Climate impact assessment for the German federal transport infrastructure

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Motivation

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

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

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

- Gross domestic product: 16
- Transport of goods on roads: 20
- Transport of goods on rail: 27
- Transport of goods by inland vessels: 28
- Population: 42

BMVI Network of Experts

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

**Topic 1:**
Adapting transport and infrastructure to **climate** change and extreme weather events

**Topic 2:**
Designing **environmentally** friendly transport and infrastructure

**Topic 3:**
Increasing the **reliability** of transport infrastructures

**Topic 4:**
Consistently developing and using **digital technologies**

**Topic 5:**
Enhanced development of **renewable energy** in transport and infrastructure
Objectives of Topic 1

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
Climate Impact Assessment – Illustration

<table>
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<th>Identification</th>
<th>Analysis and Assessment</th>
<th>Visualization</th>
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<td>Federal transport infrastructure</td>
<td>Climate Impact Assessment</td>
<td>Potentially affected routes</td>
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<td>Federal trunk road network</td>
<td>(1) Exposure</td>
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<td>Railway network</td>
<td>(2) Sensitivity</td>
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<td>Federal waterways</td>
<td>(3) Criticality</td>
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**Indicator-based approach**

**Hazards:**
- Cloud
- Sun
- Wind
- Water
- Snow

EMS Annual Meeting 2018
S. Hänsel et al. Climate impact assessment for the German federal transport infrastructure
Agreements on analysis periods, underlying scenarios, reference datasets, ensembles of climate projections, etc.

- Emission scenarios (RCP=Representative Concentration Pathways):
  - RCP2.6 („2 degrees goal“) and RCP8.5 („Business as usual“)
- 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
1st step of CIA – Exposure analysis

- 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).

**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 precipitation totals for different regions over Germany for the winter season using an ensemble of climate projections for RCPs 2.6, 4.5 & 8.5.
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:

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<th>Flood / Low flows</th>
<th>Storms</th>
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<th>Heat</th>
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<td>Hight of bridges</td>
<td>[Image]</td>
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3rd step of CIA – Criticality analysis

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

**Operationalisation:**
- Annual Average Weekday Traffic (freight, people)
- …

**Operationalisation:**
- Trains per day (freight, people)
- …

**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)
Case study ‘Ciel Canal’

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

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

- Calculating the critical events of water management using the water balance model (B)
  - Simulated discharge using RCPs (A)
  - Sensitivity study of **SLR**

(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

- Simulated discharge
- Observed and simulated discharge

Assumption: the rise of the observed sea level in the North Sea and the Baltic Sea [-]
Studied adaptation measures

- 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
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.
Contact

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