



Climate adaptation pathways of intermodal transport hubs

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1. Introduction

*Research question: Which sets of adaptation measures can **increase climate resilience of intermodal transport hubs**, particularly for ports and the associated supply chain networks?*



Photo: Port of Rotterdam

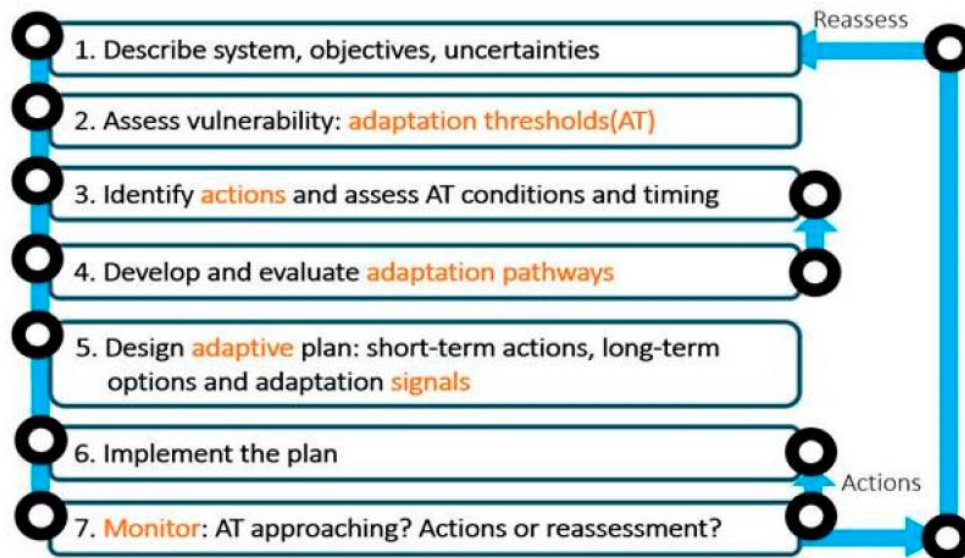
- The aim of our case study has been to present a **robust** approach to assessing climate impacts and identifying adaptation options and strategies
- A **Dynamic Adaptive Policy Pathways** approach was followed, presenting a range of adaptation responses for different scenarios
- The **North Sea Region** serves as the basis of the case study





2. Method: Dynamic Adaptive Policy Pathways

- Dynamic Adaptive Policy Pathways (DAPP) is a form of Robust Decision Making
- Incorporates features from Dynamic Adaptive Planning and Adaptation Pathways: combines **planned monitoring with sequential actions** as the system changes -> leads to *robust* strategies performing well across a range of futures
- A key feature of the approach involves **adaptation thresholds (AT)** – the point at which the system no longer performs acceptably according to predetermined criteria.



Adjustments:

Inclusion of multi-criteria analysis in Step 4 (forthcoming)

Challenges:

Identification of AT: damage tolerance can vary according to a range of factors
Our study uses an acceptable damage value of “1” meaning that the tipping points are compared to current levels of protection

