AIR POLLUTION, GREENHOUSE GASES AND HUMAN HEALTH

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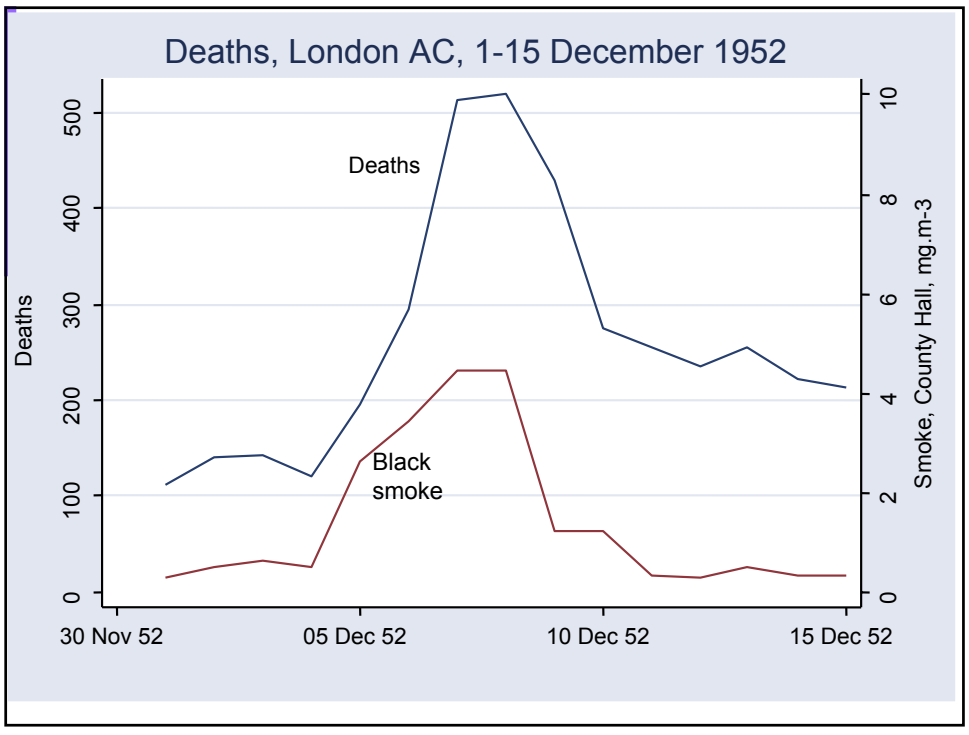


- Reduction, especially in industrial and domestic combustion sources, with substantial decline in particle (mass) concentration & SO_2
- Change from classical to photo-chemical smog (transport sources)
- Emergence of new toxicological and epidemiological evidence, incl.
  - time-series
  - semi-ecological cohorts
- Identified risks at the (lower) ambient concentrations in modern cities
- Evidence strongest for respirable particles (<10µm), but also for SO_2, ozone, NO_2, CO…

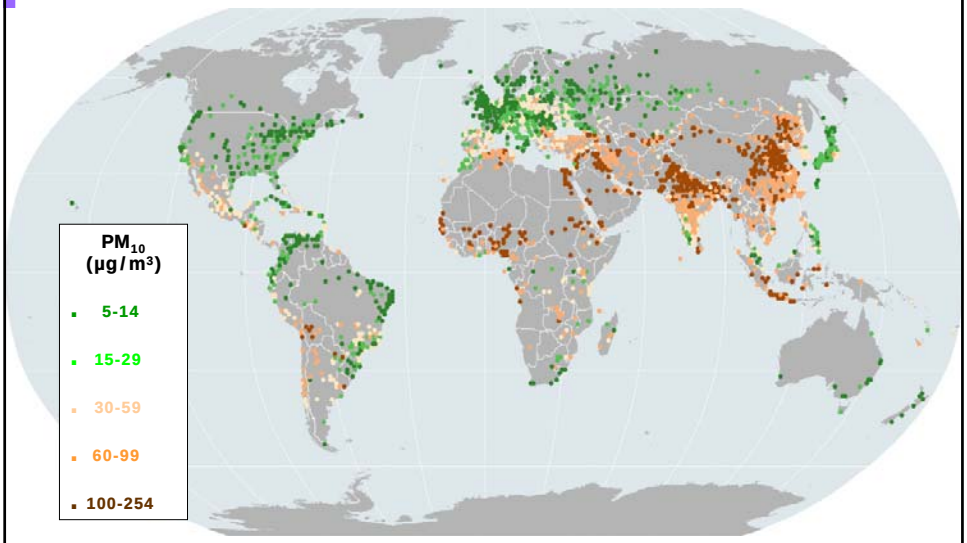
HEALTH EFFECTS OF OUTDOOR AIR POLLUTION

Patho-physiological/functional changes
- Inflammation of airways & lung
- Lung function
- Reduce lung growth
- Heart rate (variability), blood pressure
- Coagulation
- ?Atherosclerosis, calcification of the arteries by ~60%

Symptom/disease exacerbations (acute)
- Respiratory symptoms (asthma, COPD), cardiac (arrhythmia?)
- Thrombosis: myocardial infarction, stroke
- Hospitalization (cardio-respiratory)
- Death (cardio-respiratory)

