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Knowledge Ability Action

Adapting the German transport system to climate change and extreme weather events

Dr. Stephanie Hänsel (DWD)

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German Adaptation Strategy (DAS) and Adaptation Action Plan (APA)*

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DAS (2008) → APA II, DAS Progress Report (2015)

DAS aims at

- reducing vulnerability to climate change impacts
- maintaining or enhancing adaptability of natural, societal, and economic systems

Sustainable planning and acting requires to:

- widen the knowledge base
- create transparency and participation
- support stakeholders by providing the basis for decision-making
- raise public awareness
- develop strategies to deal with uncertainties

* Lead: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)

German Adaptation Strategy Fields of Action

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Regional development and civil protection		Energy sector
Human health		Soil protection
Water management, flood protection		Industry and trade
Agriculture		Finance sector
Biodiversity and nature conservation		Building trade
Transport, transport infrastructure,		Tourism
Forestry		Fisheries sector

Need for Action

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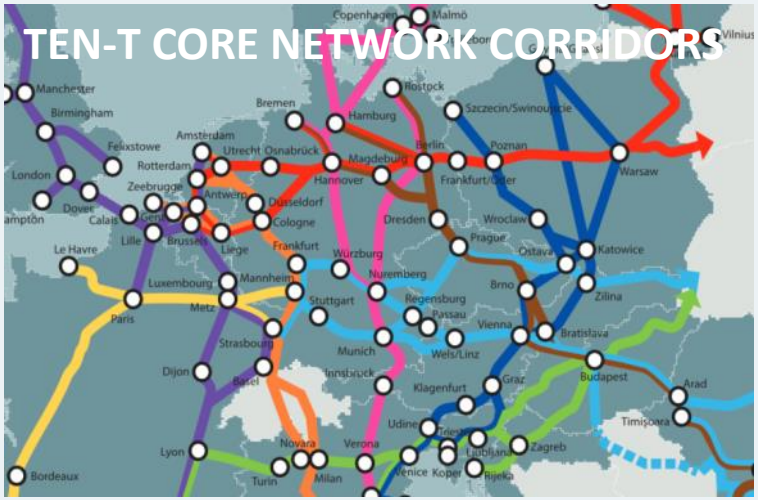
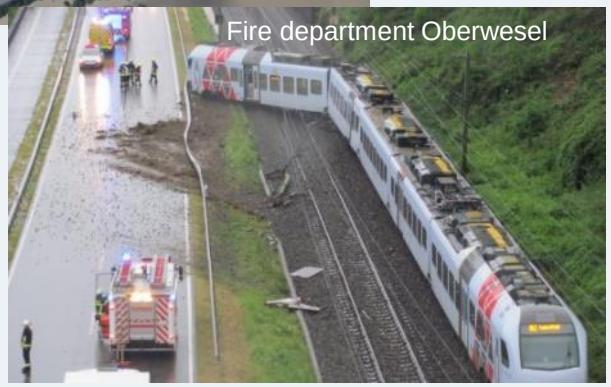
Efficient and reliable transportation is an important foundation for economy and society.

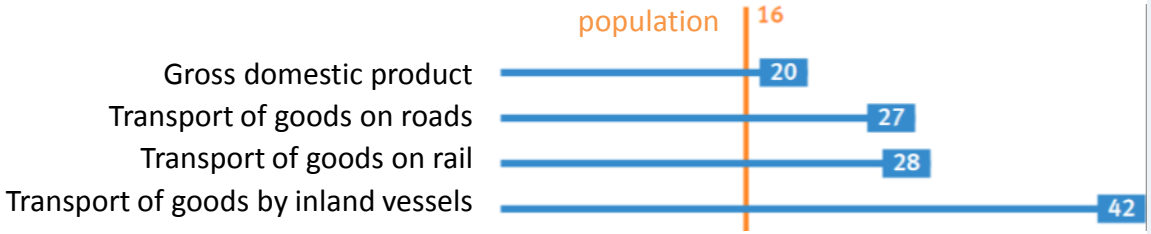


Damage to infrastructure and disruption of transport chains due to climate change and extreme weather events.


DLR (CC-BY 3.0)


Fire department Oberwesel

2010: Share of German transport indicators of EU figures [%]



Source: Eurostat; EU transport in figures, Statistical pocketbook 2012, European Commission.

