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12th ROAD TECHNICAL COMMITTEE Technical Assistance State of play

Project Team

July 2023

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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

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.

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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

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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**

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

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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)

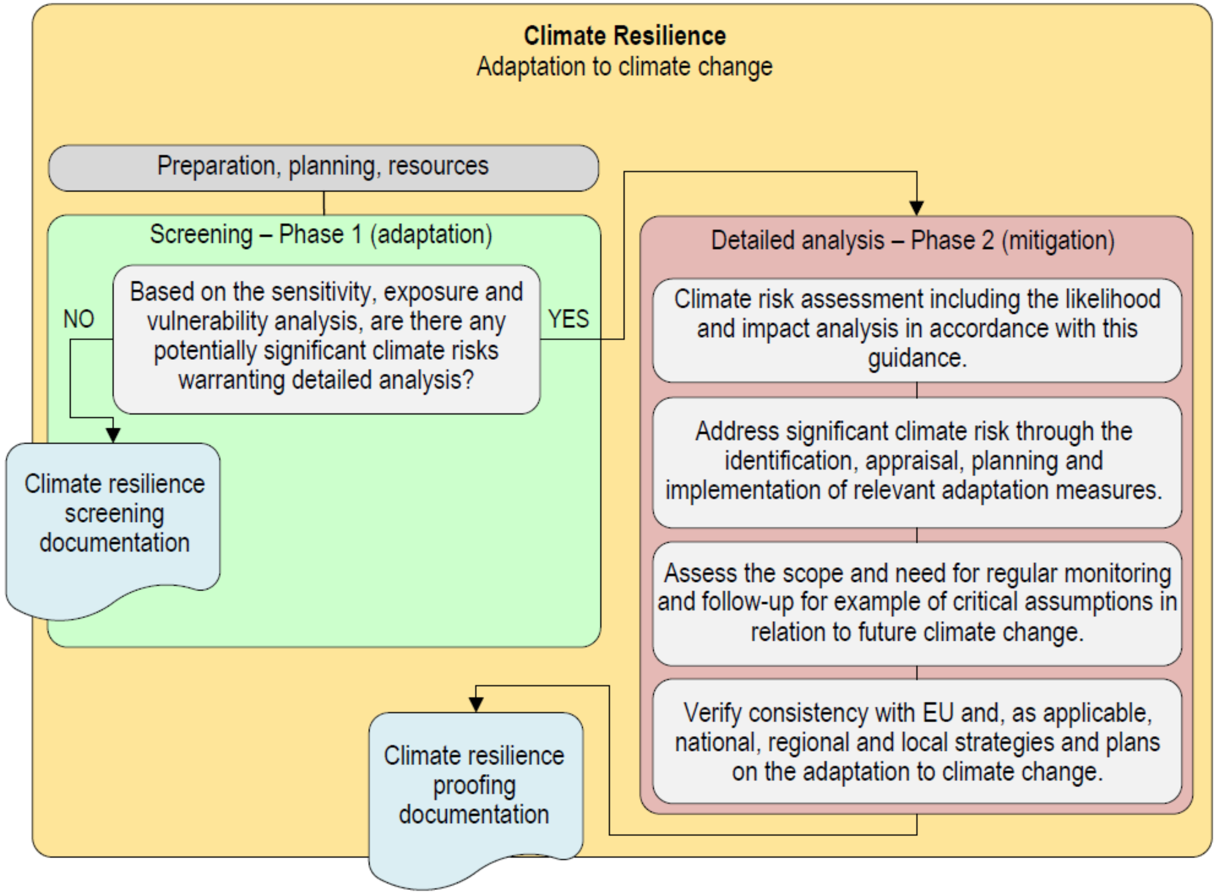
Methodology

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

Adaptation to climate change

- 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."

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Methodology

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

Original Methodology from Technical guidance

Adaptation to climate change

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

SENSITIVITY ANALYSIS

Indicative sensitivity table: *(example)*		Flood	Heat	…	Drought
		Climate variables and hazards			
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 project type, irrespective of the location, including critical parameters, and divided in e.g. the four themes.

EXPOSURE ANALYSIS

Indicative exposure table: *(example)*	Flood	Heat	…	Drought
	Climate variables and hazards			
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. For both the sensitivity and exposure analysis, the scoring system should be carefully defined and explained, and the given scores should be justified.

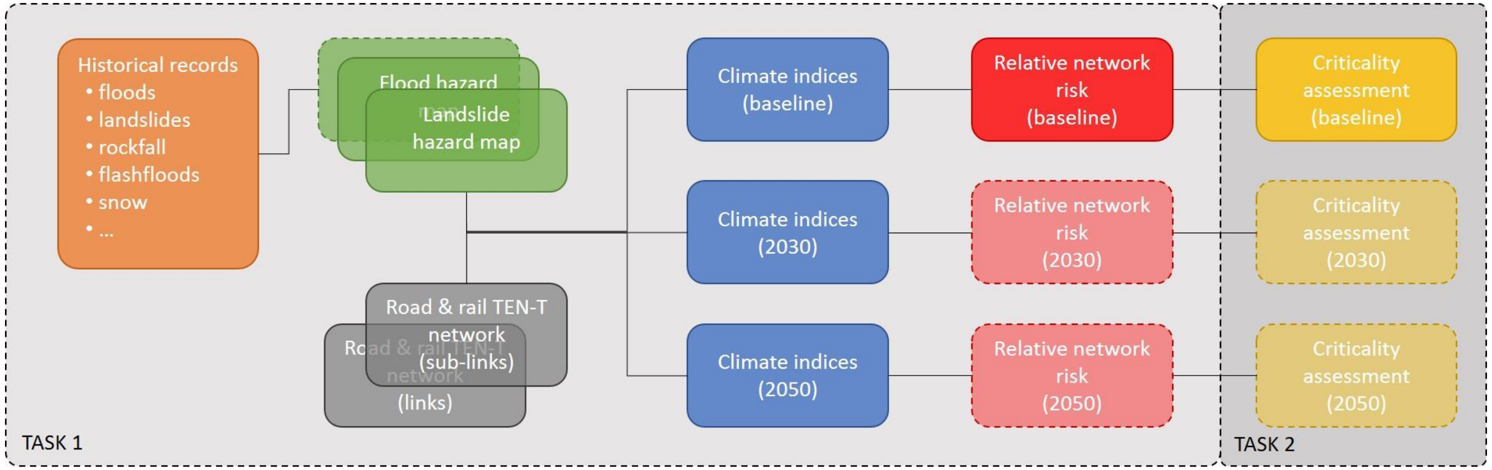
VULNERABILITY ANALYSIS

Indicative vulnerability table: *(example)*		Exposure (current + future climate): High	Medium	Low
Sensitivity (highest across the four themes)	High	Flood		
	Medium		Heat	
	Low			Drought

Legend: Vulnerability level
High
Medium
Low

The vulnerability analysis may be summarised in a table for the given specific project type at the selected location. It combines the sensitivity and the exposure analysis. The most relevant climate variables and hazards are those with a high or medium vulnerability level, which are then taken forward to the steps below. The vulnerability levels should be carefully defined and explained, and the given scores justified.

