Utrecht University

National Institute for Public Health and the Environment (RIVM)
Ministry of Health, Welfare and Sport
The Netherlands

Air quality has benefited from European emission reductions

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RIVM en Universiteit Utrecht, Netherlands

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Take home message

Since 1980, many measures have been taken in EU to improve air quality

Large avoided concentration increases of SO_2, NO_2 and $PM_{2.5}$

- $PM_{2.5}$ could have increased: 59 µg/m^3 (1980) ➔ 102 µg/m^3 (2015)
- Now about 12 µg/m^3
- More than half from reductions outside the Netherlands

Health benefits for the Netherlands in 2015

- Increase in life expectancy of 6 years
- Avoided monetary health damage € 35 - 77 billion per year

Policy measures in Europe

Air quality limit values in Europe

- 1980: Directive on air quality limit values for SO_2, PM
- 1985: ... on air quality limit values for NO_2
- 1996: ... on ambient air quality assessment
- 1999: ... on limit values various compounds
- 2008: ... on ambient air quality and cleaner air

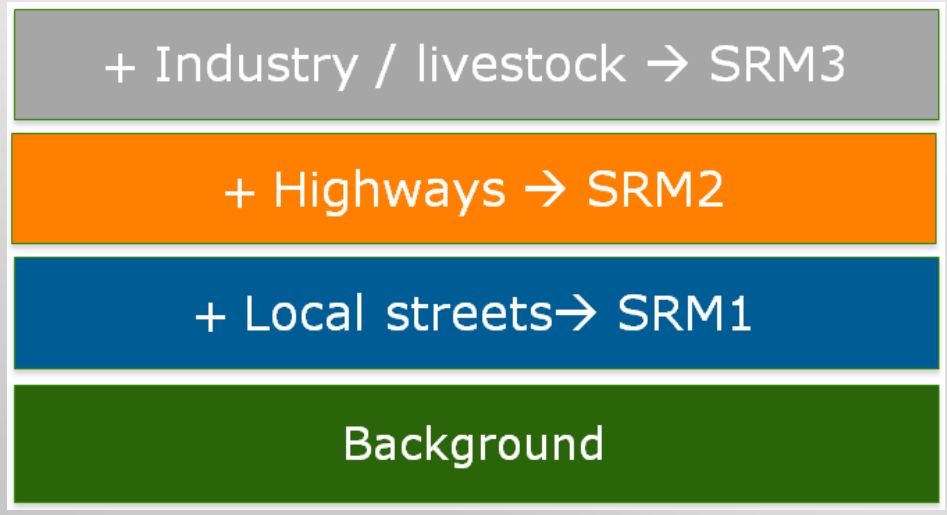
Emission reduction measures

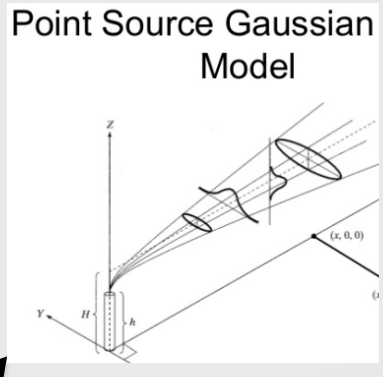
- 1970: EU CO and HC emissions of motor vehicles
- 1988: CLRTAP/Sofia protocol on NO_x emissions
- 1988: EU SO_2 emissions large combustion plants
- 1991-on: EU Euro standards for emissions of cars and trucks
- 1999/2012: Gothenburg protocol: NO_x, SO_2, VOC, NH_3
- 2001: EU NEC emission ceilings directive
- 2008: IMO for sea shipping emissions NO_x and SO_2
- 2010: EU directive on industrial emissions
- ...

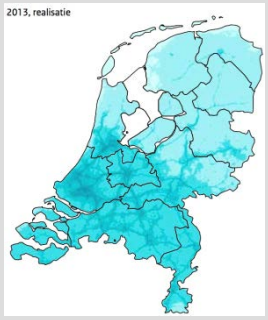
National air quality collaboration programme

