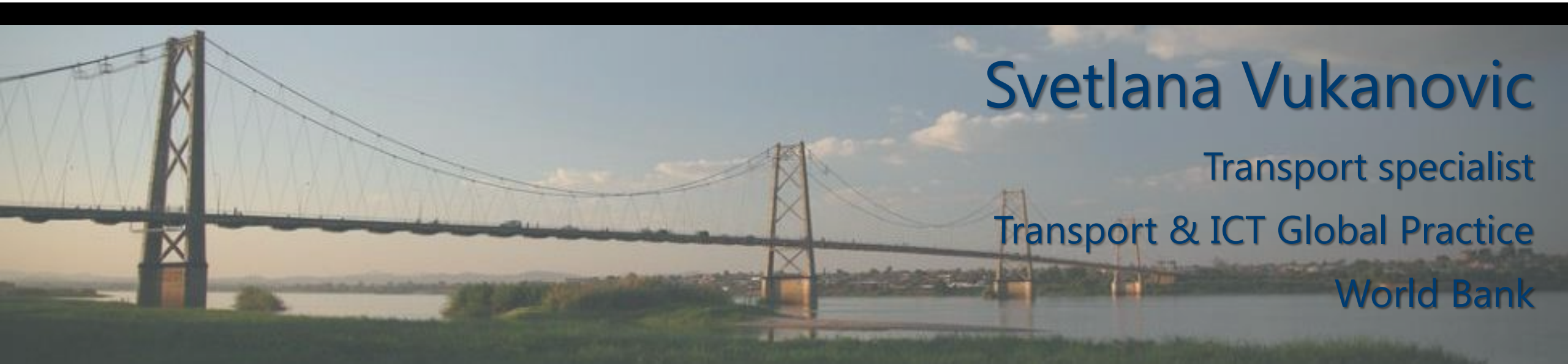
WORLD BANK GROUP
Transport & ICT

Climate and disaster resilient Transport Infrastructure



Svetlana Vukanovic

Transport specialist

Transport & ICT Global Practice

World Bank

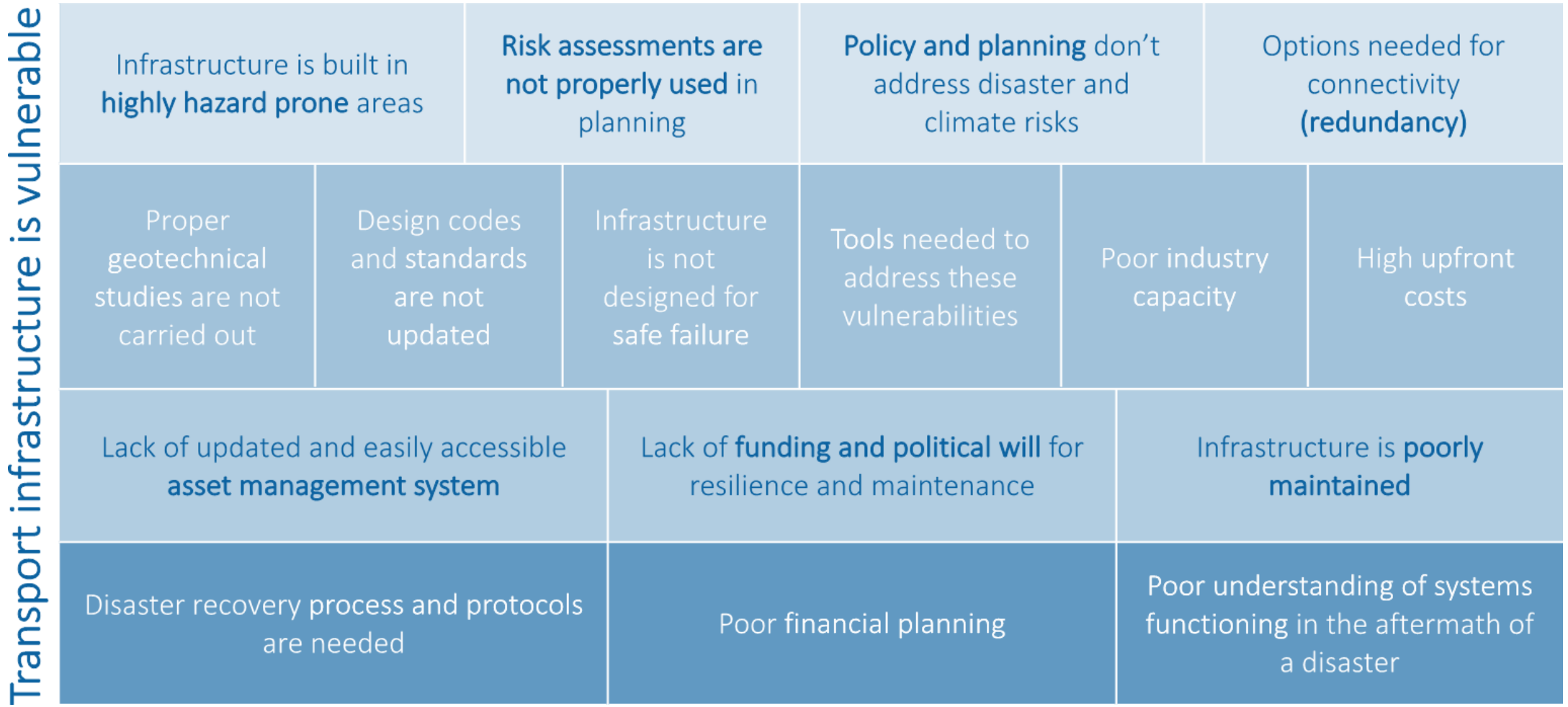
Outline

- Transport Infrastructure Resilience - challenges and opportunities
- Activities in Western Balkan countries
- Disaster Risk Management and Transport infrastructure Activities in Serbia
- Guidelines for the Road Transport Network Vulnerability Assessment
- Discussion

RESILIENCE

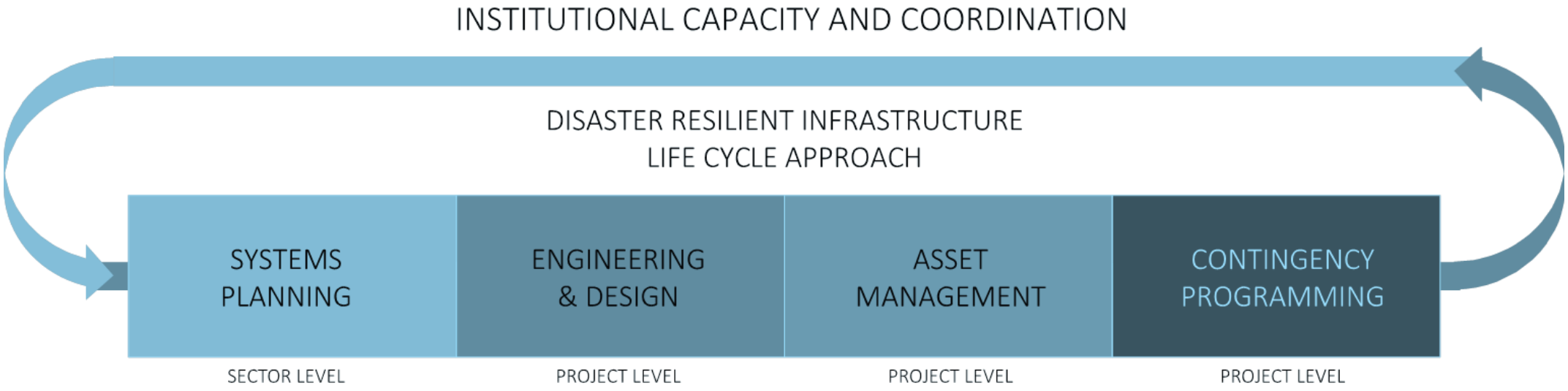
Challenges and experiences around the world

The challenge: transport infrastructure is vulnerable to climate and disaster risks



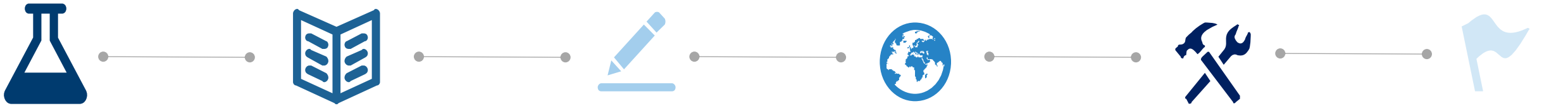
The Opportunity: Apply a lifecycle approach to increase the resilience of infrastructure

- Life cycle approach is applied to highlight that infrastructure undergoes processes of growth, reorganization / development, deterioration / conservation, and destruction.
- Addressing resilience opportunities at various phases of the life cycle enables a reflective, stable, and systems oriented resilience capacity (socio-ecological resilience).
- The objective is to respond and evolve rather than stay static and vulnerable to threats of climate hazard-induced structural or systemic failure.
- Disaster risk financing techniques can help price the risk faced by lifeline-critical infrastructure (beyond normal maintenance) and allows for better financial planning that contributes to increasing the resilience of infrastructure.



