Exhaust and non-exhaust PM emissions from road traffic

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Vito

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Flemish Institute for Technological Research
Content

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4. Non-exhaust emissions
5. Conclusions
1. Exhaust emissions

Methodology

Emission

= 

Emission factor * Activity data
1. Exhaust emissions

Data

- **Diesel vehicles: TEMAT model**
  - Emission factors: speed dependant functions
    - vehicle type
    - technology
    - age
    - road type
    - traffic type
    - cylinder capacity or weight of the vehicle
  - Activity data: total amount of covered kilometres

- **Petrol and LPG vehicles**
  - Emission factors: Literature
  - Activity data: TEMAT model
1. Exhaust emissions

Results

PM$_{2.5}$

<table>
<thead>
<tr>
<th>Category</th>
<th>1995</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger cars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light duty freight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy duty freight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coaches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ton
2. Monte Carlo sensitivity-analysis

Monte Carlo

- Different statistical techniques

- Estimated value $\rightarrow$ probability distribution

- Probability functions:
  - Input parameters of emission factors
  - Activity data
2. Monte Carlo sensitivity-analysis

**Probability distributions**

- **Emission factors (Diesel)**
  - Average speed
  - Fraction peak traffic
  - Fraction on urban roads

- **Emission factors (Petrol and LPG)**
  - Emission factor
  - Fraction un urban roads

- **Activity data**
  - Average travelled kilometres for the year 1995
  - The increase (percentage) of travelled kilometers per year
2. Monte Carlo sensitivity-analysis

Results

<table>
<thead>
<tr>
<th>PM$_{2.5}$ (ton)</th>
<th>1995</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value 95% CI</td>
<td>Value 95% CI</td>
</tr>
<tr>
<td>Total</td>
<td>5762 (7142 - 8022)</td>
<td>6284 (6008 - 6581)</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>111 (90 - 133)</td>
<td>172 (140 - 204)</td>
</tr>
<tr>
<td>Passenger cars</td>
<td>4354 (3939 - 4820)</td>
<td>3304 (3037 - 3594)</td>
</tr>
<tr>
<td>Light duty</td>
<td>1187 (1118 - 1260)</td>
<td>1157 (1088 - 1231)</td>
</tr>
<tr>
<td>Heavy duty</td>
<td>1712 (1621 - 1812)</td>
<td>1479 (1414 - 1549)</td>
</tr>
<tr>
<td>Busses</td>
<td>155 (112 - 199)</td>
<td>136 (104 - 168)</td>
</tr>
<tr>
<td>Coaches</td>
<td>43 (38 - 47)</td>
<td>36 (33 - 39)</td>
</tr>
</tbody>
</table>

Emissions for passenger cars are the most difficult to define

- large 95% CI
- Due to the older diesel passenger cars
- 95% CI decreases between 1995 and 2000
  →Replacement of old vehicles into the new generations of vehicle technologies
2. Monte Carlo sensitivity-analysis

Decrease between 1995 and 2000

<table>
<thead>
<tr>
<th>Statistics</th>
<th>1995-2000 (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>1.276,47</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>130,50</td>
</tr>
<tr>
<td>0,0 % percentile</td>
<td>880,78</td>
</tr>
<tr>
<td>2,5 % percentile</td>
<td>1.030,91</td>
</tr>
<tr>
<td>5,0 % percentile</td>
<td>1.062,61</td>
</tr>
<tr>
<td>50,0 % percentile</td>
<td>1.277,54</td>
</tr>
<tr>
<td>95,0 % percentile</td>
<td>1.492,59</td>
</tr>
<tr>
<td>97,5 % percentile</td>
<td>1.535,11</td>
</tr>
<tr>
<td>100,0 % percentile</td>
<td>1.746,17</td>
</tr>
</tbody>
</table>

Significant decrease in PM exhaust emissions from road traffic between 1995 and 2000

- Average decrease = 1 273 ton
- 95% CI shows there is significant decrease (1 062 ton – 1 493 ton)
3. Updates

New insights

- **Amount of lorries per weight class**
  - Underestimation of the weight class 32 to 40 tonne in the past

- **Yearly driven kilometres**
  - Overestimated for the light duty vehicles for freight in the past
  - Total amount of vehicle kilometres driven overestimated with 15% in the past

- **Emission factors have been reviewed**
  - PM: did not change a lot
  - NO\textsubscript{X}: higher than expected

- **TEMAT: only diesel PM**
  - PM emissions from diesel-fuelled vehicles decrease in time
  - PM emissions from vehicles driven on petrol, LPG, ... become more important in the future
3. Updates

Results

<table>
<thead>
<tr>
<th></th>
<th>TEMAT v1</th>
<th>TEMAT v2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger cars</td>
<td></td>
<td></td>
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<td>Light duty freight</td>
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<td>Heavy duty freight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Non-exhaust emissions

**Methodology**

\[ \text{Emission} = \text{Emission factor} \times \text{Activity data} \]

- **Only limited information is available**
  - General emission factors were used

- **Dependent on the circumstances**
  - Normal or peak traffic
  - Speed
  - Weather
  - ...
4. Non-exhaust emissions

Results

<table>
<thead>
<tr>
<th>Year</th>
<th>Brake wear</th>
<th>Tyre wear</th>
<th>Road abrasion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- > PM10
- Coarse
- PM2.5
4. Non-exhaust emissions

Research

More research is necessary

→ Extensive measuring programs
→ Inventory of statistical data
→ Possible reduction measures
  • Materials for road surface
  • Materials for tires
  • Materials for breaks
→ Health implications
5. Conclusions

- **Large reductions** have been achieved between 1995 and 2000 for exhaust PM emissions from road traffic.

- **Further reduction** is still necessary.

- The **uncertainty** on the total of the calculated emissions will **decrease** in time due to the introduction of cleaner passenger cars.

- **Refinement of statistical data** is very important for the results of the calculated PM exhaust emissions.

- More attentions has to be made on PM emission factors for **vehicles driven on petrol, LPG, ...**

- Contribution of **non-exhaust emissions** will become **more important** in the future.

- **More research** needs to be done for the **non-exhaust emissions**.
Questions?