Improved Methodology



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

- Hazard selection
- Hazard spatial distribution (susceptibility)
- Network characteristics
- Current and future exposure to hazard (likelihood)
- Current and future network risk (likelihood)

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Methodology

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

“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

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

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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Vulnerability Assessment

Preliminary 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:

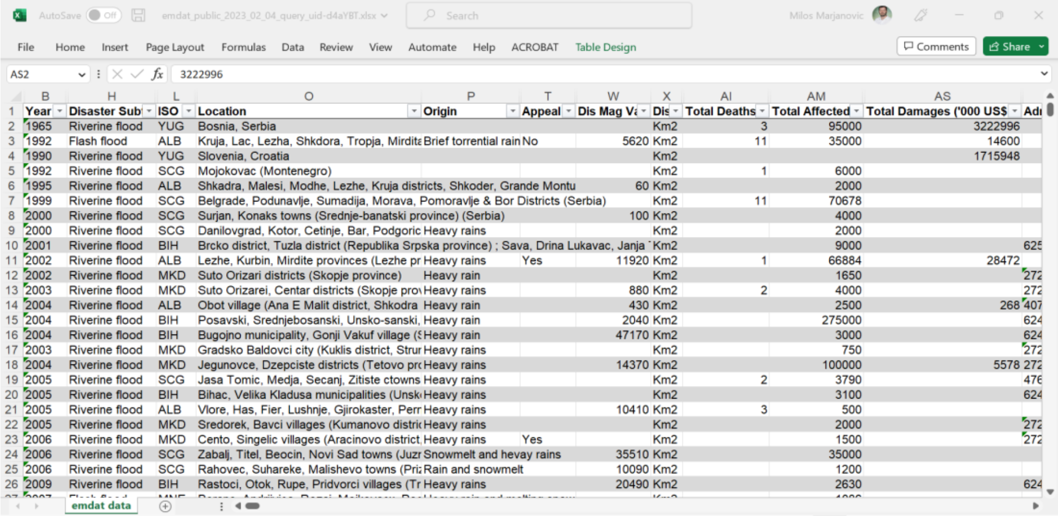
- Snow drift
- Extremely high temperatures
- Sea level rise

(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



	Year	Disaster Sub	ISO	Location	Origin	Appeal	Dis Mag Va	Dis	Total Deaths	Total Affected	Total Damages ('000 US$	Adı
2	1965	Riverine flood	YUG	Bosnia, Serbia				Km2	3	95000	3222996	
3	1992	Flash flood	ALB	Kruja, Lac, Lezha, Shkdora, Tropja, Mirdita	Brief torrential rain	No	5620	Km2	11	35000	14600	
4	1990	Riverine flood	YUG	Slovenia, Croatia				Km2			1715948	
5	1992	Riverine flood	SCG	Mojokovac (Montenegro)				Km2	1	6000		
6	1995	Riverine flood	ALB	Shkadra, Malesi, Modhe, Lezhe, Kruja districts, Shkoder, Grande Montu			60	Km2		2000		
7	1999	Riverine flood	SCG	Belgrade, Podunavlje, Sumadija, Morava, Pomoravlje & Bor Districts (Serbia)				Km2	11	70678		
8	2000	Riverine flood	SCG	Surjan, Konaks towns (Srednje-banatski province) (Serbia)			100	Km2		4000		
9	2000	Riverine flood	SCG	Danilovgrad, Kotor, Cetinje, Bar, Podgoric	Heavy rains			Km2		2000		
10	2001	Riverine flood	BIH	Brcko district, Tuzla district (Republika Srpska province) ; Sava, Drina Lukavac, Janja				Km2		9000		625
11	2002	Riverine flood	ALB	Lezhe, Kurbin, Mirdite provinces (Lezhe pr	Heavy rains	Yes	11920	Km2	1	66884	28472	
12	2002	Riverine flood	MKD	Suto Orizari districts (Skopje province)	Heavy rain			Km2		1650		272
13	2003	Riverine flood	MKD	Suto Orizarei, Centar districts (Skopje prov	Heavy rains		880	Km2	2	4000		272
14	2004	Riverine flood	ALB	Obot village (Ana E Malit district, Shkodra	Heavy rain		430	Km2		2500	268	407
15	2004	Riverine flood	BIH	Posavski, Srednjebosanski, Unsko-sanski,	Heavy rain		2040	Km2		275000		624
16	2004	Riverine flood	BIH	Bugojno municipality, Gonji Vakuf village (S	Heavy rain		47170	Km2		3000		624
17	2003	Riverine flood	MKD	Gradsko Baldovci city (Kuklis district, Strur	Heavy rains			Km2		750		272
18	2004	Riverine flood	MKD	Jegunovce, Dzepciste districts (Tetovo pr	Heavy rains		14370	Km2		100000	5578	272
19	2005	Riverine flood	SCG	Jasa Tomic, Medja, Secanj, Zitiste ctowns	Heavy rains			Km2	2	3790		476
20	2005	Riverine flood	BIH	Bihac, Velika Kladusa municipalities (Unsk	Heavy rains			Km2		3100		624
21	2005	Riverine flood	ALB	Vlore, Has, Fier, Lushnje, Gjirokaster, Perr	Heavy rains		10410	Km2	3	500		
22	2005	Riverine flood	MKD	Sredorek, Bavci villages (Kumanovo distri	Heavy rains			Km2		2000		272
23	2006	Riverine flood	MKD	Cento, Singelic villages (Aracinovo district,	Heavy rains	Yes		Km2		1500		272
24	2006	Riverine flood	SCG	Zabalj, Titel, Beocin, Novi Sad towns (Juzr	Snowmelt and hevay rains		35510	Km2		35000		
25	2006	Riverine flood	SCG	Rahovec, Suhareke, Malishevo towns (Pri	Rain and snowmelt		10090	Km2		1200		
26	2009	Riverine flood	BIH	Rastoci, Otok, Rupe, Pridvorci villages (Tr	Heavy rains		20490	Km2		2630		624

emdat data

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Vulnerability Assessment

Preliminary Results

European Commission

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/)

