



SETOF

Soil Erosion and TOrrontial Flood
Prevention: Curriculum Development at the
Universities of Western Balkan Countries

FLOOD RISK MANAGEMENT PLAN for the Upper Vardar River Basin

Workshop on Bachelor and Master Curriculum Best Practices - North Macedonia
28-29 October 2019, Skopje

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 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

**Swiss Agency for Development
and Cooperation SDC**

**State Secretariat for
Economic Affairs SECO**



**Ministry of
Environment and
Physical Planning**

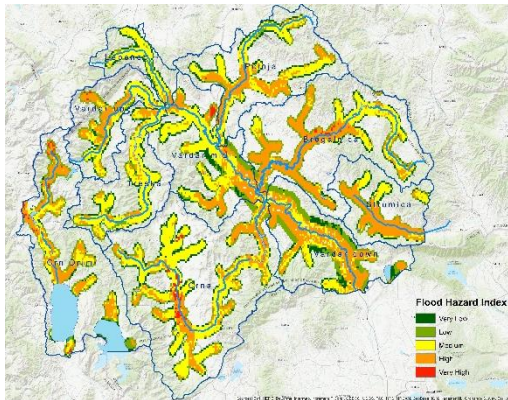
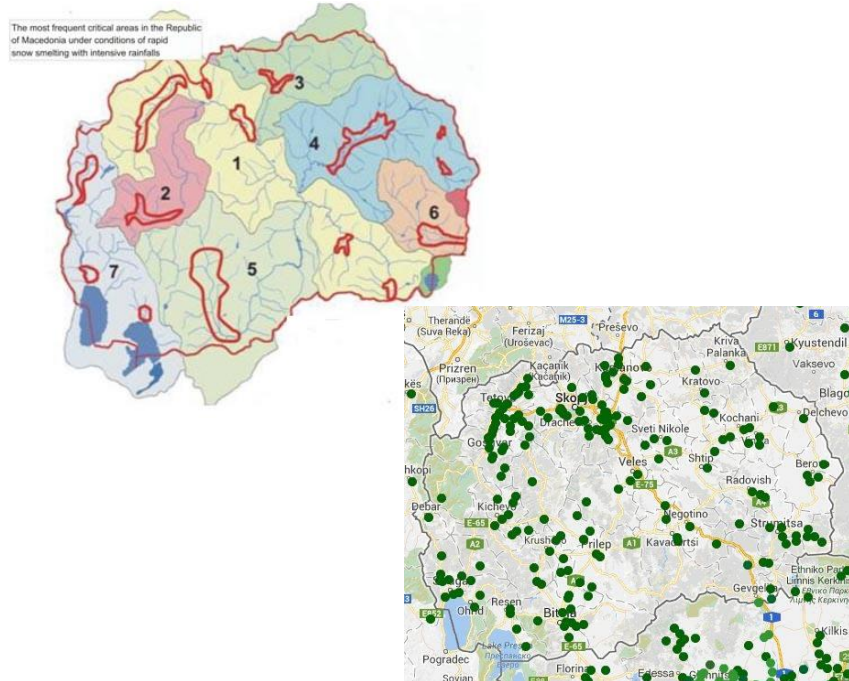


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Significant floods in the past



6th of top 10 countries in terms of disaster mortality in 2016 (1.06/100.000)

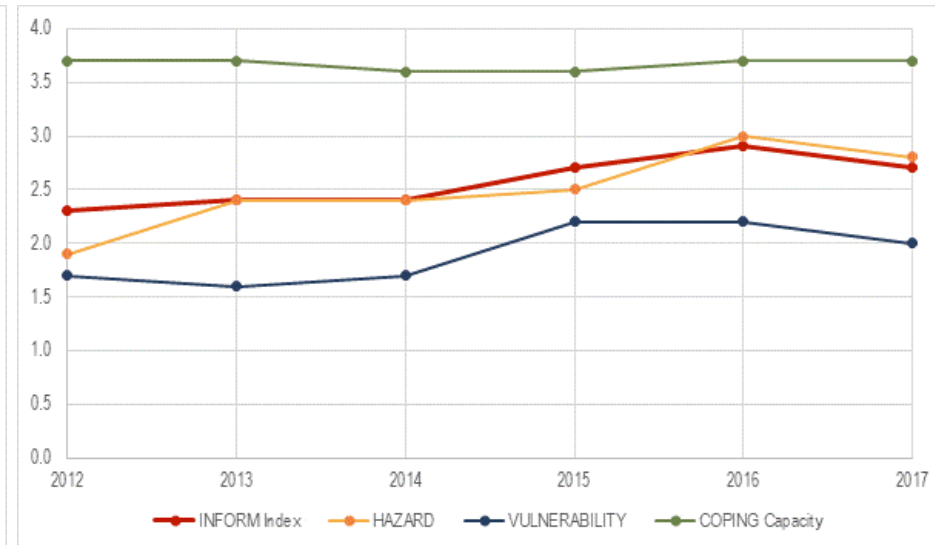
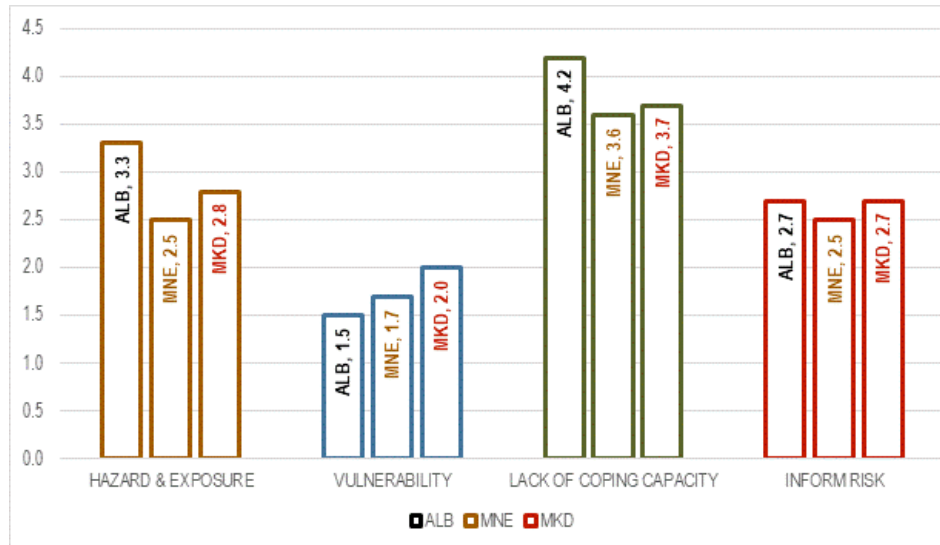
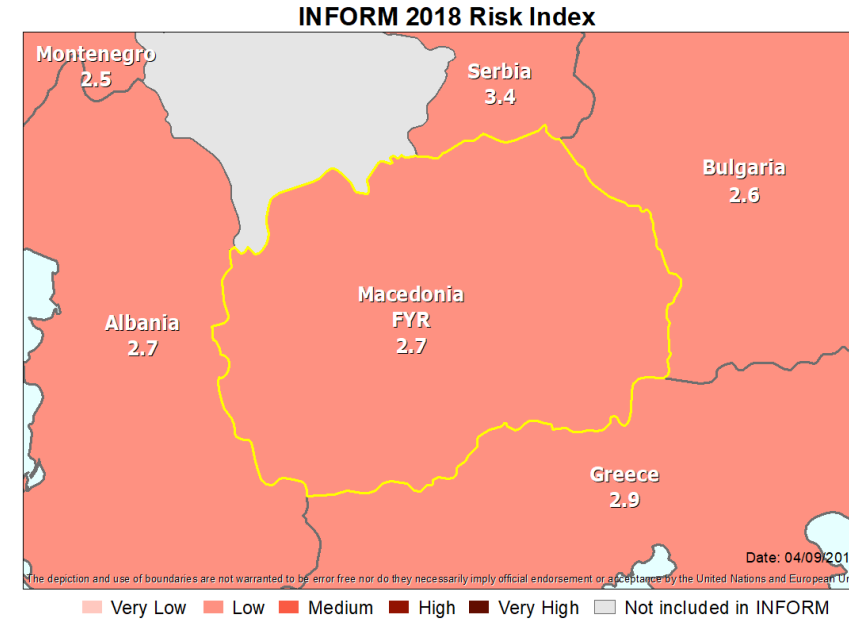
3th of top 10 countries by damages in 2016 (0.55% of GDP)

8th of top 10 countries by damages in 2015 (0.85% of GDP)





