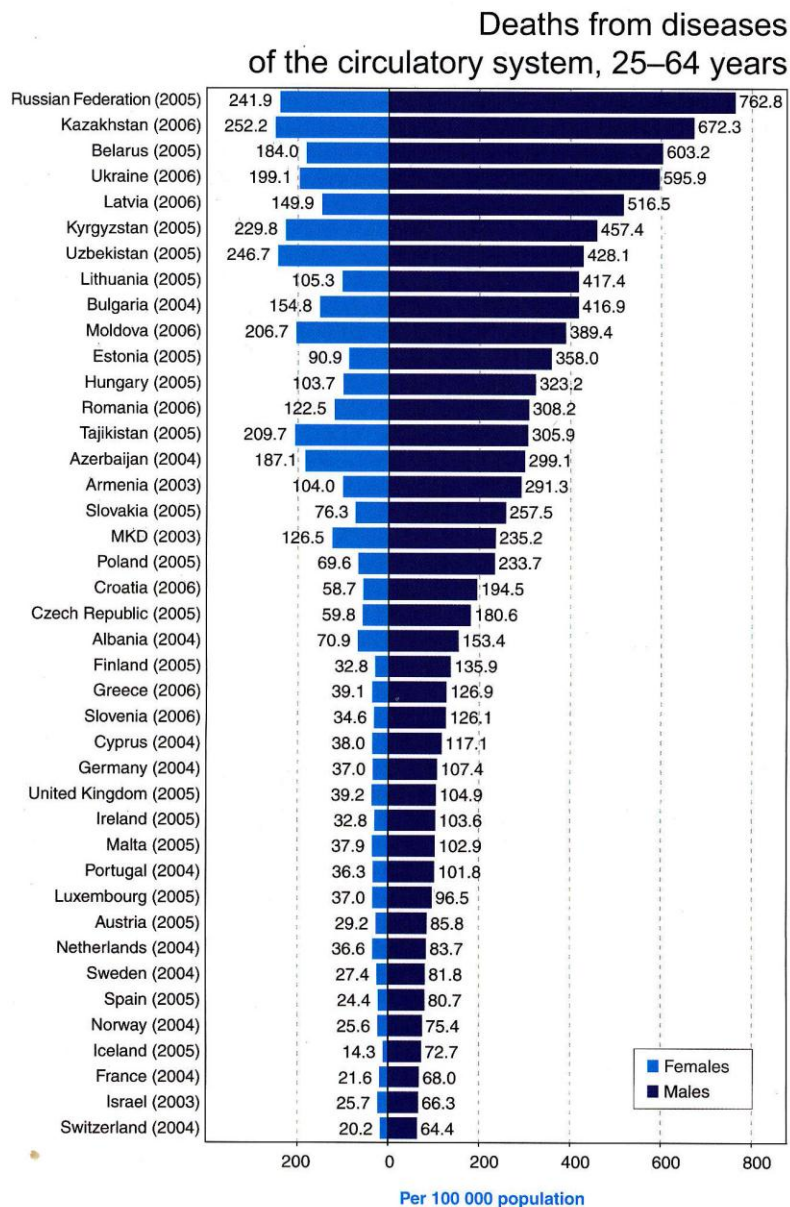
World Health Organization, 2008

Russia

Poland

Austria

Switzerland



Why atherosclerosis ?

3 triads

– **What we are**

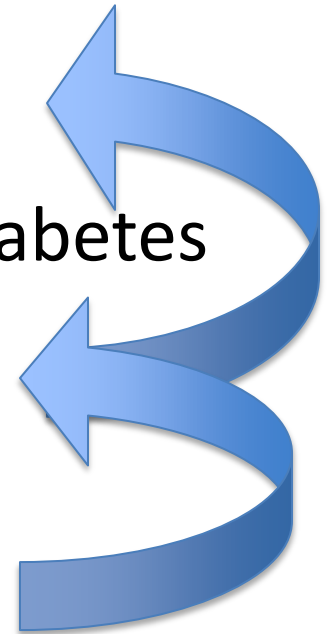
- Cholesterol, hypertension, diabetes

– **What we do**

- Sedentarity, obesity, tobacco

– **Where we are**

- Environment, food, urbanism



Human trade with environment

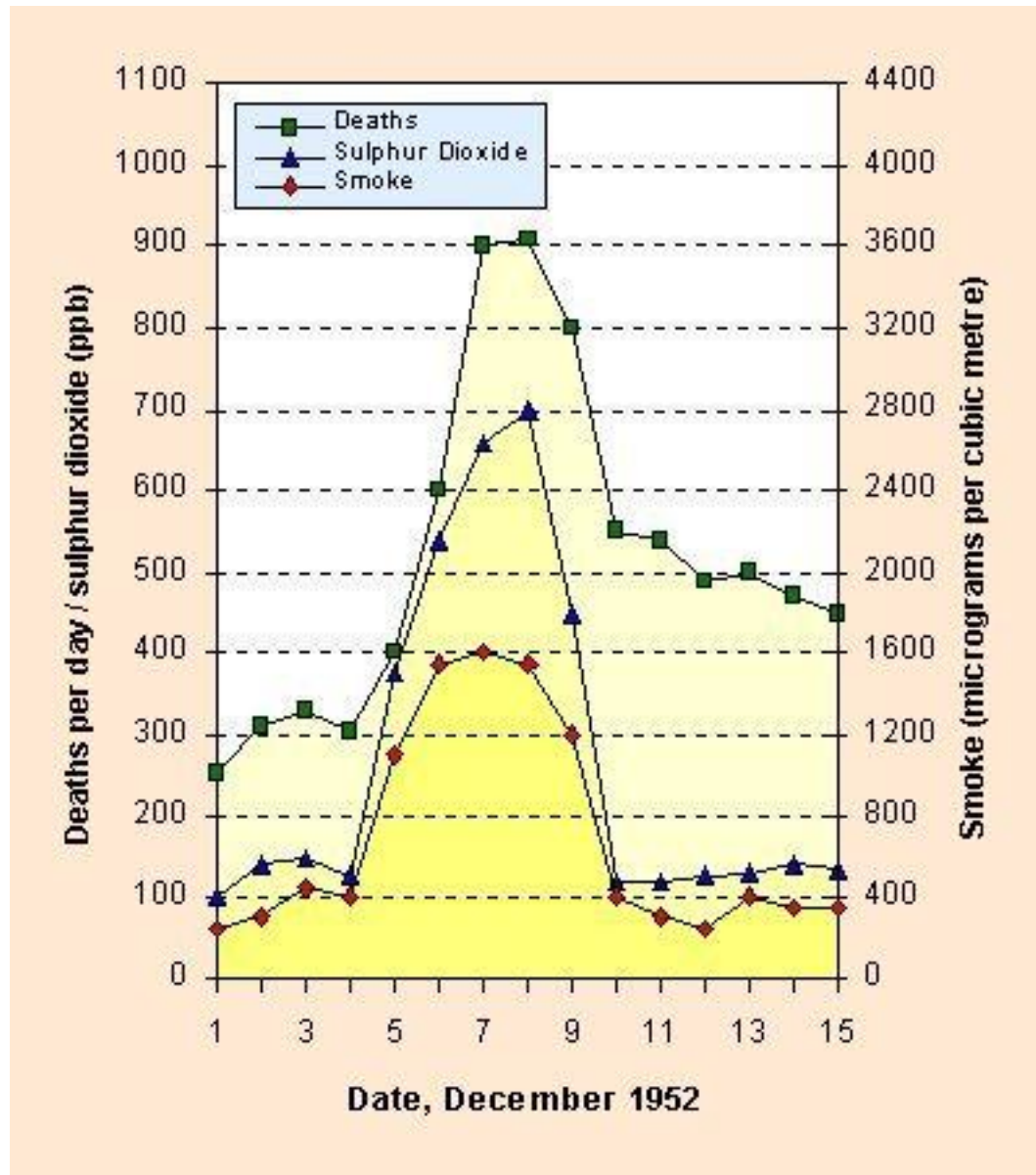
- What we eat • 1 kg
- What we drink • 2 kgs
- What we breathe • 20 kgs

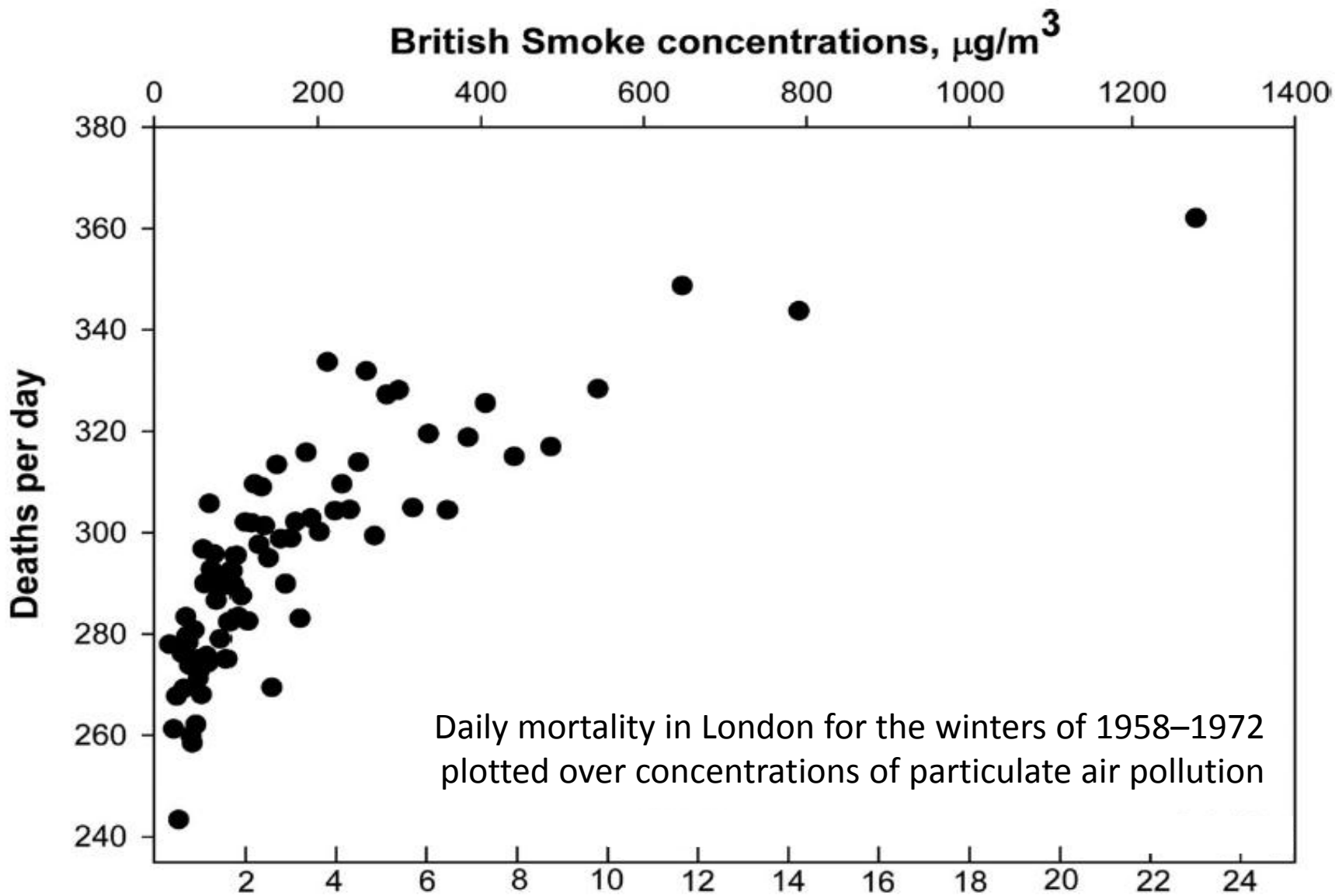
Environmental Cardiology: A few milestones

1952: the Great London Smog



"Great London Smog » : 12 000 deaths in excess





1993: The Six-Cities Study

The New England Journal of Medicine

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Volume 329

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Number 24

AN ASSOCIATION BETWEEN AIR POLLUTION AND MORTALITY IN SIX U.S. CITIES

DOUGLAS W. DOCKERY, Sc.D., C. ARDEN POPE III, Ph.D., XIPING XU, M.D., Ph.D.,
JOHN D. SPENGLER, Ph.D., JAMES H. WARE, Ph.D., MARTHA E. FAY, M.P.H.,
BENJAMIN G. FERRIS, JR., M.D., AND FRANK E. SPEIZER, M.D.

