# Climate impact assessment for federal trunk roads of Germany

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## Background

Under the guiding theme of Knowledge – Ability – Action, seven departmental research facilities and executive agencies of the Federal Ministry of Transport and Digital Infrastructure (BMVI) formed a Network of Experts in 2016 (Brochure: BMVI Network of Experts Knowledge – Ability – Action, 2017).

Topic 1 deals with the adaptation of transport and infrastructure to climate change and extreme weather events (Fig.1).

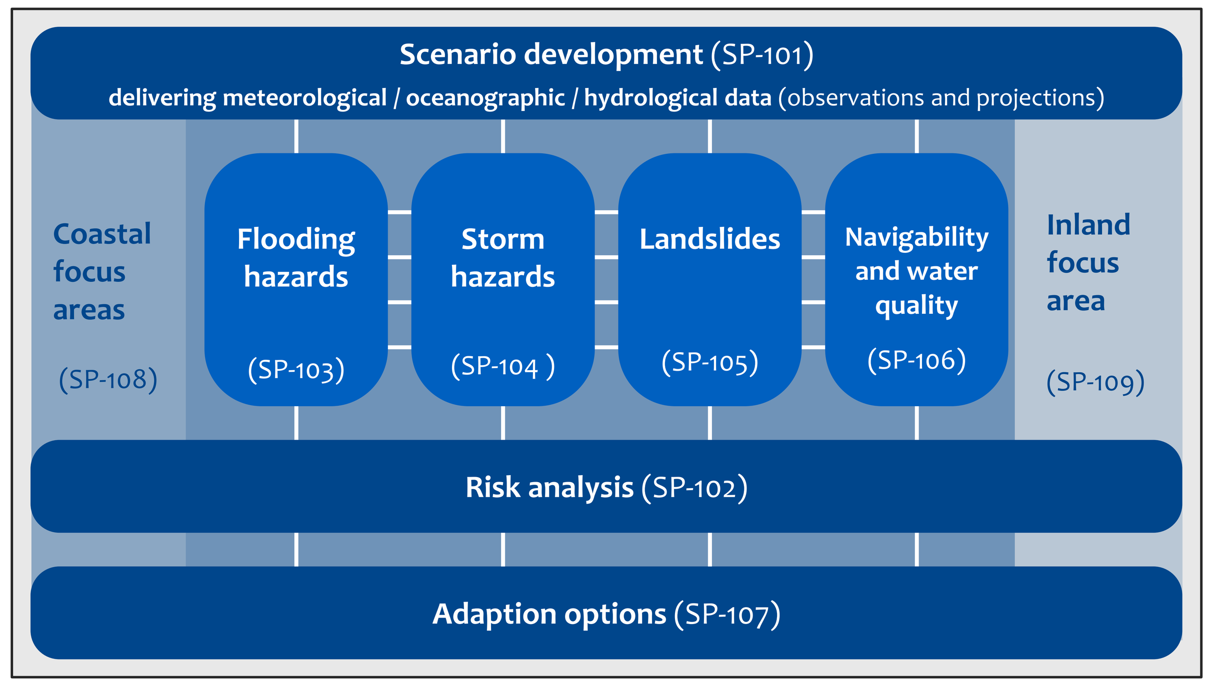


Fig. 1: Projects (SP-101 - SP-109) of Topic 1 "Adapting transport and infrastructure to climate change and extreme weather events" (www.bmvi-expertennetzwerk.de/EN).

In project SP-102 "Risk analysis" an approach to climate impact assessment is developed and applied for road, railway and waterway. For federal trunk roads the three hazards flooding, storm and landslides are considered.

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## Climate impact assessment

