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Swiss Tropical and Public Health Institute
Schweizerisches Tropen- und Public Health-Institut
Institut Tropical et de Santé Publique Suisse

Defending Public Health Priorities at Times of Scandals and Media Hypes around “Dirty Diesel”

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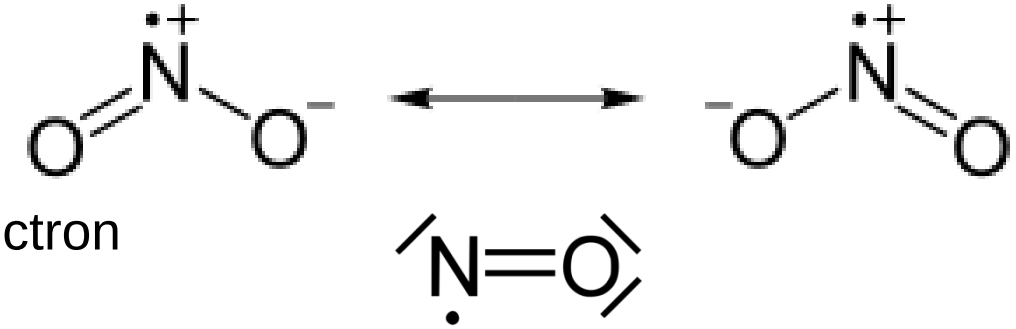
Prepared for 22. ETH Conference on Combustion Generated Nanoparticles

Wed 20.6.2018 Session Health - 14:20-15:50h - Zürich

Oxides of Nitrogen NOx



NO and NO_2: one unpaired electron

→ highly reactive

→ oxidation agent

Sources: Traffic, domestic heating, industry and the energy sector.

US EPA Integrated Science Assessment on NOx: Changes in causality assessments 2008 to 2016

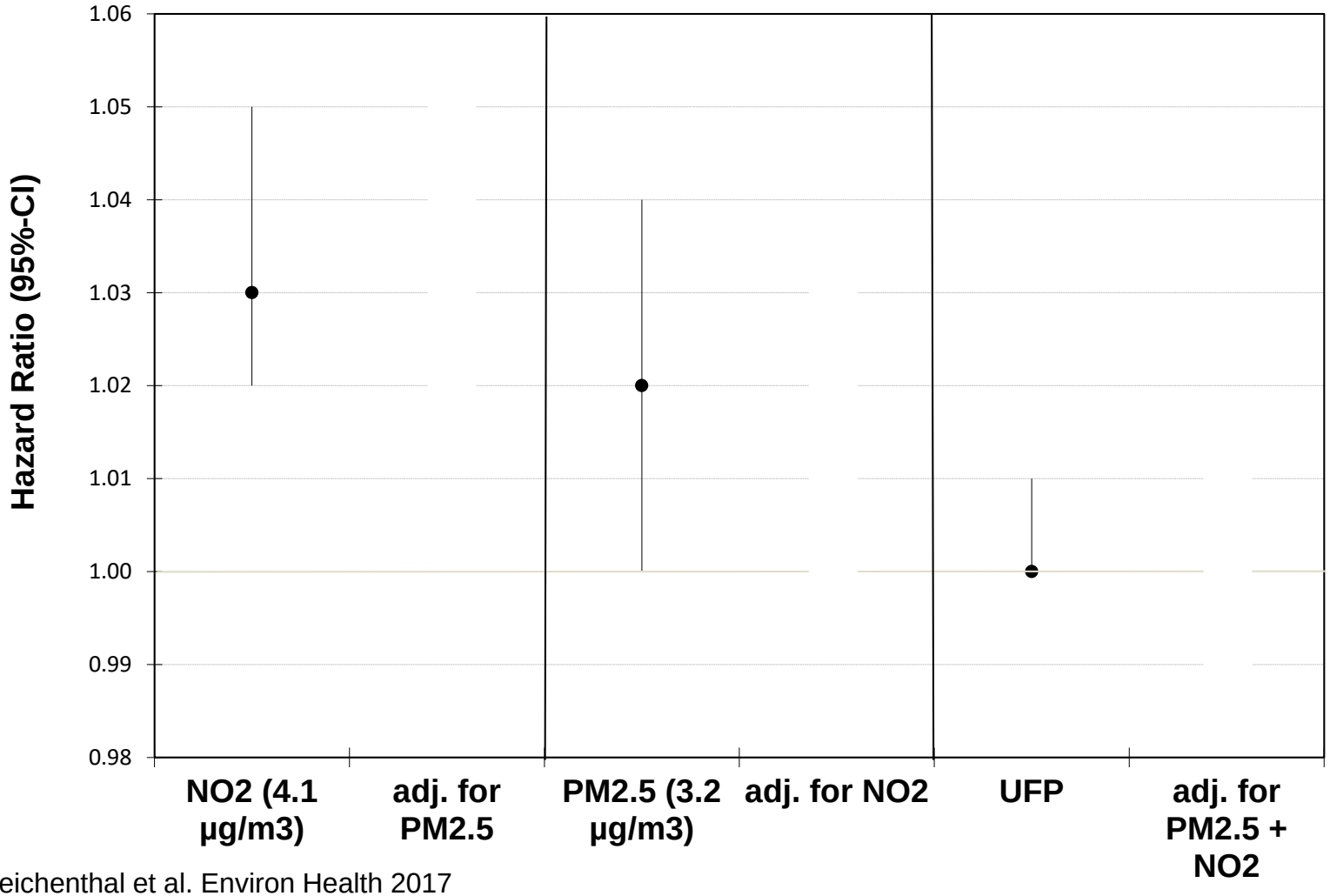
Terminology of 5 levels of «evidence for causality»:
«not likely» → «inadequate» → «suggestive» → «likely causal» → «causal»

Short-term Exposure	2008	2016
Respiratory effects	likely causal	causal
Cardiovascular effects	inadequate	suggestive

Long-term Exposure	2008	2016
Respiratory effects	suggestive	likely causal
Total mortality	inadequate	suggestive
Cardiovascular effects	inadequate	suggestive
Birth outcomes	inadequate	suggestive
Cancer	inadequate	suggestive

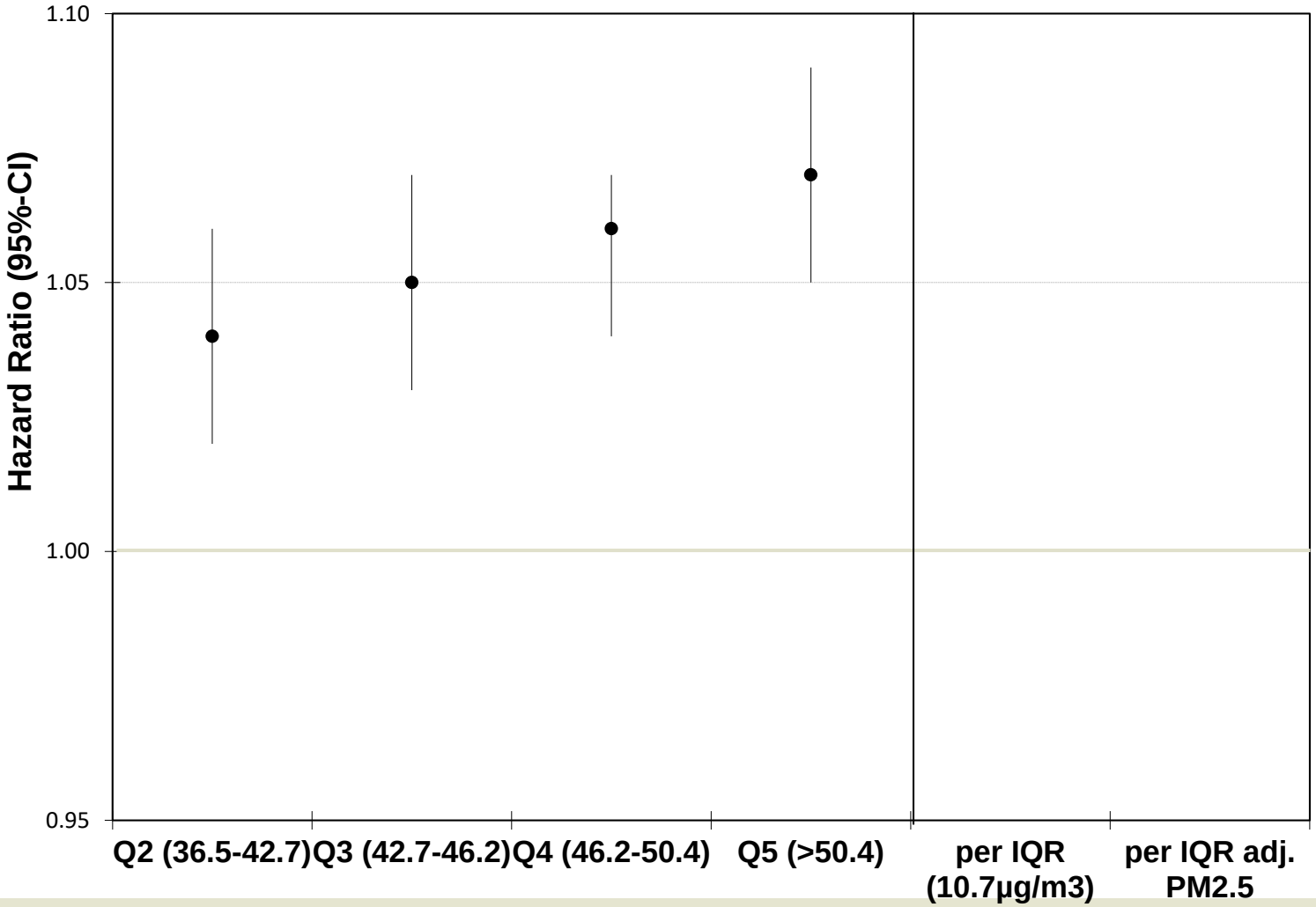
Association of home-outdoor estimates of pollutants with new onset of asthma

ONPHEC Study, 1.1 million healthy residents, 1996 – 2012 (Ontario, CAN)



Weichenthal et al. Environ Health 2017

Rome: Mortality associated with long-term NO2 exposure



Cesaroni et al. EHP 2013

Conclusions

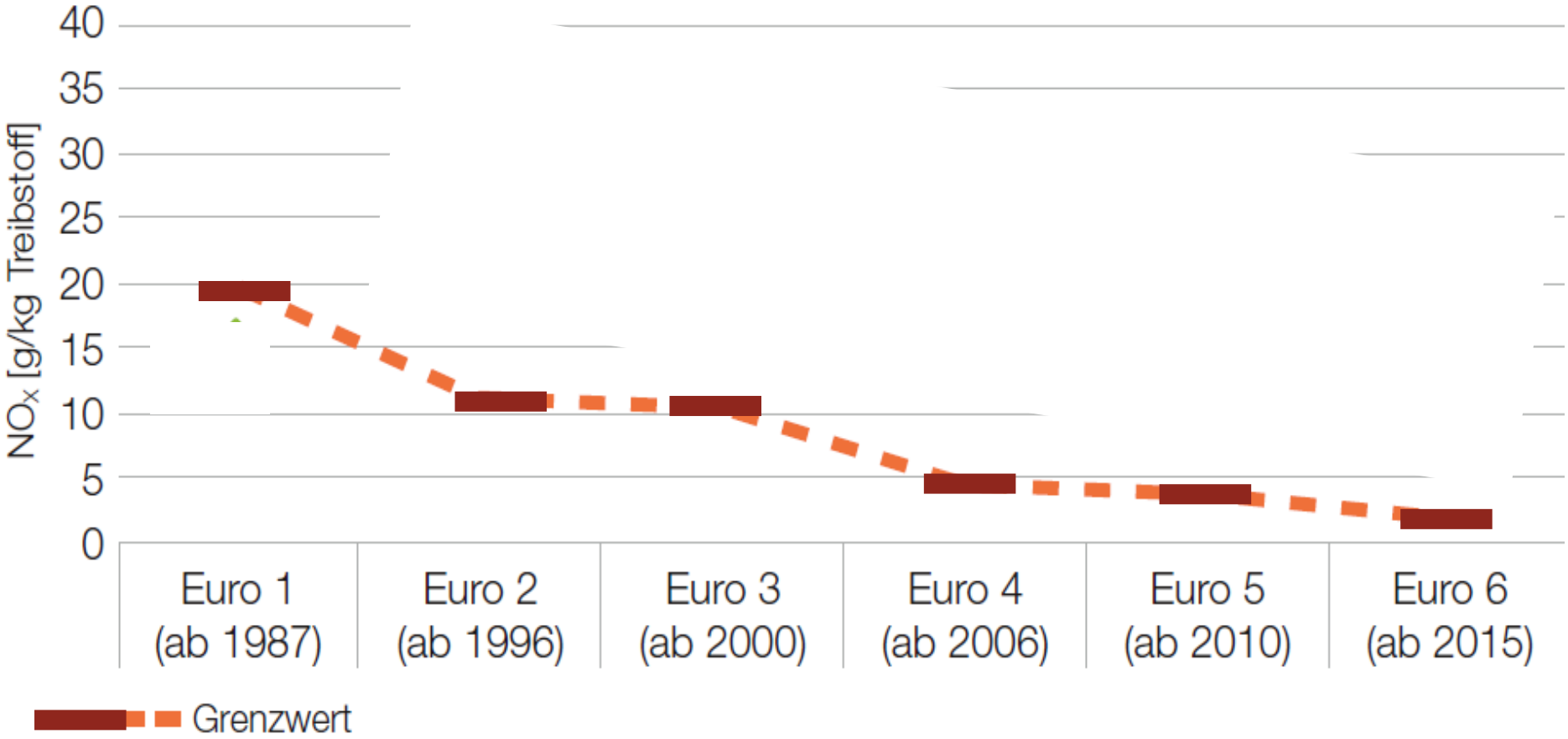
- NO_2 is a highly reactive gas contributing to the formation of ozone and particulate matter
- Epidemiologic evidence points at health effects associated with NO_2-exposure that can not be attributed to particulate matter alone
- NO_2 has been shown to be causally related to short-term respiratory effects, especially in people with respiratory disease (asthma)
- NO_2 is a well studied and very useful indicator of traffic related air pollution and its health effects

