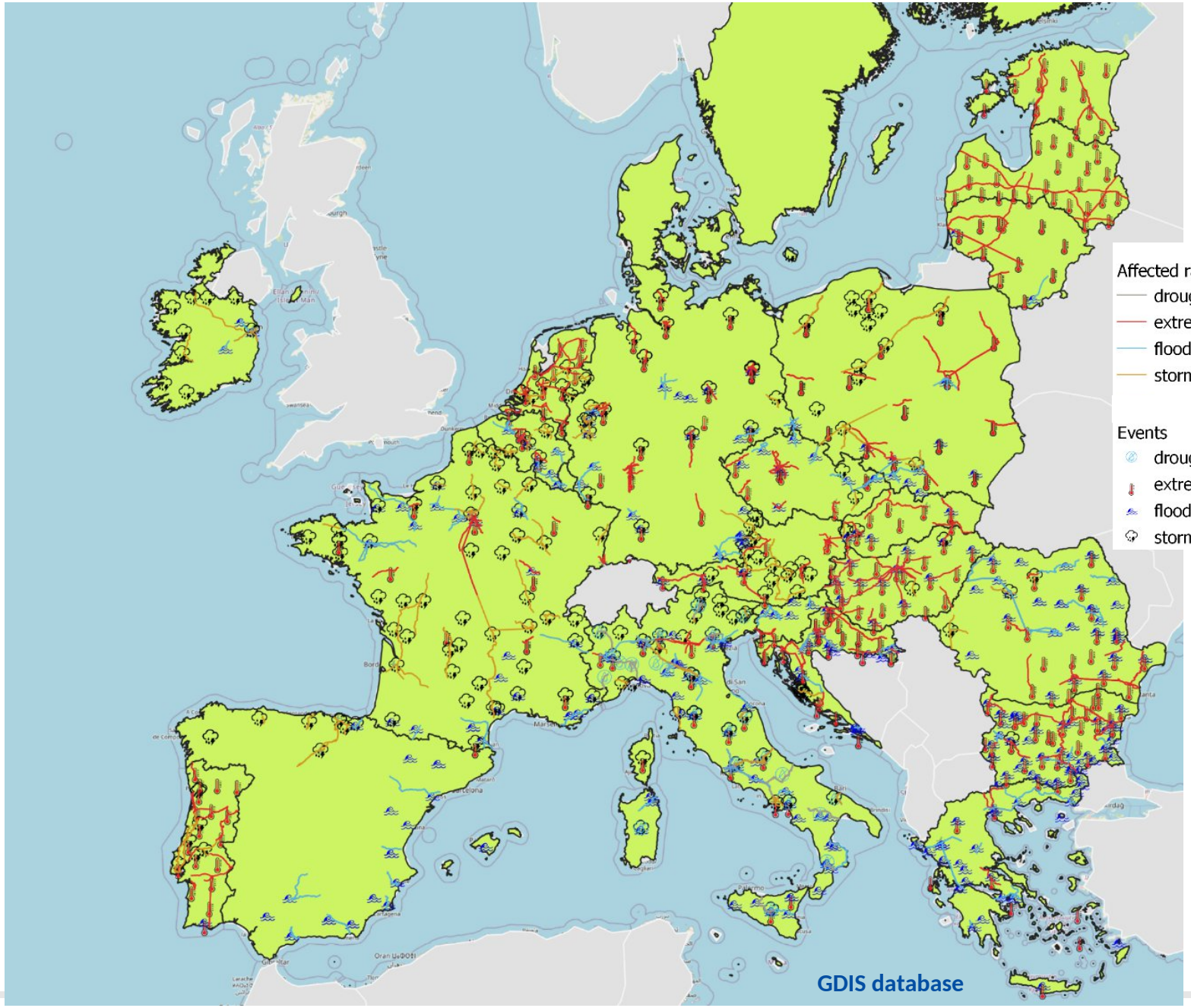
Germany, 15 july 2021
(Source: Sebastian Schmitt)

Is Europe's Transportation Network ready to face Climate Change?

Cristina Deidda and Wim Thiery

European transport infrastructure faced multiple climate extremes between 2010-2018



Infrastructure damages

Physical damages on infrastructures buildings and elements.

Operations

Interruption of operations and services, delays.

Users

Increasing waiting times, replanning routes through alternatives ways, economical refunding.

Health discomforts

Incidents, health discomforts, medical care necessity.


x3-4
2,7 billion Euro damage in 2018
(source: strangesounds.org)

(source: www.railfreight.com)


at least x1000
Palermo and Catania airports closure
(source: Palermo airport authorities)

CLIMATE CHANGE AND EUROPEAN TRANSPORT INFRASTRUCTURE

A REVIEW OF CHALLENGES AHEAD

Authors:
Cristina Deidda & Wim Thiery

Affiliation:
Vrije Universiteit Brussel

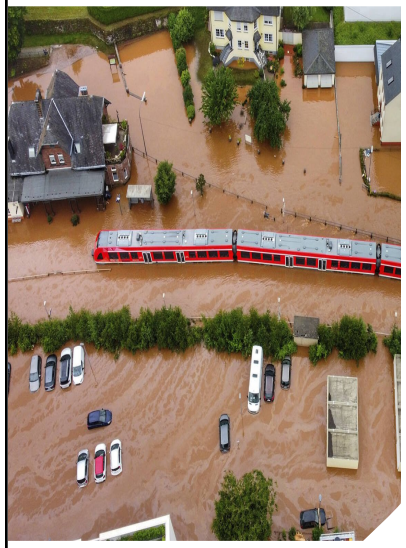
VUB VRIJE UNIVERSITEIT BRUSSEL

POLICY BRIEF

European Commission

M-FIVE TRT VUB ISL

Support study on the climate adaptation & cross-border investment needs to realise the TEN-T network



Authors of the study:

M-Five GmbH Mobility, Futures, Innovation, Economics:

Dr. Wolfgang Schade, Dr. Arpita Asha Khanna, Simon Mader, Marcel Streif, Thomas Abkai

TRT Trasporti e Territorio srl:

Claudia de Stasio, Francesca Fermi, Dorota Bielanska

Vrije Universiteit Brussel:

Dr. Cristina Deidda, Prof. Dr. Wim Thiery

Institute of Shipping Economics & Logistics:

Dr. Sönke Maatsch

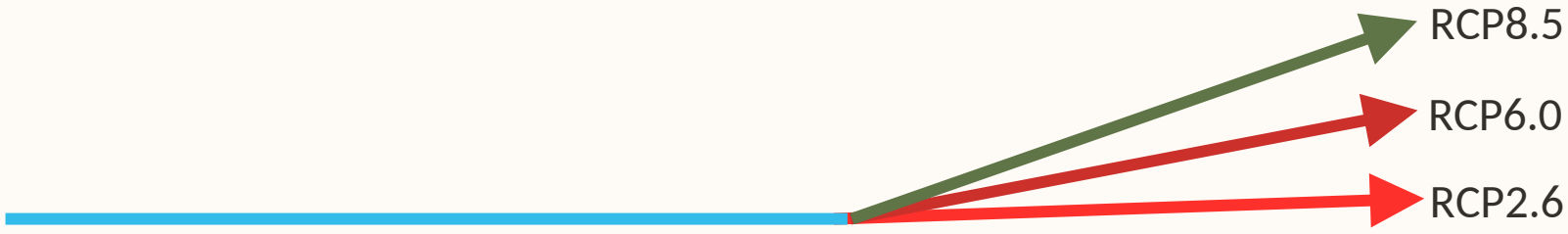
Recommended quotation:

