European Commission

JRC PESETA III Science for Policy Summary Series

CLIMATE CHANGE IMPACTS ON AIRPORTS, SEAPORTS AND INLAND WATERWAYS

Transport infrastructures and operations are designed to be resilient to some extreme weather events. However, climate change will increase the frequency and magnitude of extreme events. This poses a threat to the transportation sector: by the end of the century, under a high warming scenario, 196 airports and 852 seaports across Europe could face the risk of inundation due to higher sea levels and extreme weather events. On the other hand, transportation along the rivers Rhine and Danube could face less drought-related disruptions relative to nowadays. The projected impacts highlight the importance of climate change mitigation and adaptation to reduce the impacts on airports and seaports.

RISK TO AIRPORTS FROM COASTAL FLOODING

1,187 airports currently lie within the coastal zone in Europe, placing them at risk from higher sea levels. Airports are generally designed to be resilient to coastal floods up to a water depth of 1m.

However, coastal floods over 1m could adversely impact airport operations. 42 airports are projected to be at risk from coastal flooding that is over 1m and up to 3m, by the end of the century due to increases in sea level and extreme weather events under a high warming scenario (Figure 1). An additional 8 airports are projected to be at risk of even larger coastal floods that exceed 3m. Countries by the North Sea have the greatest number of airports at risk of coastal flooding that exceeds 1m of inundation, including:

- UK (19)
- Norway (5)
- Germany (5).

RISK TO AIRPORTS FROM RIVER FLOODING

Inland airport operations, whilst largely being free from the direct effects of coastal flooding, are at risk from river flooding. 47 airports across Europe are already currently at risk of inundation levels of between 1-3m from the kind of extreme river floods that are statistically expected to occur once every 100 years (known as a "1 in 100 year flood"). An additional 27 airports are currently at risk from over 3m of inundation. Climate change poses a significant threat because extreme floods of this level are projected to occur more frequently across Europe by the end of the century under high emissions.

RISK TO SEAPORTS FROM COASTAL FLOODING

In common with airports, seaports are also generally resilient to coastal floods less than 1m.

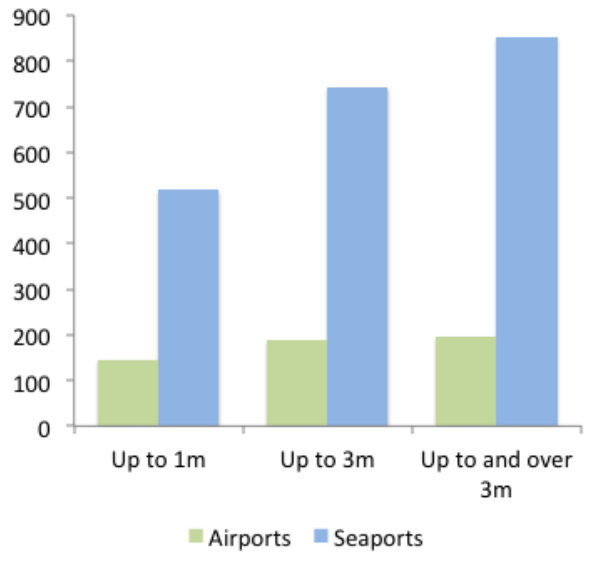
However, 225 seaports are at risk from coastal flooding of between 1-3m by the end of the century under the high warming scenario (Figure 1). An additional 109 seaports are at risk from coastal flooding that exceeds 3m. Countries by the North Sea have the greatest number of seaports at risk of coastal flooding that exceeds 1m, including:

- UK (85)
- Denmark (46)
- Norway (18)
- Germany (14).

RISK TO SEAPORTS FROM RIVER FLOODING

42 seaports are currently at risk of inundation levels of between 1-3m from a 1 in 100 year flood. An additional 42 are at risk from inundation of over 3m.

Figure 1. Number of airports and seaports respectively at risk by the end of the century to different levels of coastal flood, under a high warming scenario.