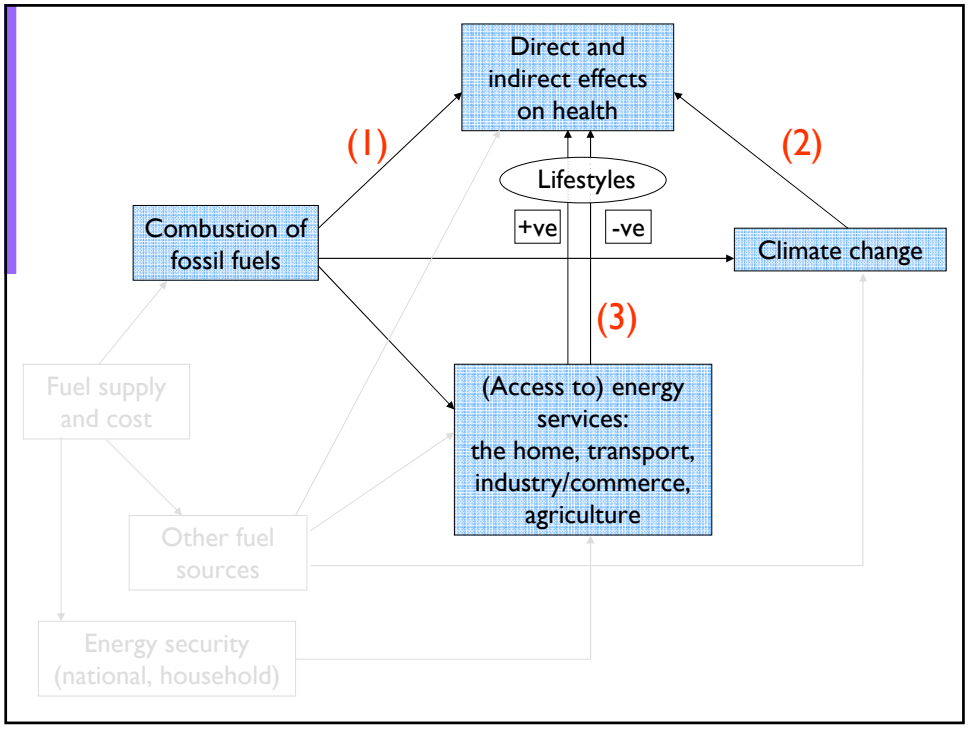
Chronic disease
- Chronic obstructive pulmonary disease, asthma
- Lung Cancer
- Reduced life expectancy

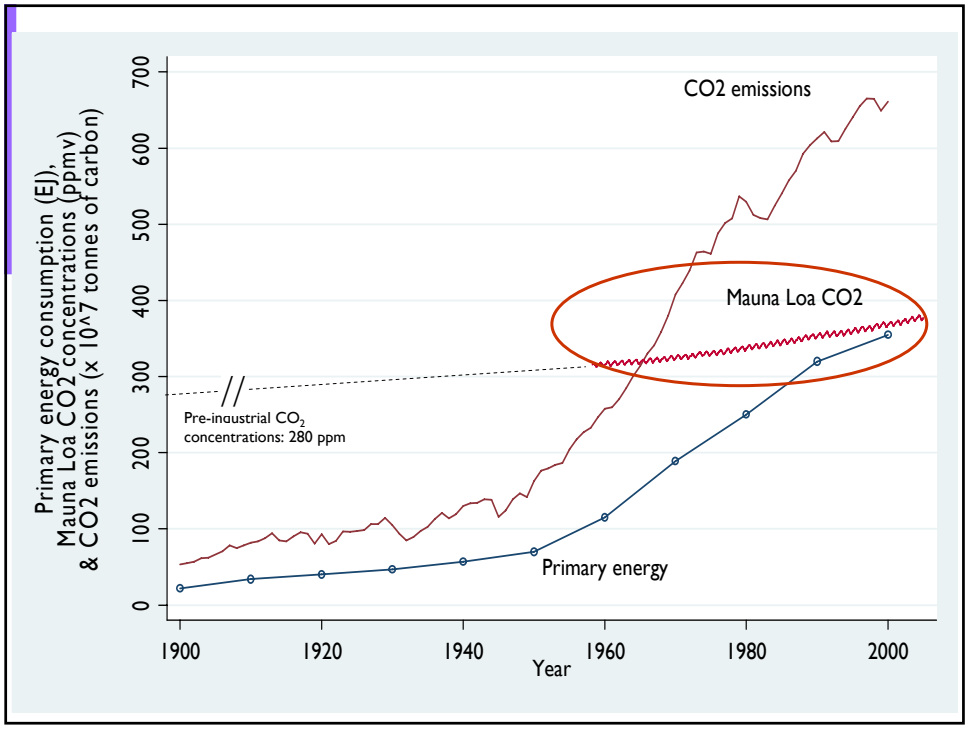
Estimated PM_{10} Concentration in World Cities (pop >=100,000)

