Air Pollution and Health –

a reflection of putting this issue into a historical dimension

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German Environment Agency

Air Pollution in Europe: this is, where we are…

the SO_2 example

Figure 5.3 Trend in average annual SO_2 concentrations (2001–2010) per station type

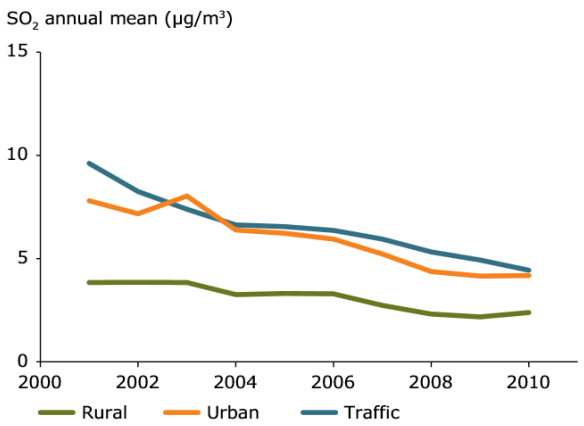
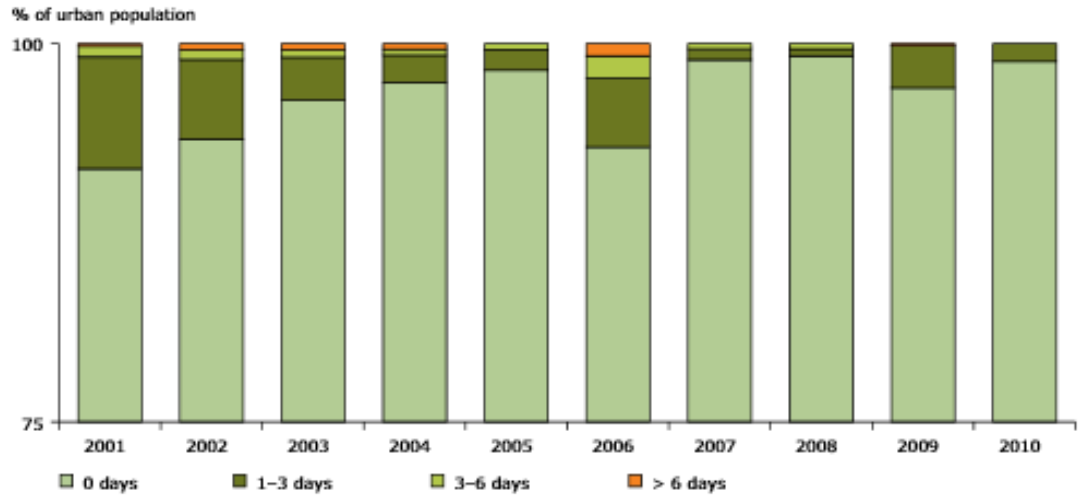
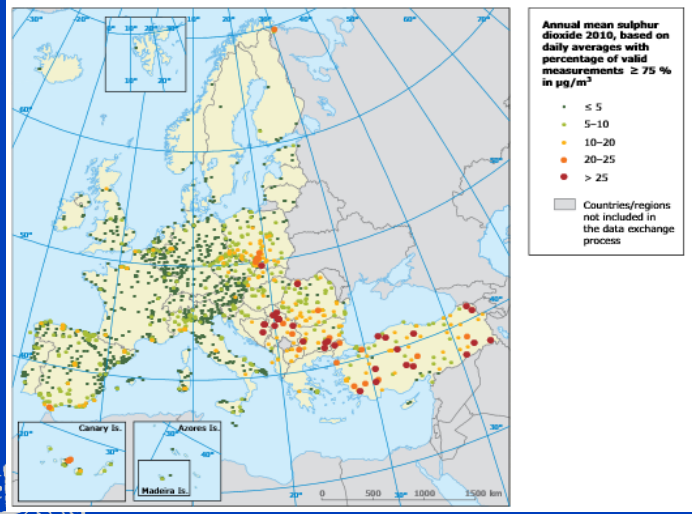


Figure 5.4 Percentage of the EU urban population exposed to SO_2 concentrations over the daily average limit value for protection of human health, 2001–2010



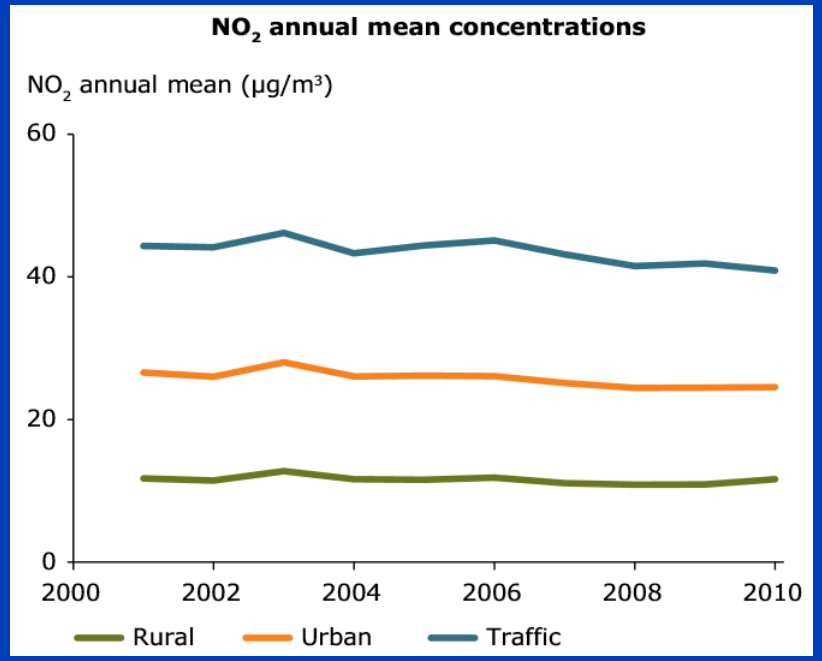
Map 5.1 Annual mean SO_2 concentrations (µg/m³), 2010