CLIMA PROOF

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

Preliminary 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):

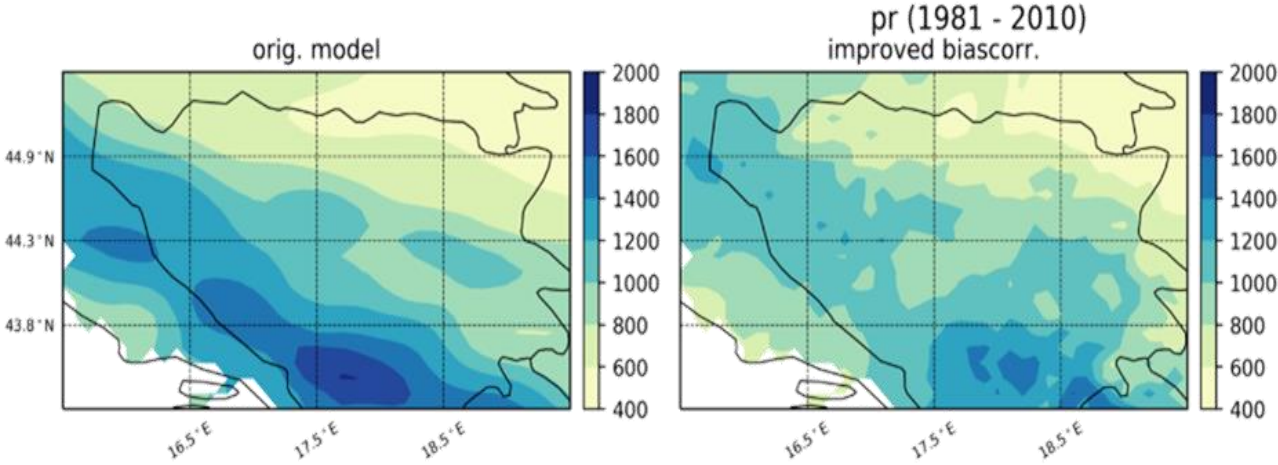
- ✓ Selection tool (helps to select among 3000+ climate change models for a particular case)
- ✓ Downscaling tool (adapts coarse resolution multi-temporal models to fine resolution)
- • ICC-OBS tool (allows the user to generate bias-corrected climate models from own datasets)

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



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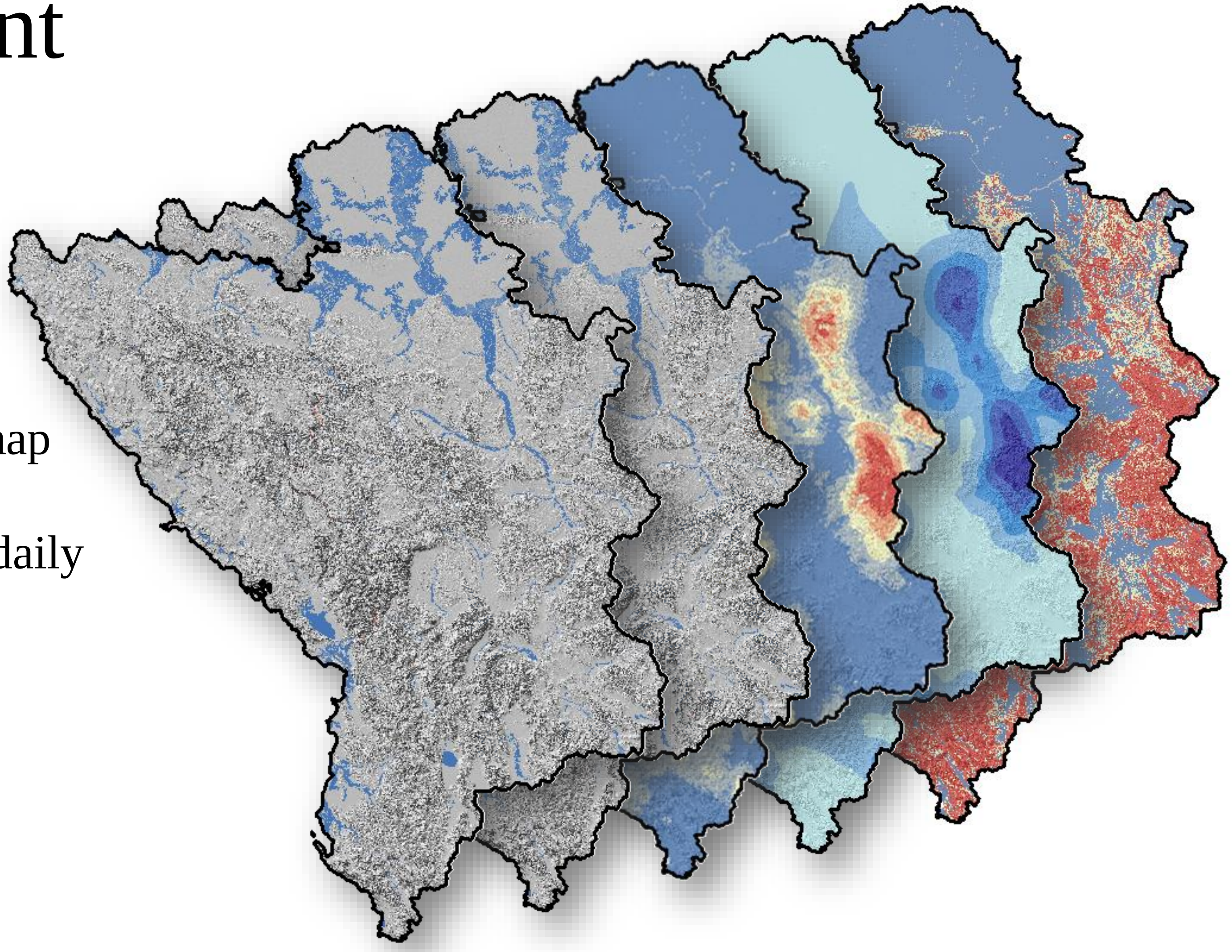
Vulnerability Assessment