Engeenering and design

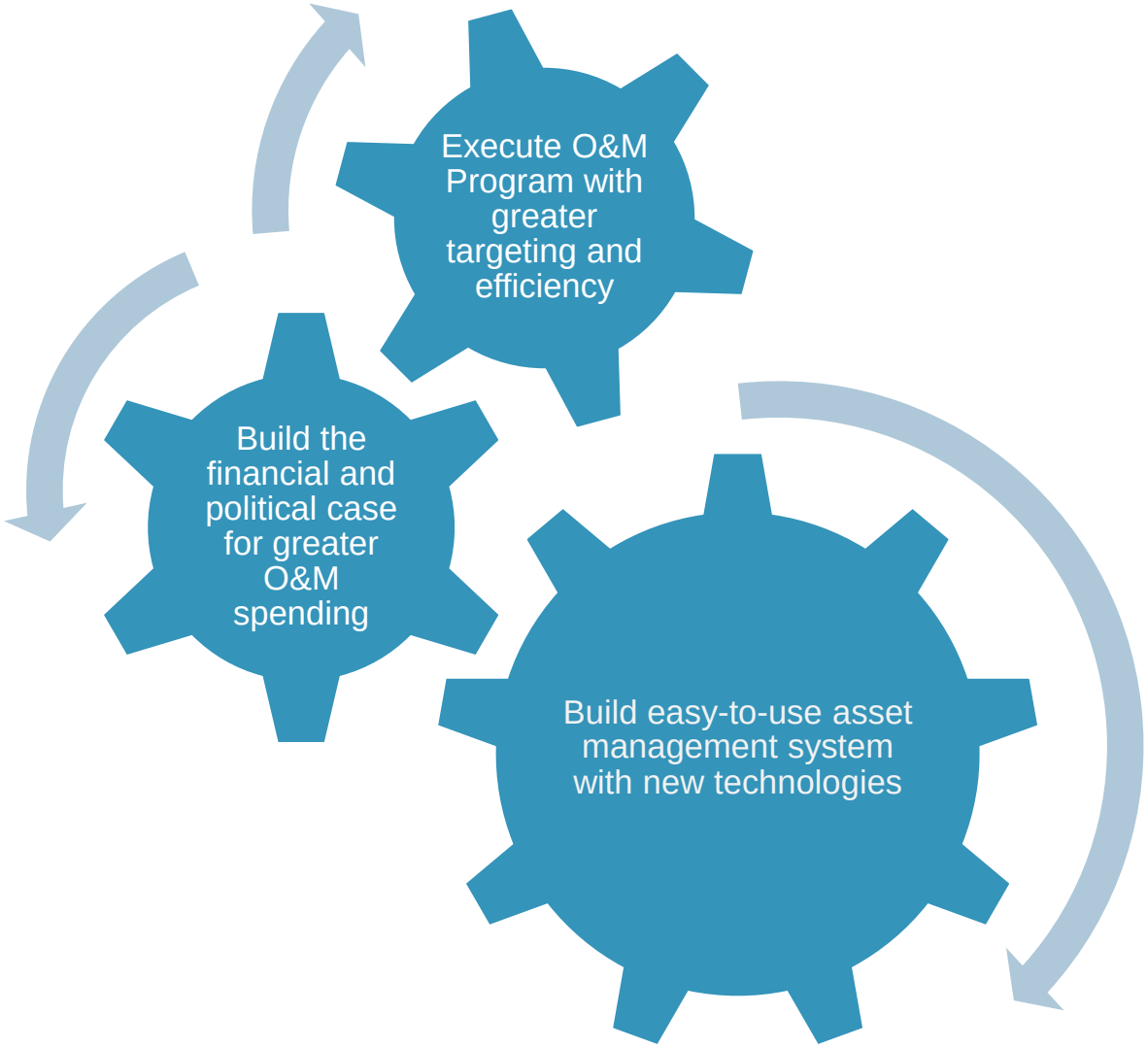
- Innovative material's design standards and specifications that enhance robustness and flexibility of infrastructure
- Conducting hazard assessment of project site to identify and reduce risks of and around infrastructure.
- Conducting infrastructure level vulnerability assessments to identify points of weakness and identify what modifications preventative measures and response mechanisms could be put in place to reduce the likelihood of failure or for ensuring safe failure.



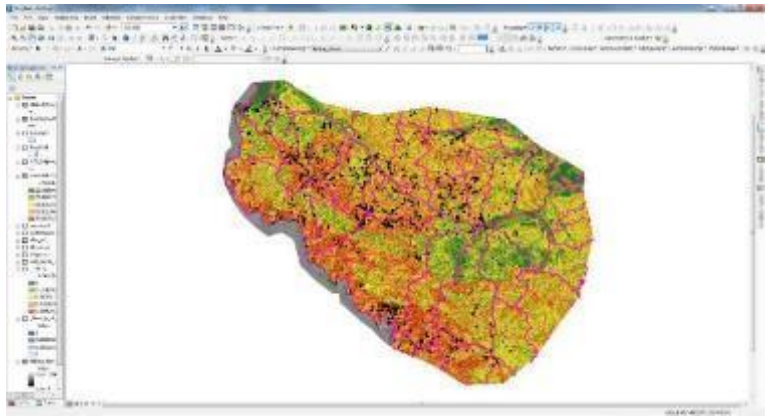
Operation and Maintenance (example Mozambique)

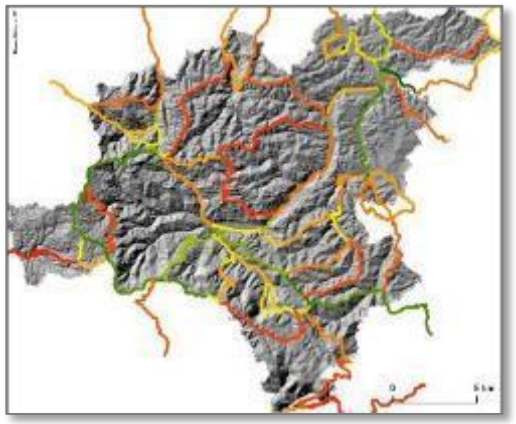
- Inventorying and mapping of transport infrastructure assets using open and inter-operable technologies and improving institutional, financial and contractual arrangements for infrastructure maintenance.

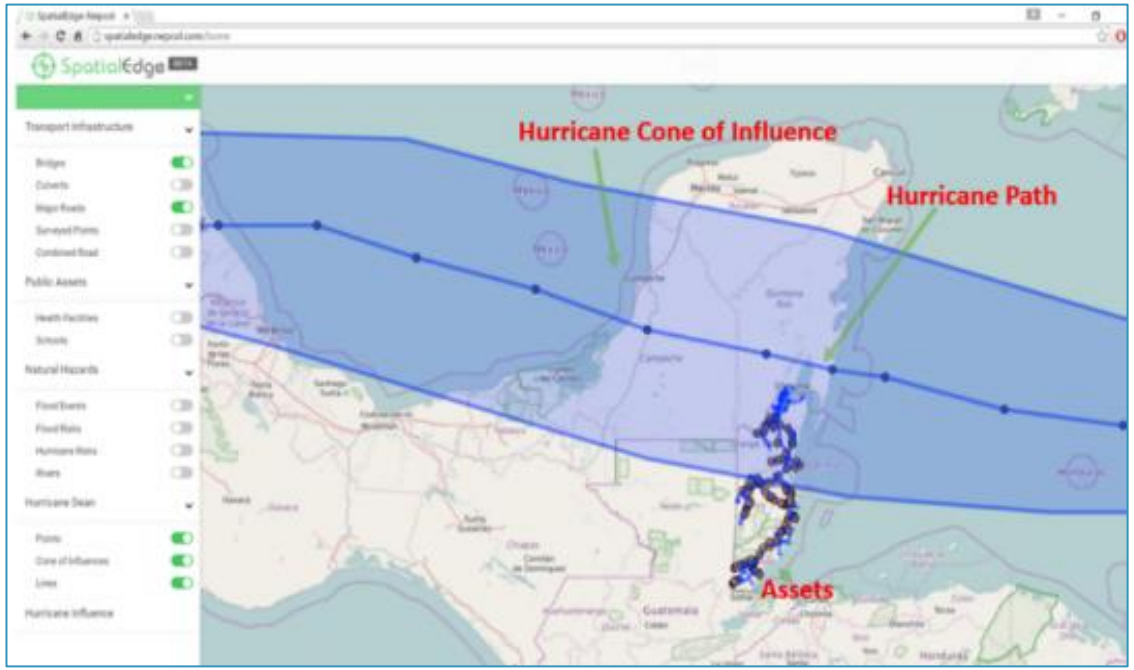
- Integrating climate and disaster risk considerations in the prioritization of investments in new infrastructure, rehabilitation, and restoration.



Data & Technology (example Belize and Dominica)







