



# **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*

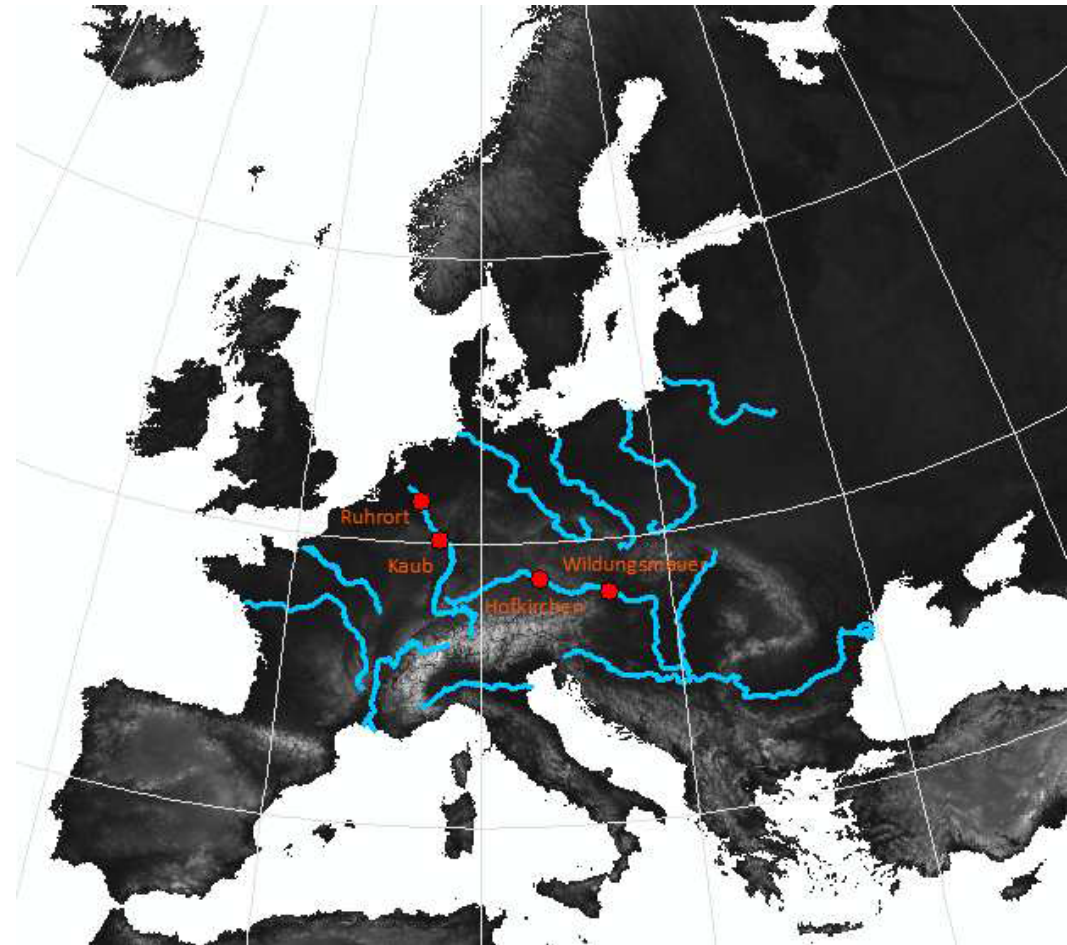
# Impacts of droughts on IWW

*Focus on four locations  
of the Rhine and the  
Danube*

*On the Rhine:  $\approx 70\%$  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