Abstract Background. Recent studies have reported associations between particulate air pollution and daily mortality rates. Population-based, cross-sectional studies of metropolitan areas in the United States have also found associations between particulate air pollution and annual mortality rates, but these studies have been criticized, in part because they did not directly control for cigarette smoking and other health risks.

Methods. In this prospective cohort study, we estimated the effects of air pollution on mortality, while controlling for individual risk factors. Survival analysis, including Cox proportional-hazards regression modeling, was conducted with data from a 14-to-16-year mortality follow-up of 8111 adults in six U.S. cities.

Results. Mortality rates were most strongly associated with cigarette smoking. After adjusting for smoking and

other risk factors, we observed statistically significant and robust associations between air pollution and mortality. The adjusted mortality-rate ratio for the most polluted of the cities as compared with the least polluted was 1.26 (95 percent confidence interval, 1.08 to 1.47). Air pollution was positively associated with death from lung cancer and cardiopulmonary disease but not with death from other causes considered together. Mortality was most strongly associated with air pollution with fine particulates, including sulfates.

Conclusions. Although the effects of other, unmeasured risk factors cannot be excluded with certainty, these results suggest that fine-particulate air pollution, or a more complex pollution mixture associated with fine particulate matter, contributes to excess mortality in certain U.S. cities. (N Engl J Med 1993;329:1753-9.)

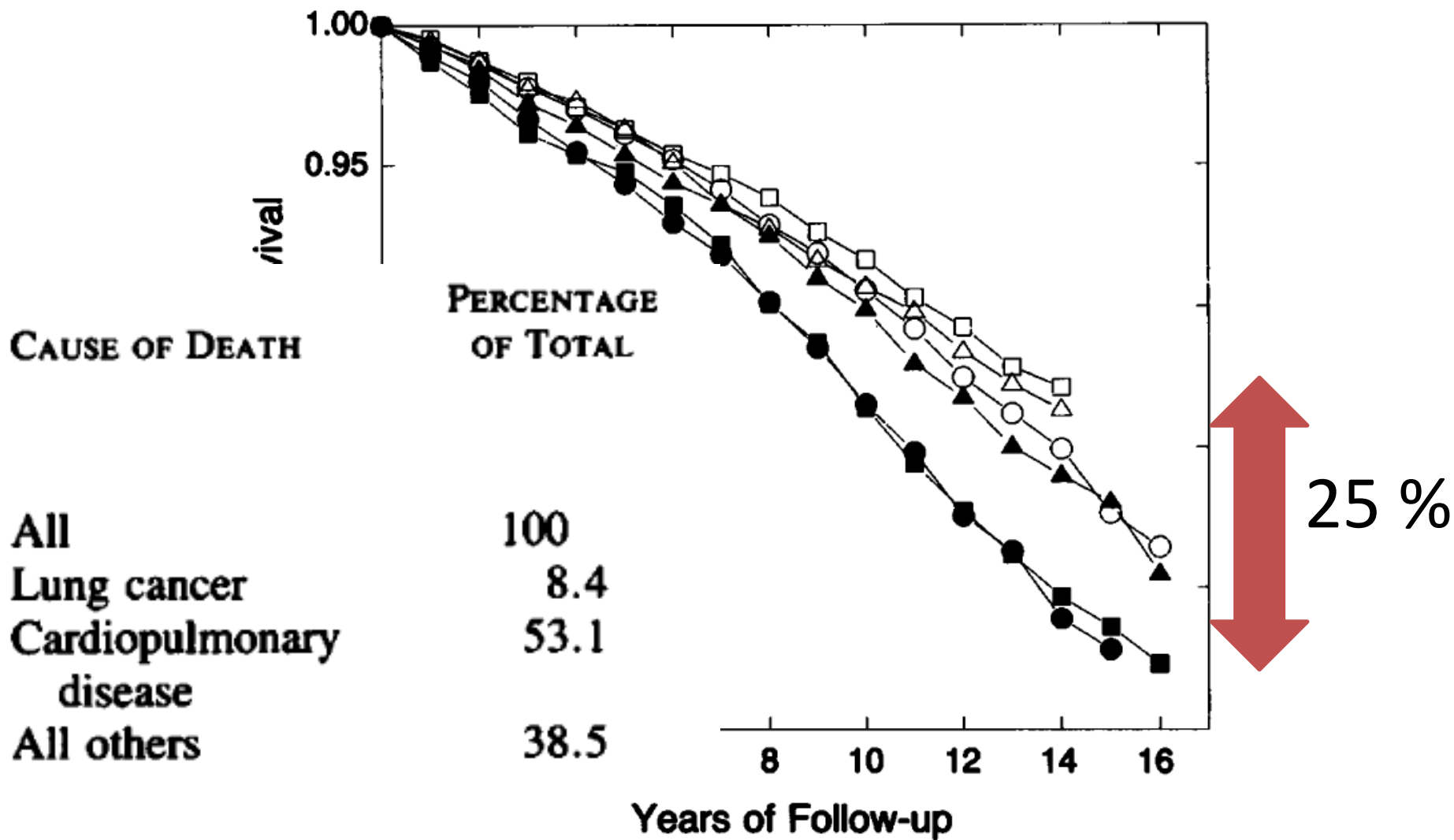


Figure 2. Crude Probability of Survival in the Six Cities, According to Years of Follow-up.

2004; 2010

AHA Scientific Statement

Particulate Matter Air Pollution and Cardiovascular Disease An Update to the Scientific Statement From the American Heart Association

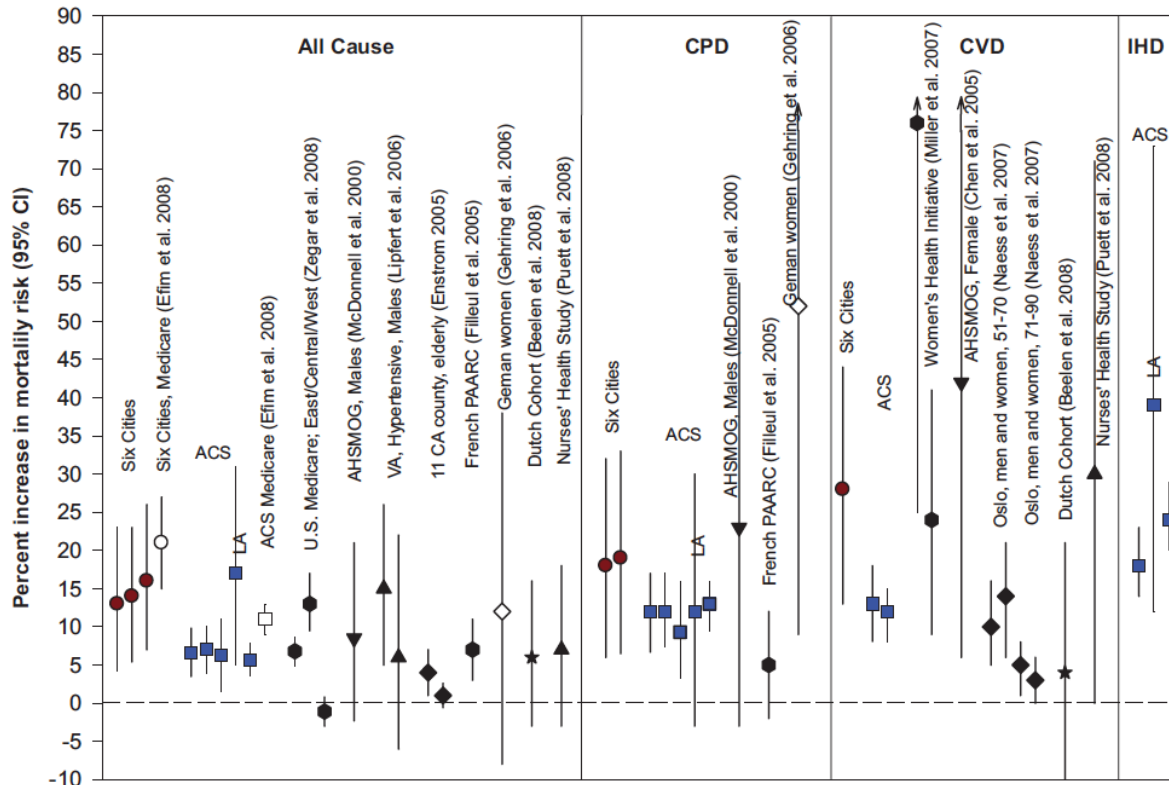


Figure 1. Risk estimates provided by several cohort studies per increment of $10 \mu\text{g}/\text{m}^3$ in $\text{PM}_{2.5}$ or PM_{10} . CPD indicates cardiopulmonary disease; IHD, ischemic heart disease.

2008

The environmental burden of disease in Canada: Respiratory disease, cardiovascular disease, cancer, and congenital affliction

David R. Boyd^{a,*}, Stephen J. Genuis^b

- 20,000 deaths in excess
- 5-11 000 cardiovascular deaths
- 33-67 000 cardiac hospitalizations
- 1,5 million hosp days for heart disease
- 9,1 billions dollars

Envir. Research, 2008, 106:240-249.

2012 Worldwide

**COST OF POLLUTION
IN CHINA**
ECONOMIC ESTIMATES OF PHYSICAL DAMAGES



 THE WORLD BANK

 THE GOVERNMENT OF THE
PEOPLE'S REPUBLIC OF CHINA

L'air tue 2 millions de personnes par année

Mise à jour le lundi 26 septembre 2011 à 14 h 40 HAE

Commenter 10 3 +1 1 Recommander 64

Partager T+



(archives)

Les maladies causées par la pollution de l'air tuent chaque année au moins deux millions de personnes dans le monde, montre un rapport de l'Organisation mondiale de la santé (OMS).

