Risk of climate change on German waterways

What do we expect?

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Climate impact chains (navigation)
(selected, simplified)

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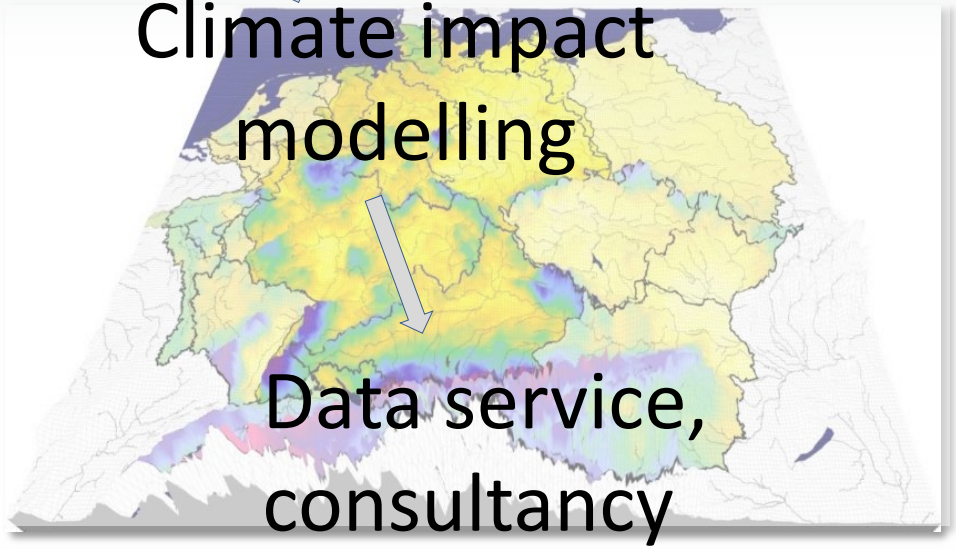
sea level, (river flow)	tidal currents, flow velocity	sediment dynamics	water depth	navigation
air temperature, precipitation,…	high flow, flow velocity	sediment dynamics	water depth	navigation
air temperature, precipitation,…	water level above threshold (HSW)			navigation
air temperature	water temperature	icing		navigation
air temperature, precipitation,…	low flow	water depth		navigation

Model chains and resarch network (of networks)
(selected, simplified)