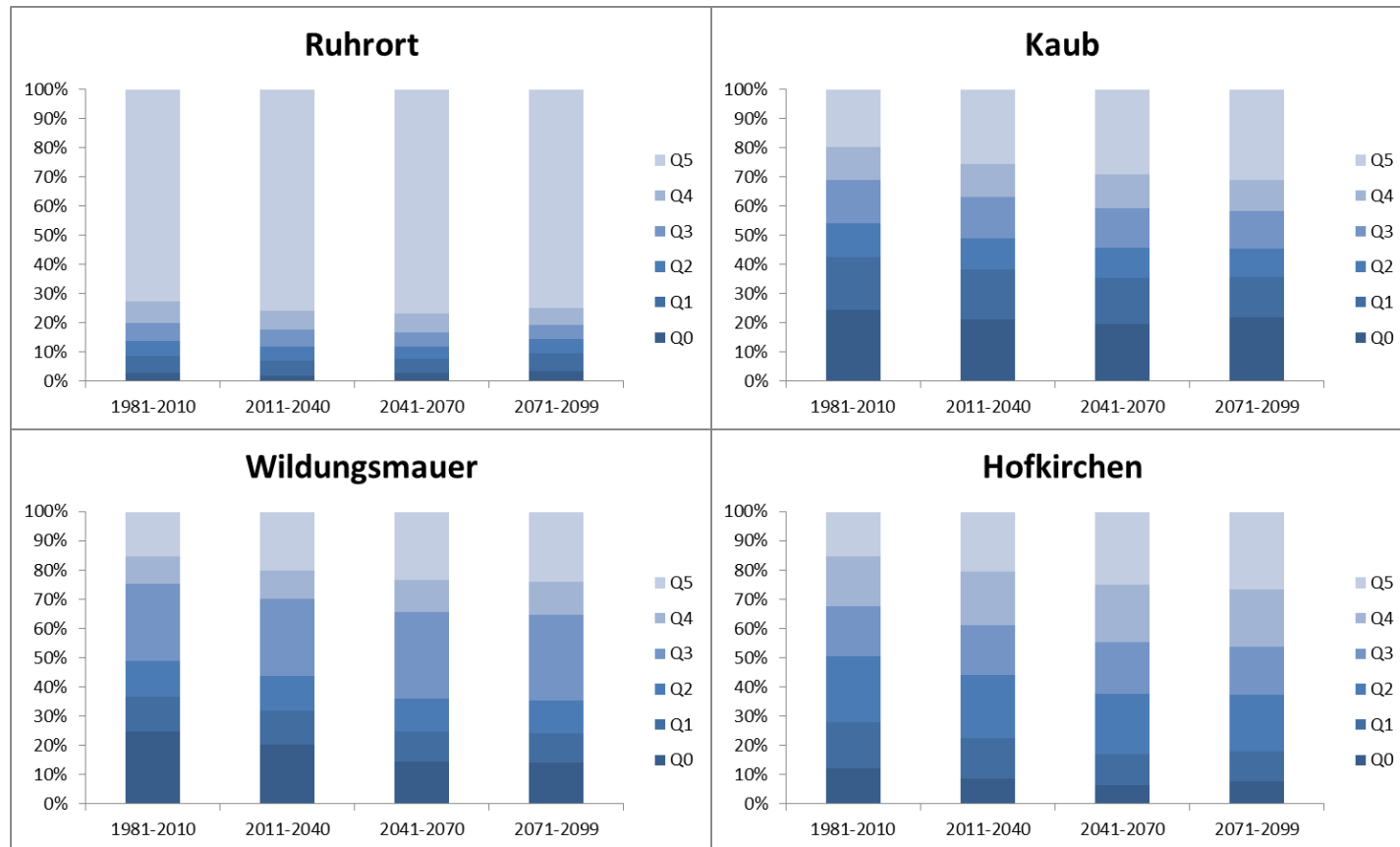
*Freight activity on the IWW network*

*Draught and loading capacity of vessels*

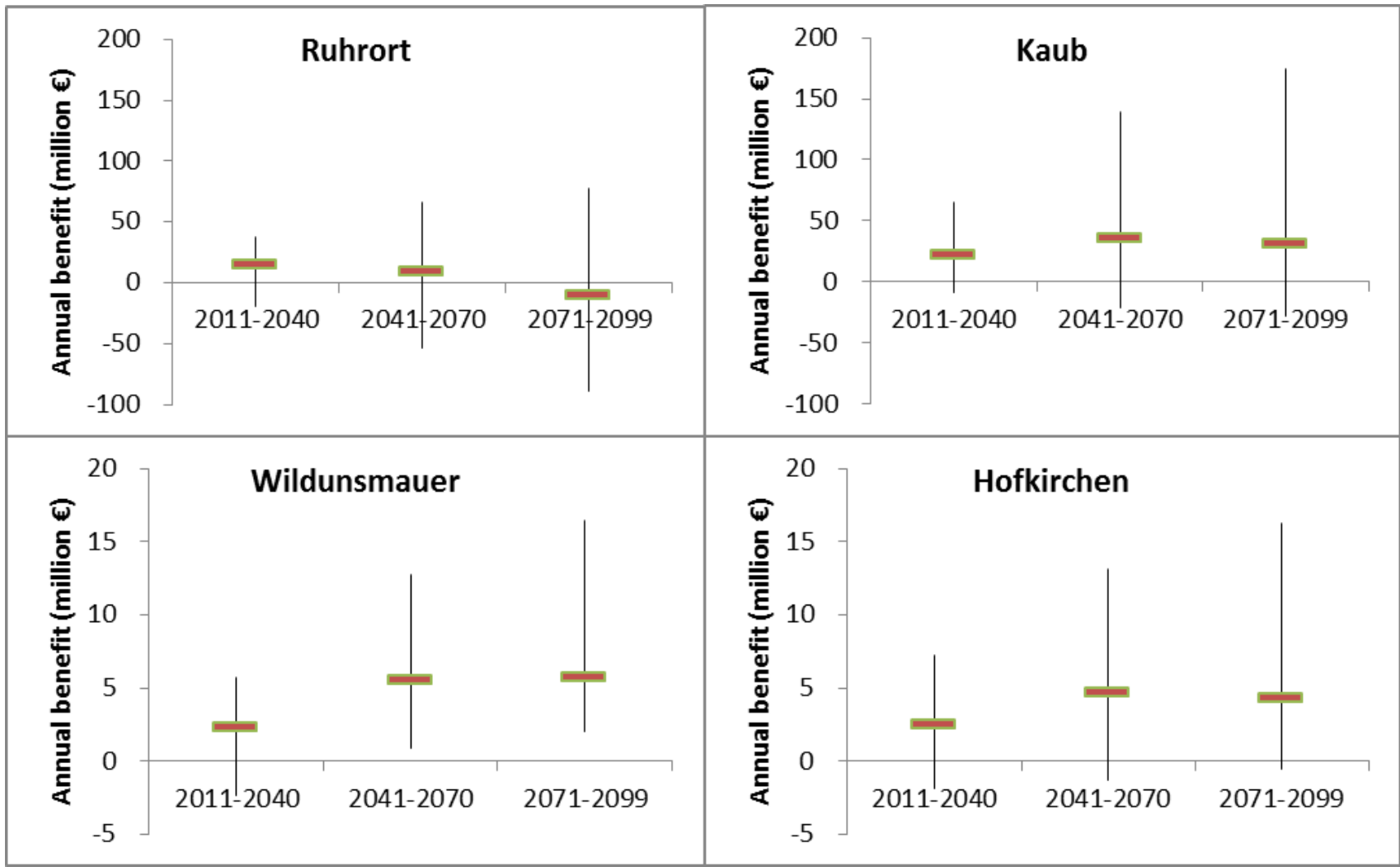
