Environmental performance of inland shipping in comparison with other modes

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Eelco den Boer
CE Delft

- Independent, not-for-profit consultancy, founded in 1978
- Based in Delft, the Netherlands
- Transport, Energy, Economy
- 15+ years of experience with environmental policies for aviation and shipping
- Clients include European Commission, national governments, ports, branch organisation, NGOs, IMO
Outline

- Introduction
- Objectives
- Methodological framework
- Factors defining the specific emissions
- Comparison of transport modes on specific links
- Conclusions
Objectives

• Why comparing emissions of transport modes?
  • 60% emission reduction in transport

• EU Transport White Paper put modal shift on the agenda
  • Climate point of view now
  • Air quality remains important
  • 30-50% over 300 km distance by waterborne and rail in 2030-2050

• Ports face accessibility and sustainability difficulties
  • Rotterdam applies modal shift criteria at MVII:
    - Inland shipping: 45% (currently approx. 30%).
    - Rail: 20% (currently approx. 10%).
    - Road: 35% (currently approx. 60%).

• Sustainability programs of shippers
Methodology

- STREAM = Study into TRansport Emissions of All Modes

- Different factors define the emissions per output (tkm):
  - Emission characteristics (e.g. Euro standard)
  - Scale
  - Detouring
  - Pre- and end haulage
  - Type of goods

- Well-to-wheel analysis

- Main pollutants covered
  - CO₂, NOₓ, PM and SO₂
- Current situation (2009) and 2020
- Representing the EU situation (electricity/refining)
- Focussing on longer distance
Methodology

• Calculation of emission factors grammes per tkm for all modes

\[
EM_{overall} = \frac{vkm_{mode} EM_{mode} + \left(vkm_{truck} + EM_{truck}\right)_{post-transport} + EM_{transfer}}{vkm_{truck} \cdot load_{mode}}
\]

• \( EM_{mode} \): emissions per vehicle including the fuel cycle
• \( Load \): maximum capacity * utilization factor
• \( Detour \) factor: \( vkm_{mode} / vkm_{truck} \)

• Emission data
  • Road: Dutch emissions inventory (TNO)/TREMOVE
  • Rail: Ecotransit
  • Inland barge: Dutch emissions inventory (TNO)
  • Seagoing ship: 2nd IMO GHG study

• Logistics data: market consultation
## Impact of detouring/pre-end haulage

- **Case:** Large scale container transport Rotterdam-Duisburg-Essen
  - **Road:** Rotterdam-Essen; 230km
  - **IWT:** Rotterdam-Duisburg; 214 km + road 26 km

<table>
<thead>
<tr>
<th>depart</th>
<th>arrival</th>
<th>rail/road</th>
<th>iww/road</th>
<th>SSS/road</th>
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<tbody>
<tr>
<td>Port of Rotterdam</td>
<td>Milan</td>
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<td>Duisburg</td>
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<td>Duisburg</td>
<td>1.04</td>
<td>1.06</td>
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<tr>
<td>Port of Rotterdam</td>
<td>Essen via Duisburg</td>
<td>1.04</td>
<td>1.06</td>
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<tr>
<td>Port of Rotterdam</td>
<td>Dortmund via Duisburg</td>
<td>1.09</td>
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<td>Groningen Port</td>
<td>Vienna</td>
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<tr>
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<td>Port of Rotterdam</td>
<td>1.04</td>
<td>--</td>
<td>1.04</td>
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<tr>
<td>Amsterdam Port</td>
<td>Regensburg</td>
<td>1.05</td>
<td>1.41</td>
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</table>
Impact of scale of transport/future outlook

- NO\textsubscript{x} emissions (g/tkm)

<table>
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<tr>
<th>Mode</th>
<th>2010</th>
<th>2020</th>
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<tbody>
<tr>
<td>Truck + Trailer</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Long train Electric</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Long train Diesel</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Spits-Peniche</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Rhine Herne Canal Ship</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Pushed Convoy 2x2</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Products tanker 0-5 kton</td>
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<td>0.00</td>
</tr>
<tr>
<td>Products tanker 5-10 kton</td>
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<td>0.00</td>
</tr>
<tr>
<td>bulk carrier 10-35 kton</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

- Products tanker

- Road

- Rail

- IWW

- SEA

- 2020

- 2010
Comparison of specific modes on specific links

- Average emission technology (2010)
- Representative logistical data
  - Real world distances/detouring/end haulage
- Emissions of transhipment included
- Definition of goods types

- Amsterdam - Regensburg
- Rotterdam - Duisburg, incl. end haulage
Steel Amsterdam-Regensburg

- CO₂ emissions (g/tkm)

- Truck trailer
- Long train Electric (44 wagons)
- Long train Diesel (44 wagons)
- Rhine Herne Canal Ship

- Emission per tkm
- Emission per tkm incl. detouring
Steel Amsterdam-Regensburg

![Graph showing NOx emissions (g/tkm) for different modes of transport.

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- Long train Electric (44 wagons)
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Emission per tkm and Emission per tkm incl. detouring]
Steel Amsterdam-Regensburg

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Emission per tkm
Emission per tkm incl. detouring
Containers Rotterdam-Duisburg

**CO₂ emissions (g/tkm)**

- Truck trailer
- Train Electric 70 TEU
- Train Diesel 70 TEU
- Containership 270 TEU

**Legend**
- Emission per tkm
- Emission per tkm incl. detouring
- End haul. to Essen (26 km)
- End haul. to Dortmund (63 km)
Containers Rotterdam-Duisburg

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Conclusions

- Many factors influence emissions
  - Logistical characteristics
  - Emission standard
  - Type of good

- Modal comparisons depend heavily on vehicle capacity and utilisation
  - CO₂ emissions:
    - Clear advantage for large ships
    - Small ships: load factors decisive
  - Pollutant emissions: road transport comparable or cleaner
    - Strongly dependent on case
    - 2020 difference greater than 2010
  - Significant GHG reduction potential IWT
  - Fuel efficiency and carbon-intensity road likely to improve
Thank you for your attention!

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