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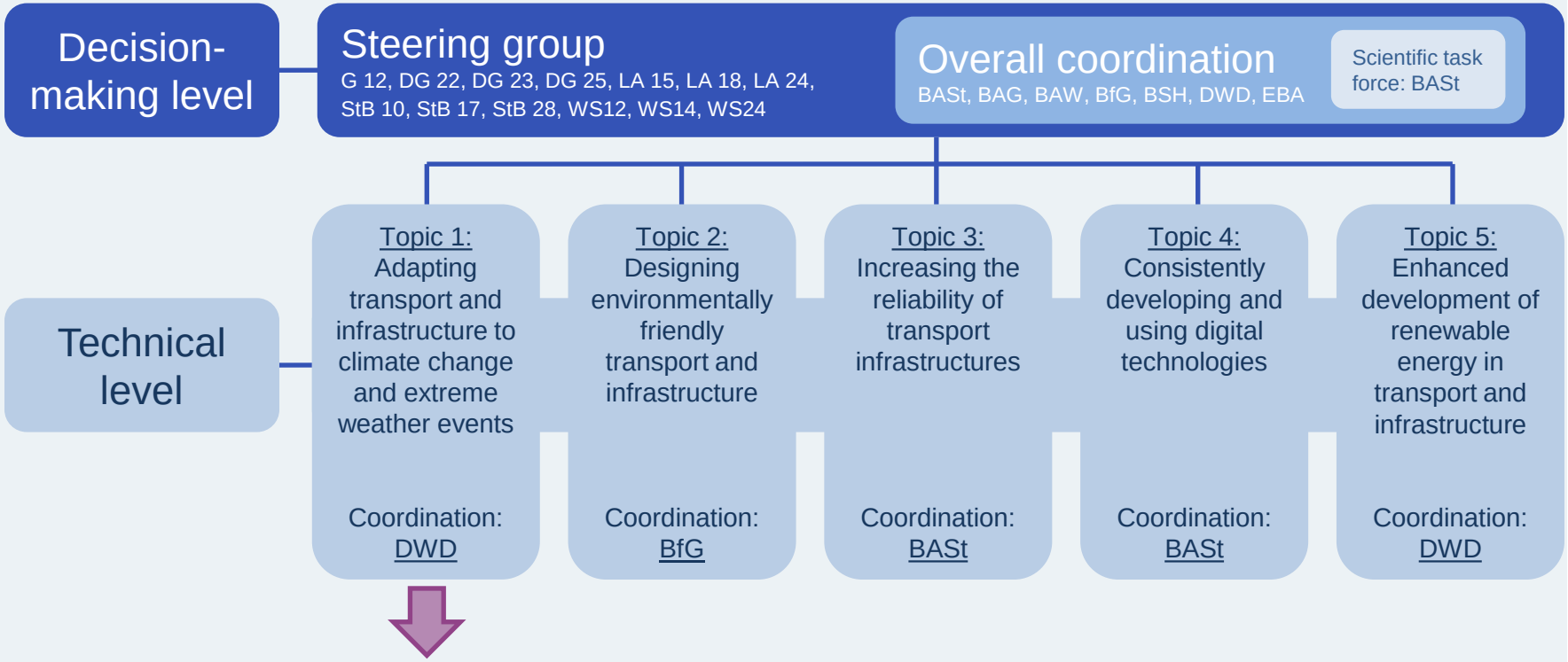
- interdisciplinary knowledge, skills and action
- Applied and intermodal research network



Generating knowledge about the spatial pattern of expected climate change impacts and about the vulnerability of transport infrastructure

Objectives of Topic 1

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Increasing the resilience of transport and federal transport infrastructure to climate change and extreme weather events

- → Integrating the knowledge on climatic changes in atmosphere and ocean with practical knowledge about the modes of transport (waterway, road, railway)
- → Building on the results of preceding projects (e.g. KLIWAS for waterways and AdSVIS for roads).
- → Developing targeted climate services that go beyond basic climatological statistics and integrate user requirements.
- → Providing a basis for the implementation of the German Adaptation Strategy

Our research topics

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Scenario development (DWD)

Provision of meteorological / oceanographic / hydrological data and evaluations (observations and projections)

Coastal focus areas (BSH)

Flooding hazards (DWD)

Storm hazards (EBA)

Landslides (BASt)

Navigability and water quality (BfG)

Inland focus areas (BASt)

Risk Analysis (BASt)

Integration of the hazard and transport mode specific results of climate impact analyses in a common framework

Adaptation options (EBA/BAW)

Developing guidelines for handling the addressed hazards and suggesting/testing specific adaptation options

Project coordination (DWD)

Climate Impact Assessment – Approach

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- Based on the Guidelines for Climate Impact and Vulnerability Assessments (Buth et al., 2017) that shall support the German adaptation strategy

Analytic steps:

- Exposure analysis: Spatial identification of network sections exposed to climate impacts
- Sensitivity analysis: Spatial identification of network sections sensitive to climate impacts

Evaluation of climate impacts by analysing the Criticality of impacted network sections → Spatial identification of network sections critical to the transport system

Indicator-based approach:

- System analysis to describe cause-effect relationships
- Use of indicators to operationalise the exposure, sensitivity and criticality of network sections