Climate modelling

Climate impact modelling



Data service, consultancy

application

ECMWF

opernicus
Europe's eyes on Earth

WCRP CMIP3/5/6
World Climate Research Programme

WCRP CORDEX

ENSEMBLES

ReKliEs-De
Regionale Klimaprojektionen Ensemble für Deutschland

ECCONET

KLIWAS
Klima · Wasser · Schifffahrt

CHR KHR

imprex
Learn from today to anticipate tomorrow

SIS SWICCA

BMVI Expertennetzwerk
Wissen Können Handeln

DAS Basisdienst
Klima und Wasser

IKSR CIPR ICBR

Climate Change Service

WSV.de

KLIVO

DEUTSCHES KLIMAVORSORGE-PORTAL

LAWA
Bund/Länder-Arbeitsgemeinschaft Wasser

Europe


Sweden
Russia
Estonia
Latvia
Denmark
Lithuania
United Kingdom
Belarus
Ireland
Netherlands
Poland
Germany
Belgium
Luxembourg
Czechia
Ukraine
Slovakia
Austria
Liechtenstein
Hungary
Moldova
France
Switzerland
Slovenia
Romania
Croatia
Bosnia and Herzegovina
San Marino
Serbia
Monaco
Montenegro
Bulgaria
Andorra
Italy
Kosovo*
North Macedonia
Georgia
Albania
Armenia
Spain
Portugal
Azerbaijan
Turkey
Greece
Malta
Cyprus
Syria
Lebanon
Iran
Tunisia
Iraq
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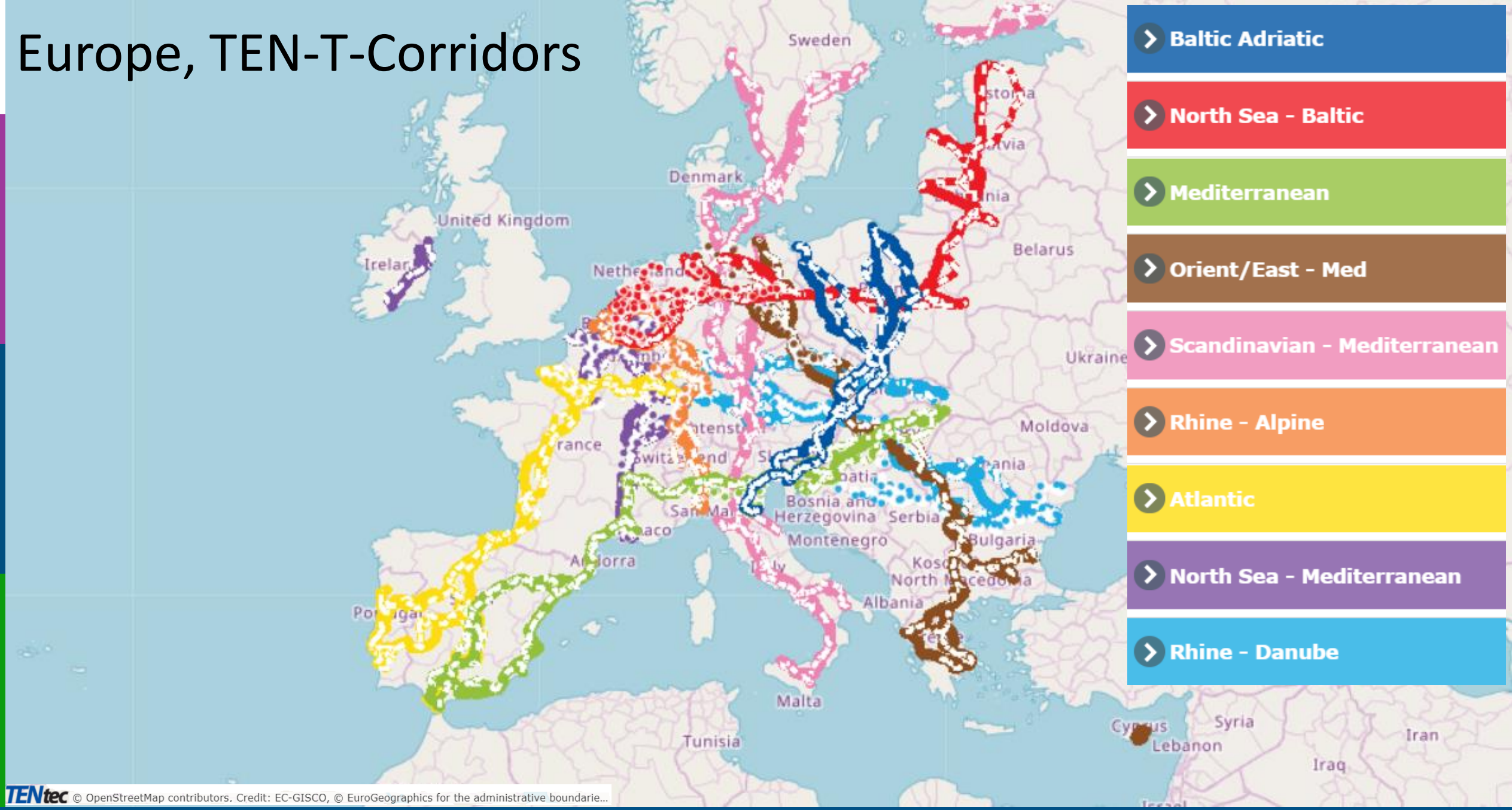
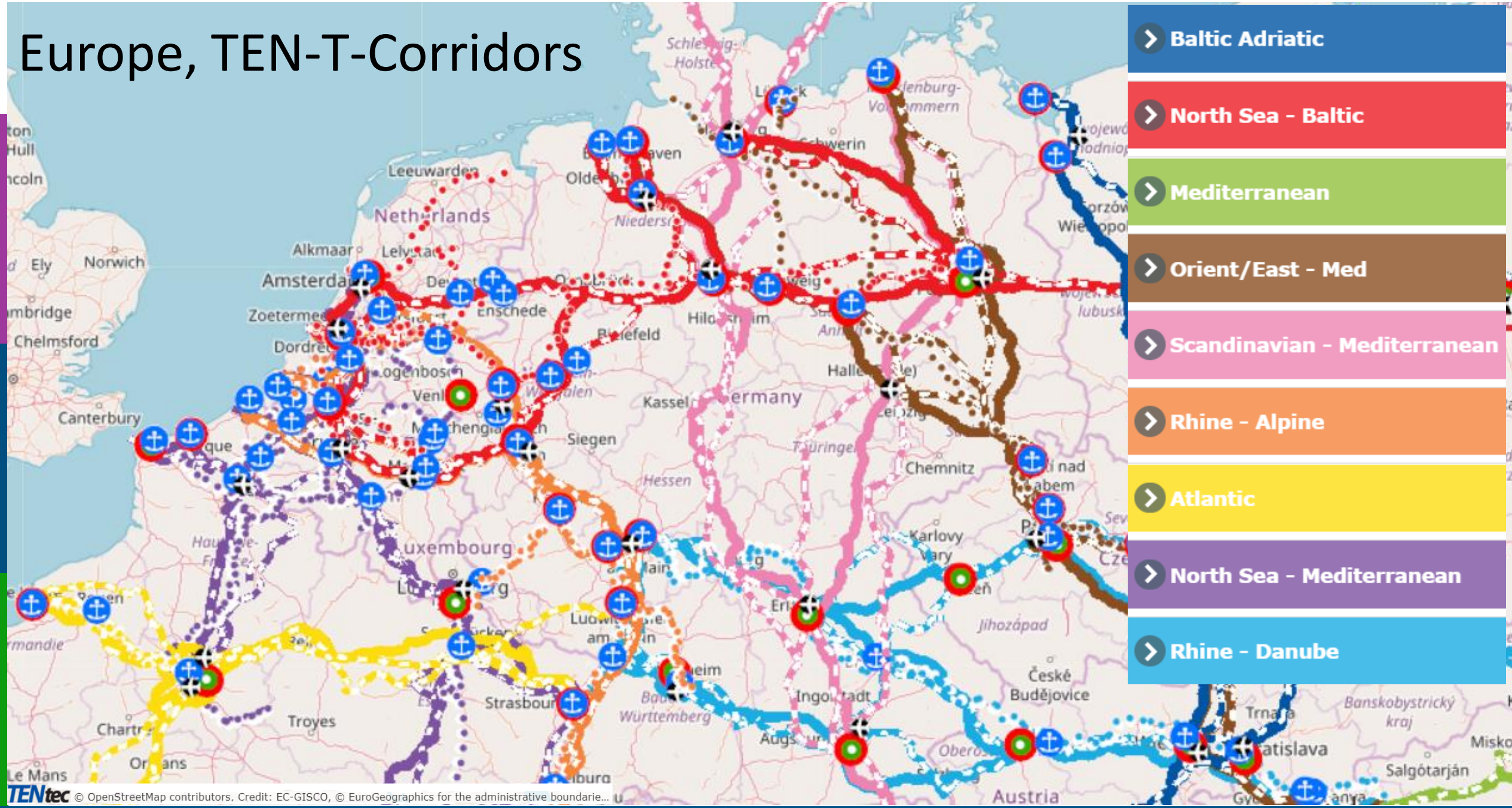
Europe, TEN-T-Corridors



Europe, TEN-T-Corridors



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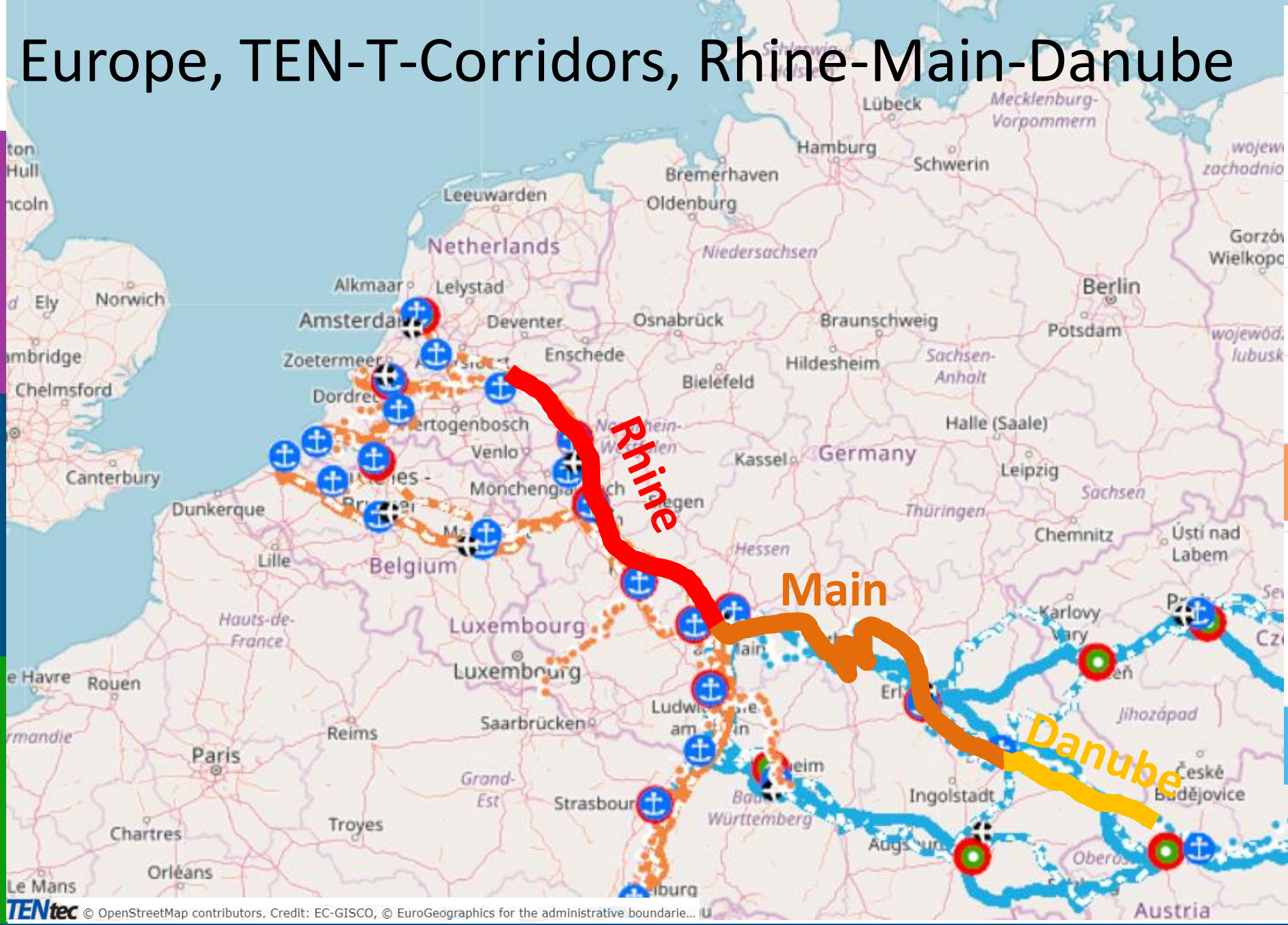
Europe, TEN-T-Corridors, Rhine-Main-Danube



