13th ROAD TECHNICAL COMMITTEE
Technical Assistance State of play

Project Team
September 2023
Improving Climate Resilience and Adaptation Measures in the Indicative Extension of TEN-T Road and Rail Networks in Western Balkans

Project Context

• Ensure the development of the indicative extension of the TEN-T Core and Comprehensive networks to the Western Balkans
• This Project is one of the actions set in the Sustainable and Smart Mobility Strategy for the Western Balkans
• Project assignment focus shall be given to the existing indicative extension of TEN-T roads networks
• Project shall also consider planned sections that are currently under development
The indicative roads extension of TEN-T in Western Balkan includes:

5,287 km of TEN-T roads, out of which 3,540 km on the Core Network

*This designation is without prejudice to positions on status and is in line with UNSCR 1244 (1999) and the ICJ Opinion on the Kosovo declaration of independence.*
Project objective

Reduce climate change risks

Vulnerability analysis

Undertake the Vulnerability analysis based on the sensitivity and the exposure to climate-related hazards

Measures and strategies

Identify and select adaptation measures and strategies for mitigation of climate hazards on road and rail

Criticality assessment

Undertake the Criticality assessment of the road TEN-T network

Build capacity

Build institutional capacity on climate resilience
The Project will use transport model outputs from the Technical Assistance for the Deployment of Smart and Sustainable Mobility in the Western Balkans.

The network to be considered will be 1) existing, 2) ongoing to be completed by the timeline and 3) mature projects in Five Year Rolling Work Plan for Development.

The Project commenced on January 26, 2023.

Two workshops planned are to be organised.

The TCT shall provide contacts of relevant stakeholders.

Project ends with the end of year 2023.
## Stakeholder Engagement

**Transport Ministry (and/or Infrastructure Ministry)**

- Ministry-level commitment and accountability; Policy and regulatory influence

**Rail/Road operators (planning department, investment/finance planning department and maintenance department)**

- Planning department is responsible for ensuring that the road infrastructure is designed, constructed / maintained to withstand the potential impacts of climate change

**Maintenance department**

- Ensuring that the infrastructure is in good working order and can withstand the wear and tear of daily use, as well as the potential impacts of climate change (including prompt response to climate-related emergencies and restoring operations after a weather event has occurred)

**Investment/Finance planning department**

- Important for allocating funds to maintain and upgrade existing infrastructure and invest in new projects, and it is directly linked with the Planning department
Data Collection

Aiming for successful Project outcomes

Different group of data needed for the successful project outcomes. All related to TEN-T Core/Comprehensive corridors:

- Database of hazard occurrence: such as rockfalls, floods, snowstorms and landslides
- Database regarding performed work (maintenance, rehabilitation, reconstruction) related to above listed hazards occurrence
- Current state (condition) of the subject TEN-T infrastructure
- Traffic demand data per TEN-T sections/links for year 2021 and 2022
- Historic traffic accidents along TEN-T sections/links related to above listed hazard occurrence

Note: All database are preferably required in open format (GIS or excel)
Methodology

Technical guidance on the climate proofing of infrastructure by European Commission (drafted in 2021)

Part 1 Mitigating climate change (climate neutrality)

Part 2 Adaptation to climate change (climate resilience)  Our focus

- Screening – Phase 1 (ToR tasks 1-2)
  - Sensitivity
  - Exposure
  - Vulnerability

- Detailed analysis – Phase 2 (ToR tasks 2-4)
  - Likelihood
  - Impact
  - Risks
  - Adaptation measures

“This guidance may be complemented with additional national and sectoral considerations and guidance.”
Methodology

Technical guidance on the climate proofing of infrastructure by European Commission (drafted in 2021)

Adaptation to climate change
Methodology

**Improved methodology**

“There are multiple definitions of vulnerability and risk. For example, see IPCC AR4 (2007) on vulnerability and IPCC SREX (2012) and IPCC AR5 (2014) on risk (as a function of likelihood and the consequences of the hazard)”

Identifying infrastructure sensitivity high-low to climate-related hazard
- Assets and processes
- Inputs
- Outputs
- Access and transport links

Defining spatial asset exposure
- Current climate
- Future climate

Vulnerability of asset to climate-related hazard
- Sensitivity vs. Exposure

**Technical guidance approach**

**Sensitivity (our approach):**
Appraisal of network intrinsic features (e.g., link length - LL) + historical records on reported damage, interruption or closure.

