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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

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Roads

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

Criticality assessment

Undertake the Criticality assessment of the road TEN-T network

Measures and strategies

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

Build capacity

Build institutional capacity on climate resilience

Project Timeline

From beginning to end

The Project commenced on **January 26, 2023**

The Project will use transport model outputs from the Technical Assistance for the Deployment of Smart and Sustainable Mobility in the Western Balkans

Two workshops planned are to be organised

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 TCT shall provide contacts of relevant stakeholders

Project ends with the **end of year 2023**

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Stakeholder Engagement

Support the project from the very beginning

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

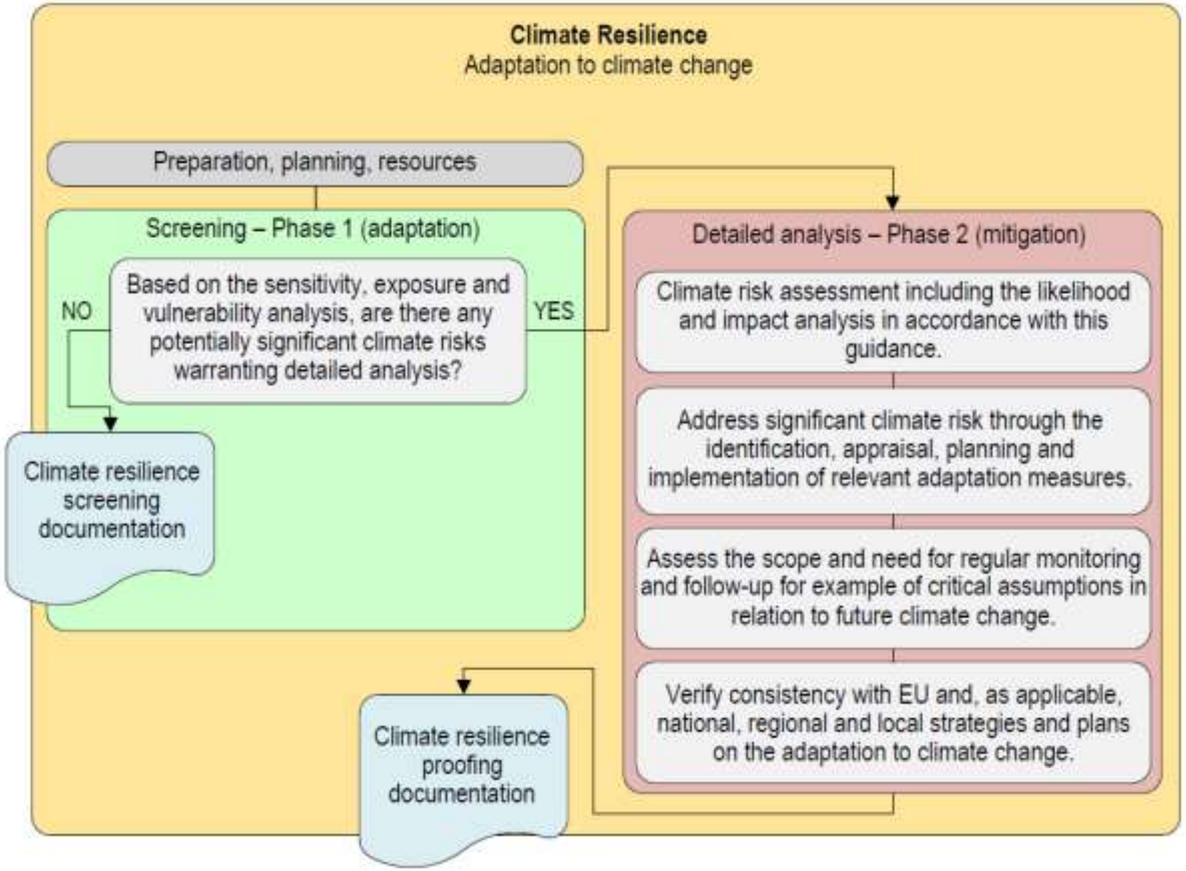
Technical guidance on the climate proofing of infrastructure by European Commission (drafted in 2021)

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



Based on the sensitivity, exposure and vulnerability analysis, are there any potentially significant climate risks warranting detailed analysis?

Climate risk assessment including the likelihood and impact analysis in accordance with this guidance.

Address significant climate risk through the identification, appraisal, planning and implementation of relevant adaptation measures.

Assess the scope and need for regular monitoring and follow-up for example of critical assumptions in relation to future climate change.

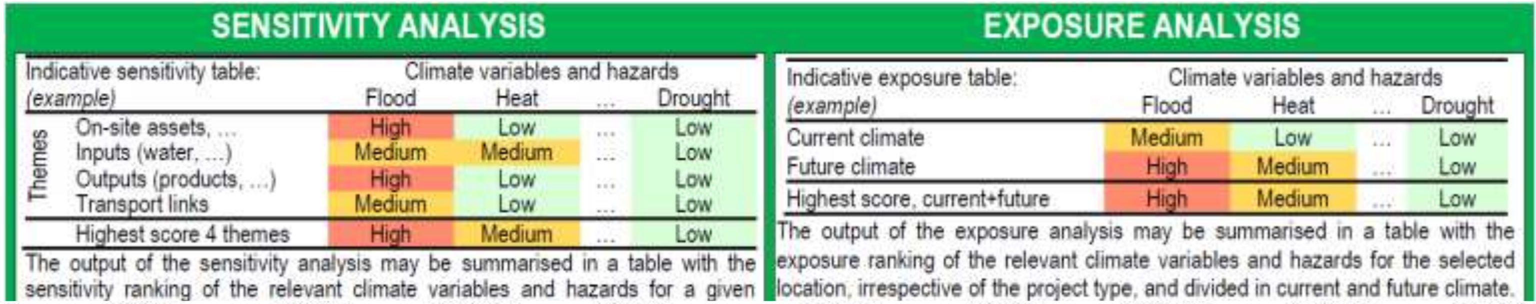
Verify consistency with EU and, as applicable, national, regional and local strategies and plans on the adaptation to climate change.

“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



SENSITIVITY ANALYSIS

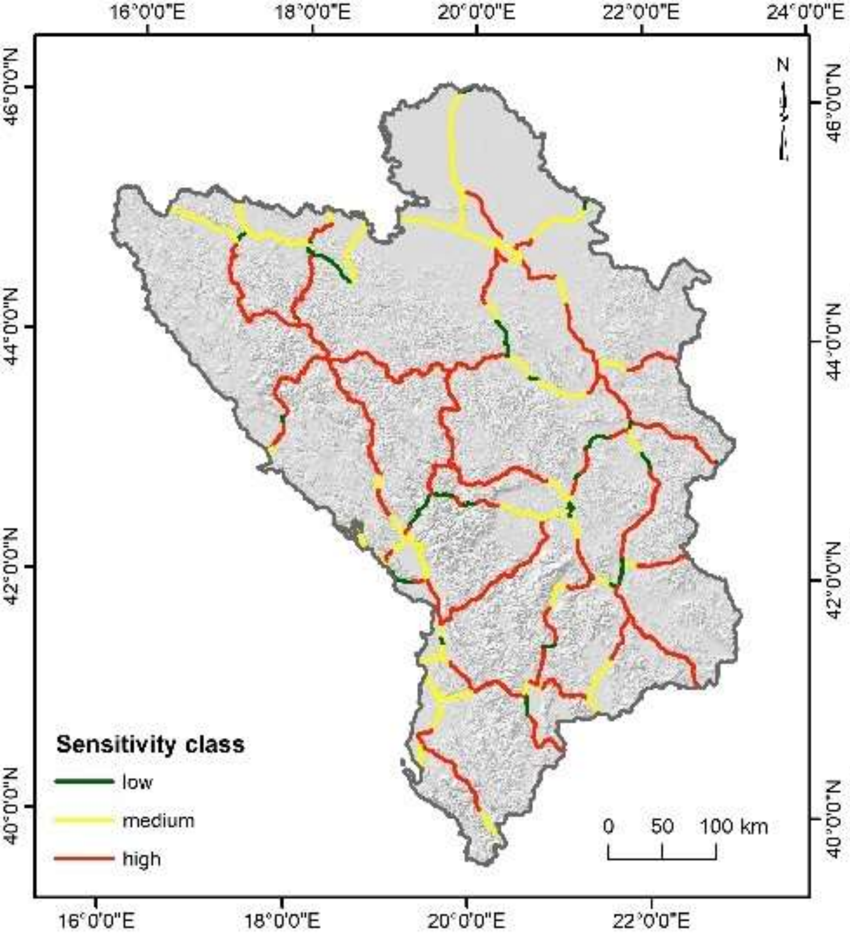
Indicative sensitivity table: *(example)*		Climate variables and hazards			
		Flood	Heat	…	Drought
Themes	On-site assets, …	High	Low	…	Low
	Inputs (water, …)	Medium	Medium	…	Low
	Outputs (products, …)	High	Low	…	Low
	Transport links	Medium	Low	…	Low
	Highest score 4 themes	High	Medium	…	Low