- Baltic Adriatic
- North Sea - Baltic
- Mediterranean
- Orient/East - Med
- Scandinavian - Mediterranean
- **Rhine - Alpine**
- Atlantic
- North Sea - Mediterranean
- **Rhine - Danube**

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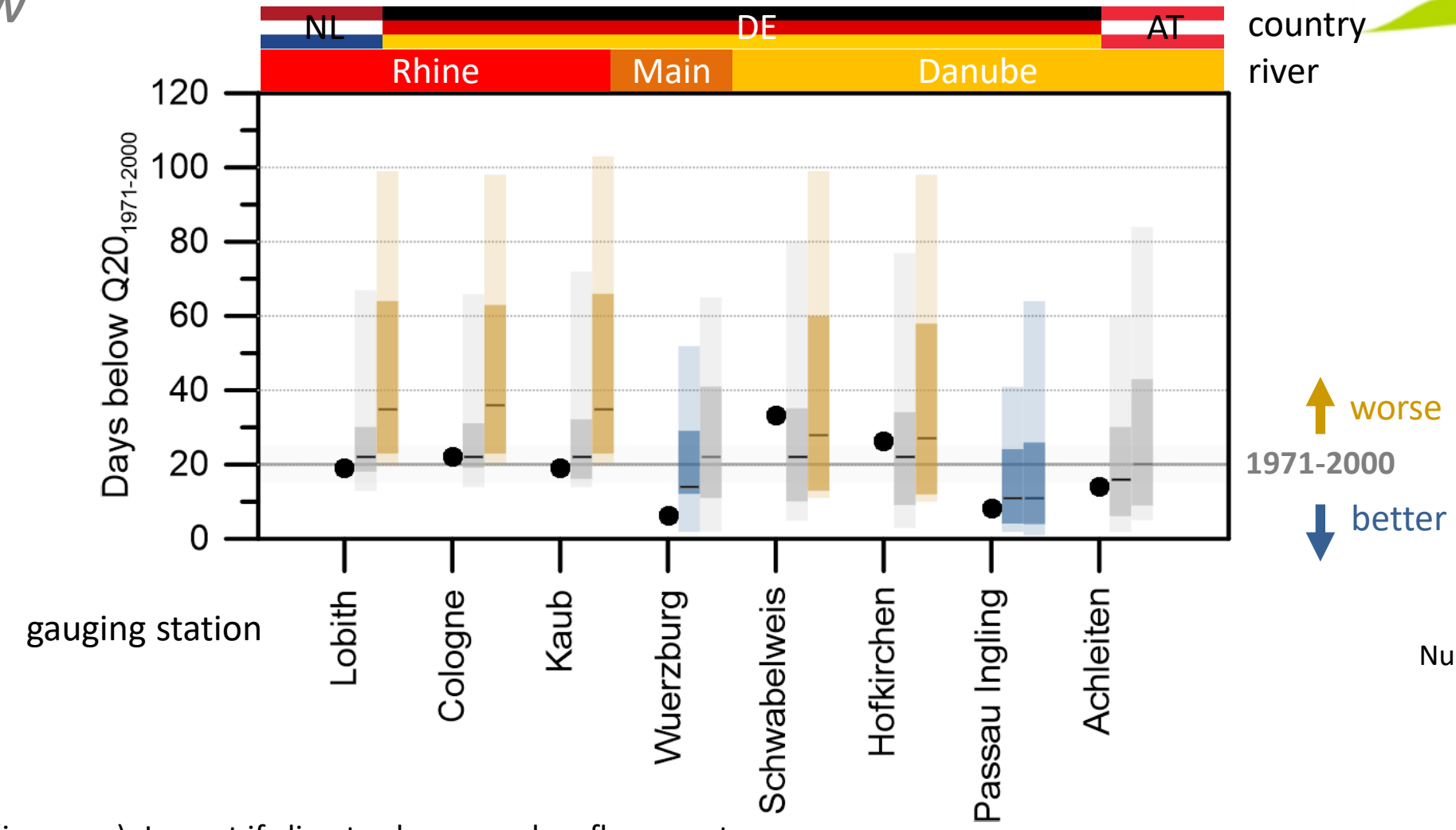
Future sectoral impact: inland navigation