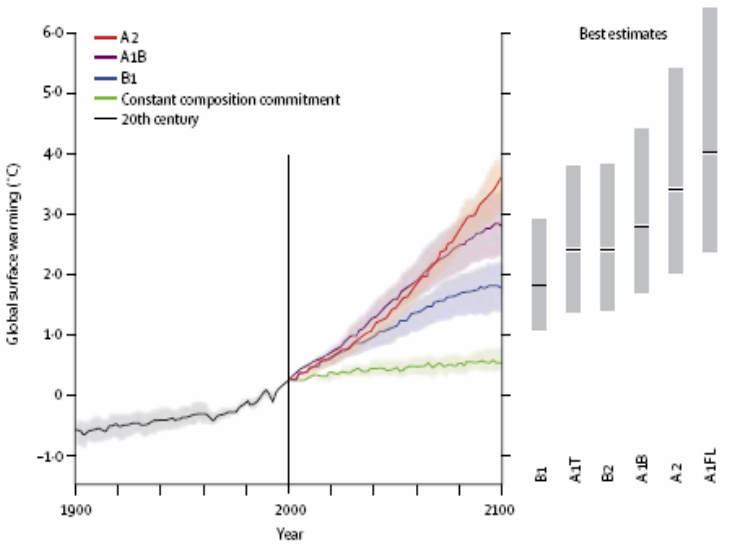


Source: Cohen AJ et al. 2004

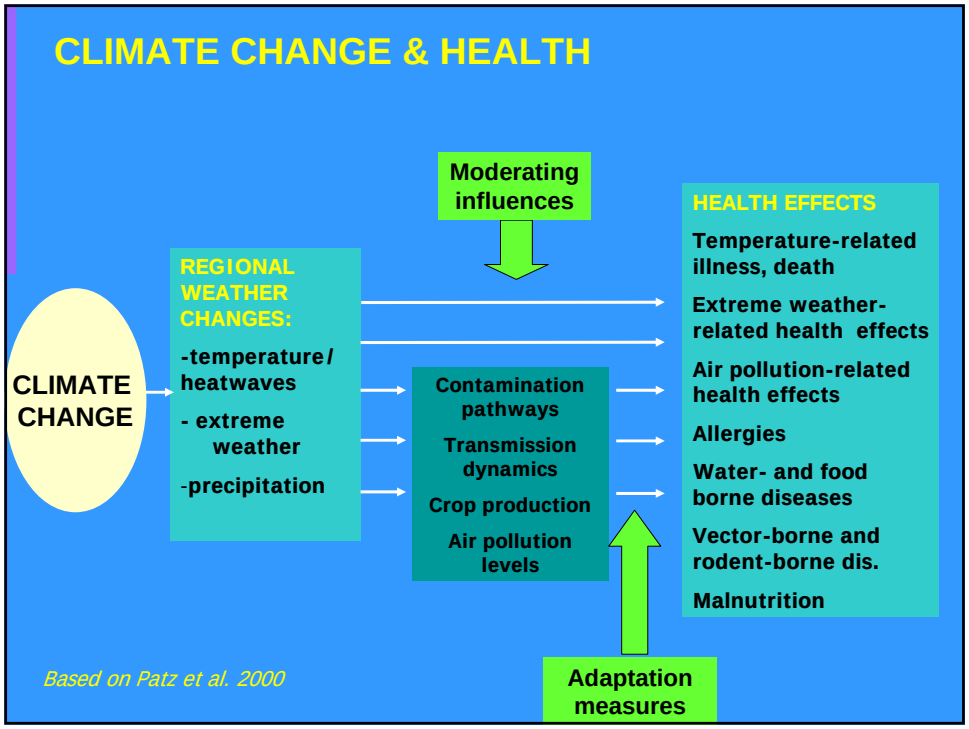
Excess deaths from selected environmental factors			
Environmental risk	Global estimate	Asian estimate (S, SE Asia + W Pacific)	Asia as a percent of global
Unsafe water	1,730,000	730.000	42%
Urban outdoor pollution	799,000	487,000	65%
Indoor air	1,619,000	1,025,000	63%
Lead	234,000	88,000	37%

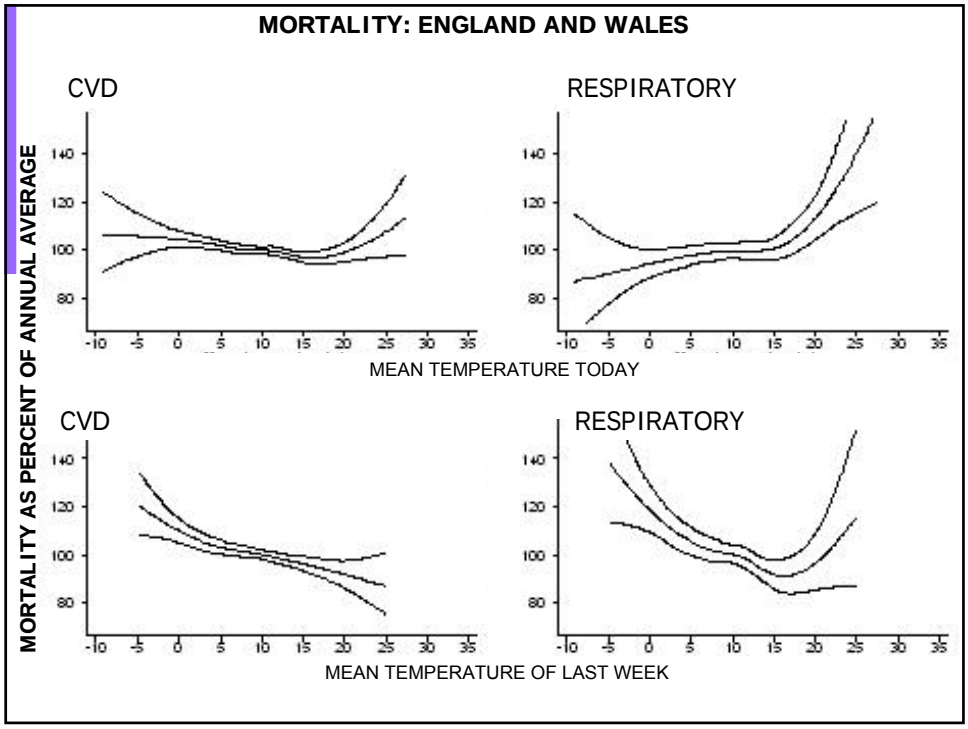

Direct and indirect effects on health
(1)
(2)
Lifestyles
+ve
-ve
Combustion of fossil fuels
Climate change
(3)
(Access to) energy services: the home, transport, industry/commerce, agriculture
Fuel supply and cost
Other fuel sources
Energy security (national, household)

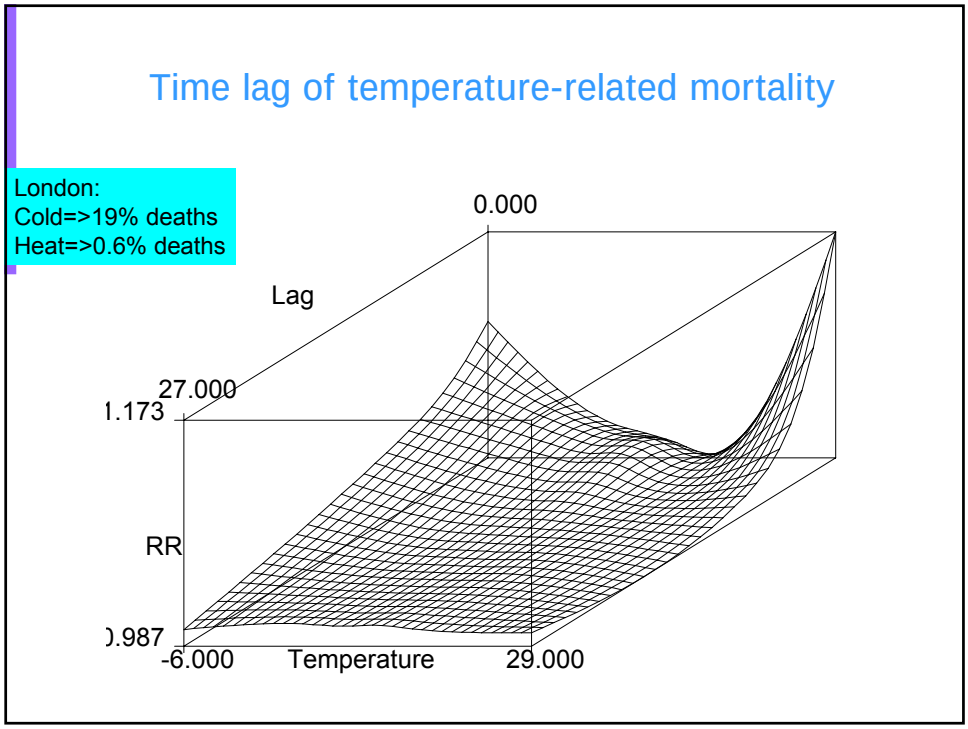

Primary energy consumption (EJ), Mauna Loa CO2 concentrations (ppmv) & CO2 emissions (x 10^7 tonnes of carbon)
0
100
200
300
400
500
600
700
1900
1920
1940
1960
1980
2000
Year
CO2 emissions
Mauna Loa CO2
Pre-industrial CO2 concentrations: 280 ppm
Primary energy