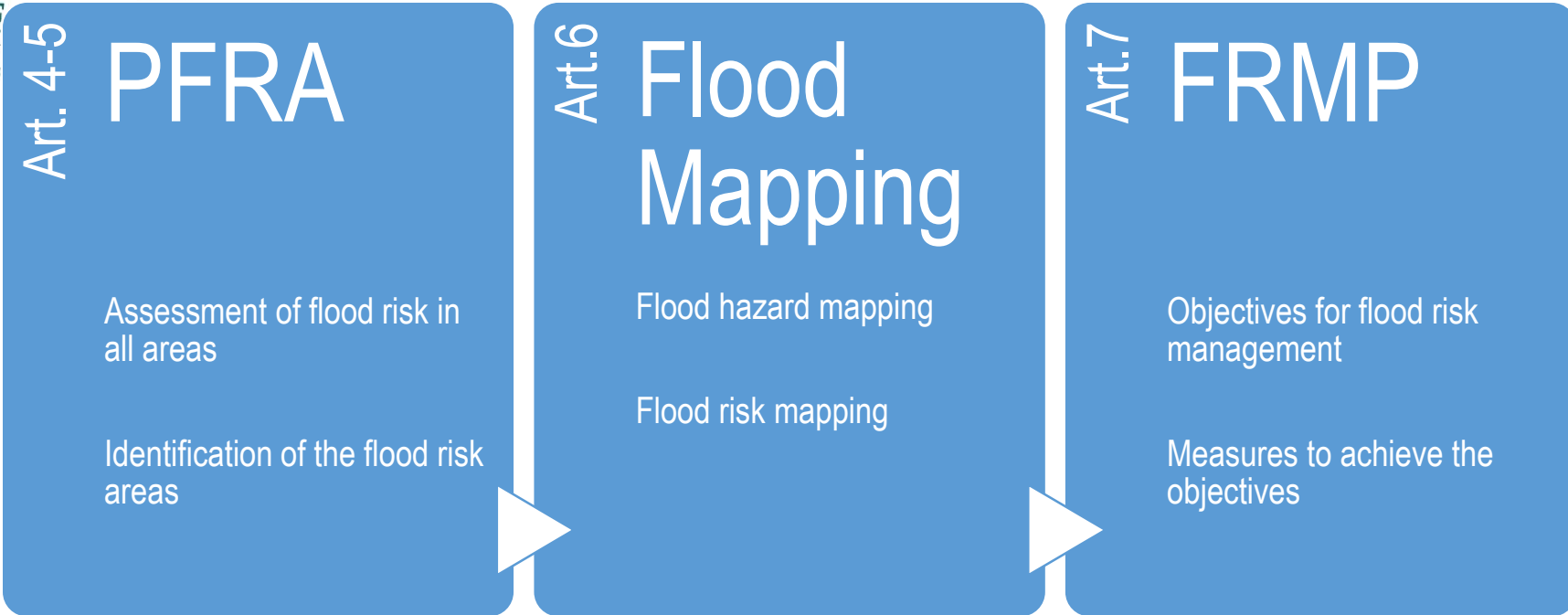
Ranking level	INFORM																
Concept level (Dimensions)	Hazard & Exposure				Vulnerability				Lack of Coping Capacity								
Functional level (Categories)	Natural		Human		Socio-Economic		Vulnerable Groups		Institutional	Infrastructure							
Component level	Earthquake	Tsunami	Flood	Tropical cyclone	Drought	Current Conflict Intensity	Projected Conflict Risk	Development & Deprivation (50%)	Inequality (25%)	Aid Dependency (25%)	Uprooted People	Other Vulnerable Groups	DRR	Governance	Communication	Physical Infrastructure	Access to Health System





Soil E
Prevent
Univers

Indicative time table for EU Flood Directive Implementation



Information / Verification / Consensus / Capacity Building

Inputs for maps / Local knowledge / Receptors / Risk Assessment / Verification / Capacity Building

Identification of measures / Take over responsibility / Agreement on measures / Final agreement on FRMP

EU 22.12.2011
MK 31.12.2017

EU 22.12.2013
MK 21.12.2020

EU 22.12.2015
MK 31.12.2024

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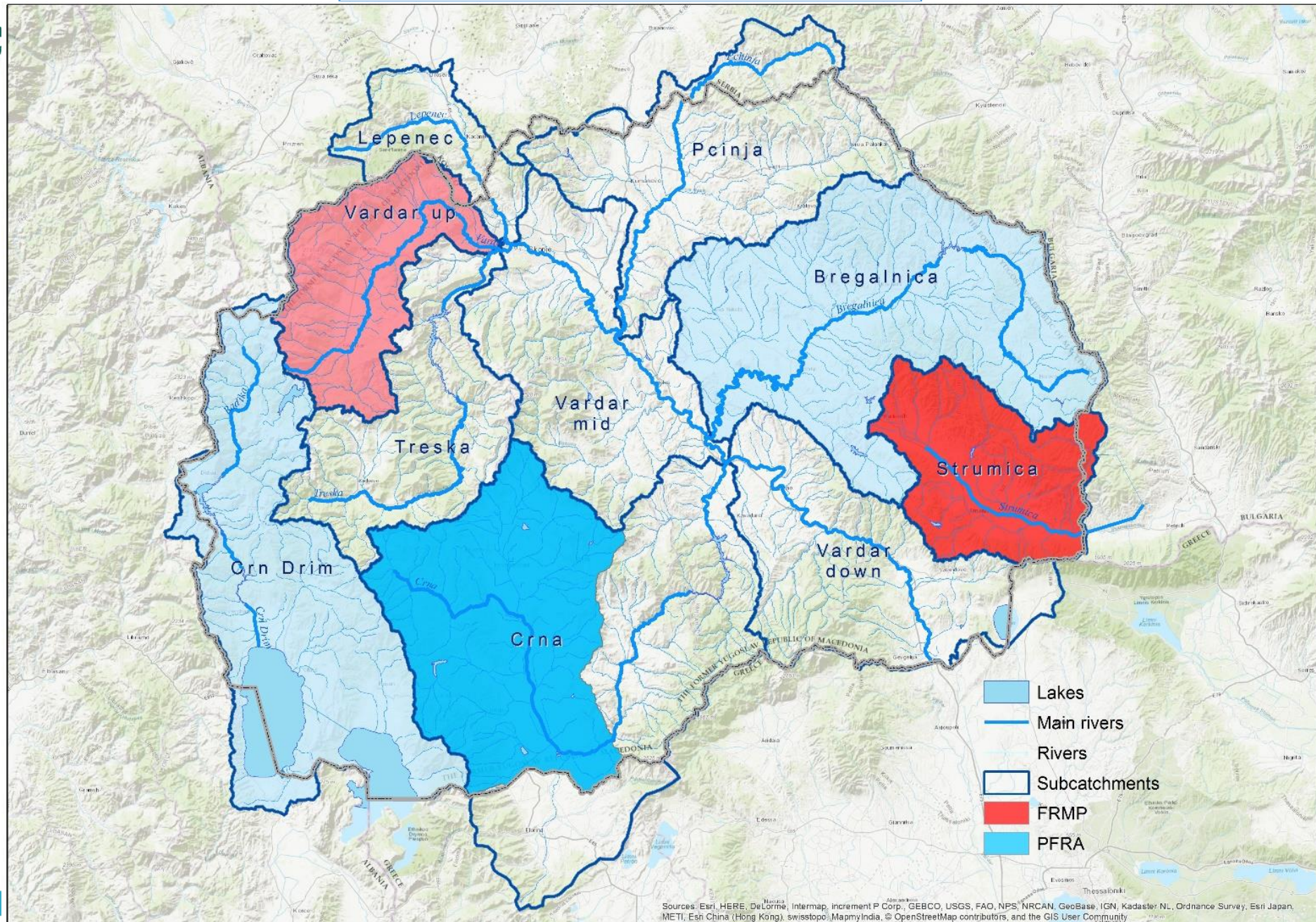


Repeat on a six yearly cycle

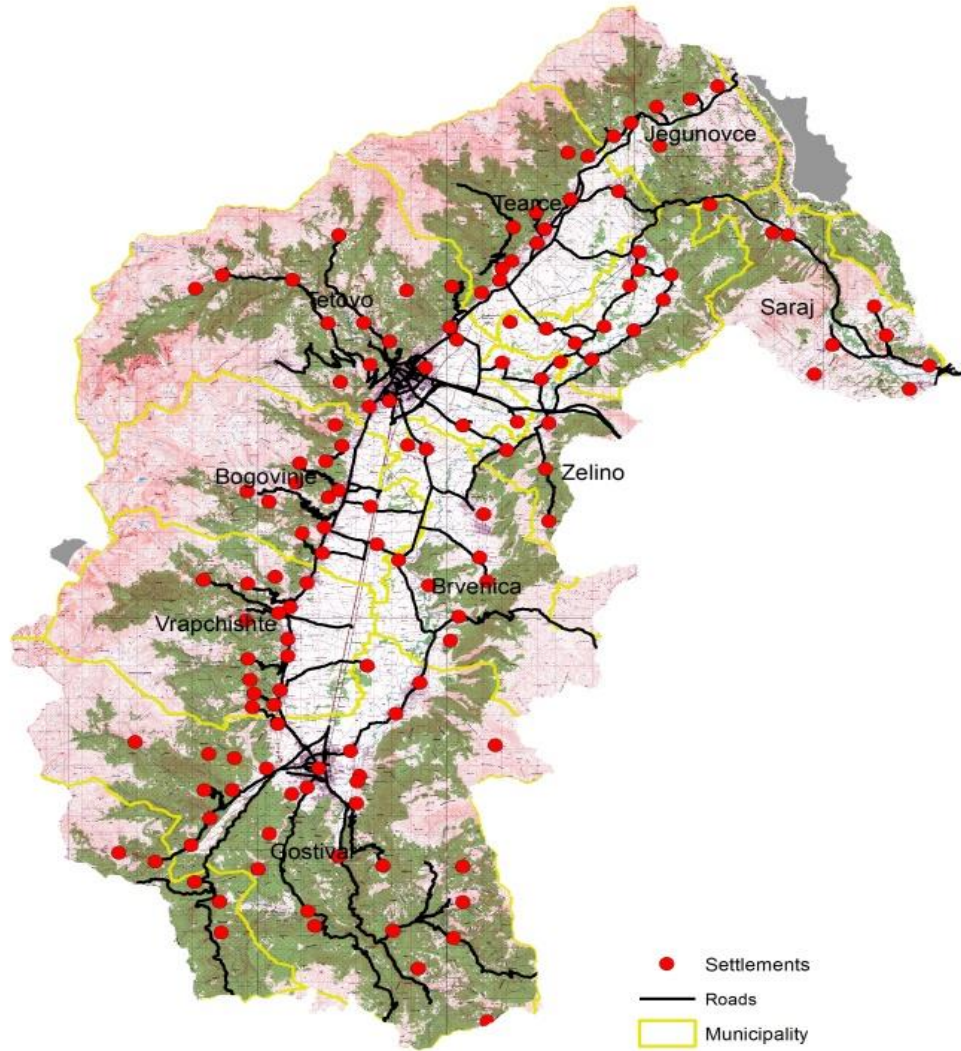


Soil Erosion
Prevention: Cu
Universities of

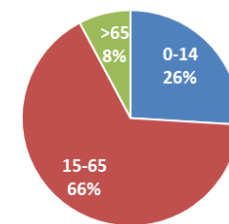
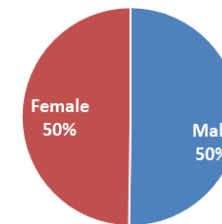
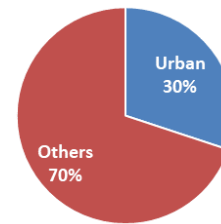
Existing FRM documents



