



Background paper: Addressing climate change in European supply chains

The COACCH project is analysing climate change impacts and adaptation activities in **manufacturing industries, supply chains and intermodal transport hubs**. The workshop is split across four sessions addressing different aspects tied to European supply chains. This paper provides background for the presentations as well as some questions for reflection.

Climate change adaptation to transboundary climate risks: needs, options and locations (Birgit Bednar-Friedl, University of Graz)

While many industrial sectors are highly aware of risks posed by climate policy such as the EU ETS, the topic of climate change impacts on industry is a relatively new one. The goal of this talk is to provide an overview of the current state of knowledge on adaptation to these risks, with a particular focus on so-called transboundary climate risks – risks that are transmitted between countries via supply chains and trade networks. The talk starts with a short overview on how climate change impacts differ by world region and how European industries are connected to these regions via trade linkages. Based on a systematic literature review of both academic and grey literature (around 100 articles/reports in total), we synthesize which climate hazards (flooding, temperature increase, precipitation changes etc.) are most prevalent and how industries are affected by them in their operations. The central part of the presentation looks into adaptation options to these risks. In addition, we discuss where these adaptation options can be taken (in the country where this risk originates; along the supply chain; or at the country of destination) and by which private and public actors. Questions of international governance will also be addressed.

Topics for discussion:

- *How well is the European industry prepared to tackle these transboundary risks of climate change, also in comparison to other countries?*

Current and future exposure of European industries to supply chain shocks by natural disasters (Stefan Borsky, University of Graz)

Every year numerous natural disasters happen worldwide, which often result in large societal and economic losses. Besides direct macroeconomic impacts, countries can also be affected by large natural disasters happening abroad, which are propagated globally over economic network structures. In this presentation, empirical evidence is provided on the current and future impact of natural disaster shocks in the supply chain on a country's export activity. Therefore, we combine sectoral input-output linkages based on the production network of 172 countries and 12 sectors from 1990 to 2015 and information on extreme weather events to determine the impact of supply chain disruptions on a sector's export performance. Our results indicate that a one percent increase in our supply chain shock measure reduces a sector's export value by around 0.3 percent.

We then discuss how the supplier network's specific structural characteristics, i.e., the number of input suppliers and supplier market concentration, may serve as a layer of protection as their redundancy smooths out short-term negative supply chain shocks for the importer. Finally, we turn to the impact of supply chain shocks on a sector's export performance, taking future exposure to natural disasters due to climate change into account. We show that the effect of climate change is heterogeneous between the countries and depends on the extent of a sector's global production network and the strength of an increase in natural disasters in that region.

Topics for discussion:

- *How do you see the increasing internalization of input sourcing regarding the supply chain risk of (European) industries?*

Climate impacts of river floods on road transport infrastructure (Kees van Ginkel, Deltares)

This presentation gives an overview of novel rapid assessment tools to assess the vulnerability of European road networks against river flooding. We first introduce a model to calculate direct river flood damage to all road segments in Europe, from a large motorway to any small alley in a city. Novelties of this approach are a set of new damage curves to relate flood depth to road damage, and asset-specific handling of all road segments in OpenStreetMap on high spatial resolution. This approach bridges the gap between continental-scale and local-scale risk assessments for roads. We show how the assessment is done at the continental scale, while still providing perspective of action for local road operators.

We then discuss model approaches to estimate non-physical, more indirect damage, such as travel time losses, reduced accessibility of certain regions and industries, and the loss of network performance. We mutually compare the resilience of the networks of European countries, and then zoom further in to Austria, where we complemented our analysis using a national transport model. Another step deeper we illustrate how we studied the vulnerability of the supply chain of one particular car and truck manufacturer.

Finally, we give an example of a recent project where these approaches were combined to study the road network of the Netherlands. This project assessed flood depths, infrastructural damage and travel time losses at even higher resolution (up to 1m).

Topics for discussion:

- *The European road network is already rather resilient, which challenges still keep you awake at night?*
- *Which tools are most applicable for decision makers on different spatial levels (e.g. international investment banks, national road operator, supply chains of a particular sector)*

Climate adaptation pathways of intermodal transport hubs (John Tarpey, Ecologic Institute)

To examine adaptation planning for European supply chains, we have employed an “Adaptation Pathways” approach to explore climate adaptation impacts and responses at seaports and their associated supply chain networks. Specifically, the method identifies and sequences different adaptation measures into a set of pathways representing different possible routes to achieve climate resilience. As a case study area, we used the North Sea Region, which is the most important logistical hub in the EU, and faces a range of climate impacts including sea-level rise, higher storm surges, increased precipitations and flooding, and heatwaves.

Through a detailed literature review, we collected adaptation measures for seaports and the associated hinterland transport networks and supply chains. In total, 26 measures were identified and grouped according to their orientation. Six bundles of measures were established: those targeting port infrastructure, the hinterland transport infrastructure, green or nature-based solutions, supply chain management measures, logistics/supply chain digitalization, and “soft” and risk management measures. Subsequently, these bundles were arranged into a set of adaptation pathways, with different measures implemented in the short (2020-2050), medium (2050-2080), and long term (2080 and later). In the upcoming workshop, we will present the pathways, discuss how they were developed, and gather feedback and inputs. This will help us to develop a dynamic adaptive plan going into further detail about the sequencing and timing of the measures, contingency planning, and monitoring.

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?*