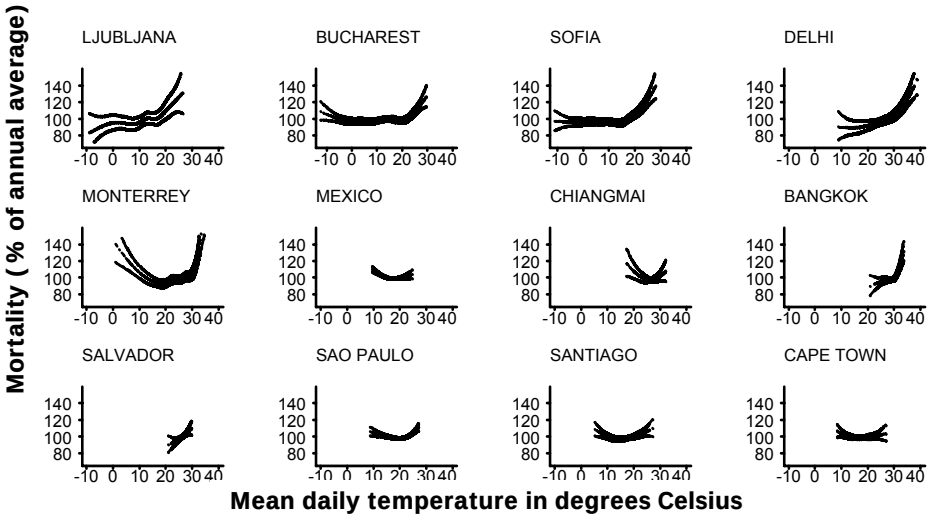
Projected change in global mean temperatures in selected IPCC scenarios. Lines beyond 2000 are multi-model global averages of surface warming, relative to 1980–99, for SRES scenarios A2, A1B, and B1. *Source: IPCC, 2007*

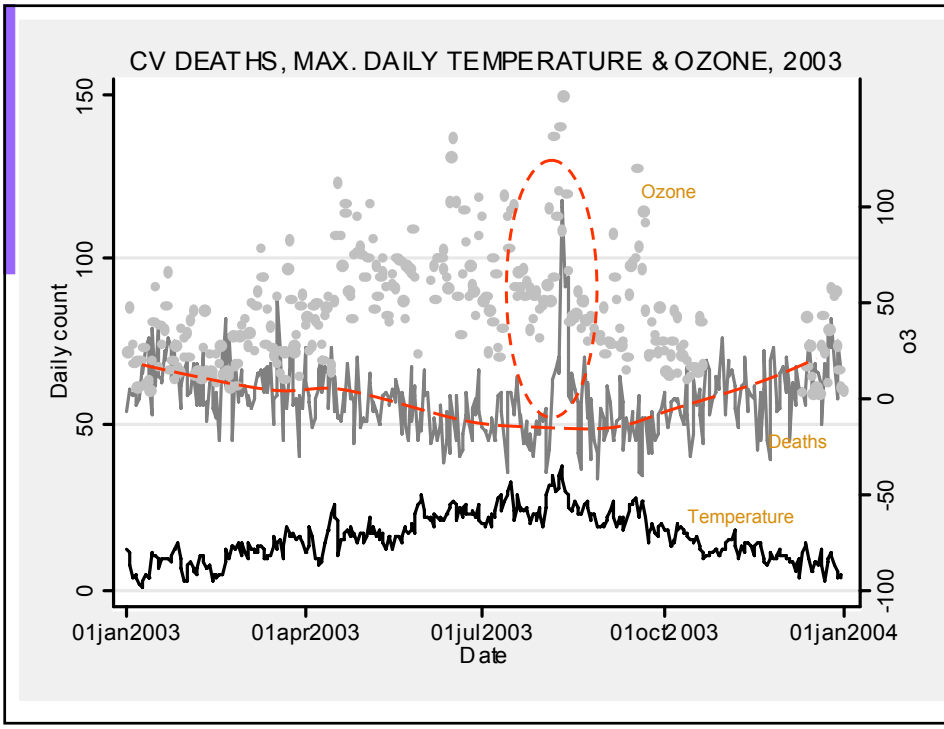


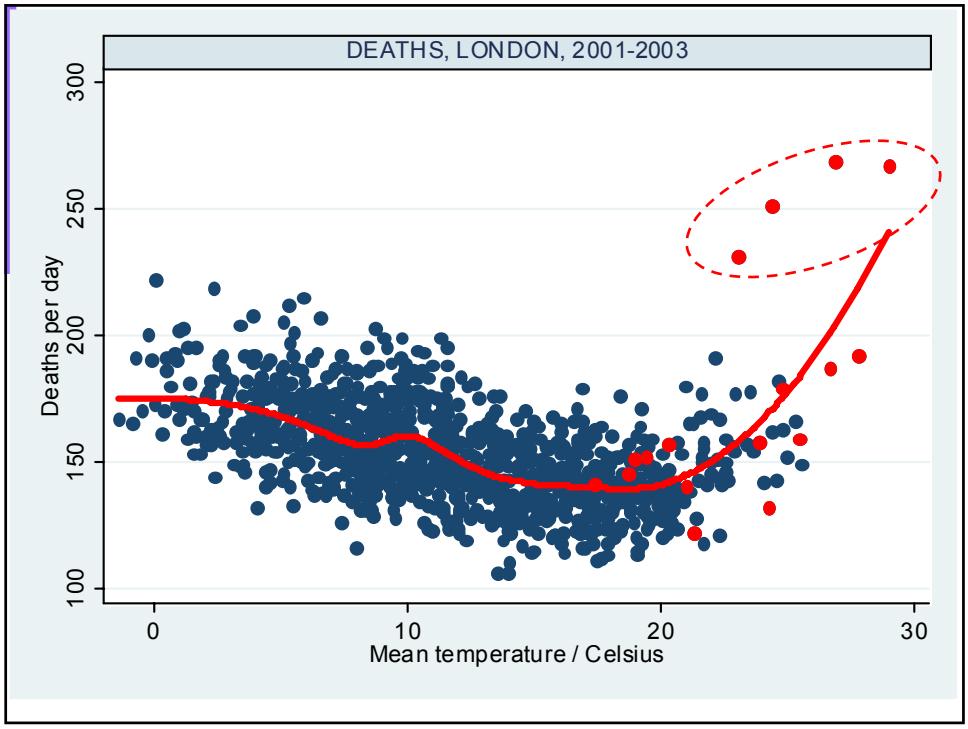

MORTALITY: ENGLAND AND WALES
CVD
RESPIRATORY
MORTALITY AS PERCENT OF ANNUAL AVERAGE
MEAN TEMPERATURE TODAY
CVD
RESPIRATORY
MEAN TEMPERATURE OF LAST WEEK