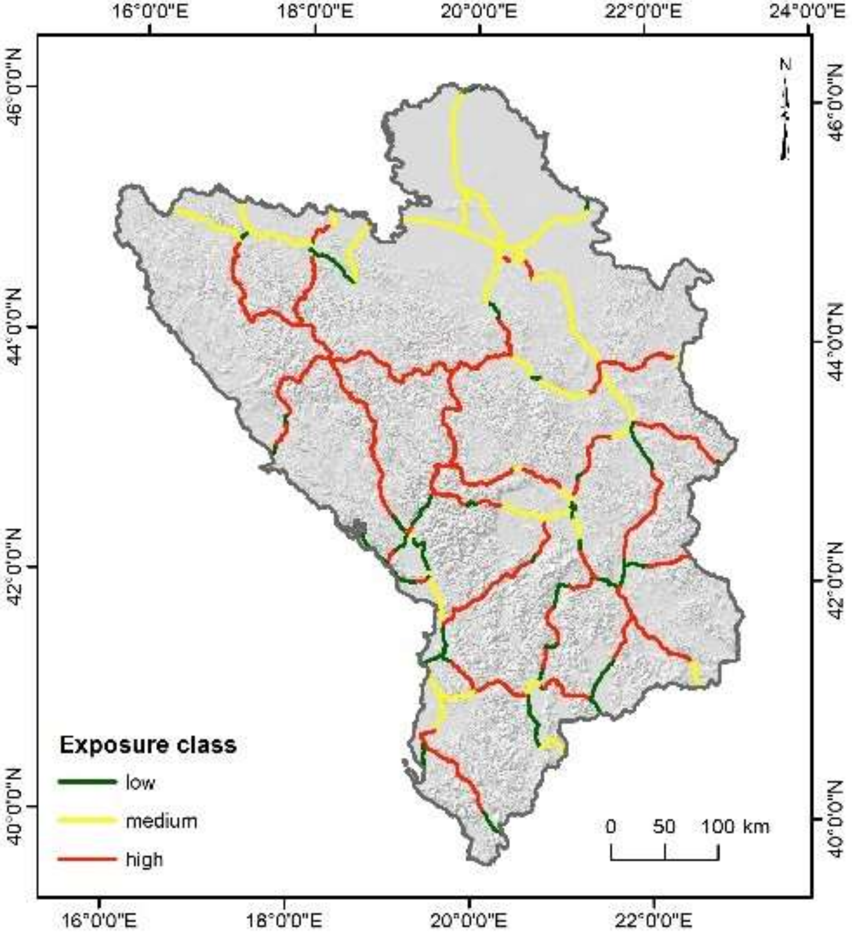
The output of the sensitivity analysis may be summarised in a table with the sensitivity ranking of the relevant climate variables and hazards for a given

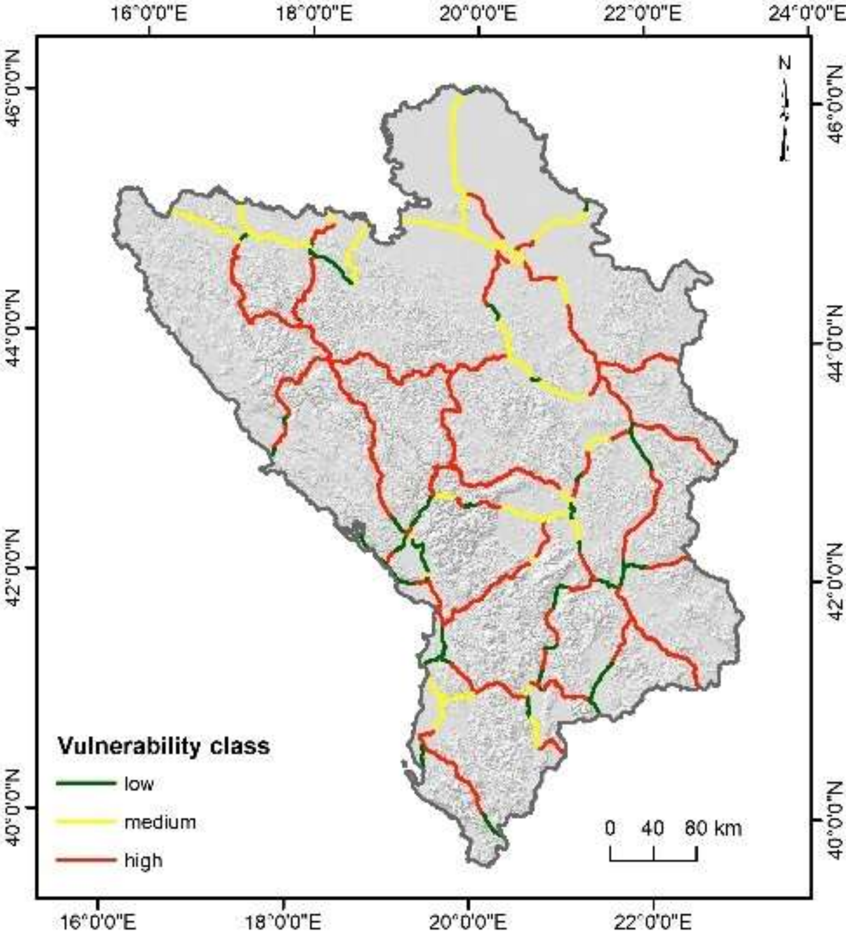
EXPOSURE ANALYSIS

Indicative exposure table: *(example)*	Climate variables and hazards			
	Flood	Heat	…	Drought
Current climate	Medium	Low	…	Low
Future climate	High	Medium	…	Low
Highest score, current+future	High	Medium	…	Low

The output of the exposure analysis may be summarised in a table with the exposure ranking of the relevant climate variables and hazards for the selected location, irrespective of the project type, and divided in current and future climate.