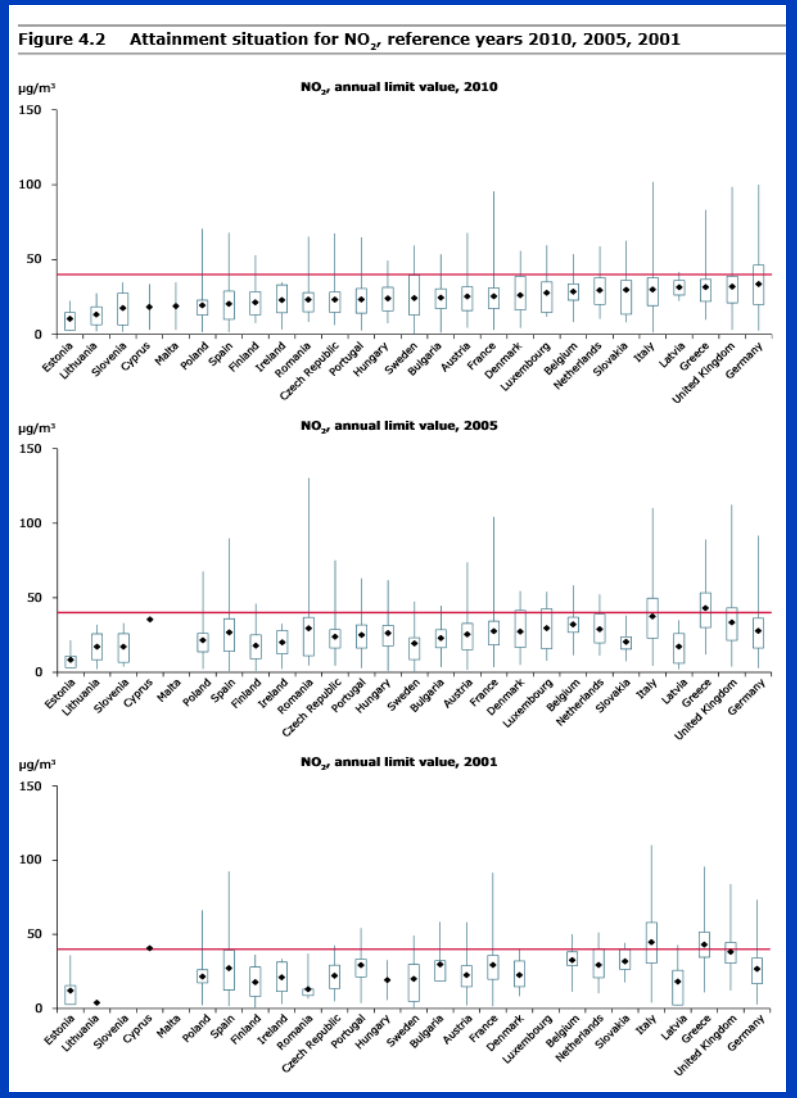


Source: EEA Air Quality Report 2012

Air Pollution in Europe: this is, where we are…

the NO_2 example



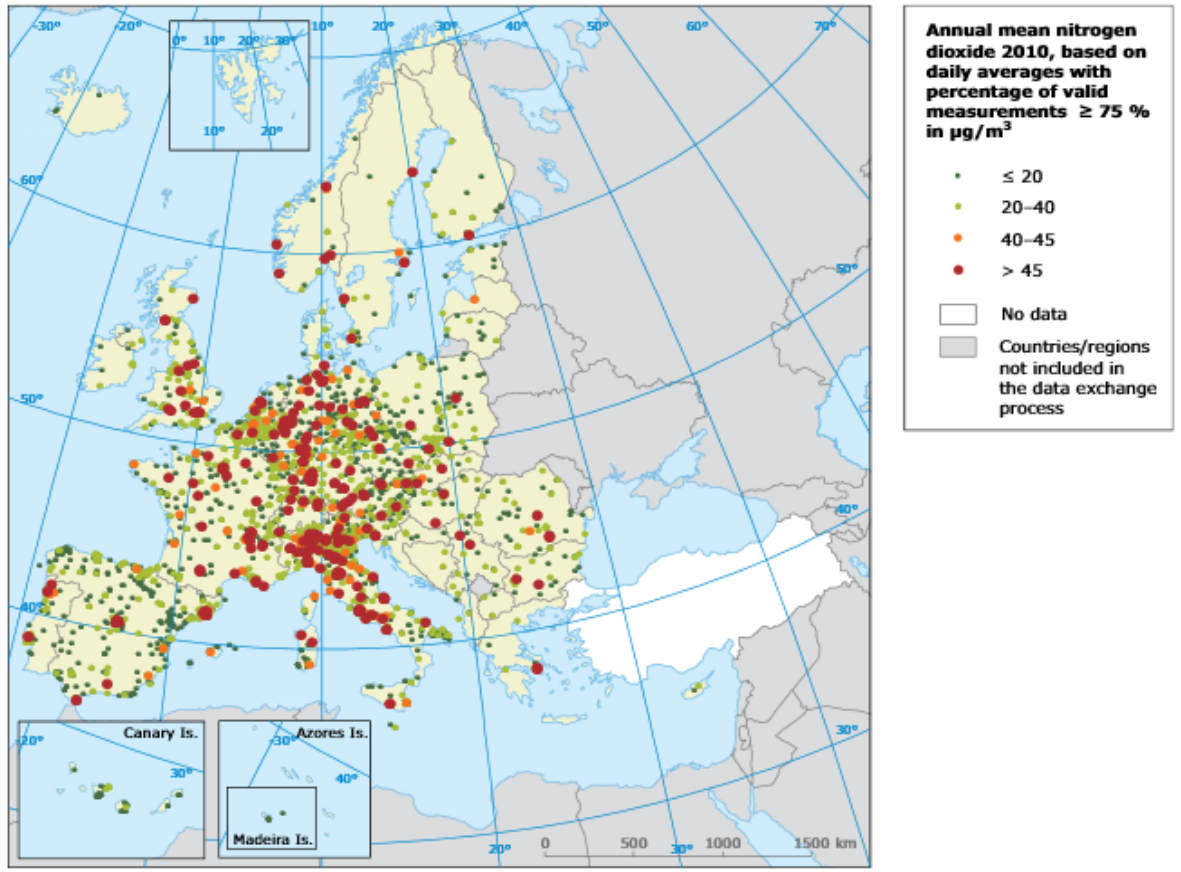


Source: EEA Air Quality Report 2012

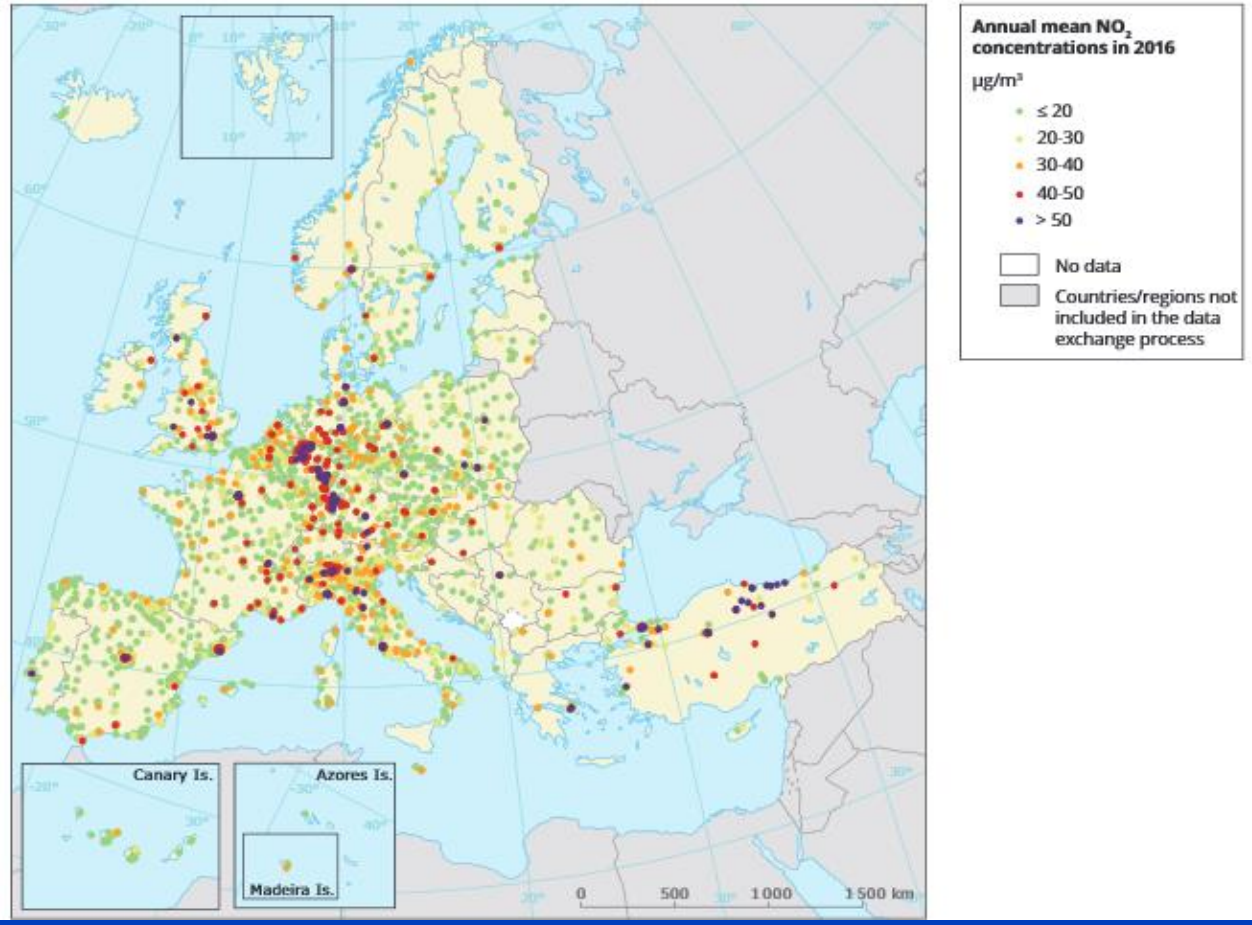
Air Pollution in Europe: this is, where we are…

the NO_2 example

Map 4.1 Annual mean concentration of NO_2 in 2010



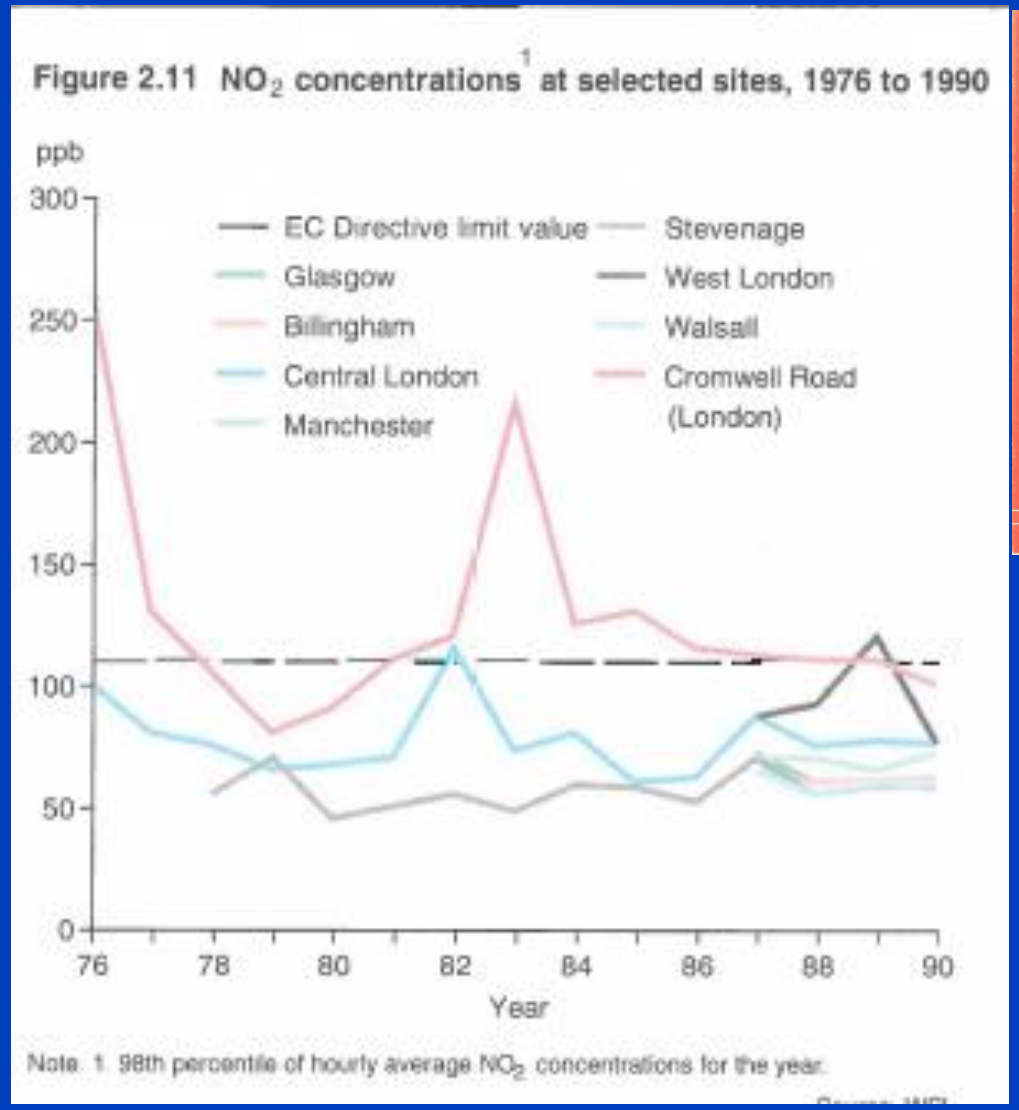
Map 6.1 Concentrations of NO_2, 2016

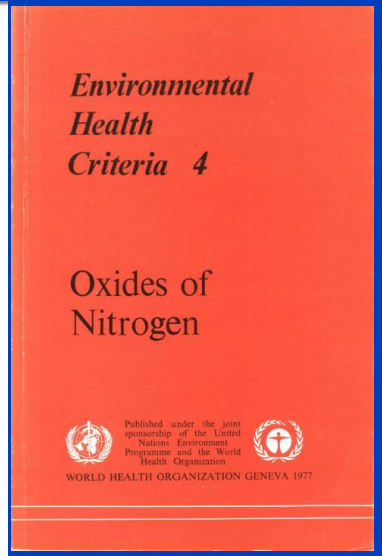


Source: EEA Air Quality Report 2012

…but this, where we came from

NO_2 and SO_2 concentration time series – indicator of long-term exposure





NO_2 air quality standard (85/203/EEC)