PROJECT AREA

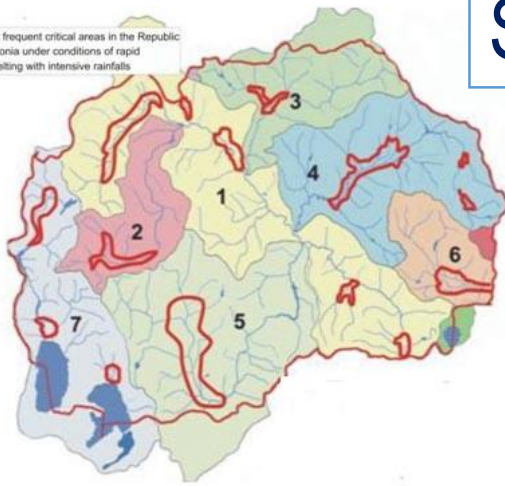


Municipality	Area km ²	Settlements N ^o	Population N ^o	Density N ^o /km ²
Zelino	54	7	13.469	250
Vrapchishte	158	15	25.399	161
Tetovo	261	18	85.446	327
Tearce	136	12	22.459	165
Saraj	93	9	11.459	123
Mavrovo i Rostusha	63	5	131	2
Jegunovce	172	17	10.790	63
Gostivar	375	32	81.858	218
Brvenica	121	9	14.927	124
Bogovinje	141	14	28.997	205
Total	1.574	138	294.935	187

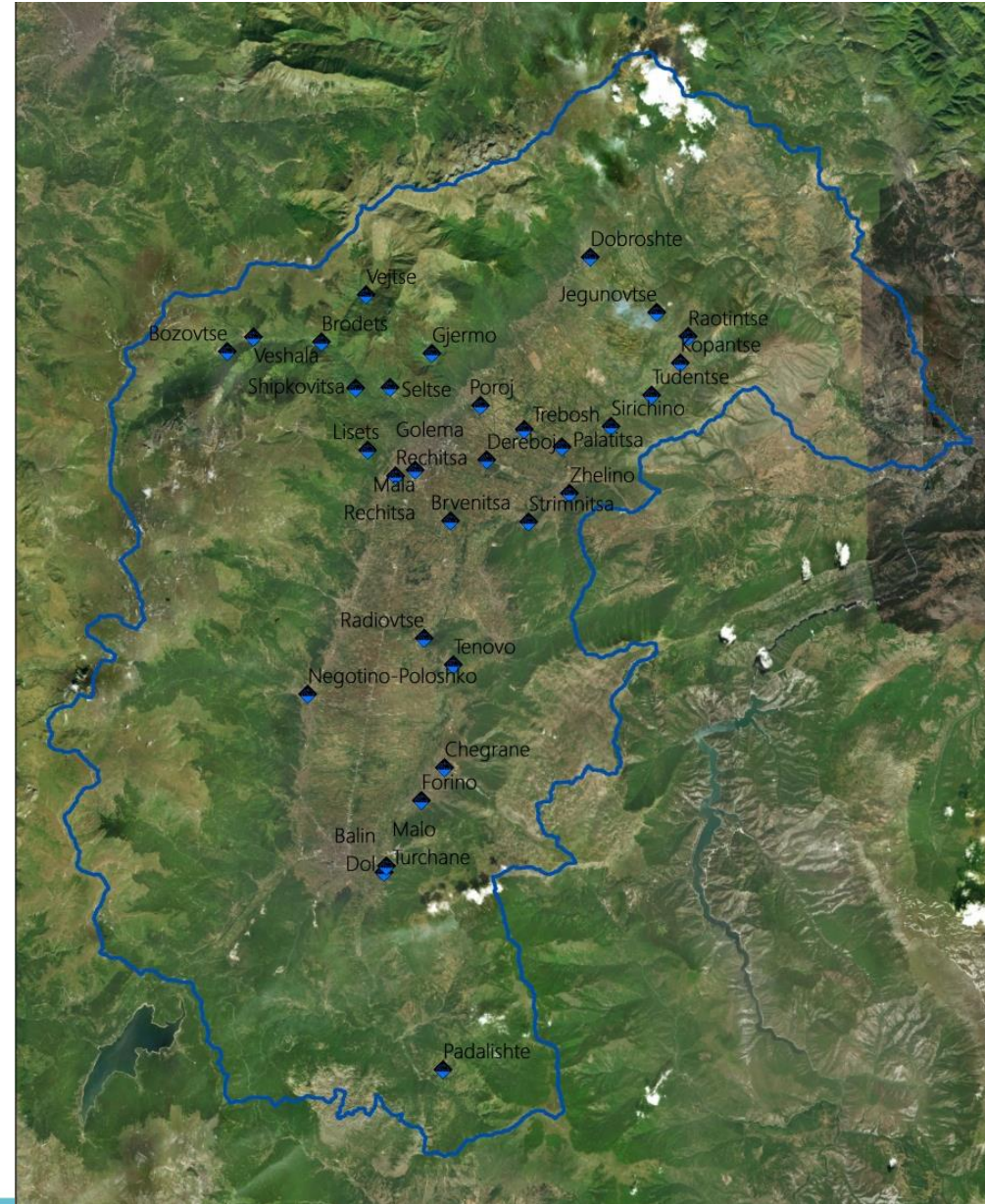
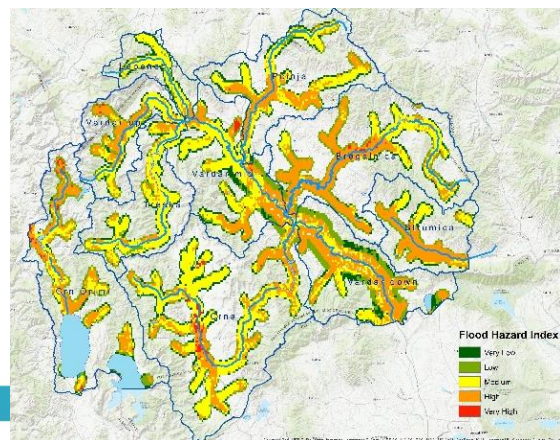
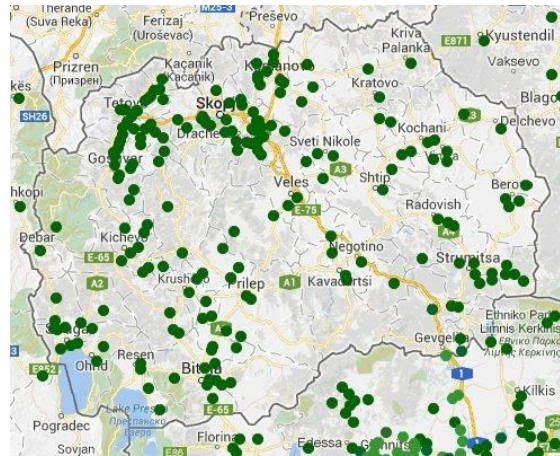




The most frequent critical areas in the Republic of Macedonia under conditions of rapid snow smelting with intensive rainfalls



Significant floods in the past and potential future floods



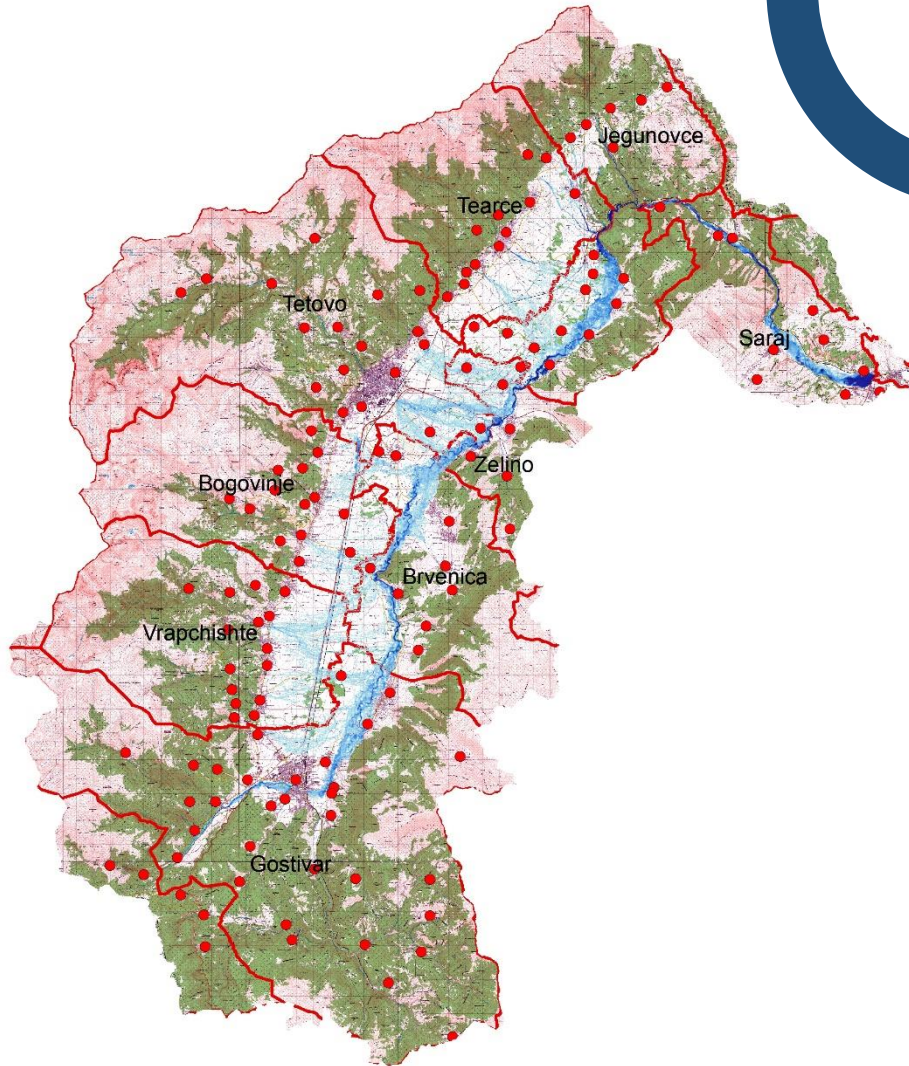
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Type of floods

48%

52%



Fluvial - EU Flood Directive

Torrential - ?