Schade, W., Khanna, A.A., Mader, S., Streif, M., Abkai, T., de Stasio, C., Fermi, F., Bielanska, D., Deidda, C., Thiery, W., Maatsch, S., (2024): *Support study on the climate adaptation & cross-border investment needs to realise the TEN-T network. DRAFT FINAL REPORT.* Report on behalf of the European Commission. Karlsruhe, Milano, Brussels, Bremen

Exposure analysis of TEN-T network

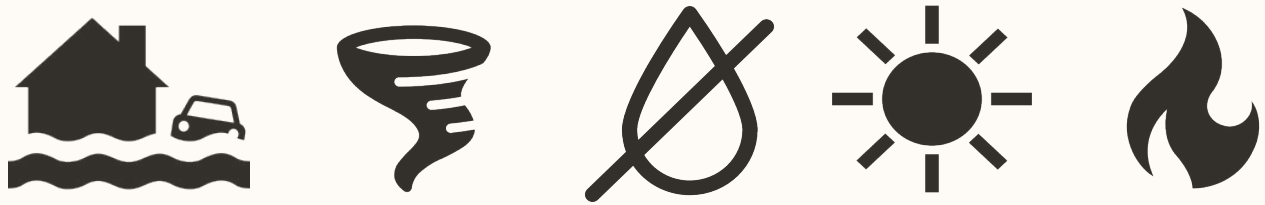
Dataset

ISIMIP Project



Yearly data of five extreme events categories:

River floods, tropical cyclones, wildfires, droughts, and heatwaves



ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

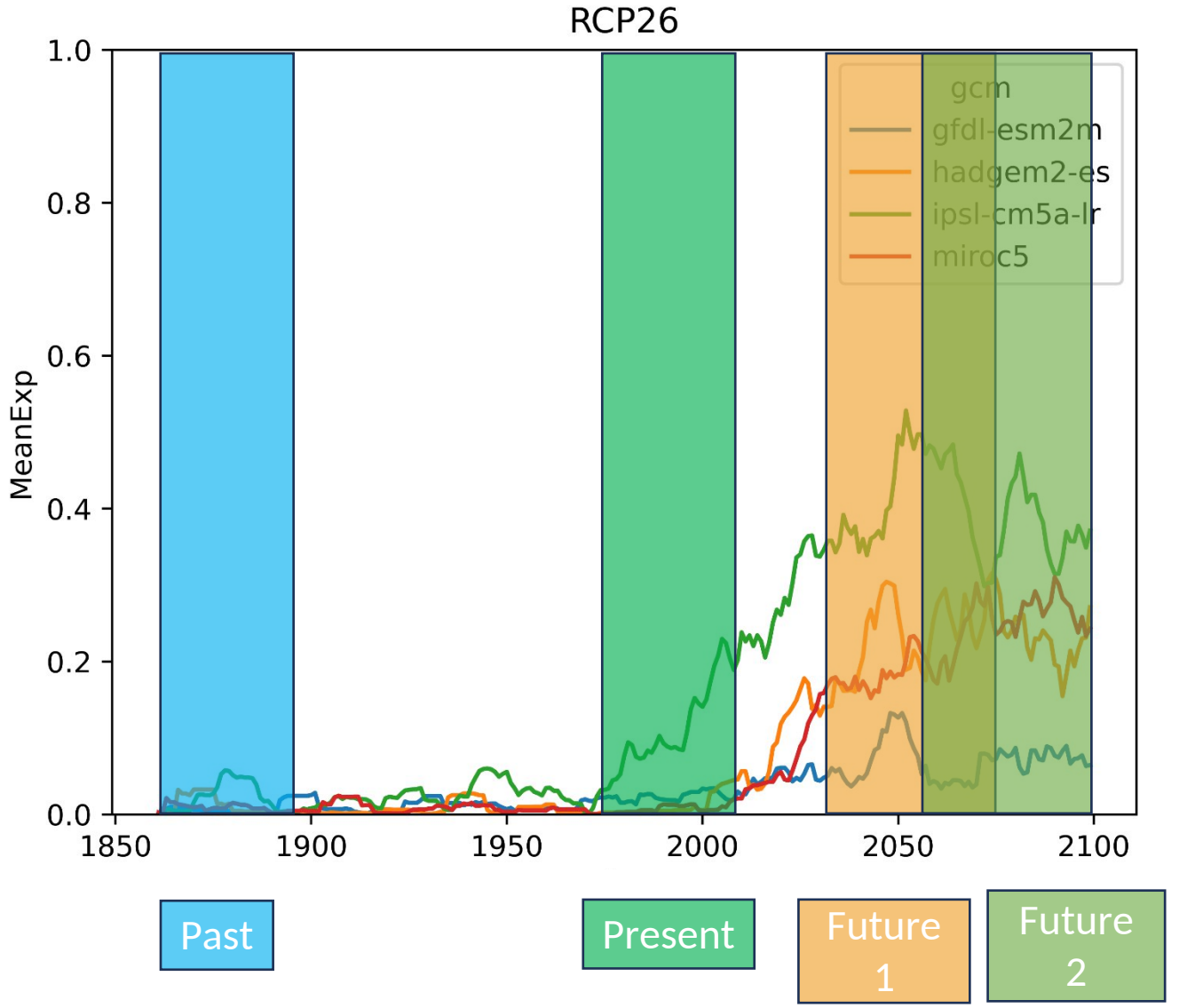
Exposure analysis of TEN-T network

Methods

Exposure multiplication factor

$$EMF_{past} = \frac{N\ event\ future}{Nevent\ past}$$

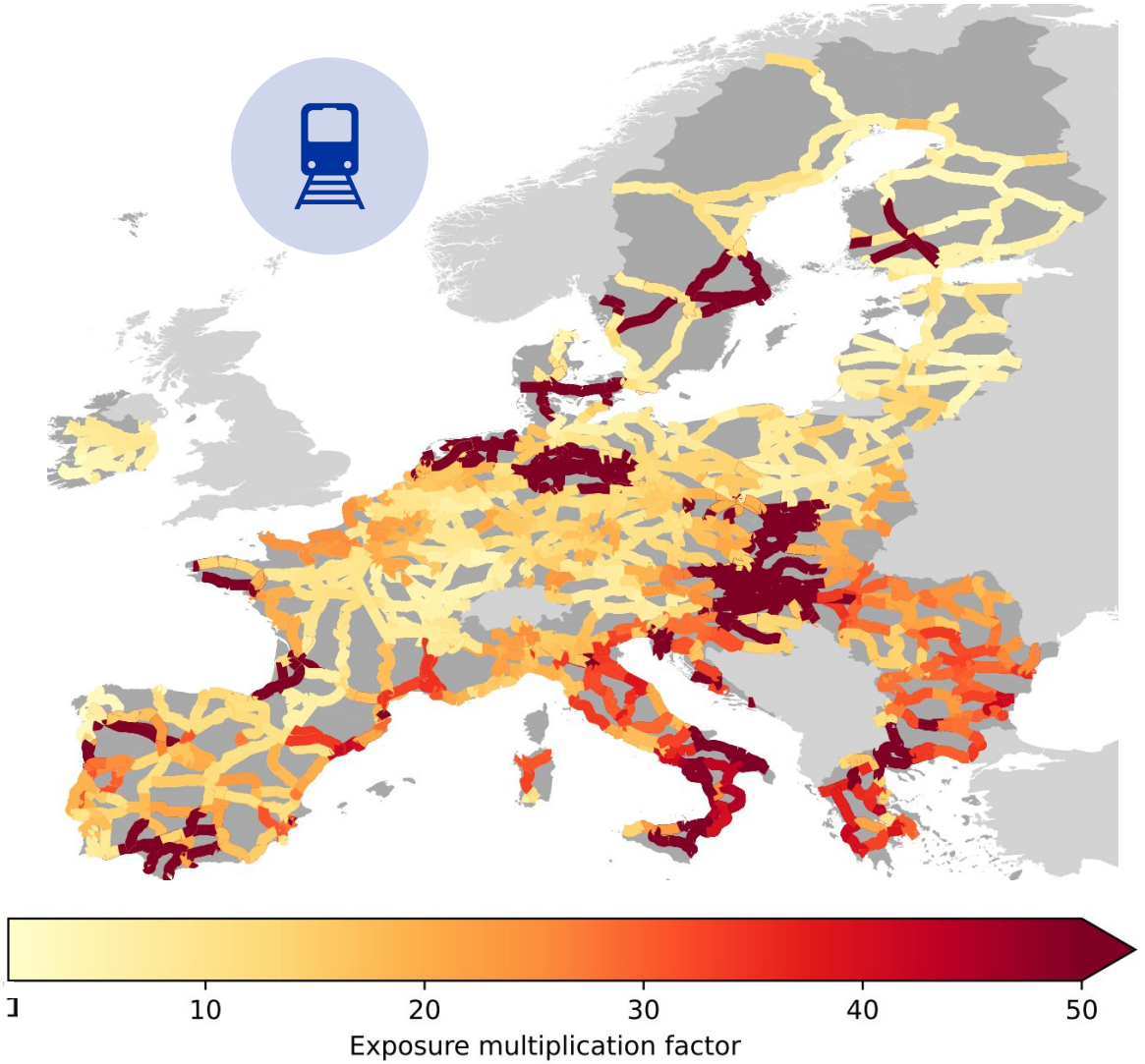
$$EMF_{pres} = \frac{N\ event\ future}{Nevent\ present\ day}$$



