United Nations ECE/TRANS/WP.5/GE.3/2019/2

Economic and Social Council

Distr.: General
13 February 2019

Original: English

Economic Commission for Europe

Inland Transport Committee

Working Party on Transport Trends and Economics

Group of Experts on Climate Change Impacts and Adaptation for Transport Networks and Nodes

Seventeenth session
Geneva, 24 and 25 April 2019
Item 2 of the provisional agenda
Climate Change and Transport Networks and Nodes: Presentations of initiatives at national and international levels

Adapting the German transport system to climate change*

Submitted by the Government of Germany

I. Introduction

1. This document briefly introduces the climate change adaptation undertakings for transport system in Germany. The Group of Experts requested at the sixteenth session that this case study is tabled as on official document at the seventeenth session.

II. The German Adaptation Strategy

2. In order to provide climate change adaptation in Germany with a political framework, the federal government adopted the German Strategy for Adaptation to Climate Change (DAS) (German Federal Government, 2008) in December 2008. The DAS aims at reducing vulnerability to climate change impacts and maintaining or enhancing adaptability of natural, societal, and economic system. It considers both the impact of gradual climate changes and the consequences of increasing extreme events. The DAS presents possible consequences of climate change in different fields of action (Buth et al., 2015) and suggests

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potential courses of action (Adaptation Action Plan, APA) in order to make Germany more resilient to climate change impacts.

III. Research programs – The German Federal Ministry of Transport and Digital Infrastructure Network of Experts

3. The challenges posed by climate change and extreme events to the German transport system are addressed by a series of research programs financed by the German Federal Ministry of Transport and Digital Infrastructure (BMVI). Starting in 2009 the KLIWAS[1] programme investigated specific effects on the German waterways (BMVI, 2015). Likewise, the AdSVIS program with the RIVA project (Auerbach et al., 2014; Korn et al., 2017) addressed road specific issues including a risk analysis. Starting in 2016, the expertise and competencies of seven departmental research institutes have been pooled in a new program focusing on "Adapting transport and infrastructure to climate change and extreme weather events" (www.bmvi-expertennetzwerk.de/EN, BMVI (2017)). Integrating the perspectives of road, railway and waterway transport, the program fosters the interdisciplinary exchange of knowledge and skills. Thereby it creates the potential for innovative solutions for climate change adaptation and a sustainable development of the German transport system in a dialogue between science, policy and practice. Together, seven Federal authorities address complex challenges affecting strategic planning at the level of the transport network as well as technical adaptation measures to traffic routes and individual infrastructure elements. Thereby, expertise in climate sciences (Germany's Meteorological Service Deutscher Wetterdienst (DWD), Federal Maritime and Hydrographic Agency (BSH)) is combined with practical knowledge on the modes of transport (road: Federal Highway Research Institute (BASt); rail: Federal Railway Authority (EBA); waterways: Federal Institute of Hydrology (BfG), and Federal Waterways Engineering and Research Institute (BAW); goods: Federal Office for Goods Transport (BAG)).

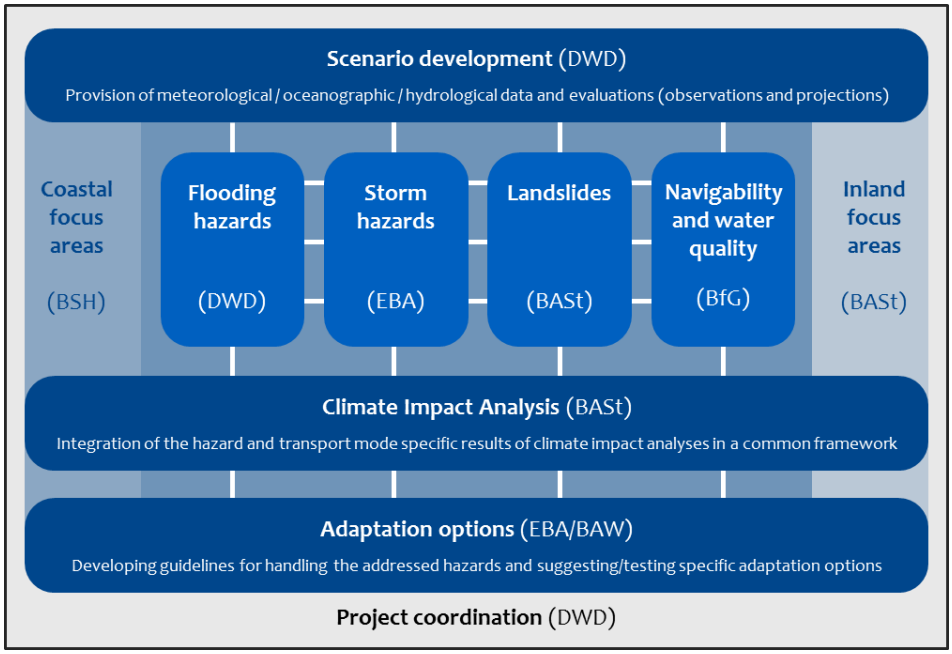
IV. Adapting transport and infrastructure to climate change and extreme weather events