Preliminary 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
  - H=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	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

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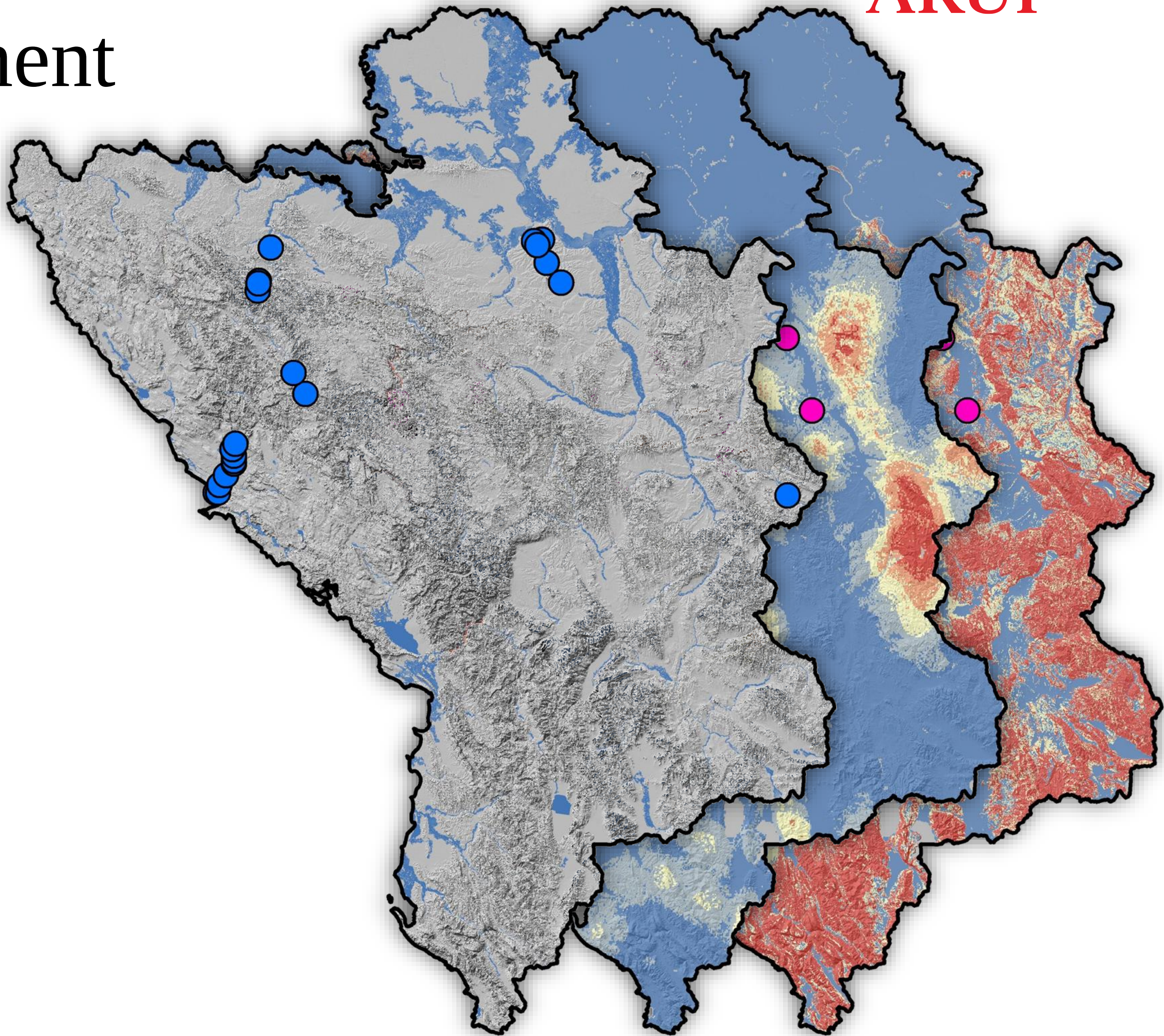
Vulnerability Assessment

Preliminary Results

Hazard spatial distribution (Exposure)

Validation (using stakeholder data):