Collaboration between

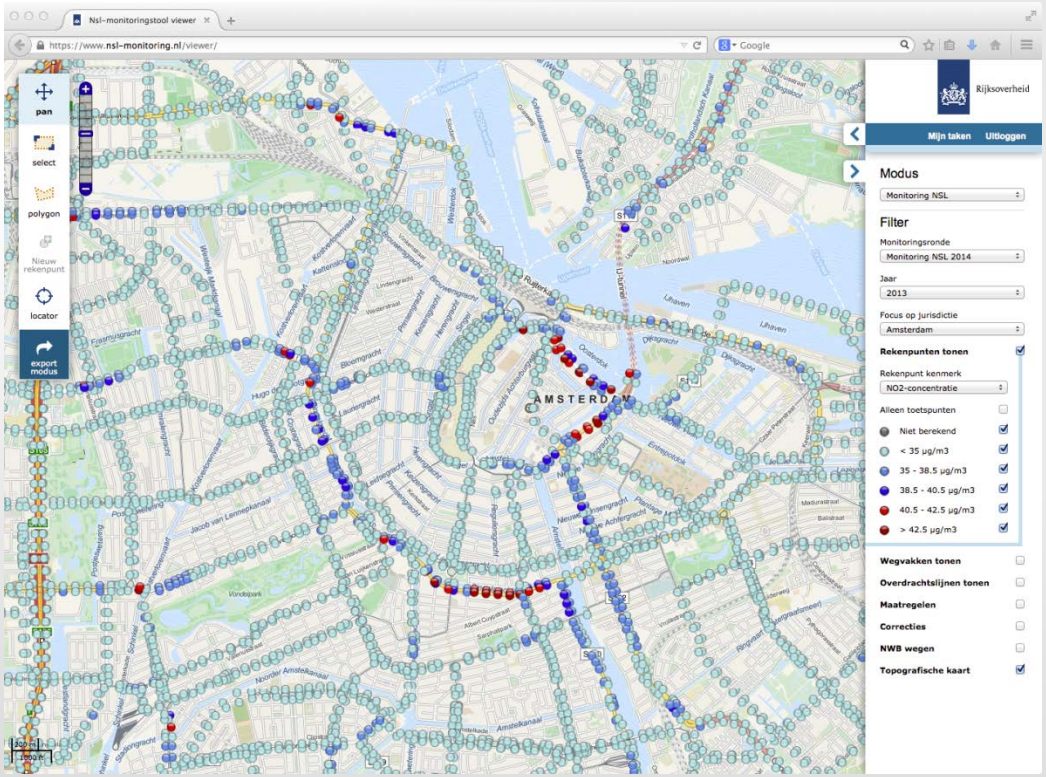
- National government
  - Background concentrations
  - Models
  - Measurements
- Local authorities: cities
  - Local inputs for models







Monitoring tool: Concentrations Amsterdam



Local concentrations the result from

- **European** emissions and measures
- **National** emissions and measures
- **Local** emisions and measures

Scenario study

Baseline scenario

- Reported emissions in NL and rest of Europe

World Avoided scenario

- How the emissions could have increased without policy measures
- Emission factors (kg/activity) unchanged from 1980 on
- Growth according to growth in activity per sector