→ Health impact assessments based on NO_2 will provide complementary insights into the health burden of ambient air pollution

Due to manipulations, NO_x-emissions of diesel vehicles did not decrease «as expected»

AWEL, Zürich

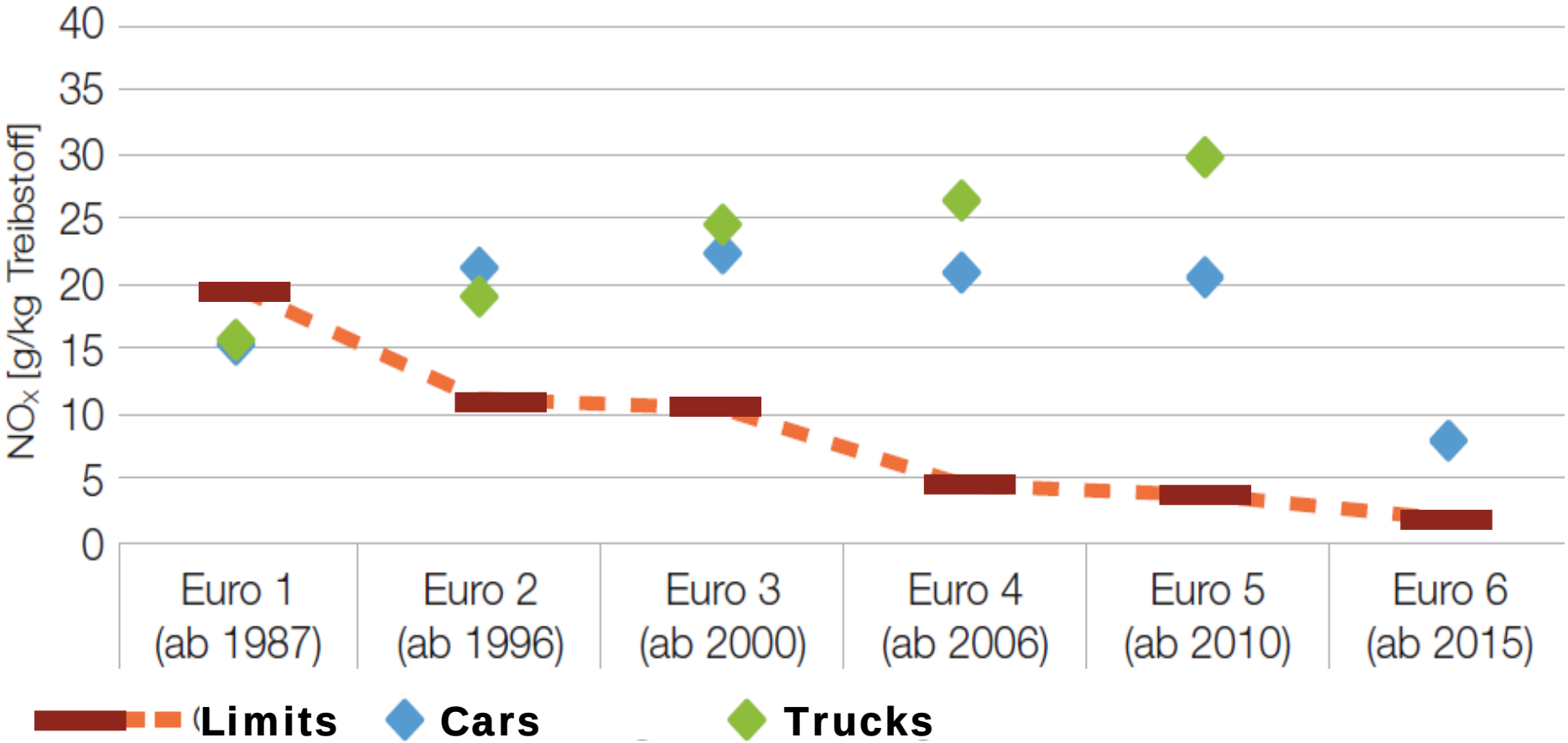
Diesel vehicle: NOx-Emissions, Euro 1 to 6



Due to manipulations, on-road NO_x-emissions of diesel vehicles did not decrease as expected

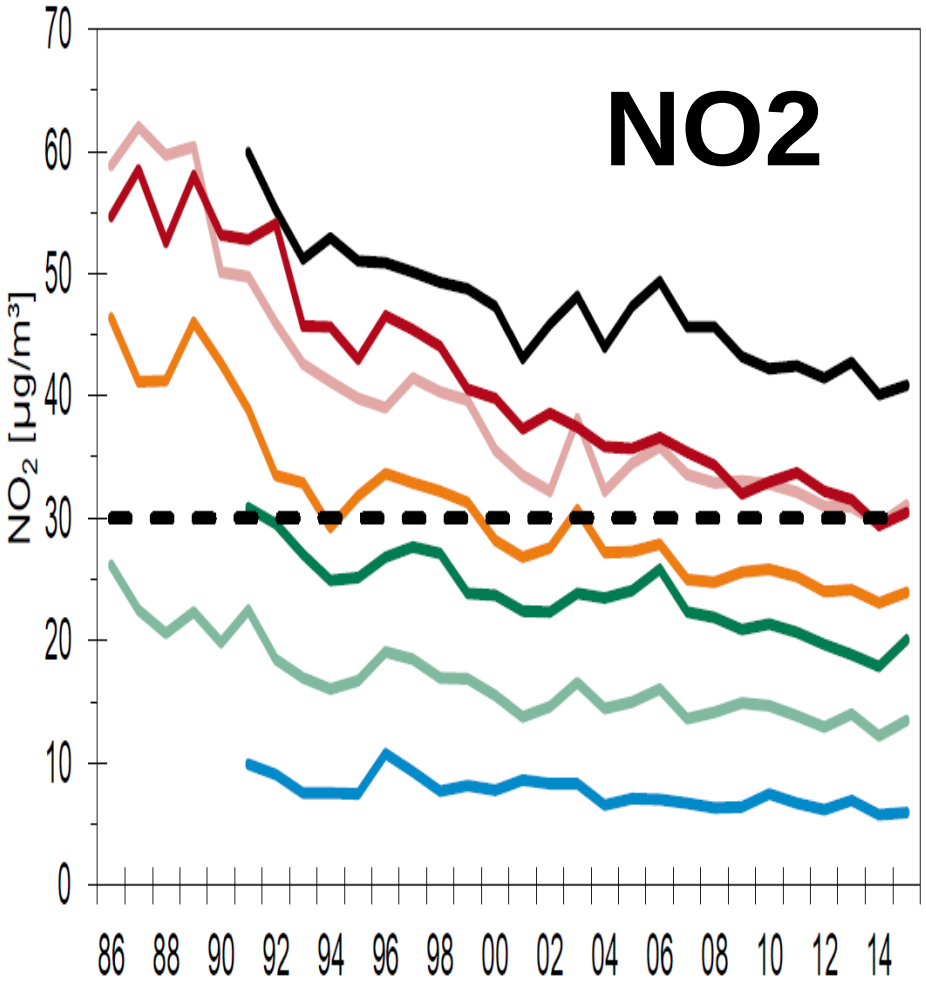
AWEL, Zürich

Diesel vehicle: NOx-Emissions, Euro 1 to 6



→ Decline of ambient NO_2 concentrations less strong than predicted…

Swiss NABEL Network (1986-2015)



Health relevance of the «Diesel scandal» is determined by the effects of the «excess NO_2» due to NOT REACHING lower levels because of MANIPULATIONS

Health impact of the «diesel scandal»

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Two relevant dimensions:

1) Direct health effects of NO_2

2) Indirect effects: NO_2 contributes to the development of particulate matter and ozone

Can NO_2 be used as an indicator for the estimation of the health burden due to air pollution?

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YES… but:

- As complementary or sensitivity analyses
- Some "NO_2 effects" may overlap with effects of PM2.5 or other markers of air pollution

→ DO NOT ADD UP $PM_{2.5}$ + NO_2 burden!!

World Health Organization
REGIONAL OFFICE FOR Europe

Health risks of air pollution in Europe – HRAPIE project

New emerging risks to health from air pollution – results from the survey of experts

By: Susann Henschel and Gabrielle Chan

This publication arises from the HRAPIE project and has received funding from the European Union.

Int J Public Health
DOI 10.1007/s00038-015-0690-y

ORIGINAL ARTICLE

Quantifying the health impacts of ambient air pollutants: recommendations of a WHO/Europe project

Marie-Eve Héroux · H. Ross Anderson · Richard Atkinson · Bert Brunekreef · Aaron Cohen · Francesco Forastiere · Fintan Hurley · Klea Katsouyanni · Daniel Krewski · Michal Krzyzanowski · Nino Künzli · Inga Mills · Xavier Querol · Bart Ostro · Heather Walton

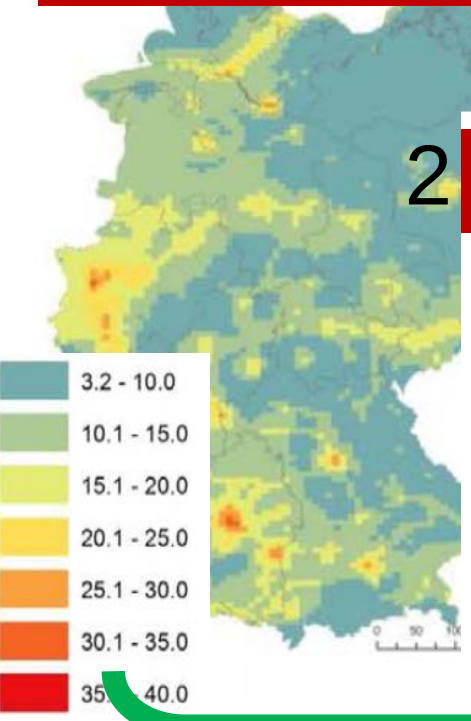
Received: 1 December 2014 / Revised: 7 May 2015 / Accepted: 11 May 2015

1) Direct health burden of NO_2

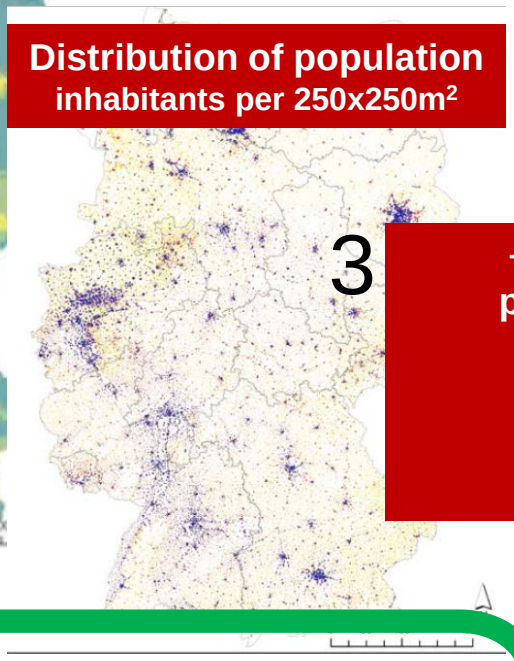
Example for Germany: long-term effects on mortality

