Climate impact assessment for the German federal transport infrastructure

Stephanie Hänsel[1], Martin Klose[2], Christoph Brendel[1], Markus Forbriger[3], Jens Kirsten[2], Enno Nilson[4], Elise Lifschiz[5], Anna-Dorothea Ebner von Eschenbach[4], Nils Schade[6], Jan Ork[2], and Annegret Gratzki[1]

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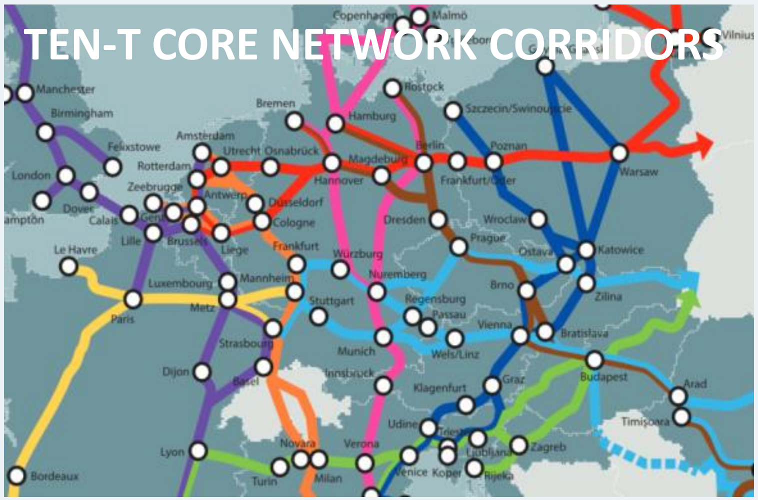
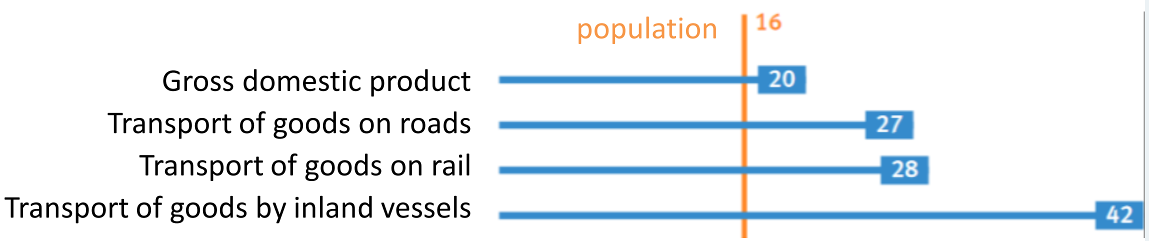
Motivation

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

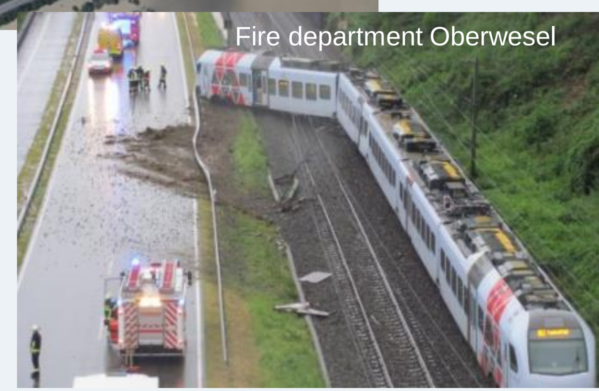


2010: Share of German transport indicators of EU figures [%]



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

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



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BMVI Network of Experts

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Knowledge Ability Action

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

Topic 1:	Topic 2:	Topic 3:	Topic 4:	Topic 5:
Adapting transport and infrastructure to **climate** change and extreme weather events	Designing **environ-mentally** friendly transport and infrastructure	Increasing the **reliability** of transport infrastructures	Consistently developing and using **digital technologies**	Enhanced development of **renewable energy** in transport and infrastructure

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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