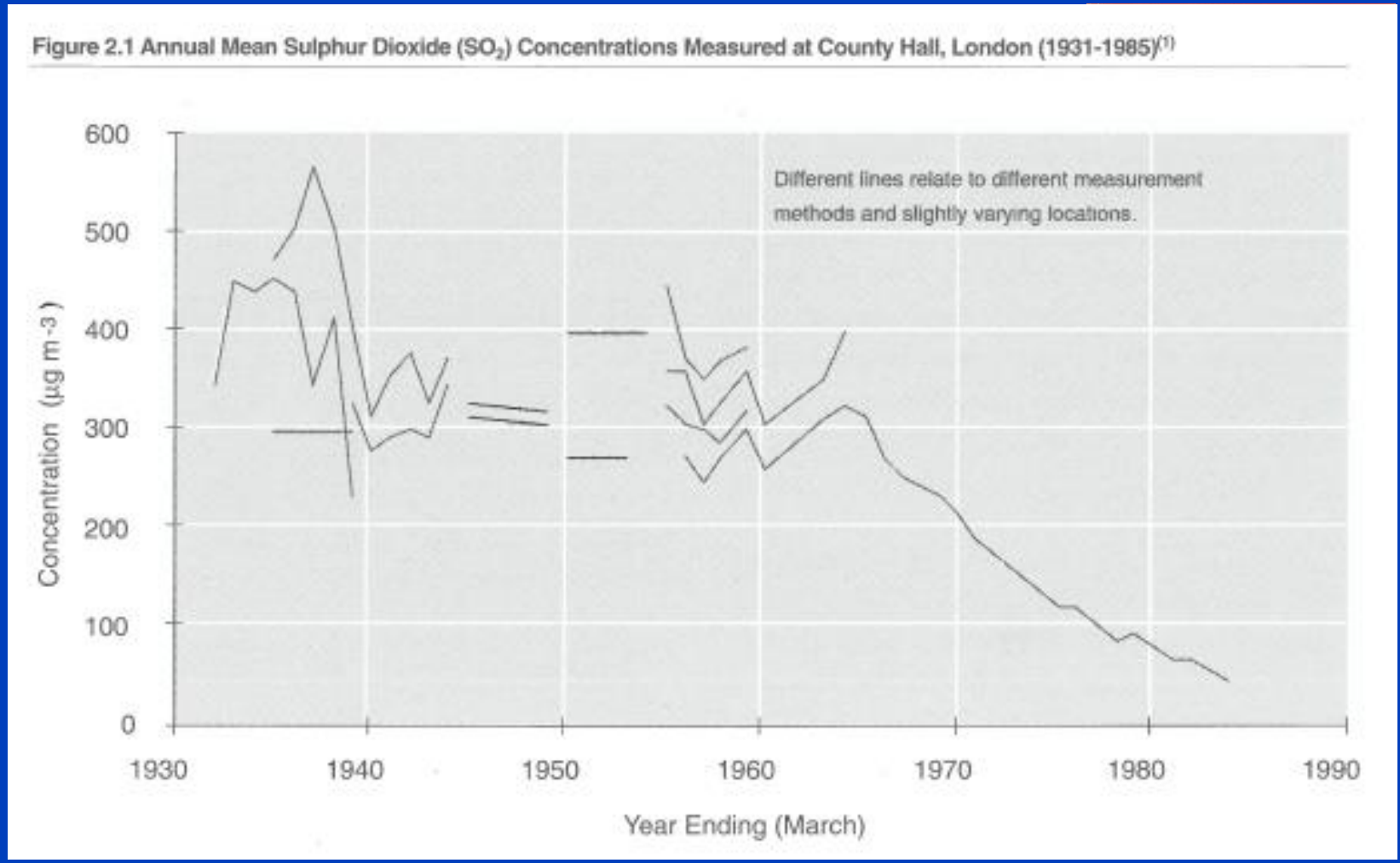
limit value: 200 µg/m³ annual average (98th perc.)

guide value: 135 µg/m³ annual average (98th perc.)

Source: UK Dept Environment 1992/93

…but this, where we came from

NO_2 and SO_2 concentration time series – indicator of long-term exposure



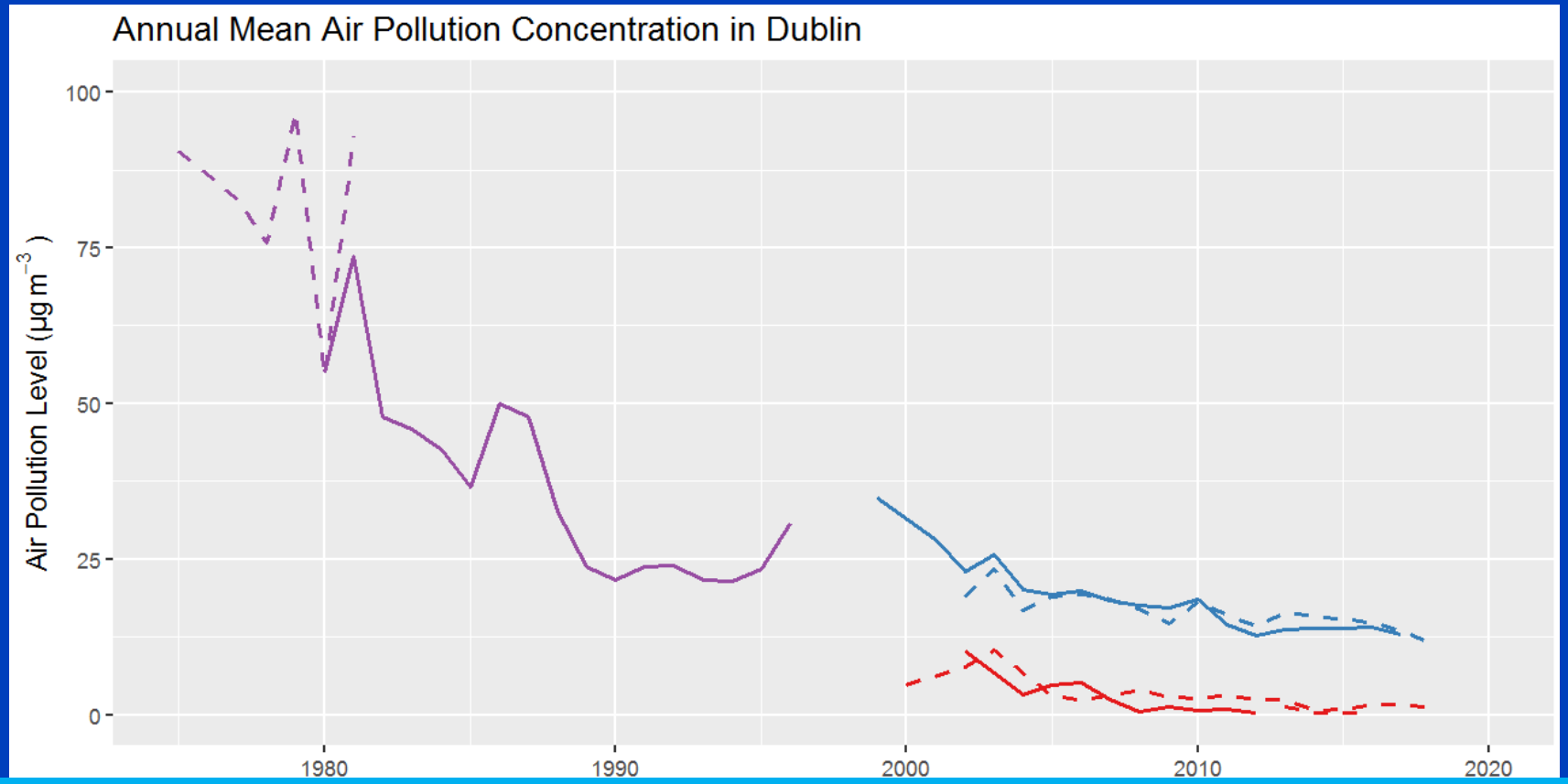
Source: UK Dept Environment 1992/93

Hans-Guido Mücke

Umwelt Bundesamt
German Environment Agency

…but this, where we came from

SO_2 concentration time series – long-term trend indicator



1st aspect to recognize

Health impacts of air pollution are depending on **long-term (chronical) exposure**

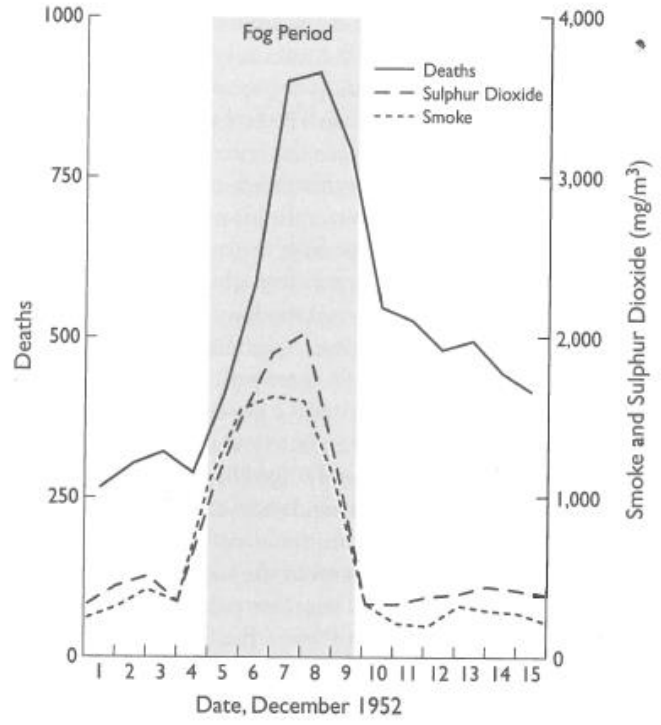
Source: EEA Data series 2019

Health Impact Assessment of Air Pollution Exposure

the London „smog“ episode (December 1952) resulted in a total of about 4,000 excess deaths

FIGURE 1.1

Daily Mean Pollution Concentrations and Daily Numbers of Deaths During the London Fog Episode of 1952