(Schneider et al, 2018)

1 **Distribution of NO_2 annual mean**

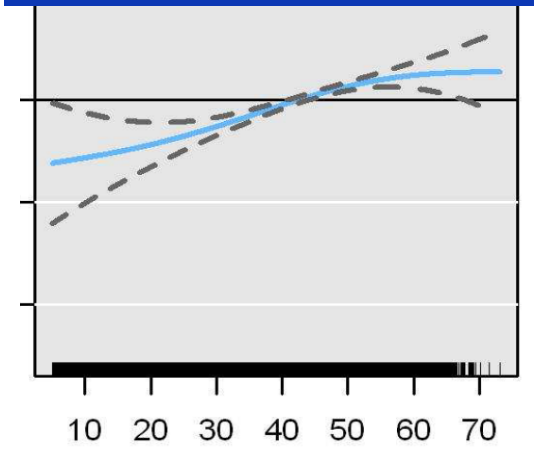


2 **Distribution of population**
inhabitants per 250x250m²



3 → **Derivation of population-weighted annual mean concentration:**
→
18.0 µg/m³

4 **Association between NO_2 and cardio-vascular mortality**
(Cesaroni, 2013)



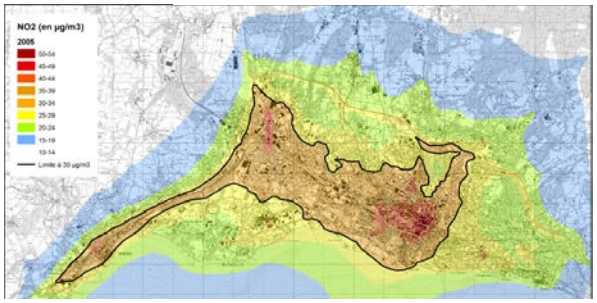
3% (95% conf. interval: 1-5%) increase in cardiovascular death per 10 µg/m³ NO_2

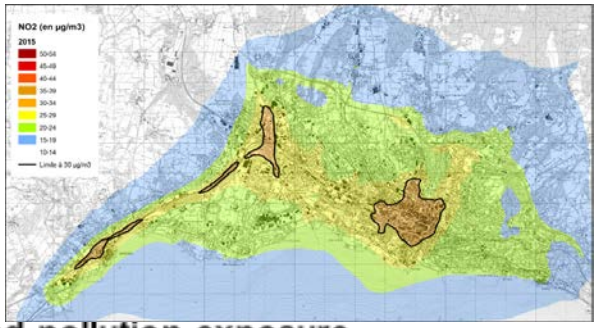
~6'000 cardio-vascular death per year
(1.8% of cardio-vascular mortality)
attributabel to NO_2 being, on average, at 18 µg/m³
instead of 10 µg/m³ (background reference value)

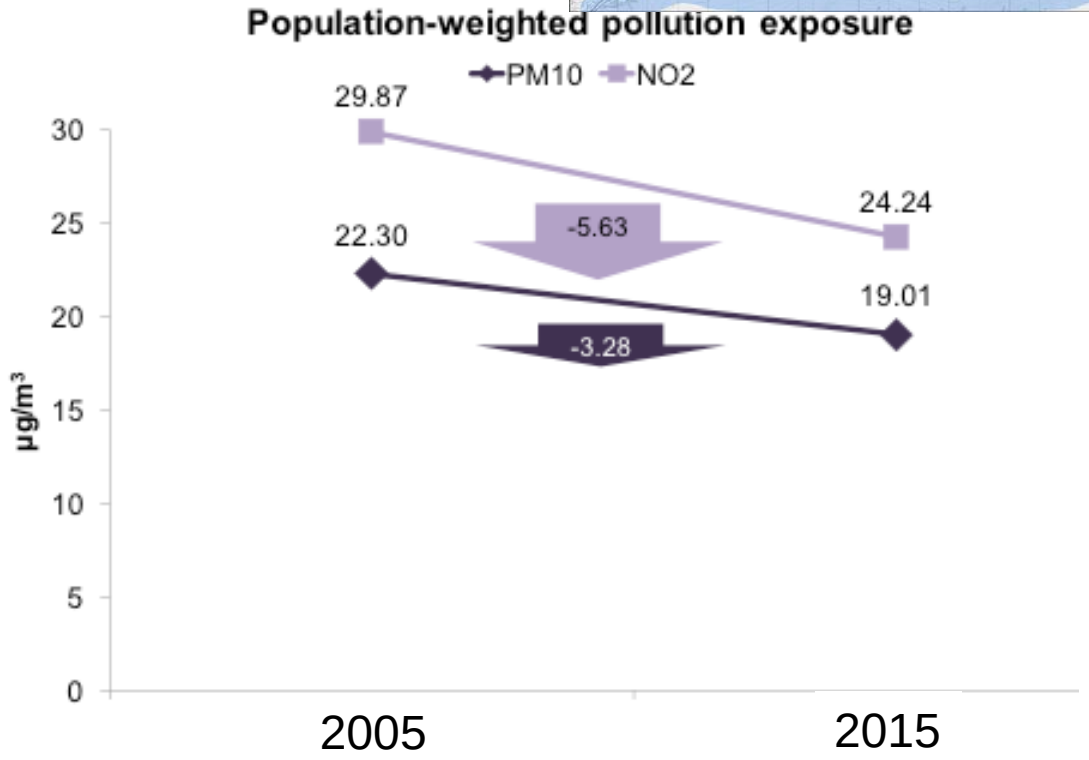
Health benefits of a reduction of PM_{10} and NO_2 exposure after implementing a clean air plan in the Agglomeration Lausanne-Morges

Alberto Castro [a,*], Nino Künzli [b,c], Thomas Götschi [a]

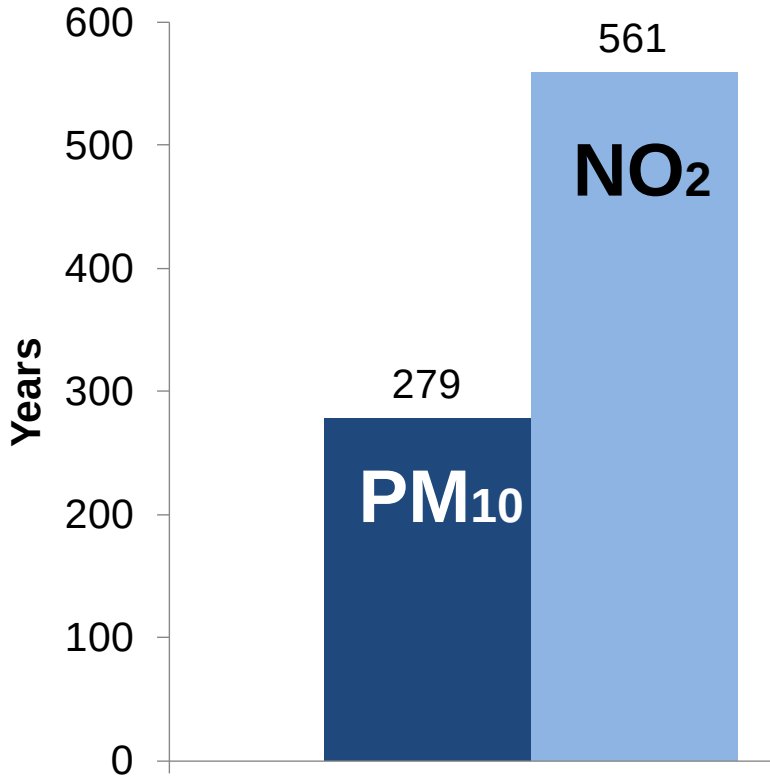
International Journal of Hygiene and Environmental Health 220 (2017) 829–839







Prevented years of life lost due to improved air quality based on two indicators of pollution



2) Indirect health burden of NO_2

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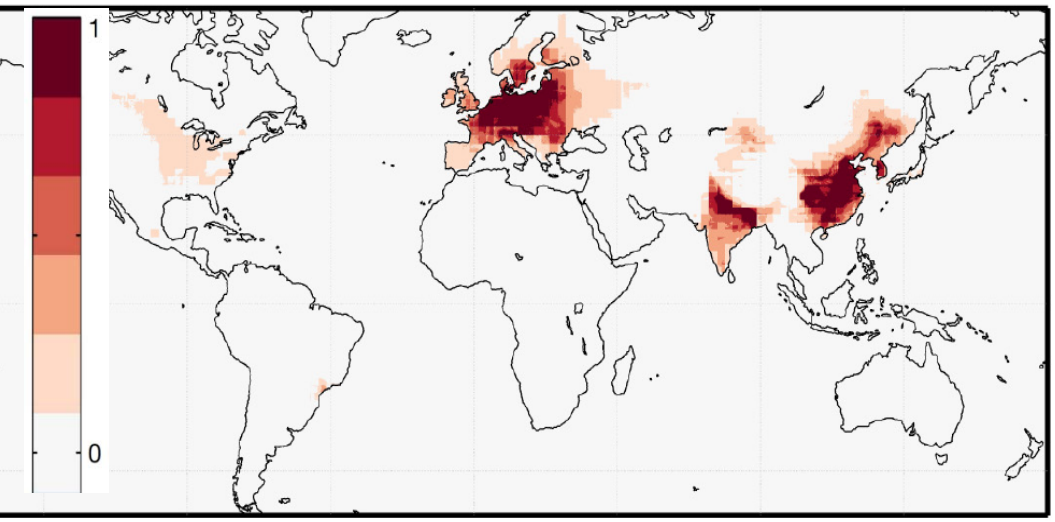
Increase in $PM_{2.5}$ (µg/m^3) related to «additional NO_2-emissions» due to non-compliance with emission standards

Global estimate

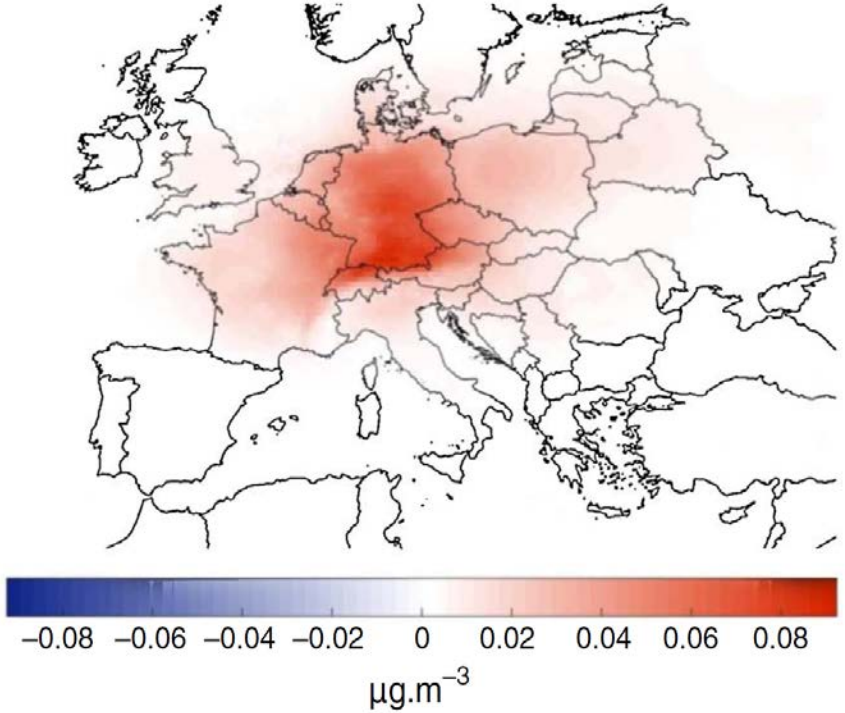
(Anenberg et al, Nature 2017

$PM_{2.5}$ (µg m^{-3})



Europe

(Chossière et al, Env Res Letter 2017)



Related GLOBAL death burden: ~38'000 death per year attributabel to «NO_2 manipulation»

… or: approximately 1% of global air pollution attributable death (>4 Million per year)

Premature death due to $PM_{2.5}$ and O_3 due to NOx emissions of Light-Duty Diesel Vehicles