RISK TO INLAND WATERWAYS

River floods tend to have less severe impacts on transportation than droughts because floods are relatively shorter events. Droughts can severely disrupt inland navigation services by reducing water levels to the point where navigation is impossible, or to a point where water vessels have to carry a reduced load.

Under the high warming scenario, by the end of the century, low flow events become less frequent at the points considered on the Danube. Fewer low flow events are also projected for Kaub on the Rhine. In total, the Rhine and Danube inland waterway networks are projected to operate with fewer disruptions from low water levels by the end of the century under the high warming scenario, at least at three out of the four key points considered.

Fewer low flow events due to climate change translate into potential economic savings in terms of transportation costs, when compared to nowadays, because navigation is possible more often and water vessels are not required to reduce their loads, or interrupt their operation, as frequently (Figure 2). By the end of the century, under the high warming scenario, marginal average annual losses of €5 million are estimated for Ruhrort on Rhine, while the average annual savings at Kaub are €45 million. Freight activity is significantly lower on the Danube and the savings here are at around €5 and €7 million for Hofkirchen and Wildungsmauer, respectively.

ADAPTATION

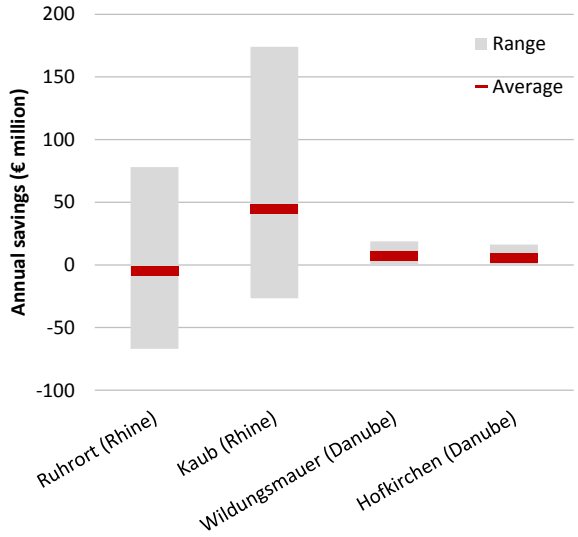
Adaptation strategies should be incorporated in the design or upgrade of coastal transport infrastructure.

Adaptation strategies for airports and seaports may include protection of infrastructure with dykes and levees or elevation of critical infrastructure.

For inland waterways adaptation measures may include:

- improving forecasts of water levels and discharge;
- improving vessel carrying loads, such as through the development of lightweight structures, small vessels and vessels with flat hulls; and
- improving logistics and governance of inland waterways, such as by creating strategic alliances between inland waterway authorities and other modes of transport to improve the seamlessness of the supply chain during low flow days.

Figure 2. Average annual savings (when costs are negative) due to fewer low flow river events, under a high warming scenario at end of the century (range is due to using climate projections from different climate models).



APPROACH

PESETA III investigated the impact of coastal flooding under a high warming scenario on airports and seaports across all of Europe. The projections of sea level were obtained from the same model used to assess coastal flood risk in PESETA III.

The current exposure of airports and seaports to different river flood inundation levels associated with flood events of different severity were estimated. The river inundation levels were obtained from the same model used to assess river flood impacts in PESETA III.

The impact of changes in river flows under a high warming scenario on inland waterways was assessed for four critical points along the Rhine and Danube only, because they are two of Europe's most important inland waterways: Hofkirchen (Danube), Wildungsmauer (Danube), Ruhrort (Rhine) and Kaub (Rhine). For inland waterways, only the impact of drought was estimated, by associating changes in river flows with water levels, in combination with transportation activity data, vessel carrying load restrictions and transportation costs. The projections of drought were obtained from the same model used to assess river flood risk, drought, and water resources in PESETA III.

All impacts were estimated assuming no adaptation strategies are introduced in the future.

Read more
PESETA III Task 6: Transport. Available on our website https://ec.europa.eu/jrc/en/peseta