Climate Impact Assessment – Illustration

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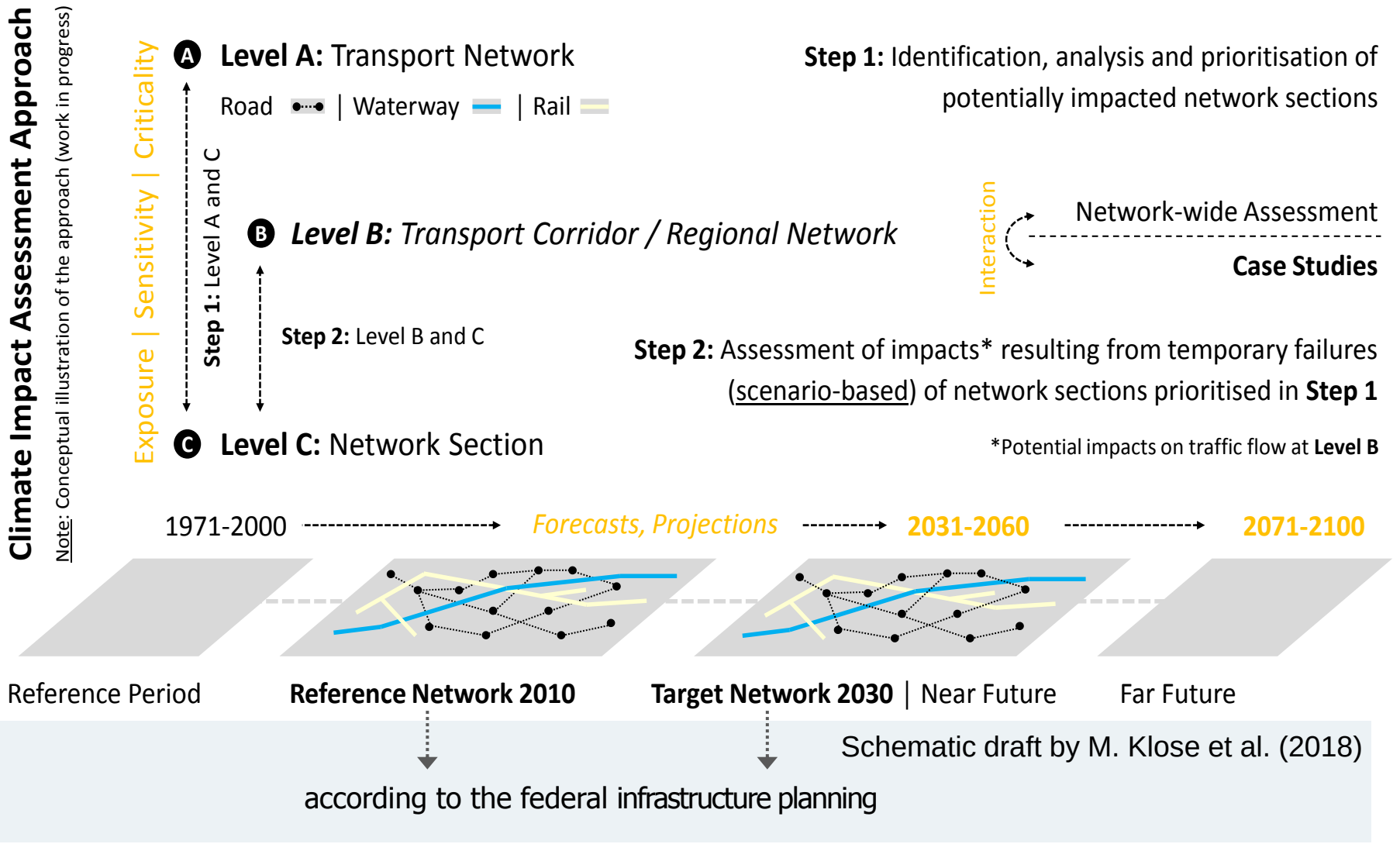

Evaluation Framework

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- Agreements on analysis periods, underlying scenarios, reference datasets, ensembles of climate projections, etc.
- Analysis periods within 1951-2100: Reference: 1971–2000 / Future: 2031–2060 and 2071–2100
- Emission scenarios (RCP=Representative Concentration Pathways):

  RCP2.6 („2 degrees goal“) and
  RCP8.5 („Business as usual“)

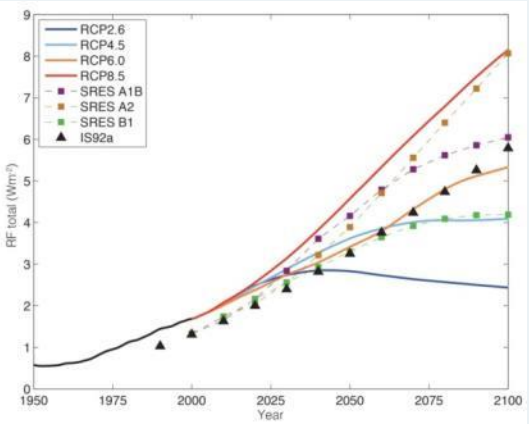


Figure 1.15 from IPCC (2013)