low flow

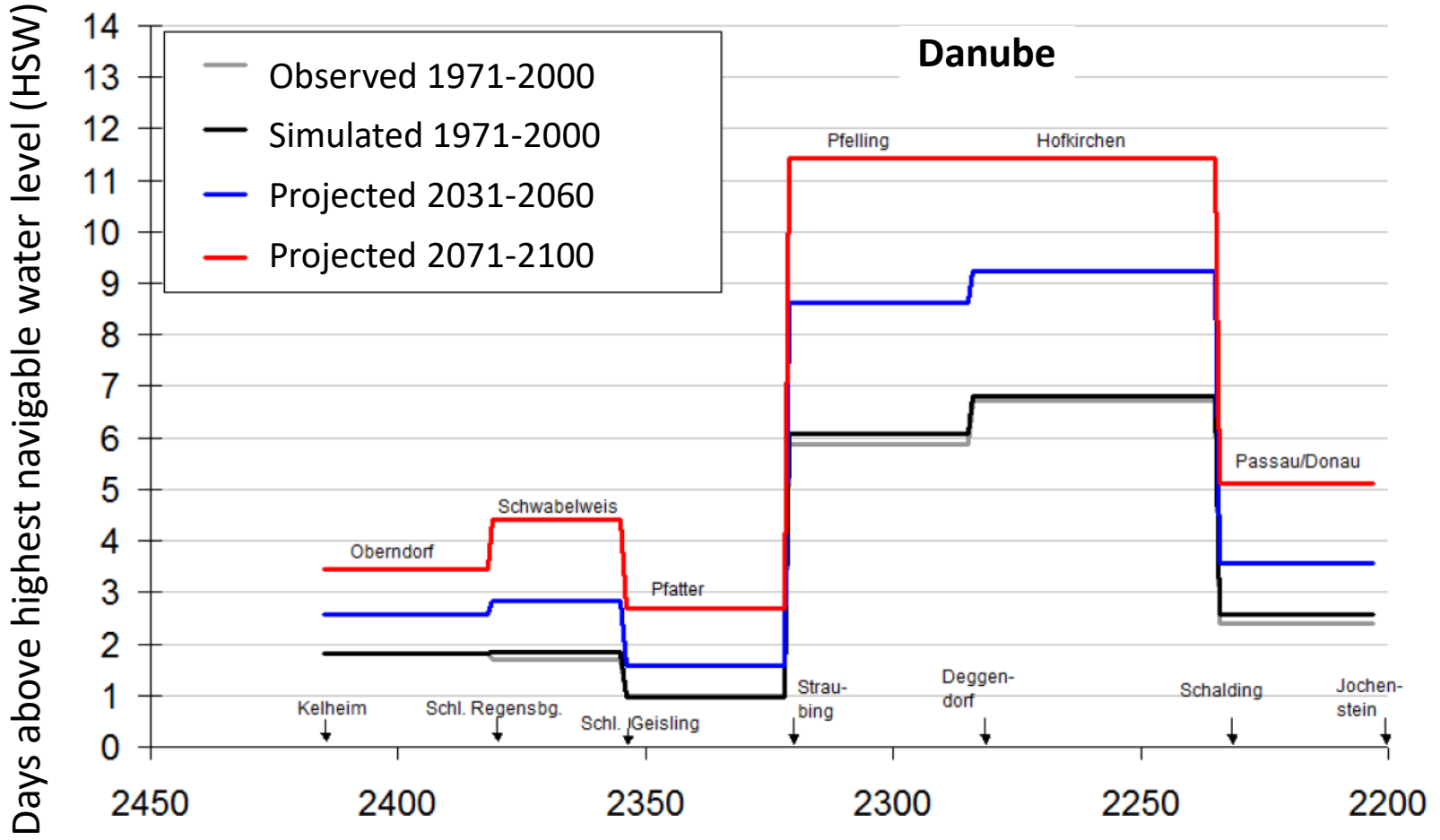


Nilson et al. (in press.): Impact if climate change on low flows, water temperature, and water quality. In: Belz et al.: The low flow sequence 2015 to 2018 in Germany. BfG-report (in German)