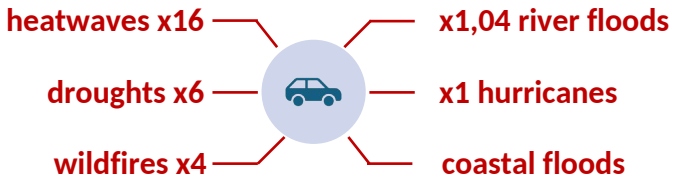
Heatwaves

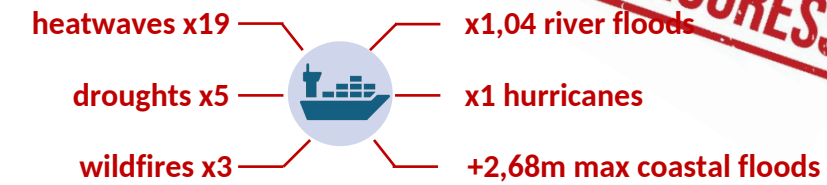
medium-high emission scenario, mid-century

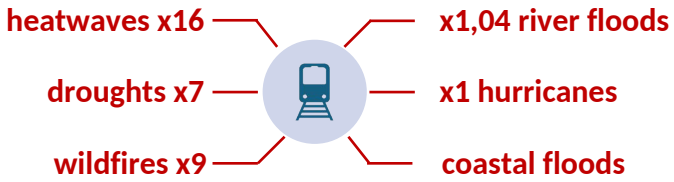
Half of European railways will experience at least x 16 more heatwaves by 2050 compared to today under a medium-high emission scenario