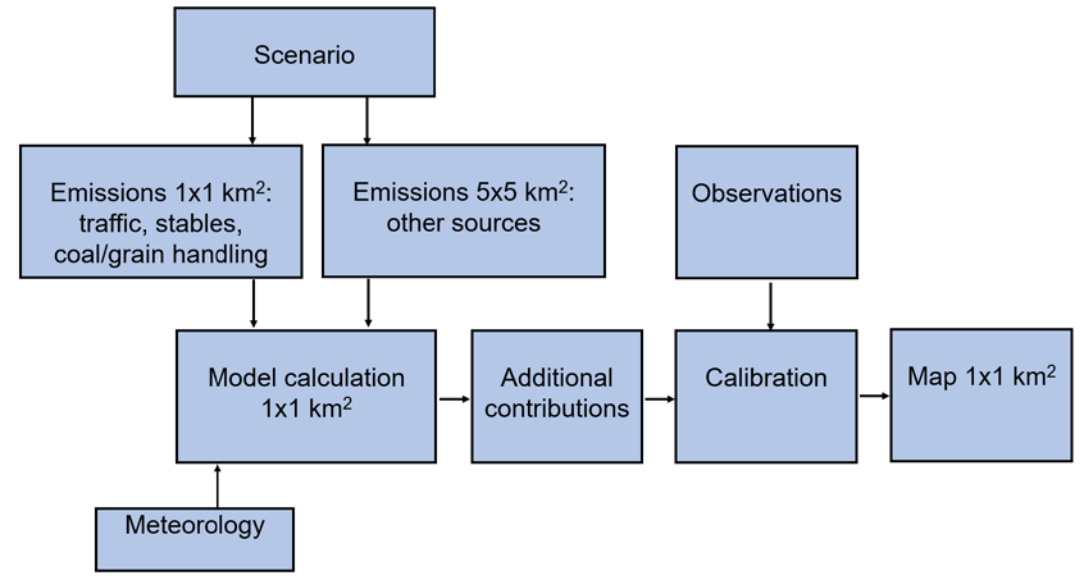
Model calculations

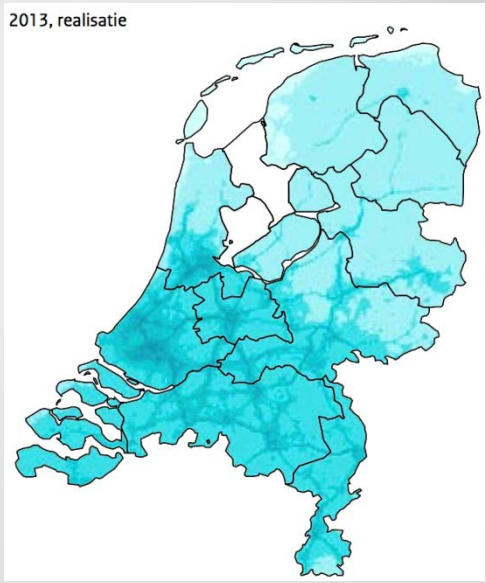
- OPS model ➔ large scale concentration (1x1 km; GCN2017)
- NSL/TREDM ➔ local traffic contributions (8.8 million addresses)

Concentrations and associated avoided health effects

➔ **Published: Velders et al. Atmos. Env. (2020)**

Model setup





Model calculation

- Lagrangian trajectory for long-distance transport
- Gaussian plume for dispersion on local scale
- Particle contributions calculated separately
- Non-linear effects through background concentration fields

Setup World Avoided scenario

Start point are the emissions and distributions of 1980

Various drivers used to increase the 1980 emissions

- Scaling factors applied: $Emission_{year} = Emission_{1980} \times \frac{Driver_{year}}{Driver_{1980}}$
- Economic drivers from OECD, NEC/IIR, and ER/CBS (for Netherlands)
- Netherlands: about 80 sectors
- Rest of Europe: 10 SNAP sectors

Spatial distributions unchanged (i.e., current 2015 data)

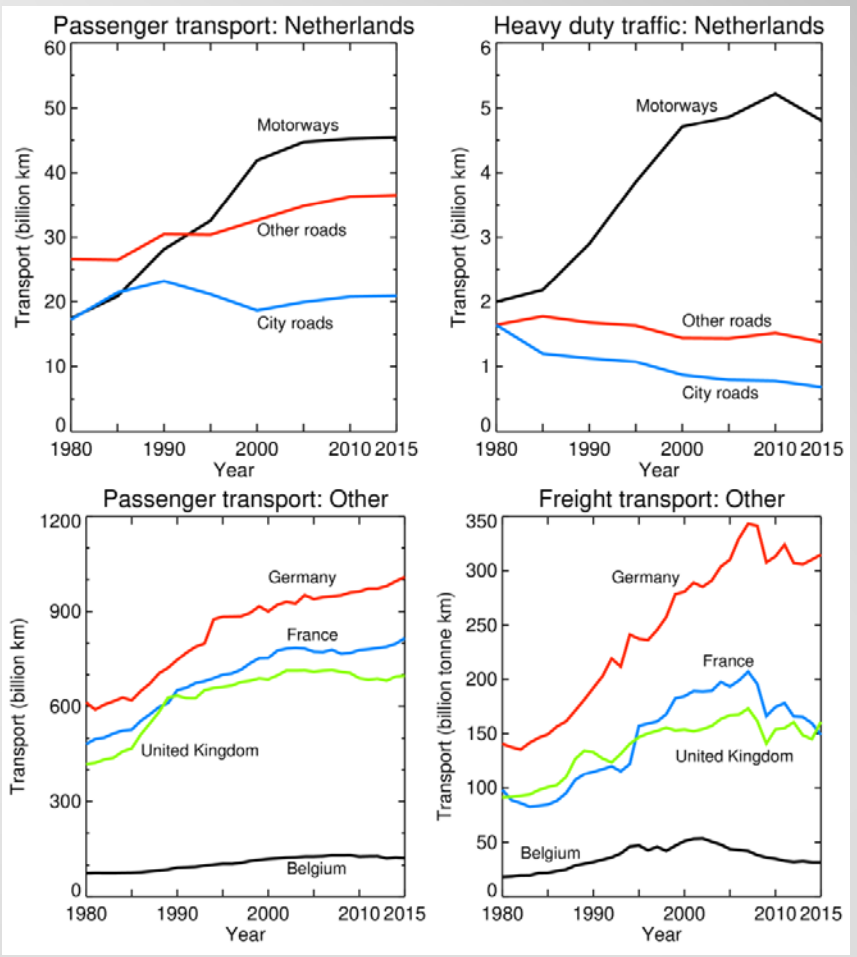
Drivers for traffic

For Netherlands

- Transport in billion km driven
  - Passenger cars
  - Light duty vehicles
  - Heavy duty transport
- Large increase in transport motorways
- Very large increases light duty transport

For other countries

- Passenger transport in billion km driven
- Freight transport in billion tonne km