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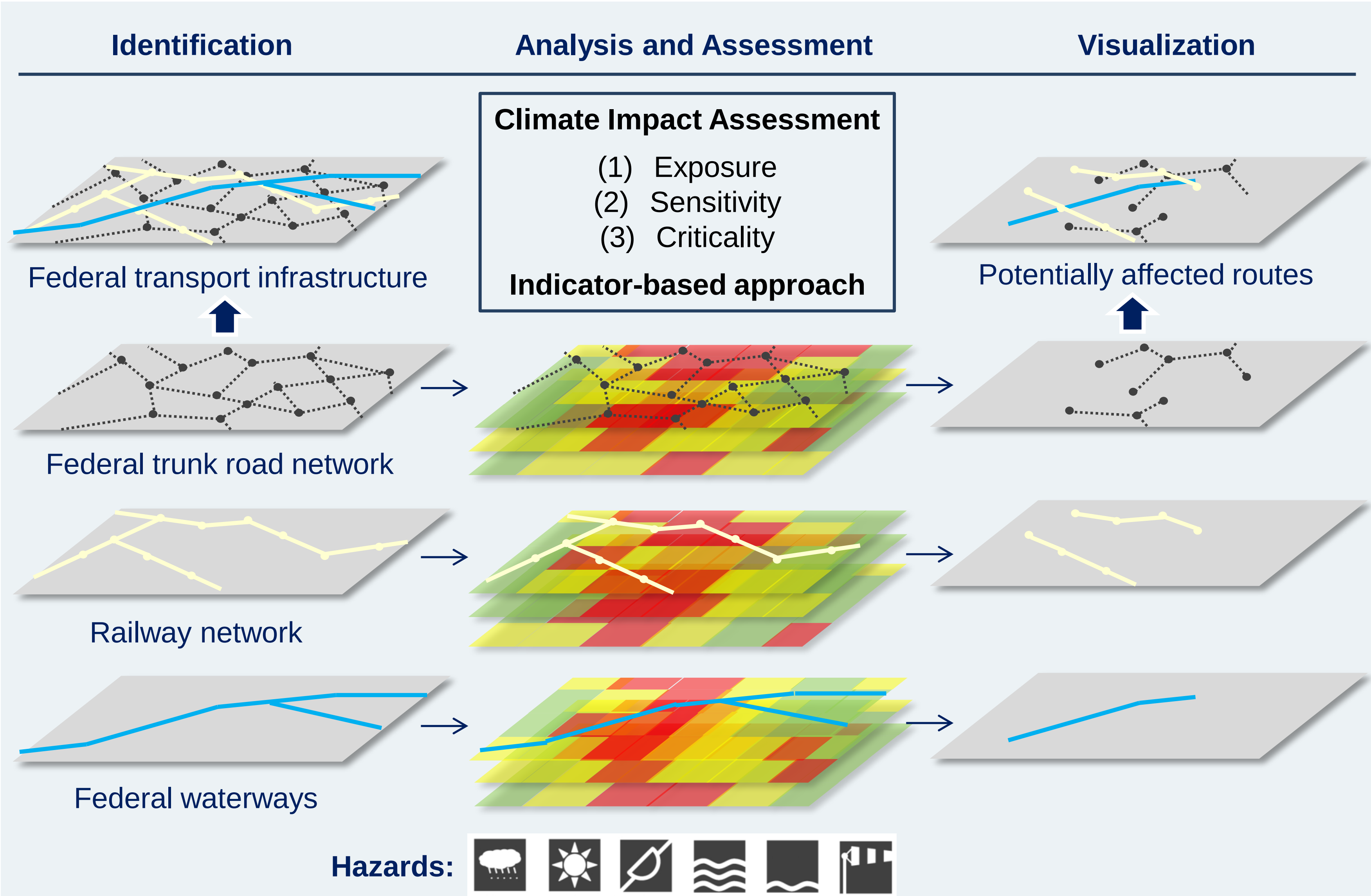
Climate Impact Assessment – Illustration