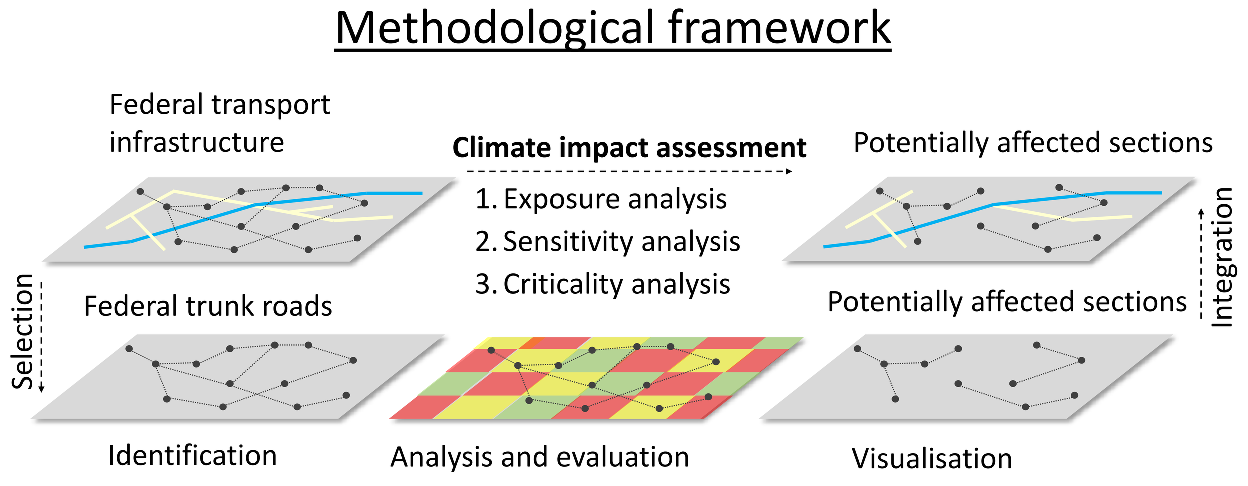


Fig. 2: Methodological framework of the network-wide climate impact assesment for federal trunk roads, federal railways and federal waterways of germany.

### Analytic steps

1. Exposure analysis: Identification of road sections which are exposed to potential climate impacts
2. Sensitivity analysis: Identification of road sections which are sensitive to potential climate impacts
3. Criticality analysis: Identification of road sections which show high importance for road traffic

## Examples of exposure analysis

### Landslides:

The exposure analysis for landslides is done by a landslide susceptibility map. This is based on a geotechnical knowledge based approach. The landslide geo-hazard potential is determined in the first step by combining slope angle classification and geo-technical rock classification in a geographic information system (Tab.1). The initial classification result was further refined by including additional parameters like land use, rock deformation sensitivity, the degree of rock fracturing, the presence of divisional surfaces in the rock and flow accumulation (Fig. 4). These modifiers were combined by an algorithm which allows the final down- or upgrade of the initial geo-hazard potential classes by one class down (-1) or up (+1).

Tab. 1: Knowledge-based classification scheme (decision tree) of the geo-hazard potential by combining rock classes and slope classes

| Geo-hazard Potential Class | Slope Angle Classification | Unconsolidated Rocks | | | Hard Rocks |
|---|---|---|---|---|---|
| | | *GK = 3; 7; 5* mixed-grained | *GK = 4; 8* non-cohesive | *GK = 2; 6* cohesive | *GK = 1; 0* |
| 15 | | | | | |
| 14 | *DGM = 5* | > 36° | | > 30° | > 60° |
| 13 | | | | | |
| 12 | | | | | |
| 11 | *DGM = 4* | > 30 - 36° | > 36° | > 25 - 30° | > 50 - 60° |
| 10 | | | | | |
| 9 | | | | | |
| 8 | *DGM = 3* | > 25 - 30° | > 30 - 36° | > 10 - 25° | > 30 - 50° |
| 7 | | | | | |
| 6 | | | | | |
| 5 | *DGM = 2* | > 10 - 25° | > 25 - 30° | 0 - 10° | 0 - 30° |
| 4 | | | | | |
| 3 | | | | | |
| 2 | *DGM = 1* | 0 - 10° | 0 - 25° | | |
| 1 | | | | | |

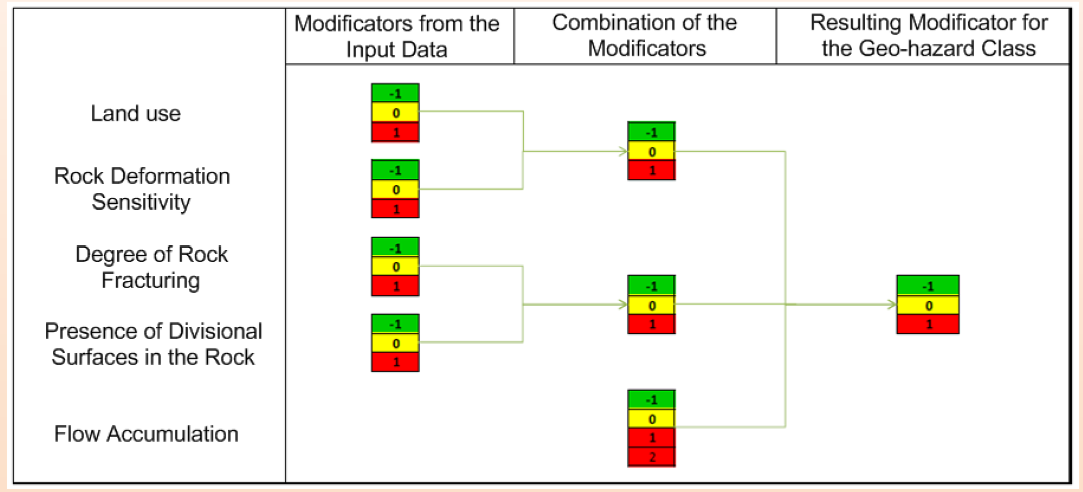


Fig. 4. Flow scheme (algorithm) for calculation of the resulting modification (specification) of the geo-hazard potential classes by combining the modifiers from the different controlling model input data. (Source: Knobloch et al. / TRA2018, Vienna, Austria, April 16-19, 2018).