Flood Hazard Mapping = f(Intensity, Probability)

	High	Red	Red	Red	Green
Intensity	Medium	Red	Yellow	Green	Green
	Low	Yellow	Green	Green	Green
		High	Medium	Low	Very low
		10	100	500	1000
		Probability			

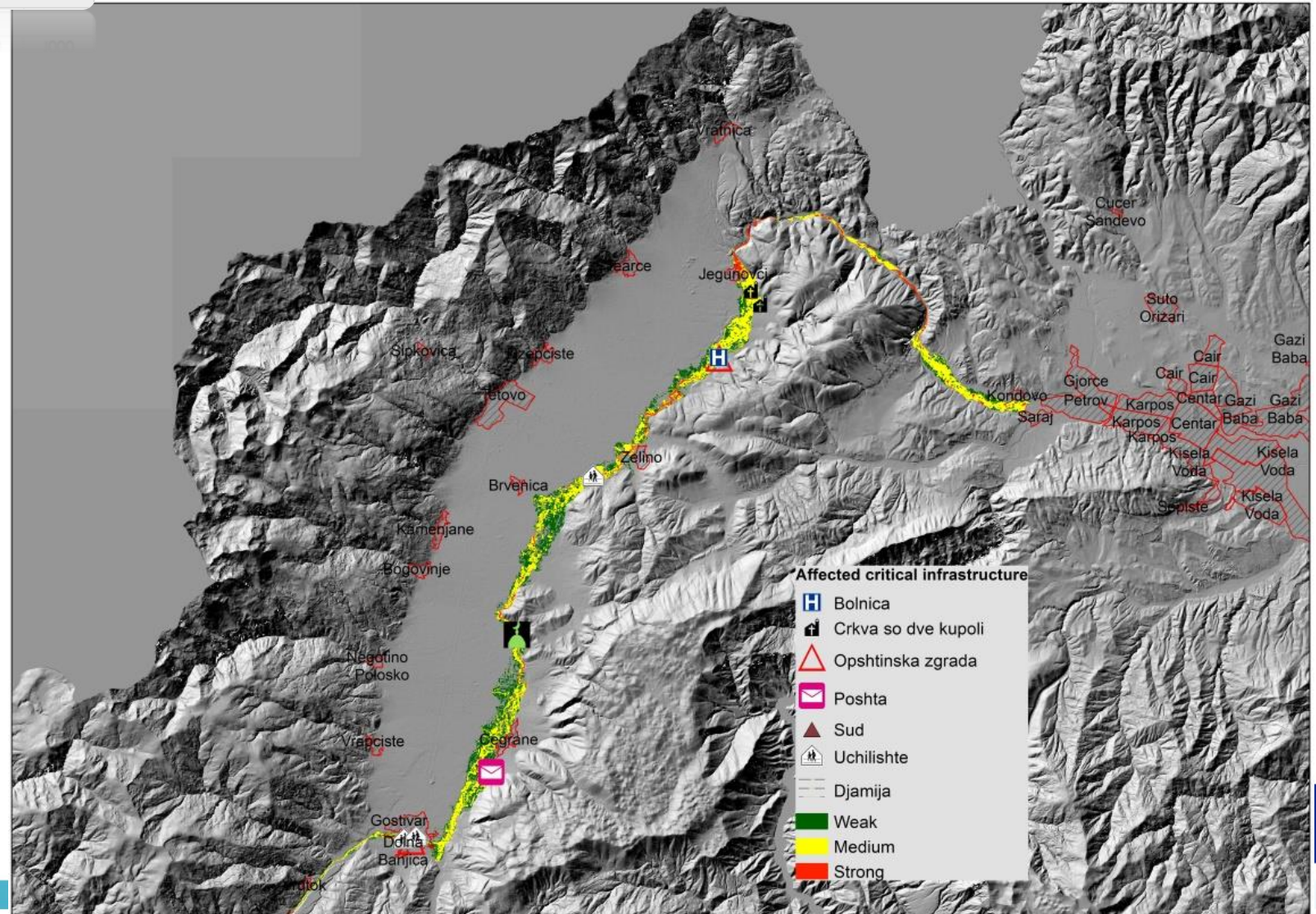
DEFINITION OF MUD OR DEBRIS FLOW INTENSITY
Product of maximum depth h times maximum velocity v (m ² /s)
v h > 1.0 m ² /s
0.2 m < v h < 1.0 m ² /s
v h < 0.2 m ² /s

DEFINITION OF WATER FLOOD INTENSITY
Product of maximum depth h times maximum velocity v (m ² /s)
v h > 1.5 m ² /s
0.5 m ² /s < v h < 1.5 m ² /s
0.1 m ² /s < v h < 0.5 m ² /s

Persons are in danger both inside and outside their houses. Structures are in danger of being destroyed.

Persons are in danger outside their houses. Buildings may suffer damage and possible destruction depending on construction characteristics.

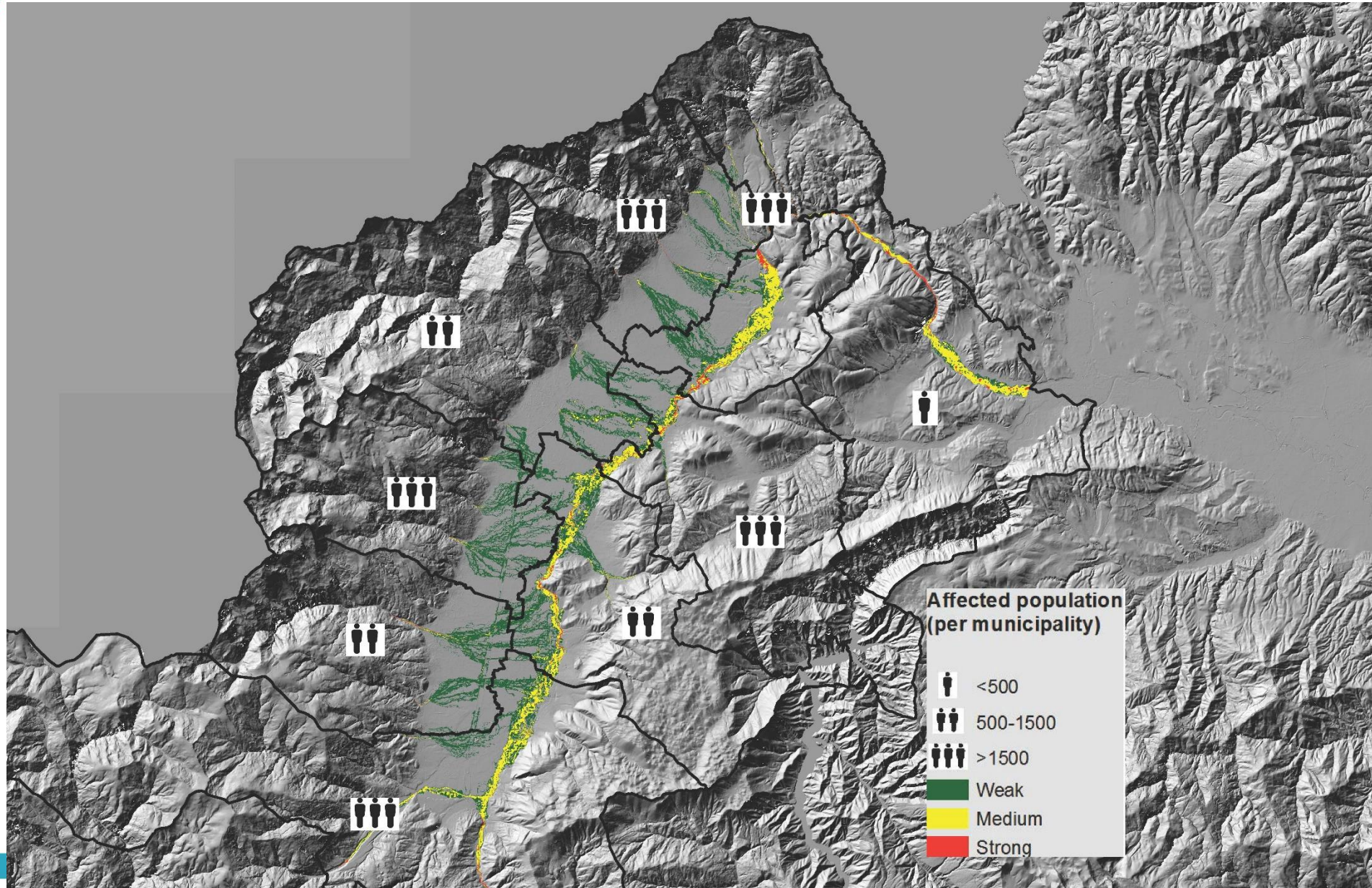
Danger to persons is low or non-existent. Buildings may suffer little damages, but flooding or sedimentation may affect structure interiors.





Flood Risk Mapping – Medium probability scenario, Affected population

Flood risk=f(hazard, exposure, vulnerability)