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
$V=H_{mean}/LL$

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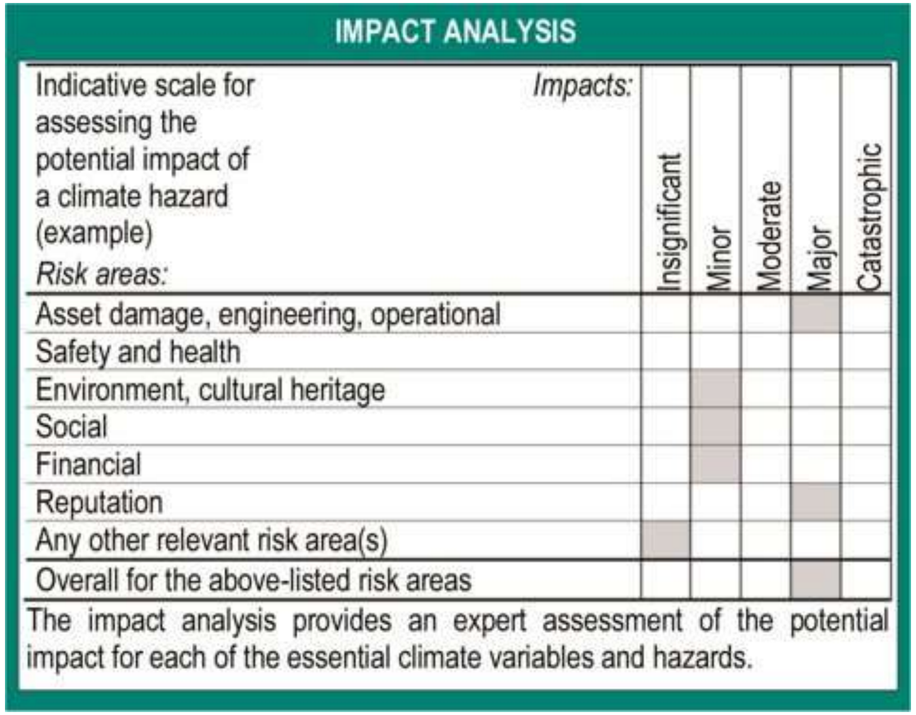
Methodology

Improved methodology

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 ANALYSIS

Indicative scale for assessing the potential impact of a climate hazard (example) *Impacts:* *Risk areas:*	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational				▨	
Safety and health					
Environment, cultural heritage		▨			
Social		▨			
Financial		▨			
Reputation				▨	
Any other relevant risk area(s)	▨				
Overall for the above-listed risk areas				▨	

The impact analysis provides an expert assessment of the potential impact for each of the essential climate variables and hazards.

Technical guidance

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

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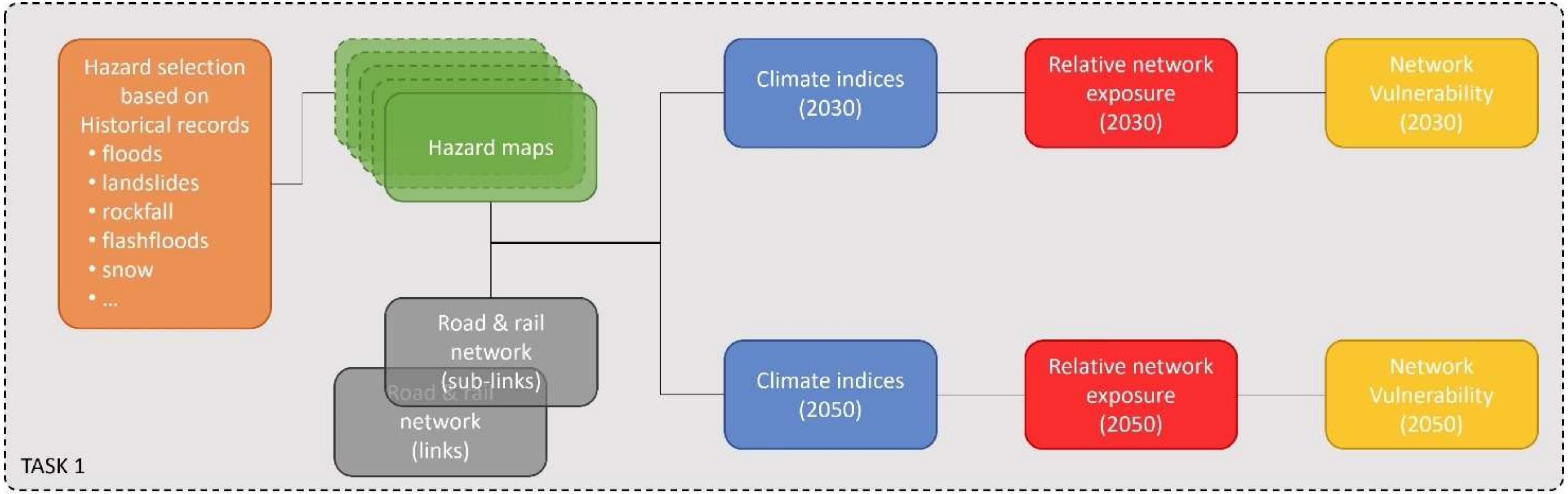
Methodology

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)



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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:

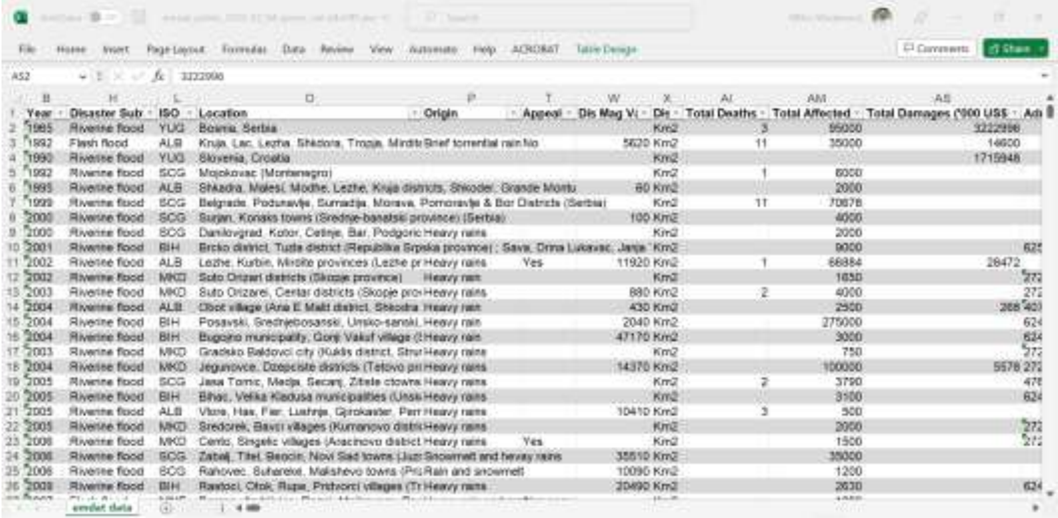
- Snow drift
- Extremely high temperatures
- Sea level rise

(limited section of the TEN-T network)

Preliminary sensitivity table	Flood	Landslide	Snow drift	High temperature	Sea level rise
Assets and processes	High	High	Low	Medium	Low
Inputs	Medium	Medium	Low	Low	Low
Outputs	Low	Low	Low	Low	Low
Access and transport links	High	High	Medium	Low	Medium

*landslides = slides, rockfalls, debris flows etc.