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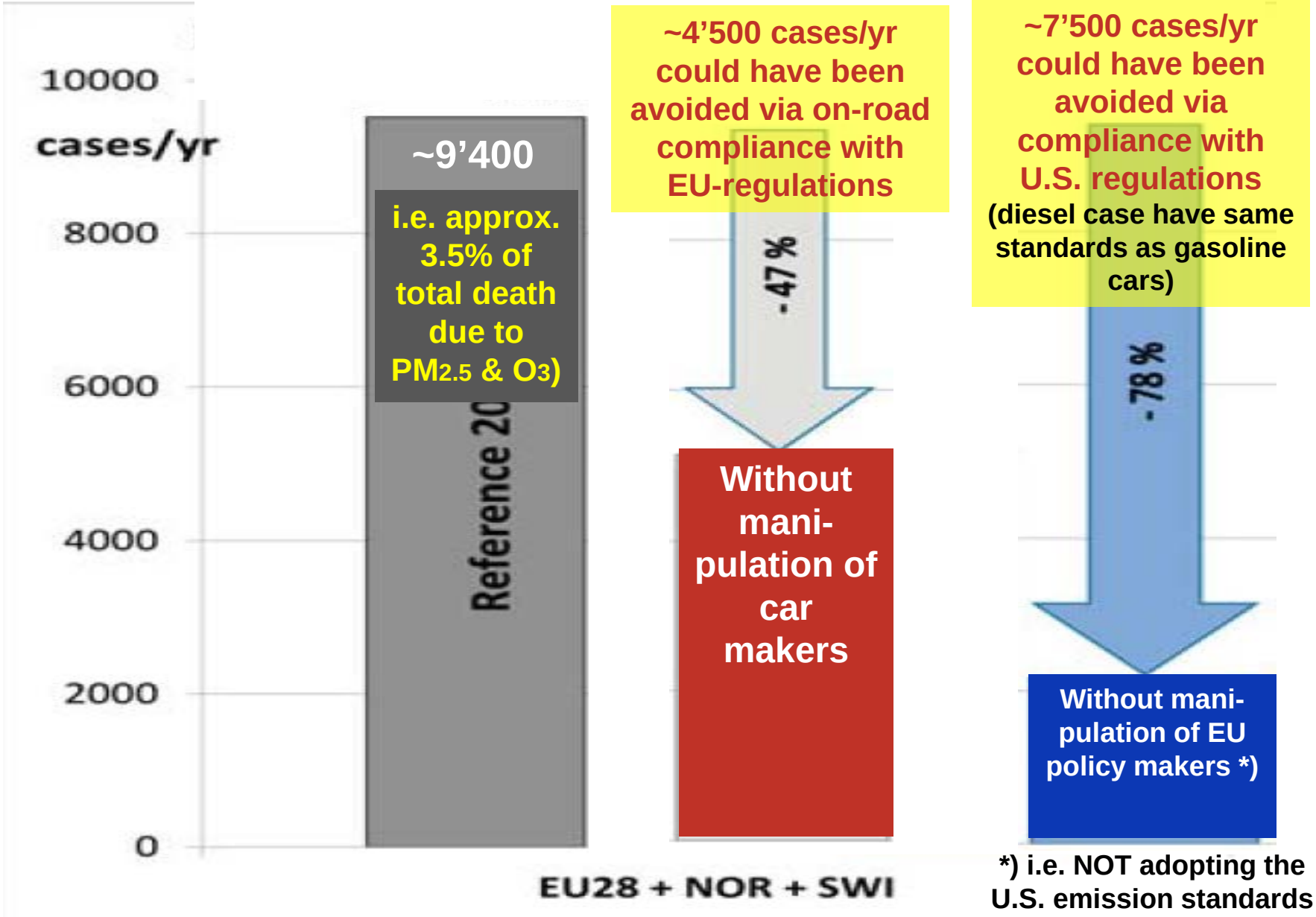
EU_{28} + Norway + Switzerland (Jonson et al, 2017)



*) i.e. NOT adopting the U.S. emission standards

Bringing science back to NO_2 & air quality policy

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1. Enforce «best possible fuel quality» **globally**

NOTE: for e-mobility, «fuel quality» relates to source of electricity!

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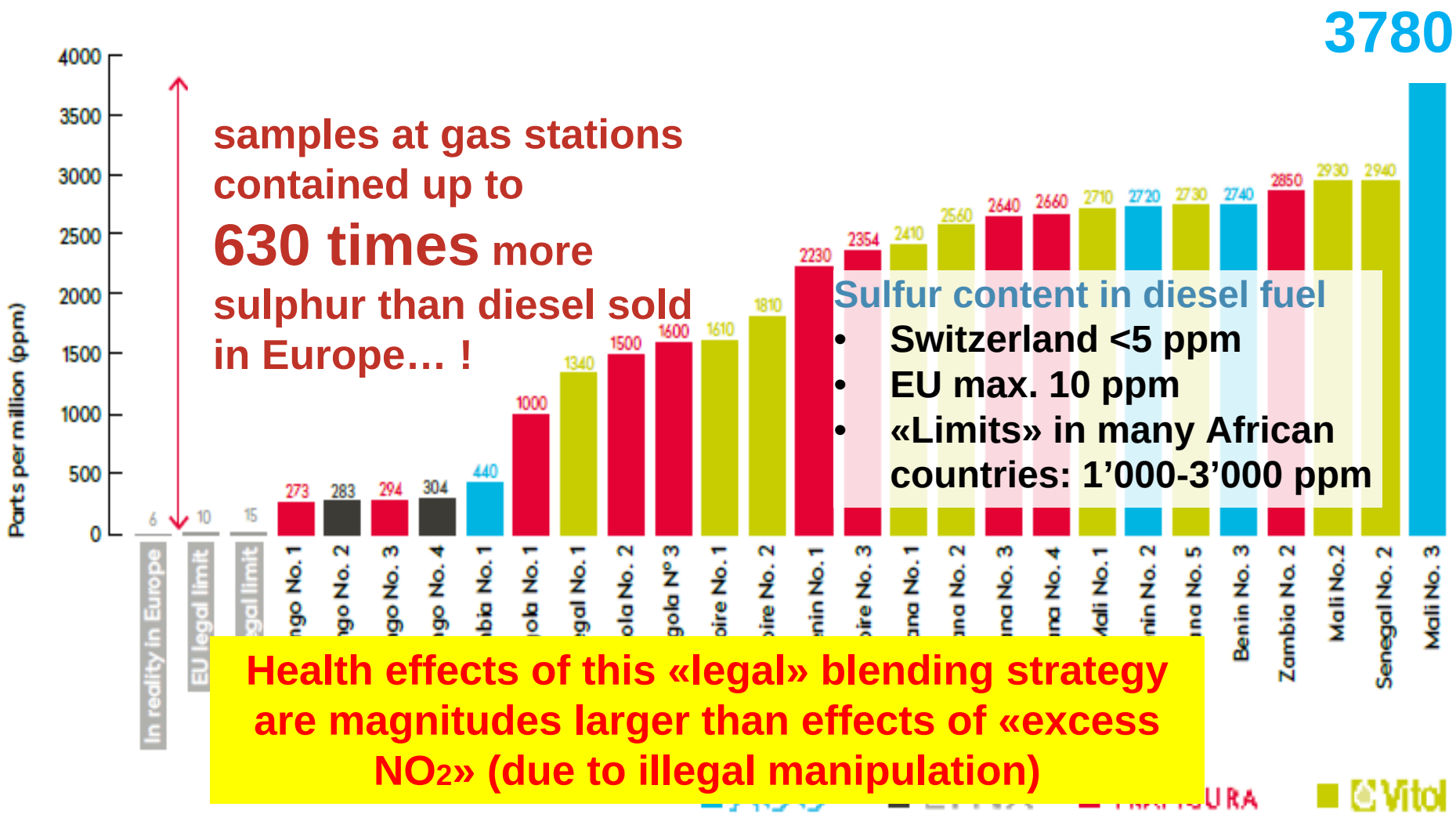
Swiss traders blend crudes to derive the «poorest (legally possible) quality» of diesel for Africa



Vitol

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1. Enforce «best possible fuel quality» **globally**
2. Enforce **existing** EMISSION Standards (Euro VI/6) **globally**

… beyond NO_2 !

Percentage of Diesel cars among sales of Light-Duty Vehicles 1990-2017

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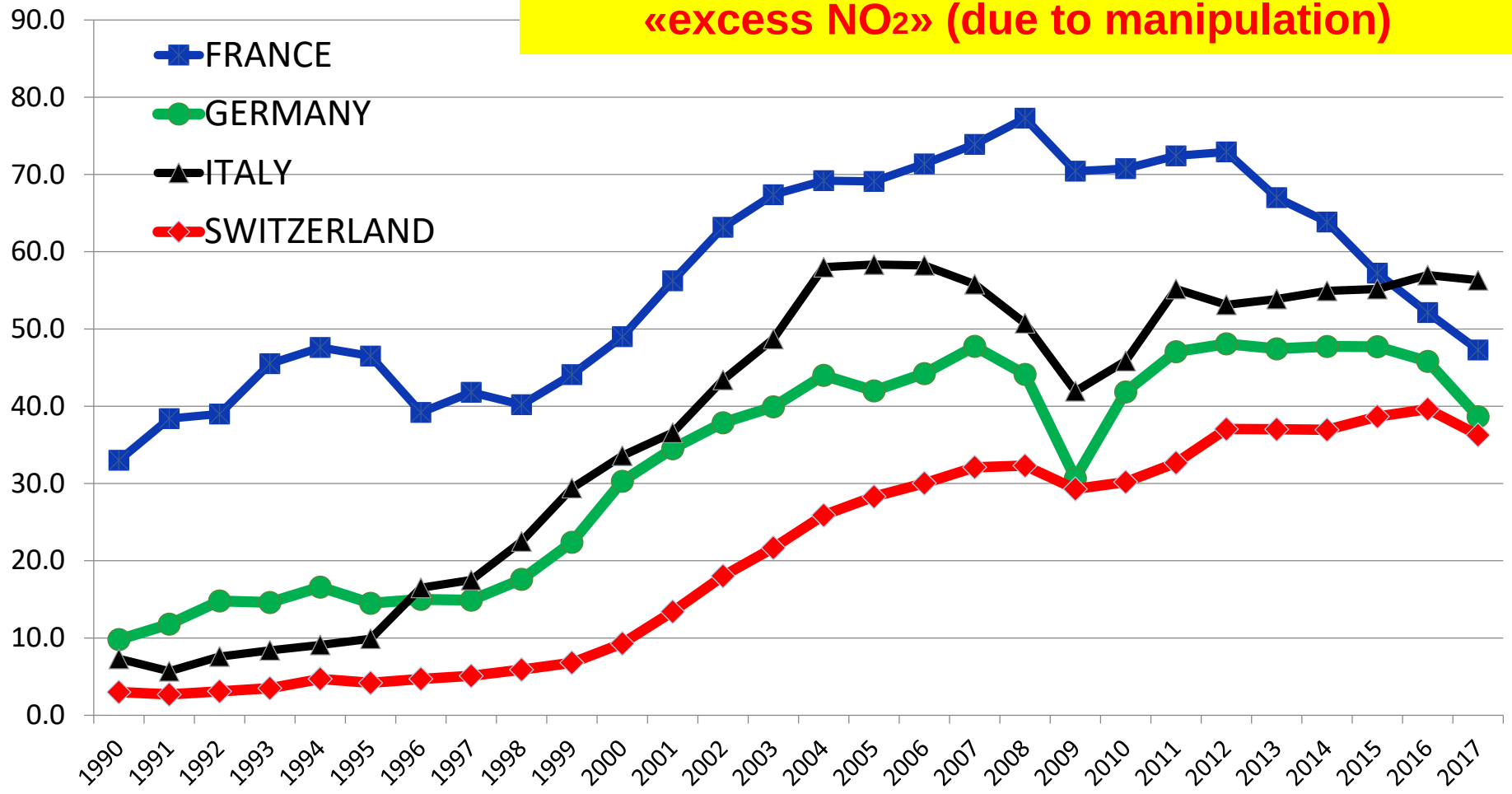
... «you get what you want»...