### Flooding hazards:

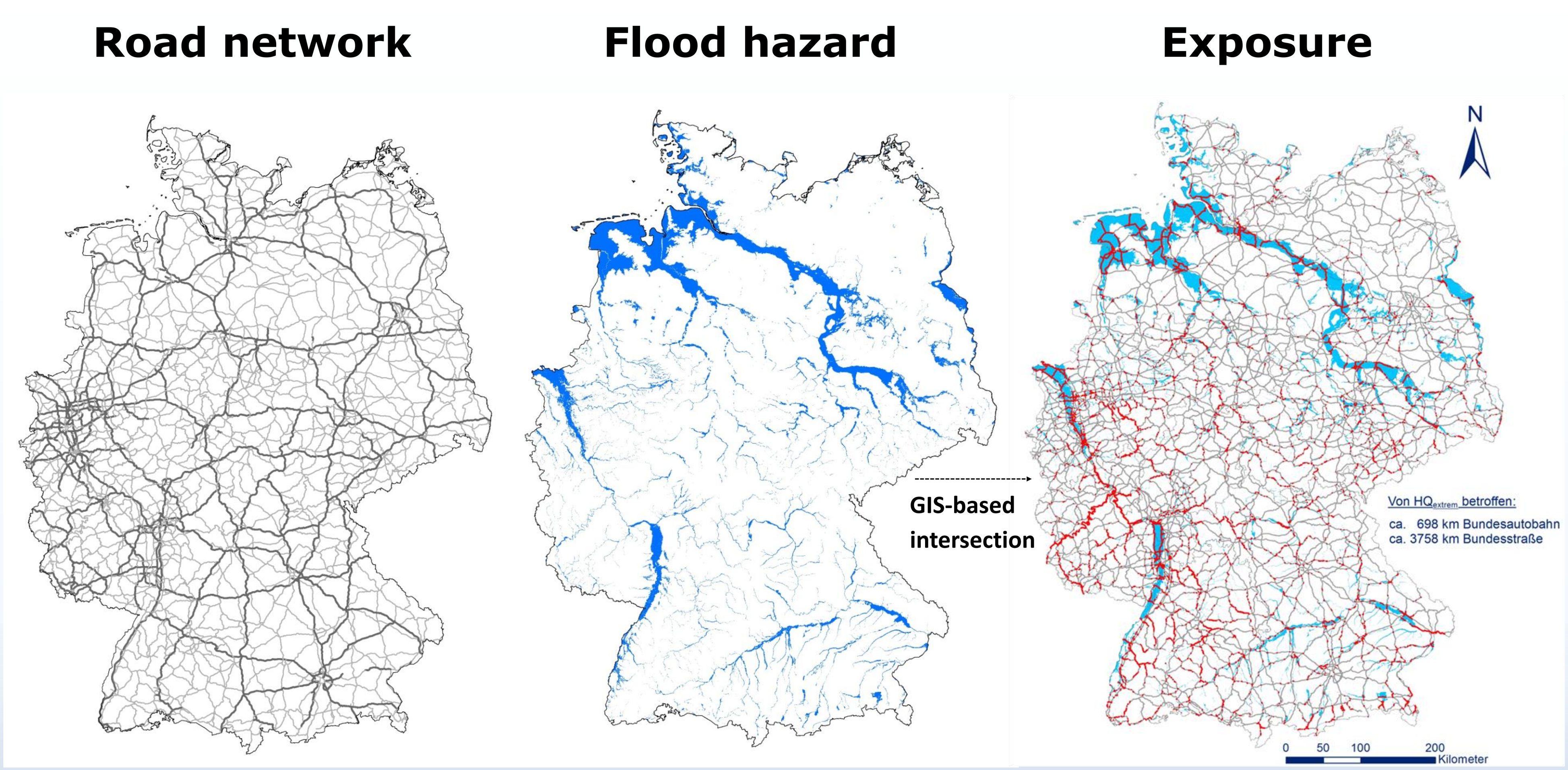


Fig. 3: GIS-based flood exposure analysis for the federal trunk roads of Germany. Road sections potentially affected by „extreme flooding "(return period > 100 a ) highlighted in red.