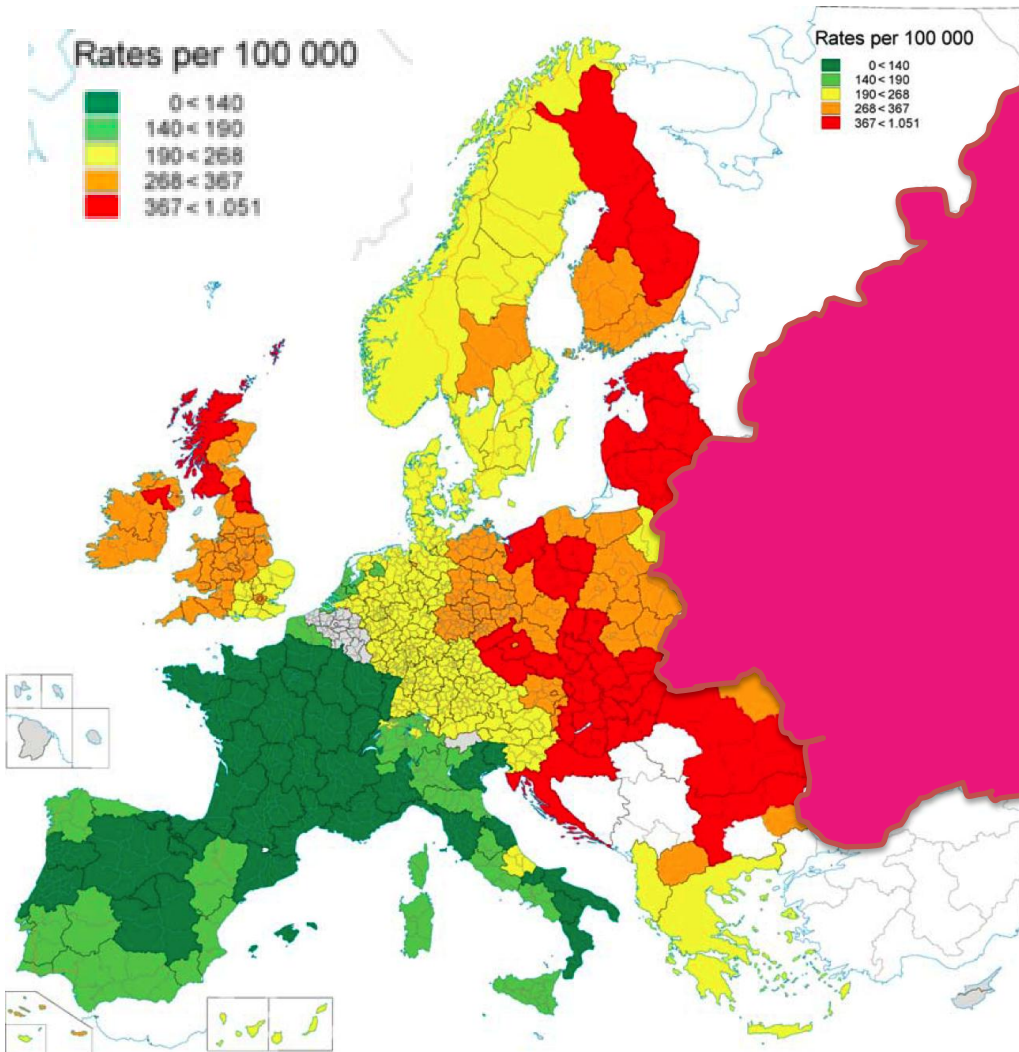
OCDE 2010-2050

Air: Health Impact

Cardiovascular and pulmonary disease

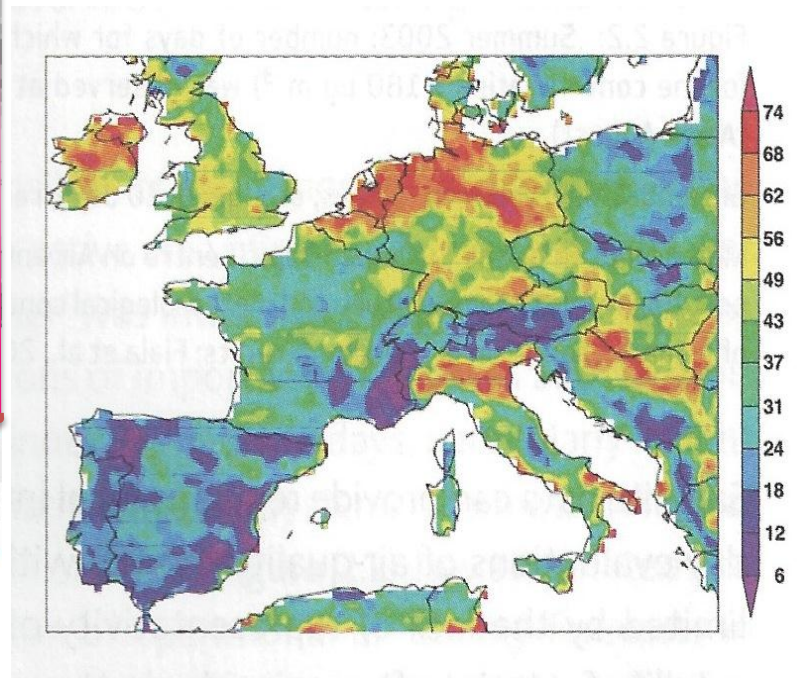
- 1st cause of premature deaths
- Fines Particles
 - Increase from 1 M to 3,6 M †
- Ground Ozone
 - Increase from 380 000 à 800 000 †

Cardiovascular deaths Men 45-74. Europe 2000



« An update on regional variation in cardiovascular mortality within Europe ». *European Heart Journal* 2008 doi : 10.1093/eurheartj/ehm604.