- Landslide susceptibility map
- Landslide hazard map
- Flood hazard map



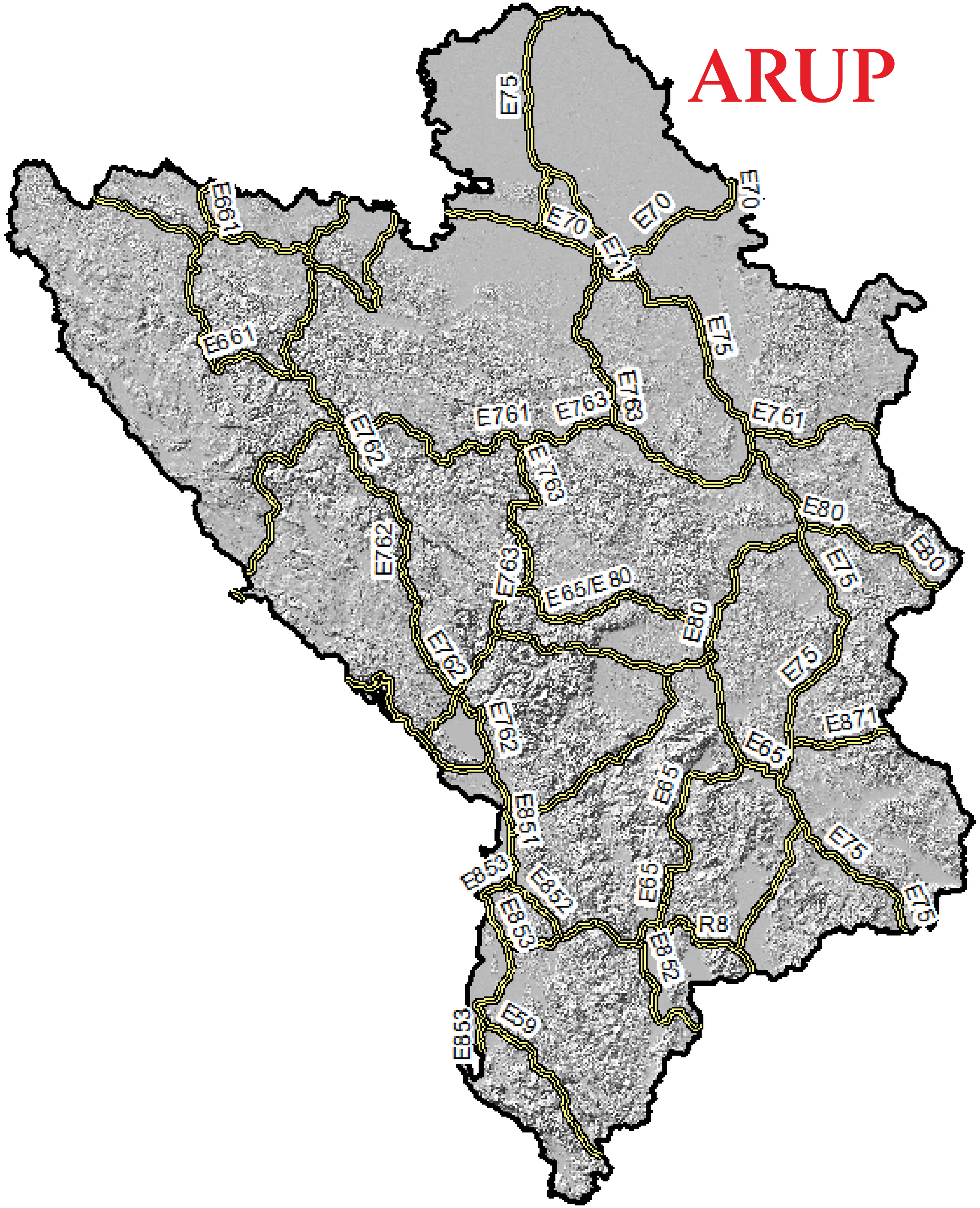
Vulnerability Assessment

Preliminary Results

Network characteristics (Vulnerability)

TEN-T comprehensive and core road network:

- With predefined network links and nodes (TC)
  199 road links with different lengths
- With arbitrarily split segments
  intervals of ~1 km in length



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Vulnerability Assessment

Preliminary Results

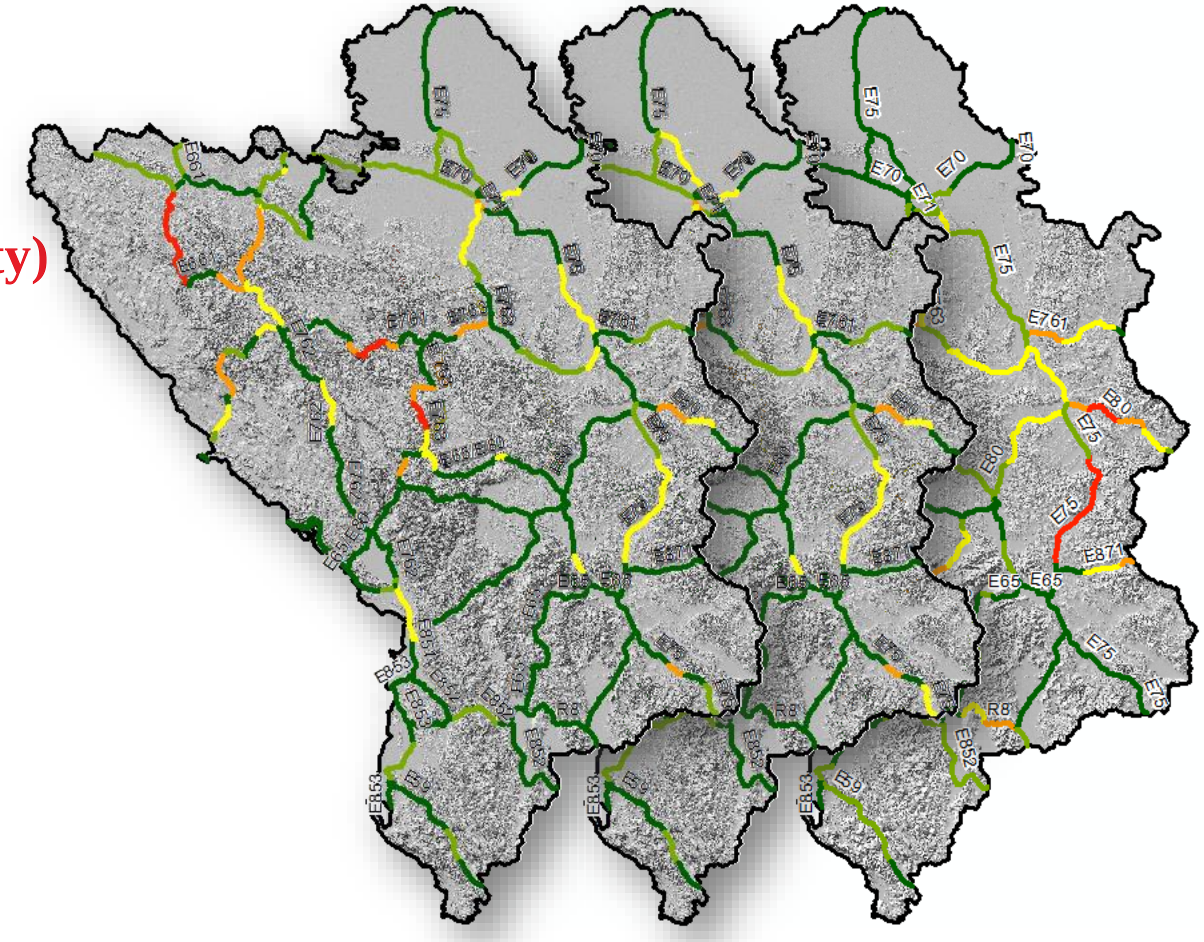
Current and future exposure to hazard (Vulnerability)

PER LINK

Overlapping road network vector with:

- Landslide hazard map
  - For standard links
    - ✓ for 2030
    - for 2050

- Flood hazard map
  - For standard links
    - ✓ for 50y return period
    - ✓ for 100y return period