Source: emdat.be



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/)
- ✓ Global sea level model (NASA: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool)

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

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Vulnerability Assessment

Final Results

CLIMA PROOF

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):

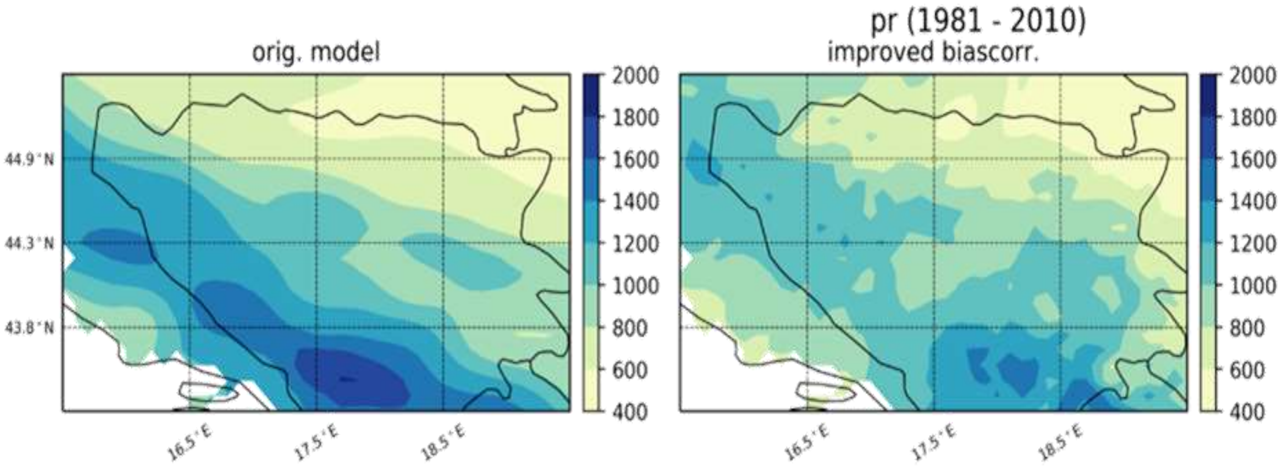
- ✓ Selection tool (helps to select among 3000+ climate change models for a particular case)
- ✓ Downscaling tool (adapts coarse resolution multi-temporal models to fine resolution)
- ICC-OBS tool (allows the user to generate bias-corrected climate models from own datasets)

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

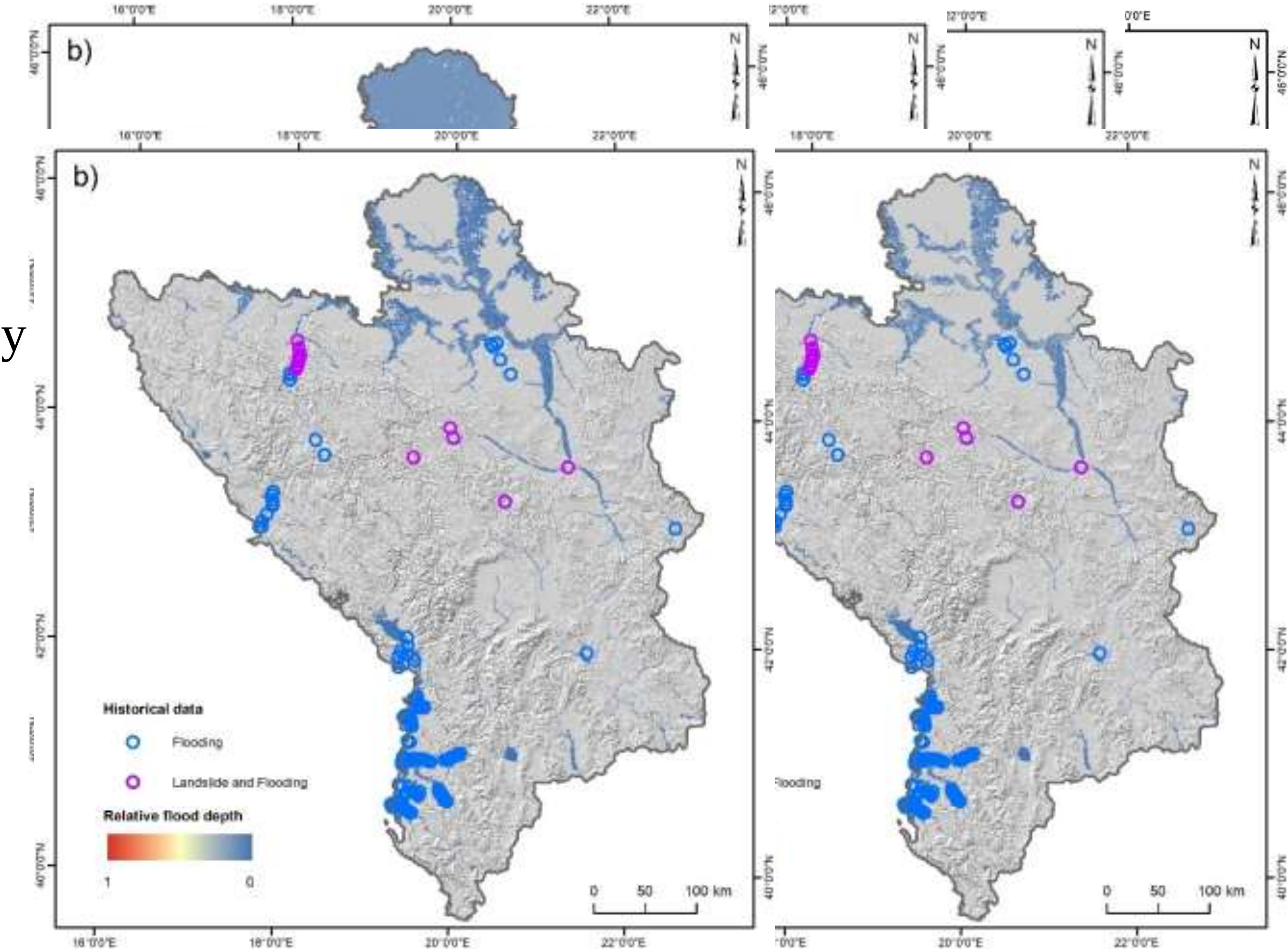
Hazard spatial distribution (Exposure)

Preliminary exposure table	Flood	Landslide	Snow drift	High temperature	Sea level rise
Current climate (2030)	Medium	High	Medium	Low	Low
Future climate (2050)	Medium	High	Low	Medium	Low