Drivers other sectors

Electricity production

- Non-nuclear in TeraWatt hour

Households

- Population

Industry

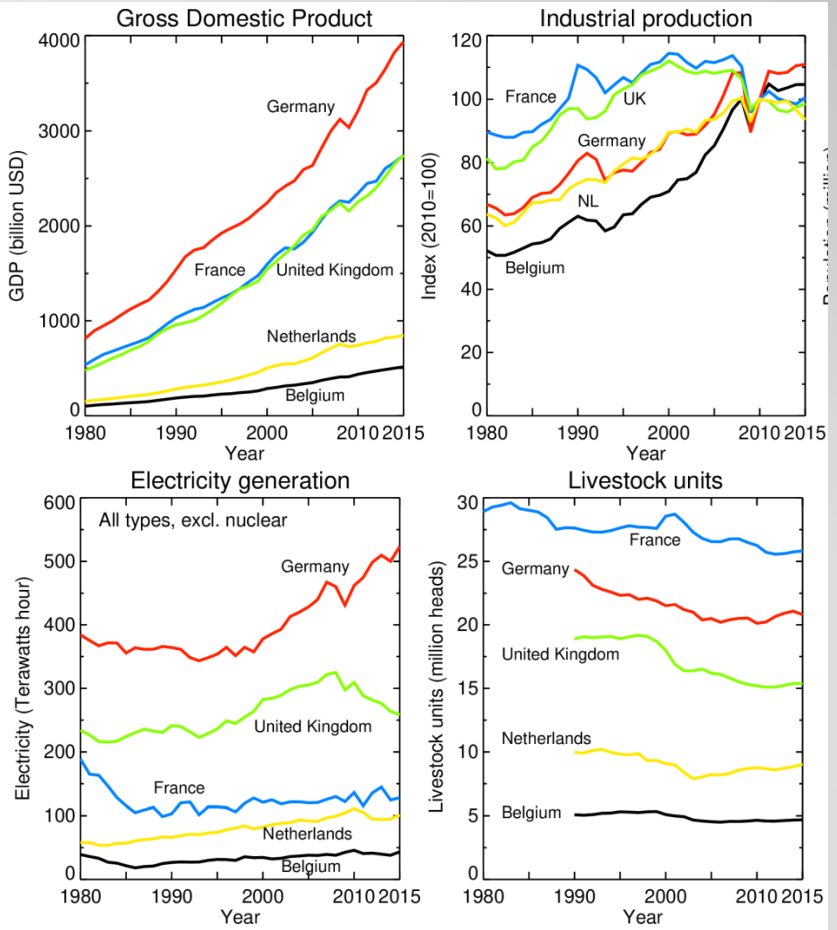
- Industrial production index

Agriculture

- Livestock index

Other (e.g. non-road traffic)