- Roadways
- Bridges
- Earthwork
- Drainage

- Flood
- Landslide

Asset

Hazard

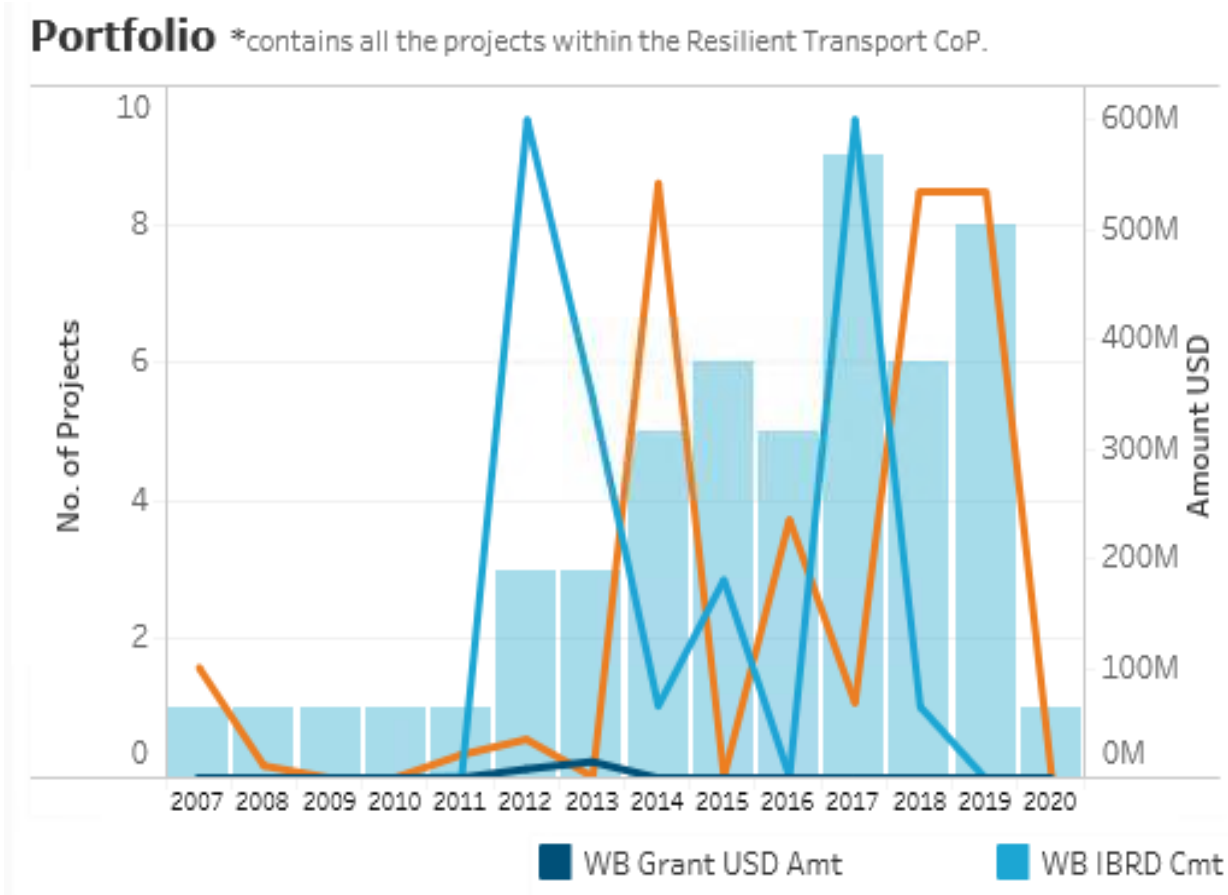
Context

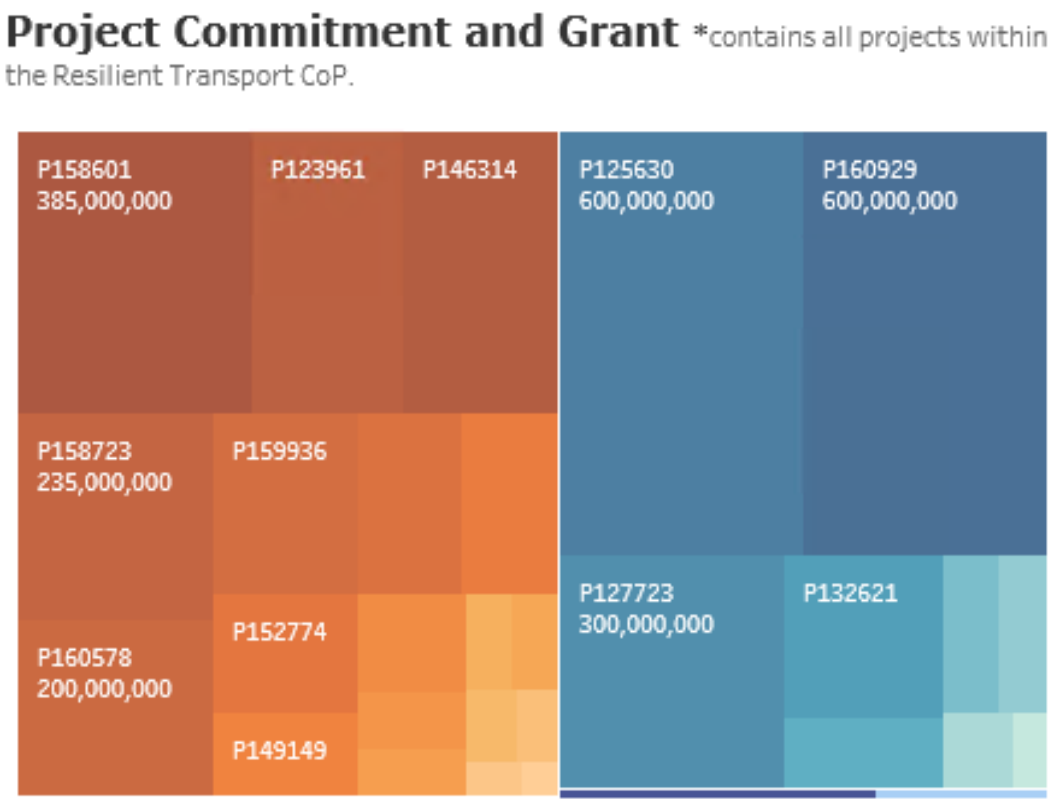
Stake-holder

- Social
- Economic
- Environmental

- MoPWP
- Community

World Bank growing portfolio in resilient transport

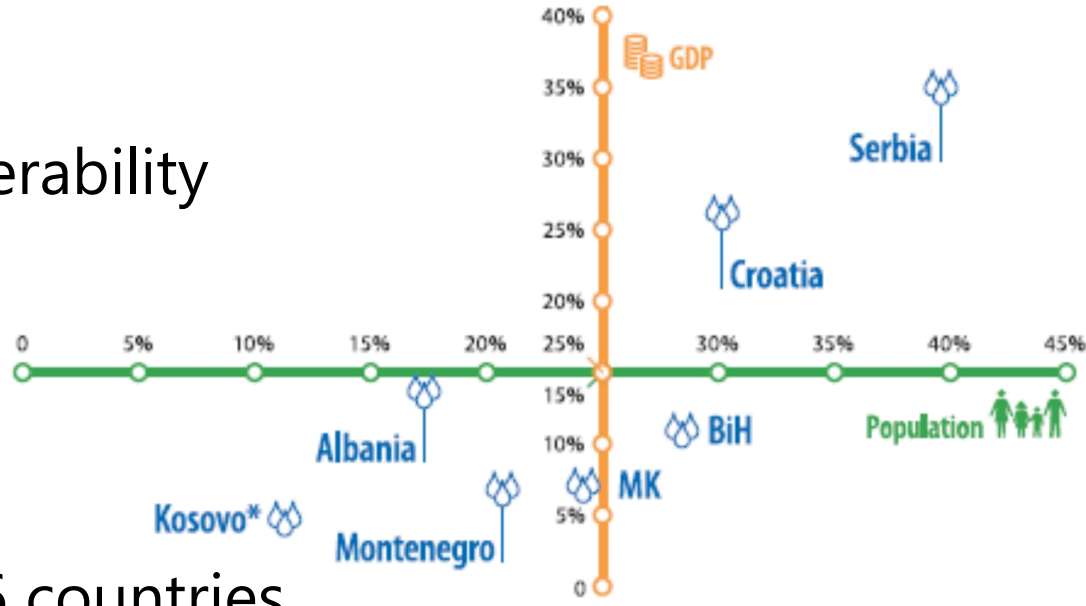




Western Balkan Countries

Activities in Western Balkan Countries

- Grant funded activities:
  - Albania (~300 K): under preparation
  - Bosnia and Herzegovina (~100 K): assess vulnerability and prioritize list of climate resilient related interventions for roads under the program
  - Serbia (~200K)
  - Regional resilience operation covering all WB6 countries (1 million): to build on country specific activities and recommendations
- Integral part of all ongoing and planed lending activities in the client countries



FLOOD EXPOSURE IN THE WESTERN BALKANS

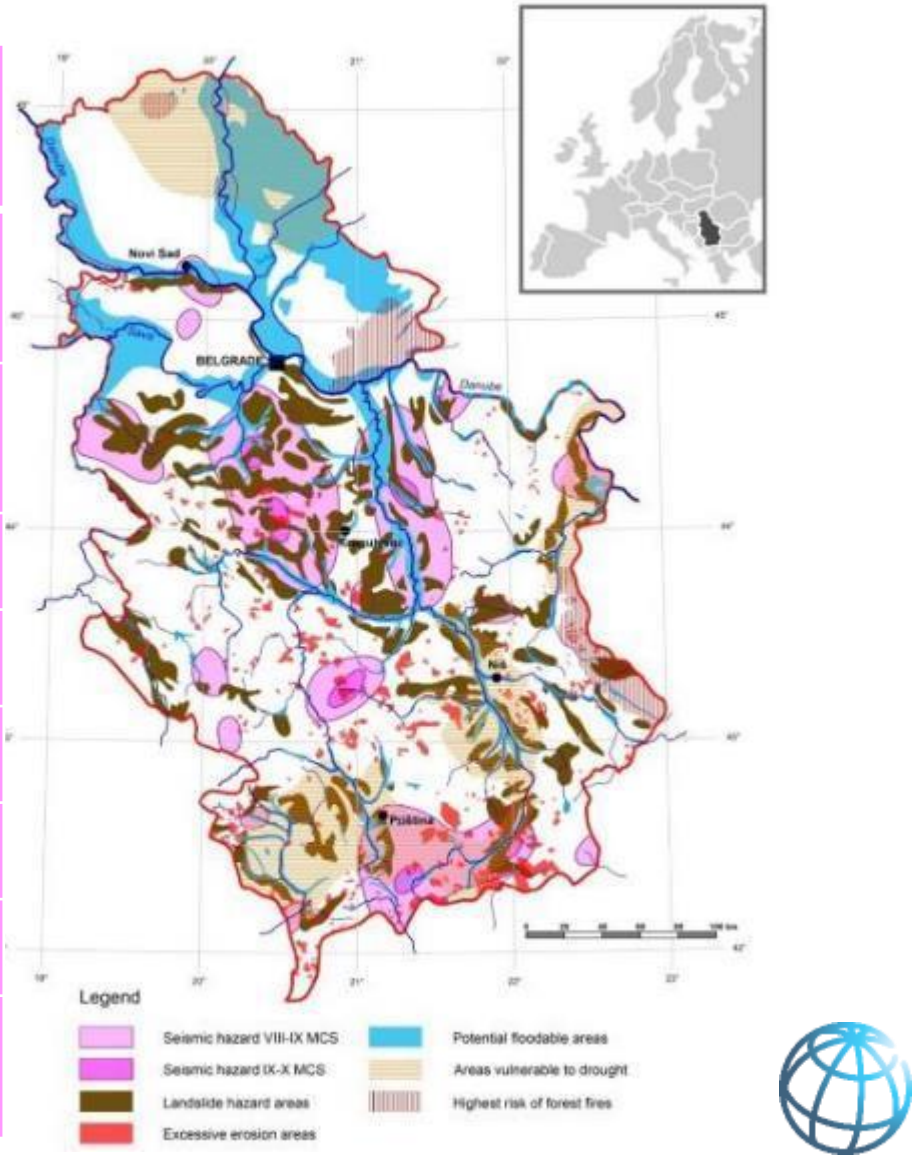
SOURCE: UNDP – RISK PROOFING THE WESTERN BALKANS (2016 HUMAN DEVELOPMENT REPORT)

DRM and transport resilience activities in Serbia

Natural Hazards (spatial plan 2010-20 and projections)

- Total damage caused by extreme climate and weather conditions, since 2000, exceeds 5 Billion EUR.
- More than 70% of losses are associated with drought and high temperatures.
- A major cause of significant losses were floods.
- The two most extreme climate and weather episodes were the drought in 2012 and the floods in 2014.

