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).

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

Methodological framework

Federal transport infrastructure
Climate impact assessment
1. Exposure analysis
2. Sensitivity analysis
3. Criticality analysis
Potentially affected sections

Fig. 2: Methodological framework of the network-wide climate impact assessment 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).

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) & Überflutungszenarien der HWRML-DE, © WasserBlick/BIG & Zuständige Behörden der Länder.

Storms:
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 included. Because this is necessary to give a valid statement about the hazard potential, projects with laser-scanning methods are planned for future.

Fig. 5: Expos of national trunk roads to vegetation. The identified sections will be combined with climate projection data (Storm-days with intensity > 8Bt). Source: Bundesinformationssystem Straße (BISStra) & Datenbestände des ATKIS Basic-DLM der Länder.

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

<table>
<thead>
<tr>
<th>Slope Angle Classification</th>
<th>Risk Rating</th>
</tr>
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<tbody>
<tr>
<td>0° - 3°</td>
<td>-1</td>
</tr>
<tr>
<td>&gt; 0° - 10°</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 10° - 20°</td>
<td>+1</td>
</tr>
<tr>
<td>&gt; 20° - 30°</td>
<td>+2</td>
</tr>
<tr>
<td>&gt; 30° - 40°</td>
<td>+3</td>
</tr>
<tr>
<td>&gt; 40° - 50°</td>
<td>+4</td>
</tr>
<tr>
<td>&gt; 50° - 60°</td>
<td>+5</td>
</tr>
<tr>
<td>&gt; 60° - 70°</td>
<td>+6</td>
</tr>
<tr>
<td>&gt; 70° - 90°</td>
<td>+7</td>
</tr>
<tr>
<td>&gt; 90° - 109°</td>
<td>+8</td>
</tr>
</tbody>
</table>

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. / TKA2018, Vienna, Austria, April 16-19, 2018.

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