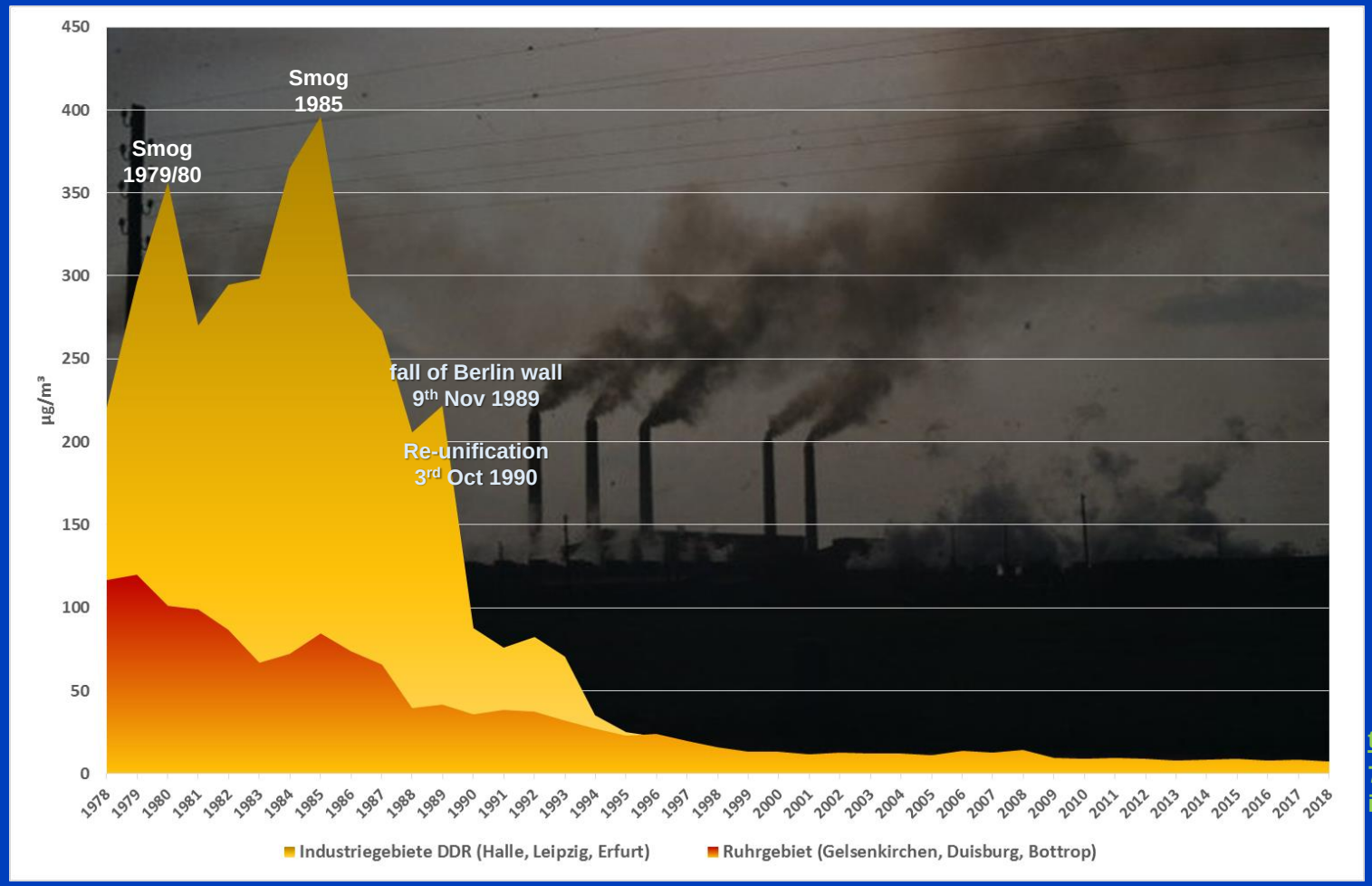
Source: Beaver, 1954

2nd aspect to recognize

Health impacts of air pollution are depending on **short-term (acute) peak exposure**

Air Pollution and Health in East and West Germany

long-term trend of SO_2 annual mean values in industrial areas of GDR and FRG



SO_2 in Berlin (West); Smog:

25.01.1980: 830 µg/m³ (24h)
22.01.1985: 650 µg/m³ (24h)
01.02.1987: 900 µg/m³ (24h)

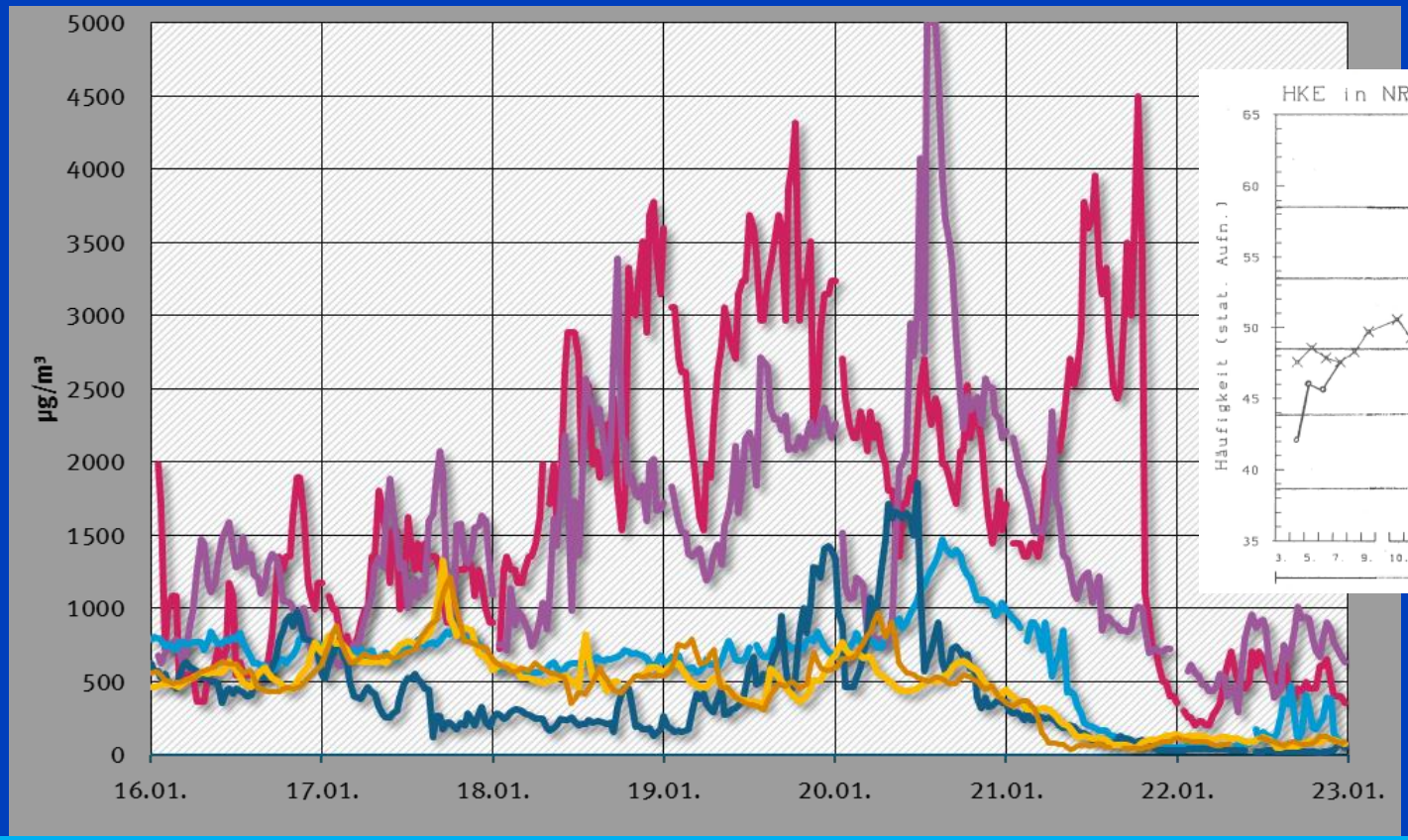
today:

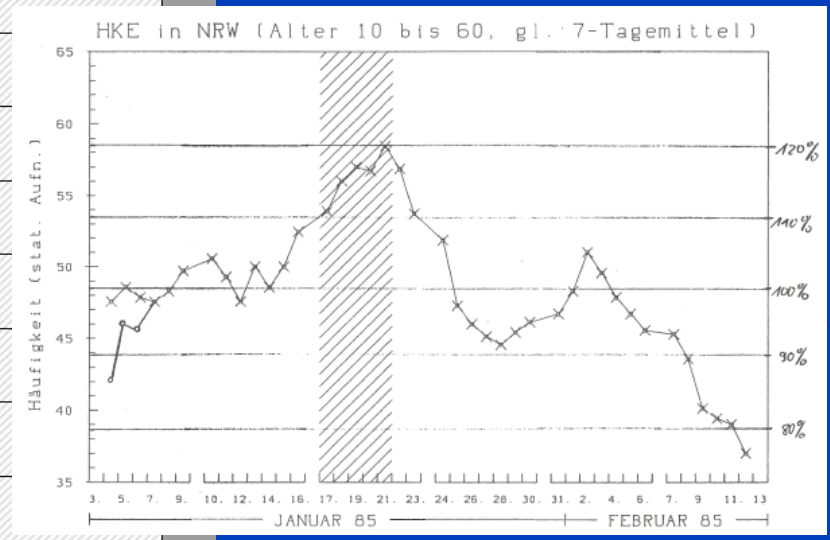
7-10 µg/m³ at industrial sites

Photo: Leipzig power plant (1983), Peter Wensierski

Air Pollution health impacts are depending on
a) short-term peak episodes

the example of the smog episode 16 to 22 January 1985 in GDR and FRG





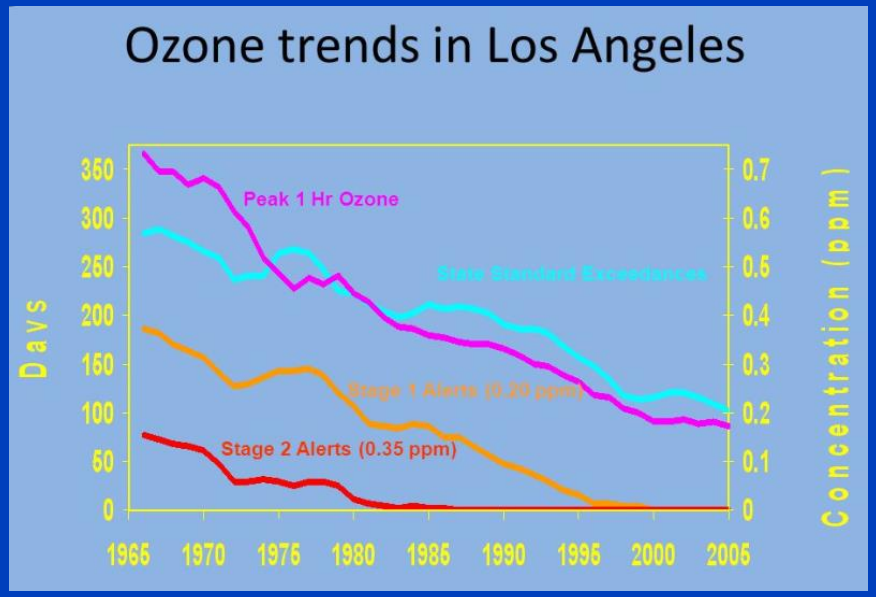
Source: Wichmann 1985

3rd aspect to recognize

Health impacts of air pollution are depending on **seasonal and special weather conditions**

Health Impact Assessment/HIA of Air Pollution Exposure

long-term trend of the ozone concentration in Los Angeles - LA smog



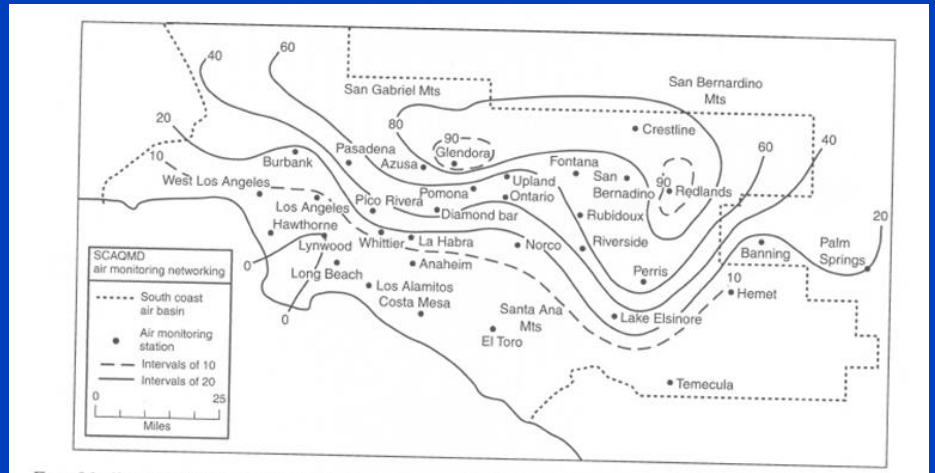


Figure 9.1 *Number of days on which the federal one-hour ozone standard of 120 ppb (240 μg/m³) was exceeded in the South Coast Air Basin in 1993*