Future sectoral impact: inland navigation

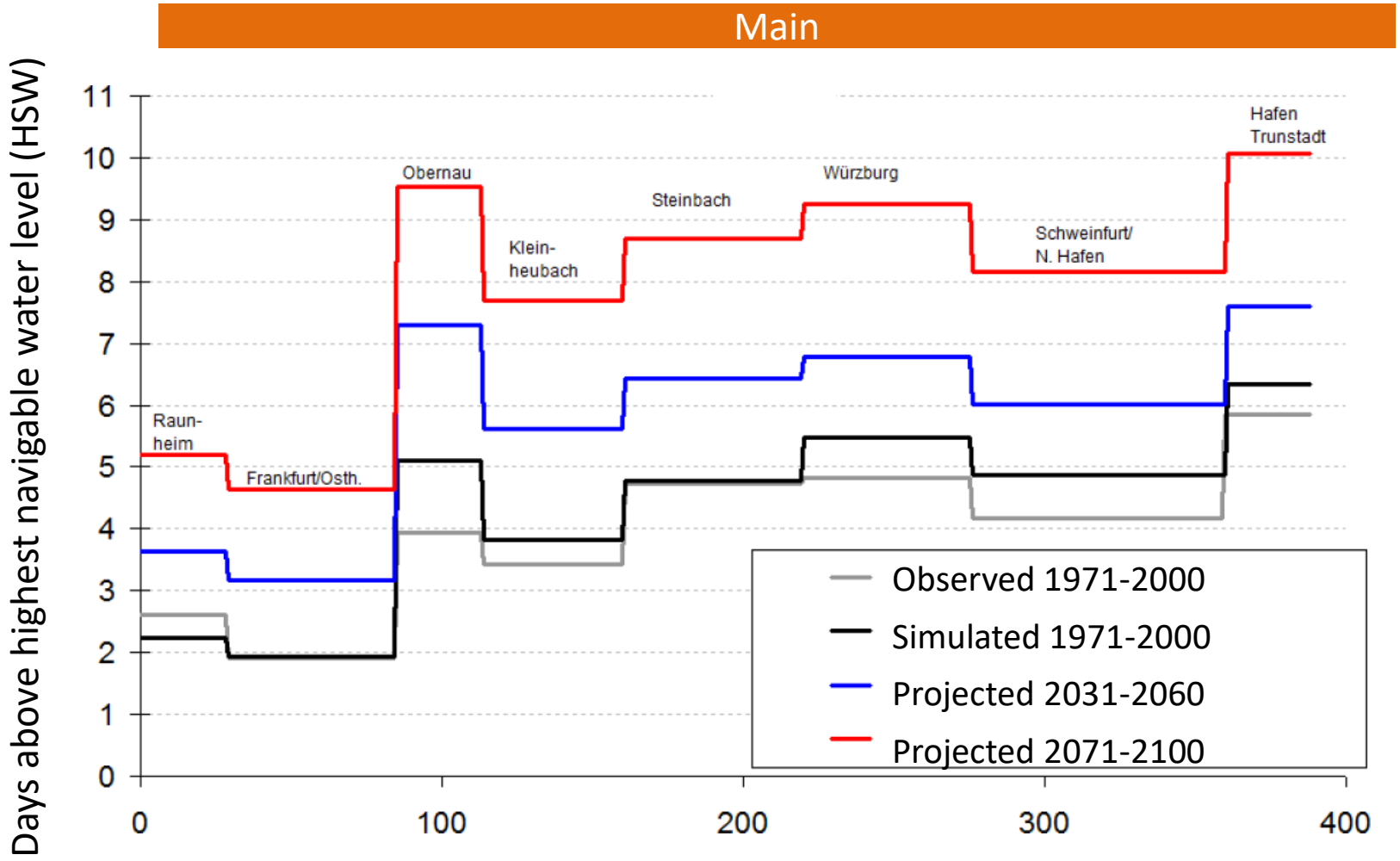
high flow

Danube



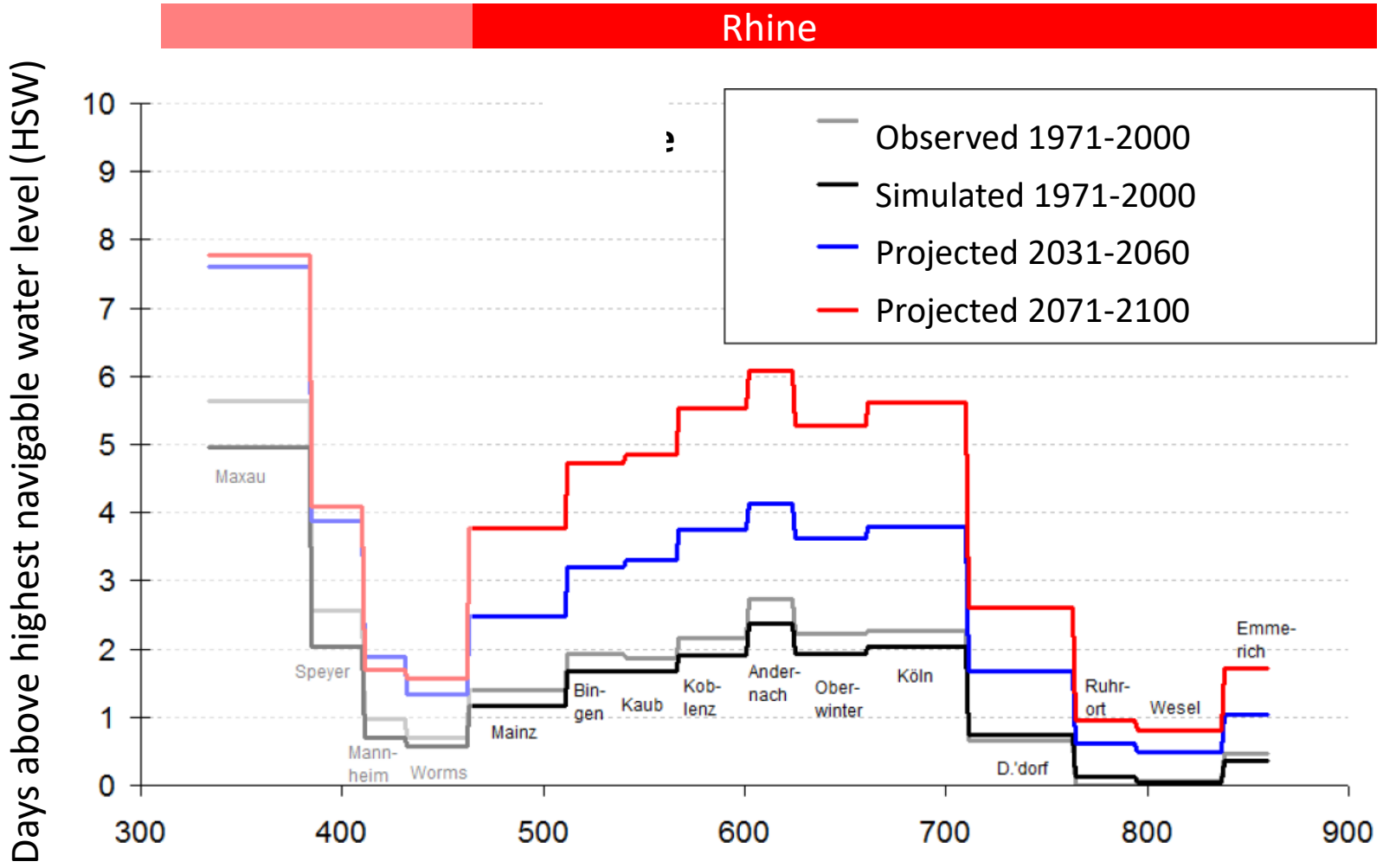
Future sectoral impact: inland navigation

high flow



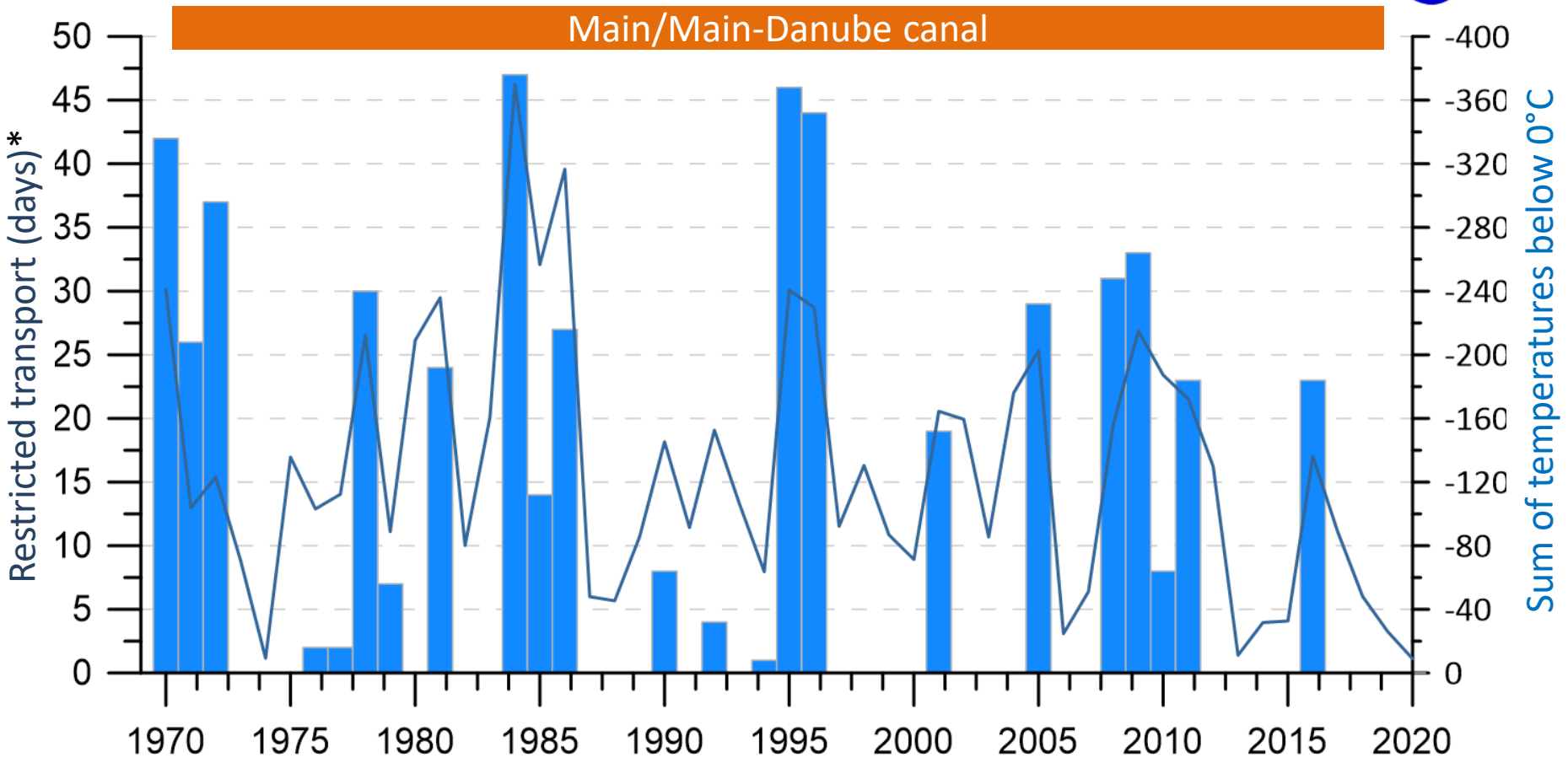
Future sectoral impact: inland navigation