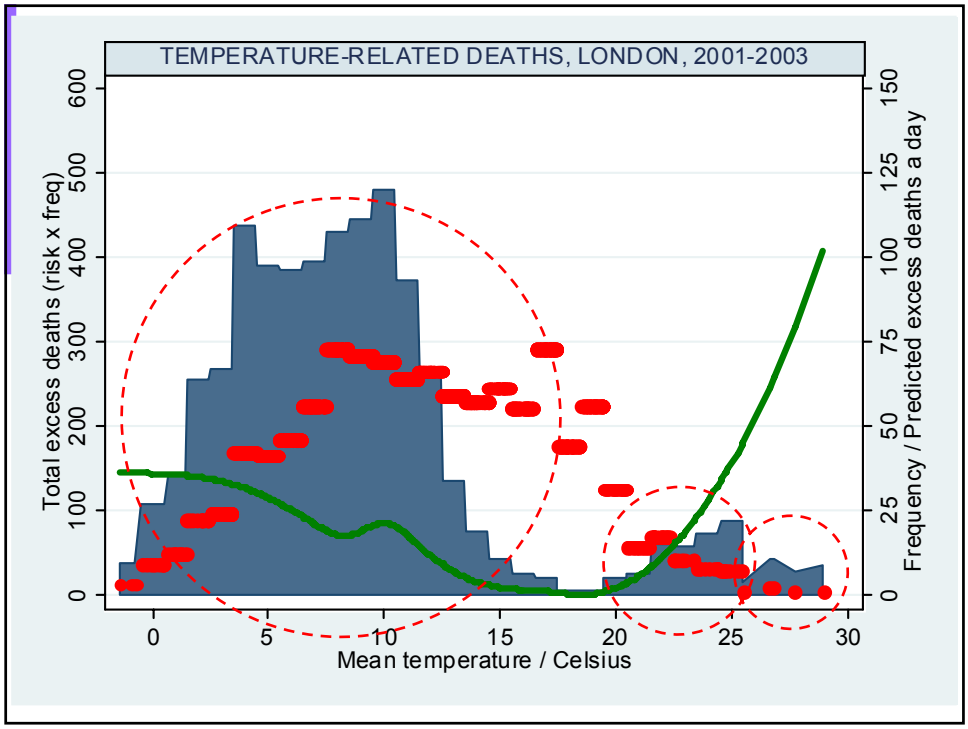

Time lag of temperature-related mortality
London:
Cold=>19% deaths
Heat=>0.6% deaths
0.000
Lag
27.000
1.173
RR
0.987
-6.000
Temperature
29.000

Daily mortality in relation to mean temperature during preceding two days

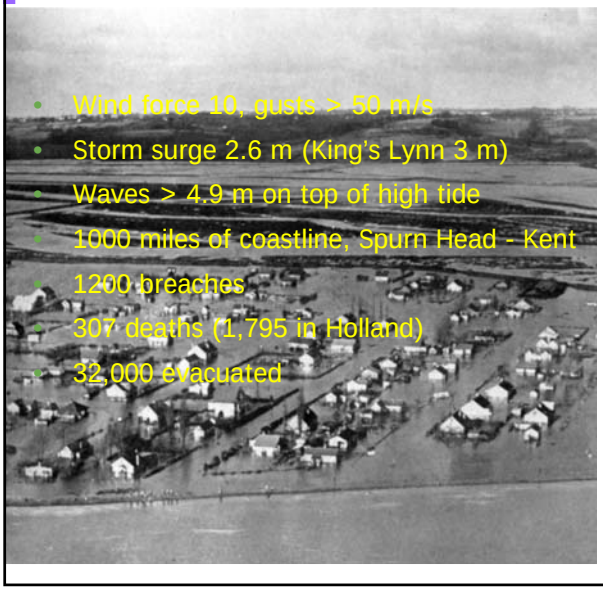




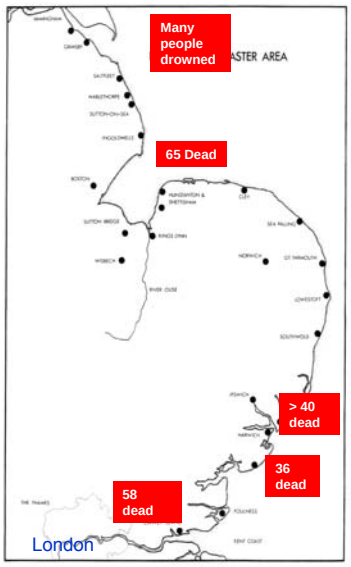

DEATHS, LONDON, 2001-2003
Deaths per day
100
150
200
250
300
0
10
20
30
Mean temperature / Celsius


TEMPERATURE-RELATED DEATHS, LONDON, 2001-2003
Total excess deaths (risk x freq)
0
100
200
300
400
500
600
Frequency / Predicted excess deaths a day
0
25
50
75
100
125
150
0
5
10
15
20
25
30
Mean temperature / Celsius

FLOODING: EAST ANGLIA & SOUTH EAST ENGLAND, 31 JAN - 1 FEB 1953

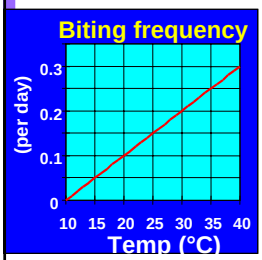


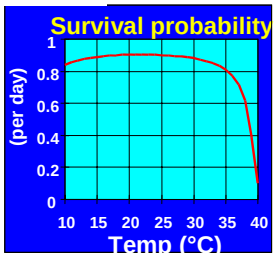
- Wind force 10, gusts > 50 m/s
- Storm surge 2.6 m (King's Lynn 3 m)
- Waves > 4.9 m on top of high tide
- 1000 miles of coastline, Spurn Head - Kent
- 1200 breaches
- 307 deaths (1,795 in Holland)
- 32,000 evacuated