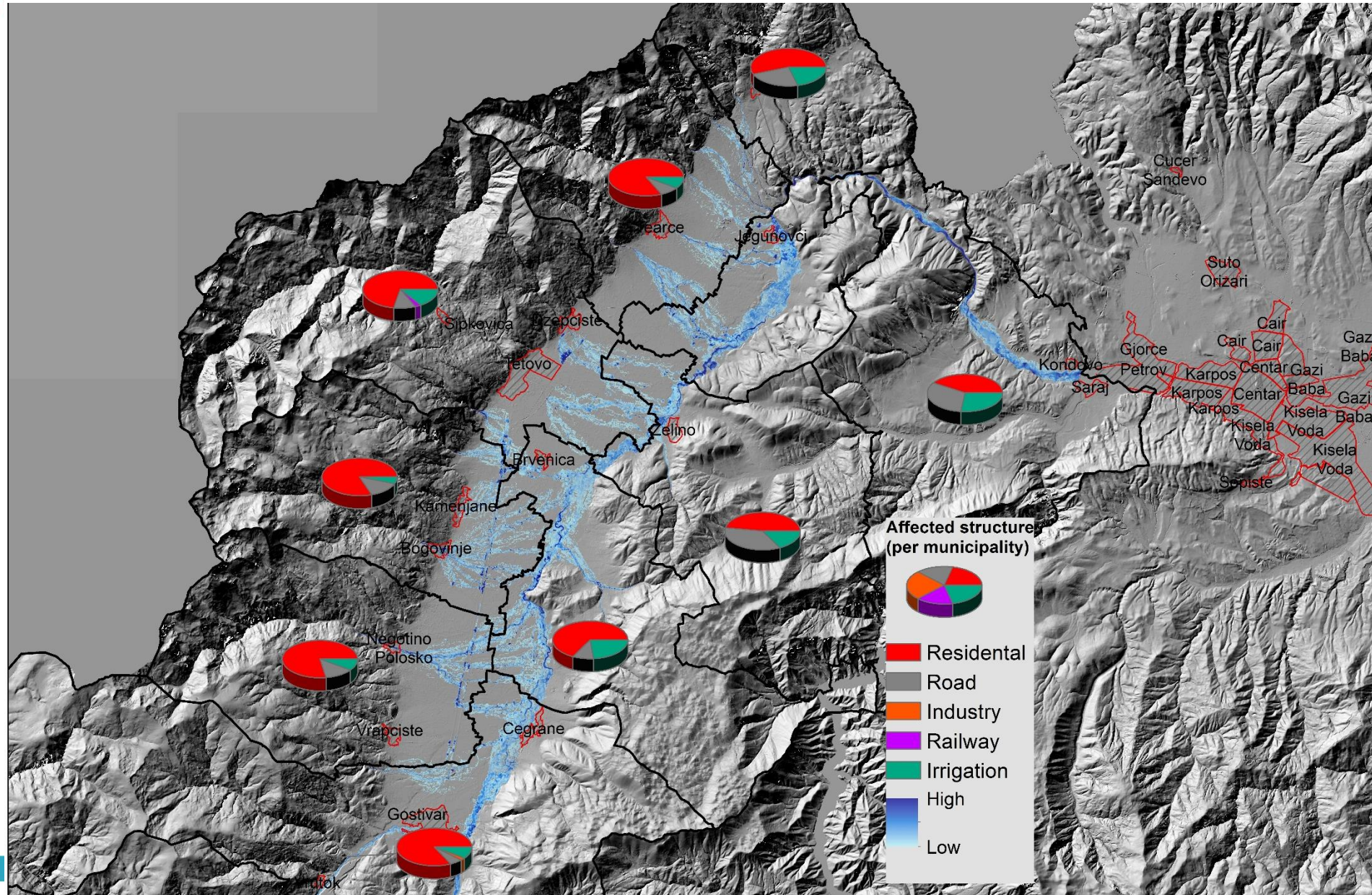
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Flood Risk Mapping – Medium probability scenario, Affected infrastructure

Flood risk=f(hazard, exposure, vulnerability)



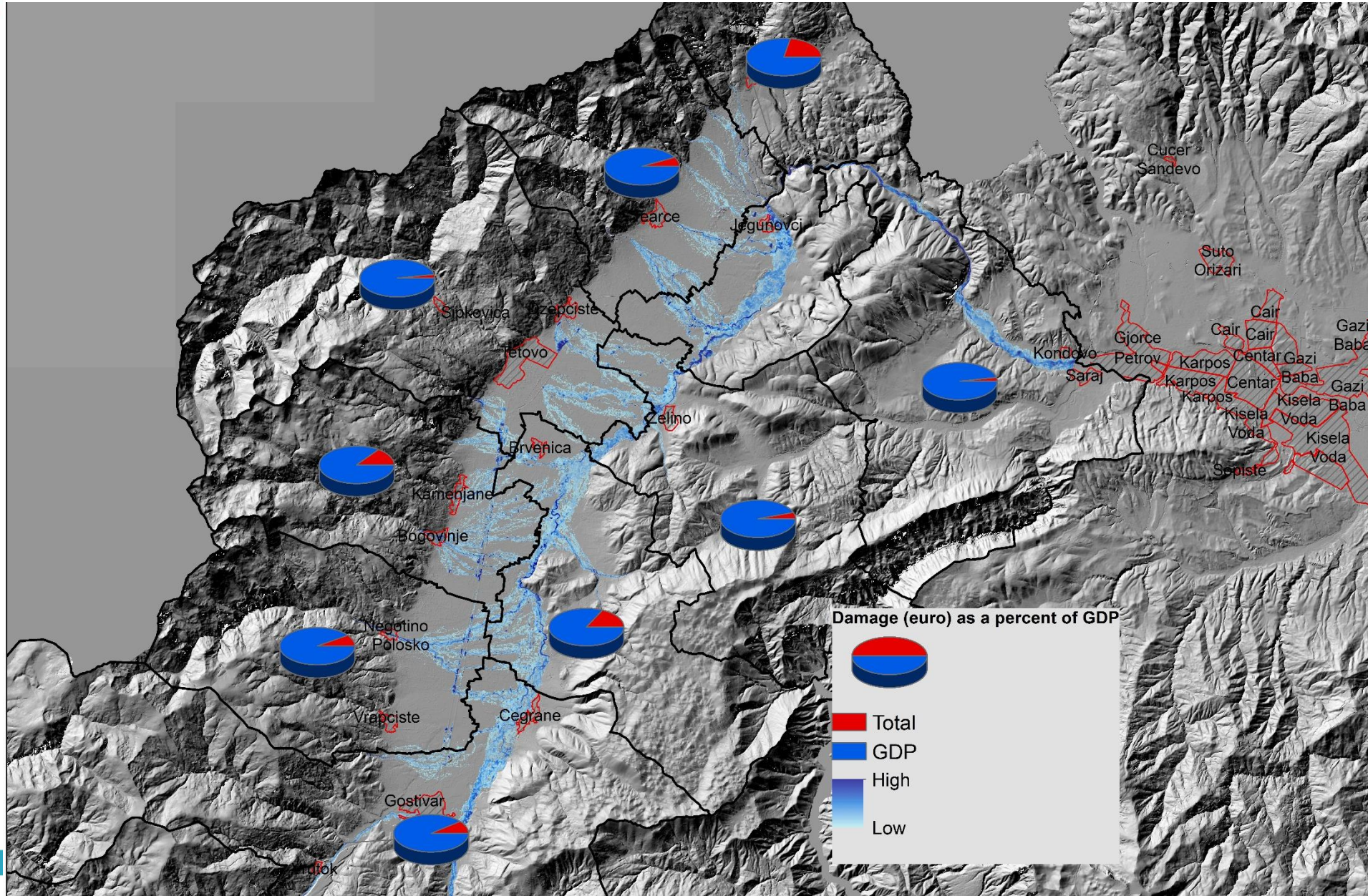
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Flood Risk Mapping – Medium probability scenario, Damage as a % of GDP

Flood risk=f(hazard, exposure, vulnerability)



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Catalogue of Measures

Integrated Flood Management refers to the integration of land and water management in a river basin using a combination of measures that focus on coping with floods, while recognizing that floods can never be fully controlled.

Non-structural measures for flood protection

"keep the resources away from floods in the floodplain"

Structural measures for flood protection

"keep the floods away from resources in the floodplain"

- Measures to avoid new risks
- Measures reducing the existing risks
- Measures strengthening resilience
- Awareness raising measures
- Measures implementing the solidarity principle

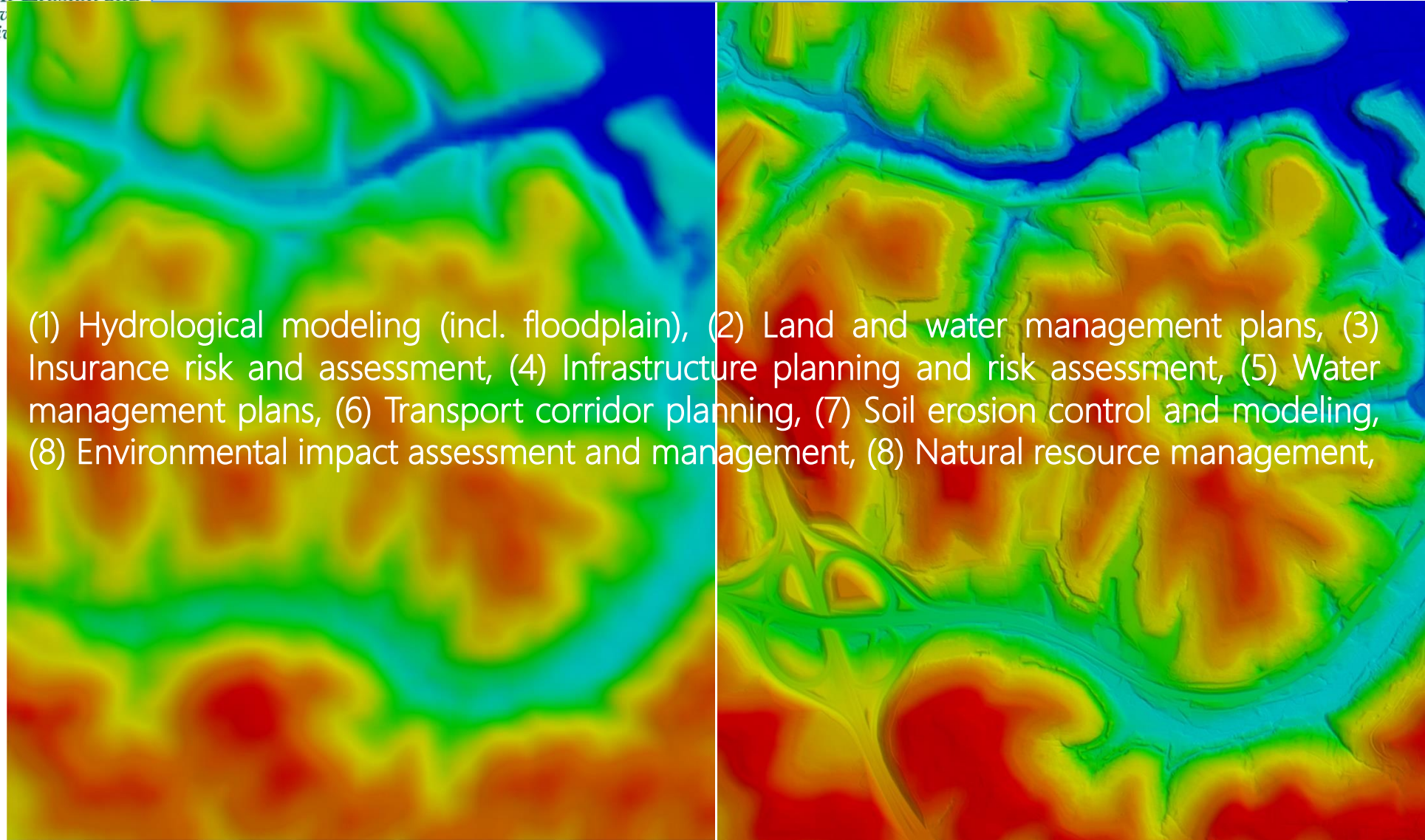
According to the 4 priorities of the Sendai Framework