Natural hazards	P [km^2]	[%] of total P
Seismicity VIII–IX MCS	16 388.59	18.55
Seismicity IX–X MCS	1109.71	1.26
Excessive erosion	3320.80	3.76
Landslides	13 327.60	15.08
Drought	18 306.93	20.72
Floods	15 198.07	17.20
Wild fire	3154.95	3.57
Total area	50 659.87	57.33



Floods 2014 (https://www.youtube.com/watch?v=cK1OBD1hLWk

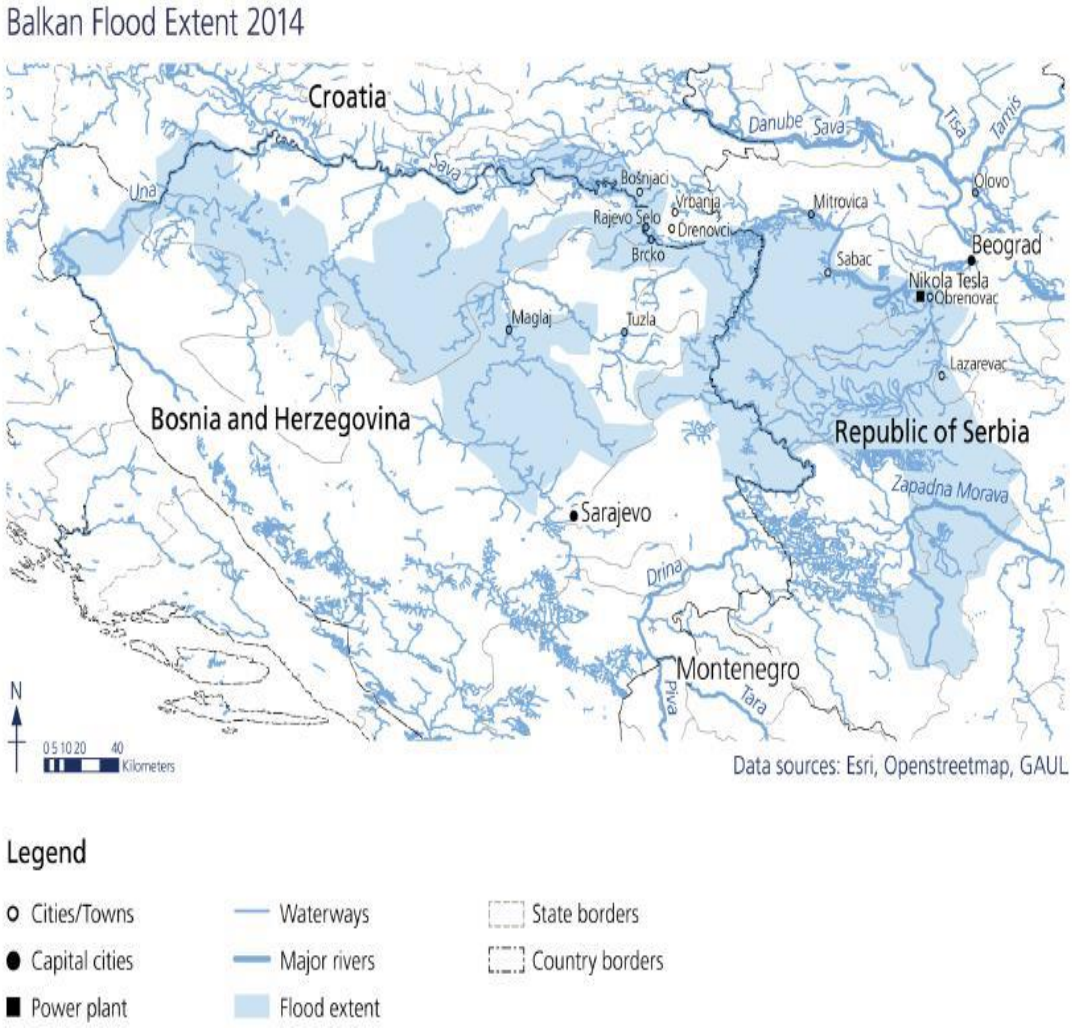
- Most severe flooding in 120 years.
- More than 1.6 million people affected (22% of the total population) in 38 municipalities.
- 57 lives lost and 32,000 families evacuated and displaced.
- Recovery needs assessment with support from the European Union, United Nations, and the World Bank Group.
- The total effects of the disaster in 24 affected municipalities selected for the assessment amounted to EUR 1,525 million, of which EUR 885 million (57% of the total effects) represented the value of destroyed physical assets, and EUR 640 million (43% of the total) refer to losses in production. When considering all the 38 affected municipalities, the total value of disaster effects rose to EUR 1.7 billion (or over 4% of GDP).
- The hardest hit sectors were energy and agriculture (32% of the total), followed by housing, transport and trade, each accounting for around 15%.
- Flood protection infrastructure suffered as well, leading to increased concerns over power and food shortages and leaving the country even more exposed to subsequent flooding.
- Approximately 51,800 people temporarily lost their job due to the interruption of productive activities and household incomes declined

Sector	Sub sector	Disaster effects, million EUR		
		Damage	Losses	Total
Social	Total	234.6	7.1	241.7
	Housing	227.3	3.7	231.0
	Education	3.4	0.1	3.5
	Health	3.0	2.7	5.7
	Culture	1.0	0.6	1.6
Productive	Total	516.1	547.6	1063.6
	Agriculture	107.9	120.1	228.0
	Manufacturing	56.1	64.9	121.0
	Trade	169.6	55.2	224.8
	Tourism	0.6	1.6	2.2
	Mining and energy	181.9	305.8	487.7
Infrastructure	Total	117.3	74.8	192.1
	Transport	**96.0**	**70.4**	**166.5**
	Communication	8.9	1.1	10.0
	Water and sanitation	12.4	3.2	15.6
Cross cutting	Total	17.2	10.6	27.9
	Environment	10.6	10.1	20.7
	Governance	6.7	0.6	7.3
Total		885.2	640.1	1,525.3

WB DRM Wide Support

- Establishment of a National Disaster Risk Management Program (NDRMP) to coordinate efforts to boost resilience throughout the country.
- The initial $300 million (recently revised to $245 million) Emergency Recovery Loan from WB to support the recovery efforts after floods in 2014 in the energy, agriculture and flood protection sectors.
- The first ($70 million) Disaster Risk Management Development Policy Loan from WB in the region to take advantage of the Catastrophe Deferred Drawdown Option (Cat-DDO).
- EU and WB support of EUR6.15 million, creation of high resolution Digital Terrain Models using advanced LiDAR survey technology to better assess future flood risks.
- SDC and WB support of $1.6 million for institutional strengthening, open data initiatives and end-to-end early warning system development. BEWARE

- Shifting focus over time from flood **prevention** and recovery to multi-hazard **risk management** at both the local and national levels.
- **Expanding** DRM approaches to selected **sectors** such as transport and urban planning for improved resilience.
- Strengthening **financial protection mechanisms** to protect against fiscal shocks of natural hazards. (CAT DDO)
- Mitigating the impact of climate change and making the **economy more disaster resilient**.
- Managing and implementing the National DRM Program.
- Supporting **regional** initiatives on risk assessment, resilient planning, preparedness and response.



Transport context

- Connectivity is a critical driver of competitiveness, and the quality of infrastructure networks is an important factor for Serbia to shift the economy towards export-orientation.

- World Bank ongoing investment lending projects, Corridor X Highway Project, Road Rehabilitation and Safety Project, and P4R are complementing the government's efforts to improve the quality of road infrastructure.

- In 2016, the World Bank supported the preparation of a Joint Action Plan that was endorsed by the 6 Governments of the Western Balkans at the Western Balkan Paris summit in July. This action plan included amongst other the development of Network Resilience plans and the Identification of interventions for climate mitigation and increased network efficiency, and preparation of draft plans for their implementation. – regional project and SEETO

Category of state roads/subcategory (A and B)	Length (km)
I A category state roads (motorways)	741.46
I B category state roads	4,486.10
II A category state roads	7,765.00
II B category state roads	3,170.15
Total category I (A+B)	5,227.56
Total category II (A+B)	10,935.15
Total categories I+II	16,162.71

WB support to transport infrastructure resilience

The World Bank Transport team is supporting the GoS to mainstream climate resilience in the road sector through:

a) Ongoing and planned investment projects => **interventions and policy support**

b) Pilot-testing of the Handbook/Toolkit for Geohazard Risk Management in Transport Sector (Geohazard Handbook) => **provide diagnostics of the current state of affairs and identification of major improvements needed; and**

c) Mainstreaming climate resilience in road transport management in Serbia with support of the Global Facility for Disaster Reduction and Recovery Trust Fund Facility (GFDRR) => **methodology for vulnerability assessment, RAMS, GIS…**

Main initial findings (Geohazard Handbook testing)

The preliminary analysis from the Handbook testing suggests that there is no established methodology for systematic management of the network vulnerability. In particular:

- Climate resilience is considered only on an ad-hoc basis and is usually driven by the expert knowledge of few employees from PERS.
- There is no clear regulation governing how the investments in potentially critical locations should be planned or financed; in addition usage of available resources is inefficient.
- Serious lack of equipment (inclinometers, piezometers, etc.) has been reported and observed in the most severe existing landslide locations.
- Design legislation and guidelines for geohazards in the road network have been defined as sufficient and recently strengthened to comply with the European standards, however insufficient funding limits considerably its application and results in insufficient instrumentation and geotechnical designs.
- Cooperation between central and local relevant government agencies is insufficient. The authority dealing with emergency situations (SES) and PERS should work more closely, interact and share data, utilizing available Early Warning Systems and jointly respond in a timely and combined manner in emergency situations.
- There is lack of historical and observational data to monitor the climate change sensitivity/vulnerability of different sectors and ecosystems on the basis of unified and recognized system of indicators; in addition, spatial data are insufficient and/or publicly unavailable. Traffic and statistical data are available.
- Data on landslides are partially recorded in the relational database, but there is no established road vulnerability map in GIS environment.
- There is lack of unified and publicly available methodologies for elaboration of climate change related assessments;
- Insufficiency of regional coordination mechanisms. The high exposure and vulnerability and a up to now a reactive approach to disasters, as well as environment degradation factors urge a need to further work on mainstreaming climate resilience of the road transport network and improvement of disaster risk management and emergency response in Serbia.

Mainstreaming climate resilience in the road transport management in Serbia (GFDRR grant, 200K)

Objectives:

- support the government in establishing a foundation for mainstreaming climate resilience considerations in the road transport sector management in Serbia by developing an effective methodology for assessing vulnerability of the road transport network to the climate related risks,
- improving capacities of key stakeholders in road network climate resilience planning, and
- setting the path for development of structured and systematic response plans.

