EMISSION INVENTORIES
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OUTLINE

- Introduction - Why & how make an inventory?
  - Insight in emission reporting
  - Emission database and trends
  - Comparison between countries (examples)
  - Some definitions
  - Zooming in on the city
  - Air quality – what is it made of?
  - Validate and Verify
- Questions & Discussion
DPSIR FRAMEWORK....

- Emissions are key!
BOTTOM-UP EMISSION INVENTORIES AND HYBRID, COMPILED INVENTORIES

› Classic Emission inventory

\[ Emission_{pollutant} = \sum_{activities} Activity\ rate_{activity} \times Emission\ factor_{activity,pollutant} \]

› **EMEP/EEA air pollutant emission inventory guidebook**: Technical guidance to prepare national emission inventories


› Examples: Dutch Emission Registration; The Emissions Database for Global Atmospheric Research (EDGAR) http://edgar.jrc.ec.europa.eu/

› **Hybrid, compiled Emission inventory** (collecting various different bottom-up estimates, possibly including expert judgements)

› Example TNO-MACC (Kuenen et al., ACP, 2014)
OFFICIALLY REPORTED EMISSIONS OF PM10 (KT)

Important consequences:

• Emission inventories are not fixed! New insights generate revised EIs
• As a user you need to be aware of what you use (year, version)
• Rule in EI world: If the time series is extended, all years need to be updated

Thanks to EMEP- CEIP for keeping the data and making it available!
EUROPEAN EMISSION INVENTORY CONTAINS PRIORITY AIR POLLUTANTS FROM 200+ SOURCES (GROUPED IN 10 CATEGORIES)

Emissions per source sector (2011) per pollutant

Source TNO-MACC_III inventory
Example of derived Elemental carbon emissions by country by sector

Dominant sources vary by country!
Effective policy in Netherlands addresses road transport, in Poland focus should be on residential combustion
SOME EMISSION INVENTORY (EI) DEFINITIONS...

IF ONLY FOR 20 MINUTES

1. Bottom-up EI at the national scale

2. Top-down or downscaled based on 1)

3. Bottom-up city EI

4. Top-down EI using inverse modelling, Earth observations (EO), concentration measurements

5. Bottom-up using EO data (the EO give the activities e.g. burnt area)
A NATIONAL SCALE BOTTOM-UP EI FOR DIFFUSE SOURCES WOULD HAVE THIS RESOLUTION...

Point sources are independent of resolution if the coordinates are known... Errors could be in wrong assignment of emissions or address complications (head quarters vs facility)
RESULTING EMISSION MAPS

NOx in 2009

y2009_all
NOx tons/cell

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 75
- 75 - 100
- 100 - 125
- 125 - 150
- 150 - 200
- 200 - 250
- 250 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 5000
- 5000 - 10000
- > 10000
- no data

SNAP Descriptions:
1. Power plants & refineries
2. Residential combustion
3. Iron & steel industry
4. Oil, coal & gas production
5. Industrial, domestic & constructional solvents
6. Machinery, non-road transport & shipping
7. Landfills & waste incineration
8. Agriculture
9. Road transport - gasoline
10. Road transport - diesel
11. Road transport - LPG
12. Road transport - nkt
QUANTIFICATION OF THE URBAN AIR POLLUTION INCREMENT AND ITS DEPENDENCY ON THE USE OF DOWN-SCALED AND BOTTOM-UP CITY EMISSION INVENTORIES

CASE STUDY 1: PARIS

- The emission authority in Paris is AirParif (http://www.airparif.asso.fr/).
- Emission inventory for the Ile-de-France region incl. Paris
- To keep consistency we take over complete Ile-de-France region
- Compare local bottom-up inventory to European down-scaled inventory per sector
RESULT: DOWNSCALED EMISSION DATA SET WITH NESTED BOTTOM-UP EMISSION INVENTORIES

<table>
<thead>
<tr>
<th>Bottom up divided by TNO-MACC</th>
<th>London</th>
<th>Paris</th>
<th>Rhine-Ruhr</th>
<th>Po Valley</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM10</strong></td>
<td>26%</td>
<td>33%</td>
<td>55%</td>
<td>110%</td>
</tr>
<tr>
<td><strong>NOx</strong></td>
<td>62%</td>
<td>95%</td>
<td>108%</td>
<td>107%</td>
</tr>
</tbody>
</table>

MACC / MEGAPOLI
2005 PM10 total

- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- 20 - 40
- 40 - 80
- 80 - 160
- 160 - 320
- > 320

London

Po Valley

Rhine-Ruhr

Ile-de-France including Paris

Po Valley
AIR POLLUTION
WHAT IS IT MADE OF?

NOx emissions  = NO + NO2;

*It is what it is....*

PM = ....?
Study about traffic particles and cardiovascular health

- NC highway patrol troopers
- Troopers work up to 9 hrs inside their cars
- Health effects associated with metals in PM2.5 (brake wear)

TROOPER STUDY

- Traffic particles are associated to negative health effects
- (This) Occupational study proposes brake wear involvement
  
  - Strong response to “Speed change” PM;
  - Vascular inflammation & coagulation; Changed autonomous control of the heart
  - Cell studies show increased inflammation to brake wear
- Insufficient data to estimate scale for general population
- In the Netherlands we realized the data and composition profiles in our emission inventory were outdated.....
METAL CONTENT (% M/M) OF SELECTED BRAKE PAD SAMPLES BY XRF ANALYSIS

A major change in composition – from combustion to wear dominated…..
**Validation and Verification**

- **Validation** checks whether or not the guidelines have been applied, whereas **Verification** checks whether the data are true.
TO SUMMARIZE....

Good emission data are crucial!

- To understand the state of the environment
- Source sector information (from inventories) is essential for mitigation policies
- Bottom-up at the national scale results in a down-scaled map at grid level
- A national downscaled map is often not accurate at the city scale...corrections can be made but takes time – (see Kuik et al., ACP 2016)
- PM10 / PM2.5 is complex differs from other pollutants like NO₂ or SO₂
- PM composition is a big issue in inventories and in health impact
- Ambient PM composition changes over time due to shifting source contributions
- Independent verification of inventories is necessary
THANK YOU FOR YOUR ATTENTION

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