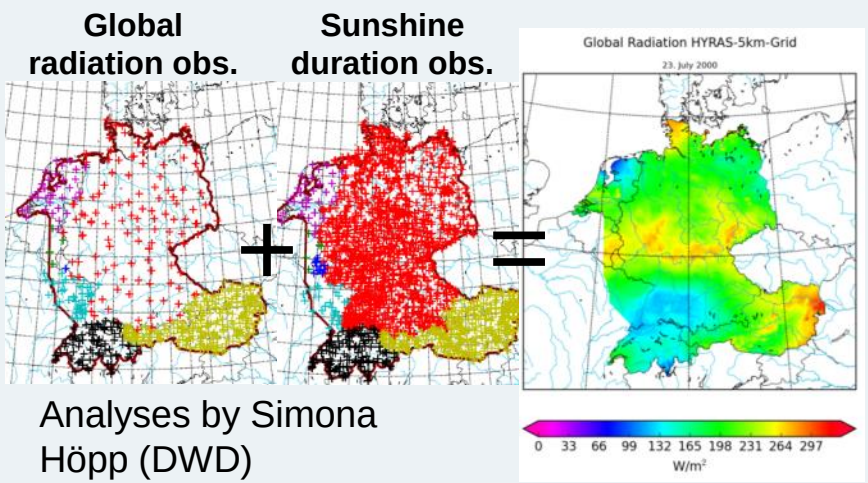
- Traffic scenarios according to the federal infrastructure planning: Reference (2010) and target network (2030)
- Ensemble analysis for each RCP with display of ensemble bandwidth (15th and 85th percentile)

→ **Important basis for the climate impact assessments**

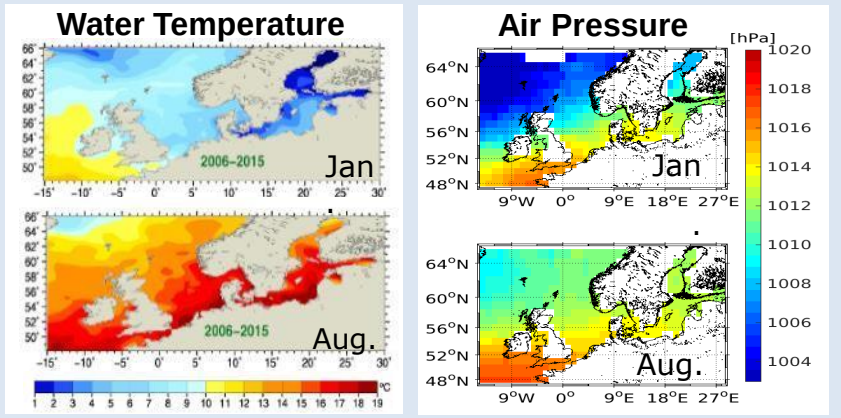
Example – Climate reference data

Important for validating and assessing regional climate models (e.g., bias correction) and climate impact models (e.g. hydrological modelling)

- Inland: Gridded data sets for temperature (Av., min., max.), humidity, precipitation and global radiation
- Ocean: Gridded data sets for ocean (temperature, salinity) and atmosphere (temperature, pressure, dew point temperature



Analyses by Simona Höpp (DWD)