- Test the proposed methodology/guidelines and road asset management on Pilot region around Valjevo (200 km) with the use of GIS
- Framework and all outputs are expected to be applicable to the entire country and to any road class
- IMC Worldwide and Faculty of Geology and Mining, University of Belgrade

Specific tasks

Task 1. Methodology for Climate Change and Natural Hazard Road Network Vulnerability Assessment (and beyond)

- Vulnerability assessment **methodology**
- **Framework** for prioritization of interventions based on vulnerability and criticality criteria
- **Guidelines** for climate change and natural hazard road network vulnerability assessment

Task 2. Recommendations for Inclusion of Climate Resilience in the Road Asset Management and Corresponding Action Plan

- Develop recommendations for actions across the full scope of road asset management and action plan.
- Monitoring and observation * Financing
- Investment Decision Making Framework * Institutional and legal reforms
- Asset Life Cycle Strategy Adjustments

Task 3: Pilot Testing of the Proposed Approach for the Valjevo Region and Development of corresponding GIS Maps

- Vulnerability assessment and asset plans pilot testing with corresponding GIS maps

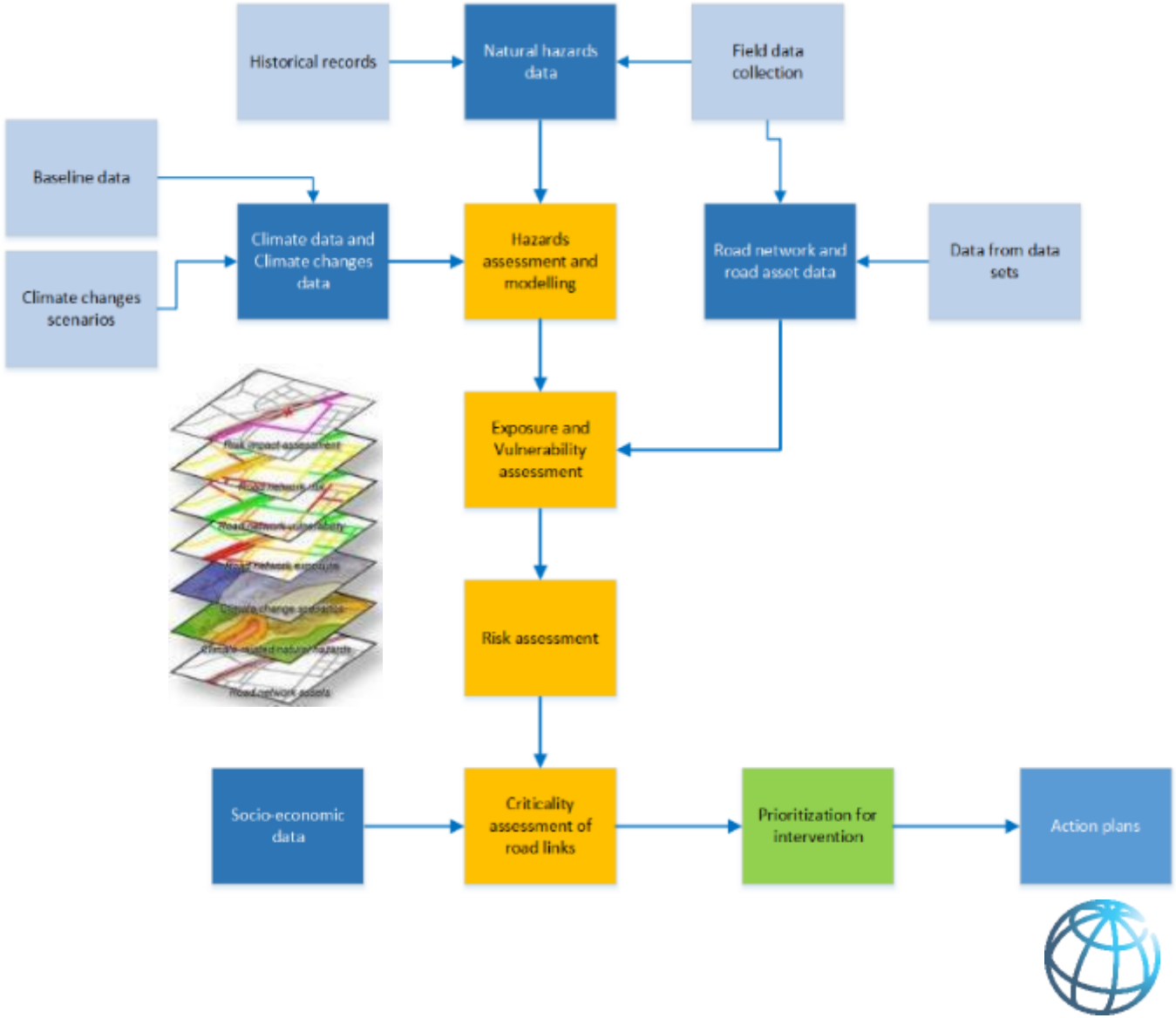
Task 4: Development of a ToR for Network Vulnerability Analysis and Emergency Response Plans for the Main Trade Routes

- Policy frameworks, disaster response mechanisms
- Protocols for traffic queuing and coordination, evacuation routes, etc and Disaster communication protocols and equipment
- Procurement, Financial planning and protection
- Establishing sectoral disaster assessment teams and provision of risk understanding, awareness, and technical training

Task 5: Dissemination and Knowledge Sharing Workshops

Methodology for Climate Change and Natural Hazard Road Network Vulnerability Assessment

- Identify existing and likely future key hazard types and risk levels (e.g. riverine floods, erosion, high temperatures, landslides, etc.)
- Assess demographic and socioeconomic data and identify areas with high densities of population, especially the poor or other vulnerable people;
- Identify the location of (a) critical services and (b) major economic activities, existing and planned. Assess economic potential of high risk areas
- Identity priority geographical areas and road links that are vulnerable to existing and future climate driven risks.



Guidelines for climate change and natural hazard road network vulnerability assessment

Translate methodology for easy to use guidelines, applicable and understandable to central and local authorities

- What parts of the road network cross areas with high climate related hazard(s) and what is the risk level
- What kind of socio-economic impacts could be generated in the case of hazard events on particular road(s)
- How to prioritise critical road interventions for investment (both in the current climate conditions / related hazards and for future climate change projections); and
- How to develop estimated budgets prioritising mitigating and resilience measures with respect to climate and natural hazard events

1. Exposure of different areas to natural hazard

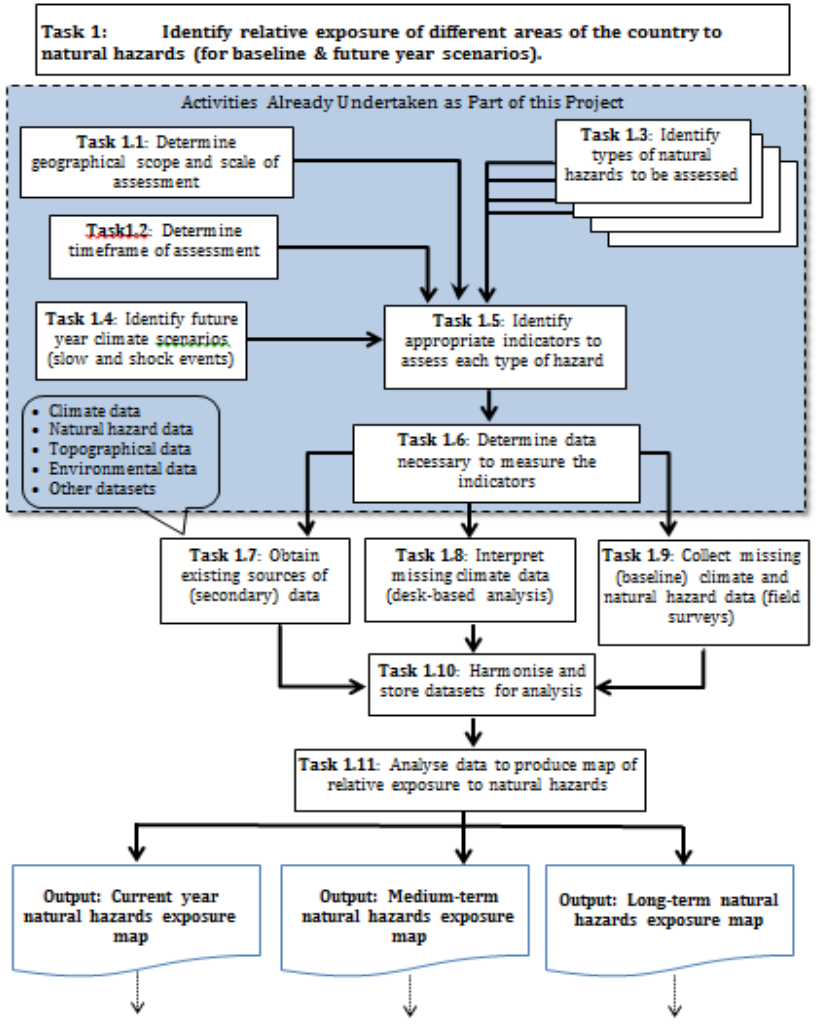
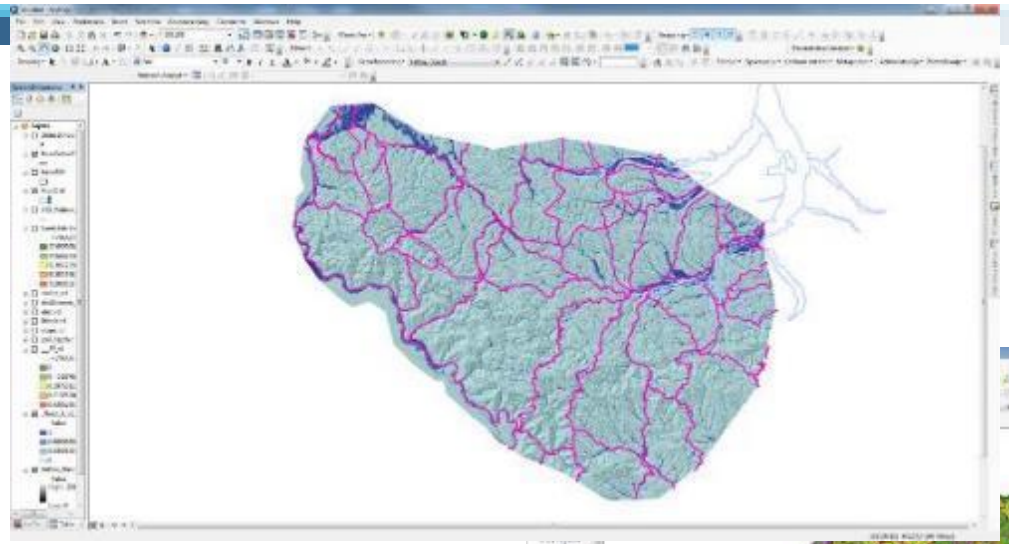
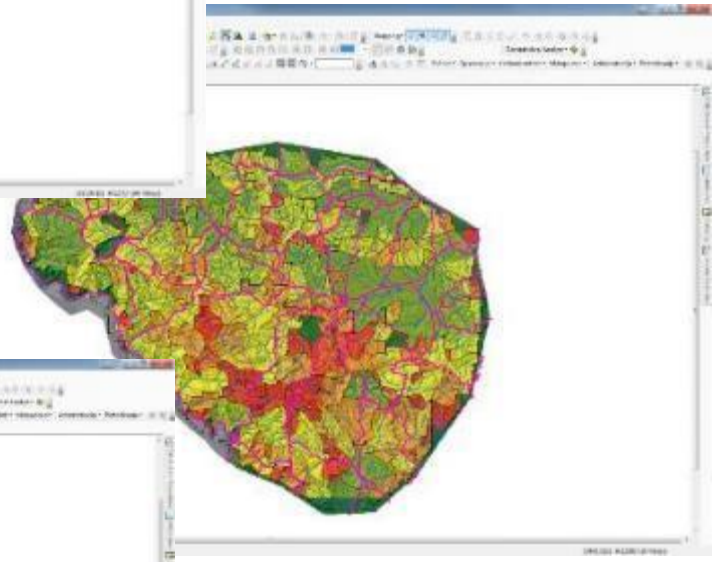
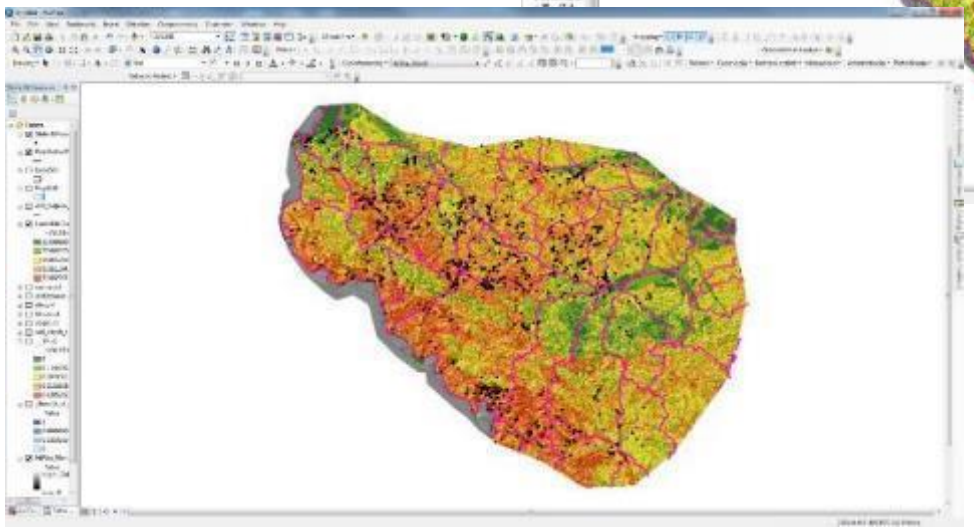