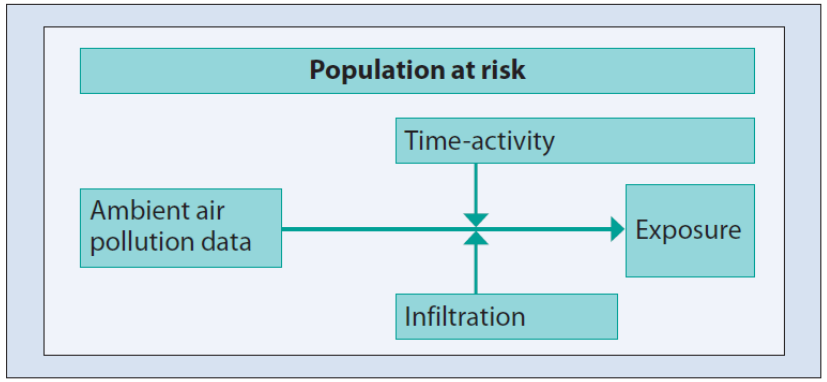
Source: South Coast Air Quality Management District (1994) *Final 1994 Air Quality Management Plan: Meeting the Clean Air Challenge*, SCAQMD, Diamond Bar, ch 2, p 10

4th aspect to recognize

Health impacts of air pollution are depending on **geographical, climatological and topographical conditions**

HIA of Air Pollution Exposure is a real complex thing

Fig. 5.1. Exposures driven by ambient concentrations are modified by time-activity and infiltration



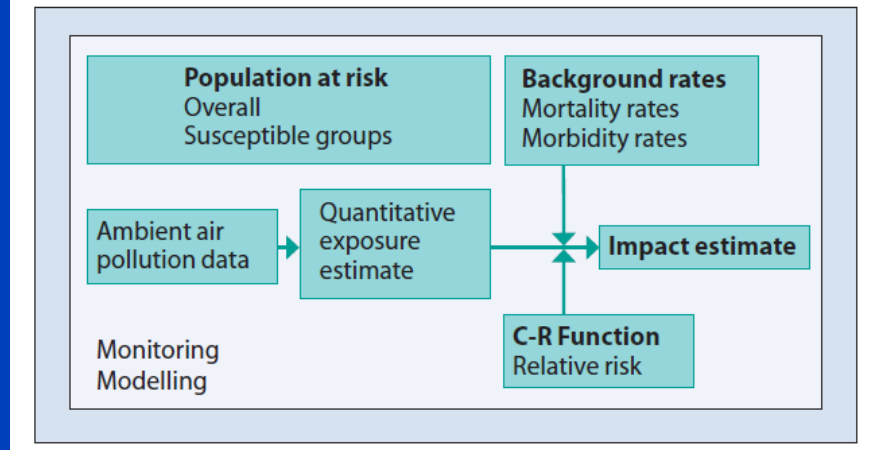


Fig. 6.1. The steps in a health impact assessment

…much more aspects have to be recognized and taken into account

Health impact assessment of air pollution depends on

- temporal/daily Air Pollution concentration cycles
- time-activity patterns (-> personal sampling)
- AP measurements/monitoring itself (continuous vs discontinuous methods)
- emitting-behaviour (eg smoking, car driving, barbequeing, open fire/burning)
- interactions between/multi pollutant co-effects (synergisms)
- combinations of outdoor and indoor Air Pollution
- influences of Air Pollution on Climate Change vice verca
- vulnerable people at risk (babies, patients, ageing, population distribution)
- …

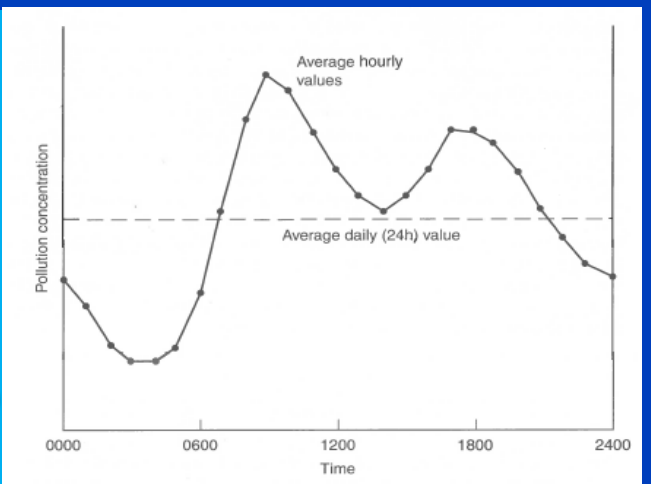
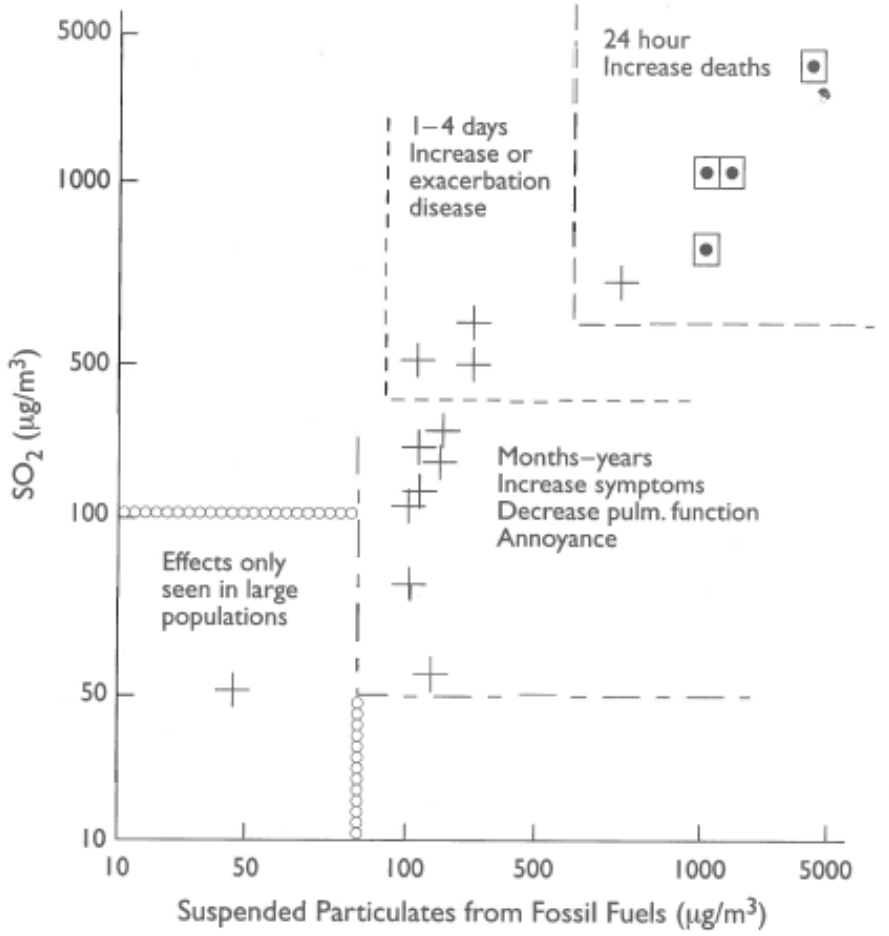


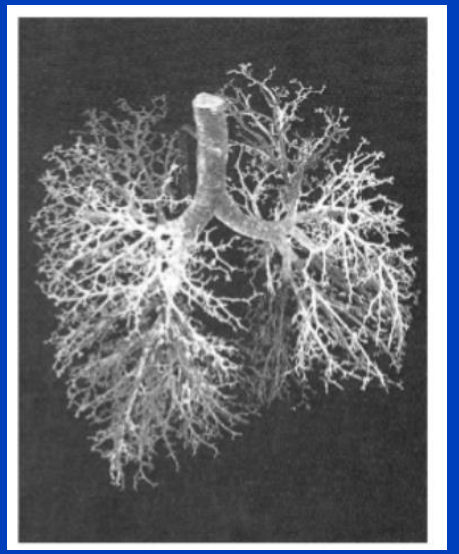
Figure 4.2 *How daily (24 h) averaging values may conceal hourly peaks of pollution concentrations that may pose serious health risks. The diurnal pollution cycle depicted is typical of that produced by traffic emissions such as carbon monoxide and nitrogen oxides*

Air Pollution and Health: dose response relationship

FIGURE 1.2

Dose Response Curve for Sulfur Dioxide and Total Suspended Particulates





Source: Wilson & Spengler 1996

Air Pollution and Health: who is at risk?

EPA United States Environmental Protection Agency

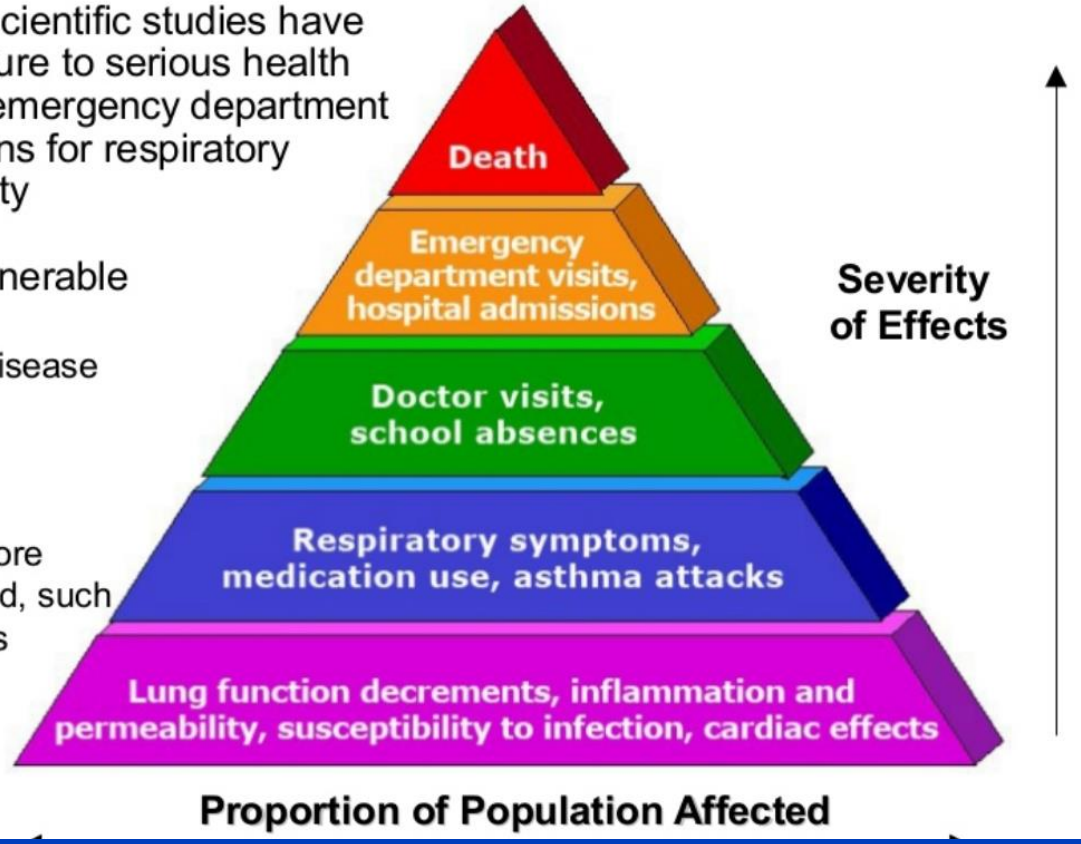
Office of Air Quality Planning and Standards