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

Vulnerability Assessment

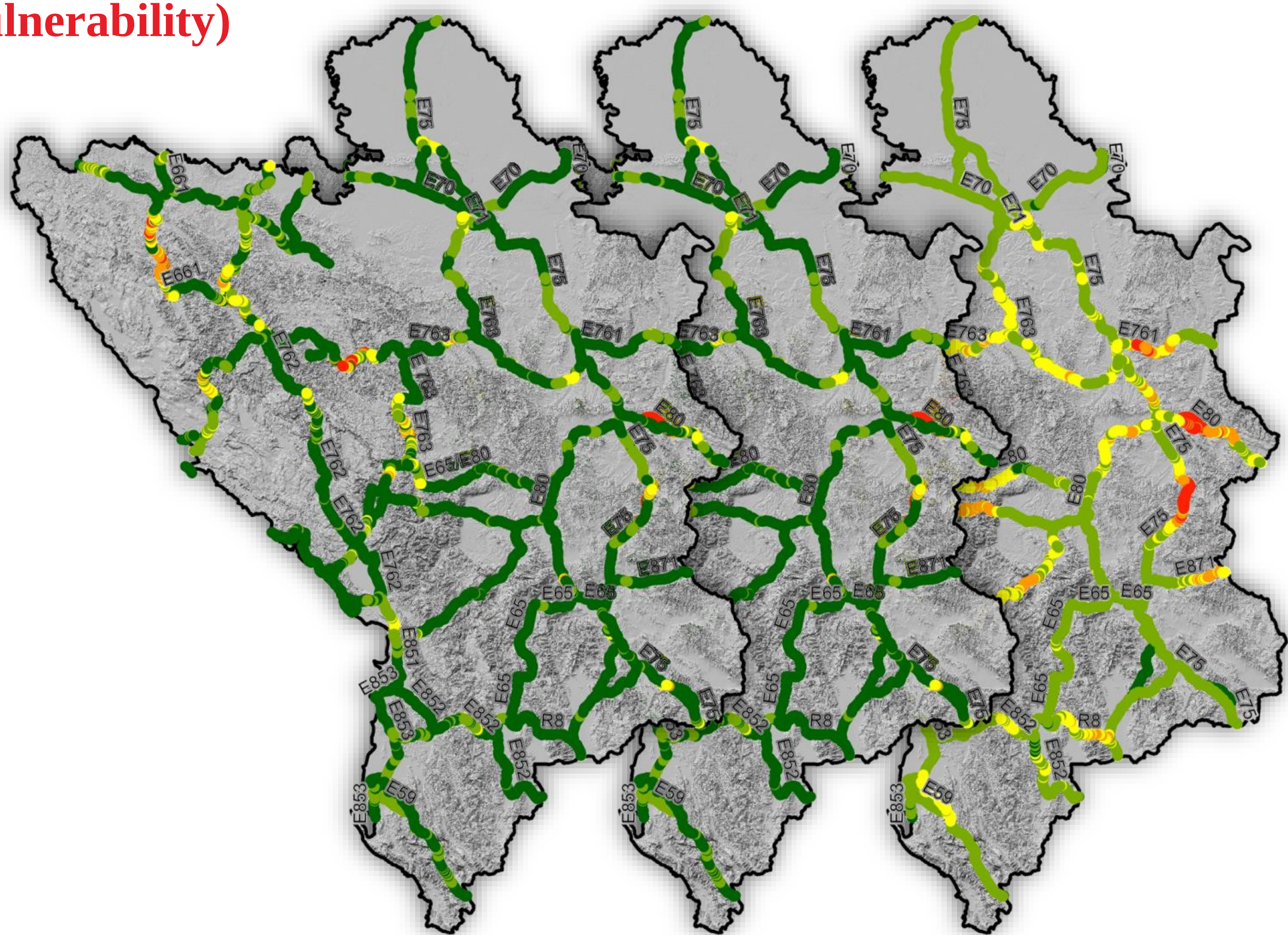
Preliminary Results

Current and future exposure to hazard (Vulnerability)

PER SUBLINK
Overlapping road network vector with:

- Landslide hazard map
  - For 1 km segments
    - ✓ for 2030
    - for 2050

- Flood hazard map
  - For 1 km segments
    - ✓ for 50y return period
    - ✓ for 100y return period



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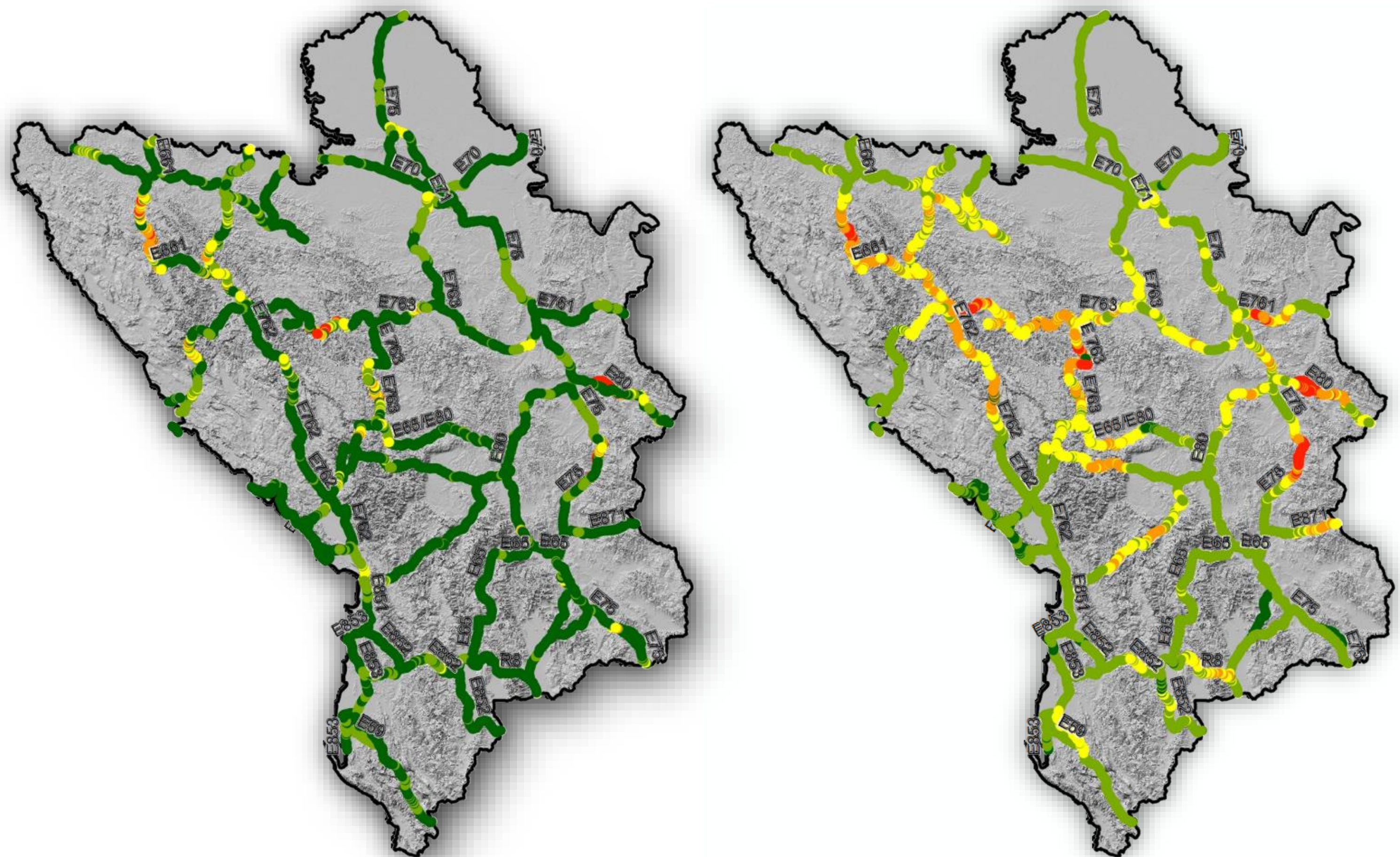
Vulnerability Assessment