4. Within topic 1 of the BMVI Network of Experts knowledge about the spatial pattern of observed and expected future climate change impacts is generated and connected with evaluations about the vulnerability and criticality of transport infrastructure in order to develop, test and implement specific adaptation options for gradual climatic changes and extreme weather events. The scientific work is structured into nine closely interrelated sub-projects, each coordinated by one of the involved partner institutions (Figure I).

[1] Climate-Water-Navigation

Figure I

Organizational flowchart of the project work within topic 1 of the BMVI Network of Experts



5. Within the sub-project "scenario development" a common framework for the impact analyses in the hazard specific sub-projects is agreed and a consistent set of scenario data, including climate, land use and transport scenarios is created and provided. Accordingly, an ensemble of regional climate projections is processed for the user-specific needs and provided to all partners. Additionally, oceanic and hydrological data including derived products are created and distributed. Based on these data specific impact analyses are done within four sub-projects focusing on floods, storms, landslides and waterway specific hazards affecting navigability and water quality. The results of these impact studies obtained for different modes of transport and different climate hazards are integrated into a GIS-based assessment method to evaluate the exposure, sensitivity and criticality of transport infrastructure. This method aims at providing information relevant to climate change adaptation at the network level and for specific sections of the transport network.

6. Based on classification and evaluation systems current climate impacts on infrastructure are represented and projected into the future. Those assessments of potential risks under current and future climate conditions are a valuable support for decisions on the (re)construction and management of transport infrastructures. Finally, guiding principles for the handling of the addressed hazards and specific adaptation options are developed. They target at tailoring technical guidelines and rules, adjusting management practices (e.g., changes in the water and sediment management connected to altered flow conditions) and developing new materials and technical constructions (e.g., adaptation of road surface materials to a higher spread of extreme temperatures or constructive aspects connected to changes in flooding or storminess). The impact assessment is complemented by regional case studies integrating different risks and encompassing different modes of transport in higher detail. These studies are conducted in several inland and coastal focus areas that allow addressing specific, intermodal risks like those posed by sea level rise in coastal areas or those connected to widespread flooding or low flow situations in the inland. These focused analyses allow the application of specific impact models and to identify cause-effect relationships that may be transferred to a larger scale.

V. Integrated climate impact assessment

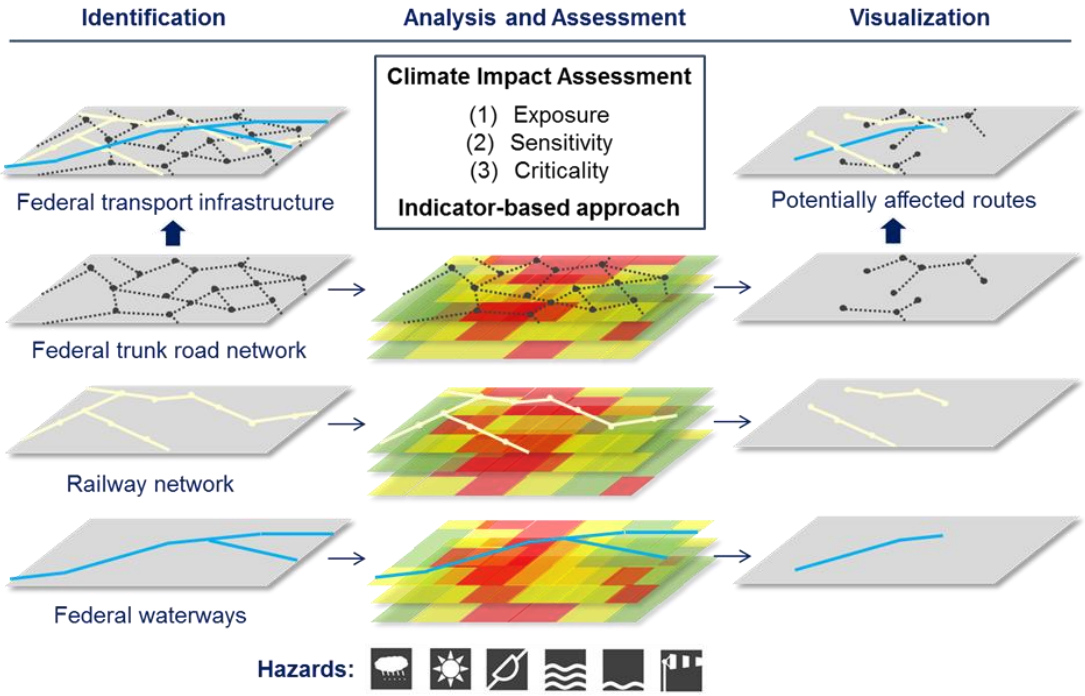
7. Climate impact analyses for specific hazards and modes of transport are integrated in a common assessment tool in order to provide a robust basis for climate adaptation measures in the transport sector. In order to obtain comparable results, common