- Gross Domestic Production



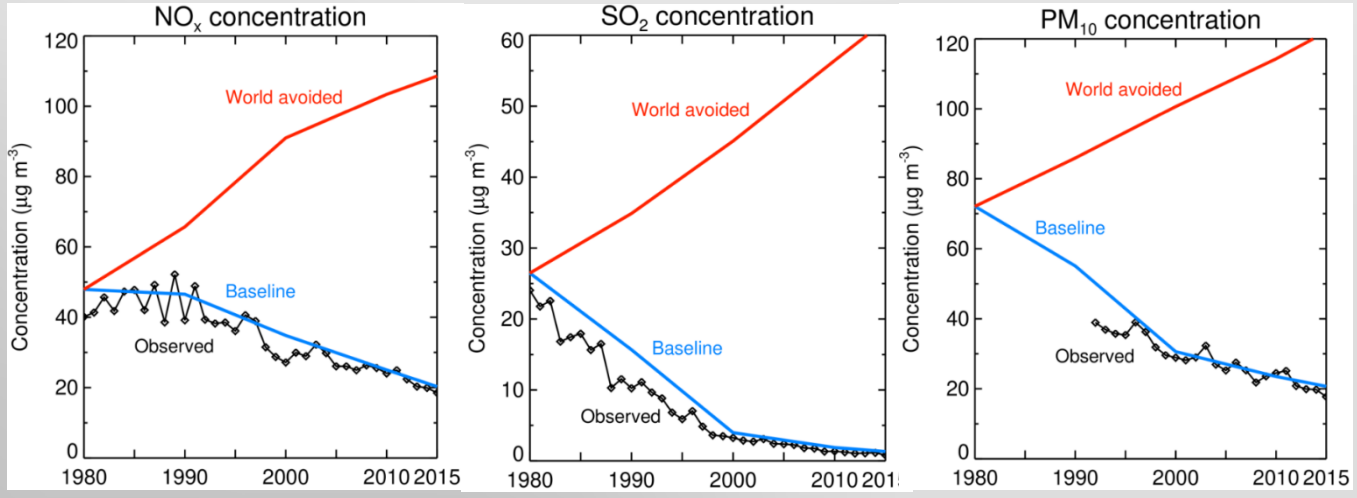
Concentrations NO_x, SO_2, PM

World avoided: increases in NO_x (and NO_2), SO_2, PM_{10}, $PM_{2.5}$

Decreases in Baseline scenario

Good agreement with observations NO_x (and NO_2) and SO_2

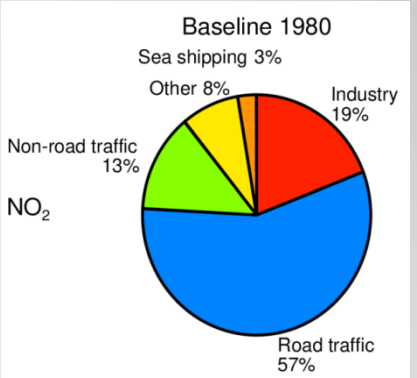
Current concentrations in Asian cities: PM_{10} over 200 µg/m^3



Contributions to NO_2 concentration

Emissions of road transport are dominant

- 57% in 1980; 40% in 2015 (baseline)
- Almost half from domestic passenger cars and delivery vans



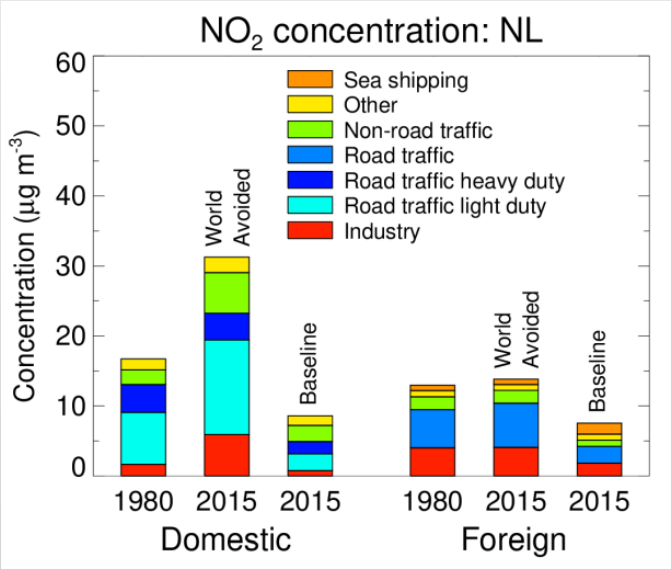
Without measures NO_2 would have increases: 30 ➔ 45 µg/m³

- Decreased to 16 µg/m³ in baseline

➔ 29 µg/m³ avoided:

- NL light traffic: 11 µg/m³
- NL industry: 5 µg/m³
- Foreign traffic: 4 µg/m³

- Largest foreign contri. from: UK and Belgium



Contributions to $PM_{2.5}$ concentration

Dominant contributions from sources outside Netherlands

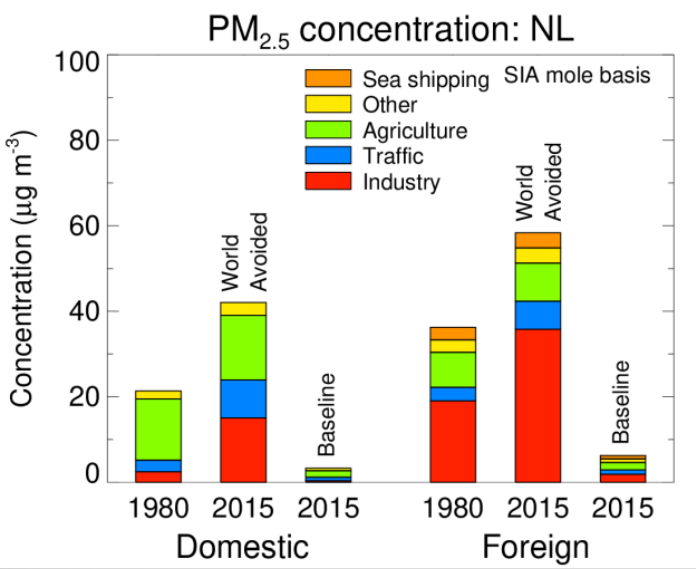
- 40% from domestic sources
- 27% from German sources, 20% from UK, Belgium and France combined
- Dominant sectors: industry and agriculture

Without measures $PM_{2.5}$ would have increases: 59 ➔ 102 µg/m³

- Decreased to 12 µg/m³ in baseline

➔ 90 µg/m³ avoided:

- Foreign industry: 34 µg/m³
- NL industry: 15 µg/m³
- NL agriculture: 14 µg/m³
- All traffic: 13 µg/m³