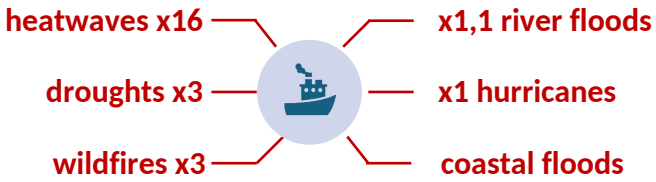


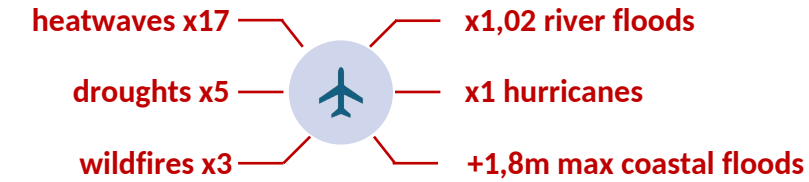
WORK IN PROGRESS







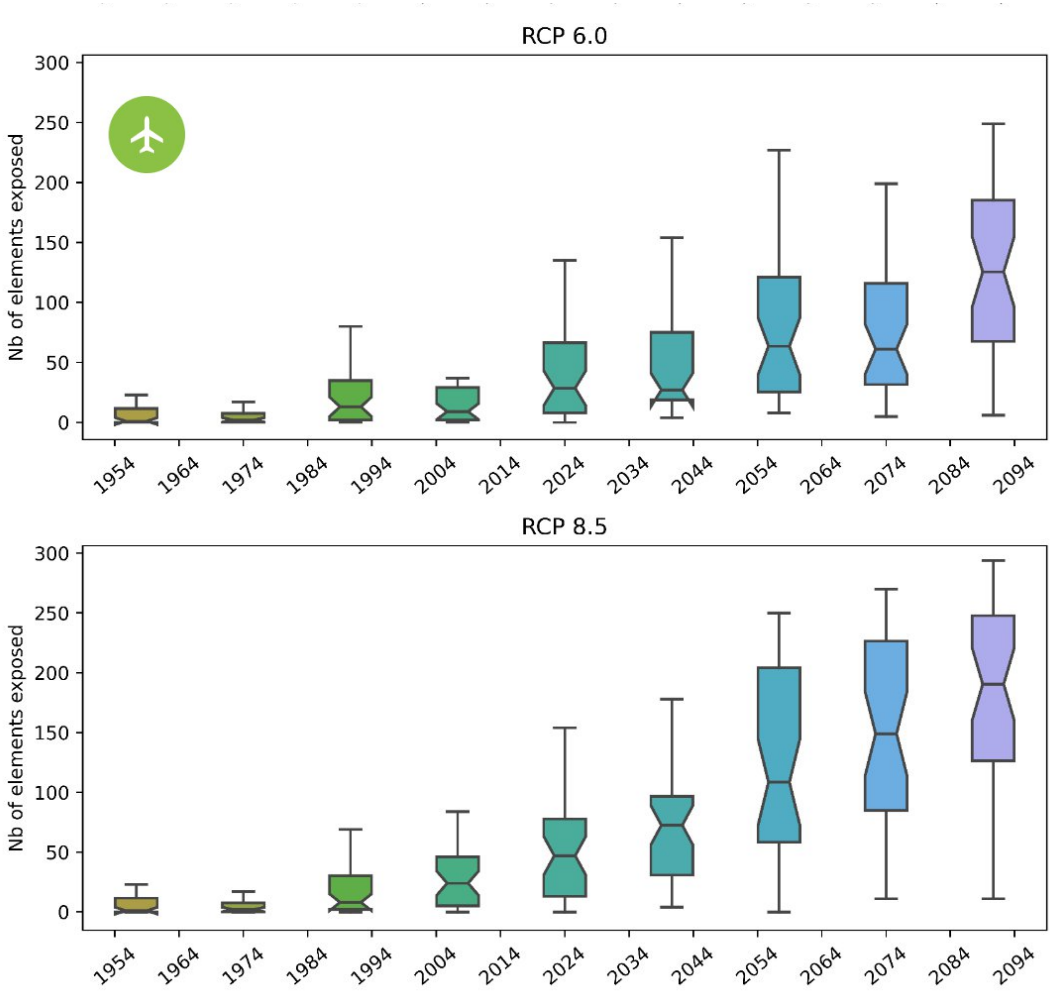




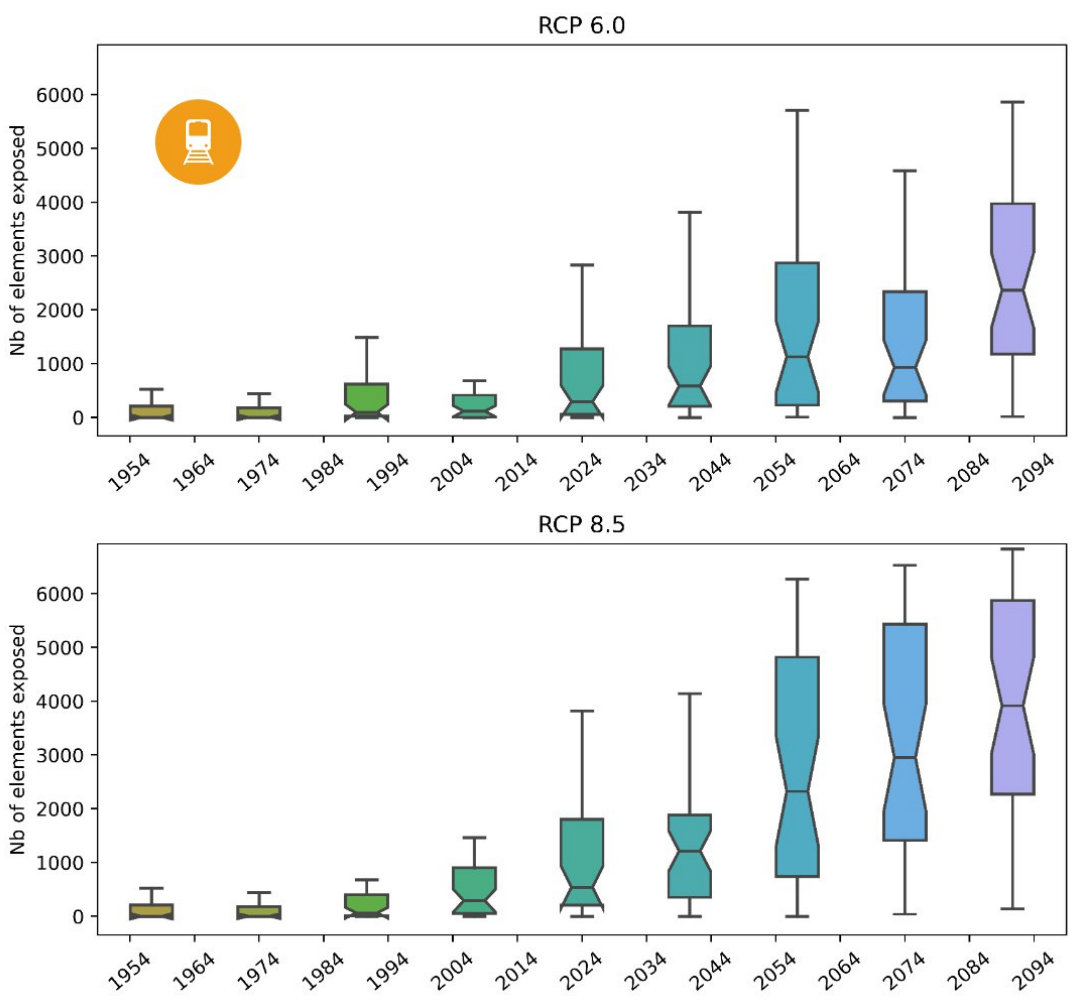
(medium-high emission scenario;
mid-century compared to today)