Ozone Health Impacts: " Pyramid of Effects"

A large number of scientific studies have linked ozone exposure to serious health outcomes such as emergency department visits, hospitalizations for respiratory causes, and mortality

Susceptible and vulnerable groups include

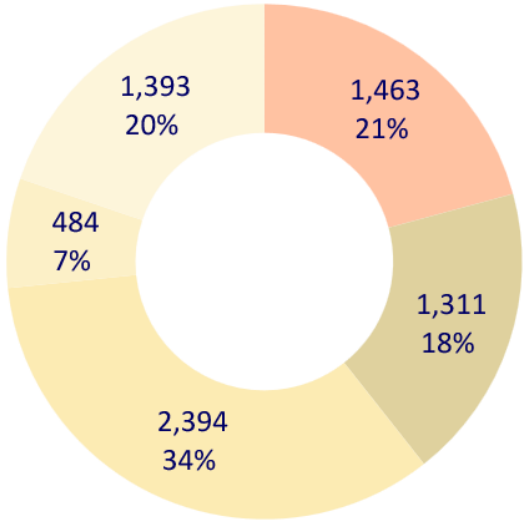
- People with lung disease such as asthma
- Children
- Older adults
- People who are more likely to be exposed, such as outdoor workers



Air Pollution and Health: AP Mortality 2016

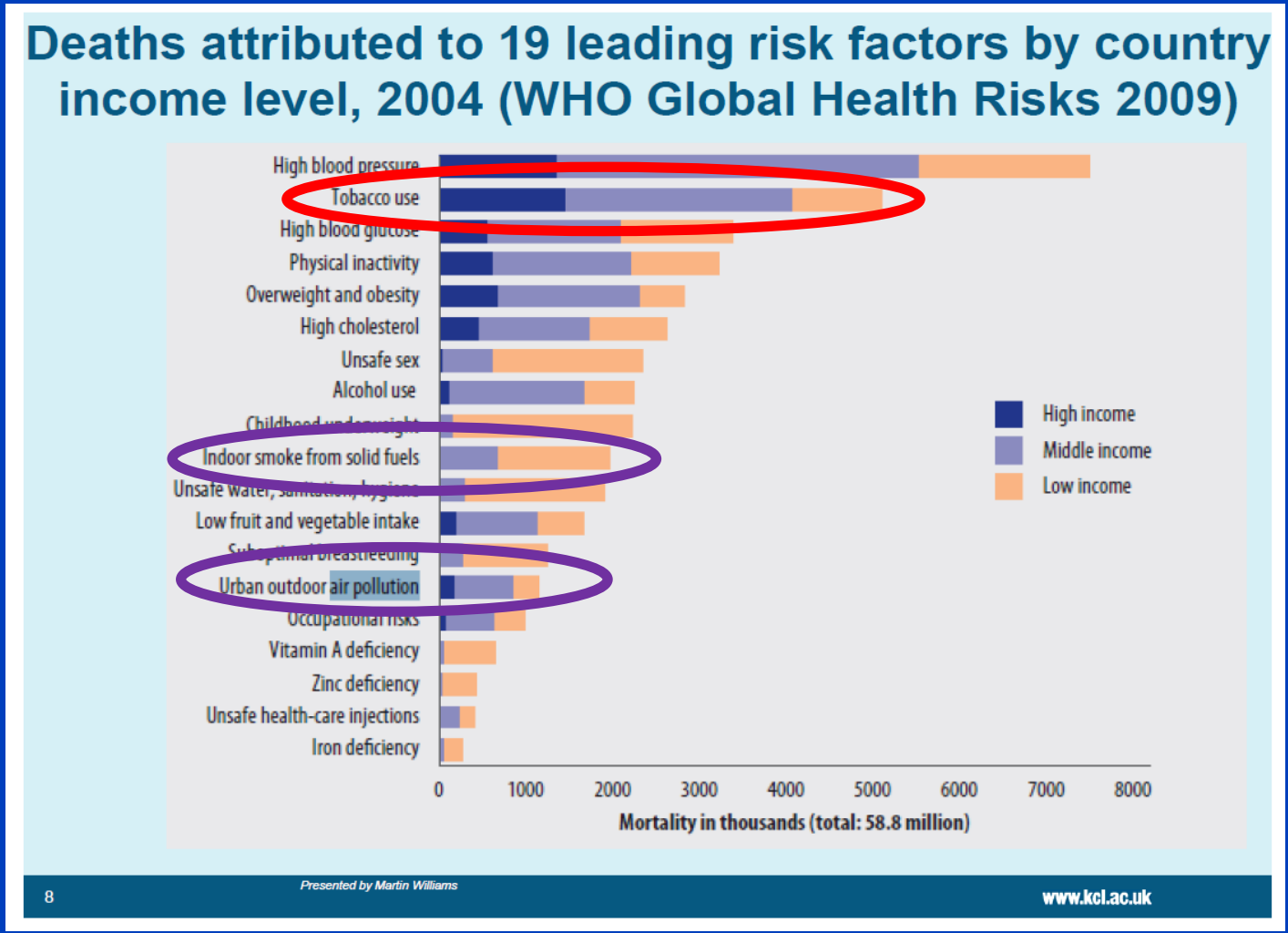
7 millions deaths – 89% are non communicable disease

- Acute lower respiratory infections
- Chronic obstructive pulmonary disease
- Ischaemic heart disease
- Lung cancer
- Stroke

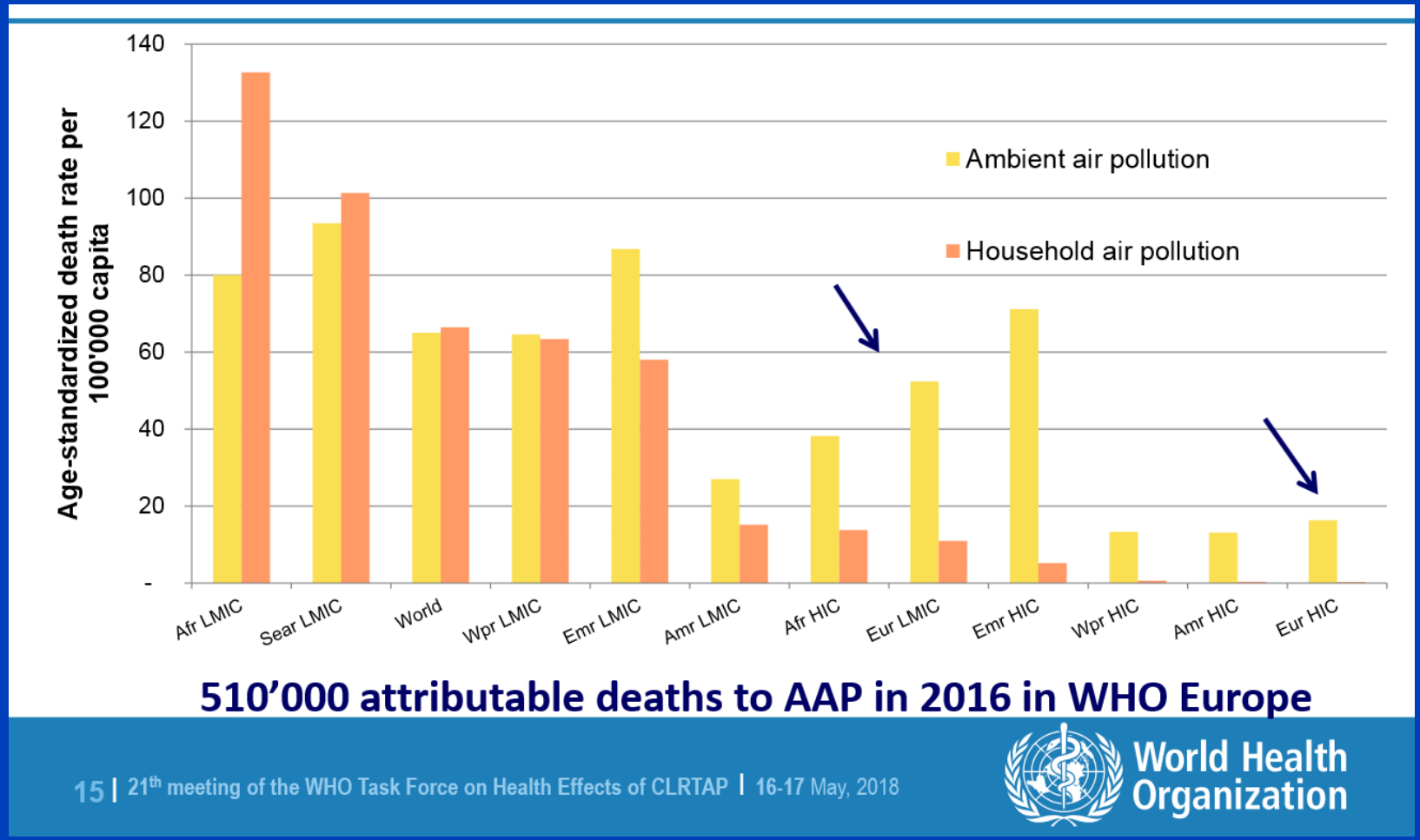


World Health Organization

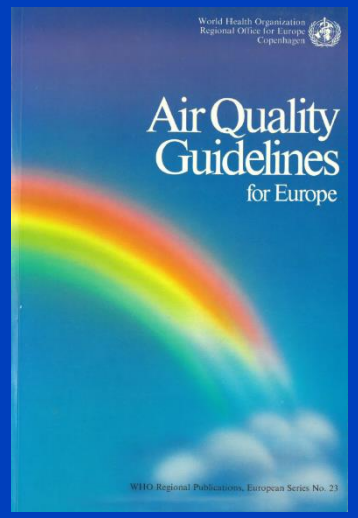
Air Pollution and Health: leading risk factors