Contributions to $PM_{2.5}$ concentration

Aerosols calculated on a molar basis

Largest contributions from sulphate aerosols

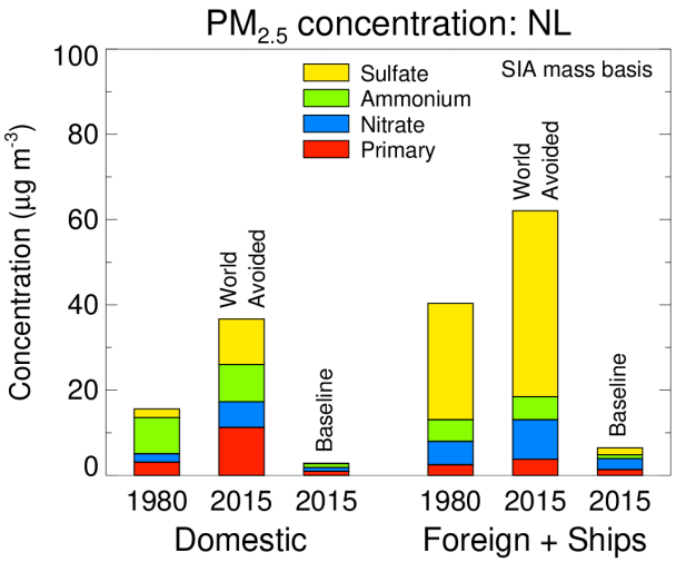
- From domestic and foreign industry
- Also responsible for largest reductions and avoided contributions in 2015

Contributions from ammonium aerosols

- From agriculture

Contributions traffic

- Primary aerosols
- Nitrate aerosols



Health effects of air pollution: Globally

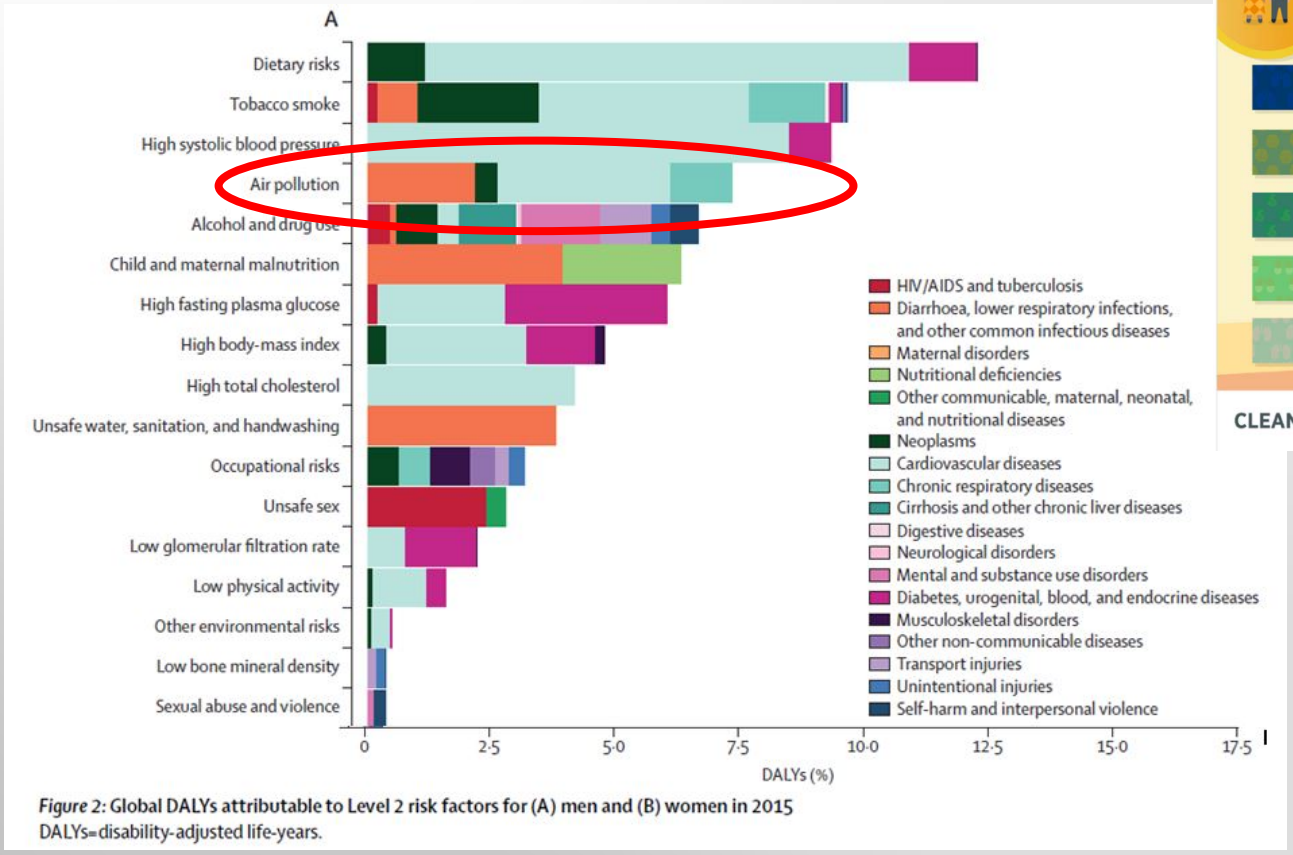
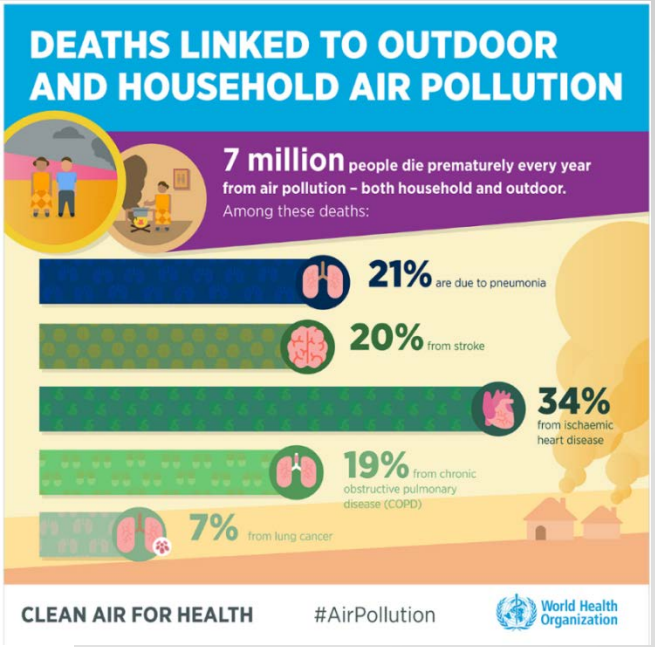