Heatwaves

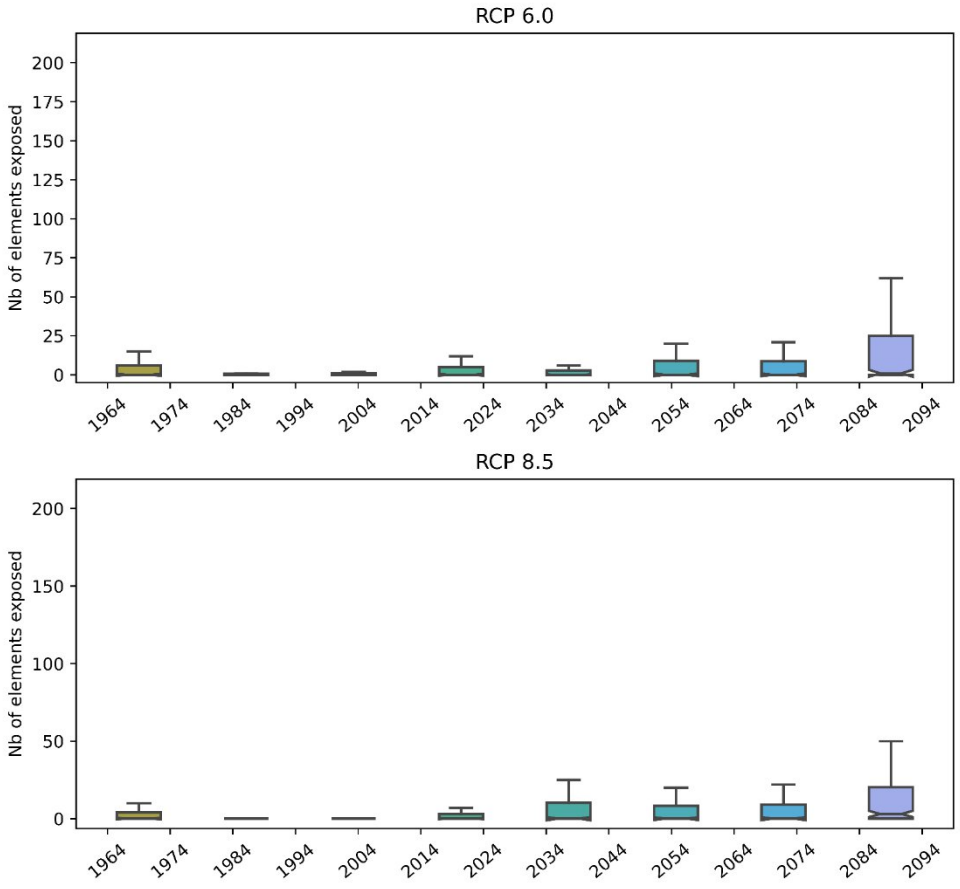
Nb of airports exposed

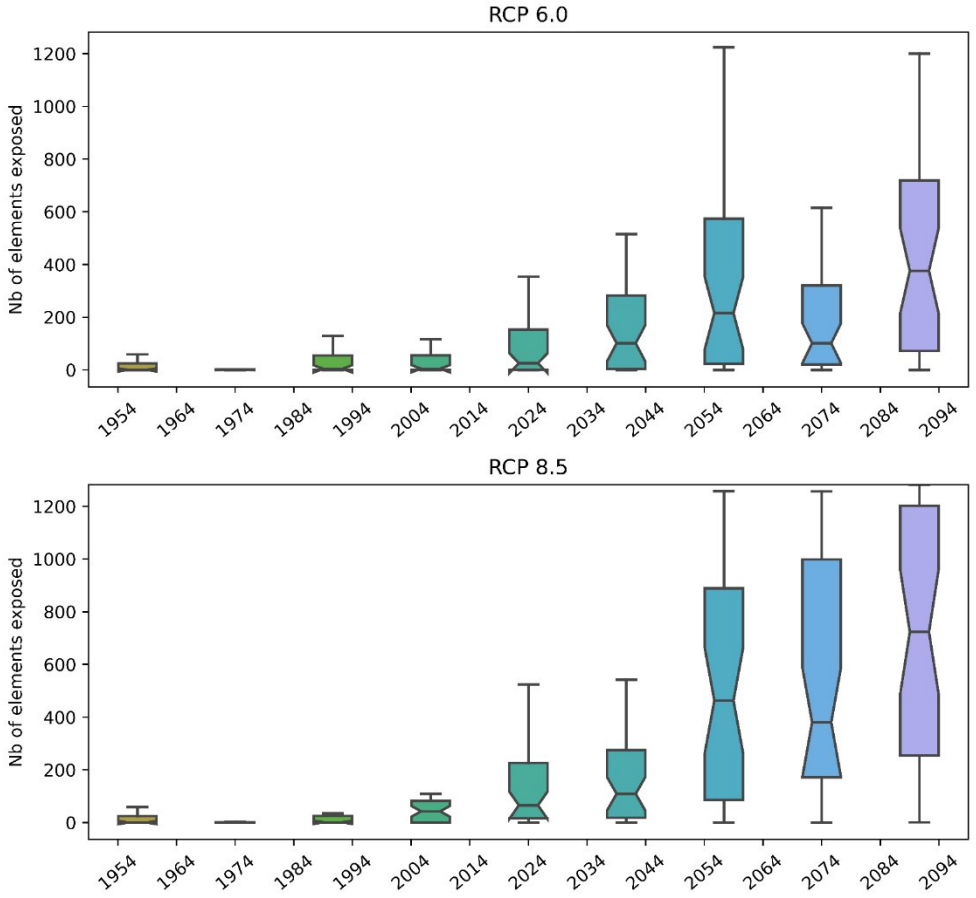


Nb of railways exposed



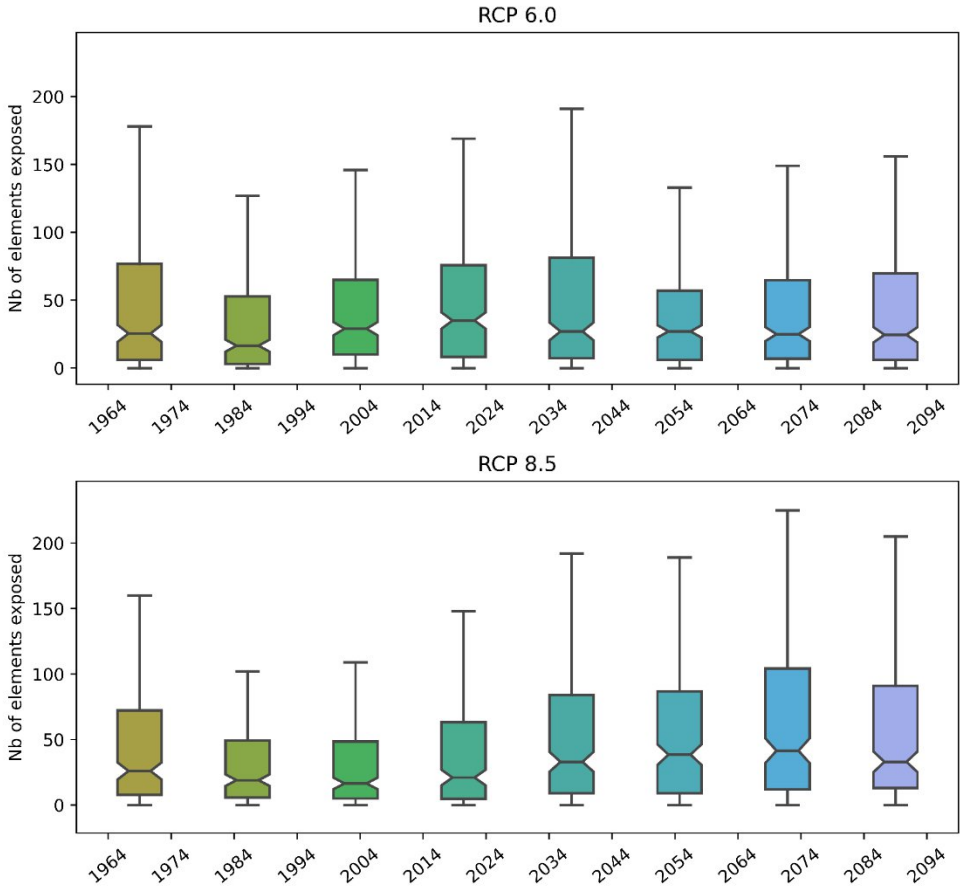
Inland water ways



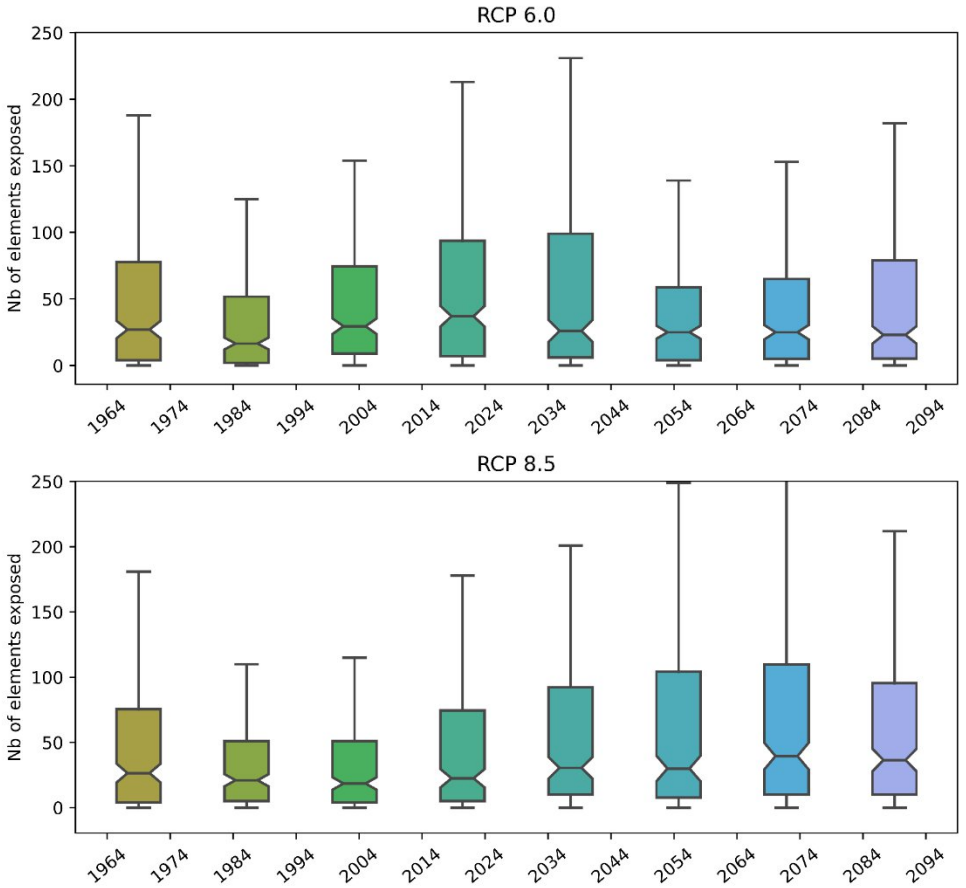


River flood

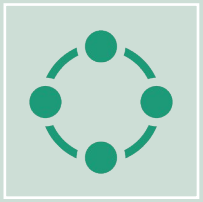
Nb of roads exposed



Nb of railways exposed

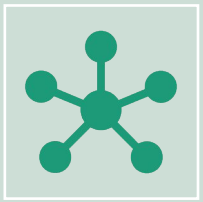


Conclusions



In the last decade, all modes of transportation have been affected by various hazards. **It is important to consider the impact of all these hazards on all modes of transport.**

In the coming years, **there will be an increase in exposure of extreme events to the TEN-T network**, especially to heatwaves (x30), floods (x3), wildfires (x4), droughts (x16), and to a lesser extent, tropical cyclones

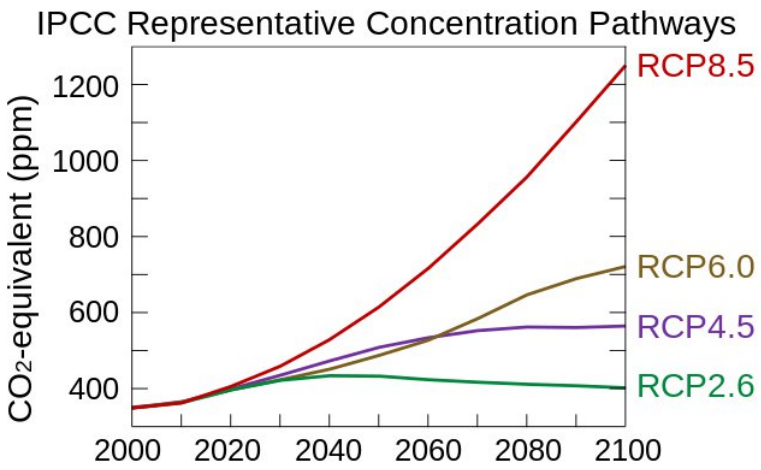


The **TEN-T network should be prepared for the occurrence of multiple hazards simultaneously**. Extreme events will occur more frequently, both sequentially and concurrently.