Figure 1: Flowchart for Task 1: Identification of relative exposure of different areas of the country to natural hazards (for baseline & future year scenarios).







2. Identify roads passing to high exposure areas

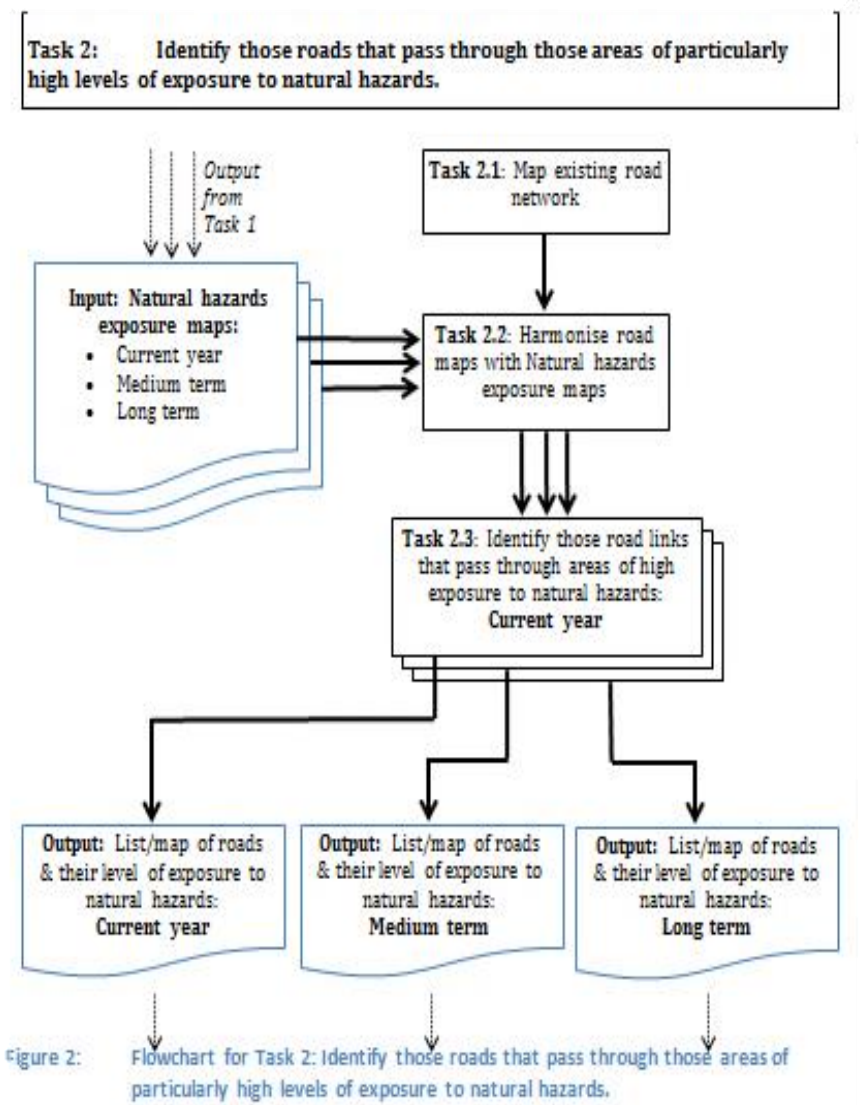
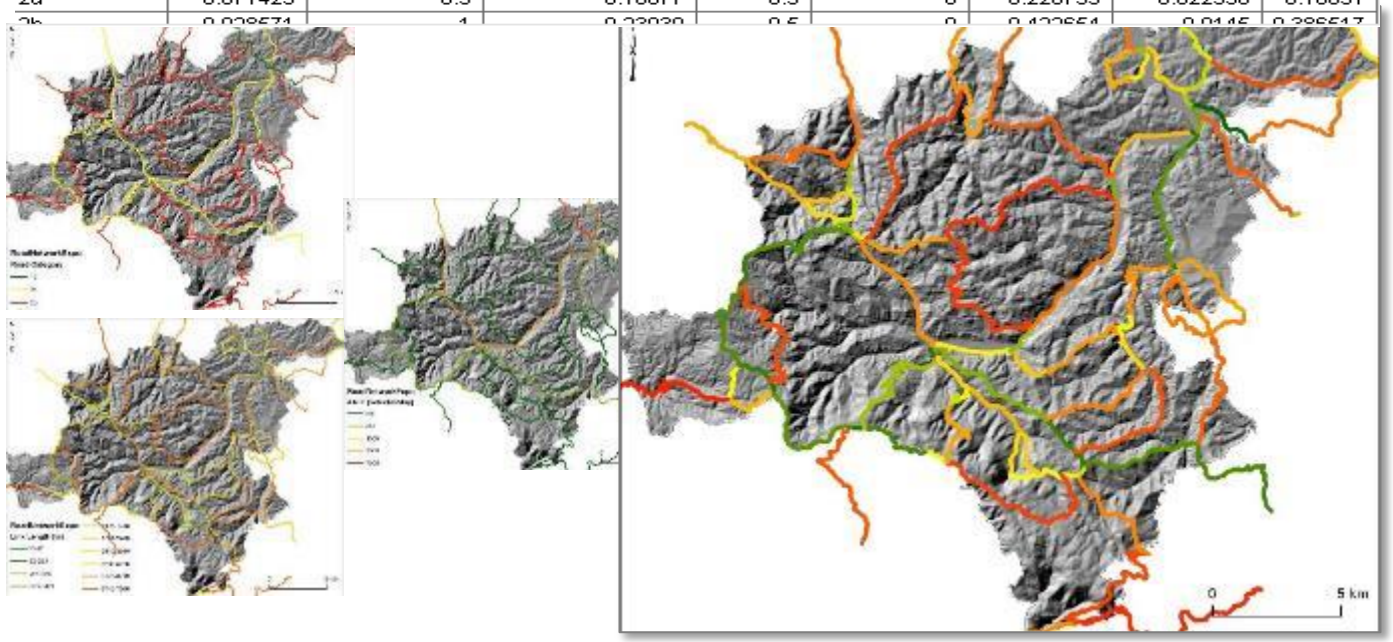
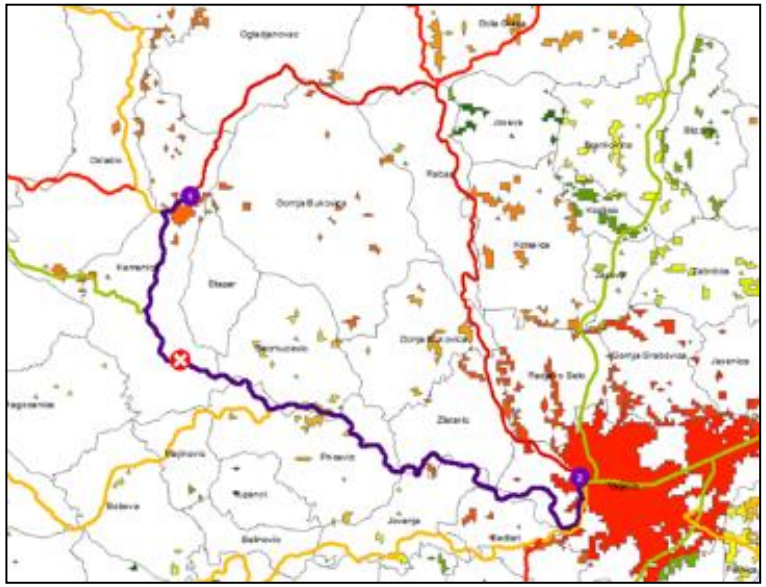


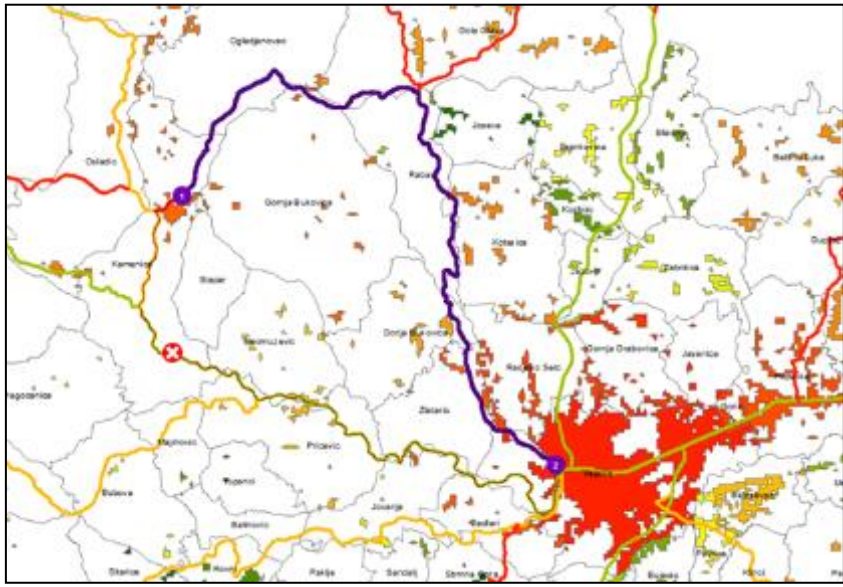
Figure 2: Flowchart for Task 2: Identify those roads that pass through those areas of particularly high levels of exposure to natural hazards.