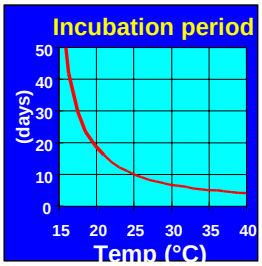
VECTOR-BORNE DISEASE

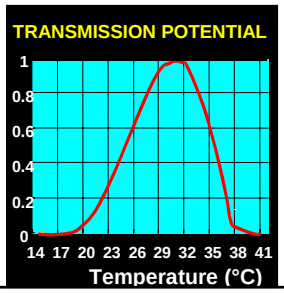
Mosquito



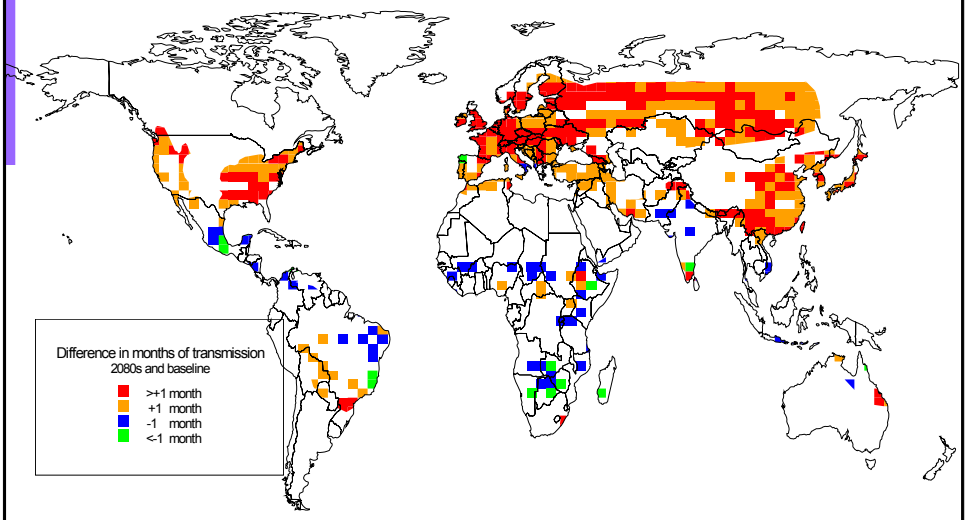


Parasite





PREDICTED CHANGE IN MONTHS PER YEAR OF FALCIPARUM MALARIA TRANSMISSION BY 2080



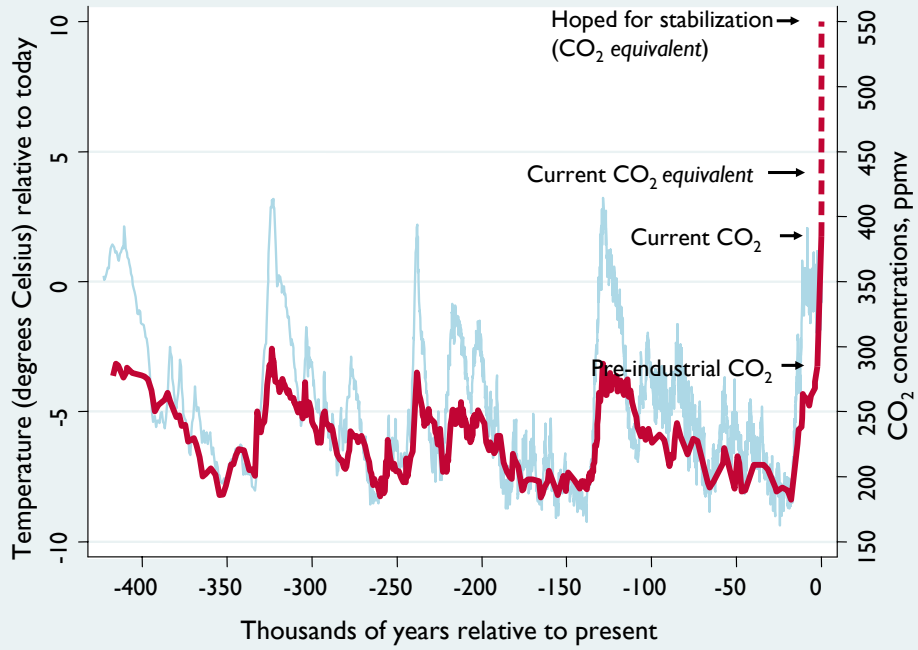
From Martens et al. 1999
[Climate change scenario developed by the UK Hadley Centre]

"If we could be absolutely sure that nothing more drastic than 'linear' changes in the climate could occur, it would be reassuring. The small chance of something really catastrophic is more worrying than the greater chance of less extreme events… [which] could negate decades of economic and social advance"

Rees, M. Our final century.
London: Arrow Books. 2004

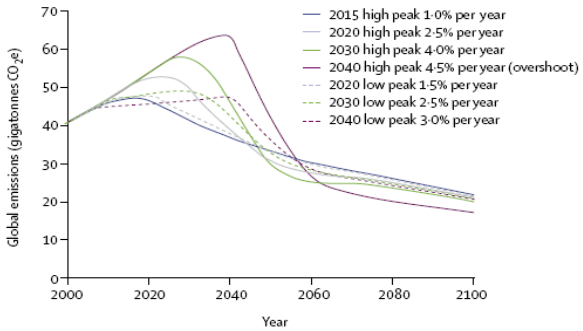
Reversal of carbon sinks (Amazon); deep ocean circulations; gas hydrates (clathrates); other…
Beware the Paleocene-Eocene Thermal Maximum!

