COASTAL FLOOD RISK TO EUROPEAN CRITICAL INFRASTRUCTURE

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INTRODUCTION

More intense and frequent extreme sea level (ESL) events are projected with high confidence for most of Europe in the IPCC's latest AR6 (Fox-Kemper, 2021, Ranasinghe et al., 2021). Flooding as a result of ESL events will impact the dense transport infrastructure that is associated with the high degree of urbanization and economic development in European coastal areas. Therefore, high-resolution risk information under present and future climate conditions is essential to inform sustainable risk-based designs and to avoid predictable losses. An object-based, quantitative ESL-driven flood risk assessment for Europe's coastal transport infrastructure has not been performed to date.

METHOD

A set of coastal flood maps for the baseline period (2010) and for the future (2030 and 2050) under RCP 8.5 climate conditions were integrated as hazard data. These maps were produced using the process-based LISFLOOD ACC model (Neal, et al., 2011), forced with median ESLs reported by Vousdoukas et al., (2018). Exposure data was prepared by intersecting the coastal flood maps with road and rail segments extracted from publicly available high-resolution Open Street Map (OpenStreetMap Contributors 2021). For vulnerability data, damage functions and maximum damage values for each asset type were adopted from a review of road and rail projects and empirical evidence of real flood events mostly within Europe (Attinà, 2018, Bubeck, et al., 2019, Van Ginkel, et al., 2021). The damage was then calculated at the individual road and rail segment level. The risk is computed as the Expected Annual Exposure in kilometers and Expected Annual Damage in Euros.

RESULTS

Results show that 1205 kilometers of critical transport networks are already exposed annually to coastal flood events in Europe. This amount is projected to increase by 19% in 2030 and by 40% in 2050 under RCP 8.5 scenarios. The risk in expected annual damage is estimated as 346 million Euros for present-day, increasing by 26% in 2030 and by 49% in 2050. The United Kingdom is the highest risk country from both present-day and future climate change-induced extreme sea level events among European countries in terms of absolute expected annual exposure and damage (Figure 1). When the expected annual damage relative to the gross domestic product (GDP) is considered, Norway, Denmark, the United Kingdom, Ireland, and Croatia appear as the top five high-risk countries. The hotspot areas are mainly Northern and North-Western countries of Europe except for the Netherlands and Belgium which have high levels of coastal protection (Figure 1). Of the 27-member states of the European Union, the absolute expected present-day annual damage is 148 million Euros which equates to 0.06% of the current annual transport expenditure in the EU. This share is projected to increase 31% to 0.08% by 2030 and increase 46% to 0.09% by 2050 under RCP 8.5.

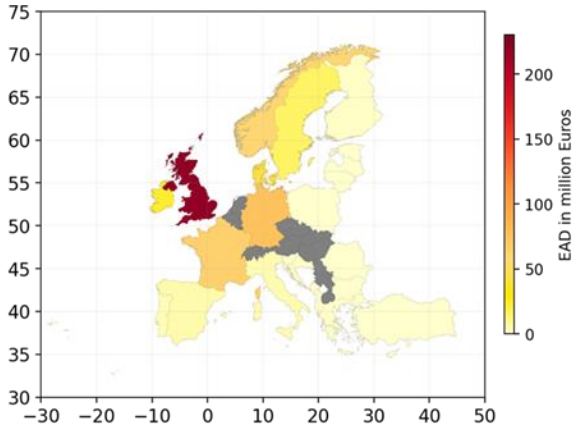

Figure 1 - Spatial distribution of absolute expected annual damage from coastal flooding in 2050 under RCP 8.5

REFERENCES

Attinà, et al. (2018): Assessment of unit costs (standard prices) of rail projects (CAPital EXpenditure), Luxembourg.
Bubeck, Dillenardt, Alfieri, Feyen, Thieken, Kellermann (2019): Global warming to increase flood risk on European railways. Climatic Change 155: 19-36 DOI 10.1007/s10584-019-02434-5.
Fox-Kemper, et al. (2021): Ocean, Cryosphere and Sea Level Change. In Climate Change 2021: The Physical Science Basis: Contribution of WGI to the IPCC AR6. Cambridge University Press, pp. 1211-1362, DOI:10.1017/9781009157896.011.
Neal, et al. (2011): Evaluating a new LISFLOOD FP formulation with data from the summer 2007 floods in Tewkesbury, UK. Journal of Flood Risk Management 4 OpenStreetMap Contributors 2021: Available under the Open Database Licence from: openstreetmap.org.
Ranasinghe, et al. (2021): Climate Change Information for Regional Impact and for Risk Assessment. In Climate Change 2021: The Physical Science Basis. Contribution of WGI to the IPCC AR6. Cambridge University Press, pp. 1767-1926, DOI:10.1017/9781009157896.014.
Van Ginkel, et al. (2021): Flood risk assessment of the European road network. Natural Hazards and Earth System Sciences 21: 1011-1027 DOI 10.5194/nhess-21-1011-202.

Vousdouskas et al. (2018): Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard. Nature Communications 9: 2360 DOI 10.1038/s41467-018-04692-w.