Preliminary Results

Current and future exposure to hazard (Vulnerability)

Comparison LINK vs. SUBLINK

- Landslide hazard map
- Flood hazard map (e.g., 100 y RP)



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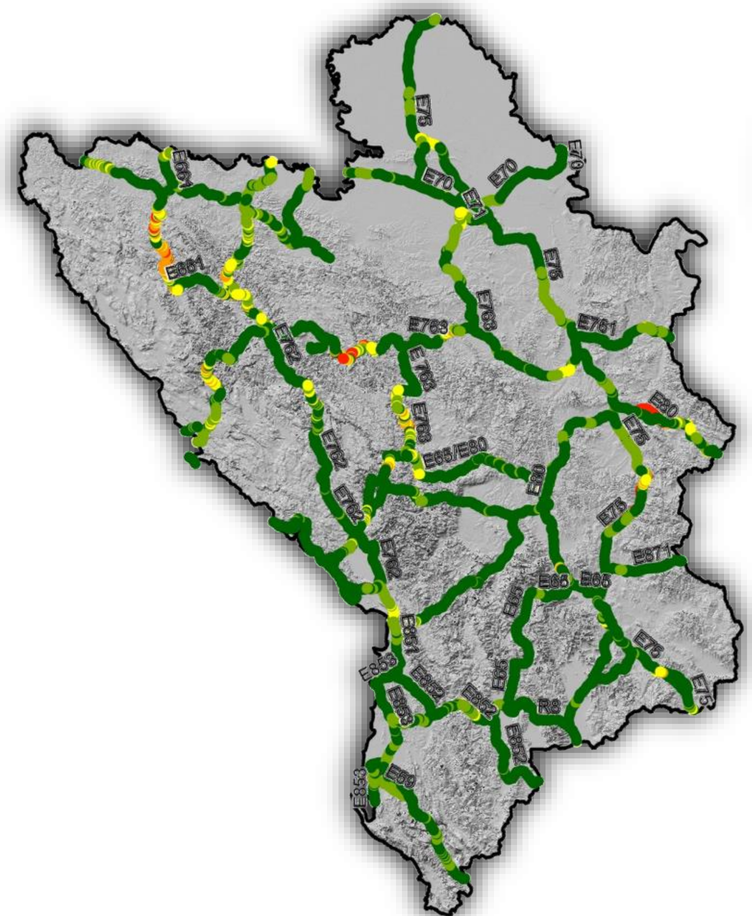
Vulnerability Assessment

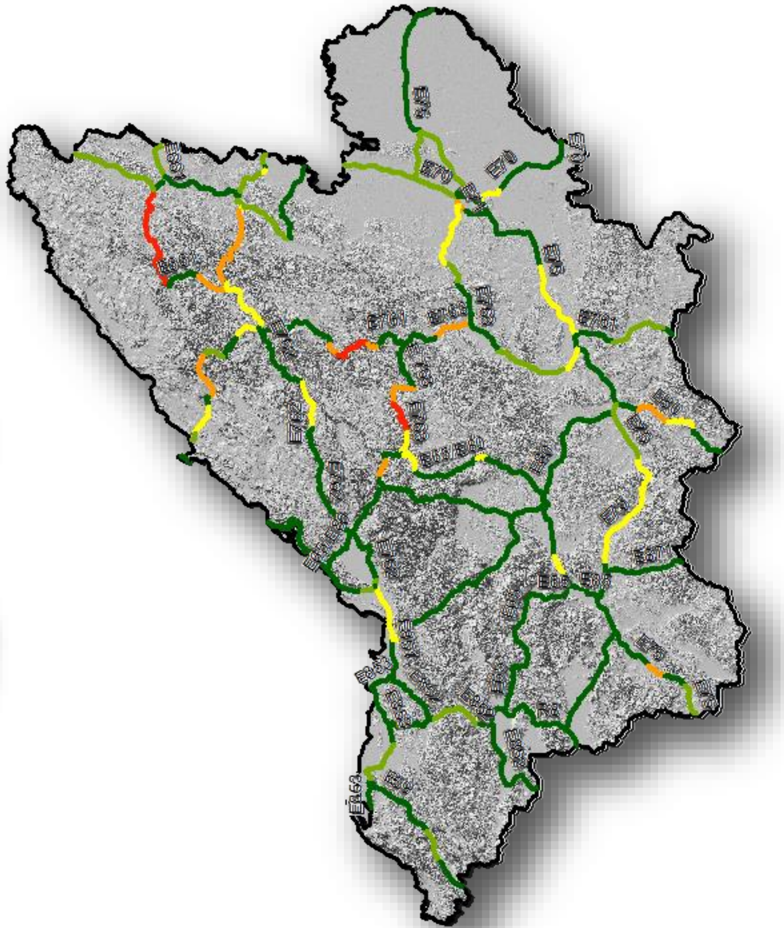
Preliminary Results

Current and future exposure to hazard (Vulnerability)