RoadCateg	AATF_01	Road_Cat_01	Link_Leng_01	IRI_01	Custom_01	Vulner_AV	Expo_01	Risk
2b	0.028571	1	0.286495	0.5	0	0.438356	0.268768	0.117816
2b	0.028571	1	0.835134	0.5	0	0.621235	0.201809	0.125371
2b	0.028571	1	0.527618	0.5	0	0.51873	0.288219	0.149508
2b	0.028571	1	0.327341	0.5	0	0.451971	0.556913	0.251708
2b	0.028571	1	0.043717	0.5	0	0.357429	0.728266	0.260304
2b	0.028571	1	0.093141	0.5	0	0.373904	0.900054	0.336534
2b	0.028571	1	0.080859	0.5	0	0.36981	0.825092	0.305127
2b	0.028571	1	0.030108	0.5	0	0.352893	0.685751	0.241997
2b	0.028571	1	0.532541	0.5	0	0.520371	0.727385	0.37851
2a	0.071429	0.5	0.126923	0.5	0	0.232784	0	0
2b	0.028571	1	0.065033	0.5	0	0.364535	0.799577	0.291474
2a	0.071429	0.5	0.050466	0.5	0	0.207298	0.731476	0.151634
2a	0.071429	0.5	0.271271	0.5	0	0.2809	0.871802	0.244889
2a	0.071429	0.5	0.341882	0.5	0	0.304437	0.812589	0.247382
2b	0.028571	1	0.114473	0.5	0	0.381015	0.963369	0.367058
2b	0.028571	1	0.139368	0.5	0	0.389313	0.941429	0.366511
2b	0.028571	1	0.437191	0.5	0	0.488587	0	0
2a	0.071429	0.5	0.034633	0.5	0	0.202021	0.921524	0.186167
2a	0.071429	0.5	0.201279	0.5	0	0.257569	0.911846	0.234863
2a	0.071429	0.5	0.10877	0.5	0	0.226733	0.822596	0.18651



3. Socio economic importance of roads





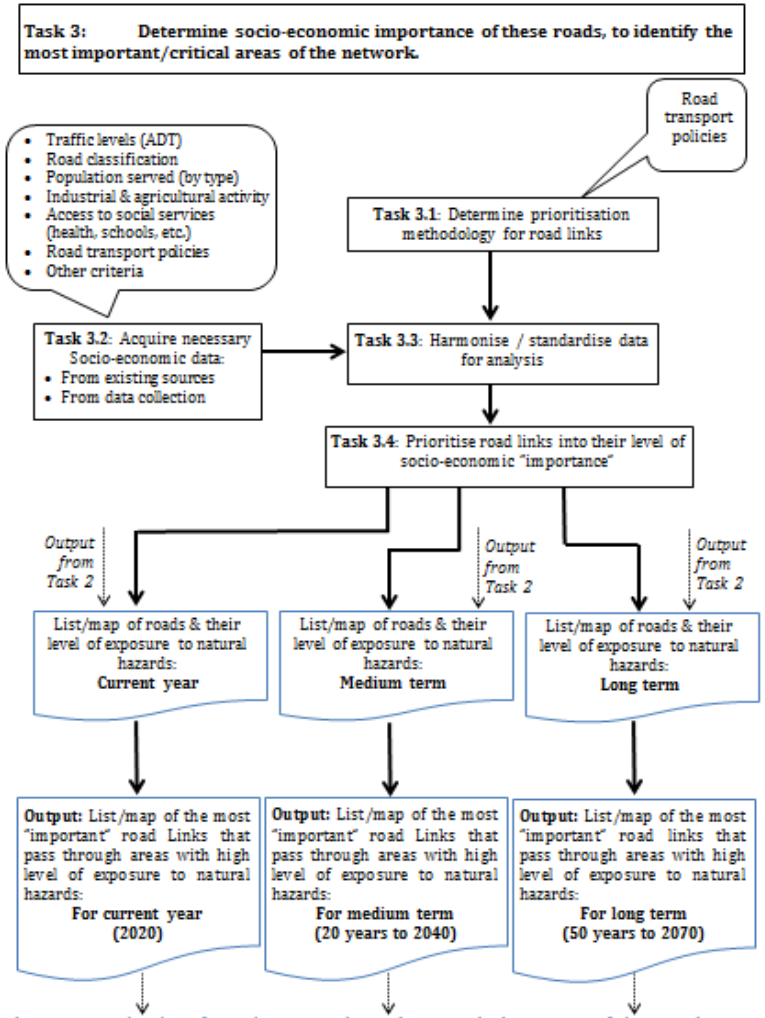


Figure 3: Flowchart for Task 3: Determine socio-economic importance of these roads, to identify the most important/critical areas of the network.

4. Engineer based assessment for vulnerability

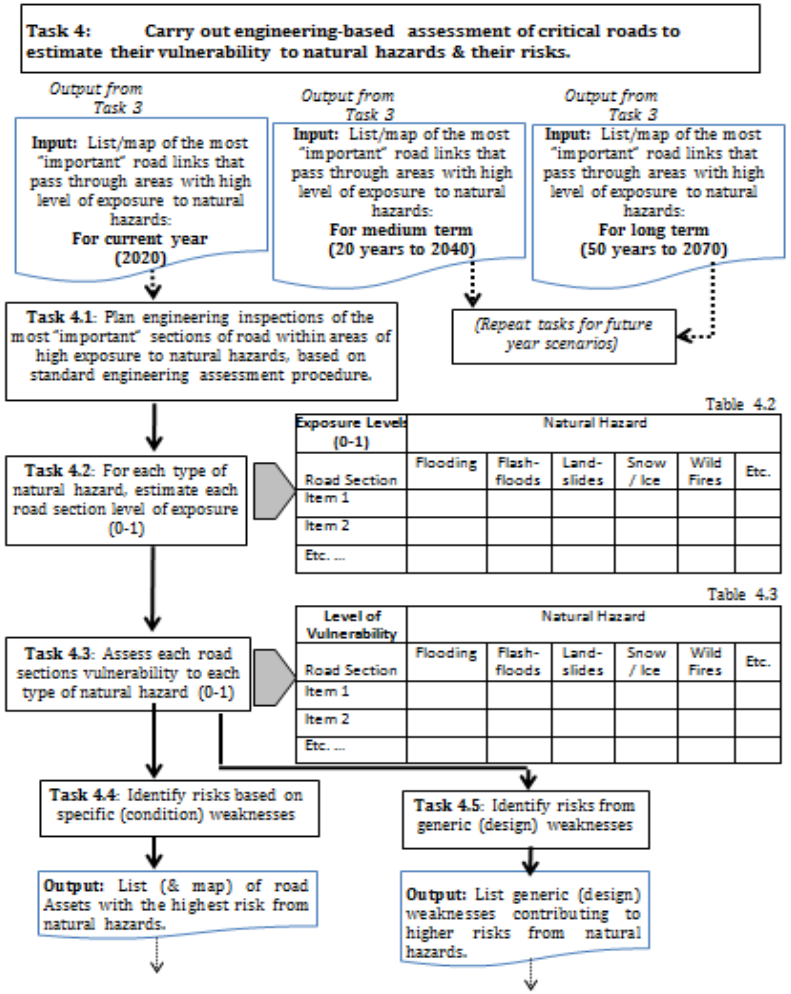


Figure 4: Flowchart for Task 4: Carry out engineering-based assessment of critical roads to estimate their vulnerability to natural hazards and their risks.

5&6. Identify & cost (site and non-site) specific interventions

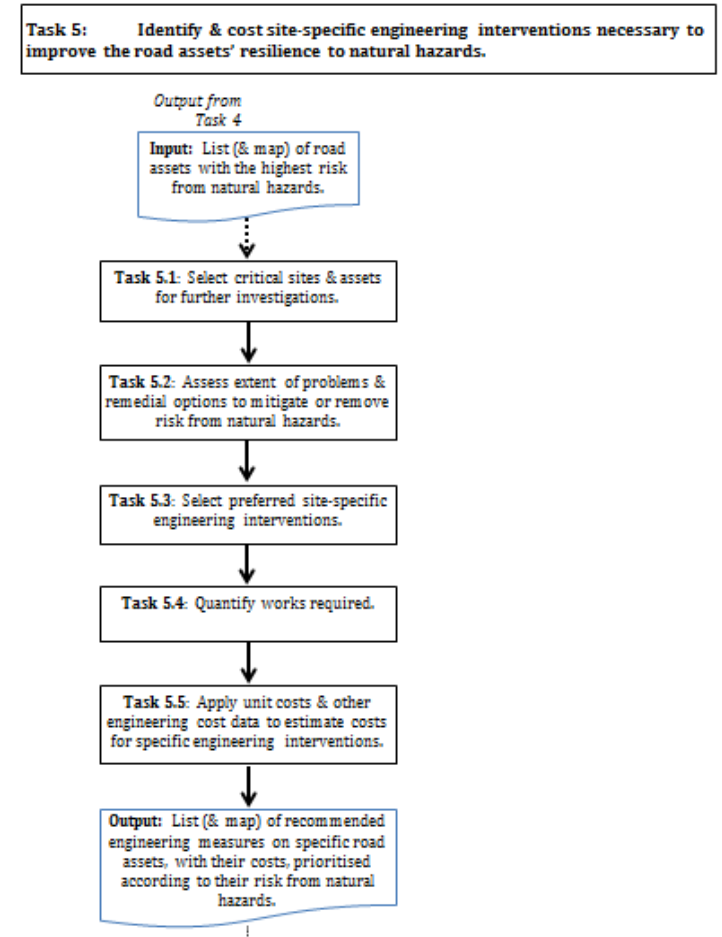
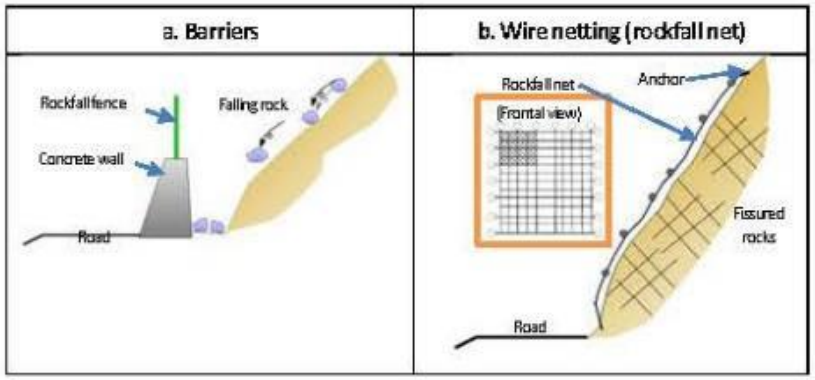


Figure 5: Flowchart for Task 5: Identify and cost site-specific engineering intervention necessary to improve the road assets' resilience to natural hazards.