Health effects of 30 years promotion of «dirty diesel» are magnitudes larger than effects of «excess NO_2» (due to manipulation)



http://www.acea.be/statistics/tag/category/share-of-diesel-in-new-passenger-cars

Very strong reduction in soot emissions due to reaching Euro 6

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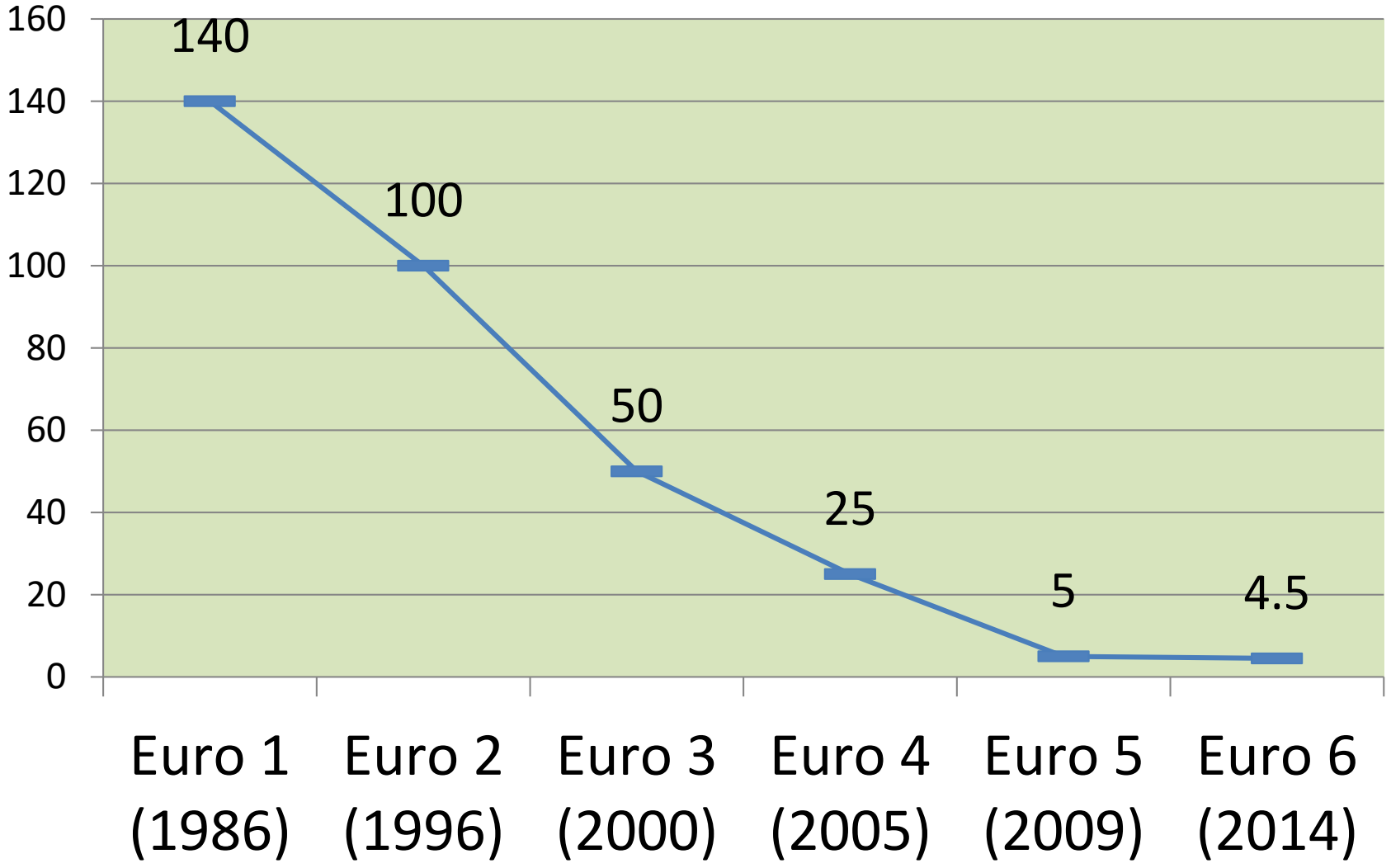
Euro 1 bis Euro 6 emissions in mg/km)



Strong decline in PM concentrations

Swiss NABEL Network (1986-2015)

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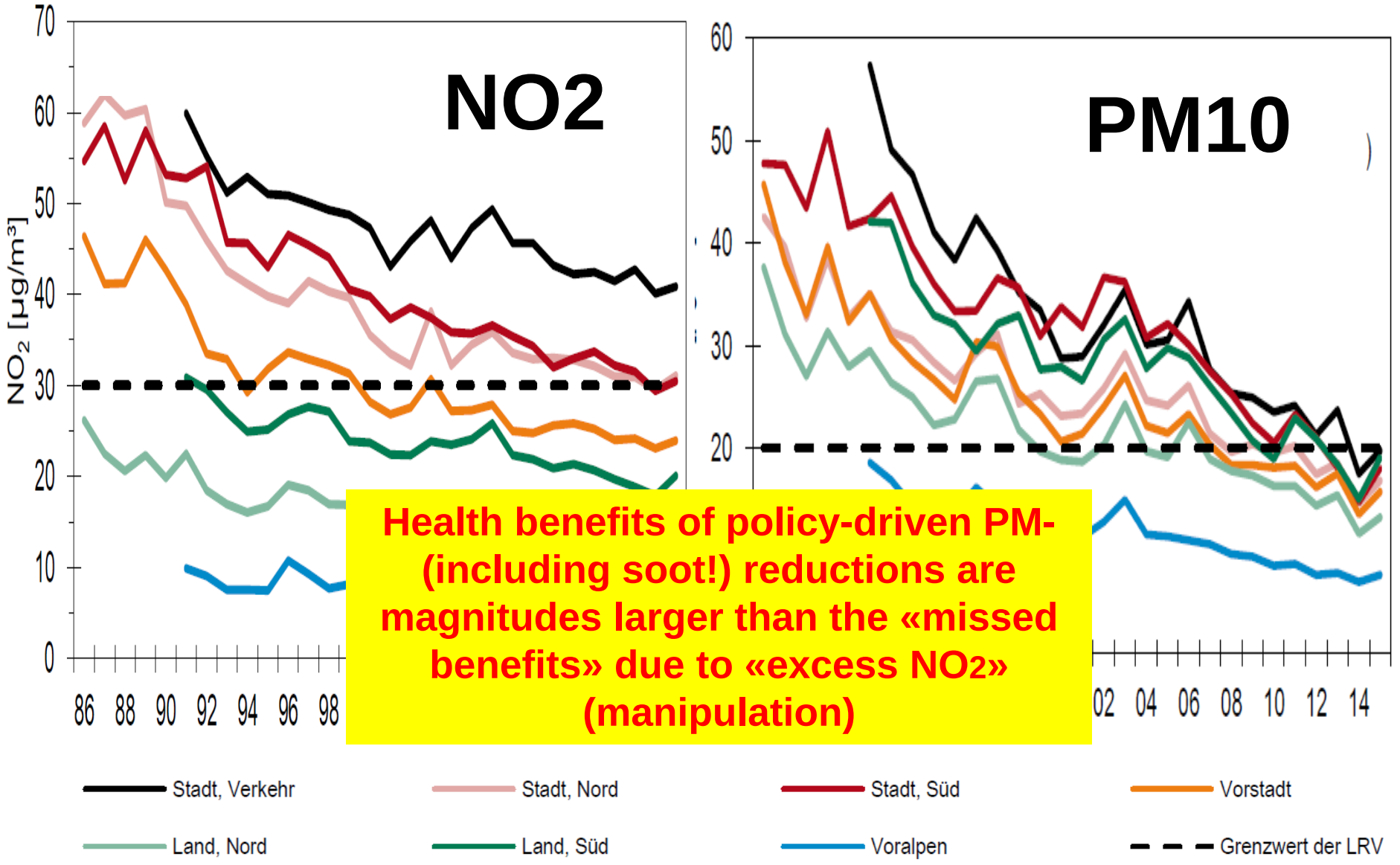

Health benefits of policy-driven PM-(including soot!) reductions are magnitudes larger than the «missed benefits» due to «excess NO_2» (manipulation)

Globalized emission standards needed
→ access to «best available technology»)

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European car makers continue to export / produce / sell diesel cars **without particle filters !**

1. Enforce «best possible fuel quality» **globally**
2. Enforce **existing** EMISSION Standards (Euro VI/6) **globally**
3. Set & enforce **existing** science based ambient AIR QUALITY STANDARDS as proposed by WHO **globally**

… beyond NO_2 !

Protect public health – not monitoring stations !

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Hamburg manipulations of concentrations at monitoring stations

- **The suggested by-passes may cause longer trips**
  → more pollution in the city!
- **«older» vehicles will be sold to other countries …**
  → outsourcing of disease and death

→ Irrational policy activism damages health !

In total, 2 (out of 4'000) kilometers of Hamburg streets are closed for trucks
(if less then Euro VI)

No scientific evidence to question, relax, or give up any of the science-based air quality standards propsed by WHO !

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… such as the following 5 examples (WHO Air Quality Guidline Values)

Long-term limits	**limit value**	**Statistical definition**
Sulphur dioxide (SO_2)	30 µg/m^3	Annual mean
Nitrogen dioxide (NO_2)	40 µg/m^3	Annual mean
PM_{10}	20 µg/m^3	Annual mean
$PM_{2.5}$	10 µg/m^3	Annual mean
Short-term limits		
Ozone (O_3)	100 µg/m^3	8-hr mean

Long way to reach Globalized air quality standards

Int J Pub Health 2017: Kutlar Joss et al (open access)

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Example Global $PM_{2.5}$ annual mean regulations: only 7 countries comply with WHO guidelines

Public health oriented air quality standards

«standards» do not protect health !

WHO Guideline Value	Afghanistan Australia Cameroon Canada Iran Malawi Switzerland ... since 1.6.2018 ☺	U.S.A. Mexico	E.U.
10 µg/m³	≤10	12	25

Health effects of EU refusing science-based guideline values of WHO are magnitudes larger than effects of «excess NO_2» (due to manipulation)

1. Enforce «best possible fuel quality» **globally**
2. Enforce **existing** EMISSION Standards (Euro VI/6) **globally**
3. Set & enforce **existing** science based ambient AIR QUALITY STANDARDS as proposed by WHO **globally**
4. Address open policy issues with science-based approaches (e.g. PAH's, secondary organics, UFP etc.)

Conclusions

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- DieselGate scandal caused «excess concentrations of NO2»
- Both, the «legal» and the criminal manipulations caused
  - ❖ additional PM and Ozone pollution
  - ❖ additional (fully preventable) diseases and deaths

…HOWEVER

- clean air policies must
  - be science-based, rational, and coherent
  - focus on public health, thus…
  - not focus on NO_2 alone nor on diesel cars alone but:
    - ❖ all types of engines and all combustion sources
    - ❖ all regulated pollutants, including PM10, PM2.5, Ultrafines, SO2, NO2, O3 …
    - ❖ Focus on PUBLIC HEALTH, not on «monitoring stations»
    - ❖ Keep a GLOBAL focus and equity

Thank you very much

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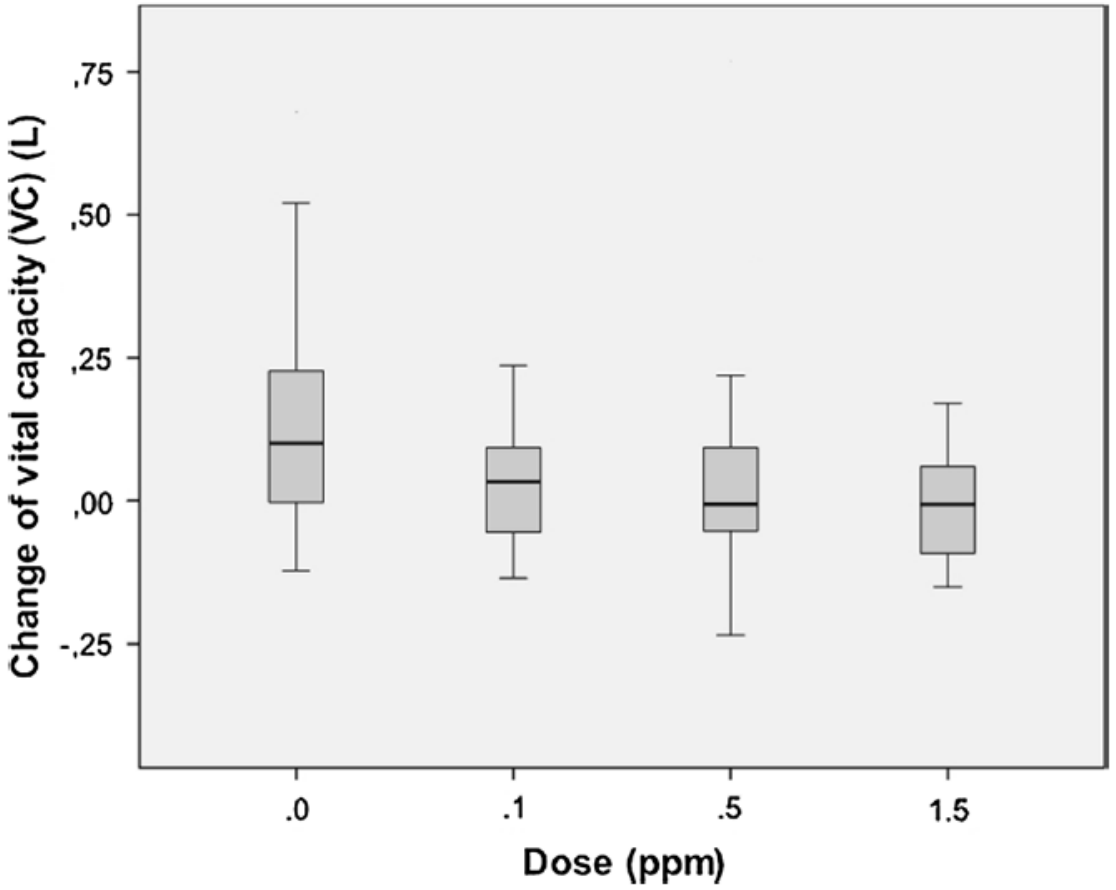
Meltem.Kutlar@SwissTPH.ch

Experimental studies with a few healthy individuals vs. Epidemiologic studies with a lot of participants

For vital capacity (VC), a nonsignificant dependency on exposure concentration

was found in the analysis of variance ($p = 0.08$) and

in the Kruskal–Wallis test ($p = 0.09$; Fig. 3).