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



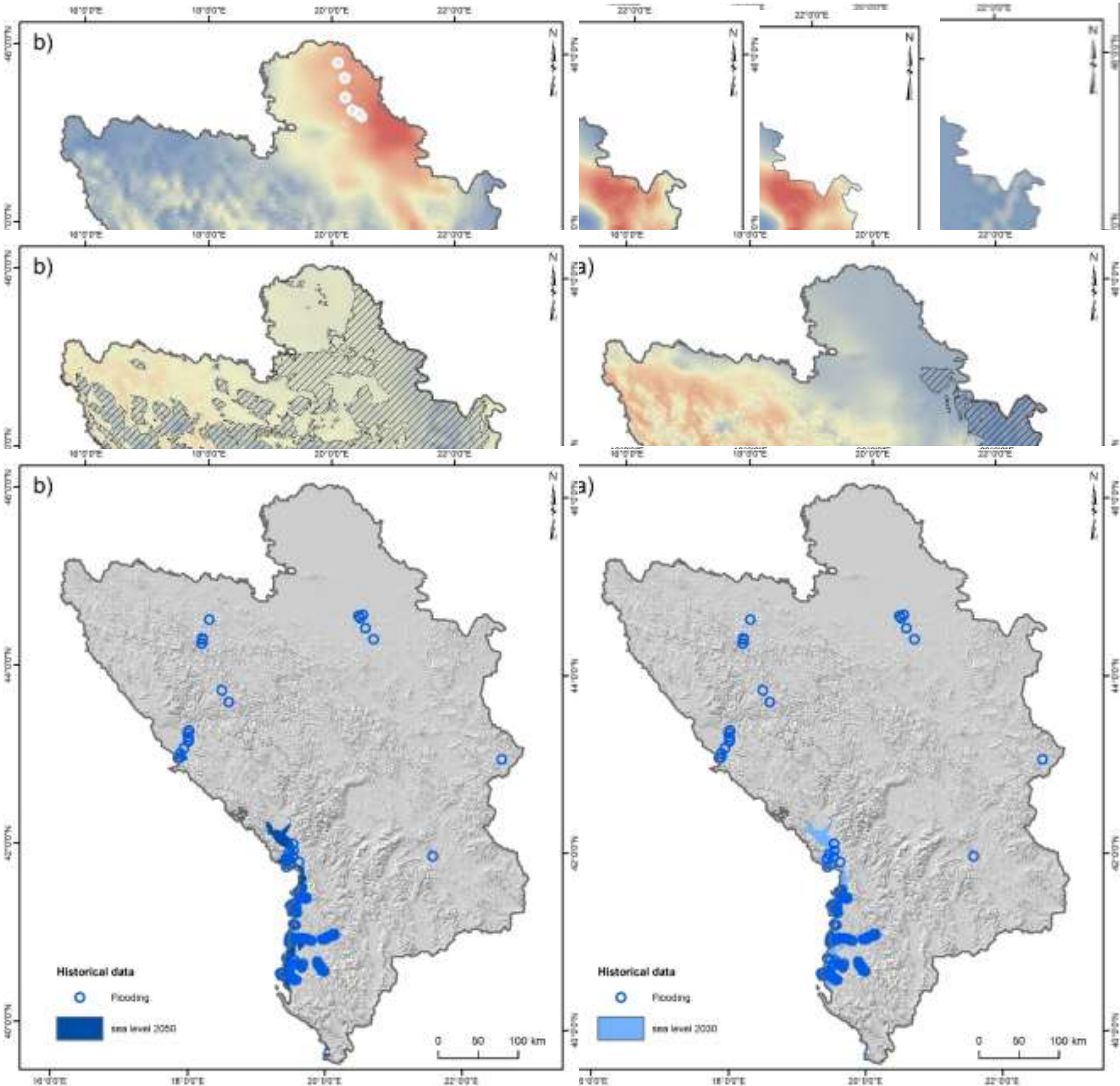
Vulnerability Assessment

Final Results

Hazard spatial distribution (Exposure)

Outputs:

- Snow drift hazard map
  - Normalized snow days indicator SD
  - Normalized wind speed climate index WS
  - SH=SD x 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



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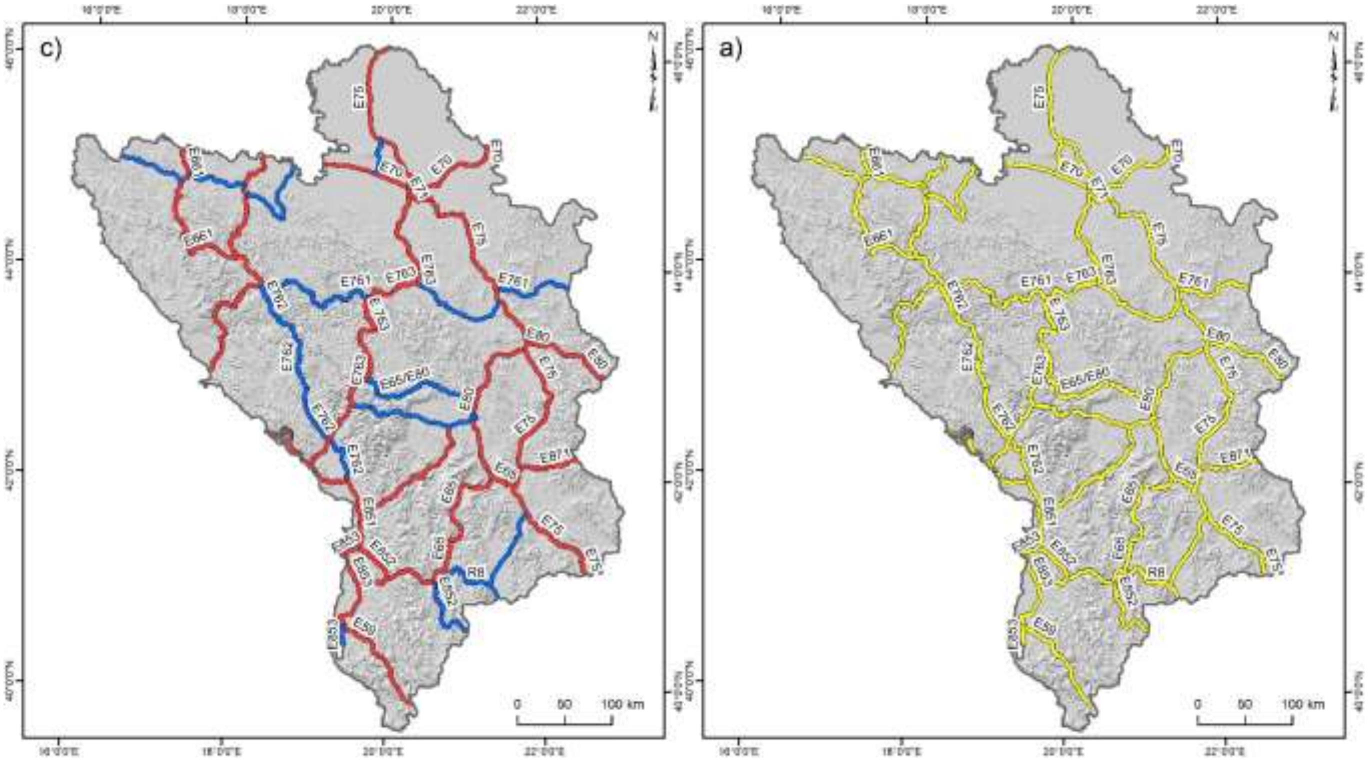
Vulnerability Assessment

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



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Vulnerability Assessment

Final Results

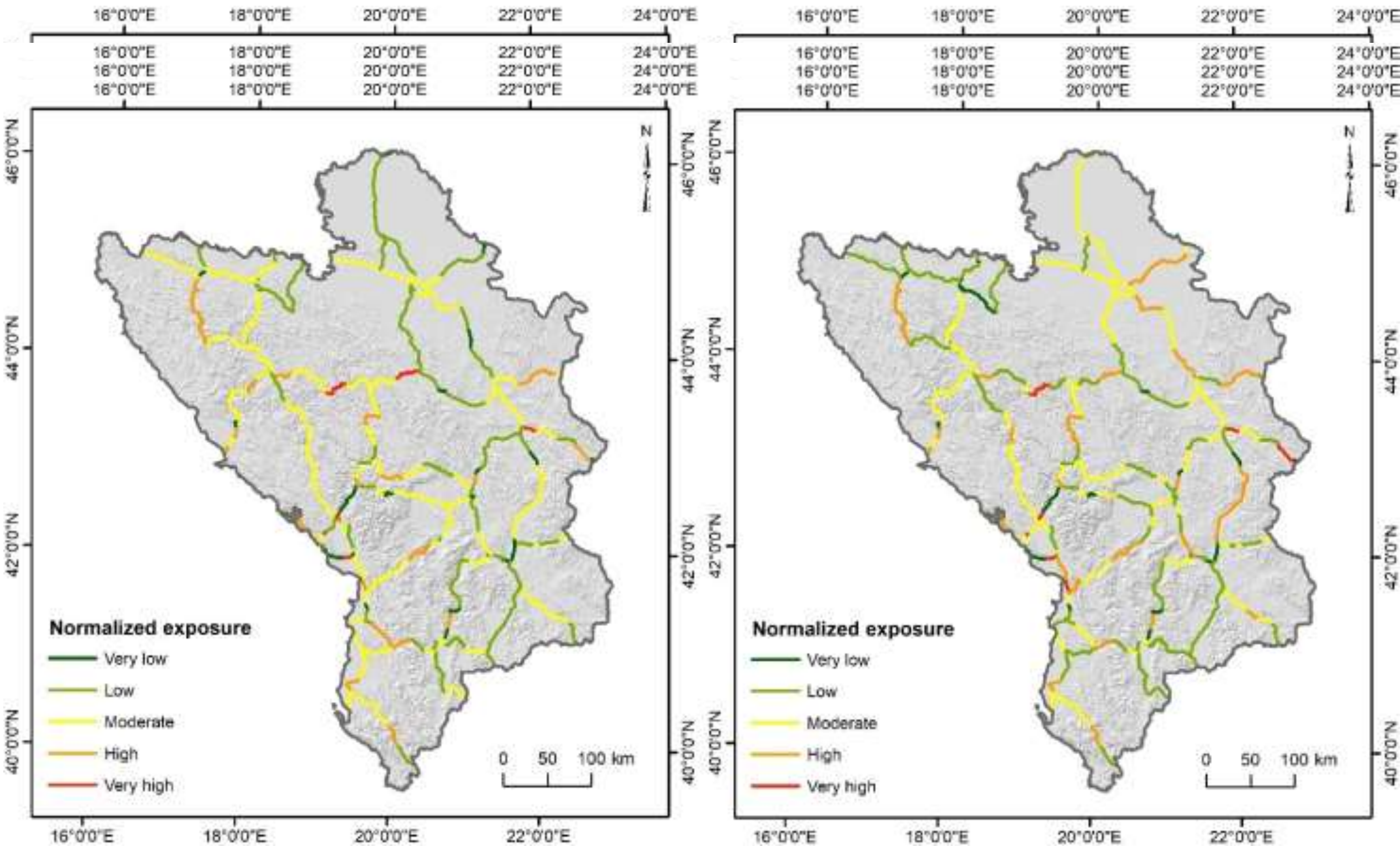
Current and future exposure to hazard (Vulnerability)