Nb occasions exceeding « moderate air-quality » PM2,5 Europe 2003

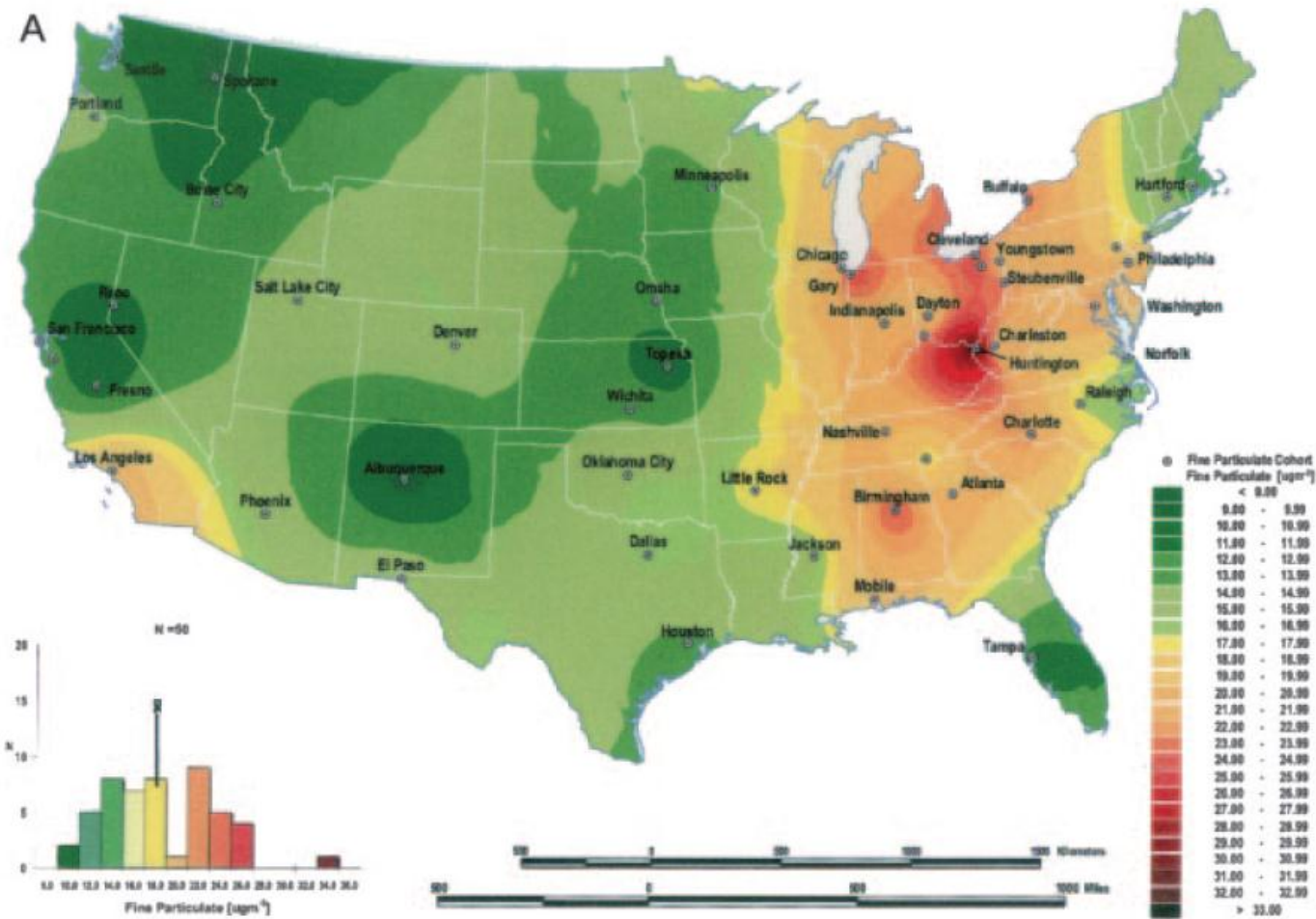


European Space Agency, Rapport TRAQ, Nov 2008

Environmental Cardiology

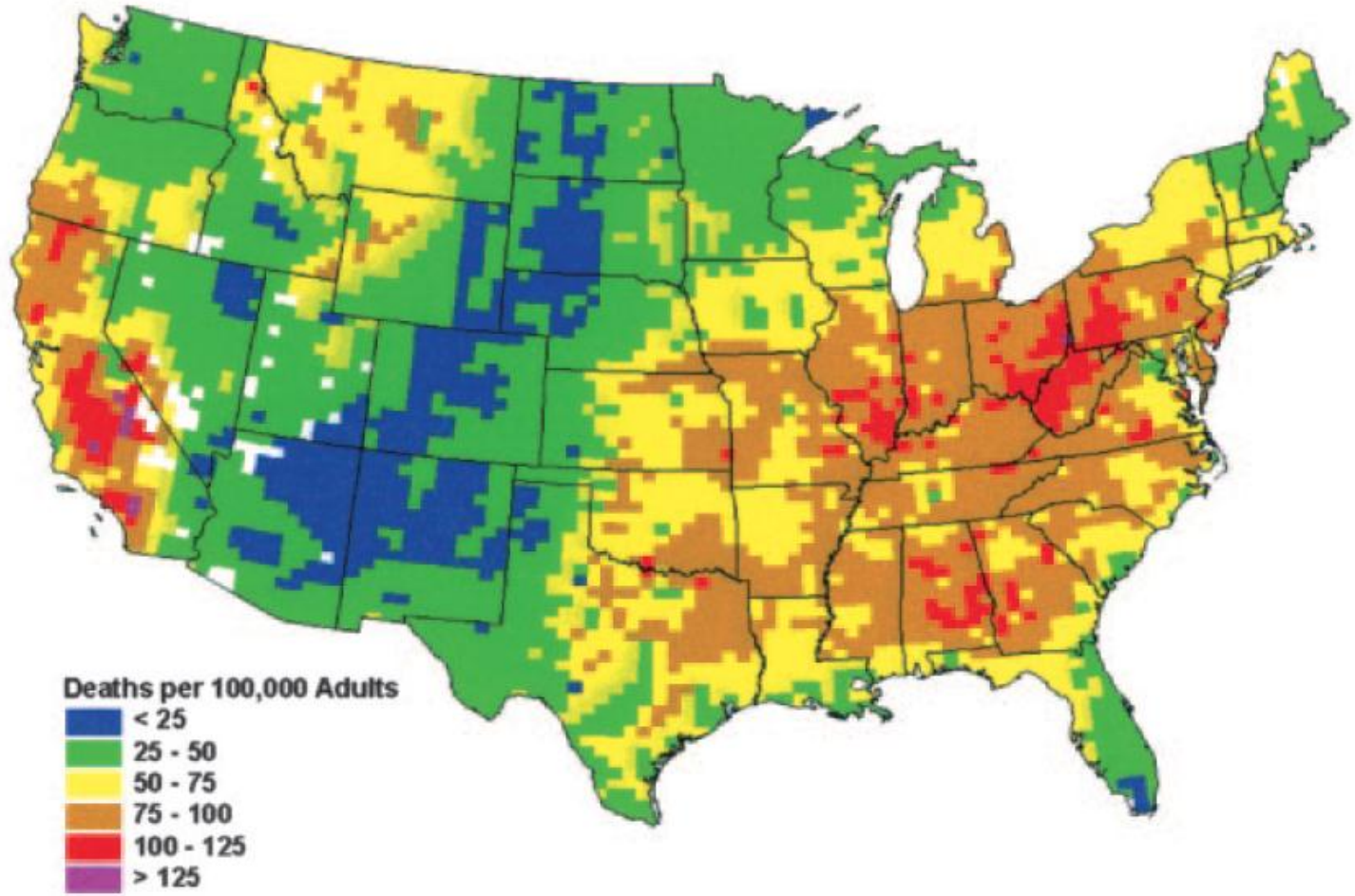
Studying Mechanistic Links Between Pollution and Heart Disease

Aruni Bhatnagar



(*Circ Res.* 2006;99:692-705.)

B



(Circ Res. 2006;99:692-705.)

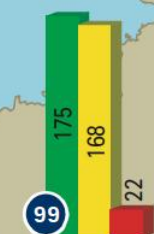
Public health importance of triggers of myocardial infarction: a comparative risk assessment

Tim S Nawrot, Laura Perez, Nino Künzli, Elke Munters, Benoit Nemery

« Our study confirms previous reports and indicates that the magnitude of pollution health effects may be larger than previously recognized.

These results suggest that efforts to limit long-term exposure to fine particulate pollution are warranted. »

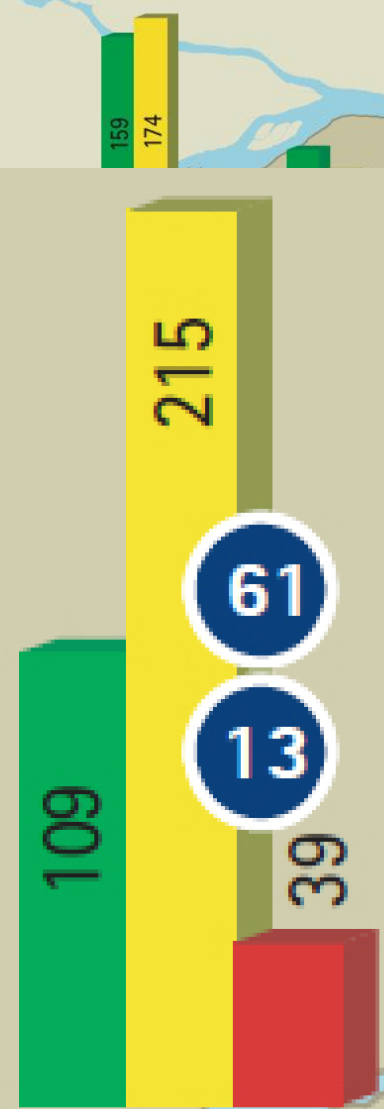
Indice de la qualité de l'air (IQA) à Montréal en 2009



Ouest



Centre-ville



Distribution des journées IQA

- Bon
- Acceptable
- Mauvais

NOTE : Seules les stations mesurant les particules fines (PM_{2.5}) en continu sont illustrées.

Ambient Air Pollution and the Risk of Acute Ischemic Stroke

Gregory A. Wellenius, ScD; Mary R. Burger, MD; Brent A. Coull, PhD; Joel Schwartz, PhD; Helen H. Suh, ScD; Petros Koutrakis, PhD; Gottfried Schlaug, MD, MPH; Diane R. Gold, MD, MPH; Murray A. Mittleman, MD, DrPH

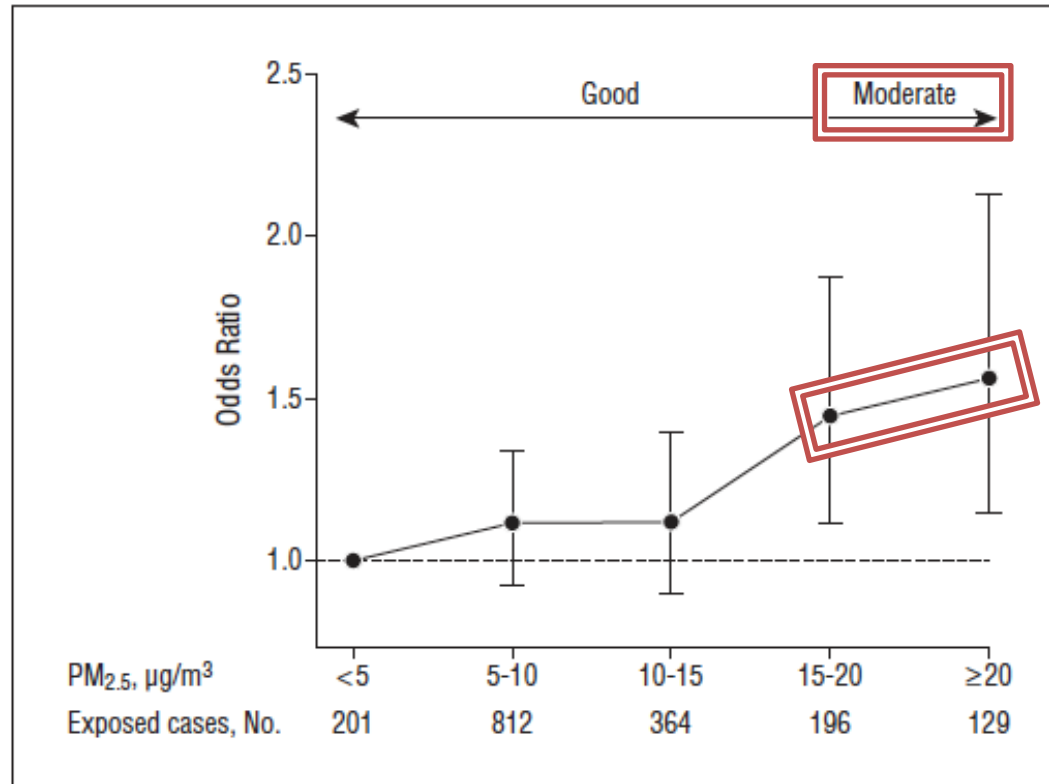


Figure 1. Odds ratio of ischemic stroke onset for US Environmental Protection Agency categories (*good* and *moderate*) of mean ambient fine particulate matter air pollution (PM_{2.5}) levels in the 24 hours preceding stroke onset. Error bars indicate 95% CIs.