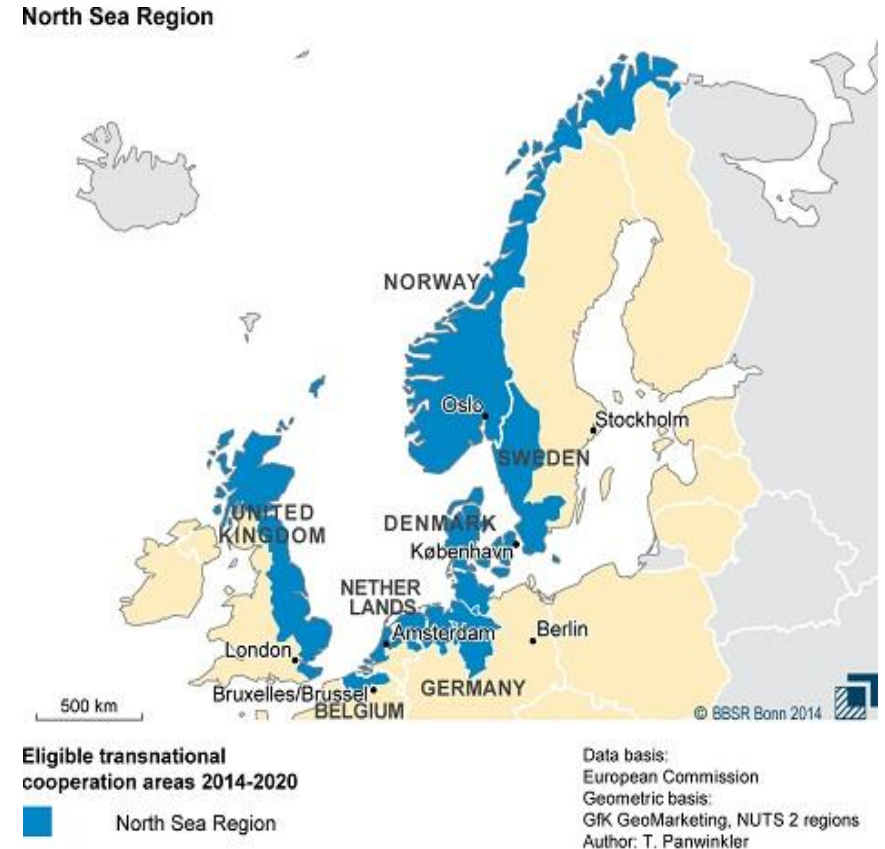
Lawrence et al. (2019)





3. Situation Analysis

- The North Sea Region is the **most important logistical hub in the EU**, facing a range of climate challenges
- Drivers:
 - Institutional value
 - Policy relevance (TEN-T, PortForward)
 - Socio-economic importance
- Climate impacts:
 - Sea-level rise
 - Storm surges
 - Increased precipitation and river flooding
 - Increased summer temperatures





4. Adaptation options

- The identification and classification of adaptation options was carried out through a detailed literature review
- A total of **26 measures** were identified, addressing different climate impacts, across different timeframes, and at different locations of the supply chain network.
- The adaptation options were then categorized into six “bundles” according to their **operational focus**:
 - Port infrastructure
 - Hinterland transport infrastructure
 - Green/nature-based solutions
 - Supply chain management
 - Logistics/supply chain digitalization
 - “Soft”/risk management measures