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

Preliminary vulnerability table		Exposure		
		High	Medium	Low
Sensitivity	High	Landslide	Flood	
	Medium		High temperature, Snow drift	Sea level rise
	Low			



Vulnerability Assessment

Final Results

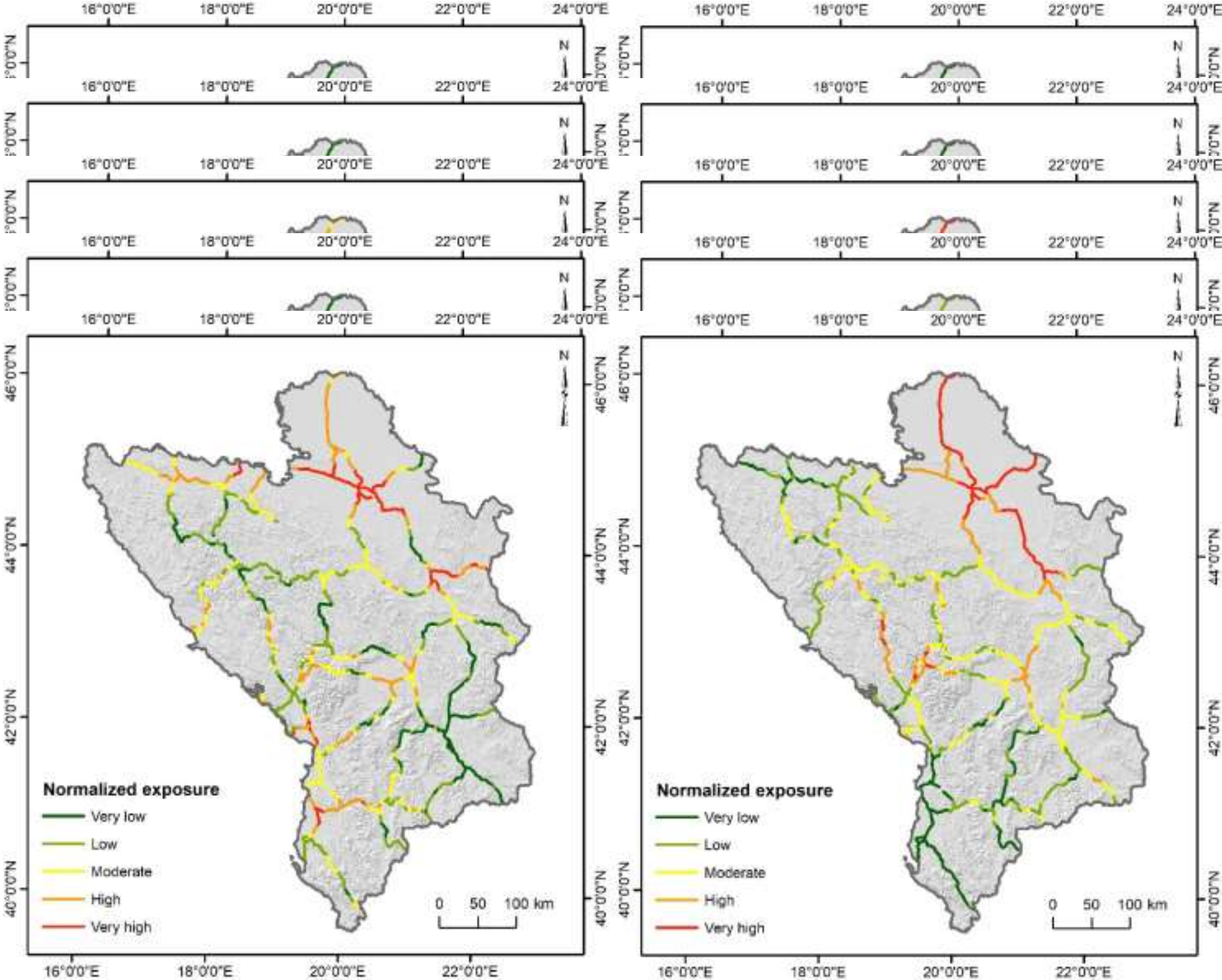
Current and future exposure to hazard (Vulnerability)