Thank you for your attention

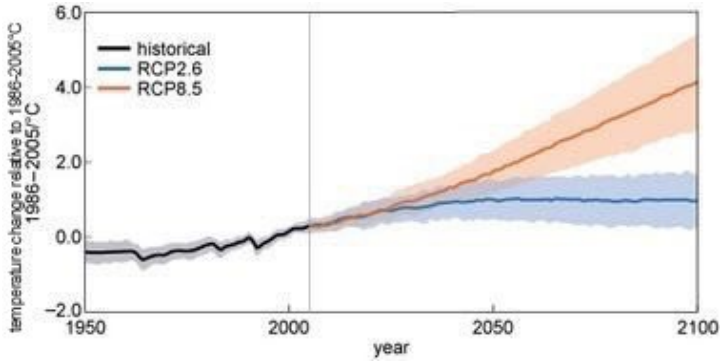
cristina.deidda@vub.be

RCP



- **RCP2.6 (Representative Concentration Pathway 2.6):** RCP2.6 represents a scenario in which aggressive and immediate global efforts are made to reduce greenhouse gas emissions. In this pathway, the concentration of greenhouse gases is limited to 2.6 watts per square meter by the end of the 21st century. **This scenario aims to keep global warming well below 2 degrees Celsius compared to pre-industrial levels, with the aspiration to limit it to 1.5 degrees Celsius.**

- **RCP6 (Representative Concentration Pathway 6):** RCP6 envisions a future with moderate efforts to mitigate climate change. It assumes that global greenhouse gas emissions continue to rise throughout the 21st century, reaching their peak around mid-century and gradually decreasing thereafter. **This pathway projects a global temperature increase of approximately 2.6 to 4.8 degrees Celsius by 2100 compared to pre-industrial levels.**



- **RCP8.5 (Representative Concentration Pathway 8.5):** RCP8.5 represents a scenario where no substantial climate mitigation measures are taken. It assumes a continued increase in greenhouse gas emissions, leading to a high radiative forcing and **a global temperature rise of 4.0 to 6.1 degrees Celsius by the end of the century.** This pathway serves as a **reference for the potential future impacts of unmitigated climate change.**

Extreme events definition

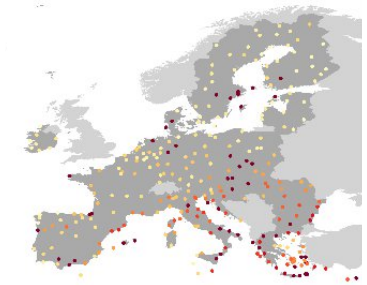
Extreme Event	Definition in (Lange et al., 2020)	Impact Models
River floods	Daily river flow within a pixel greater than 100-year return flow during pre-industrial times	CLM45, H08, JULES-W1, LPJmL, MPI-HM, ORCHIDEE, PCR-GLOBWB, WaterGAP2
Heatwaves	Occurrence in entire pixel when the Heat Wave Magnitude Index daily (HWMId) recorded that year exceeds the 99^{th} percentile of the HWMId during pre-industrial times.	HWMId99 (directly diagnosed from GCMs)
Droughts	Drop of soil water content below the 2.5^{th} percentile of the distribution during pre-industrial times considering periods longer than 6 months	CLM45, H08, JULES-W1, LPJmL, MPI-HM, ORCHIDEE, PCR-GLOBWB, WaterGAP2
Crop failures	Drop of crop yield below the 2.5^{th} percentile of the distribution during pre-industrial times	GEPIC, LPJmL, PEPIC
Wildfires	Total annual burnt area	CARAIB, LPJ-GUESS, LPJmL, ORCHIDEE, VISIT
Tropical cyclones	Exposure to hurricane-induced winds during the year	KE-TG-meanfield

The impact models are described in: CLM45 (Lawrence et al., 2011; Thiery et al., 2017), H08 (Hanasaki et al., 2018), JULES-W1 (Best et al., 2011), LPJmL (Schaphoff et al., 2018a, b), MPI-HM (Hagemann and Gates, 2003; Stacke and Hagemann, 2012), ORCHIDEE (Guimberteau et al., 2018), PCR-GLOBWB (Wada et al., 2014, 2016), WaterGAP2 (Müller Schmied et al., 2014, 2016), HWMId (Russo et al., 2015, 2017; Lange et al., 2020), GEPIC (Folberth et al., 2012), PEPIC (Liu et al., 2016), CARAIB (Dury et al., 2011), LPJ-GUESS (Smith et al., 2014), VISIT (Ito and Oikawa, 2002; Ito and Inatomi, 2012) and KE-TG-meanfield (Emanuel, 2013).