*Transport cost*

# 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



## 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*

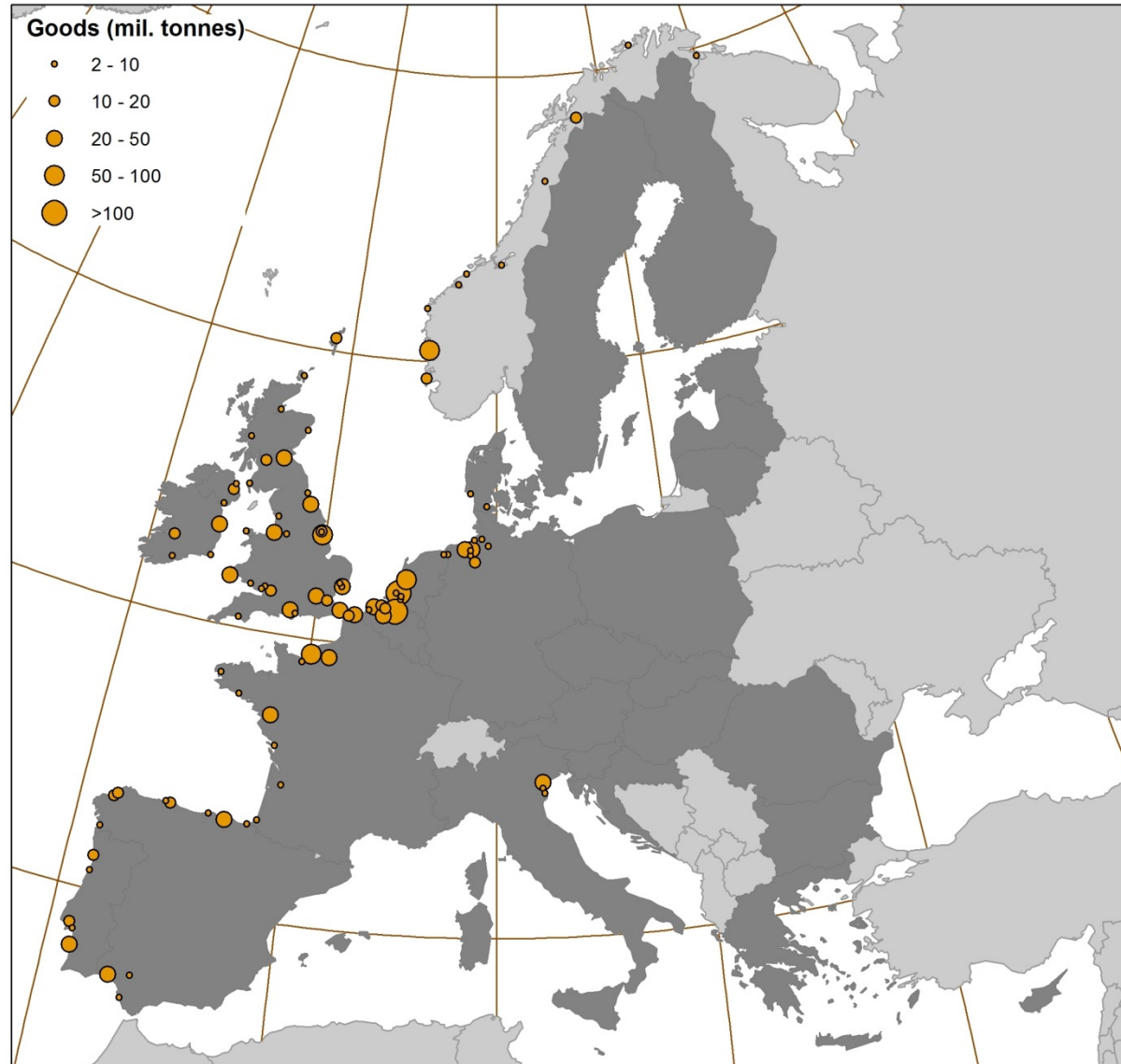
*40% of freight exchanged within the EU uses maritime transport*

*80% more seaports to be exposed to inundation levels >1m in 2080 than in 2030 (PESETAIII)*