**Exposure (our approach):**
Pre-defined (existing) hazard models in current and projected climate (H)

**Vulnerability (our approach):**
GIS context of exposed network links
\[ V = \frac{H_{\text{mean}}}{LL} \]
Impact assessment elaborates 'how fundamental this infrastructure is to the wider network or system (i.e. criticality) and whether it may lead to additional wider impacts and cascading effects.'

Impact of climate hazards (our approach):
1. Road failure assessment: a) decreased speed, b) decreased capacity, c) closed road link, d) duration of failure
2. Transport demand assessment (current and projected)
3. Socio-economic assessment (Travel time, VOC, social and env. impact, impact on the local/regional economy)

Prioritisation (our approach):
- MCA including CBA
- Short-, Medium-, and Long-term measures
Methodology

Improved methodology

Based on regional experience and data available (in compliance with the original Methodology):

- **Hazard selection**
- **Hazard spatial distribution (susceptibility)**
- **Network definition**
- **Current and future (based on climate projections) exposure to hazard (likelihood)**
- **Current and future network risk (likelihood)**
Vulnerability Assessment

Final Results

Hazard selection (Sensitivity)
By analysing publicly available hazard databases, the WB region is primarily affected by:
- Floods (riverine and flash floods)
- Landslides (type* unspecified)

By consulting stakeholders and summarizing completed or on-going projects in transport domain, transport infrastructure in the WB region is additionally affected by:
- Snow drift
- Extremely high temperatures
- Sea level rise

(limited section of the TEN-T network)

<table>
<thead>
<tr>
<th>Preliminary sensitivity table</th>
<th>Flood</th>
<th>Landslide</th>
<th>Snow drift</th>
<th>High temperature</th>
<th>Sea level rise</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets and processes</strong></td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Access and transport links</strong></td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Source: emdat.be

*landslides = slides, rockfalls, debris flows etc.
Vulnerability Assessment

Final Results

Hazard spatial distribution (Exposure)

Due to the extent of the interest region and other constrains (time, potentially unharmonized national level data, analogue data, etc.) existing (freely available) large-scale models, approved or initiated by EC (JRC) were used:

☑️ European Flood Hazard Map (EC JRC FLOODS: https://data.jrc.ec.europa.eu/dataset/1d128b6c-a4ee-4858-9e34-6210707f3c81)
☑️ Pan-European Landslides Susceptibility Map (EC JRC ESDAC: https://esdac.jrc.ec.europa.eu/)
☑️ Precipitation indices (Climate Change Centre Austria: https://data.ccca.ac.at/)
☑️ Snow indices (Climate Change Centre Austria: https://data.ccca.ac.at/)
☑️ Wind indices (Climate Change Centre Austria: https://data.ccca.ac.at/)
☑️ Temperature indices (Climate Change Centre Austria: https://data.ccca.ac.at/)

These are all georeferenced raster models, with resolution which varies from 100 to 250 m which is sufficient for TEN-T network level of detail, or with resolution (climate variables) that requires downscaling process to adapt coarse models from >1 km resolution to 25 m resolution using Climaproof project tools.

Their verification is conducted by using stakeholder data on recorded events

- Analogue format → digital georeferenced points
- Existing spatial databases
Vulnerability Assessment

Final Results

Hazard spatial distribution (Exposure)

ClimaProof (Enhancing Environmental Performance and Climate Proofing of Infrastructure Investments in the Western Balkan Region from an EU integration perspective: climaproof.net) is a climate change adaptation-oriented project targeting the WB region.