high flow



Future sectoral impact: inland navigation

icing



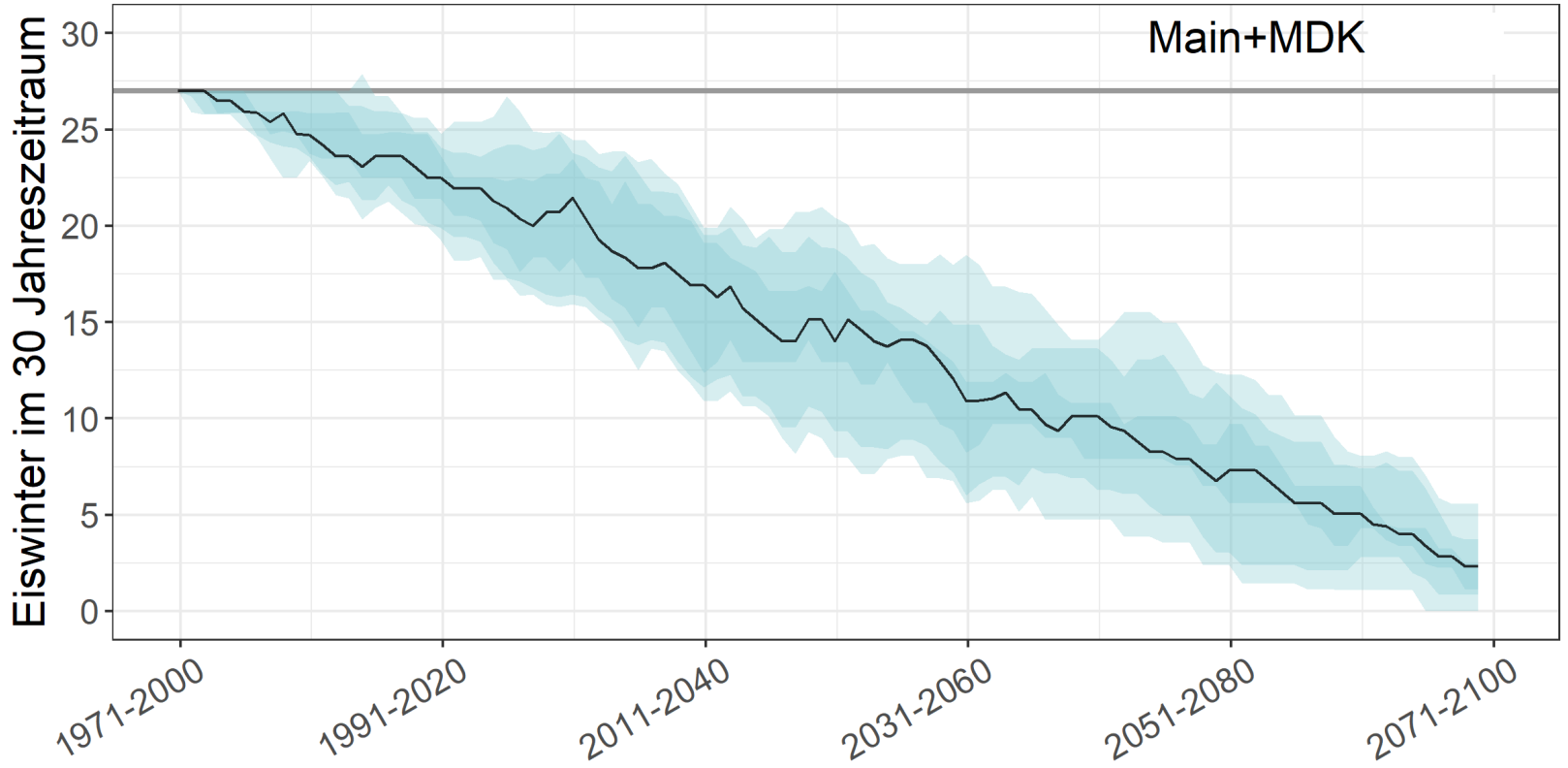
- Ice observations (1970-2020) according to WSV reports and sum of temperatures below 0°C per winter (Nov-Mar)

* at least one segment affected

Data: DWD, BfG
Source: BfG

Future sectoral impact: inland navigation

icing



- Estimated based on sum of temperatures below 0°C per winter
- 16 projections (RCP8.5)

Data: DWD, BfG
Source: BfG

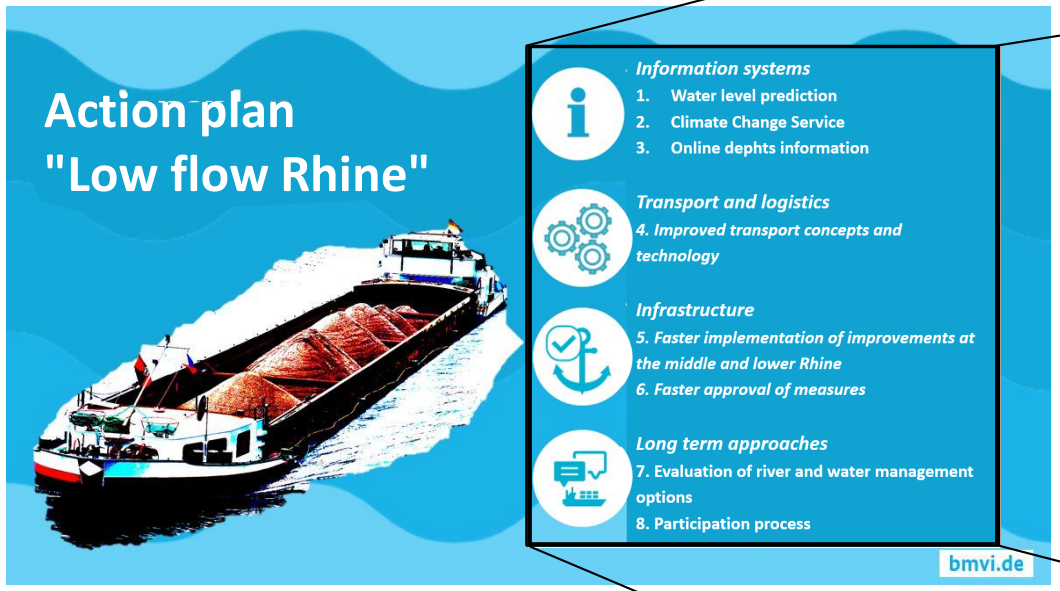
Legal aspects of climate impacts (Germany)
(selected)

Obligation to account for climate change according to laws:

- Spatial planning act (ROG)
  Section 1, § 2 (2) 6
- Building Code (BauGB)
  Chapter 2, Teil 1, Section 1, § 136 (2) 1
- Environmental Impact Assessment Act (UVPG)
  Annex 4, (4) c) hh)
- Water Resources Act (WHG)
  Chapter 2, Section 1, § 6 (1) 6