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Evaluation Framework

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

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

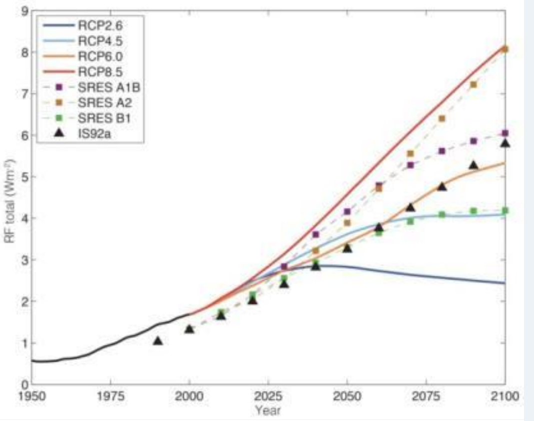

Figure 1.15 from IPCC (2013)

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

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

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1st step of CIA – Exposure analysis

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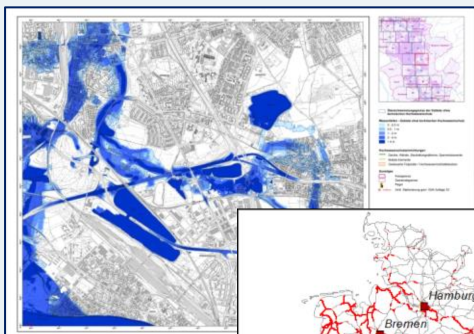
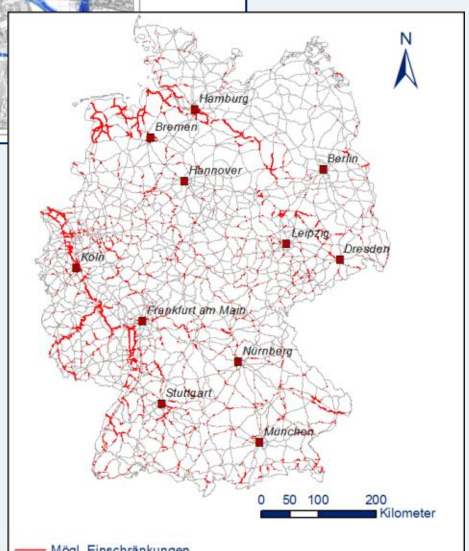
- Identification of routes potentially affected by climate impacts e.g. by intersecting the infrastructure network with maps of current hazard potentials and maps of expected future climatic changes

Flood hazard map

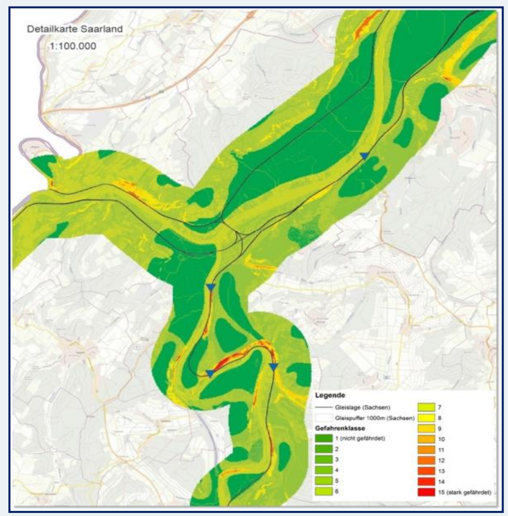


Flood risk map for the Rhine (Kartenblatt: 92/104, Nov. 2013, Bezirksregierung Köln).