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



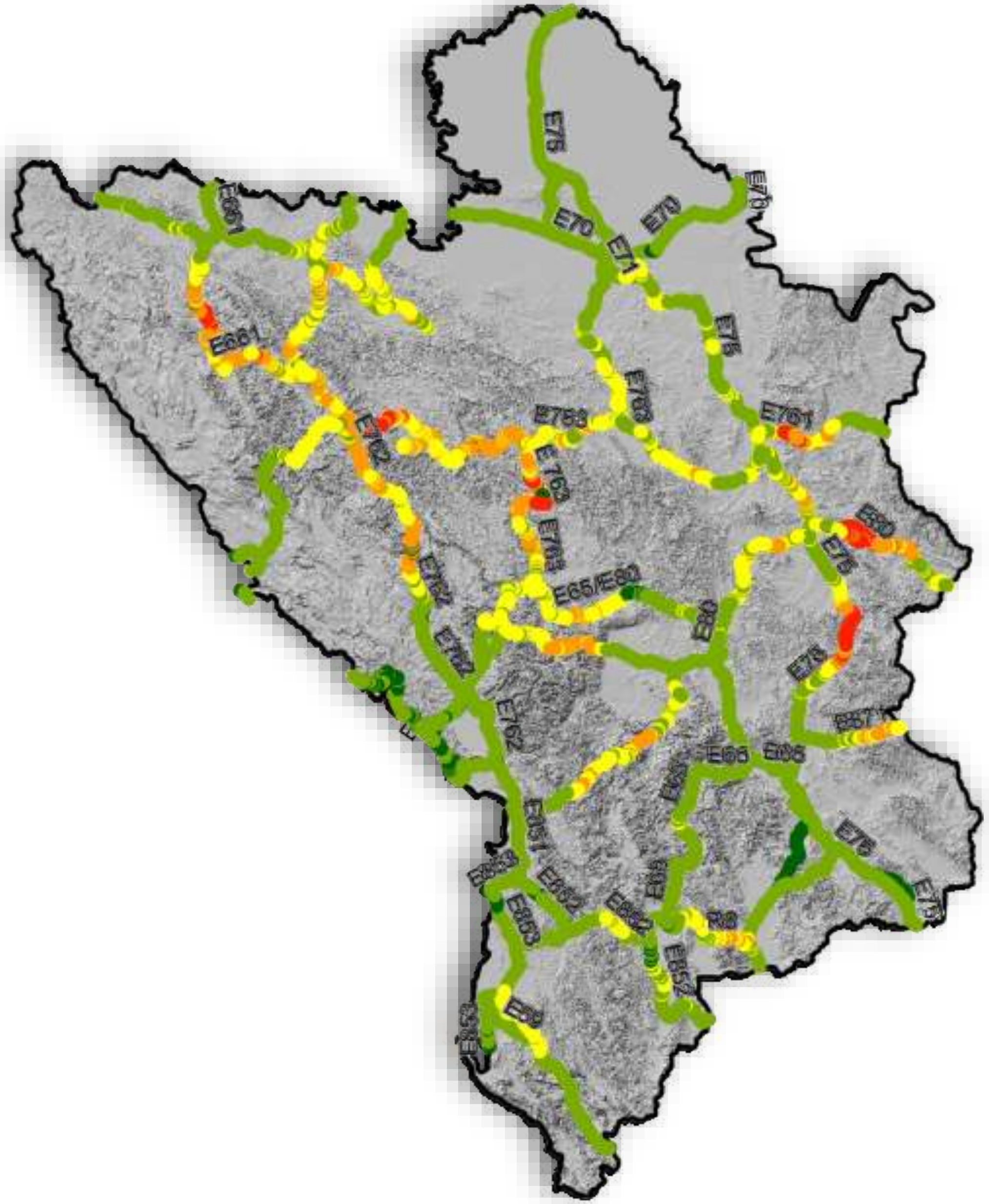
Vulnerability Assessment

Final Results

Current and future exposure to hazard (Vulnerability)

Example of comparing LINK vs. SUBLINK

- Landslide hazard map



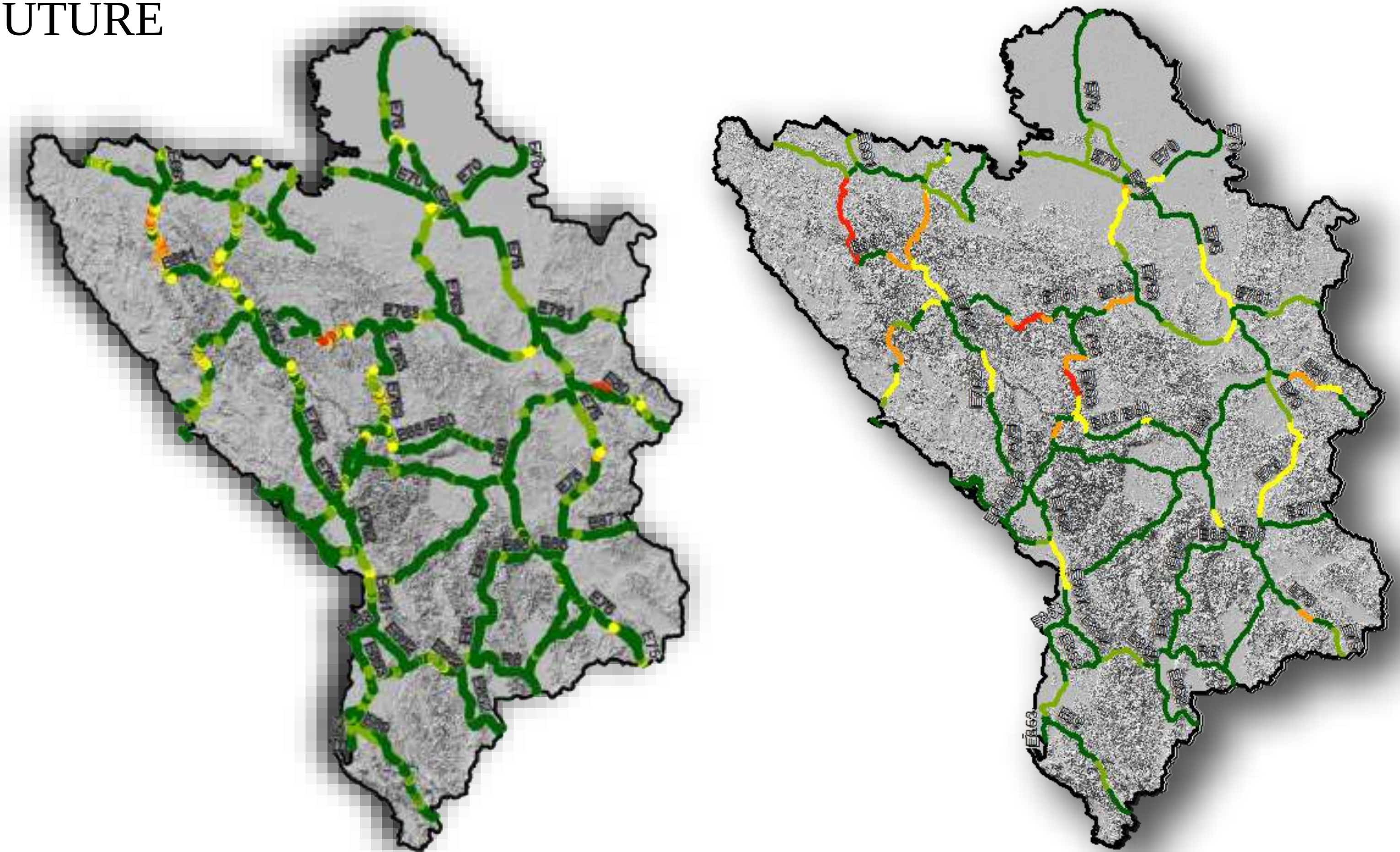
Vulnerability Assessment

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



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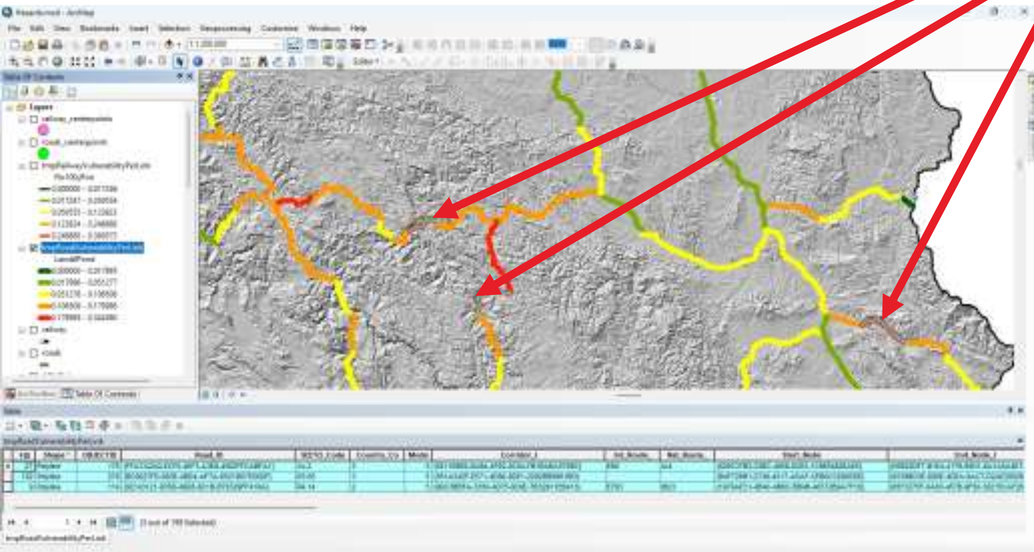
Vulnerability Assessment