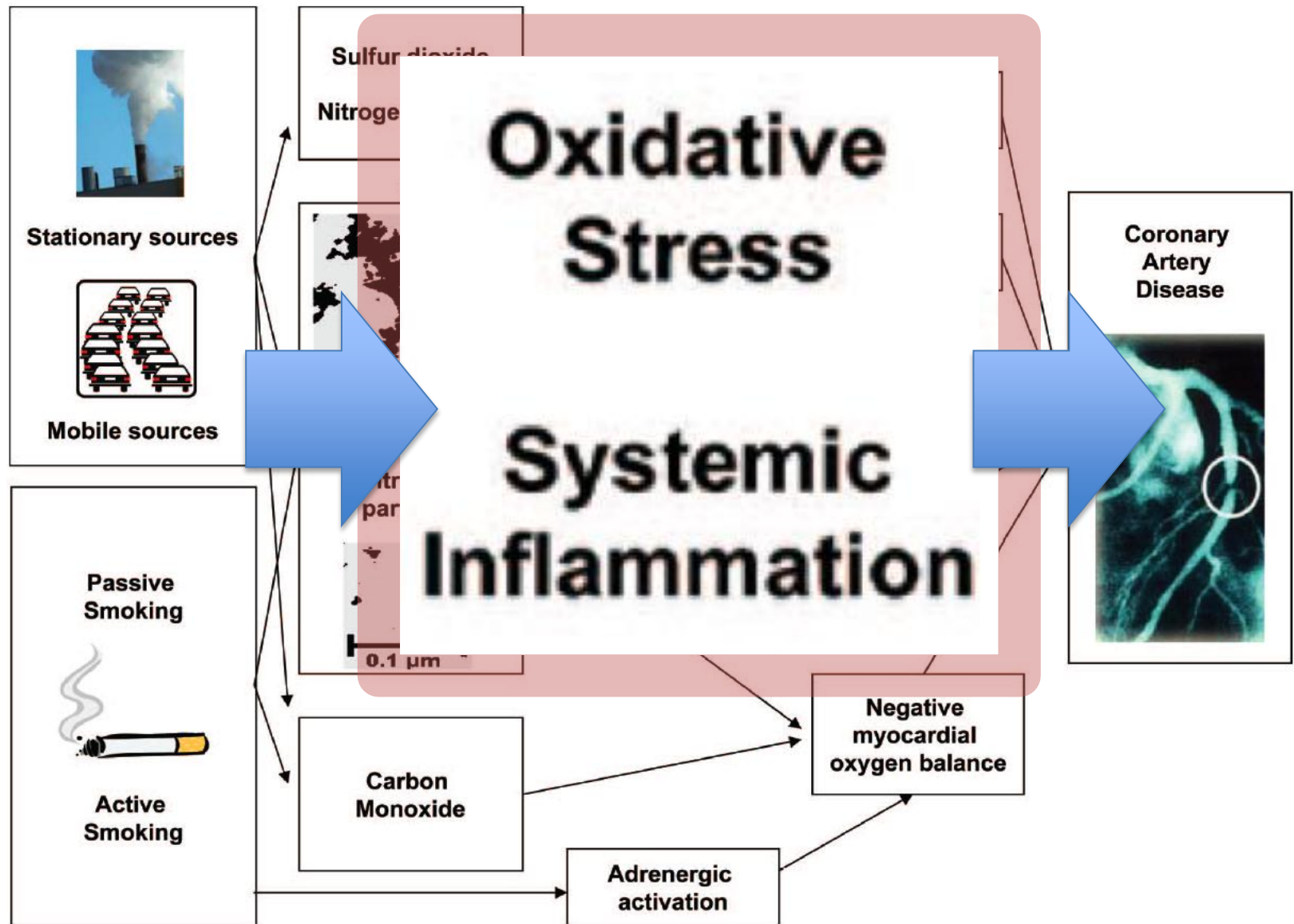
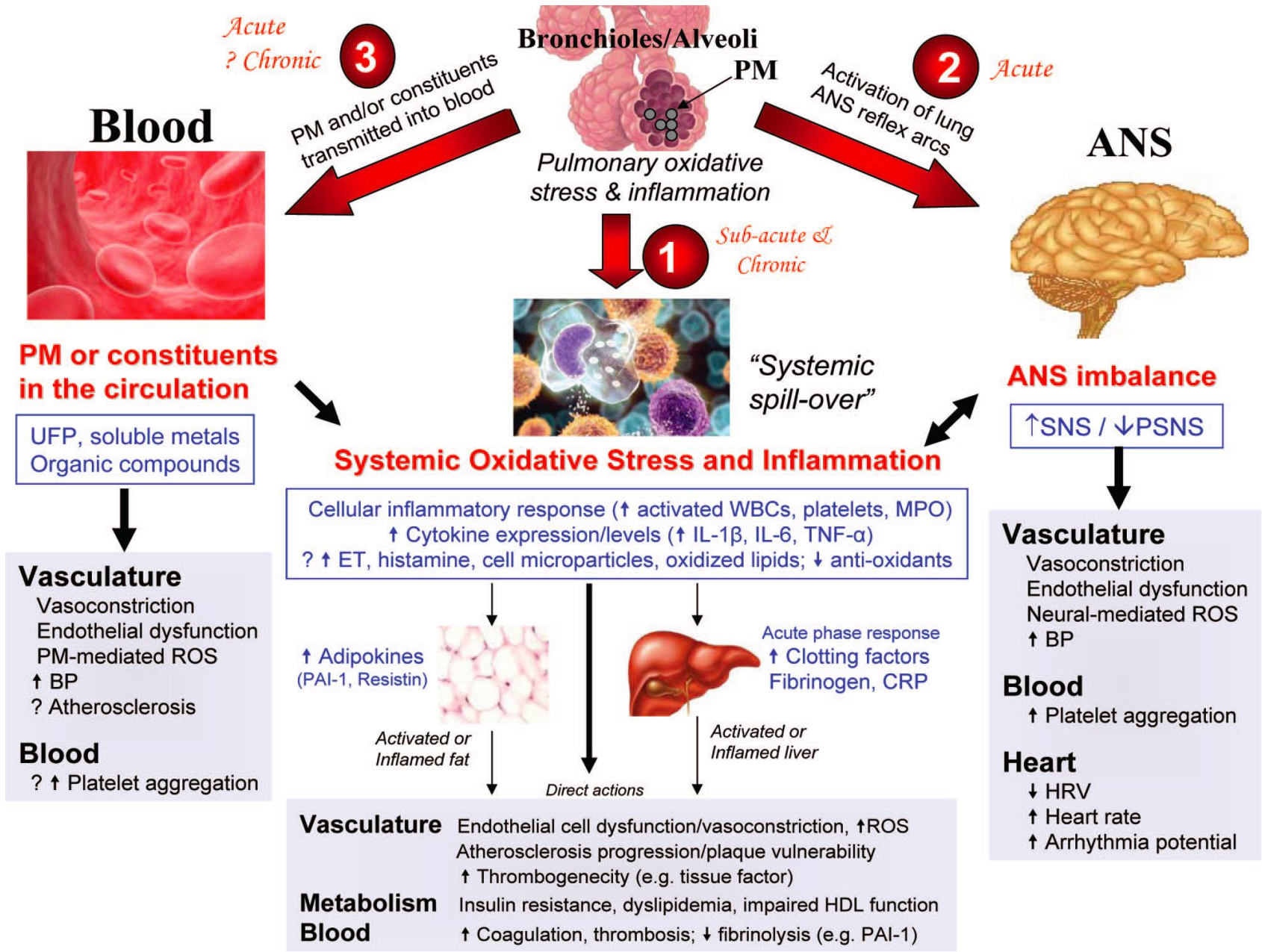


Figure. Overview on pathomechanism linking ambient air pollution,⁴ secondhand smoke,⁷ and active smoking to acute coronary syndromes.

ENVIRONMENT AND « TRADITIONAL » RISK FACTORS

If one presents with
high blood pressure, diabetes, high
cholesterol and obesity.

Does environment play a role?



Brook et al; Particulate Matter Air Pollution and CVD. Circulation 2010. 121; 2331-2378

Pollution and High Blood Pressure

- B. Urch, J.R. Brook, D. Wasserstein et al. « Relative contributions of PM2.5 chemical constituents to acute arterial vasoconstriction in humans ». *Inhalation Toxicology* 2004 16 : 345–352.
- B. Urch, F. Silverman, O. Corey et al. « Acute blood pressure responses in healthy adults during controlled air pollution exposures ». *Environmental Health Perspectives* 2005 113 (8) : 1052–1055.
- C.R. Bartoli, G.A. Wellenius, E.A. Diaz et al. « Mechanisms of inhaled fine particulate-induced arterial blood pressure changes ». *Environmental Health Perspectives* 2009 117 : 361–366.
- Robert D. Brook. « You are what you breathe : evidence linking air pollution and blood pressure ». *Current Hypertension Reports* 2005 7 : 427-434.

Pollution and Diabetes

- More diabetes in a polluted milieu

- « Diabetes and air pollution ». Alan H. Lockwood. *Diabetes Care* 2002 25 : 1487-1488.

- Synergy pollution-diabetes

- Pollution peaks: Diabetics suffer twice the rate of cardiac complications as compared to non-diabetics

- T.F. Bateson et J. Schwartz. « Who is sensitive to the effects of particles on mortality ? A case-crossover analysis ». *Epidemiology* 2004 15 : 143– 149.
 - A. Zanobetti et Joel Schwartz. « Are diabetics more susceptible to the health effects of airborne particles ? ». *American Journal of Respiratory Critical Care Medicine* 2001 164 (5) : 831– 833.
 - A. Zanobetti et A. Schwartz. « Cardiovascular damage by airborne particles : are diabetics more susceptible ? ». *Journal of Epidemiology* 2002 13 : 588– 592.

Pollution and Obesity

American Journal of Epidemiology Advance Access published April 13, 2012



American Journal of Epidemiology

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DOI: 10.1093/aje/kwr455

Original Contribution

Association of Childhood Obesity With Maternal Exposure to Ambient Air Polycyclic Aromatic Hydrocarbons During Pregnancy

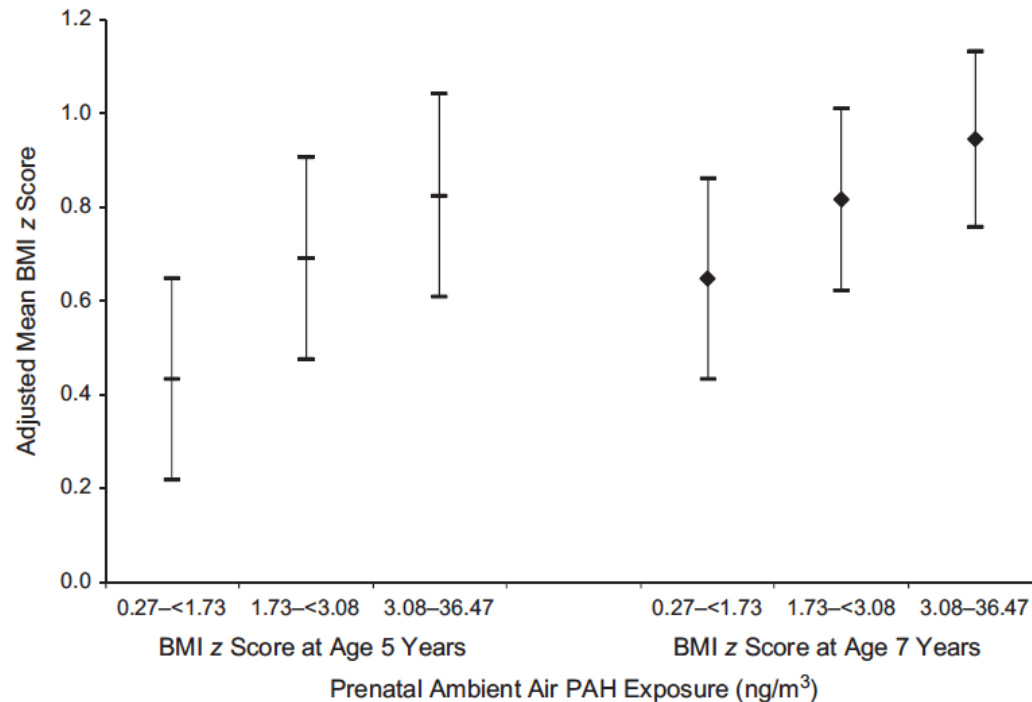
Andrew Rundle*, Lori Hoepner, Abeer Hassoun, Sharon Oberfield, Greg Freyer, Darrell Holmes, Marilyn Reyes, James Quinn, David Camann, Frederica Perera, and Robin Whyatt

* Correspondence to Dr. Andrew Rundle, Department of Epidemiology, Mailman School of Public Health, Columbia University, 722 West 168th Street, Room 730, New York, NY 10032 (e-mail: agr3@columbia.edu).