- 1) Know your risk (18 measures)
- 2) Risk governance (19)
- 3) Risk reduction and increasing resilience (61) - Investing in economic, social, cultural, and environmental resilience
- 4) Preparedness for response and recovery (33)

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Detailed DTM, LIDAR or geodetic surveying

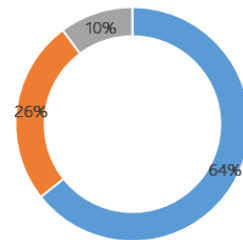
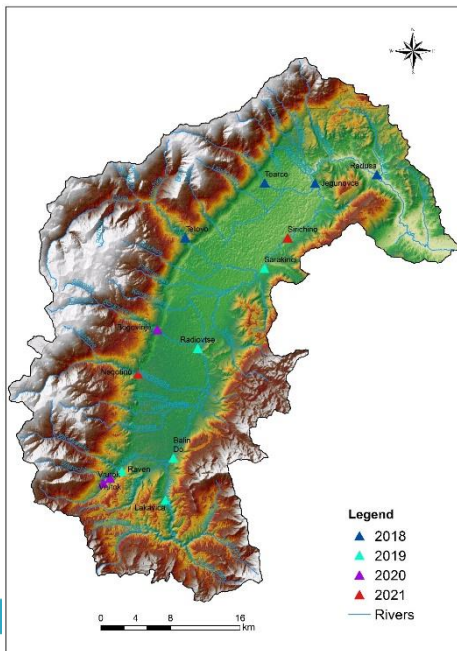
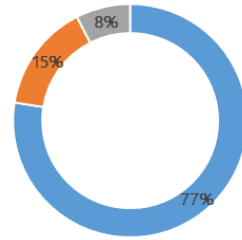
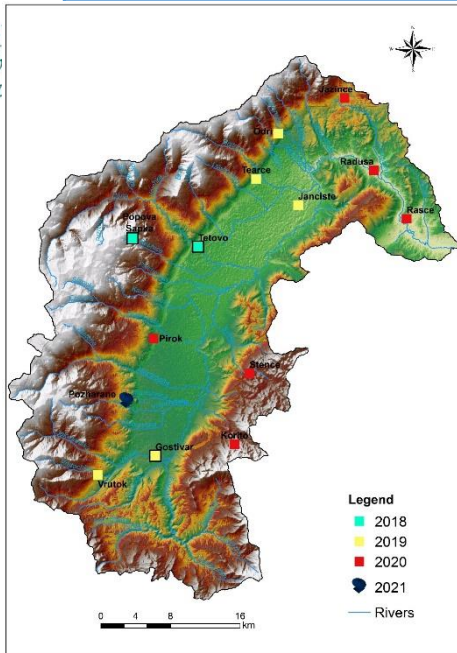


(1) Hydrological modeling (incl. floodplain), (2) Land and water management plans, (3) Insurance risk and assessment, (4) Infrastructure planning and risk assessment, (5) Water management plans, (6) Transport corridor planning, (7) Soil erosion control and modeling, (8) Environmental impact assessment and management, (8) Natural resource management,

DEM

Lidar DEM

Benefits of HYDROMET Services - FLOOD IMPACT DAMAGE ASSESEMENT

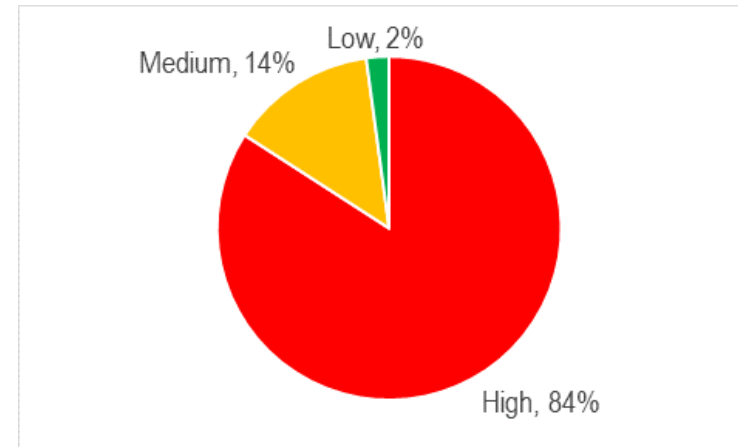
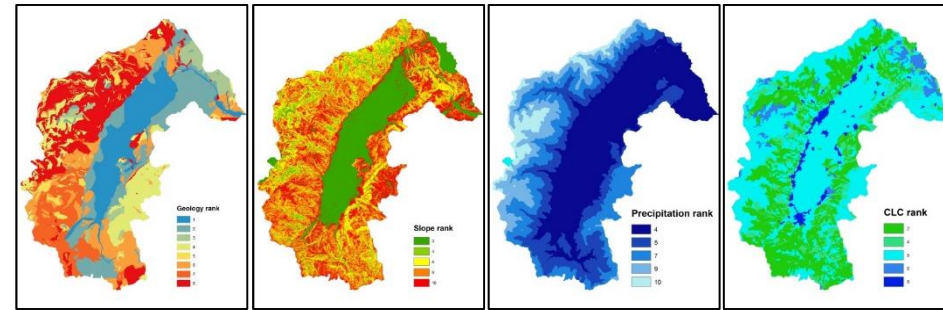
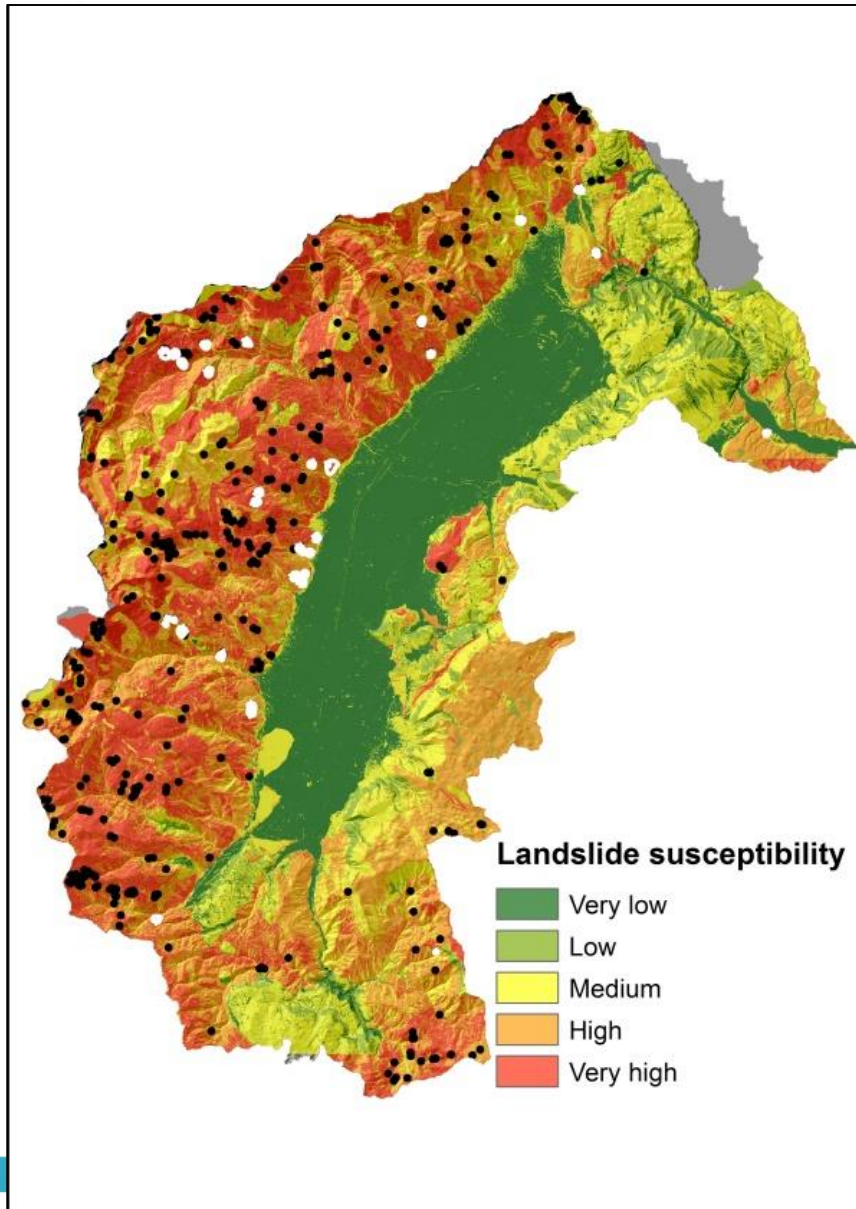