New Review by Atkinson *et al*. on long-term effects of NO_2

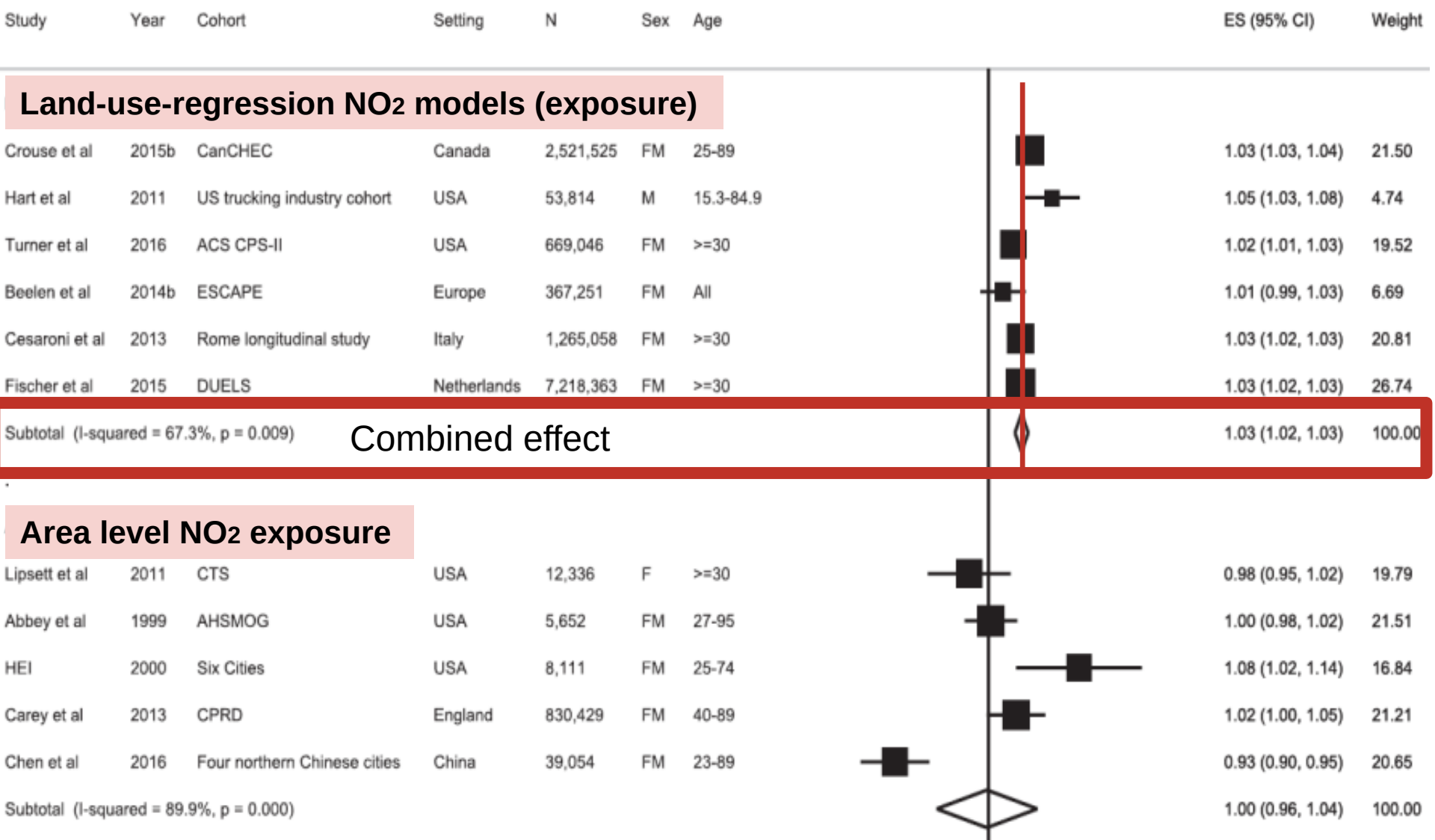
(Epidemiology 2018)

- Outcome: Mortality
- 42 publications on 31 cohort studies

  (i.e. longitudinal studies)
- High heterogeneity of study results
  (I-square 67-90%)
- Effect: 2% increase in mortality per 10 µg/m^3 NO_2
  (95%-Confidence Interval: 1-3%)
- → wide prediction intervals: -0.01% to 6%

New Review by Atkinson *et al*. on long-term effects of NO_2

(Epidemiology 2018) **(cont)**

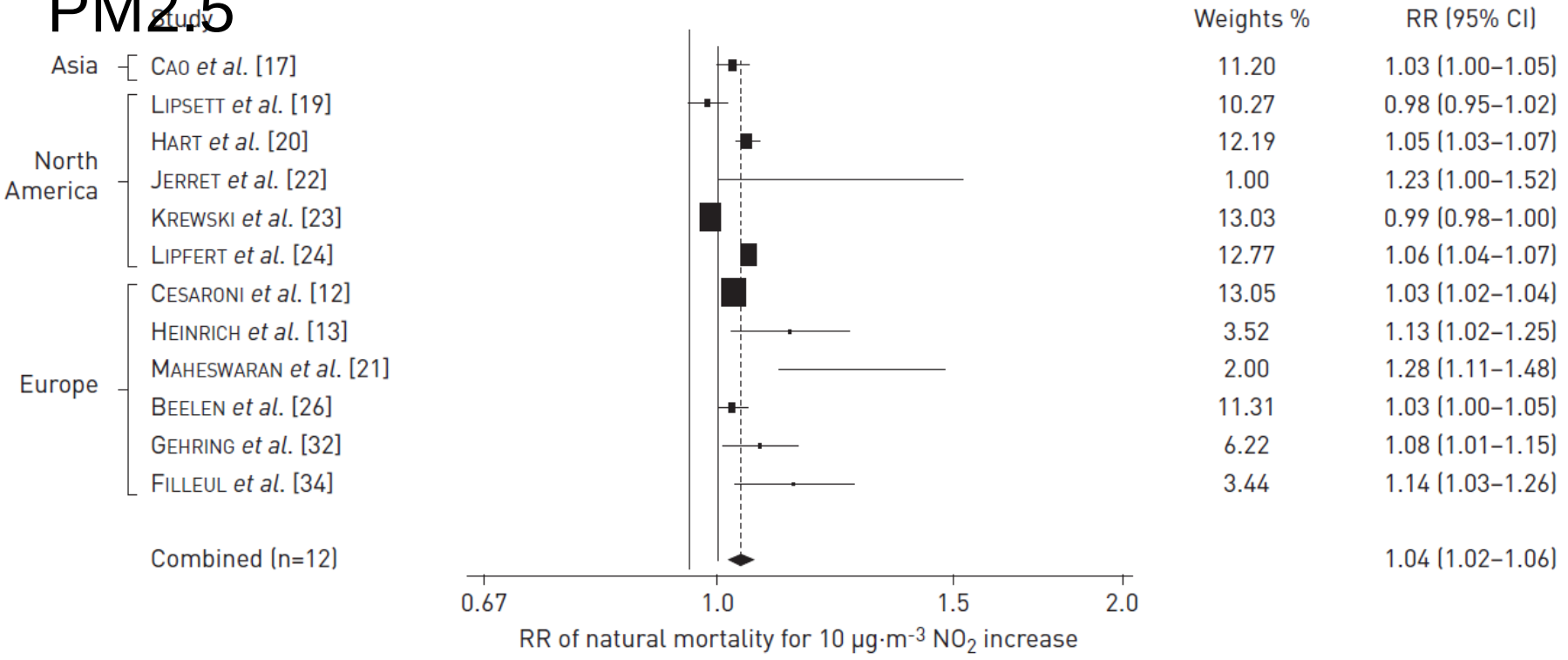


Study	Year	Cohort	Setting	N	Sex	Age	ES (95% CI)	Weight
Land-use-regression NO_2 models (exposure)								
Crouse et al	2015b	CanCHEC	Canada	2,521,525	FM	25-89	1.03 (1.03, 1.04)	21.50
Hart et al	2011	US trucking industry cohort	USA	53,814	M	15.3-84.9	1.05 (1.03, 1.08)	4.74
Turner et al	2016	ACS CPS-II	USA	669,046	FM	>=30	1.02 (1.01, 1.03)	19.52
Beelen et al	2014b	ESCAPE	Europe	367,251	FM	All	1.01 (0.99, 1.03)	6.69
Cesaroni et al	2013	Rome longitudinal study	Italy	1,265,058	FM	>=30	1.03 (1.02, 1.03)	20.81
Fischer et al	2015	DUELS	Netherlands	7,218,363	FM	>=30	1.03 (1.02, 1.03)	26.74
Subtotal (I-squared = 67.3%, p = 0.009)							1.03 (1.02, 1.03)	100.00
Area level NO_2 exposure								
Lipsett et al	2011	CTS	USA	12,336	F	>=30	0.98 (0.95, 1.02)	19.79
Abbey et al	1999	AHSMOG	USA	5,652	FM	27-95	1.00 (0.98, 1.02)	21.51
HEI	2000	Six Cities	USA	8,111	FM	25-74	1.08 (1.02, 1.14)	16.84
Carey et al	2013	CPRD	England	830,429	FM	40-89	1.02 (1.00, 1.05)	21.21
Chen et al	2016	Four northern Chinese cities	China	39,054	FM	23-89	0.93 (0.90, 0.95)	20.65
Subtotal (I-squared = 89.9%, p = 0.000)							1.00 (0.96, 1.04)	100.00

Combined effect

Review: Faustini et al. Eur Respir J 2014

- Mortality effect estimates similar NO2 and PM2.5
- NO2 effects remain stable also after adjustment for PM2.5



Test for heterogeneity: Chi-squared=102.28 df=11
p=0.001 I^2=89%
Test for overall effect: z=3.632 p=0.001

Environmental pollution – the leading cause of premature death (globally)