Adaptation measures

eight-point plan of BMDV



Information systems

1. **Water level prediction**
2. **Climate Change Service**
3. **Online dephts information**

Transport and logistics

4. Improved transport concepts and technology

Infrastructure

5. Faster implementation of improvements at the middle and lower Rhine

6. Faster approval of measures

Long term approaches

7. Evaluation of river and water management options

8. Participation process

Source: German federal ministry ot Transport and Digital Infrastructure BMVI, 2019

Decisions on different time scales

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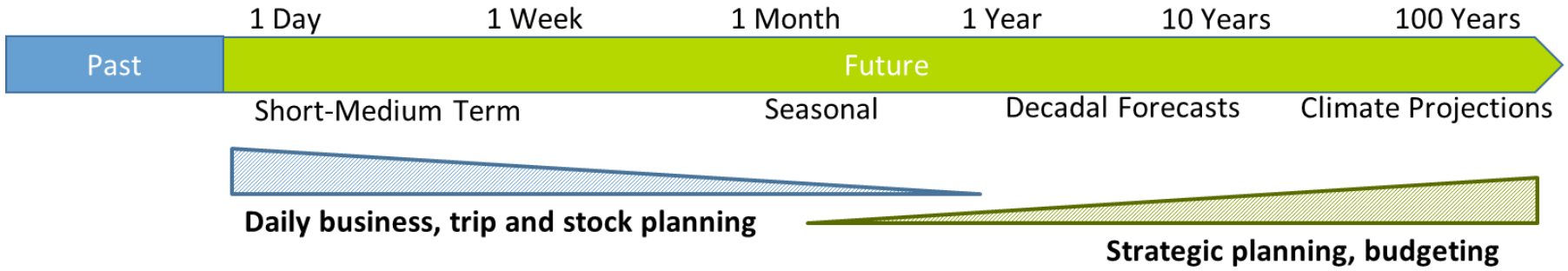
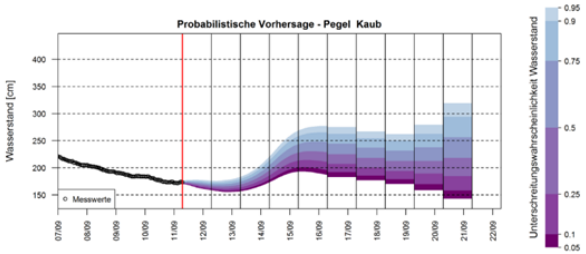
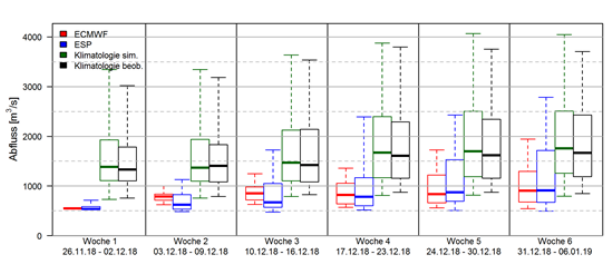
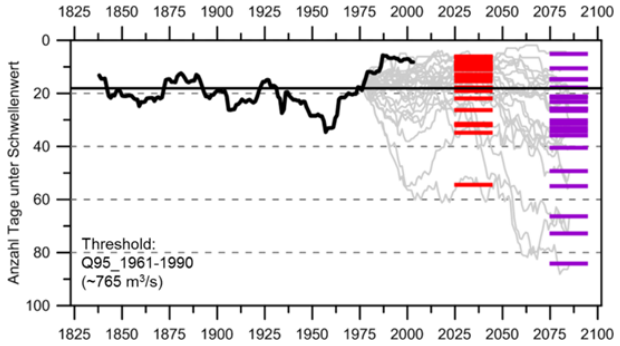


Maritime – IWT
economic outlook
future fleet planning
optimize load
stock management
transport management
security energy supply
Investment stock facilities
alternative transport concepts
plan transport cycles
transport capacity planning
infrastructural waterway management
multi-modal split planning