It consists of several tools which are design to facilitate easier implementation of climate change agenda in planning and design (which may use regular spatial modelling, such as hazard mapping):

✓ Selection tool (helps to select among 3000+ climate change models for a particular case)
✓ Downscaling tool (adapts coarse resolution multi-temporal models to fine resolution)
• ICC-OBS tool (allows the user to generate bias-corrected climate models from own datasets)

Our focus

It contains a repository with over 3000 climate models and indices suitable for various climate parameters and for various time spans.

It can partly compensate for a climate change expert.

It can be used for subsequent likelihood assessment.
Vulnerability Assessment

Final Results

Hazard spatial distribution (Exposure)

Outputs:
- Landslide hazard map
  - LS – Original landslide susceptibility map normalized to 0-1
  - PF – Downscaled Precipitation factor (daily annual average) map normalized to 0-1
  - LH=LS x PF – Landslide hazard map
    ✓ for 2030
    ✓ for 2050

- Flood hazard map
  - Different return periods
    ✓ 50y corresponds to 2030
    ✓ 100y corresponds to 2050

Preliminary exposure table

<table>
<thead>
<tr>
<th></th>
<th>Flood</th>
<th>Landslide</th>
<th>Snow drift</th>
<th>High temperature</th>
<th>Sea level rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current climate (2030)</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Future climate (2050)</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>
Vulnerability Assessment

Final Results

Hazard spatial distribution (Exposure)

Outputs:
- Snow drift hazard map
  - Normalized snow days indicator SD
  - Normalized wind speed climate index WS
  - $SH = SD \times WS$ – Snow drift hazard map
    ✓ for 2030
    ✓ for 2050
- Temperature hazard map
  - Normalized maximal temperature change
    ✓ for 2030
    ✓ for 2050
- Sea surge hazard map
  - Digital terrain model DTM
  - Simulated sea level SSL
  - $SLH = DTM - SSL$
    ✓ for 2030
    ✓ for 2050
Vulnerability Assessment

Final Results

Network characteristics (Vulnerability)

TEN-T comprehensive and core road network:
- With predefined network links and nodes (TCT)
  199 road links with different lengths
- With arbitrarily split segments
  intervals of ~1 km in length
- Versioning for current, 2030 and 2050 road network state
Vulnerability Assessment

Final Results

Current and future exposure to hazard (Vulnerability)

PER LINK for 2030 and 2050 time split
Overlapping road network vector with:
- Landslide hazard map
- Flood hazard map
- Snow drift hazard
- Temperature hazard map
- Sea surge hazard map
- MULTI HAZARD
Vulnerability Assessment

Final Results

Current and future exposure to hazard (Vulnerability)

PER SUB-LINK for 2030 and 2050 time split

Overlapping road network vector with:
- Landslide hazard map
- Flood hazard map
- Snow drift hazard
- Temperature hazard map
- Sea surge hazard map

- MULTI HAZARD
Vulnerability Assessment

Final Results

Current and future exposure to hazard (Vulnerability)

Example of comparing LINK vs. SUBLINK

- Landslide hazard map
Vulnerability Assessment

Final Results

Current and future exposure to hazard (Vulnerability)

Example of comparing CURRENT vs. FUTURE
- Flood hazard map per link
- Flood hazard map per sublink
Vulnerability Assessment

Final Results

Current and future exposure to hazard (Vulnerability)

Output spreadsheets for roads:
- Ranking most vulnerable links/segments
- Appending additional criticality criteria such as population, social, economic components, etc.
- Allowing prioritization per link/segment and mapping them in GIS environment
Project Deliverables

Delivery on time

Our work plan and time schedule are ultimately based on the time frame and submission dates for deliverables.