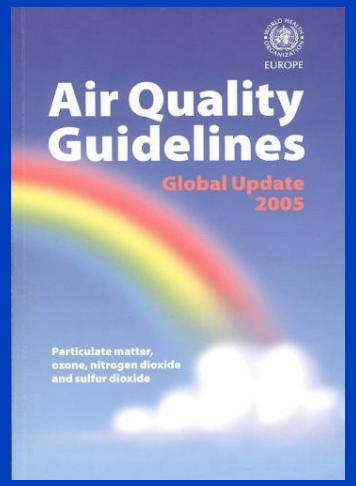


Air Pollution and Health: Mortality attributable to AP by region, globally



WHO AQG values: 1987 vs. 2005

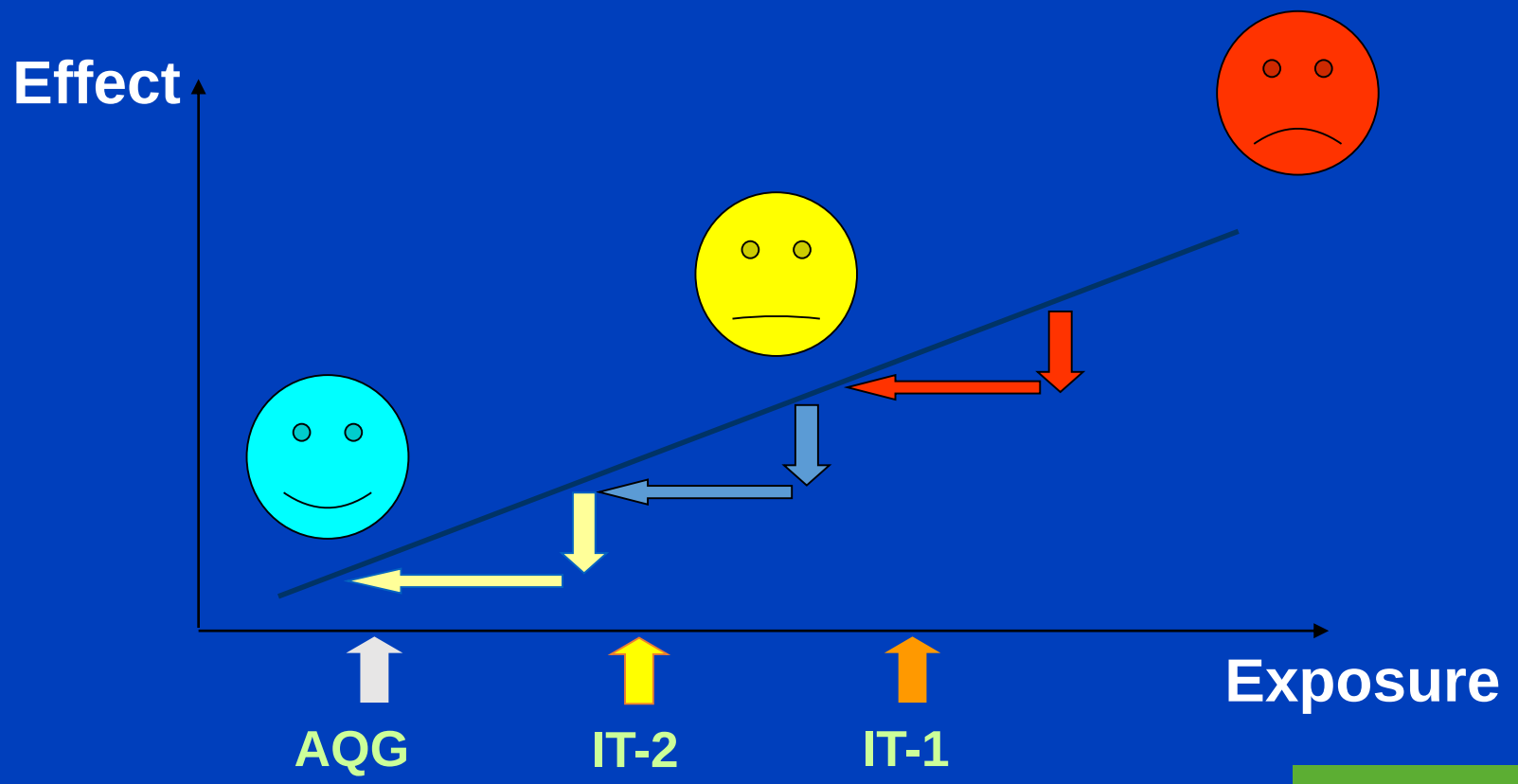




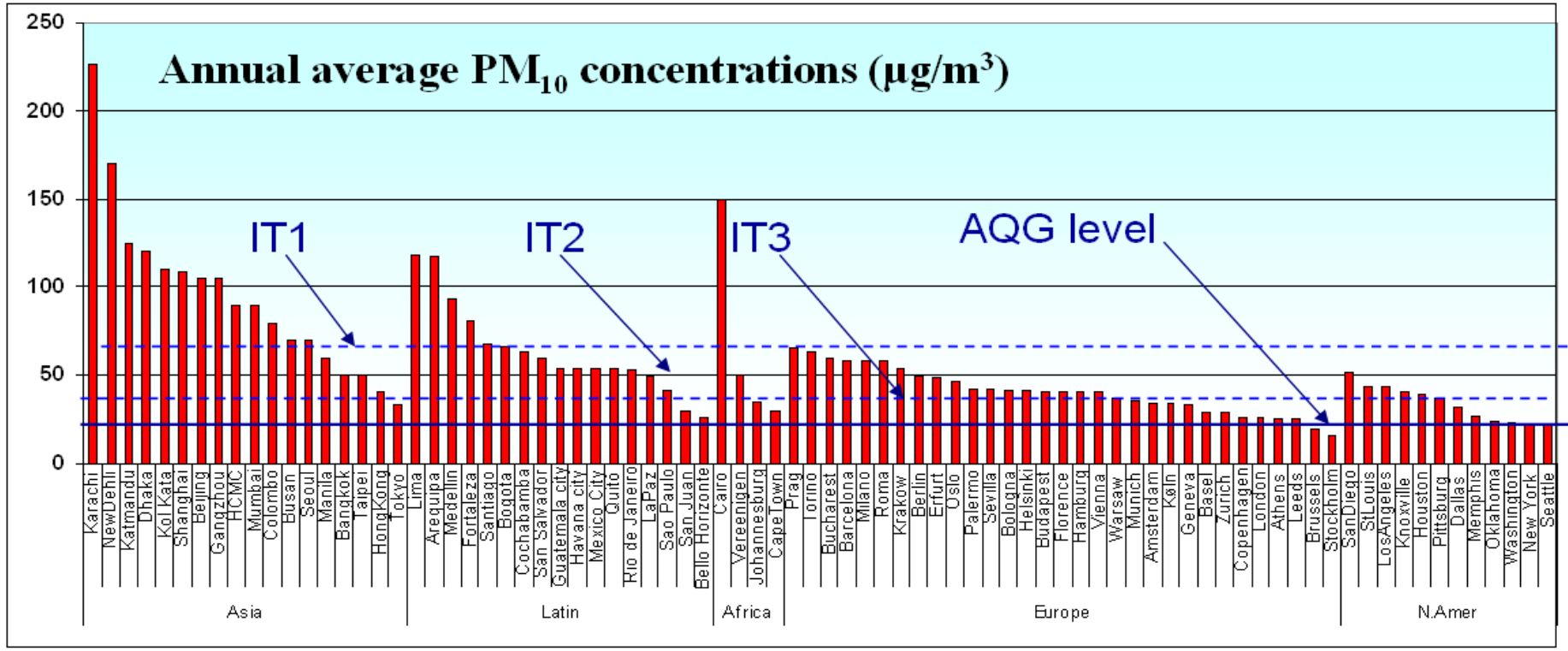
AQG levels recommended to be achieved everywhere in order to significantly reduce the adverse health effects of pollution

Pollutant	AQG 1987 (averaging time)	AQG 2005 (averaging time)
Particulate matter		
$PM_{2.5}$		10 µg/m³ (1 year) 25 µg/m³ (24h, 99th p.)
	TSP 120 µg/m³ (24h)	
PM_{10}	BS 50 µg/m³ (1 year) 125 µg/m³ (24h)	20 µg/m³ (1 year) 50 µg/m³ (24h, 99th p.)
Ozone, O_3	150-200 µg/m³ (1h)	100 µg/m³ (8h, d max.)
Nitrogen dioxide, NO_2	150 µg/m³ (24h) 400 µg/m³ (1h)	40 µg/m³ (1 year) 200 µg/m³ (1h)
Sulfur dioxide, SO_2	350 µg/m³ (1h) 500 µg/m³ (10 min.)	20 µg/m³ (24h) 500 µg/m³ (10 min.)

Passing interim targets on the way towards WHO AQG



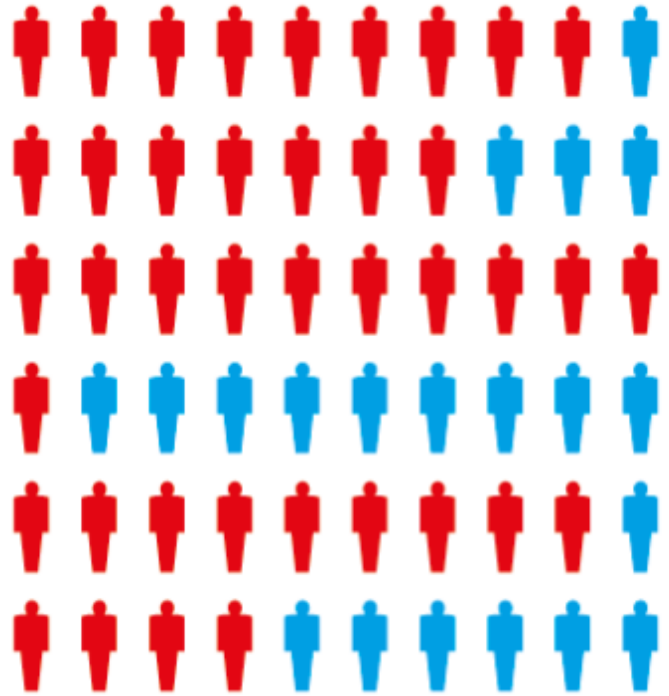
Annual average PM10 concentrations observed in selected cities worldwide



Exceedances of Air Pollution values in Europe 2016: EU standards vs. WHO guidelines

	EU urban population exposed to air pollution **above EU standards**
$PM_{2.5}$	7–8 %
PM_{10}	16–20 %
O_3	7–30 %
NO_2	7–9 %
BaP	20–25 %
SO_2	<1 %

The proportion of the population living in areas exceeding WHO air quality guideline values varies by pollutant, with over 87% of the EU population exposed to high levels of fine particles ($PM_{2.5}$) and 98% to high levels of ozone (O_3).[viii]



Source: EEA 2016

WHO Air Quality and Health programme (UNEP/WHO/GEMS Air, since 1973)

