

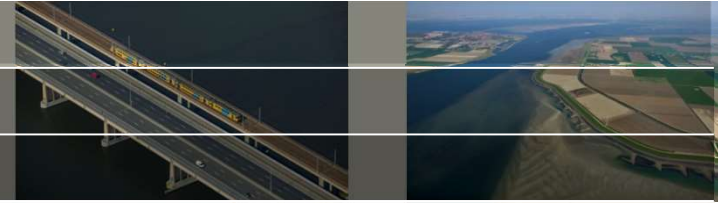


Action plan for Albania

Mike Woning

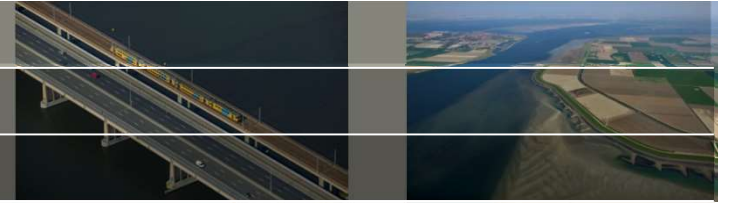
16 december 2021

Structure of presentation



- Risk assessment
 - Relevant hazards
 - Criticality
- Action planning per relevant hazard
 - Results risk assessment
 - Proposed measures
 - Economic analysis
 - Sensitivity analysis
- Conclusions

Risk assessment findings



- Little impact from earthquakes due to low probability
- Little impact from coastal floods to road assets due to little exposure

Risk assessment for floods, landslides and earthquakes

Annual Expected Damages	Floods	Land sl.	FQ	Total
01 Milot - Morine New	16,737	824,373	6,079	347,188
02 Q. Qele - Puke	13,396	112,808	14,194	140,398
03 Milot - Shkoder	1,540,190	90,040	177,787	1,808,017
04 Tirana - Durres	1,793,170	116,378	191,444	2,100,991
05 Durres - Fier	9,981,132	513,307	350,730	10,845,169
06 Tirana - Elbasan	3,004,926	456,556	127,413	3,588,895
07 Fier - Tepelene	1,252,073	105,858	61,559	1,419,491
08 Sarande - Greqi	40,927	39,710	5,553	86,189
09 Elbasan - Gramsh	717	26,243	27,484	54,444
10 Lushnje - Berat	254,003	93,458	42,334	389,796
11 Rrogozhine - Elbasan	6,332	29,090	49,935	85,357
12 Shkoder - Hani - Hotit	190,376	97,336	31,355	319,066
13 Milot - Peshkopi	517,200	198,058	27,417	742,675
14 Vlore - Sarande	136,023	178,477	23,513	338,012
15 Pogradec - Korce	-	57,172	86,054	153,225

- Annual Expected Damages per hazard and corridor
- Earthquakes excluded from action planning due to dispersed impact and limited AED/km



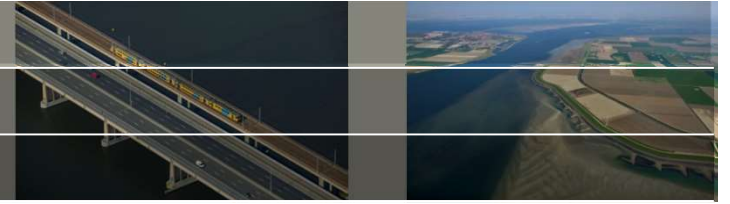
Hazards assessed for action plan



Hazards

- ~~Earthquakes~~
- Landslides
- Floods
 - ~~Coastal~~
 - Fluvial

Criticality



What defines criticality?