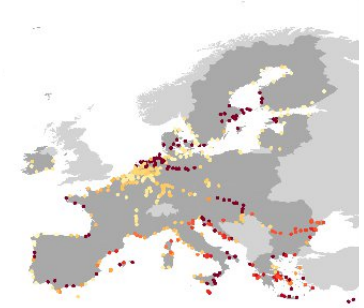
Heatwaves

medium-high emission scenario, end-of-century

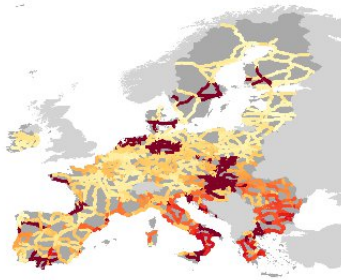
Airports



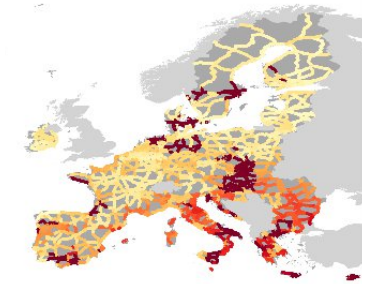
Maritime ports



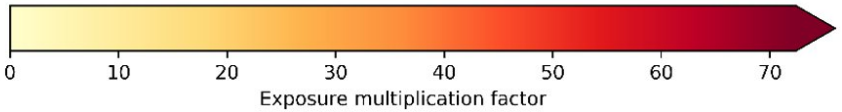
Railways



Roads



IWW

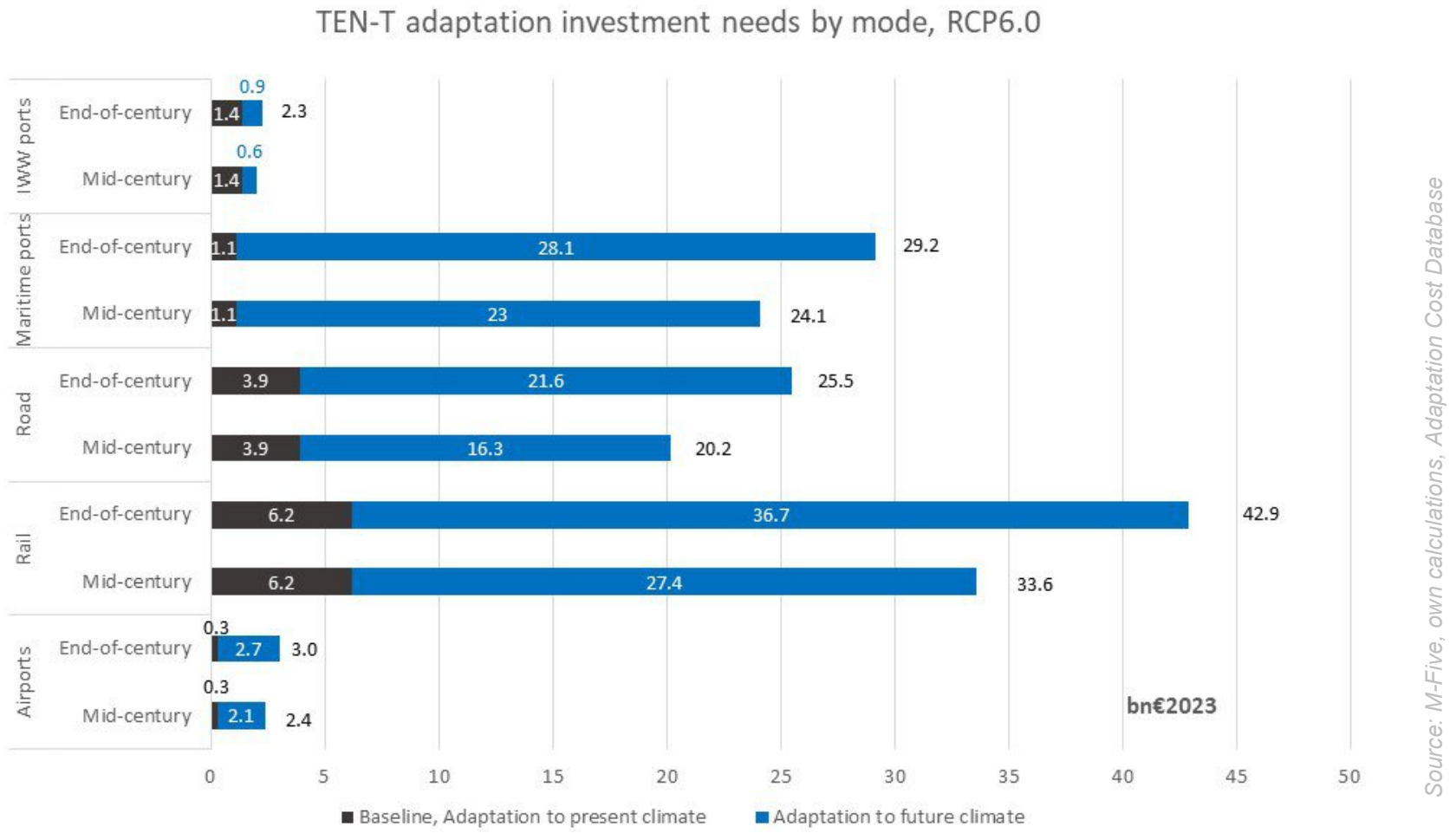


Source: VUB, own analysis, ISIMIP data

Adaptation investment needs at TEN-T by mode

medium-high emission scenario

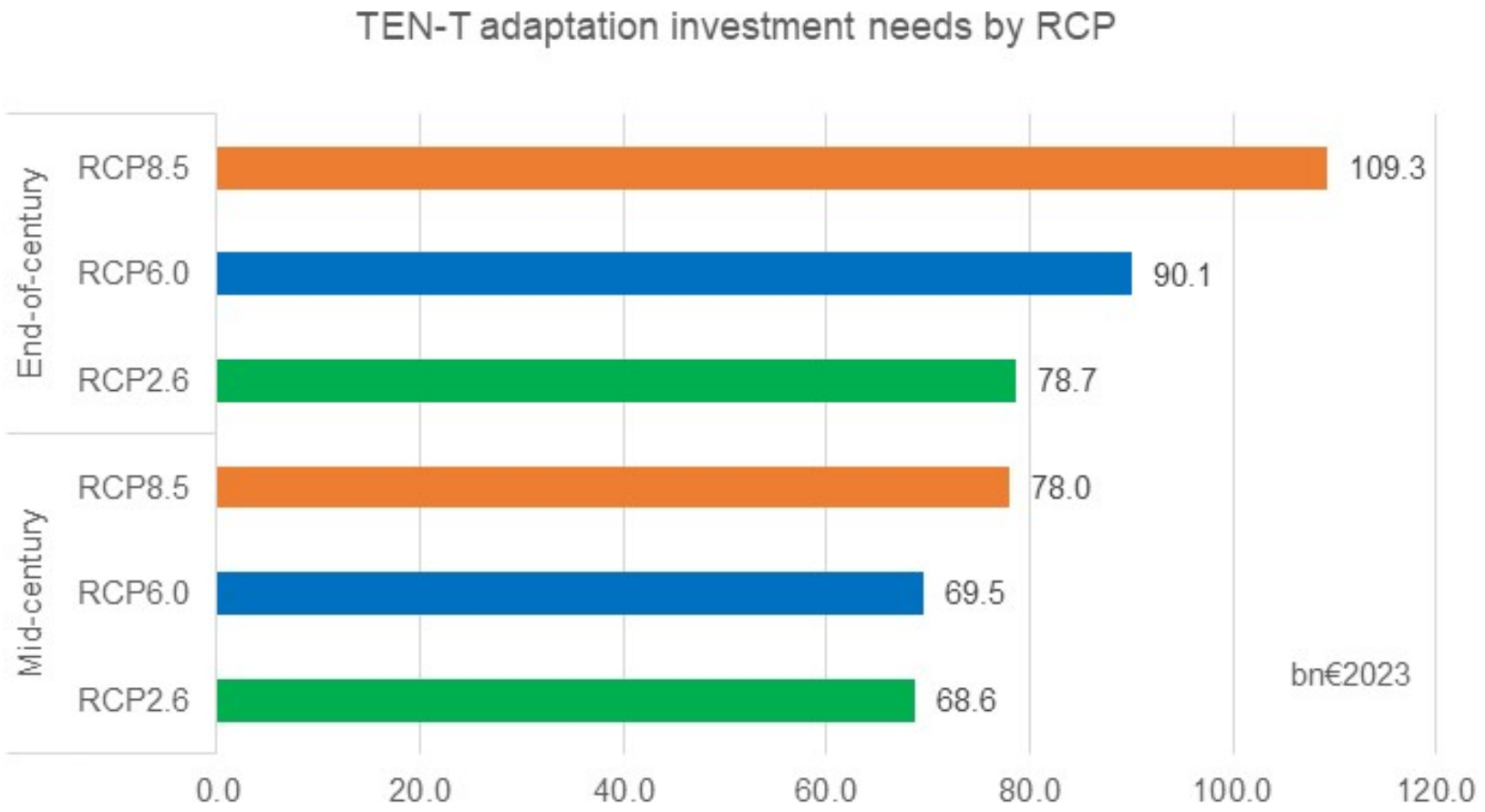
- 70 bn€ to cope with warming until about 2050, only TEN-T
- 90 bn€ to cope with warming until about 2100, only TEN-T
- Emission and warming scenario can be worse
- With global green deal it could require less investment