Source: Bundesinformationssystem Straße (BISStra) & Überflutungsszenarien der HWRMRL-DE, © WasserBLIcK/BfG & Zuständige Behörden der Länder.

### Storm hazards:

The risk of storms affecting federal trunk roads is mainly caused by the windthrow. In a first step a GIS-based intersection of the roads and Vegetation is made with the Digital Base Landscape Model (DLM). It contains different types of forests, tree avenues and other woodlands. The DLM only contains 2D data. Thus there is no statement about tree heights in-cluded. Because this is necessary to give a valid statement about the hazard potential, projects with laser-scanning methods are planned for future.

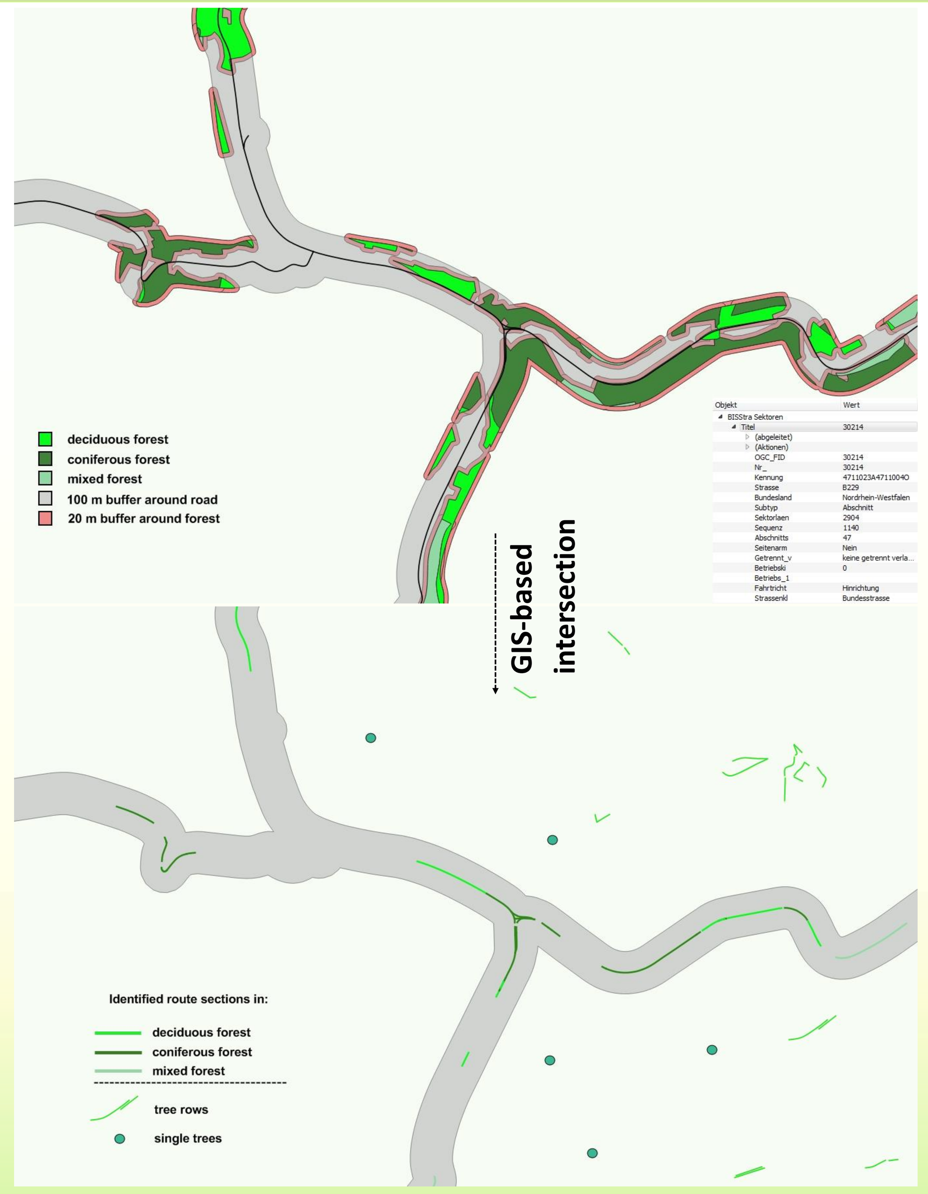


Fig. 5: Exposure of national trunk roads to Vegetation. The identified sections will be combined with climate projection data (Storm-days with intensity >8Bft). Source: Bundes-informationssystem Straße (BISStra) & Datenbestände des ATKIS *Basis-DLM* der Länder.