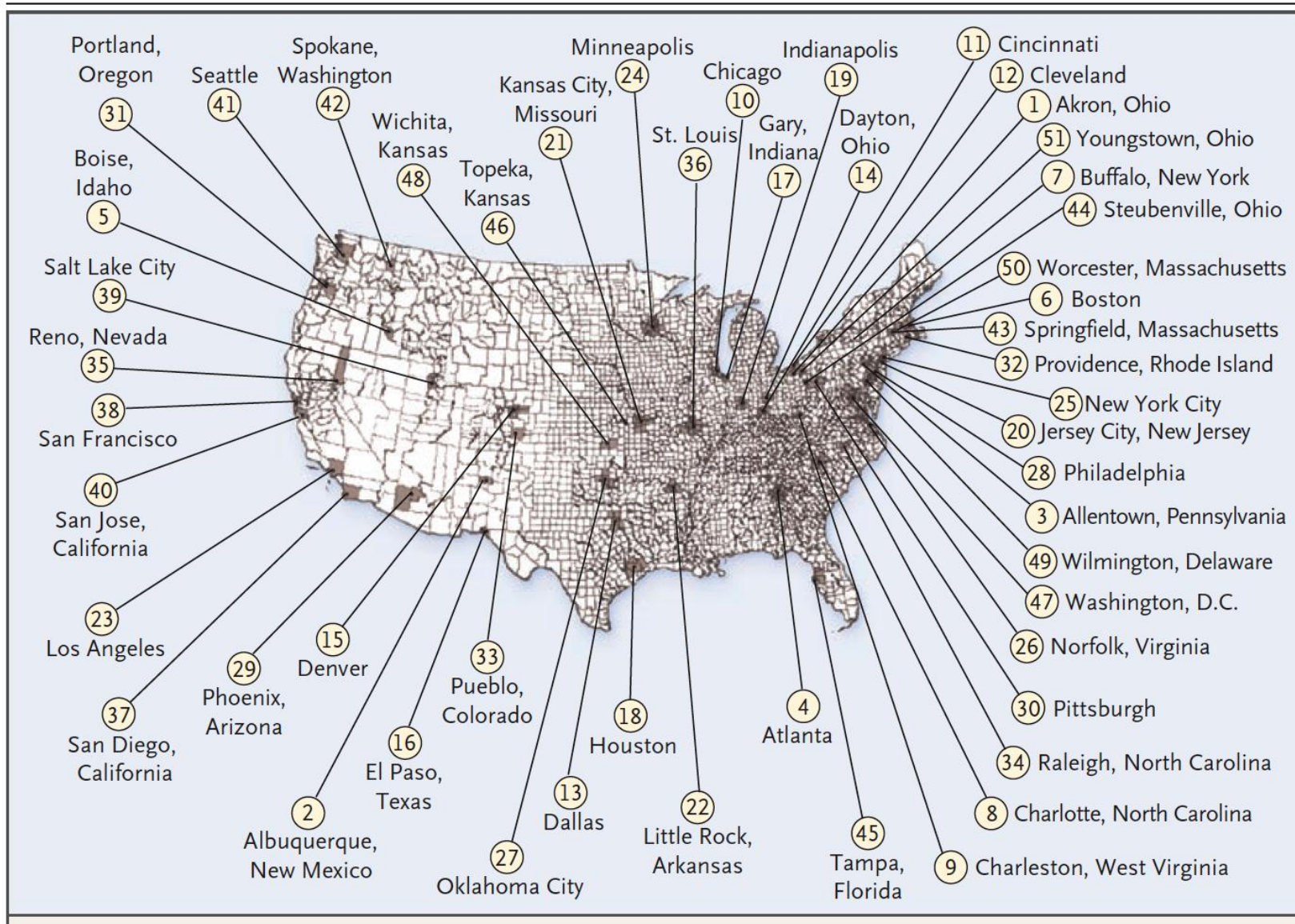
Initially submitted August 1, 2011; accepted for publication November 9, 2011.

Pollution and Obesity

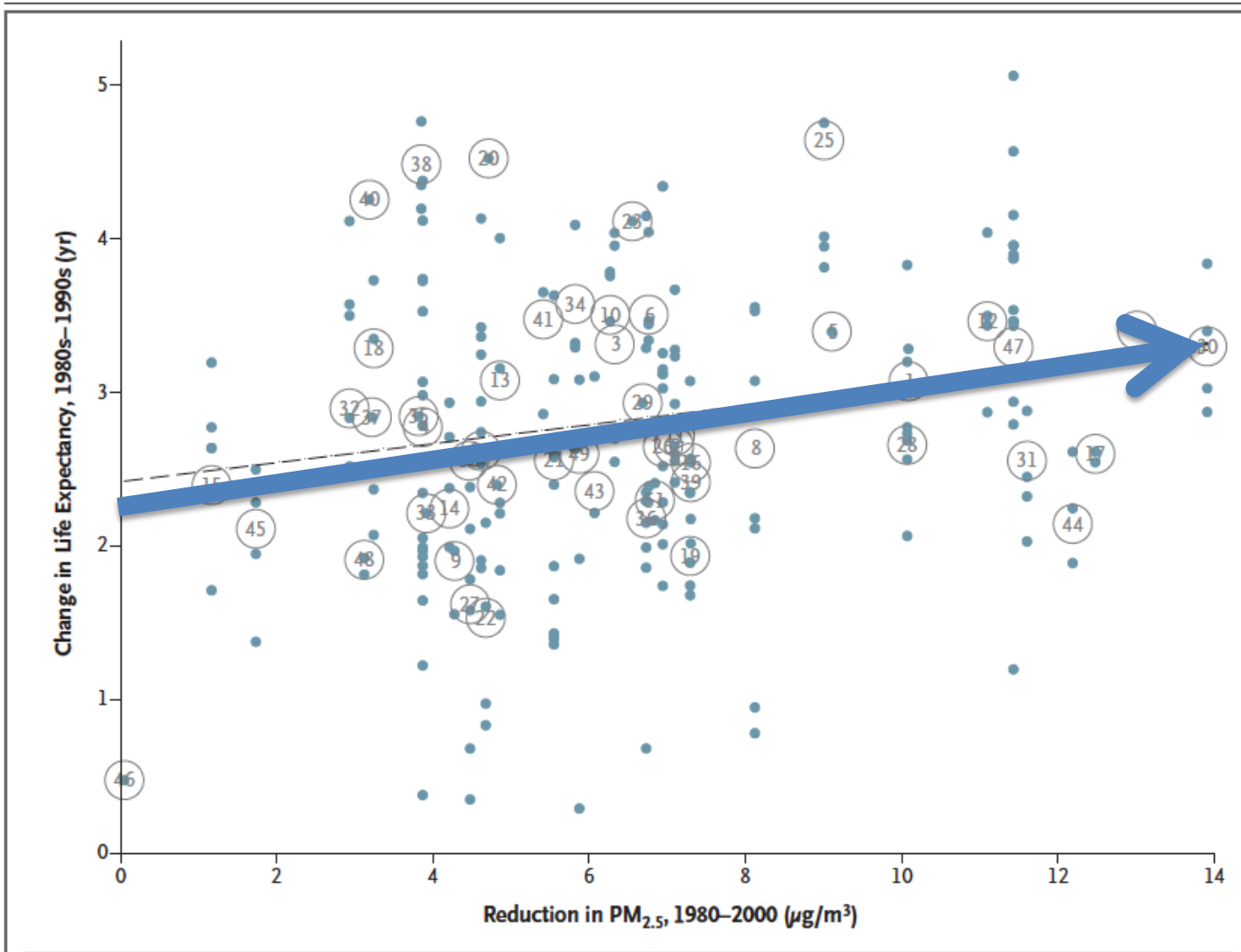
Association of Childhood Obesity With Maternal Exposure to Ambient Air Polycyclic Aromatic Hydrocarbons During Pregnancy



**DOES IT HELP
IF WE CLEAN AIR ?**



Fine-particulate air pollution and life expectancy in the United States .
 C. Arden Pope III, Majid Ezzati et Douglas W. Dockery.
New England Journal of Medicine 2009 360 : 376-86.



Changes in Life Expectancy for the 1980s–1990s,

Fine-particulate air pollution and life expectancy in the United States .
 C. Arden Pope III, Majid Ezzati et Douglas W. Dockery.
New England Journal of Medicine 2009 360 : 376-86.

Global warming,
Urban Heat Islands
and Pollution

Protect and
plant trees !

A satellite with gold thermal blankets and four solar panels is shown in space. Below it, a stylized Earth is depicted with green areas representing urban heat islands. A vertical beam of light connects the satellite to the Earth. The text "Urban Heat Islands: Biotopes Study" is overlaid in white.

Urban Heat Islands: Biotopes Study

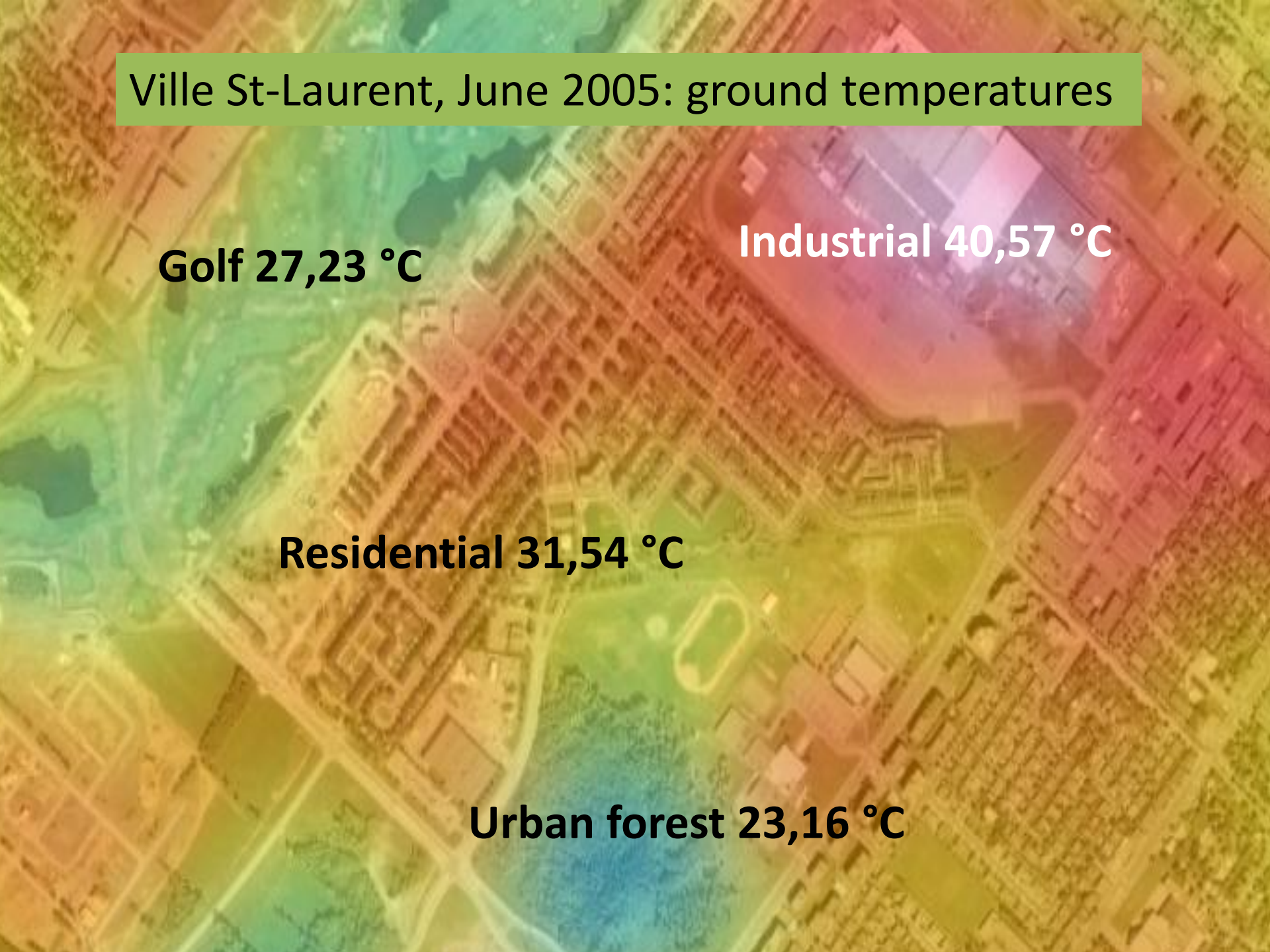
Ville St-Laurent, June 2005: ground temperatures