Source: M-Five, own calculations, Adaptation Cost Database

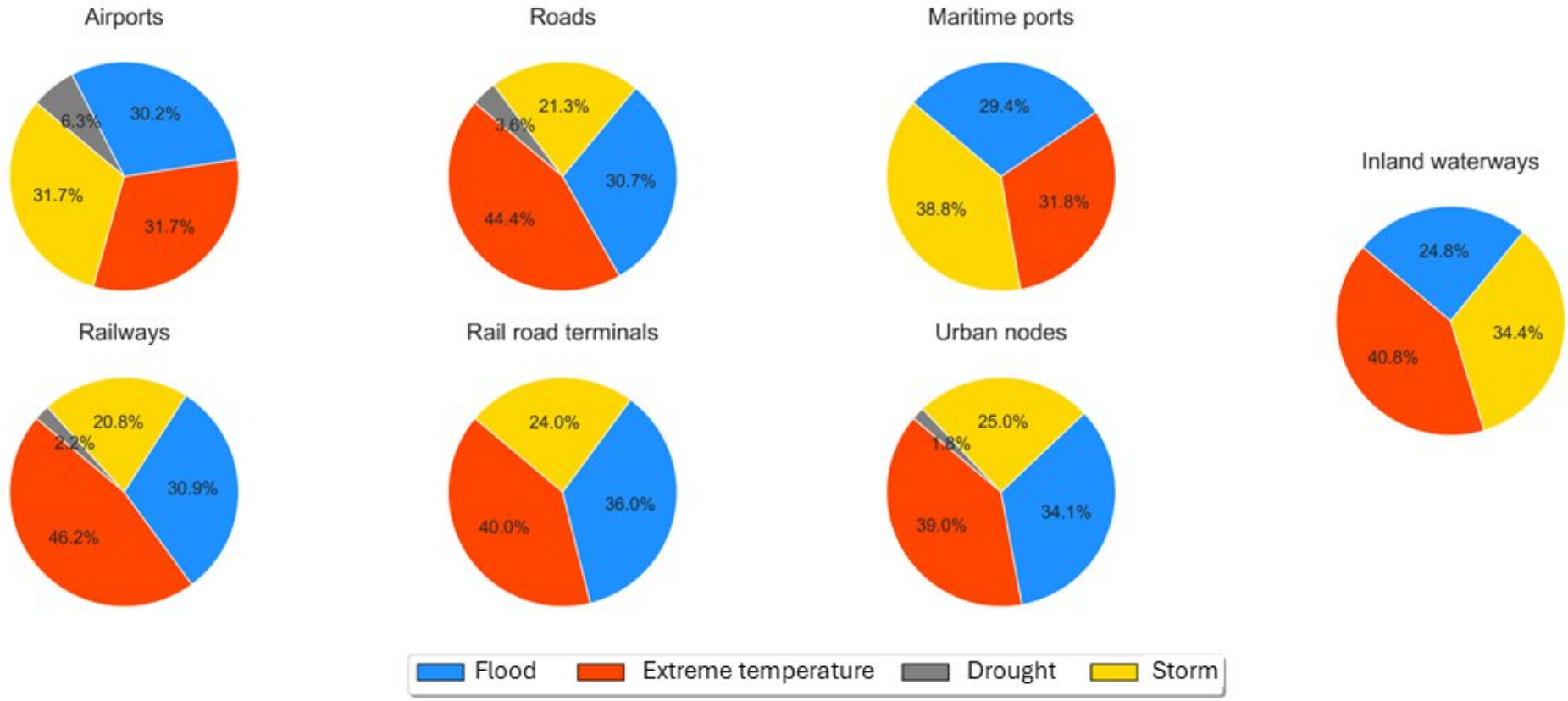
Overall adaptation costs

increase with time and emission scenario



All nodes affected by multiple hazards – **ex-post**

Calling for a multi-hazard approach

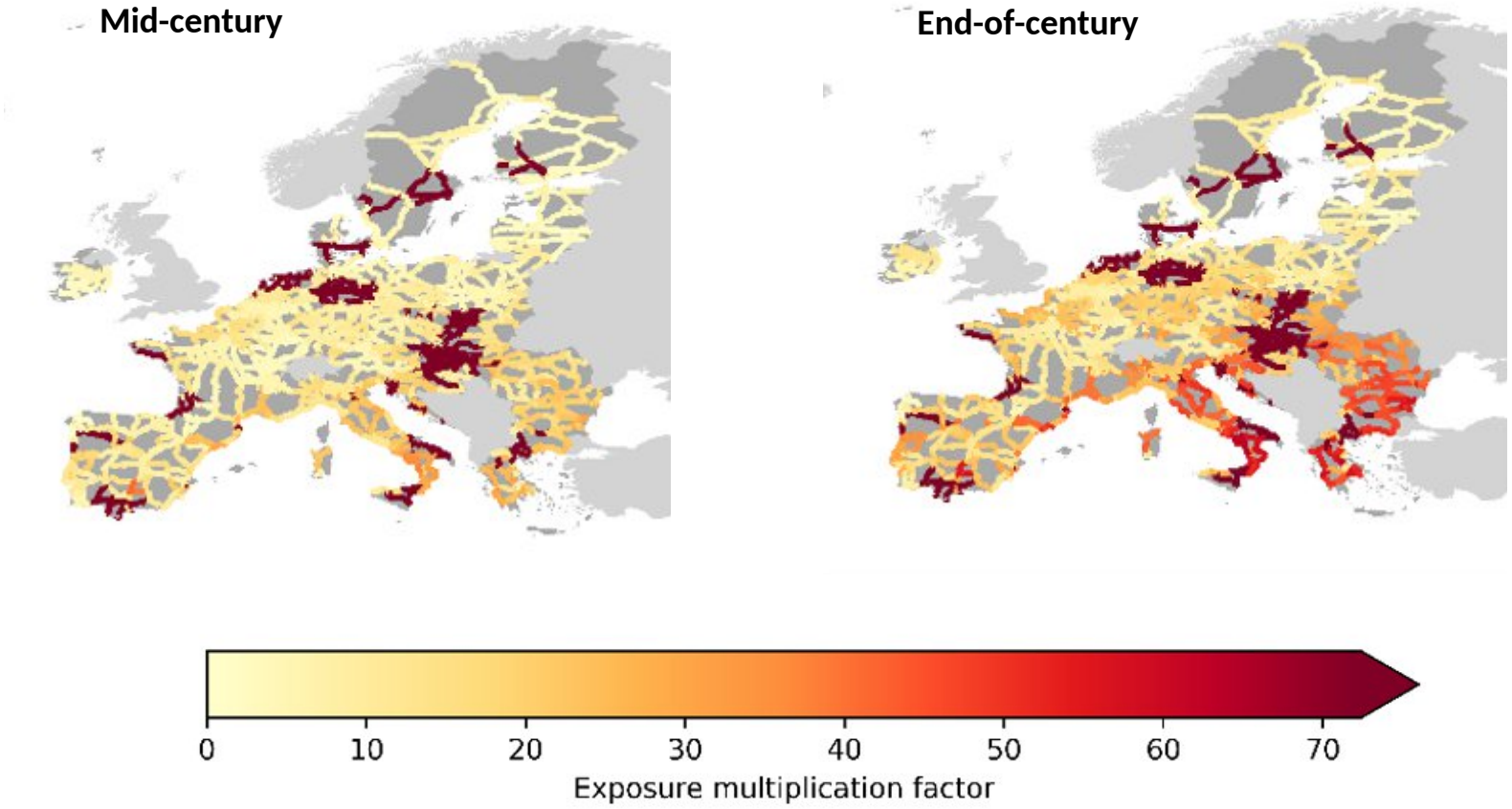


Source: VUB, own calculations, *EC database*

You should also provide
Data sources, if any were
Important.
I think this was an EU database

Heatwaves and railways

medium-high emission scenario



Source: VUB, own calculations, /SIMIP data