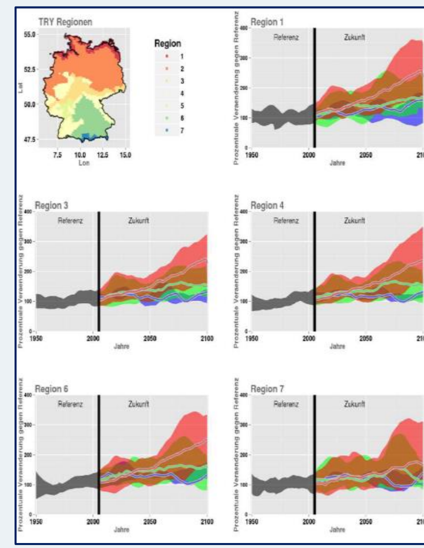
Road sections potentially flooded under the scenario of HQ_{extrem}

Landslide susceptibility map



Landslide hazard potential along German railway sections (map extract); prepared by Beak Consultants GmbH (2017) on behalf of EBA

Changes in heavy precipitation



Kernel density estimation for the 99th percentile of daily preciptation totals for different regions over Germany for the winter season using an ensemble of climate projections for RCPs 2.6, 4.5 & 8.5

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2nd step of CIA – Sensitivity analysis

- Analysis of how strongly the system reacts on climatic factors, in dependence of its characteristics
- The assessed characteristics depend on the respective hazard:

Flood / Low flows
Existing safety measures
Design
Embankment
Character of shore and riverbed
Hight of bidges


© Gina Sanders / Fotolia

Storms
Existing safety measures
Overhead lines
Hight/length of bridges


© Michael Neuhaus; DB AG

Landslides
Existing slope stabilization measures


© Ralf Braum, Deutsche Bahn AG

Heat
Orientation
Longitudinal incline
Design

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3rd step of CIA – Criticality analysis

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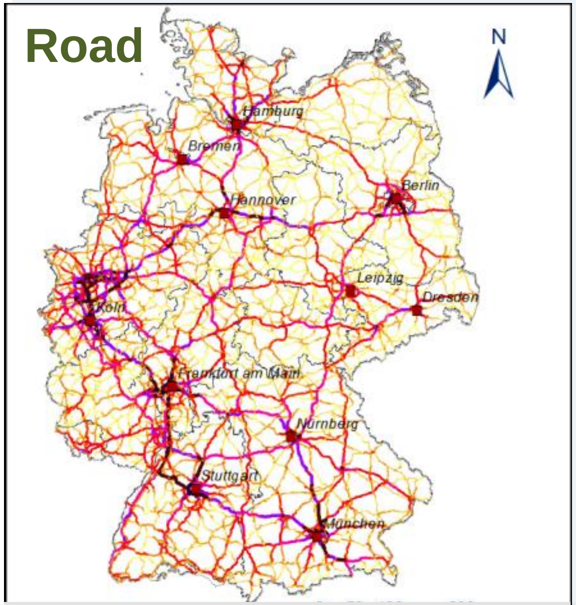
Spatial identification of network sections which are critical to the transport system, e.g. evaluation of the importance of the infrastructure (element)

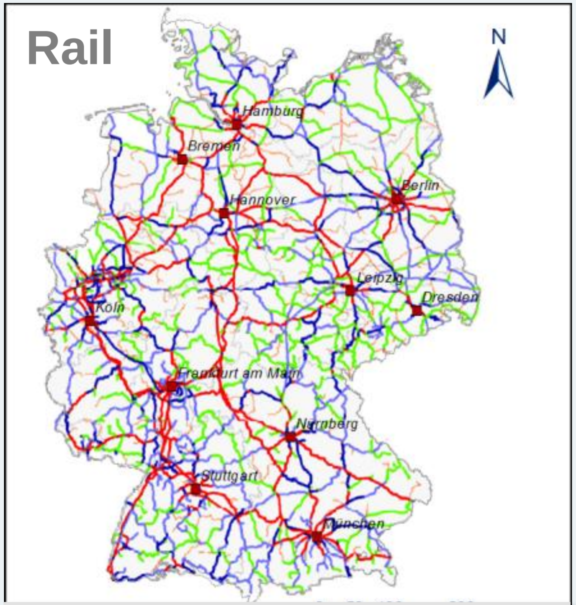
Road



Operationalisation:

- Annual Average Weekday Traffic (freight, people)
- …

Rail



Operationalisation :