BNSC-data prepared by BSH in cooperation with the university Hamburg, ICDC

Example – Regional climate projections

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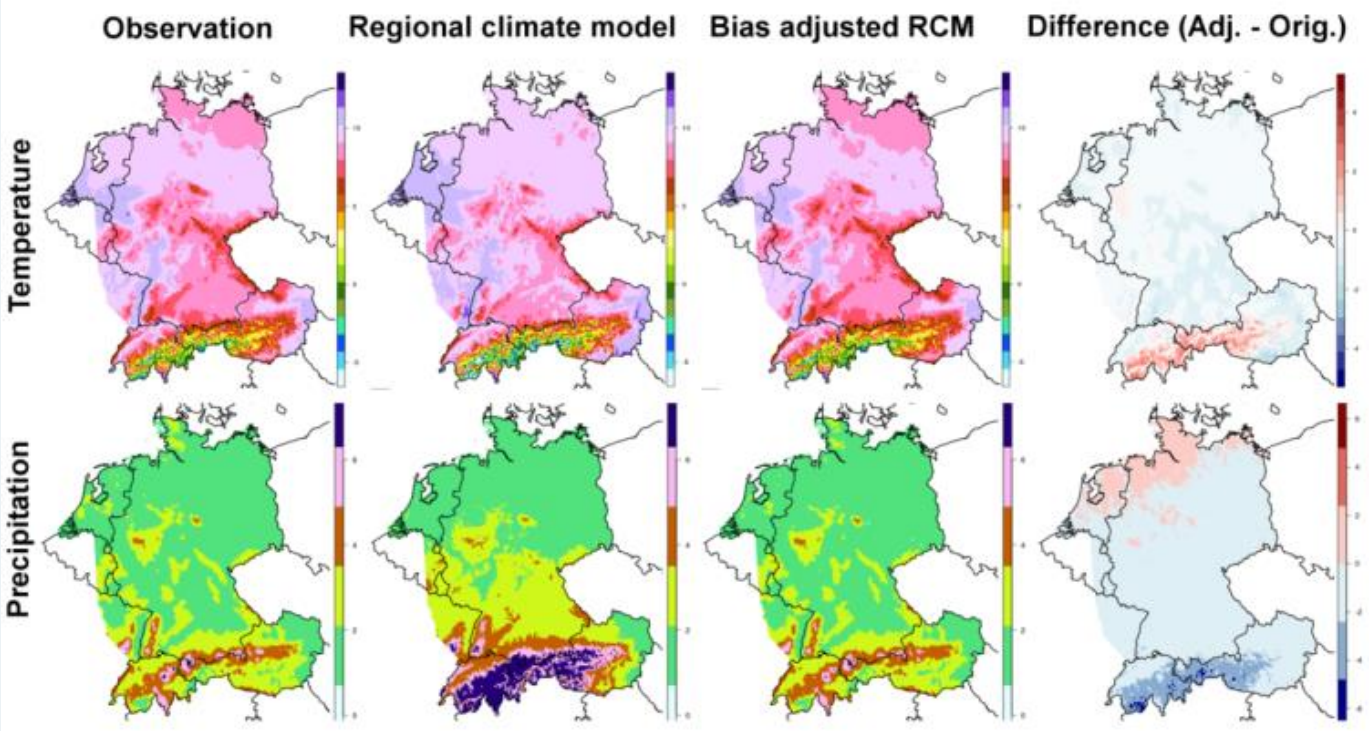
Multivariate Bias-adjustment* in order to correct for systematic deviations of regional climate model simulations from observations



Analyses by Stefan Krähenmann (DWD)

*Cannon A (2016) Multivariate Bias Correction of Climate Model Output: Matching Marginal Distributions and Intervariable Dependence Structure. J Climate 29: 7045-7064.

Example – Climate index list

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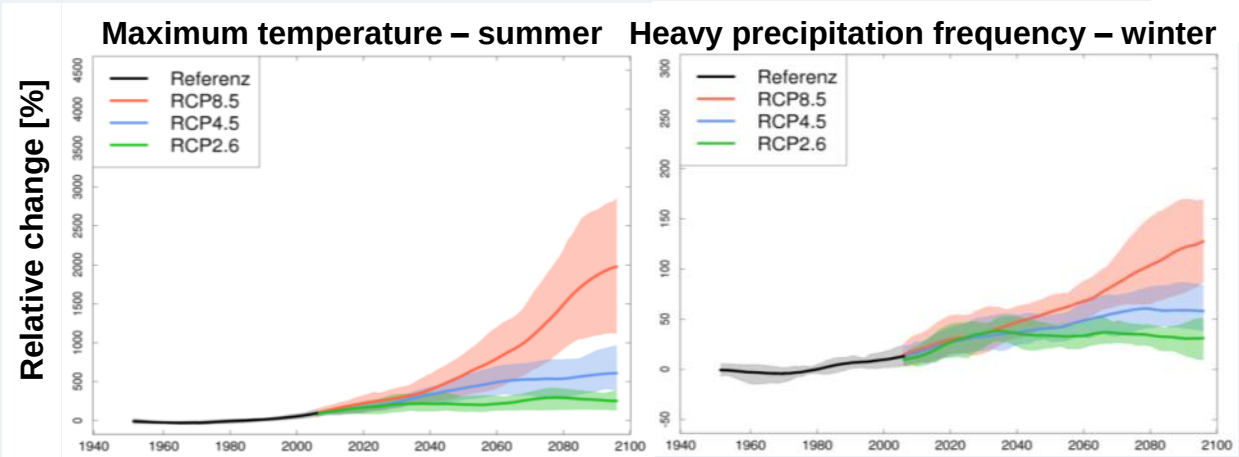
- Compilation of a list of climate indices with impact relevance and sufficient frequency for statistical analysis
- Index data, time series and maps are provided to the users

→ They form an important basis for the evaluation of future climate change impacts on transport infrastructure