Figure 2: Global DALYs attributable to Level 2 risk factors for (A) men and (B) women in 2015
DALYs=disability-adjusted life-years.



Global Burden of Disease, Lancet (2016)

Trends in health effects

740 000 DALYs avoided in 2015

- Baseline 560 000 ➔ 135 000 from 1980 to 2015

66 000 attributable death avoided

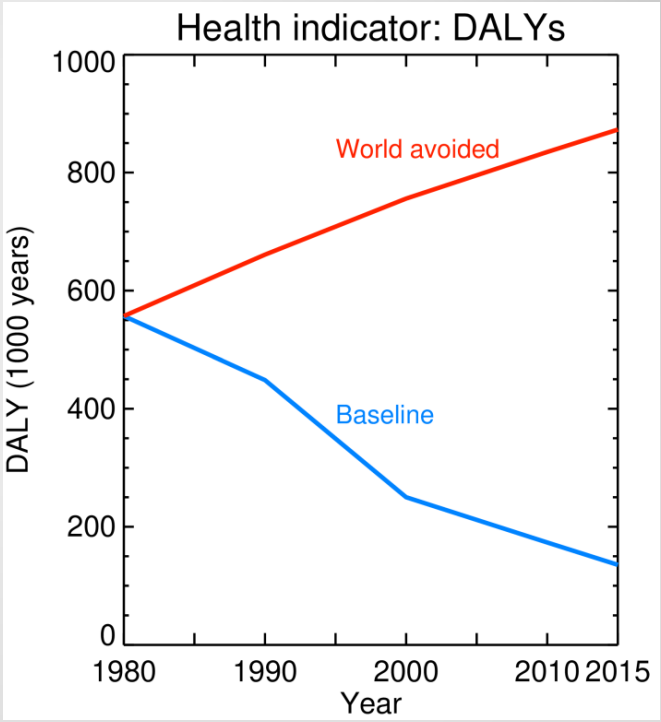
- Baseline 50 000 ➔ 12 000

6 years of loss of life expectancy avoided

- Baseline 4 years ➔ 1 year

€ 35-77 billion per year damage avoided

- Baseline 26-58 ➔ 6-14 billion



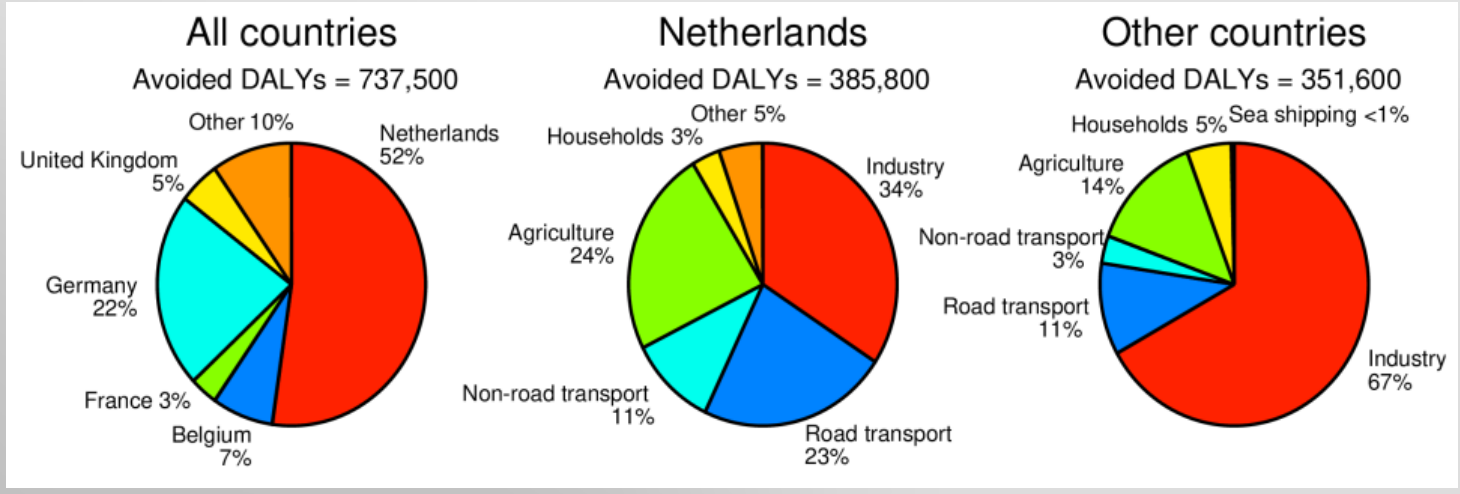
Contributions to avoided health effects

Domestic and foreign sources similar contributions to avoided DALYs

50% avoided DALYs attributable to industry

- Incl. refineries, electricity production
- Sulphate aerosols and SO_2 emissions
- EU directives on large combustion plants, other industry, liquid fuels

24% traffic, 19% agriculture, 4% households etc.