Golf 27,23 °C

Industrial 40,57 °C

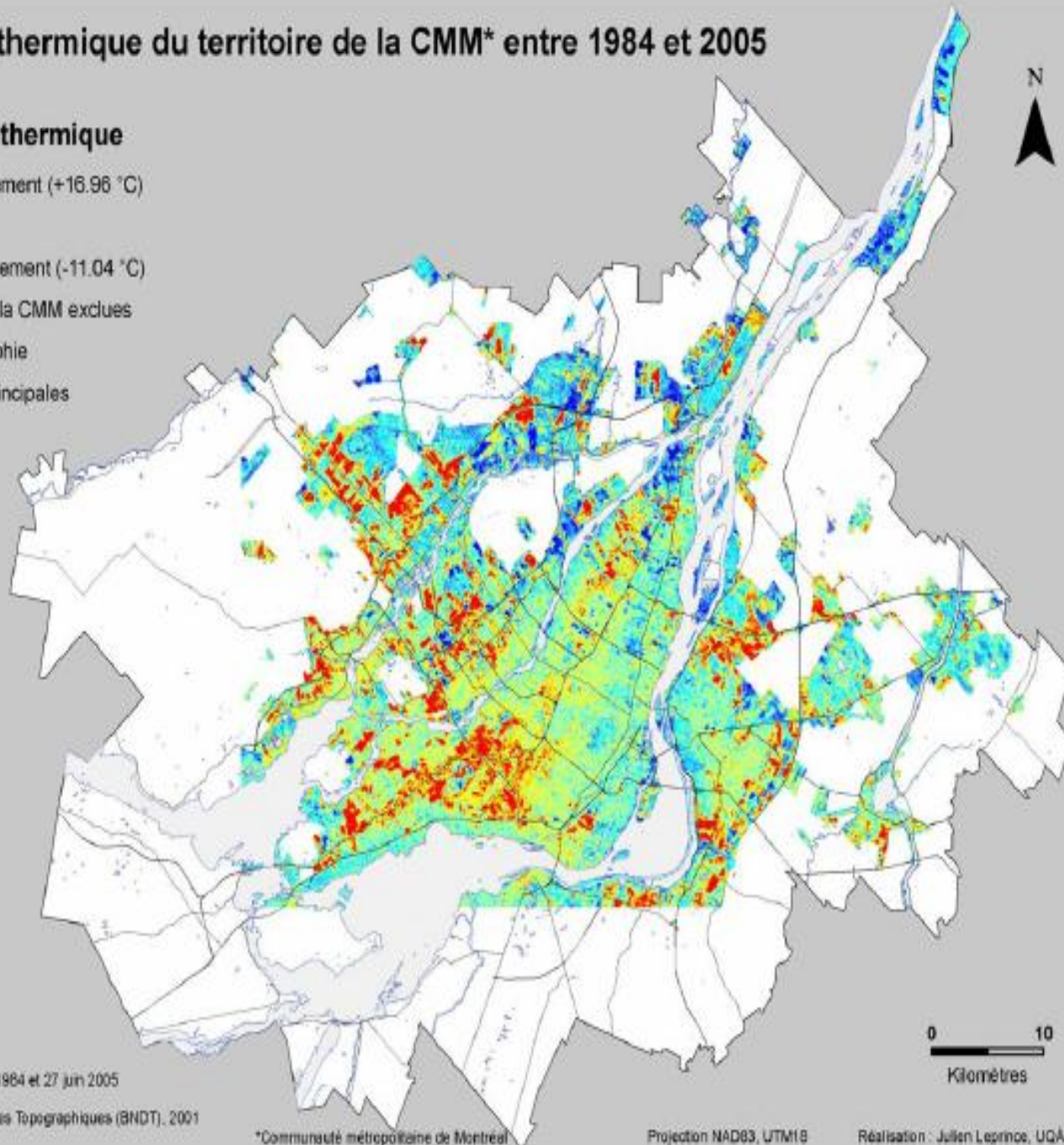
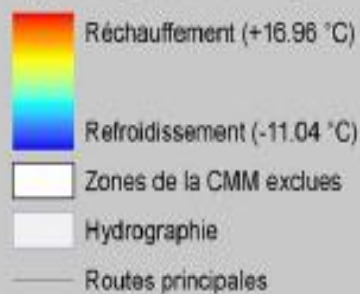
Residential 31,54 °C

Urban forest 23,16 °C



Évolution thermique du territoire de la CMM* entre 1984 et 2005

Dynamique thermique



Sources :
- Image Landsat 5, 17 juin 1984 et 27 juin 2005
- CMM*
- Base Nationale de Données Topographiques (BNDT), 2001
- GeoBase, 2006

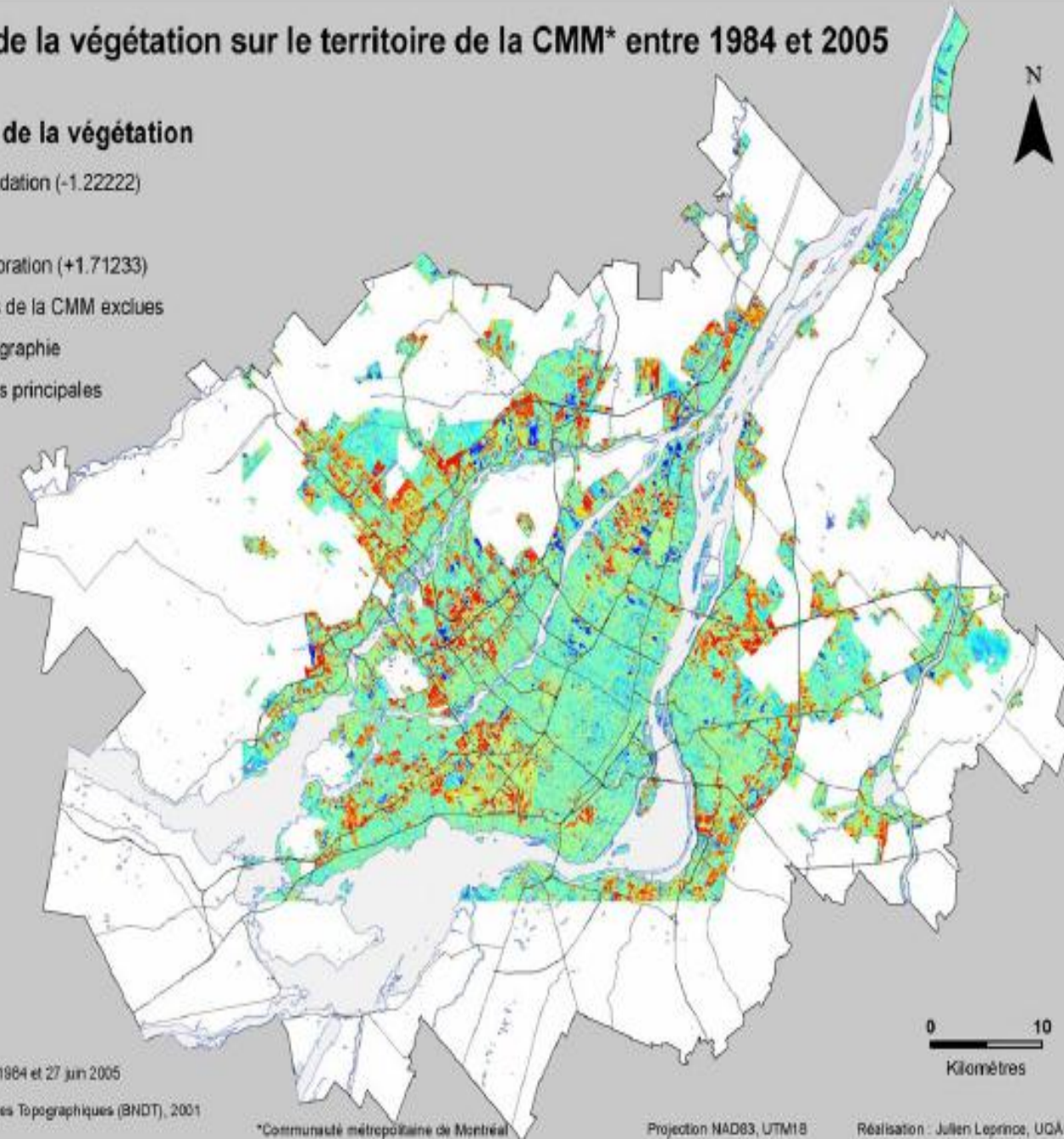
*Communauté métropolitaine de Montréal

Projection NAD83, UTM18

Réalisation : Julien Leprince, UQAM 2007

Évolution de la végétation sur le territoire de la CMM* entre 1984 et 2005

Dynamique de la végétation



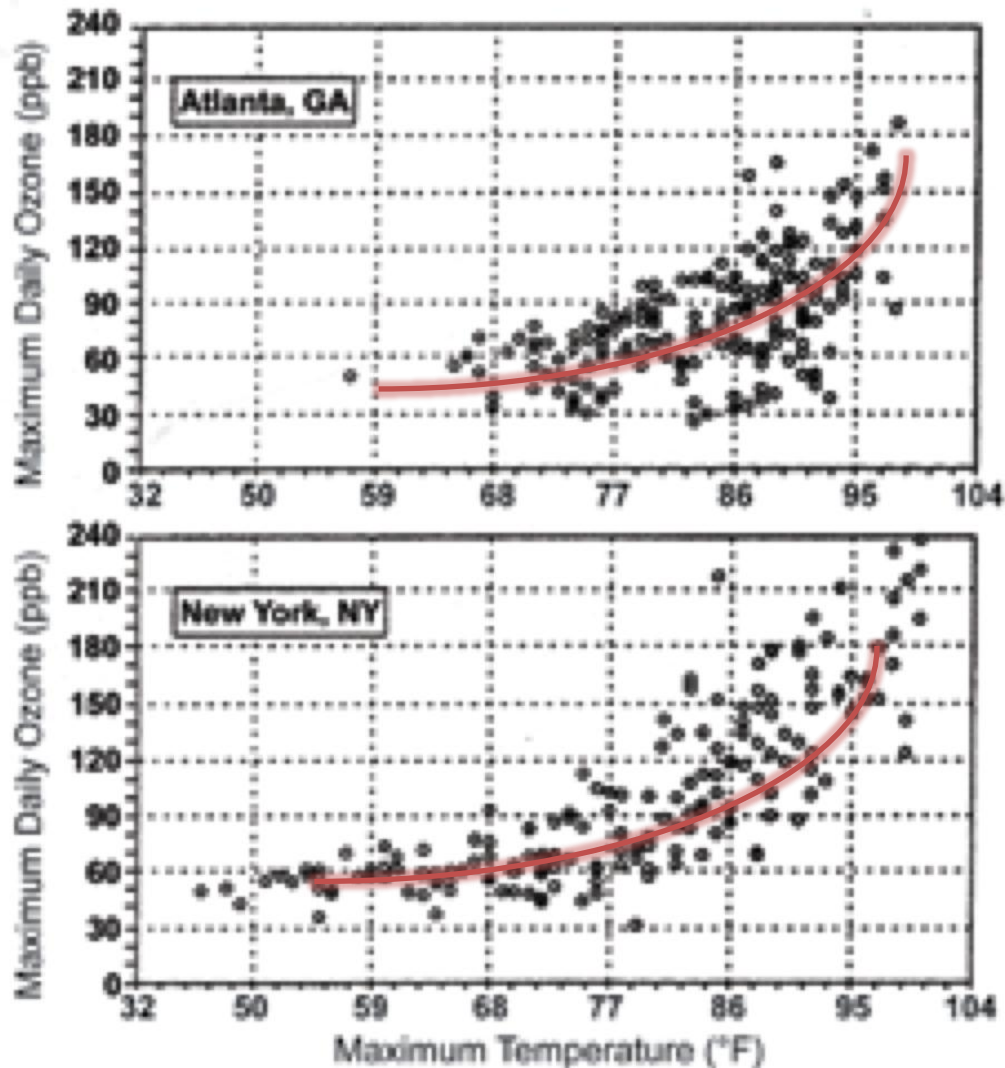
Sources :
- Image Landsat 5, 17 juin 1984 et 27 juin 2005
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- GéoBase, 2006