List of climate indices

Variable/Index	Unit	Index definition and statistics
Air temperature at 2 m height		
Diurnal temperature range	°C	Tmax – Tmin
Summer days (per month)	No.	Days with Tmax > 25°C
Hot days (per month)	No.	Days with Tmax > 30°C
Tropical nights (per month)	No.	Days with Tmin ≥ 20°C
Frost days (per month)	No.	Days with Tmin < 0.0°C
Ice days (per month)	No.	Days with Tmax < 0.0°C
Several percentile based indices	No.	Days with T# </> #th percentile
Maximum frost period	Days	Period of continuous frost days
Severe frost periods	Days	Period of consecutive days with Tmin < -5°C
Cold/warm spell duration	Days	Consecutive days with Tmin/Tmax </> 10/90th percentile
Heatwave	No.	Consecutive days with Tmax ≥ 30°C (at least 6 days)
Precipitation		
Heavy precipitation days	No.	Days with precipitation above a predefined threshold (e.g., 10/20 mm or percentile [90th, 95th, 99th])
Dry days	No.	Days with precipitation < 1 mm
Consecutive dry days	Days	Maximum duration of consecutive dry days
Dry day persistence	No.	Frequency of dry periods with predefined duration (e.g., > 4 or 11 days duration)
Consecutive wet days	Days	Maximum duration of consecutive wet days with precipitation ≥ 1 mm
Multi-day precipitation total	mm	Precipitation sum for a predefined number of days [e.g. 3, 5, 10, and 30 days])
Continuous rain	No.	Events with precipitation ≥ 40 mm/48 h or ≥ 60 mm/72 h
Other parameters and combined indices		
High winds (seasonal)	No.	Days with maximum wind speed above a predefined threshold (e.g., 90/95th percentile; 8 or 10 Beaufort)
Heavy precipitation following a dry period	No.	Dry period (> 11 days) terminated by a heavy precipitation event with ≥ 20 mm/d

To be continued …



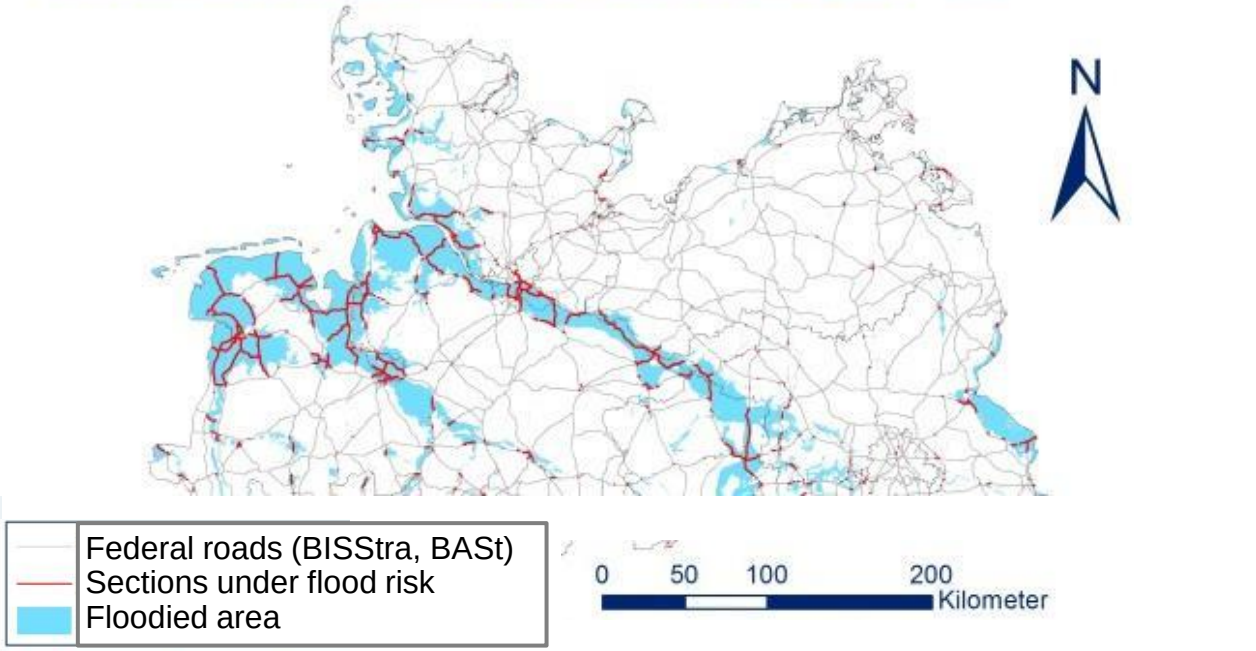
Analyses by
Christoph Brendel (DWD)

Example – Flood risk maps

Analysis of flood risk maps generated by the German Federal States

- “frequent” events (return period: 10-25 year)
- Return period of 100 yrs.
- **Extreme flooding (return period >>100 yrs.)**

Road sections under risk of flooding



Analyses by
E. Nilson (BfG),
J. Kirsten (BASt),
C. Herrmann (EBA),
N. Schade (BSH),
M. Helms (BfG),
M. Rauthe (DWD),
C. Brendel (DWD)