- Strategic function (evacuation, national corridor, international connection)
- Services specific important economic functions
- Servicing otherwise difficult to reach destinations

We use the criticality in decision making

- Prioritise interventions (what, where)

Criticality – Result of workshop

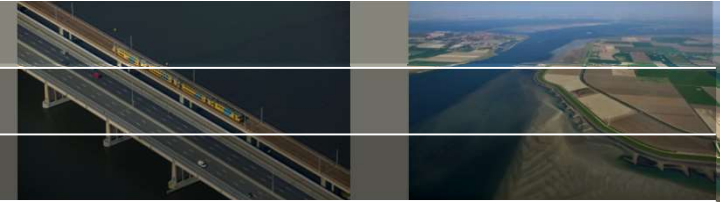


	Weight	Corridor														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
International	3.61	12.7	5.0	12.2	13.6	12.4	11.5	11.5	11.4	6.6	6.2	10.6	13.3	7.6	10.7	13.4
Industry	2.19	5.3	3.7	5.5	8.0	7.0	6.9	4.7	4.1	4.1	3.6	6.2	5.5	5.2	5.0	5.4
Harbour	3.10	8.2	4.0	6.7	11.8	10.4	7.4	5.7	7.4	4.2	3.8	7.3	6.6	5.1	10.0	5.2
Tourism	3.04	10.1	6.9	6.6	11.9	12.8	8.9	7.6	9.8	6.0	3.6	4.8	7.4	6.7	8.3	13.0
Agriculture	2.52	5.3	4.7	5.7	8.2	9.1	7.5	7.0	5.9	5.2	6.5	7.9	7.1	5.5	5.3	7.7
Evacuation*	3.33	12.5	10.0	8.0	10.5	14.0	16.0	14.0	13.1	12.5	11.1	11.1	12.2	11.0	11.3	14.1
Summation		41.6	24.2	36.7	53.4	51.7	42.2	36.5	38.5	26.1	23.6	36.7	40.0	30.1	39.2	44.8

Conclusions

- Corridors 4 and 5 are most critical → highest priority
- Corridors 2, 9 and 10 are least critical → lowest priority

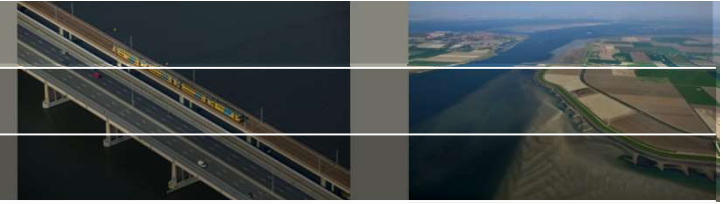
Prioritizing corridors



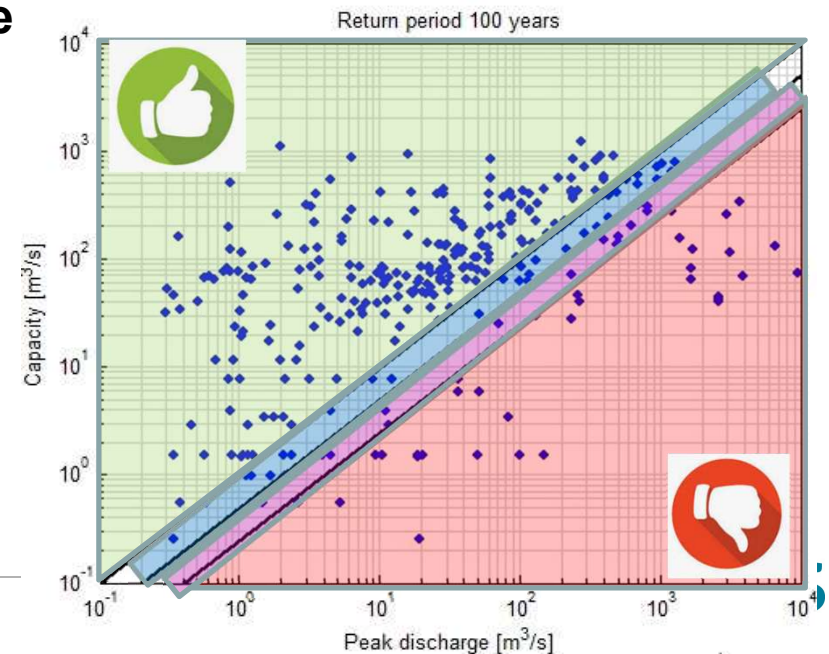
Annual Expected Damages and criticality → Input for Action Plan