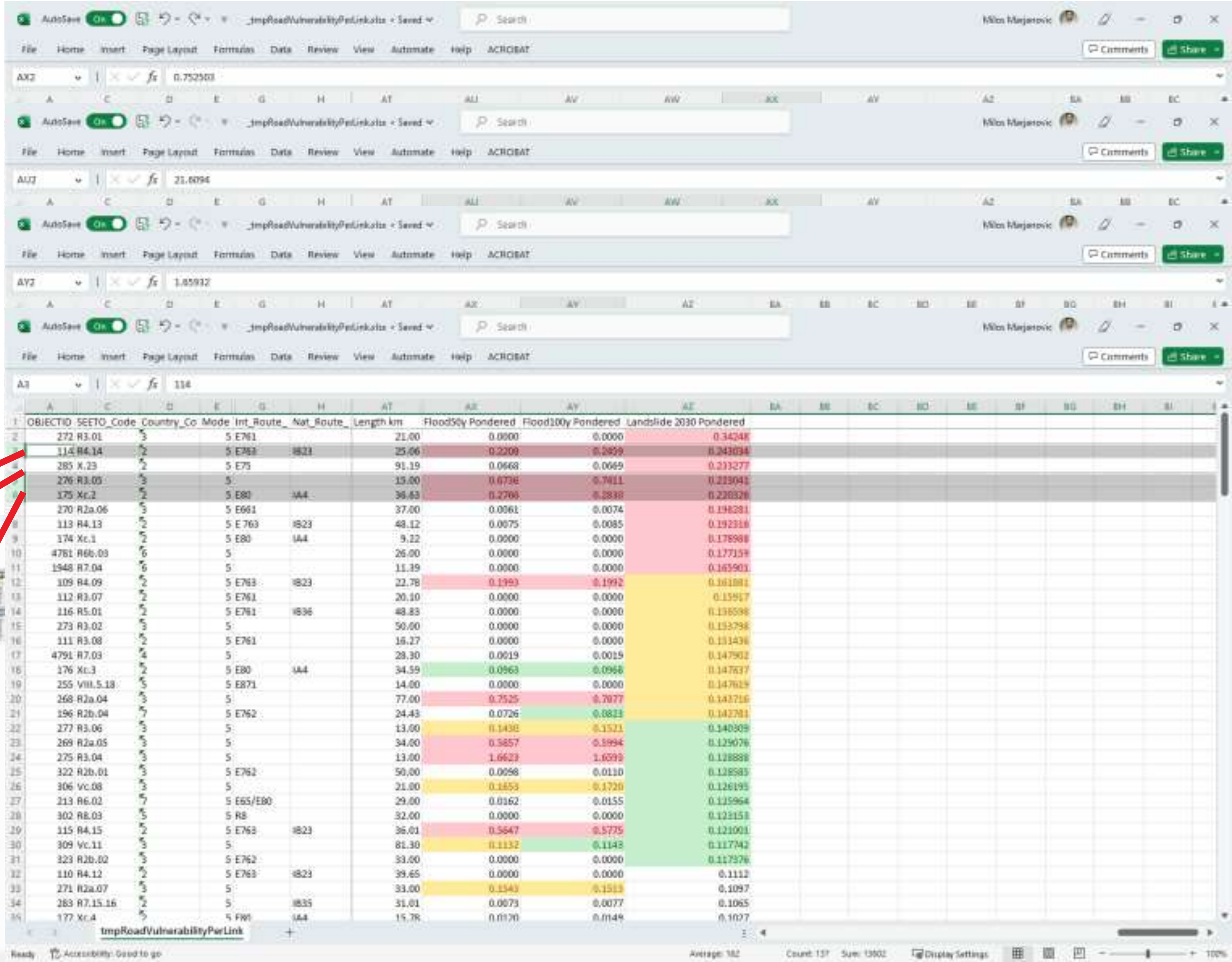
Final Results

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





OBJECTID	SEETO_Code	Country_Co	Mode	Int_Route_	Nat_Route_	Length km	Flood50y Pondered	Flood100y Pondered	Landslide 2030 Pondered
272	R3.01	3	5	E761		21.00	0.0000	0.0000	0.34248
114	R4.14	2	5	E763	IB23	25.06	0.2208	0.2459	0.243034
285	X.23	2	5	E75		91.19	0.0668	0.0669	0.233277
276	R3.05	3	5			15.00	0.6736	0.7411	0.223041
175	Xc.2	2	5	E80	IA4	36.63	0.2766	0.2838	0.220328
270	R2a.06	3	5	E661		37.00	0.0061	0.0074	0.198281
113	R4.13	2	5	E 763	IB23	48.12	0.0075	0.0085	0.192316
174	Xc.1	2	5	E80	IA4	9.22	0.0000	0.0000	0.178988
4781	R6b.03	6	5			26.00	0.0000	0.0000	0.177159
1948	R7.04	6	5			11.39	0.0000	0.0000	0.165901
109	R4.09	2	5	E763	IB23	22.78	0.1993	0.1992	0.161881
112	R3.07	2	5	E761		20.10	0.0000	0.0000	0.15917
116	R5.01	2	5	E761	IB36	48.83	0.0000	0.0000	0.156598
273	R3.02	3	5			50.00	0.0000	0.0000	0.153798
111	R3.08	2	5	E761		16.27	0.0000	0.0000	0.151436
4791	R7.03	4	5			28.30	0.0019	0.0019	0.147902
176	Xc.3	2	5	E80	IA4	34.59	0.0963	0.0968	0.147637
255	VIII.5.18	5	5	E871		14.00	0.0000	0.0000	0.147619
268	R2a.04	3	5			77.00	0.7525	0.7877	0.142716
196	R2b.04	7	5	E762		24.43	0.0726	0.0823	0.142781
277	R3.06	3	5			13.00	0.1438	0.1521	0.140309
269	R2a.05	3	5			34.00	0.5857	0.5994	0.129076
275	R3.04	3	5			13.00	1.6623	1.6593	0.128888
322	R2b.01	3	5	E762		50.00	0.0098	0.0110	0.128585
306	Vc.08	3	5			21.00	0.1653	0.1720	0.126195
213	R6.02	7	5	E65/E80		29.00	0.0162	0.0155	0.125964
302	R8.03	5	5	R8		32.00	0.0000	0.0000	0.123153
115	R4.15	2	5	E763	IB23	36.01	0.5647	0.5775	0.121001
309	Vc.11	3	5			81.30	0.1132	0.1143	0.117742
323	R2b.02	3	5	E762		33.00	0.0000	0.0000	0.117576
110	R4.12	2	5	E763	IB23	39.65	0.0000	0.0000	0.1112
271	R2a.07	3	5			33.00	0.1543	0.1513	0.1097
283	R7.15.16	2	5		IB35	31.01	0.0073	0.0077	0.1065
177	Xc.4	2	5	E80	IA4	15.78	0.0120	0.0149	0.1027

Project Deliverables

Delivery on time

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

Deliverable 1	**Deliverable 2**	**Deliverable 3**	**Deliverable 4**	**Deliverable 5**	**Deliverable 6**
Inception Report *(1 month)*	Vulnerability Assessment Report *(5 month)*	Criticality Assessment Report *(10 month)*	Identification and prioritisation of adaptation measures *(11 month)*	Report on Institutional activities *(11 month)*	Final Report *(12 month)*

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