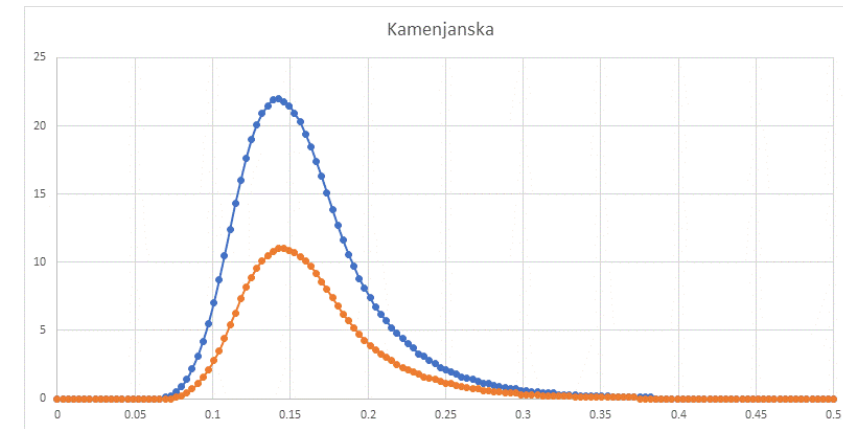
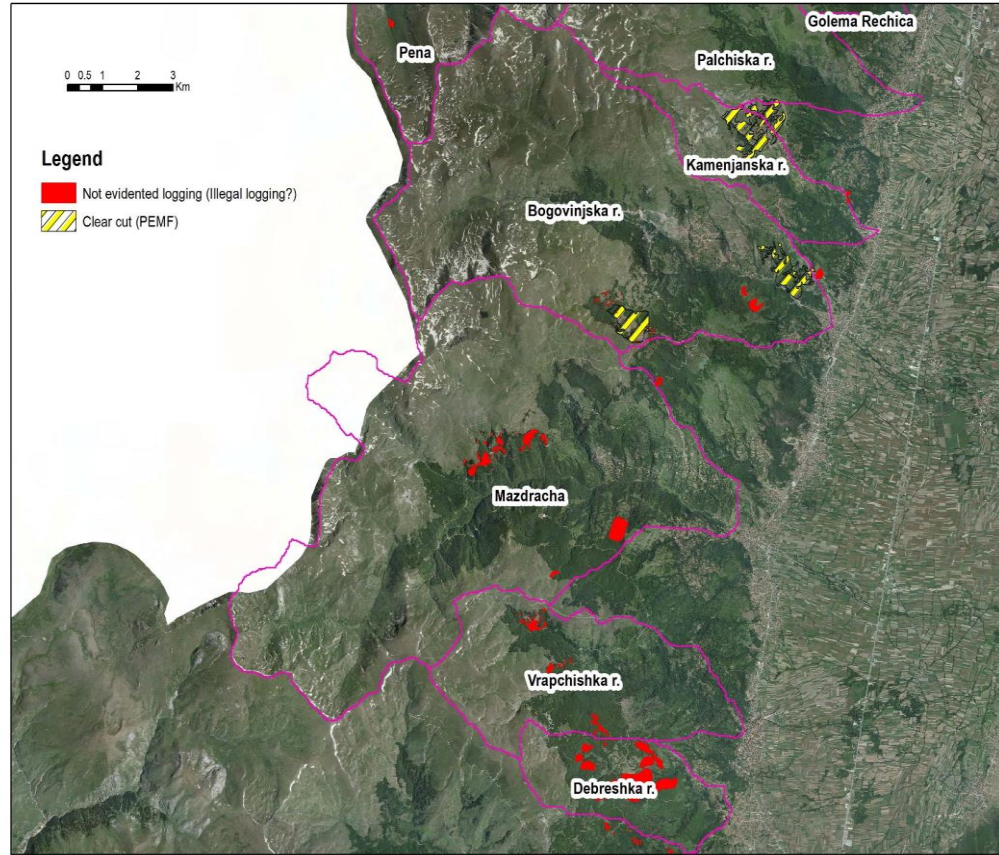
TORRENTS	Annual	Warning time	Reduction (%)	Reduction (Euro/annual)
Bistrica	88,000	1.80	4.61	4,059
Bogovinska	660,000	1.60	4.12	27,200
Belovishka	137,000	1.10	2.87	3,931
Brza Voda	113,000	1.10	2.87	3,243
Debreshka	183,000	1.30	3.37	6,175
Gabrovia	21,000	1.30	3.37	709
Kamenjane	185,000	1.40	3.62	6,705
Lakavica	955,000	2.90	7.22	68,931
Leshnichka	98,000	1.40	3.62	3,552
Leshochka	145,000	1.10	2.87	4,161
Mazdracha	621,000	1.40	3.62	22,509
Odranska	159,000	1.20	3.12	4,965
Palchishka	126,000	1.00	2.62	3,295
Ponika	56,000	1.50	3.87	2,169
Rechica	63,000	1.10	2.87	1,808
Sveta	316,000	1.20	3.12	9,867
Vrapchishka	140,000	1.20	3.12	4,372
Pena	102,000	2	5.10	5,201
TOTAL	4,168,000	1.42	3.67	182,852

VARDAR	Annual	Warning time	Reduction (%)	Reduction (Euro/annual)
Gostivar	2,771,800	4	9.66	267,620
Brvenica	530,000	8	17.09	90,563
Zhelino	143,000	11	21.27	30,417
Jegunovce	667,000	17	26.77	178,573
Saraj	310,000	19	27.98	86,737
TOTAL	4,421,800	11.8	20.55	653,910
TOTAL	8,589,800			836,761

Landslide/Dumpslide susceptibility

Landslide susceptibility = f (Lithology, Slope, Precipitation, Land cover)





PV Costs (Development, O&M) – 86.000 Euros

Av. Annual Remaining Damages without project – 272.000 Euros

Av. Annual Remaining Damages with project – 172.000 Euros

Benefit/Afforestation Cost Ratio – 14.7

Name	Forest (ha)	Non-forest	Forest (%)	Cut 2012-15 (illegal) ha	Cut 2012-15 (PEMF) ha	Annual cut	% Annual cut
<i>Bogovinjaska r.</i>	1113.4	4836.9	18.7	48.39	130	59.46	5.34
<i>Kamenjanska r.</i>	296.4	732.5	28.8	6.16	65	23.72	8.00

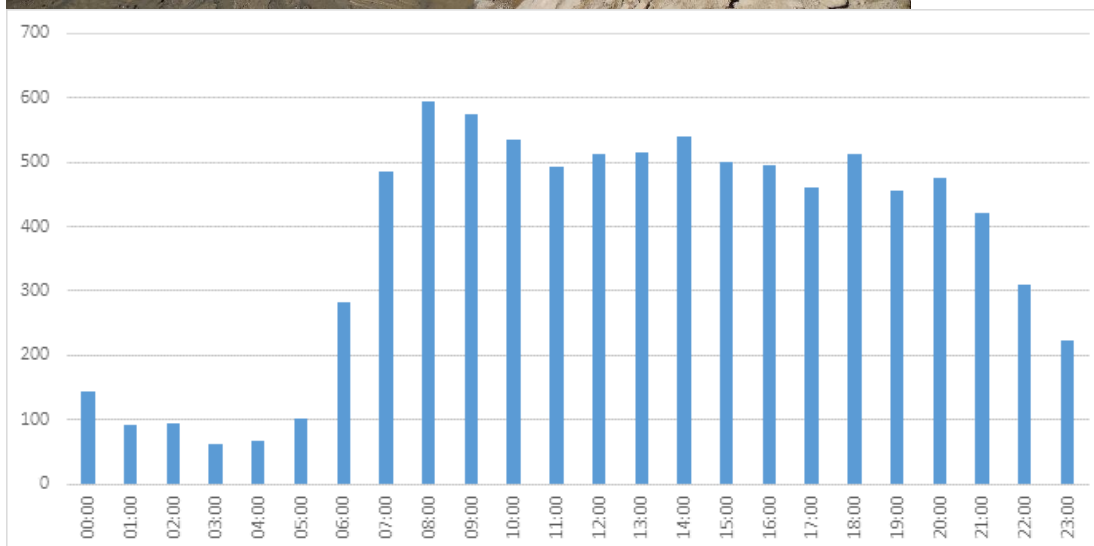


Economic analysis – Sediment management

Poroj – Brza Voda-Dzheciste



- Re/Construction of new bridge? – 300.000 Euros
- Estimated vehicle frequencies ~9.000 cars/day
- Out of function – 2 days in 3 years
- Vehicle operating costs – 16.000 Euros per event
- Value Of Occupation Time – 100.000 Euros per event
- Value Of Goods In Transit - 1.500 Euros per event
- Value Of Time Of Commercial Vehicle - 25.000 Euros per event
- NPV (@5%) (+100.000 Euros)

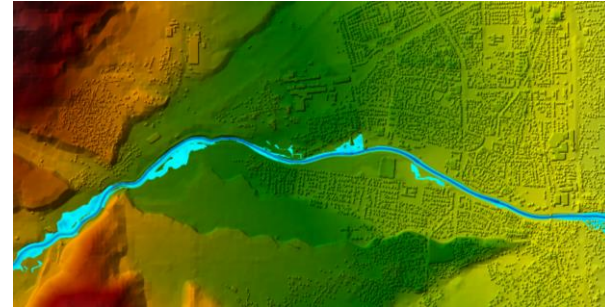


Economic analysis – River Regulation

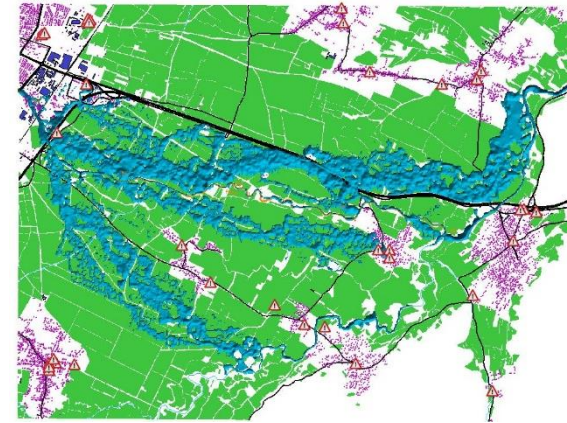


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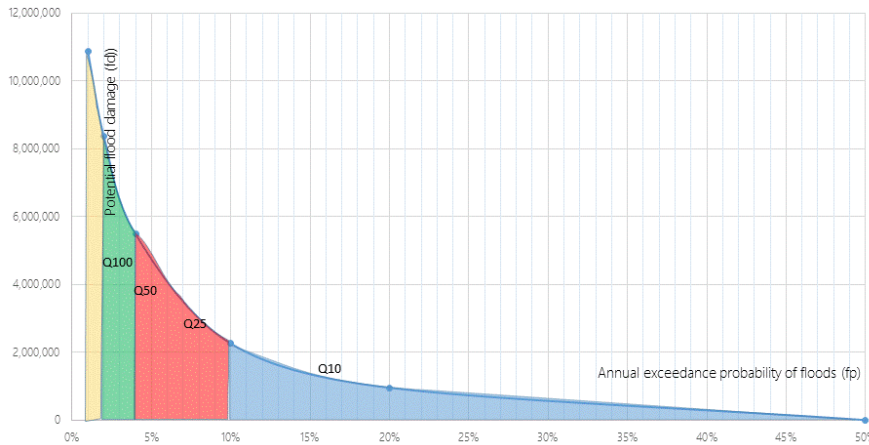
Urban zones