- Trains per day (freight, people)
- …

Inland waterways

Operationalisation :

- Transported goods [Mt/year], [TEU/year]
- …

Illustration by BAW/BfG using "TRAVIS" (BAW, in development) based on data from the German traffic integration forecast 2030 (https://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/verkehrsverflechtungsprognose-2030-netzumlegungen.pdf?__blob=publicationFile)

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Case study ‚Ciel Canal'

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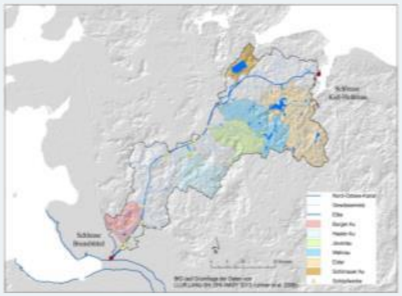
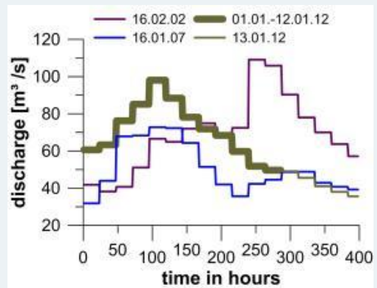
(A) Long-term simulation of daily discharge using a **rainfall-runoff model** (1951–2012, 1 x 1 km², RCP 2.6, 8.5)



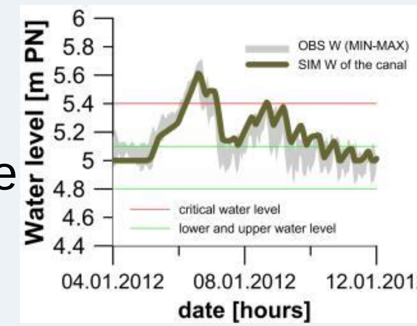
Catchment area of 1580 km²



Simulated discharge

(B) Long-term simulation of hourly water level using a **water balance model**

Settings for modelling
- Sea level North-/ Baltic Sea
- Catchment discharge
- Drainage capacity
- Lock operation

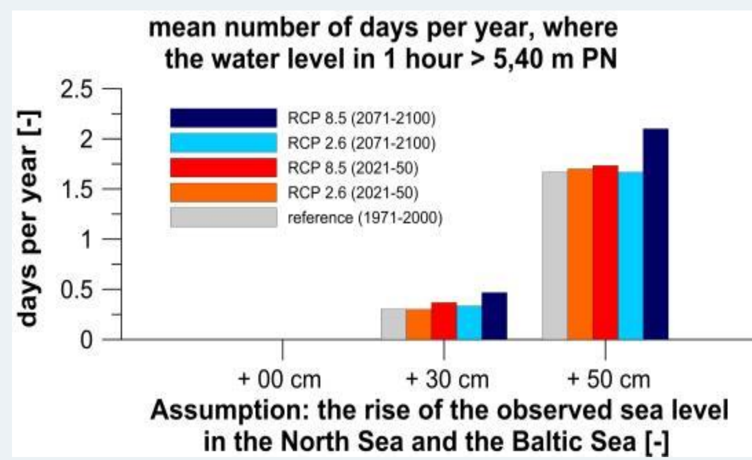


observed and simulated discharge

(C) Studying sensitivity with respect to **SLR** & changes in **catchment hydrology**

Calculation of critical events of water management using the water balance model (B)

- Simulated discharge using RCPs (A)
- Sensitivity study of **SLR**



water management of the Ciel Canal – frequency of critical events

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

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Conclusions

- User specific (waterway, road and rail) climate services

  → Climate impact assessment (exposure, sensitivity, criticality)

  → Basis for adapting the German transport system

- A resilient transport infrastructure is an important basis for maintaining and developing mobility as an important foundation for our societal development.
- We aim at incorporating 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.

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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: Markus Forbriger (EBA), ForbrigerM@eba.bund.de