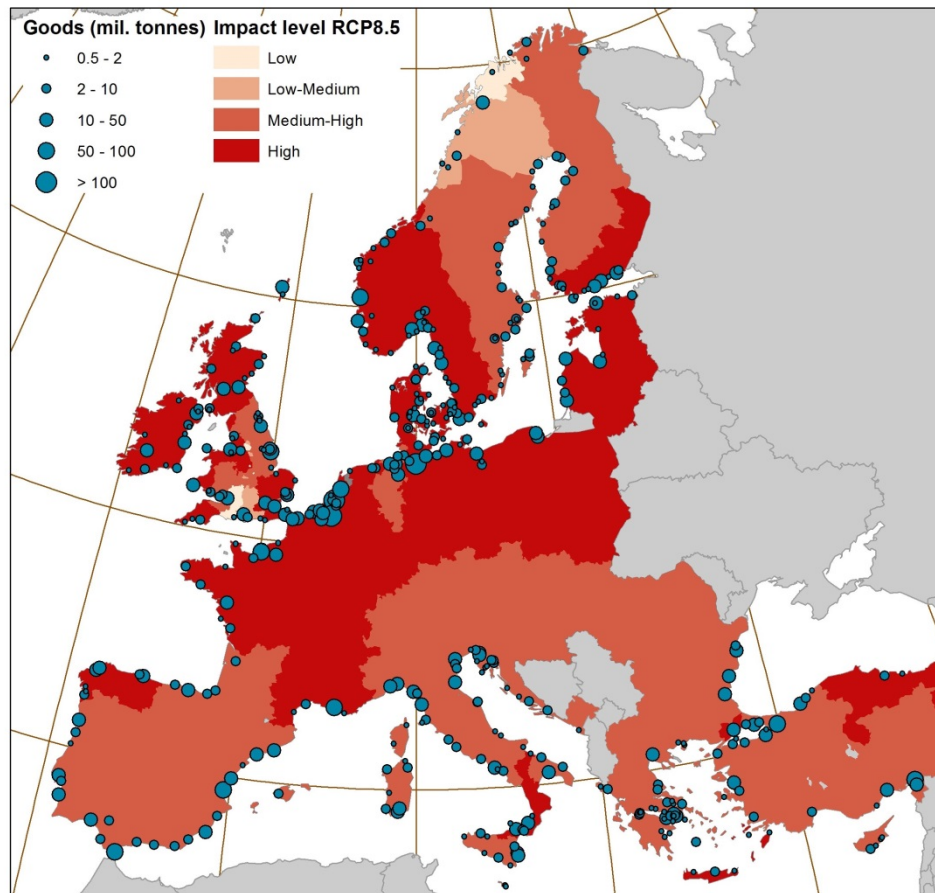
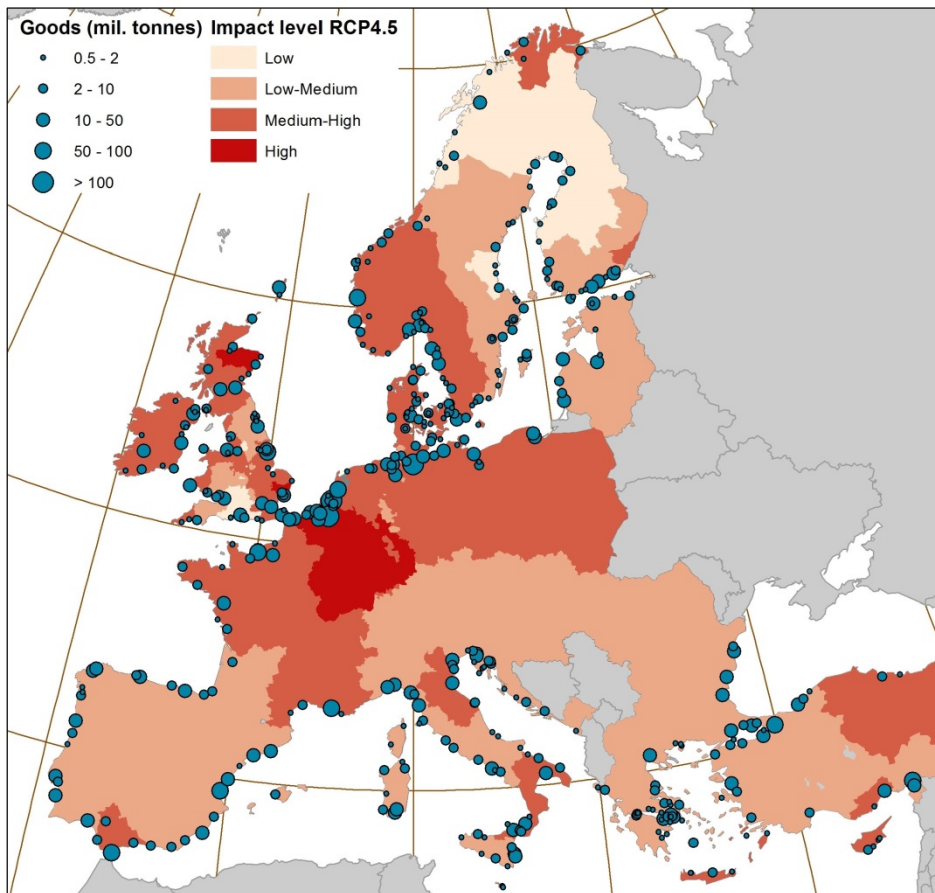
*Particularly affected will be the North Sea where ports handle cargo traffic amounting to 15% of the world total*