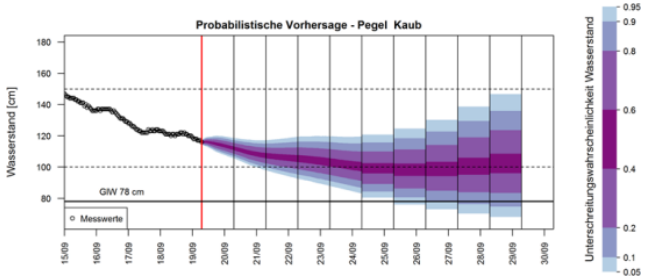


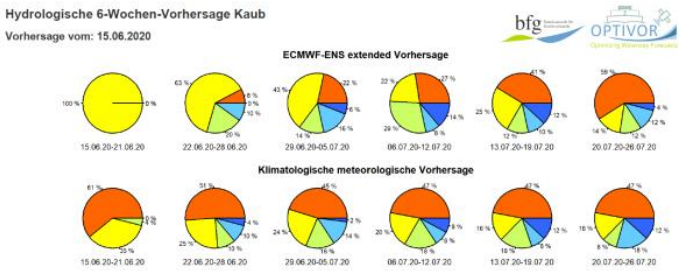


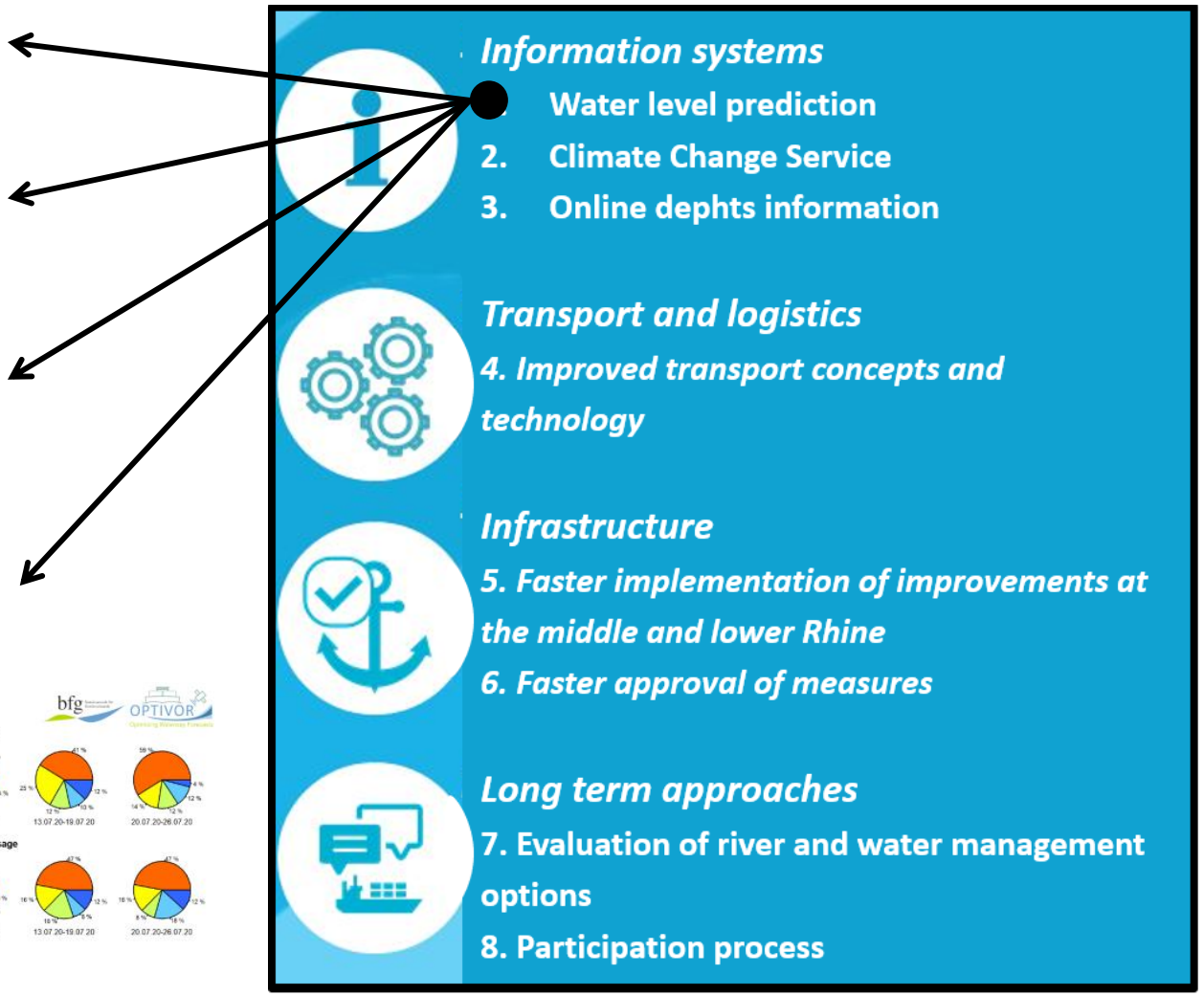
Adaptation measures

eight-point plan

- Deterministic 4-day prediction
  - operational → www.ELWIS.de
- Probabilistic 10-day prediction
  - operational → www.ELWIS.de
- Probabilistic 6-week prediction
  - pre-operational → contact BfG
  - shift to operational mode in July
- Probabilistic 3-months estimate
  - research

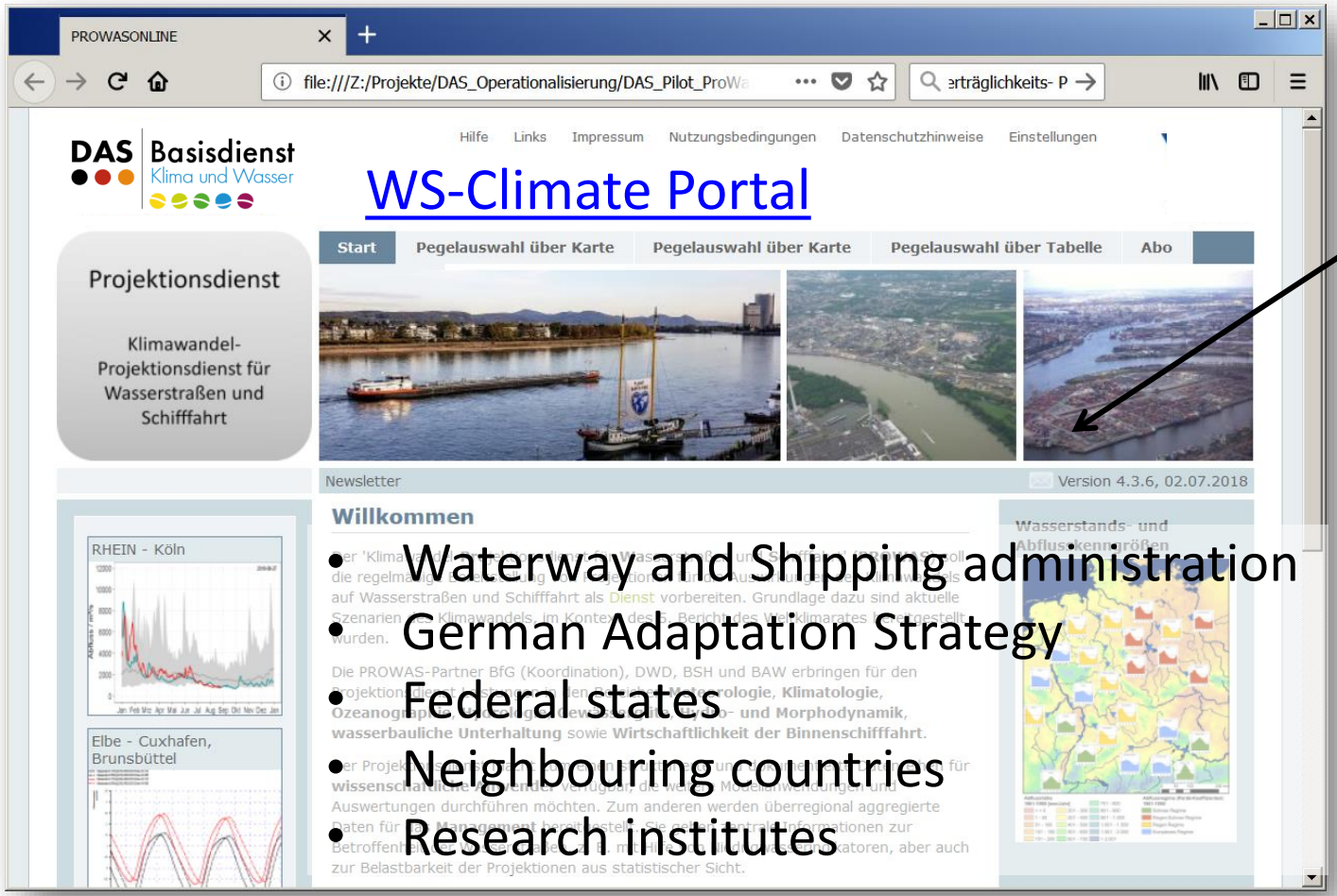






Contact: Meissner@bafg.de

Adaptation measures
eight-point plan



- Waterway and Shipping administration
- German Adaptation Strategy
- Federal states
- Neighbouring countries
- Research institutes

Information systems

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Contact: DAS-Basisdienst@bafg.de

Summary

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1. Climate change is affecting IWT via several impact chains.
2. Low flow situations are particularly relevant for IWT due to their duration.
3. Accounting for impacts of future climate change is becoming an obligation in planning procedures.
4. Flow and water level forecasts are an important tool to reduce vulnerability of IWT in extreme situations
5. Several measures are already being taken to account for future short term variability and long term changes in hydro(meteoro)logical boundary conditions of IWT.
6. Ongoing research will bring more insight into IWT-related impact chains and additional adaptation options.

Climate Change
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