Paleo-climate & CO_2 record, Vostock ice cores, Antarctica



THE CHALLENGE

- Limiting of global impact
- Reduction in GHG emissions by ~90% in high income countries by mid century
- Major shift towards low emissions energy (electricity from renewables, electricity or H2 as energy carriers for transport…)
- Behavioural change: active transport



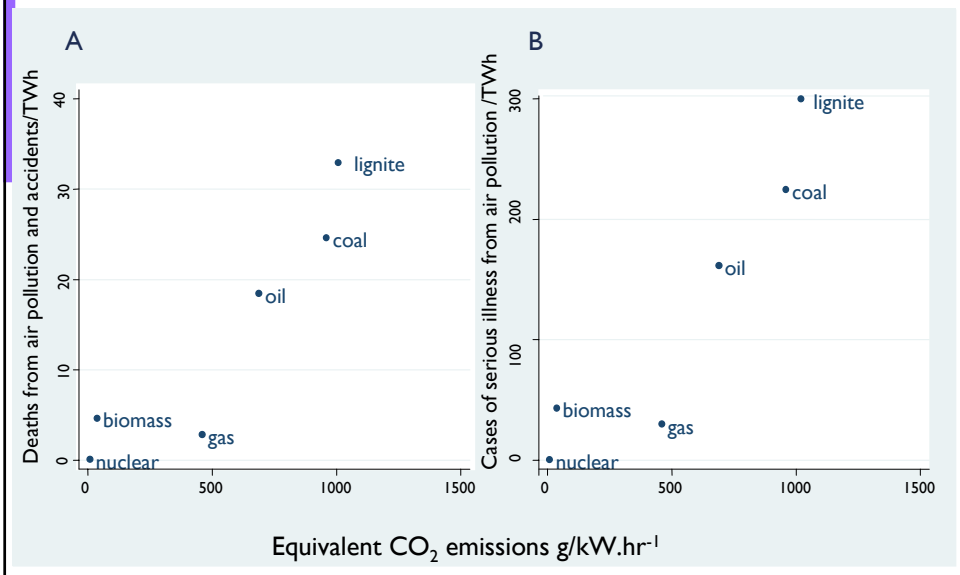
BENEFITS TO HEALTH

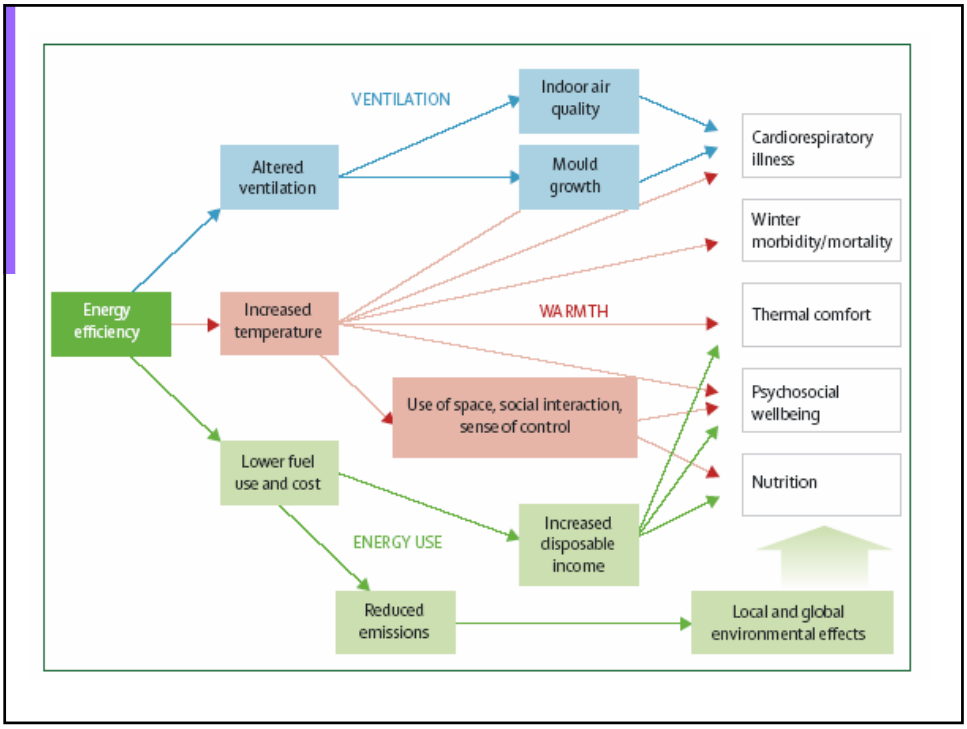
- Mitigation of health effects of climate change

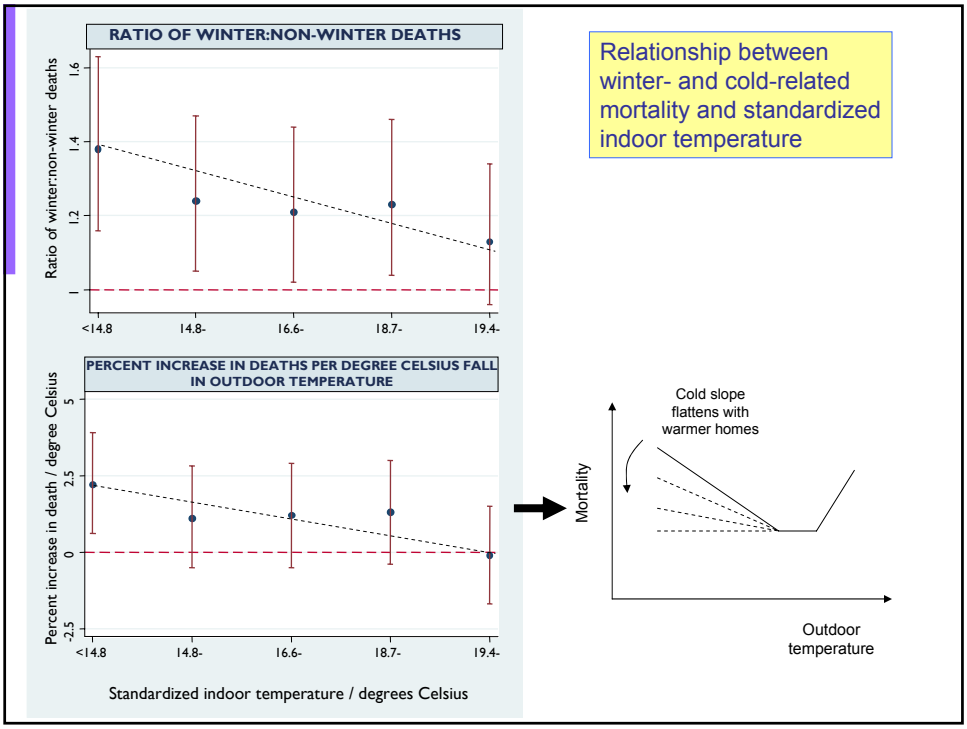
Co-benefits

- Reduced ambient air pollution
- Built environment: protection against low and high temperatures
- Active transport: physical activity, obesity, road injuries
- Quality of urban environment