*Communauté métropolitaine de Montréal

Projection NAD83, UTM18

Réalisation : Julien Leprince, UQAM 2007

Warming increases pollutants toxicity

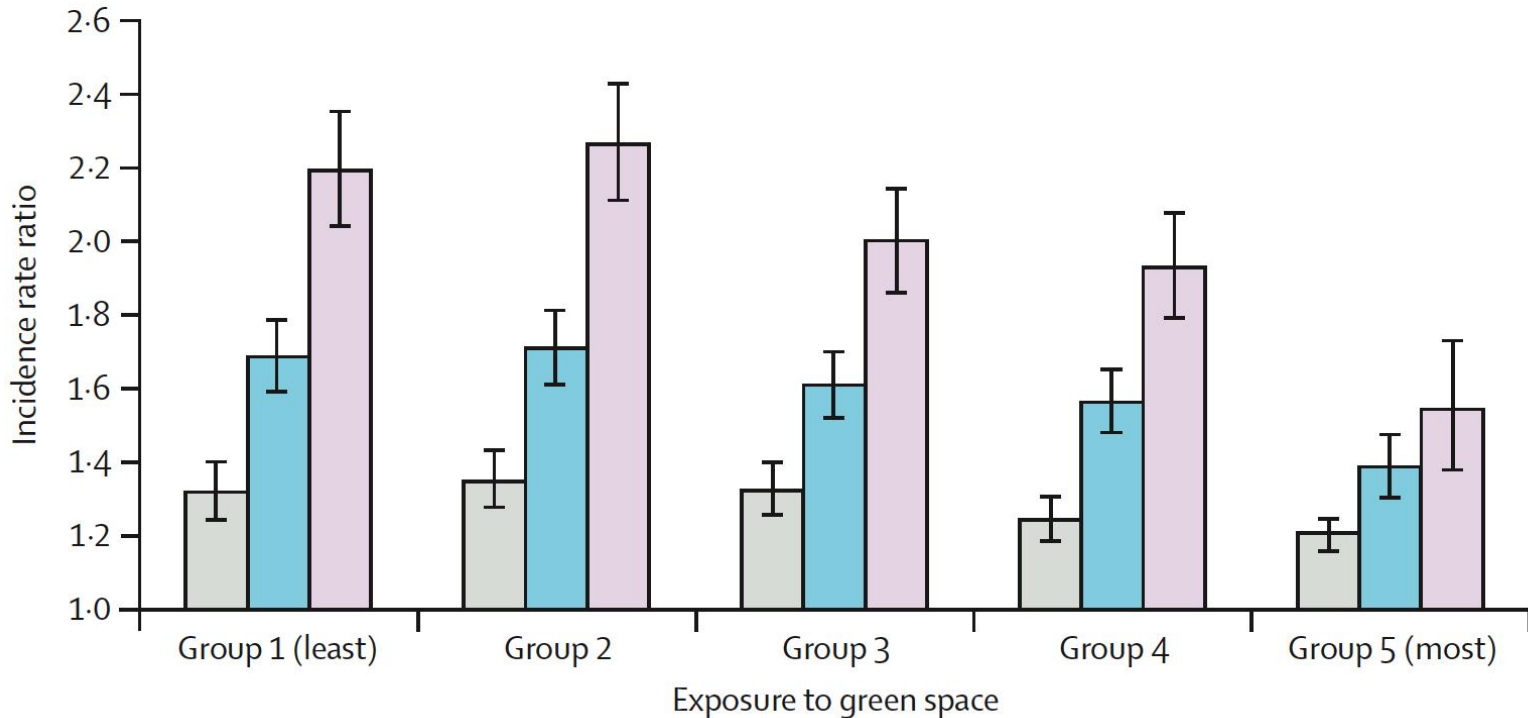


Effect of exposure to natural environment on health inequalities: an observational population study

Richard Mitchell, Frank Popham

- ✓ 2001-2005
- ✓ 40 millions of non-retired british subjects
- ✓ 360 000 deaths records
- ✓ 4 quartiles according to income
- ✓ 5 quintiles according to green exposure

B Deaths from circulatory disease



Green space exposure: **Reduction by half** (from 219 % to 154%)
of the difference of **cardiovascular deaths**
between poors (lower quartile) and riches (higher quartile).

Effect of exposure to natural environment on health inequalities; an observational population study. R Mitchell, F Popham. Lancet, nov 2008

The Relationship Between Trees and Human Health

Evidence from the Spread of the Emerald Ash Borer

Geoffrey H. Donovan, PhD, David T. Butry, PhD, Yvonne L. Michael, ScD,
Jeffrey P. Prestemon, PhD, Andrew M. Liebhold, PhD,
Demetrios Gatzliolis, PhD, Megan Y. Mao



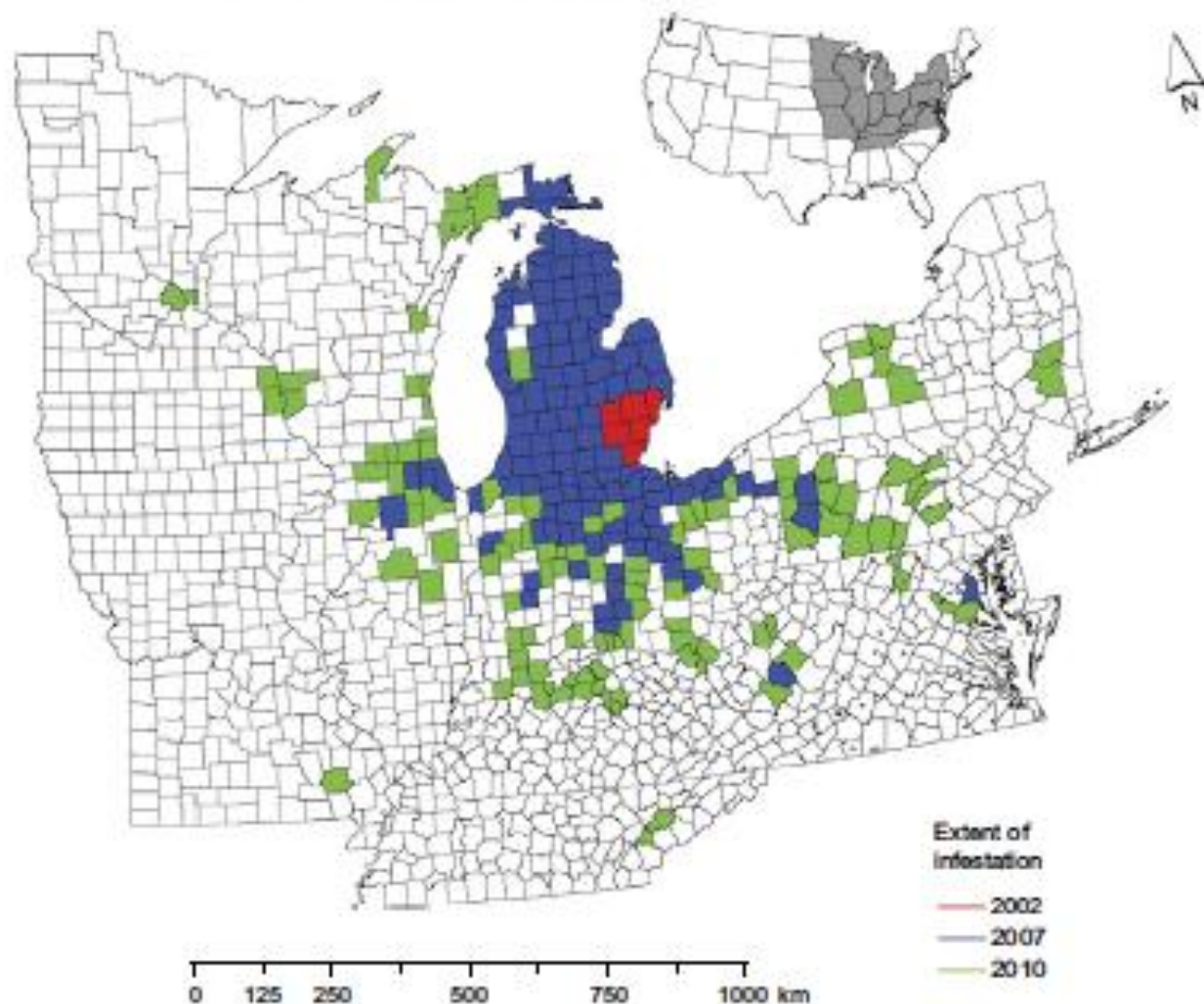


Figure 1. Counties where the emerald ash borer had been detected in 2002, 2007, and 2010

Results: There was an increase in mortality related to cardiovascular and lower-respiratory-tract illness in counties infested with the emerald ash borer. The magnitude of this effect was greater as infestation progressed and in counties with above-average median household income. Across the 15 states in the study area, the borer was associated with an additional 6113 deaths related to illness of the lower respiratory system, and 15,080 cardiovascular-related deaths.

A cardio-protective city should

- Eradicate food nano-agressors
- Eradicate airborne nano-agressors
- Eradicate fossil fuel
- Connect with nature
 - Develop with renewable energies
 - Earth is geothermy
 - Wind is eolian
 - Water is hydrolic
 - Fire is solar
 - Aim at a 25 % urban canopy.

If a City eliminates

- Food nano-agressors
 - Trans fat
 - Excess of salt
 - Added fructose
 - Phosphoric acid
- Air nano-agressors
 - CO
 - SO₂, NO₂
 - FP, UFP
 - VOC, HAP

and promotes a green and active milieu

This City may expect a
25-75 % reduction of cardiac disease

"After all, CVD was not common in 1830, so why can't it now become uncommon by 2050? That is the challenge we all face."



Dr Salim Yusuf
Cardiologist and epidemiologist
McMaster University, Hamilton, Ontario



Chaire de cardiologie environnementale