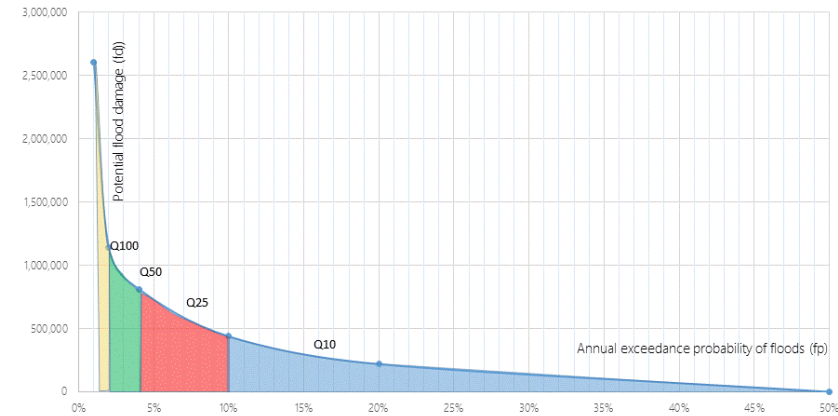
Zones with dominant agricultural



Flood Damages Probability Distribution



Flood Damages Probability Distribution



Economic Parameters	Do nothing	Reconstruction&Extention
PV Benefits (average annual damages)	€2,640,216	€12,514,431
PV Costs (Development, O&M)	€0	€3,088,206
PV Costs (Remained damages, project development and O&M)	€11,603,055	€4,424,804
Benefit/Cost Ratio	0.2	2.8
Net Present Value	-€8,962,839	€17,694,023
Average Annual Remaining Damages	€818,406	€94,275

Economic parametars	Do nothing	Do minimum	Low Project	ow/Medium Proje	Medium Project
PV Benefits (average annual damages)	€608,251	€1,216,502	€1,911,251	€2,272,760	€2,619,672
PV Costs (Development, O&M)	€0	€2,597,677	€3,453,822	€4,107,177	€4,461,796
PV Costs (Remained damages, project development and O&M)	€2,011,421	€4,000,846	€4,162,243	€4,454,090	€4,461,796
Benefit/Cost Ratio	0.3	0.3	0.5	0.5	0.6
Net Present Value	-€1,403,170	-€3,266,012	-€2,250,992	-€2,181,330	-€1,842,124
Average Annual Remaining Damages	€141,873	€98,971	€49,968	€24,469	€0

Economic analysis – Torrential rivers (Rock fall)

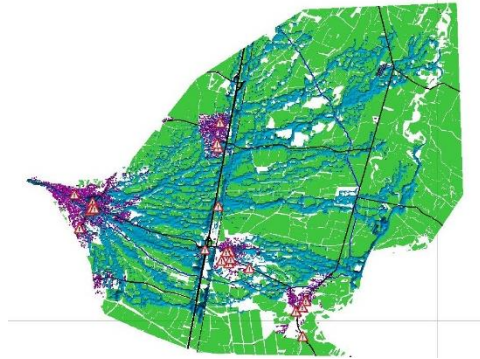


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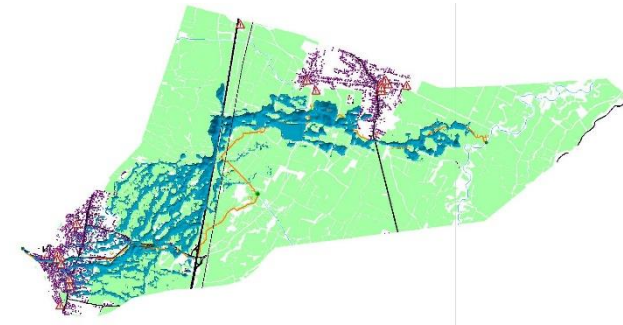
Shipkovica



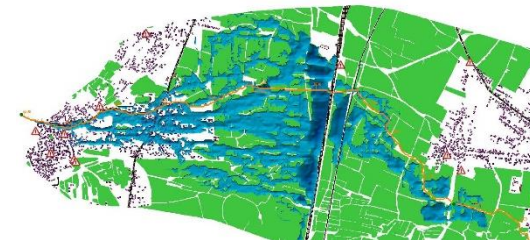
Bogovinjska



Kamenjanska



Palchishka

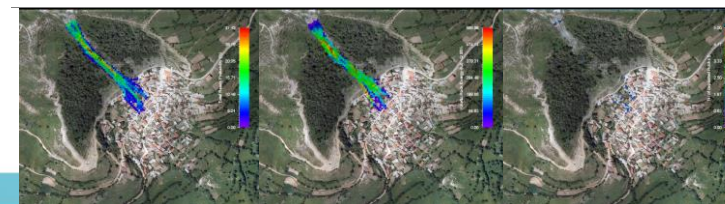


Bozovce



- Structures for slope control and sediment transport
- Structures for flow diversion- isolating parts of the basin (retention)
- Landfill removal
- Channeling through settled area
- Estimated Investment Costs ~450.000 Euros

PV Benefits (average annual damages)	€859,229
PV Costs (Development, O&M)	€454,790
PV Costs (Remained damages, project development and O&M)	€550,297
Benefit/Cost Ratio	1.6
Net Present Value	€308,932
Average Annual Remaining Damages	€6,736



Total reach probability (%) Kinetic Rock Energy (kJ) Number of deposited rocks

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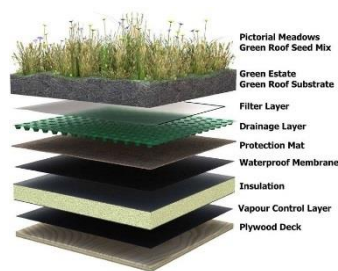
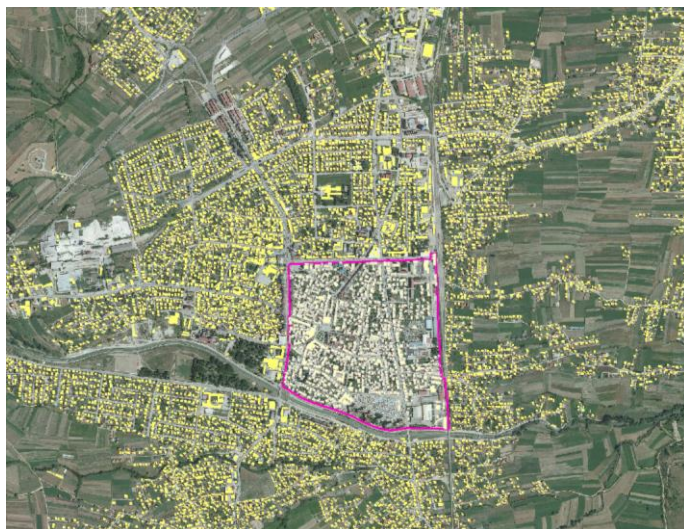




Economic analysis – Urban flooding

Urban sewerage modelling

Urban area - Gostivar city



	Area (m ²)	Ratio	C	Composite
Roads	76,609	12%	0.90	11%
Parking	33,613	5%	0.90	5%
Buildings	467,444	73%	0.90	65%
Greenery	66,437	10%	0.15	2%

Composite discharge coefficient > 80% - highly urbanized area

Analyze the effect of implementing "flood resistant urban infrastructure"

- Green roofs technology
- Flood resistant parking areas
- Maximizing green areas, reducing urban infrastructure

Hydraulic model - storm sewerage network



	Area (m ²)	Ratio	C	Composite
Roads	76,609	12%	0.90	11%
Parkings	33,613	0%	0.90	0%
Buildings	467,444	36%	0.90	33%
Greenery	66,437	52%	0.15	8%

Composite discharge coefficient ≈ 50%

- Reducing runoff volume
- Reducing the peak discharge
- Increasing urban flood resilience
- Increasing the retention capacity
- Increasing the time of concentration

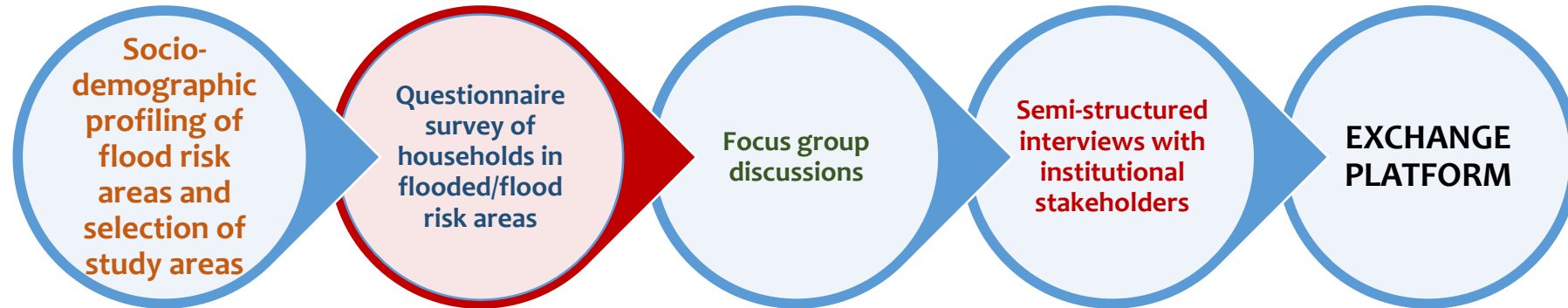


▪ Reducing investment costs 15-20%





Integrating **SOCIAL ANALYSIS** into decision-support methodology for flood risk management



- Selection of flood risk areas
- Socio-demographic group
- About you and your household
- Your experience of flooding
- Impacts of the flood
- Living with floods
- Your thoughts and opinions
- **410 households**

- ~ 70% are aware that they live in an area at risk of flooding
- More than 30% of respondents were flooded in the past
- ~ 45% of flooded households did not receive any help after the floods.
- 55 % haven't heard or received any information about floods
- Respondents still consider TV and the Internet as the best way of education and information
- Main causes of floods: Deforestation, Interventions on the riverbed, Waste in river streams
- 77% of the respondents consider that the Local government is responsible for flood protection
- 33% of the respondents are confident that the local government has ability to deal with floods
- **Still the most significant social problems in the region, are: unemployment and migration**



Roles of Non-Government and Civil-Society Organizations in Disaster Risk Reduction