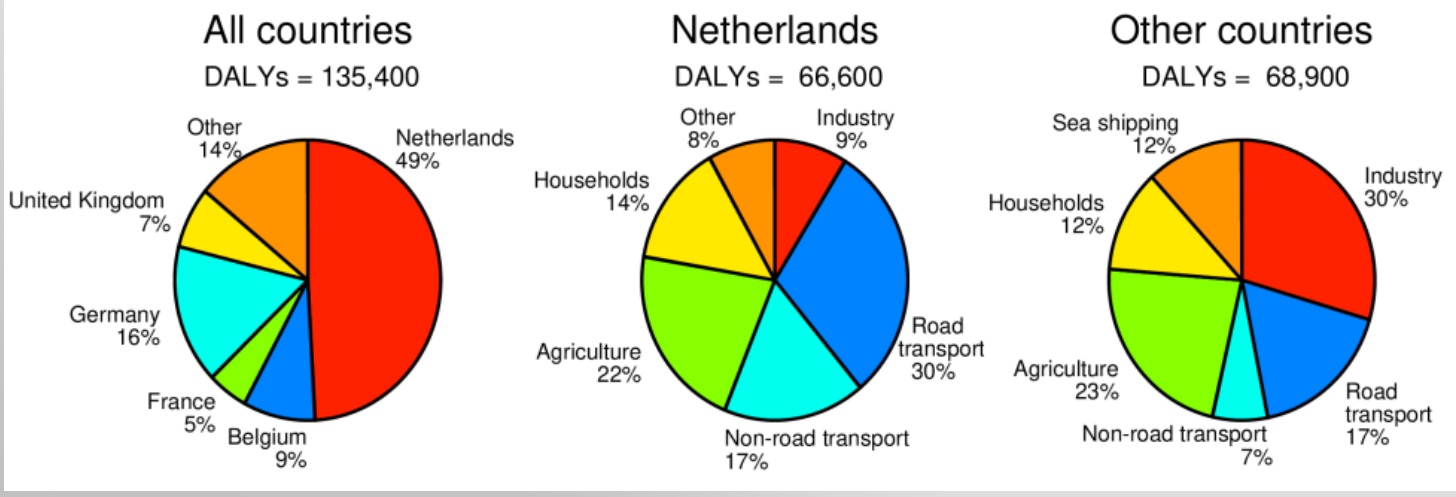
Health effects in 2015

Contributions attributable to various sectors, domestic and foreign

- Largest road transport, agriculture, industry

Domestic sectors: 49%

Foreign sectors: 51%



Conclusions

Since 1980, air quality has improved considerably in the Netherlands

Large avoided concentration increases of SO_2, NO_2 and $PM_{2.5}$

- $PM_{2.5}$ could have increased from 59 µg/m^3 (1980) ➔ 102 µg/m^3 (2015)
  (now on average 12 µg/m^3)
- More than half from reductions abroad

Health benefits for the Netherlands in 2015

- 66 000 avoided attributable deaths per years
- Increase in life expectancy of 6 years
- Avoided monetary health damage € 35 - 77 billion per year

More info: Velders et al. Atmos. Env. (2020)

Questions?

Dank u wel

Thank you

Gracias

Danke

Merci

Diolch yn fawr

Спасибо

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