Example – Landslide hazard map

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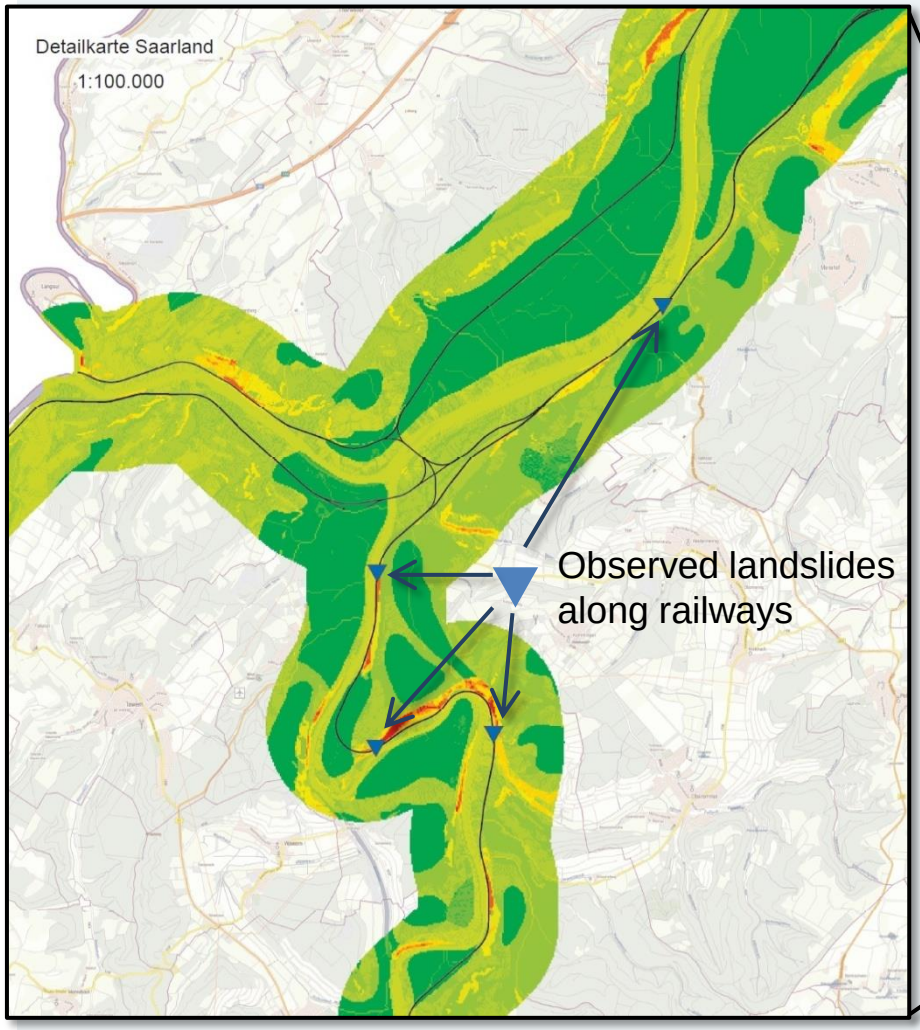
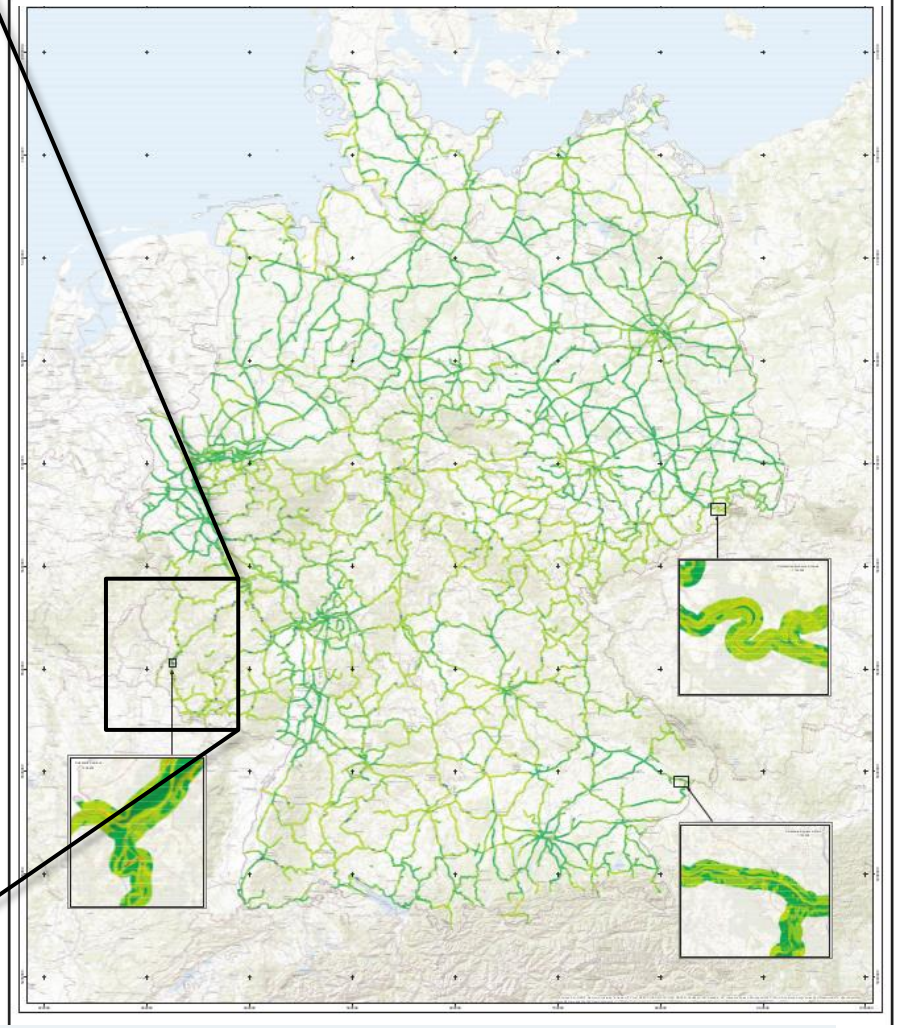