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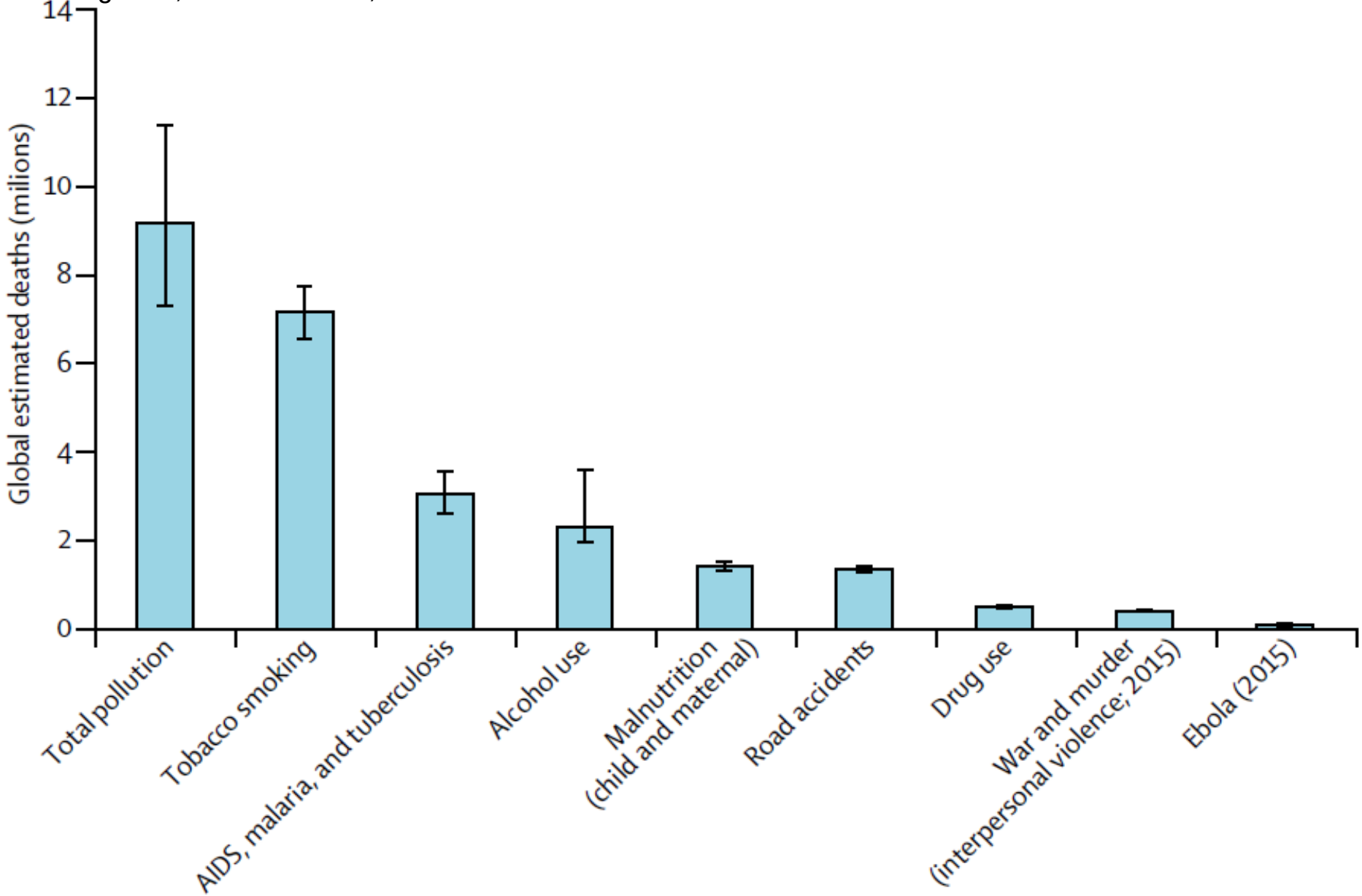
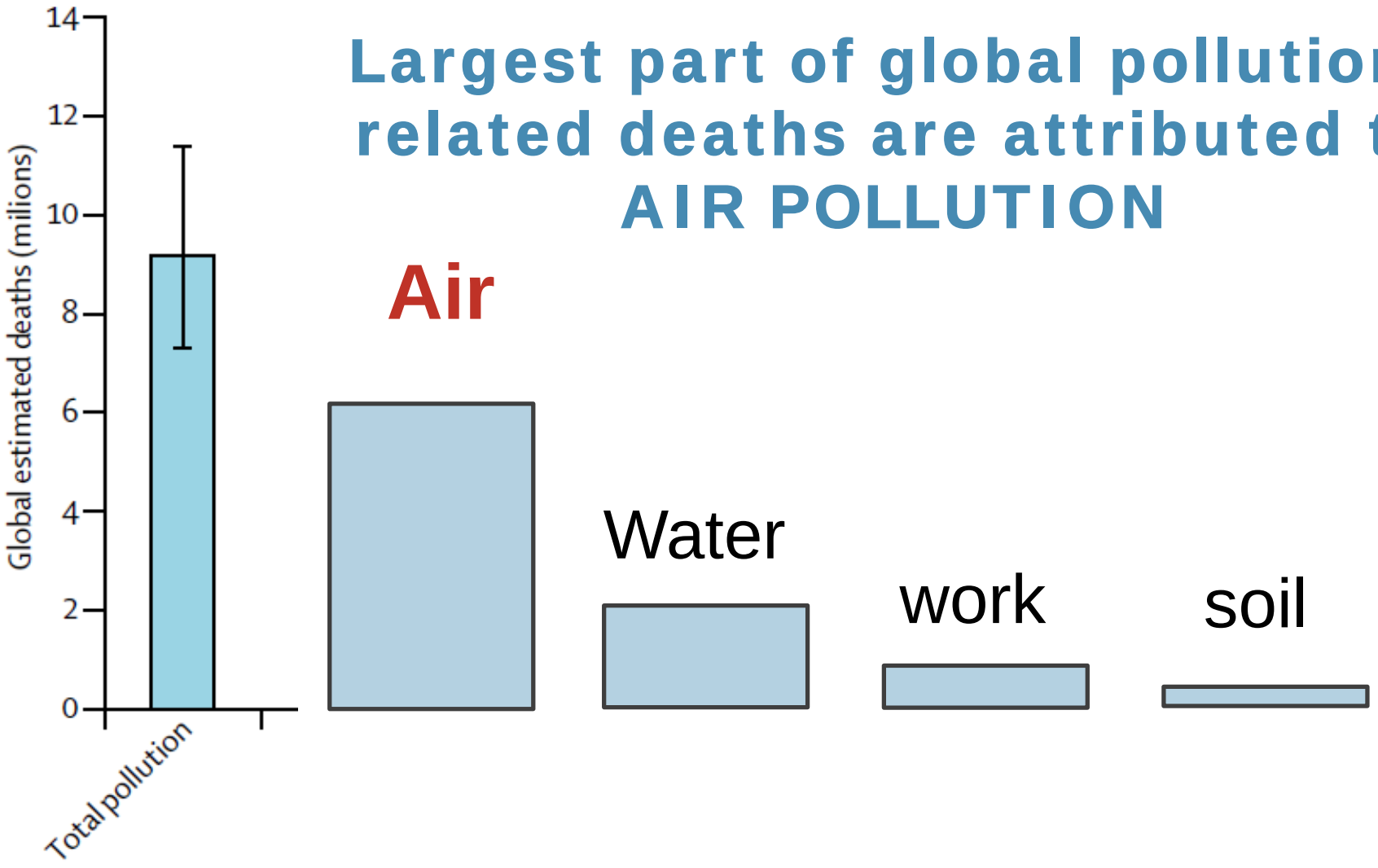
Landrigan P, Fuller R et al, Lancet Oct 2017



Largest part of global pollution-related deaths are attributed to AIR POLLUTION



Landrigan P, Fuller R et al, Lancet Oct 2017

Overwhelming scientific evidence that compliance with air quality standards proposed by WHO improve health

Schweiz 1980-2016 (NABEL Stationen) - Jahresmittel

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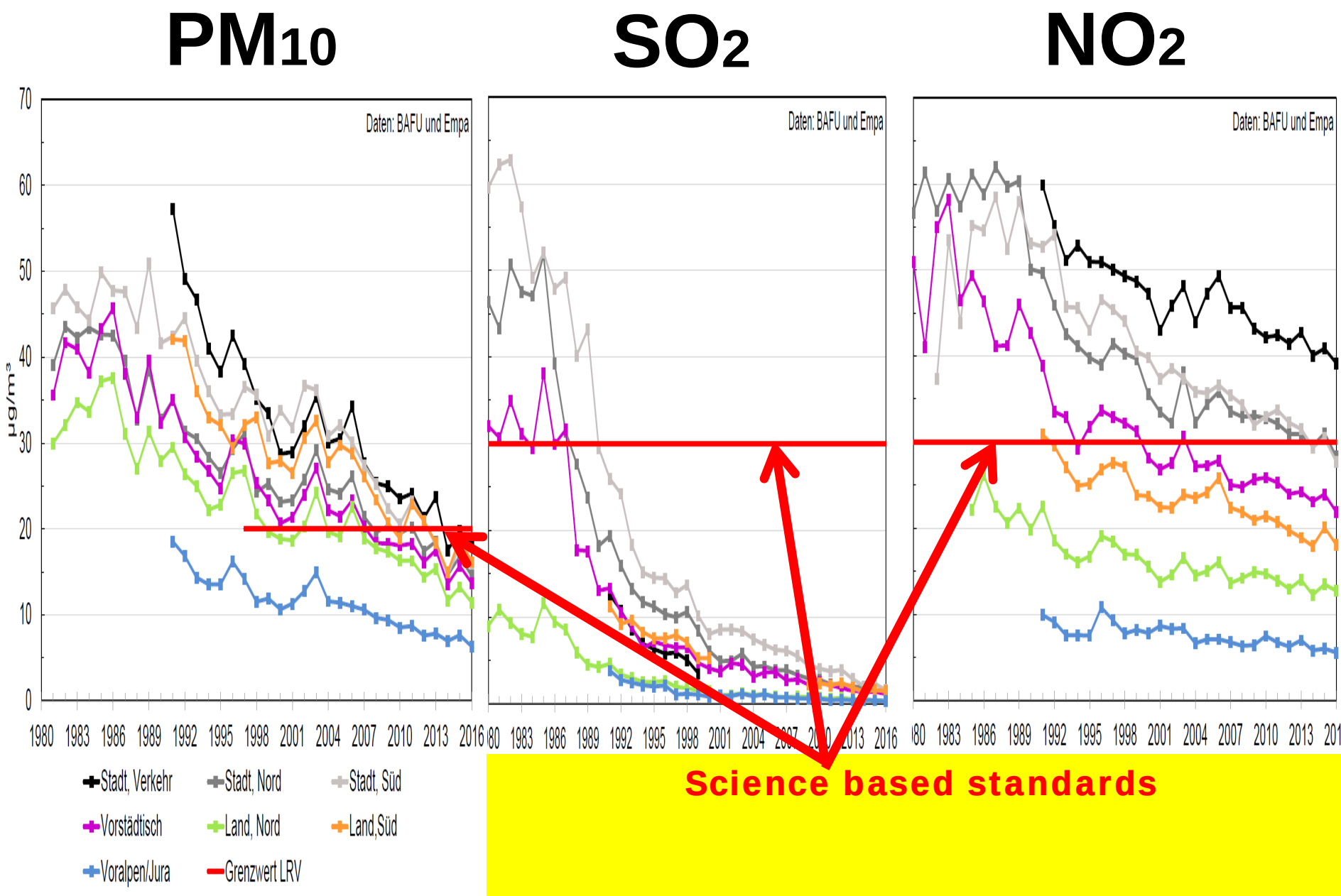


pressreader

Search Results

Zambia death stirs Glencore tensions

Scottish Daily Mail 27 Jan 2014 By Rob Davies

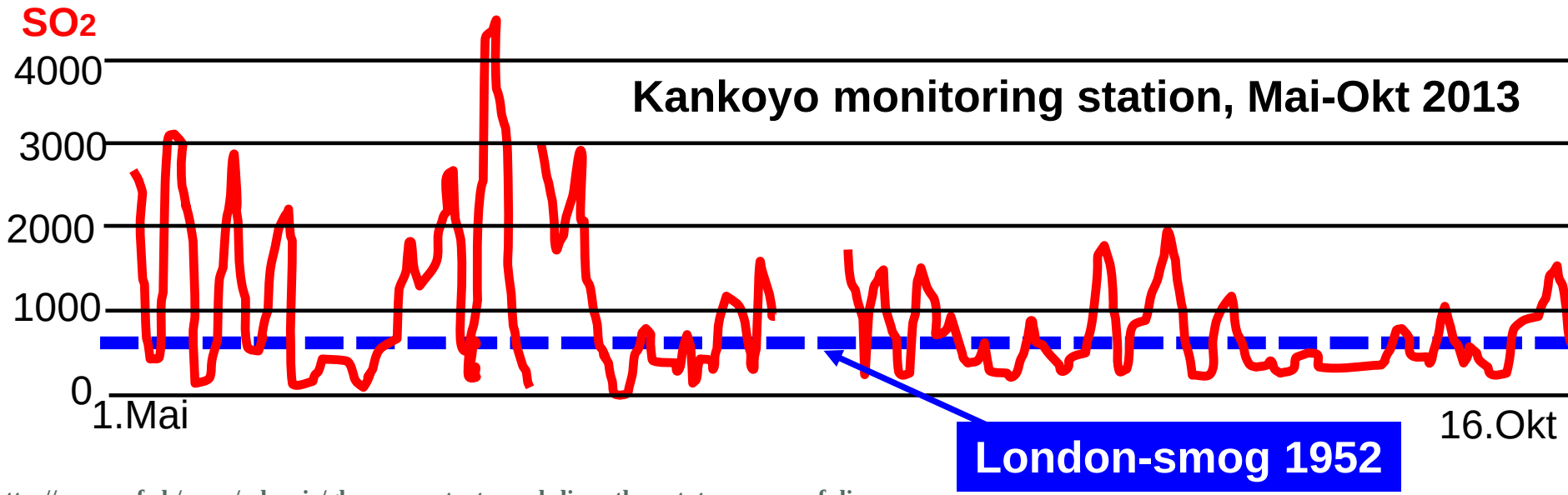
GLENCORE is facing fresh accusations over its controversial Zambian copper mine, with locals blaming the death of a politician on the commodity giant's f ail ure t o stop sulphur pollution.