- analysis periods (base period: 1971–2000, Future: 2031–2060 & 2071–2100),
- underlying scenarios (Representative Concentration Pathways RCP2.6 and RCP8.5; traffic scenarios according to the federal infrastructure planning with a reference (2010) and a target network (2030)),
- reference datasets,
- ensembles of climate projections (e.g., display of ensemble bandwidth, 15th and 85th percentile),

were agreed.

8. This common evaluation framework forms an important basis for the climate impact assessments. The methodology of the impact assessment is inspired by the Guidelines for Climate Impact and Vulnerability Assessments (Buth et al., 2017) that shall support the German adaptation strategy DAS. The analytic steps of the impact assessment (Figure II) encompass a sensitivity analysis that aims at identifying the network sections exposed to climate impacts, and a sensitivity analysis that identifies the network sections specifically sensitive to climate impacts. The relevant climate impacts are evaluated by analysing the criticality of impacted network sections that assesses how critical the network sections are within the entire transport system.

Figure II
Schematic illustration of the climate impact assessment within the BMVI Network of Experts



9. The impacts of climate change and extreme weather events on transport infrastructure and mobility may be assessed using impact models or climate indices. While

the evaluation for the waterways is largely based on impact models – simulating for instance runoff, hydrodynamics, and morphodynamics – and related impact indices, the assessments for rail and road are generally based on climate indices directly derived from climate projections. These indices are based on expert opinion and research results. In the climate impact assessment framework these impact and climate indices are combined with other indices describing the sensitivity of specific sections of the federal road, rail and waterways network and the criticality or importance of the sections for the transport system. A list of climate indices was compiled in a preliminary catalogue that has been discussed with scientists, engineers and practitioners in the agencies responsible for road, rail and waterway transport. In order to provide climate indices relevant to impact and risk analysis, a scientific exchange within the BMVI Network of Experts is essential. The challenging task is to address both, the demands of practitioners for data on extreme events and the technical capabilities of regional climate projections. Climate indices with practical relevance for damages to the infrastructure are often characterized by sub-daily timescales and high return periods, while climate simulations are generally provided in daily resolution and are most robust for average climate conditions. Thus, compromises need to be made, particularly with respect to extreme precipitation and wind indices.

VI. Conclusions and Outlook

10. As a research network the BMVI Network of Experts develops data, methodologies and tools for assessing climate change impacts on the German Federal transport system. It delivers climate impact assessments at the national level for the transport sector that are going to be integrated in the National climate impact und vulnerability assessment. For selected focus areas more detailed data and evaluations are provided and exemplarily specific adaptation options are tested. The implementation of the adaptation measures is done by the operators of the transport infrastructure, which are the Federal Waterways and Shipping Administration (GDWS; Agency of BMVI), Deutsche Bahn AG (rail) and Road administrations of the Federal States. Thereby, a regular dialogue between science and practice is established. Furthermore, GDWS supports the integration of climate change aspects into planning by preparing a climate proofing handbook for the administrative staff.

11. By combining climatological expertise and application knowledge of different transport modes within one network the BMVI takes steps towards a resilient transport system. Mobility is maintained and developed as an important foundation for our entire social development and the projected long-term developments are integrated into investment decisions of the BMVI. The results obtained for the Federal transport system are also relevant for other stakeholders at the regional level and form an important contribution to the implementation of the German Adaptation Strategy.

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