# Ports affected ESL<sub>100</sub> RCP8.5

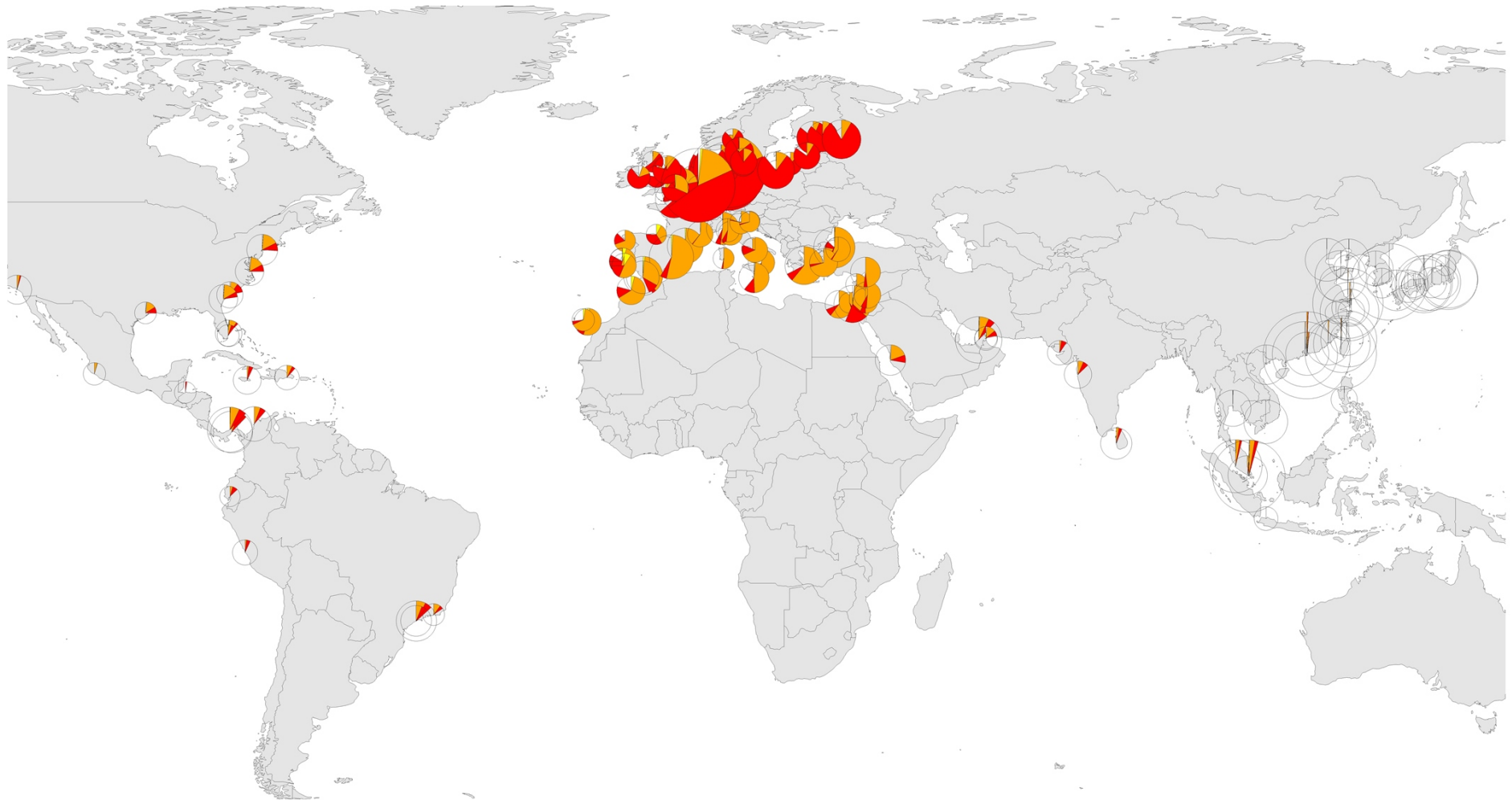
ESL (meters)	Ports	Tonnes (millions)
0-1.5	128	1135
1.5-3	159	1021
3-4.5	66	448
4.5-6	41	719
6-7.5	39	783
>7.5	16	113



# 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.*





JRC SCIENCE FOR POLICY REPORT

# Climate impacts in Europe

*Final report of the JRC  
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## Forecasting the impacts of climate change on inland waterways

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### 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 either 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 €8million annually.




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## Sea-level rise in ports: a wider focus on impacts

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**Thank you**

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