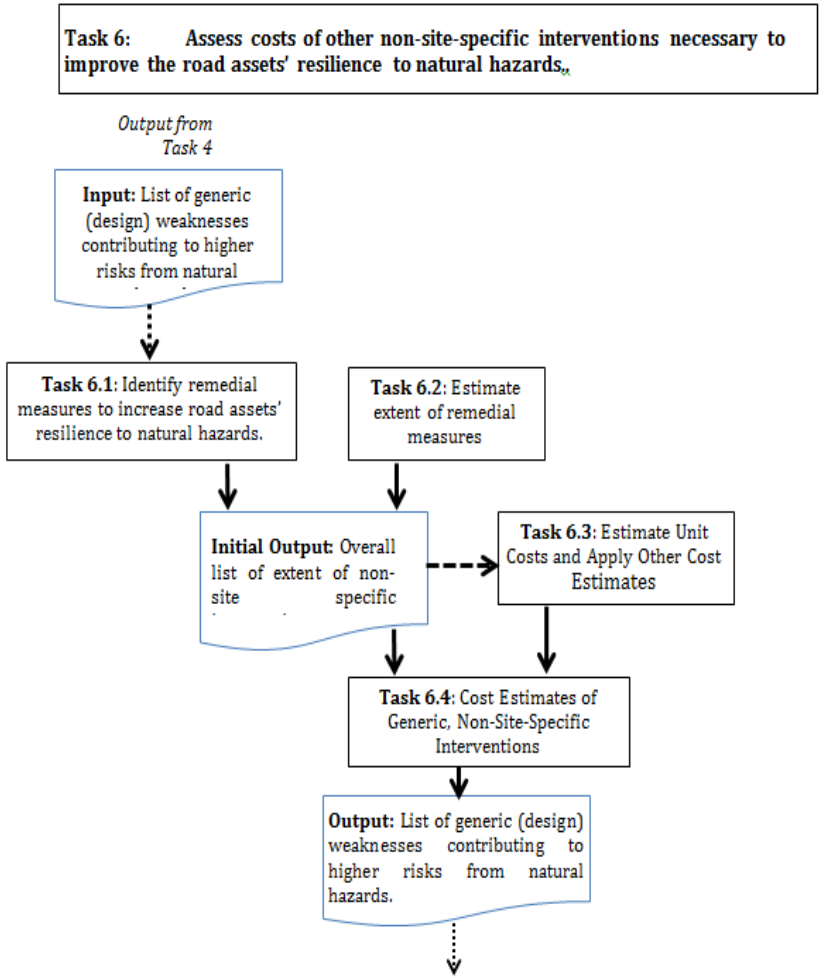


Figure 6: Flowchart for Task 6: Assess costs of other non-site-specific interventions necessary to improve the road assets' resilience to natural hazards.

7&8. Multi-criteria prioritization and investment plans

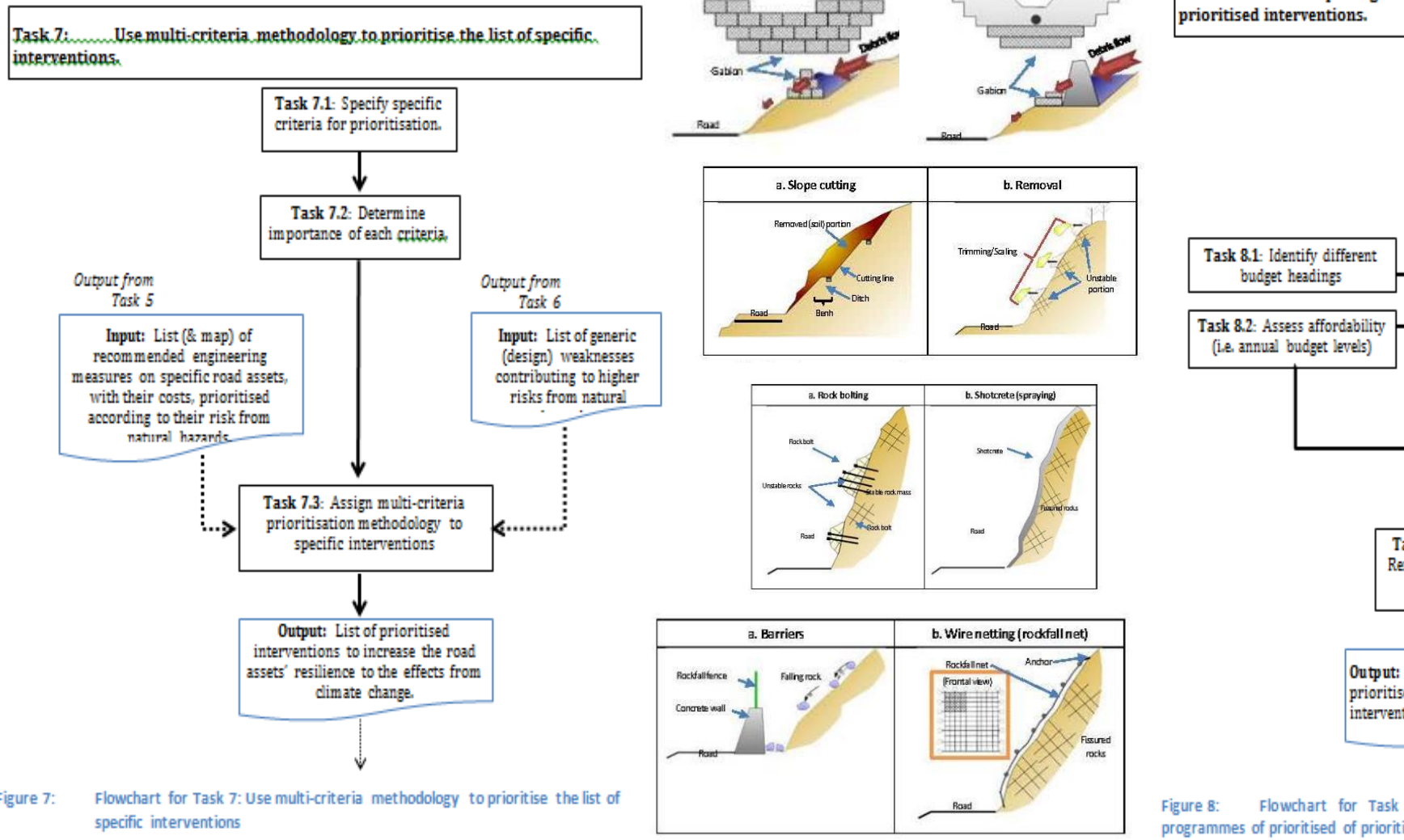


Figure 7: Flowchart for Task 7: Use multi-criteria methodology to prioritise the list of specific interventions

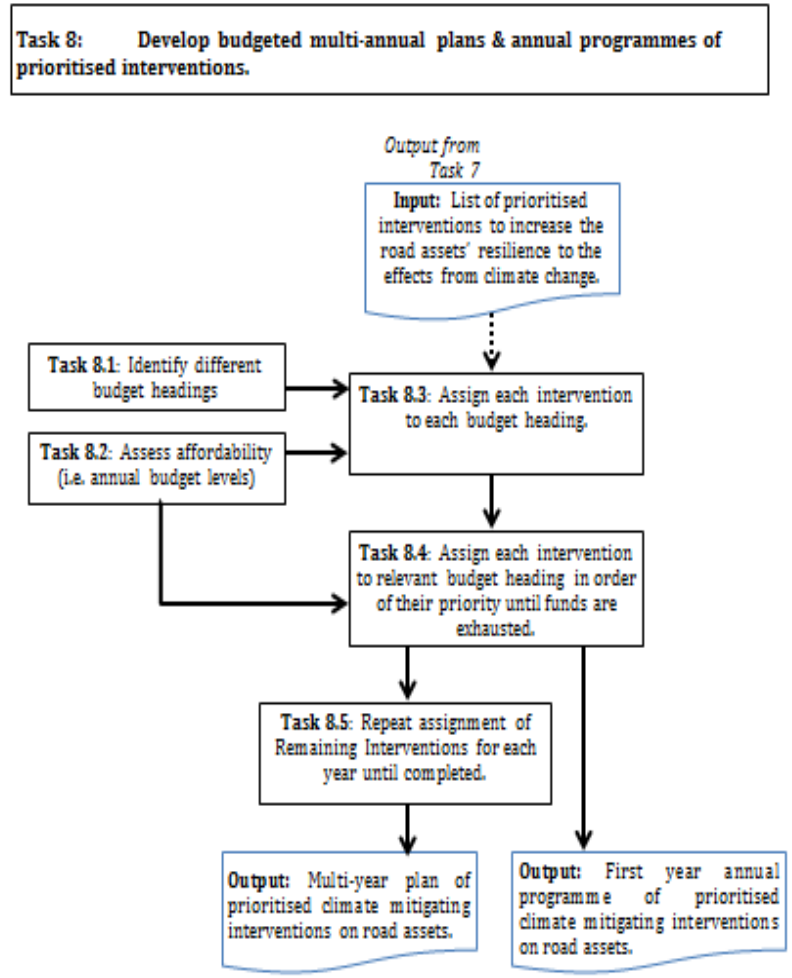


Figure 8: Flowchart for Task 8: Develop budgeted multi-annual plans and annual programmes of prioritised of prioritised interventions

DISCUSSION & THANK YOU

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