Comparison CURRENT vs. FUTURE

- Flood hazard map per link
- Flood hazard map per sublink





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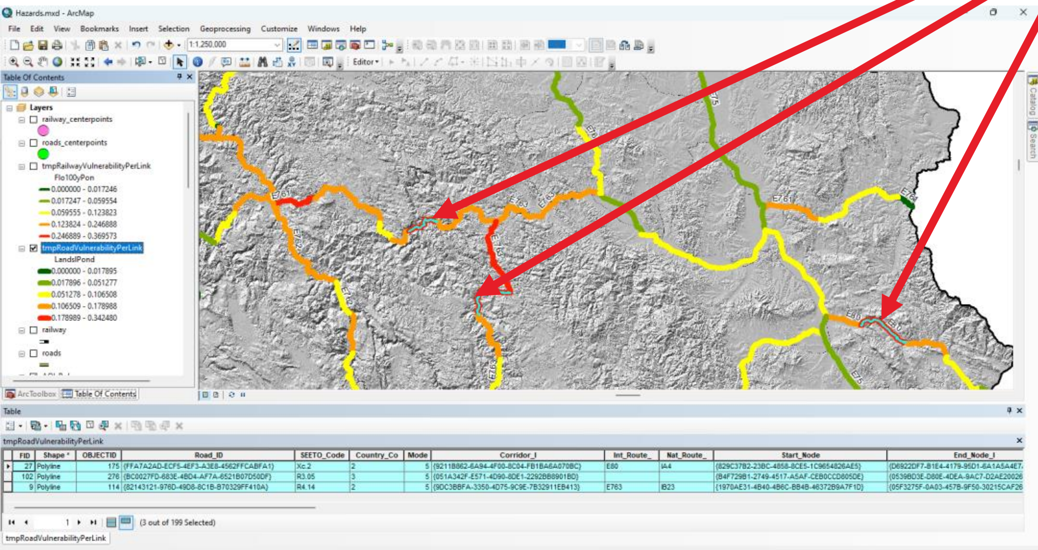
Vulnerability Assessment

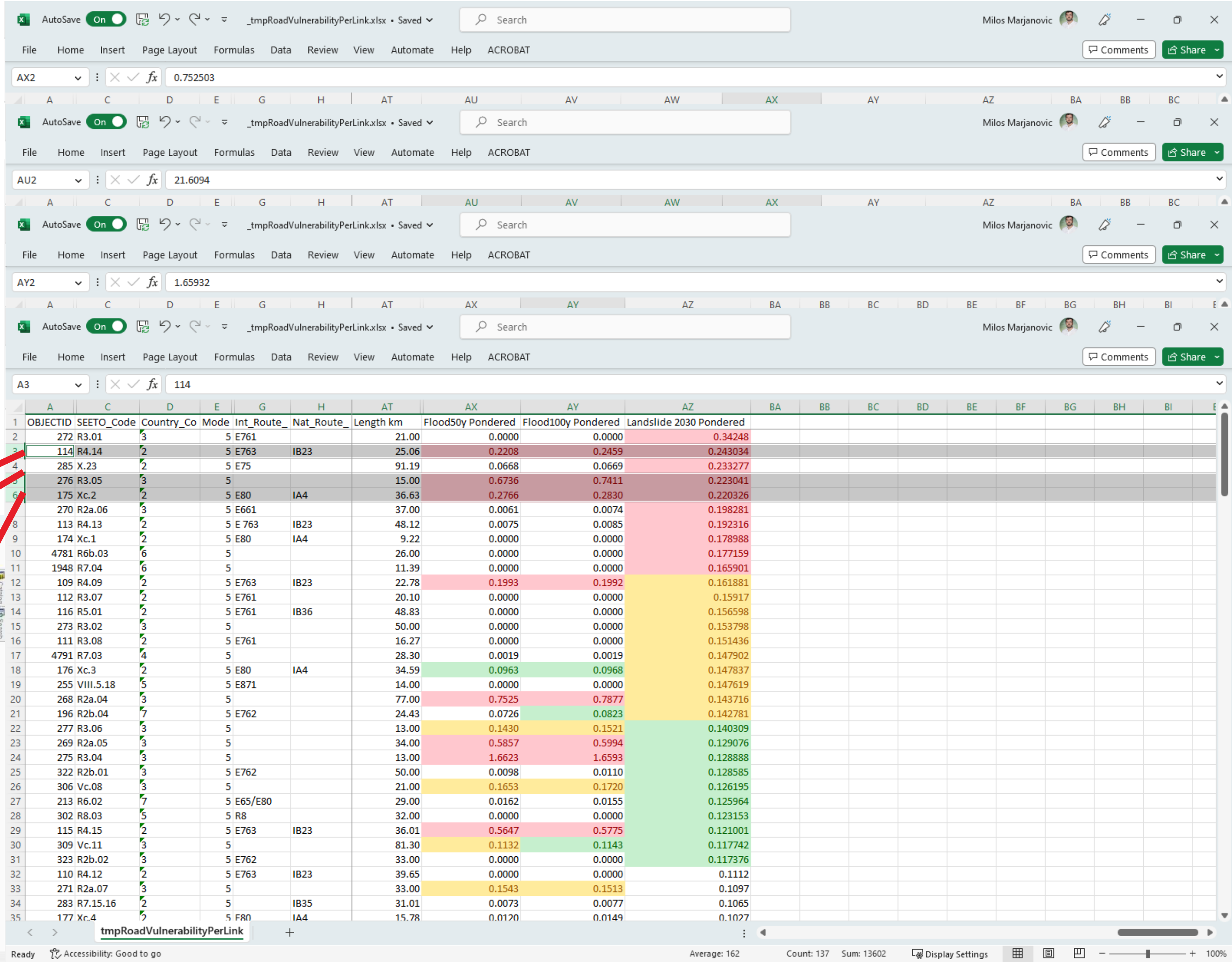
Preliminary Results

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	0.2830	0.220326
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	0.147837
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	0.143716
196	R2b.04	7	5	E762		24.43	0.0726	0.0823	0.142781
277	R3.06	3	5			13.00	0.1430	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	0.117376
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

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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

Inception Report

(1 month)

Deliverable 2

Vulnerability Assessment Report

(5 month)

Deliverable 3

Criticality Assessment Report

(7 month)

Deliverable 4

Identification and prioritisation of adaptation measures

(8 month)

Deliverable 5

Report on Institutional activities

(10 month)

Deliverable 6

Final Report

(11 month)

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