Mufulira District Commissioner Beatrice Mithi collapsed and died after inhaling toxic sulphur dioxide emissions from the nearby Mopani Copper Mine, 73pc-owned

smelter have blighted neighbouring communities since the 1930s.

While Glencore has pointed to years of mismanagement in state

Funeral of District Commissioner Beatrice Mihti (age 57) – died in SO2-smog cloud from Mopani Copper Mine, in Jan 2014



http://www.srf.ch/news/schweiz/glencore-xstrata-und-die-asthma-toten-von-mufulira
http://www.srf.ch/news/international/asthma-tote-in-sambia-angehoerige-ziehen-glencore-vor-gericht

Very strong benefits for air quality
(… and public health)

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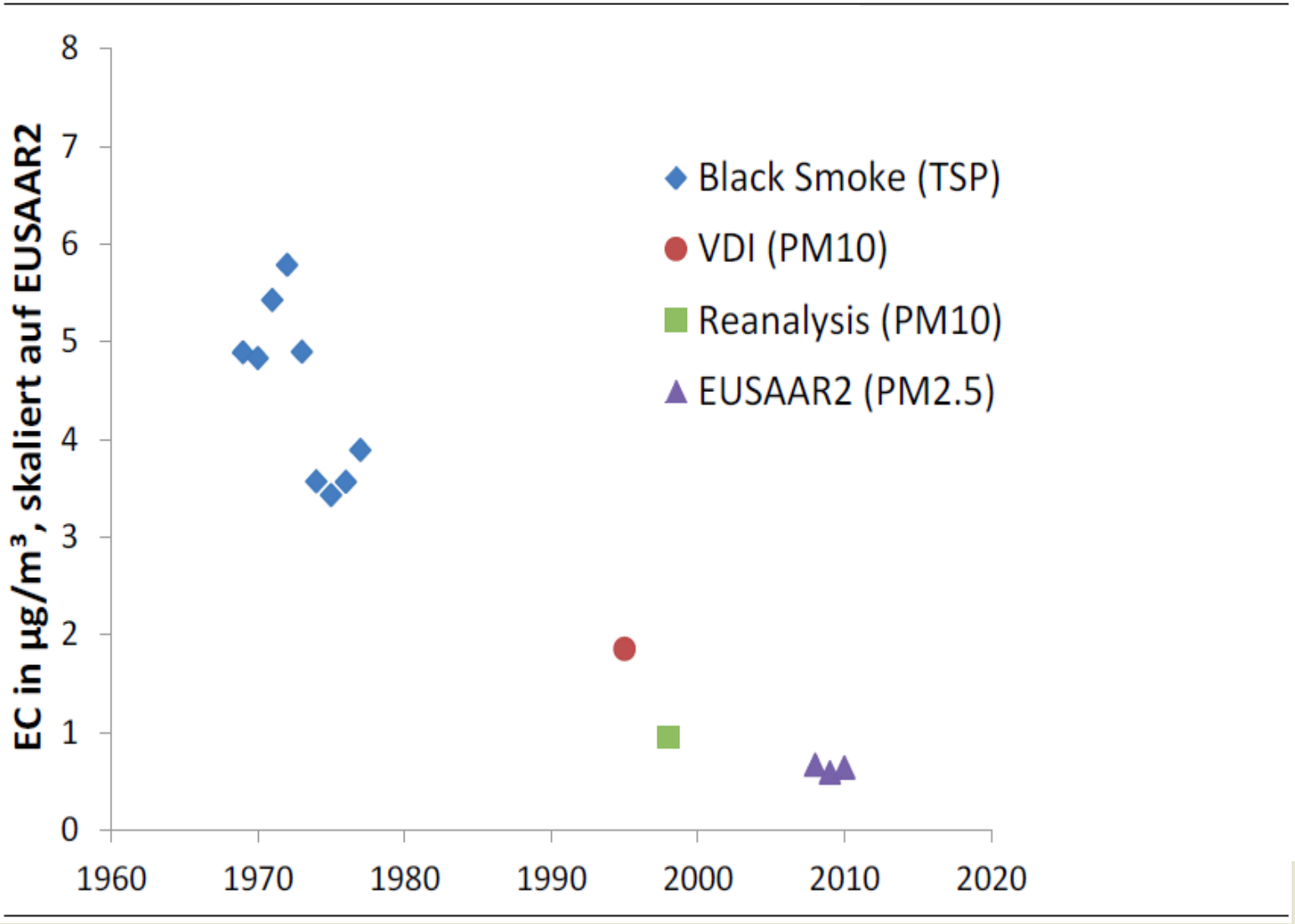
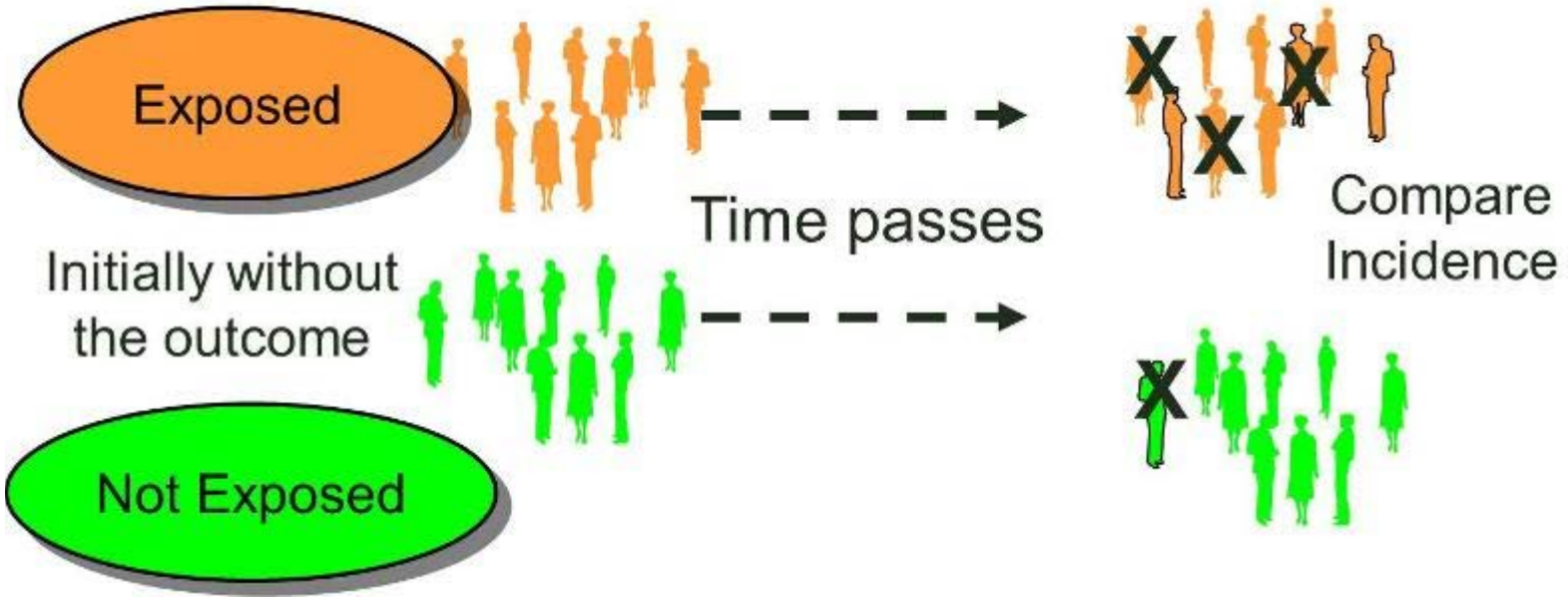
Example:
elemental carbon annual means, Payern, Switzerland

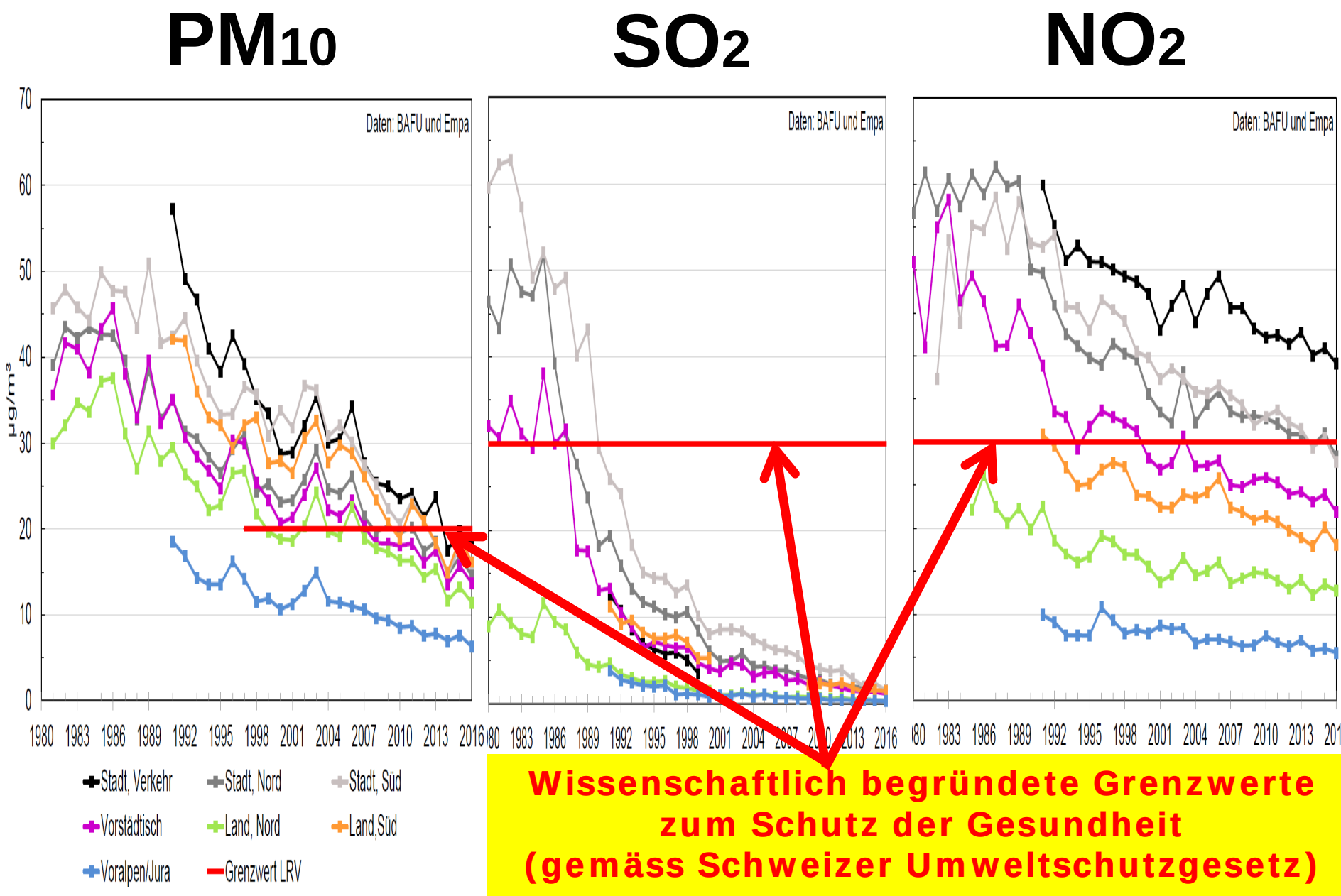



Exposed
Initially without the outcome
Not Exposed
Time passes
Compare Incidence

Trends der Schadststoff-Konzentrationen

Schweiz 1980-2016 (NABEL Stationen) - Jahresmittel

Swiss TPH



Wissenschaftlich begründete Grenzwerte zum Schutz der Gesundheit (gemäss Schweizer Umweltschutzgesetz)