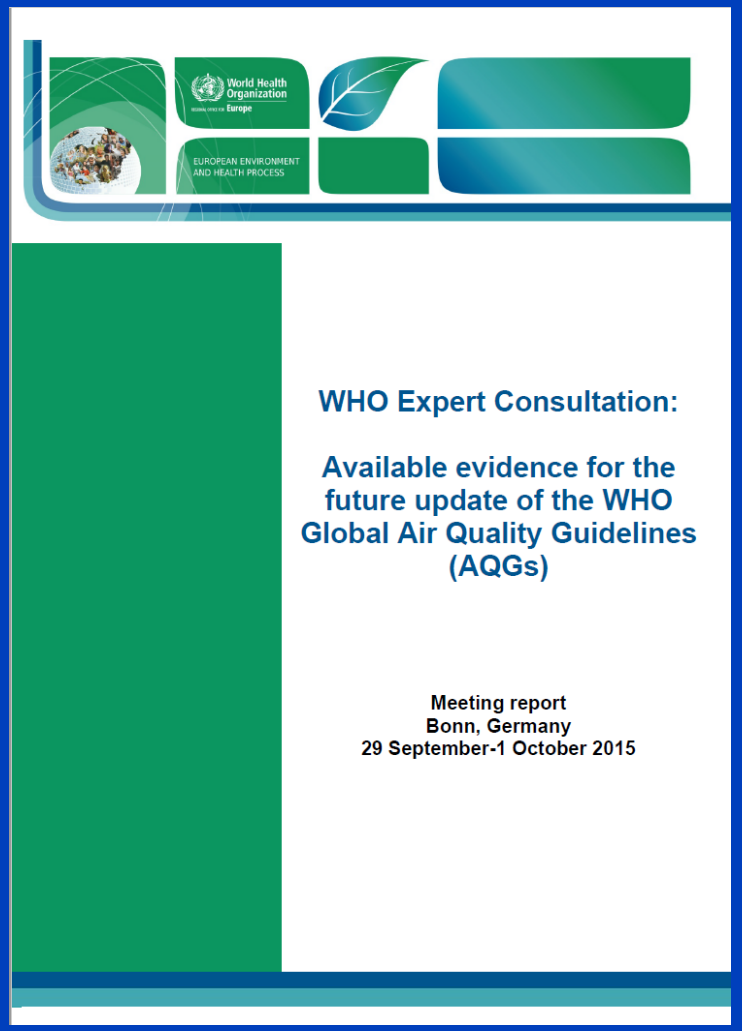
- European Commission (EC)
  - DGs for Env, Health and Research in Brussels/Luxemburg
  - Joint Research Centre in Ispra

- European Environment Agency (EEA) in Copenhagen

- UNECE/CLRTAP
  - WG on Effects – Task Force on Health at WHO/ECEH in Bonn

- WHO/WMO Joint Office in Geneva

WHO Global Air Quality Guidelines update started in 2015



WHO AQG (since 1987), a basis for effective and efficient Air Pollution control policies and measures

Fig. 1. Schematic spectrum of biological response to pollutant exposure[a]

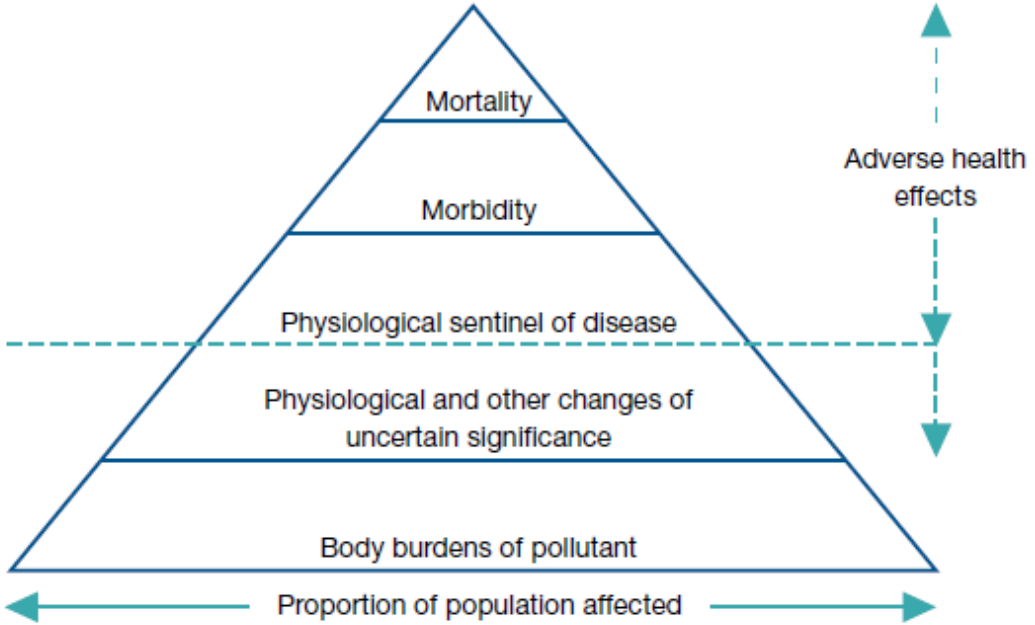
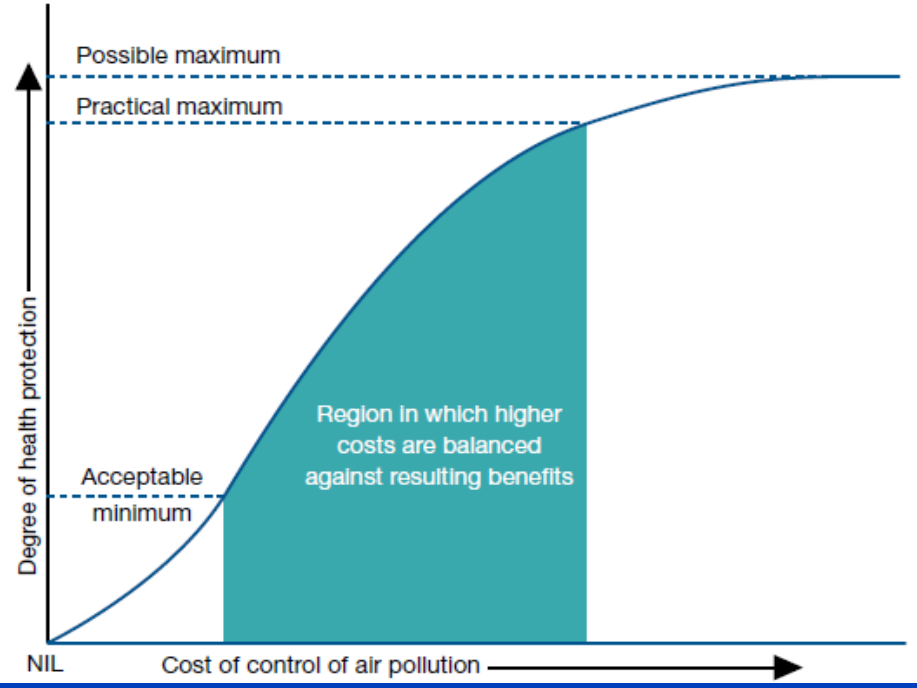


Fig. 2. Schematic representation of degree of health protection as a function of cost of air pollution control



Source: WHO 2017

The smartest control of AP is to reduce avoidable emissions wherever you can, to protect your health through active/passive abatement approaches and behavioural changes

COUNCIL DIRECTIVE

of 15 July 1980

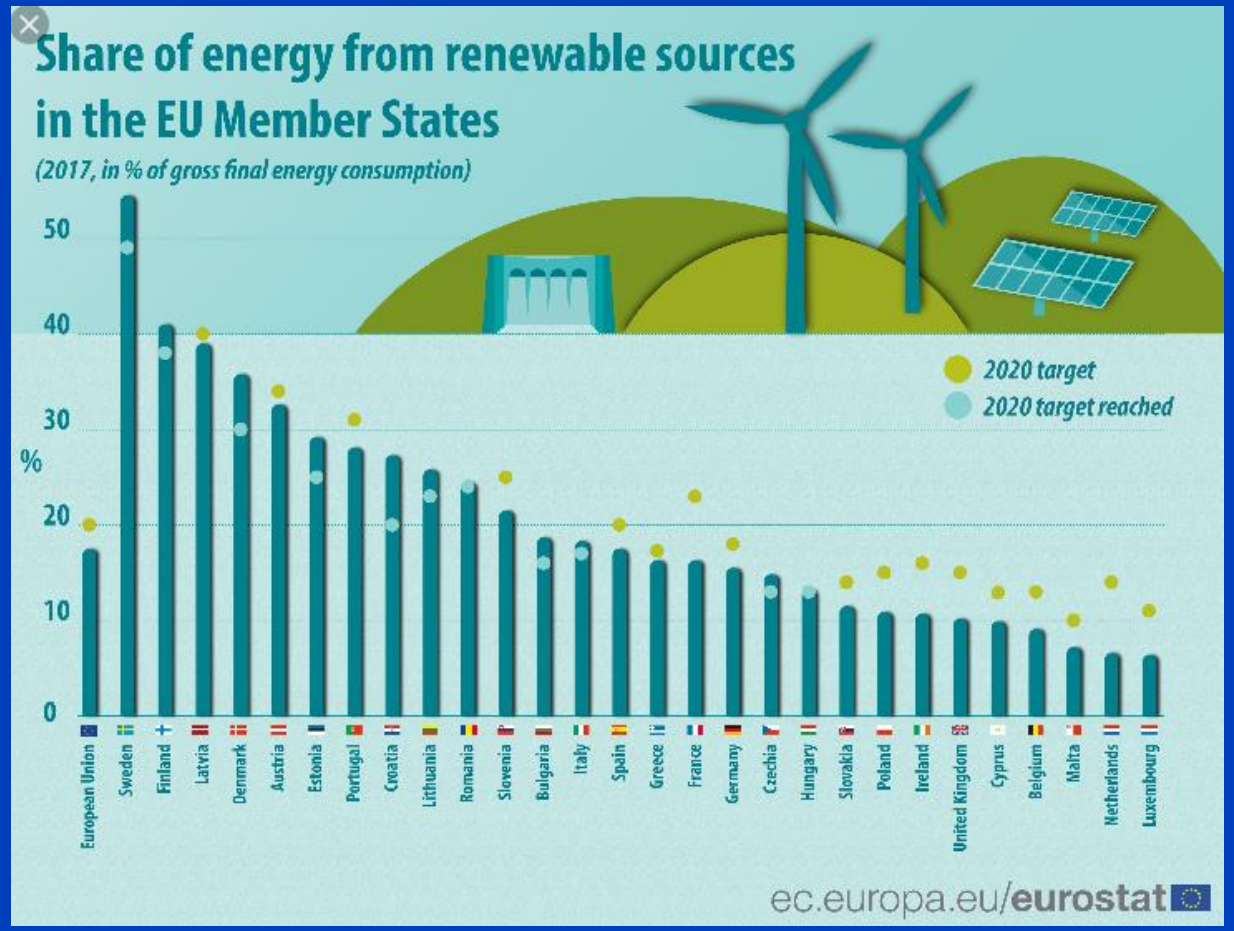
on air quality limit values and guide values for sulphur dioxide and suspended particulates

(80/779/EEC)

DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 21 May 2008

on ambient air quality and cleaner air for Europe



Thank you

Hans-Guido Mücke

Umwelt Bundesamt
German Environment Agency