Impacts of climate change on inland waterways and ports

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The Joint Research Centre of the EC

Providing scientific and technical support to the European Commission for the development, implementation and assessment of EU policies

The transport economics group in unit C.6

Covering a wide range topics at EU level including transport modelling, accessibility and congestion analysis, external costs, impact assessment and impacts of climate change on transport
Climate change disruptions to the operation of Inland Waterways

Droughts
Disrupt services by reducing water levels either to non-navigable ones or to levels at which operators are forced to reduce loads

Floods
Less disruptive because of shorter duration, adverse currents may cause accidents but impossible to model due to lack of relevant data
Impacts of droughts on IWW

Focus on four locations of the Rhine and the Danube

On the Rhine: ≈70% of the total IWW transport activity of EU15

Ruhrort: major port on the Rhine

Kaub: key bottleneck of the Rhine
Combining climate and transport data

Physical impacts - water levels
High resolution daily discharges (LISFLOOD)
Uncertainty: 11 scenarios based on RCP8.5
Low water limits

Transport system operation
Freight activity on the IWW network
Draught and loading capacity of vessels
Transport cost
Variation of water levels over the projection period

Q0: < 1.5m
Q1: 1.5m-2m
Q2: 2m-2.5m
Q3: 2.5m-3m
Q4: 3m-3.5m
Q5: > 3.5m
Economic valuation

- Ruhrort
- Kaub
- Wildunsmauer
- Hofkirchen

Annual benefit (million €)

- 2011-2040
- 2041-2070
- 2071-2099
Conclusions: impacts on IWW

- The economic implications of climate change for IWW are estimated considering uncertainty.
- IWW are projected to operate with fewer disruptions due to low water levels.
- IWW might be one of the few sectors where climate change can have even positive impact even in the “worst case” emission scenario.
- Given the moderate impact estimates and large uncertainty associated within the different model runs, we consider that the results do not indicate a significant impact of climate change on the operation of IWW.
Impacts of sea-level rise on ports

80% of the world freight is transported by sea
90% of external trade in the EU is seaborne
40% of freight exchanged within the EU uses maritime transport
80% more seaports to be exposed to inundation levels >1m in 2080 than in 2030 (PESETAIII)
Particularly affected will be the North Sea where ports handle cargo traffic amounting to 15% of the world total
## Ports affected

**ESL**$_{100}$ **RCP8.5**

<table>
<thead>
<tr>
<th>ESL (meters)</th>
<th>Ports</th>
<th>Tonnes (millions)</th>
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<tbody>
<tr>
<td>0-1.5</td>
<td>128</td>
<td>1135</td>
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<tr>
<td>1.5-3</td>
<td>159</td>
<td>1021</td>
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<tr>
<td>3-4.5</td>
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<td>448</td>
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<td>4.5-6</td>
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<td>6-7.5</td>
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<td>783</td>
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<td>&gt;7.5</td>
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</tbody>
</table>

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**Goods (mil. tonnes)**

- 2 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- >100
Impacts on hinterland
Impacts on foreland
Conclusions: impacts on ports

• 25% more cargo can be affected by extreme water levels according to RCP8.5 than RCP4.5.

• The amount of cargo to be handled in ports exposed to extreme sea levels higher than 4.5m can increase by more than 200 million tonnes from 2010 to 2100.

• The majority of these ports will be located in Spain, UK, Ireland, Portugal and Norway.

• In the Black Sea and the Mediterranean, the impacts are expected to be milder but occur more frequently in comparison to the North Sea.
Forecasting the impacts of climate change on inland waterways

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ARTICLE INFO

Keywords:
- Inland waterways
- Climate change
- Droughts
- River discharges
- Low water levels
- Impacts on transport

ABSTRACT

Inland waterways are vulnerable to climate change as river navigation depends on water levels. Droughts can severely disrupt inland navigation services by reducing water levels to completely non-navigable ones or to levels that oblige operators to reduce vessel load. We analyse the impacts of droughts induced by climate change using projections of river discharge data provided by eleven different climate model runs. We consider location-specific characteristics by focusing the analysis on four specific locations of the Rhine and the Danube where a substantial part of the total freight activity in the European Union (EU) takes place. For the majority of the cases and scenarios considered, a decrease of the number of low water level days is projected, leading to fewer drought-related disruptions in the operation of the inland waterway transport system. Although the uncertainties from the climate projections should not be neglected, the navigation sector could benefit from global warming which means that European inland waterways might be one of the few sectors where climate change can have negligible, or even positive, impact. The average economic benefit for the cases considered, from the decrease of low water levels by the end of the century is projected to be almost €3 million annually.
Thank you

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