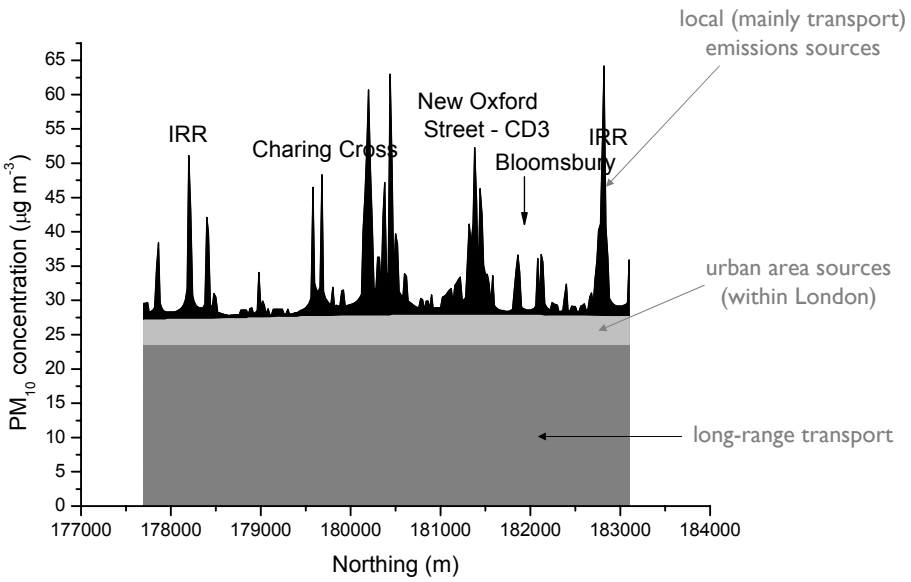
AIR POLLUTION IMPACTS VS CO_2 EMISSIONS




VENTILATION
Indoor air quality
Altered ventilation
Mould growth
Cardiorespiratory illness
Winter morbidity/mortality
Energy efficiency
Increased temperature
WARMTH
Thermal comfort
Use of space, social interaction, sense of control
Psychosocial wellbeing
Lower fuel use and cost
Nutrition
Increased disposable income
ENERGY USE
Reduced emissions
Local and global environmental effects


RATIO OF WINTER:NON-WINTER DEATHS
Ratio of winter:non-winter deaths
1
1.2
1.4
1.6
<14.8
14.8-
16.6-
18.7-
19.4-
PERCENT INCREASE IN DEATHS PER DEGREE CELSIUS FALL IN OUTDOOR TEMPERATURE
Percent increase in death / degree Celsius
-2.5
0
2.5
5
<14.8
14.8-
16.6-
18.7-
19.4-
Standardized indoor temperature / degrees Celsius
Relationship between winter- and cold-related mortality and standardized indoor temperature
Cold slope flattens with warmer homes
Mortality
Outdoor temperature

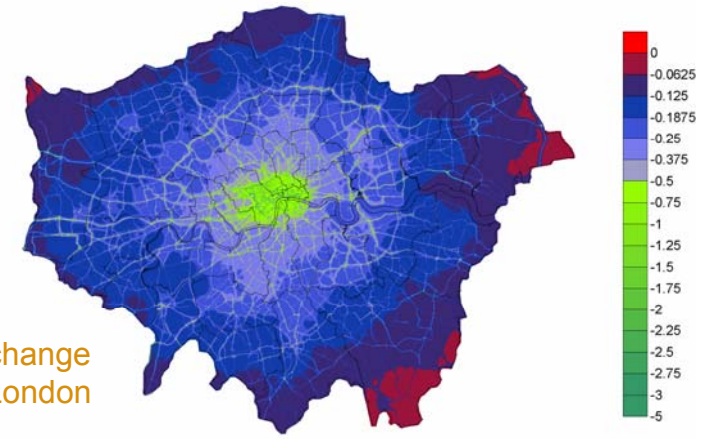
AIR POLLUTION SOURCES IN LONDON: SOUTH-NORTH TRANSECT



Sources of pollution: transect of central London (modelled)

URBAN INTERVENTIONS

- Urban layout, building design and renovation, transport system changes
- Combined technology and behaviour change
- Switch to cleaner energy carriers (electricity, hydrogen?)



Modelling change in PM_{10} in London

Hypothetical impact on pollutant emissions, concentrations and years of life gained

	'Baseline'	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Description	Business as usual	Bus fleet +20% of cars to H_2* or electric	40% lower building emissions	Half journeys <10km by walking/ cycling (50%) or publ trans	Combined
Emissions difference$ (%)	(tonnes/yr)				
PM	(3564)	-4.5%	-3.1	-3.4%	-10.6%
NO_x	(78994)	-7.9%	-11.6	-1.5%	-20.8%
CO_2	($39.5x10^{6}$)	-5.3%	-15.1	-2.2%	-22.1%
Change in concentrations	(µg.m-3)				
PM_{10}	(23.7)	-0.4%	-0.4%	-0.4%	-1.3%
NO_2	(36.8)	-4.6%	-7.0%	-0.5%	-12.0%
Gain in life years over 10 yrs:					
PM_{10} Total YLG	(baseline)	2527	1389	1736	5532
YLG per 100,000 pop		35	19	24	77
NO_2 Total YLG		26445	38223	3970	68834
YLG per 100,000 pop		366	529	55	953

* -- assumed to be hydrogen fuel cell
$ -- difference from baseline

"ACTIVE TRANSPORT": HEALTH GAINS

For an average car driving women 35-44 years…

- 15 g fat tissue per day
- 5.6 kg fat tissue per year
- Decrease
  - 20–40% in risk of premature mortality
  - 25% in breast cancer risk
  - >20% all cancer risk
  - >30% diabetes mellitus

CONCLUSIONS

- Air pollution and climate changed are linked by society's dependence on fossil fuels
- The magnitude of the climate change challenge demands major and rapid reduction in greenhouse gas emissions
- Technology alone is an insufficient solution; altered behaviours are needed and often beneficial
- Measures to achieve GHG reduction targets would be expected to yield appreciable benefits to public health

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