Geological mapping of the potential for landslides along railways in Germany (draft)



Analysis by E. Kallmeyer & A. Knobloch (Beak Consult), M. Forbriger (EBA)

Studied adaptation measures

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- Modification of technical regulations and directives
  → assessment of set of rules
- Technical adaptations
  (e.g. materials, construction)
- Adaptation of management practices
  e.g. water and sediment management
- Developing awareness of the necessity to act under uncertainty

Implementation Aspects

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- As a research network the BMVI Network of Experts
  - Develops data, methodologies and tools for assessing climate change impacts on the transport system
  - Delivers climate impact assessments at the national level
  - Provides more detailed data and evaluations for selected focus areas
  - Suggests and tests specific adaptation options
- The implementation of adaptation measures is done by the operators of the transport infrastructure:
  - Waterways: Federal Waterways and Shipping Administration (Agency of BMVI) → regular dialogue and development of a Climate proofing handbook for the administrative staff
  - Rail: Deutsche Bahn AG
  - Roads: Road administrations of the Federal States

Conclusions

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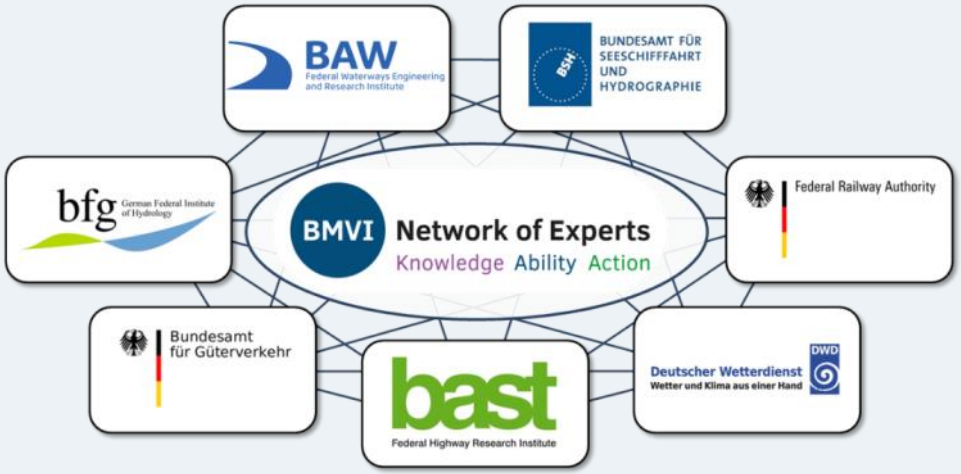
- We are (on a project basis) providing climate services according to the user requirements (waterway, road and rail) as a basis for adapting the German inland transport system to climate change and extreme weather events.
- The routine provision of user-relevant climate services is needed in support of climate change adaptation.
- A resilient transport infrastructure is an important basis for maintaining and developing mobility as an important foundation for our entire social development.
- We are going to incorporate projected long-term developments into investment decisions.
- The results are relevant for stakeholders at the regional level and for the implementation of the German Adaptation Strategy.

Contact

Project coordinator of topic 1:
Dr. Stephanie Hänsel (DWD), stephanie.haensel@dwd.de

Contact persons for the modes of transport:

- Road: Dr. Martin Klose (BASt), klose@bast.de
- Waterways: Dr. Enno Nilson (BfG), nilson@bafg.de
- Rail: Eckhard Roll (EBA), RollE@eba.bund.de



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