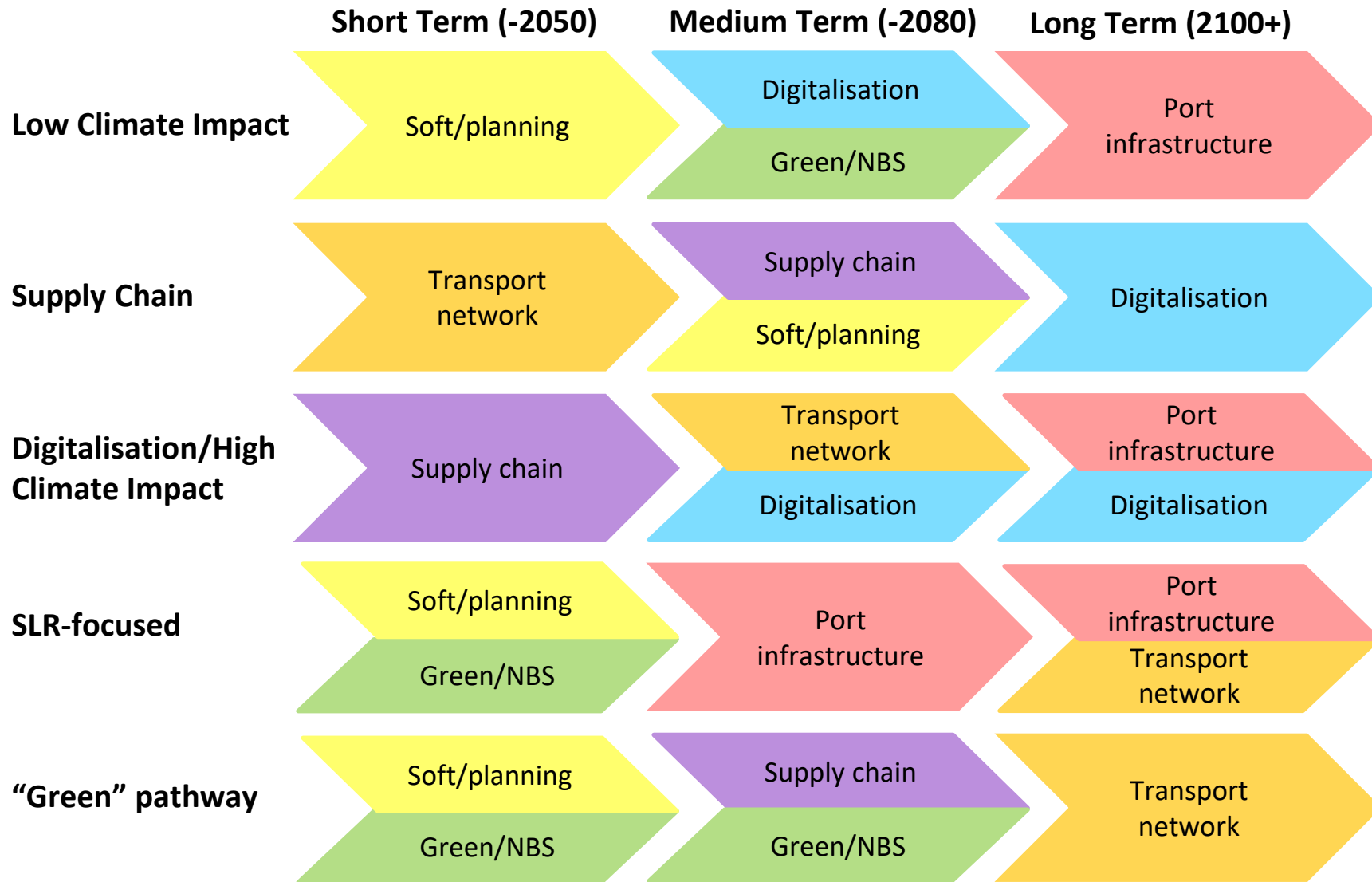
5. Adaptation option bundles

Port infrastructure measures	<ul style="list-style-type: none">• Raise port/critical infrastructure elevation• Build new breakwaters or increase breakwater dimensions• Increase quay height• Secure and weatherproof structures, equipment, cargo
Hinterland transport infrastructure	<ul style="list-style-type: none">• Improve and diversify land connections to port/terminal• Modify rail and road infrastructure to increase resilience
Green/Nature-based solutions	<ul style="list-style-type: none">• Adapted vegetation management along roads and rails• Protect coastline and increase beach nourishment programs
Logistics/supply chain digitalization	<ul style="list-style-type: none">• Adoption of smart logistics systems• Using weather data in supply chain management
Supply chain management	<ul style="list-style-type: none">• Regionalization of supply chains• Adjustments of Just-in-Time systems, incl. storage
Soft/risk management measures	<ul style="list-style-type: none">• Create financial instruments to support adaptation• Enhance emergency evacuation plans• Improve decision support tools and information





6. Pathways





7. What's next?

- As a next step, we will carry out the **multi-criteria assessment** of the pathways
- This includes a **qualitative economic evaluation** of the pathways
- Results will be collected in order to develop an **dynamic adaptive plan**, including:
 - Contingency planning
 - Monitoring plan



Photo: Reporter Logistics





8. Inputs

Topics for discussion:

- Do the bundles of measures accurately capture the multiple dimensions of European supply chains and potential adaptation approaches?
- Are the pathways easy to understand and do they make sense when considering timing, cost, and sequencing of adaptation?
- What is an acceptable damage level for supply chain networks, particularly compared with today's level of protection?





COACCCH

CO-DESIGNING THE ASSESSMENT OF CLIMATE CHANGE COSTS