Corridor	Length (km)	Total	€/km	Criticality	
01 Milot - Morine New	104	347,188	3,328	41.6	
02 Qele - Puke	126	140,398	1,118	24.2	Low
03 Milot - Shkoder	127	1,808,017	14,189	36.7	High
04 Tirana - Durres	32	2,100,991	65,058	53.4	Very high
05 Durres - Fier	152	10,845,169	71,289	51.7	Very high
06 Tirana- Elbasan	139	3,588,895	25,839	42.2	High
07 Fier - Tepelene	128	1,419,491	11,071	36.5	High
08 Sarande - Greqi	58	86,189	1,477	38.5	
09 Elbasan - Gramsh	41	54,444	1,343	26.1	Low
10 Lushnje - Gramsh	86	389,796	4,555	23.6	
11 Rrogozhine - Elbasan	40	85,357	2,128	36.7	
12 Shkoder - Hani - Hotit	125	319,066	2,562	40.0	
13 Milot - Peshkopi	136	742,675	5,459	30.1	
14 Vlore - Sarande	131	338,012	2,587	39.2	
15 Pogradec - Korce	69	153,225	1,975	44.8	

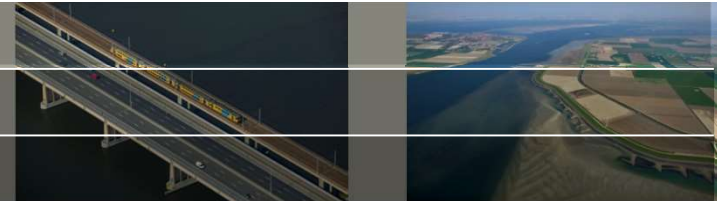
Adaptation pathways/ DMU



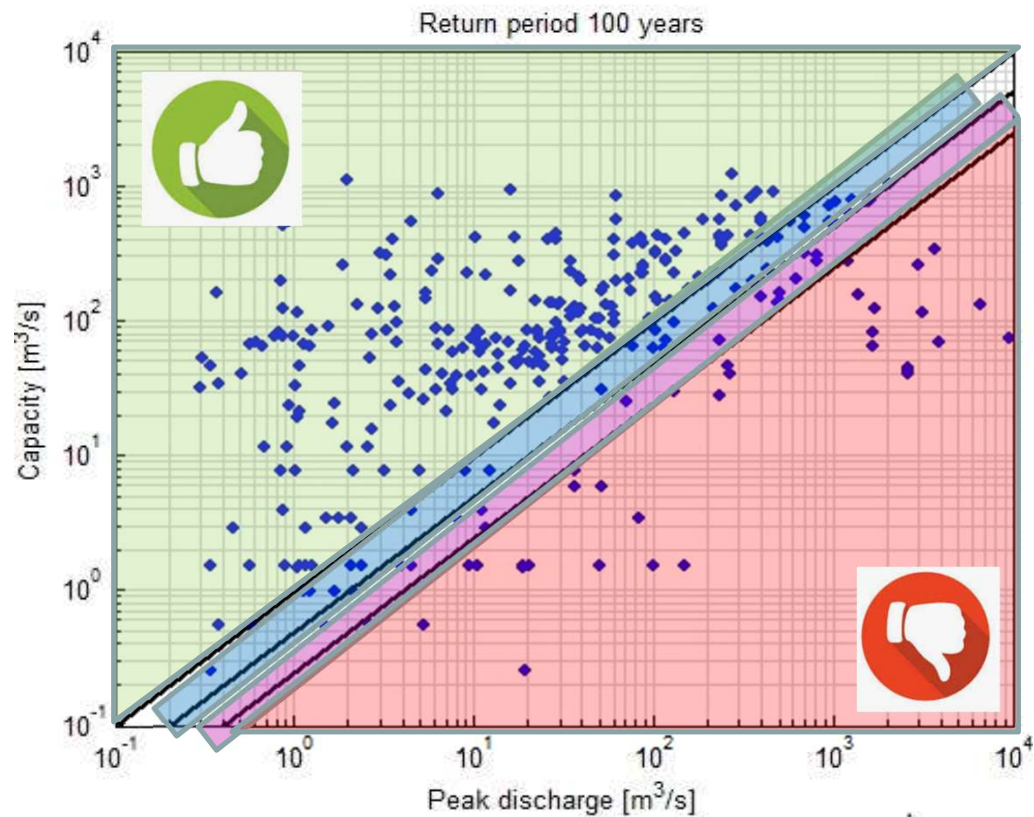
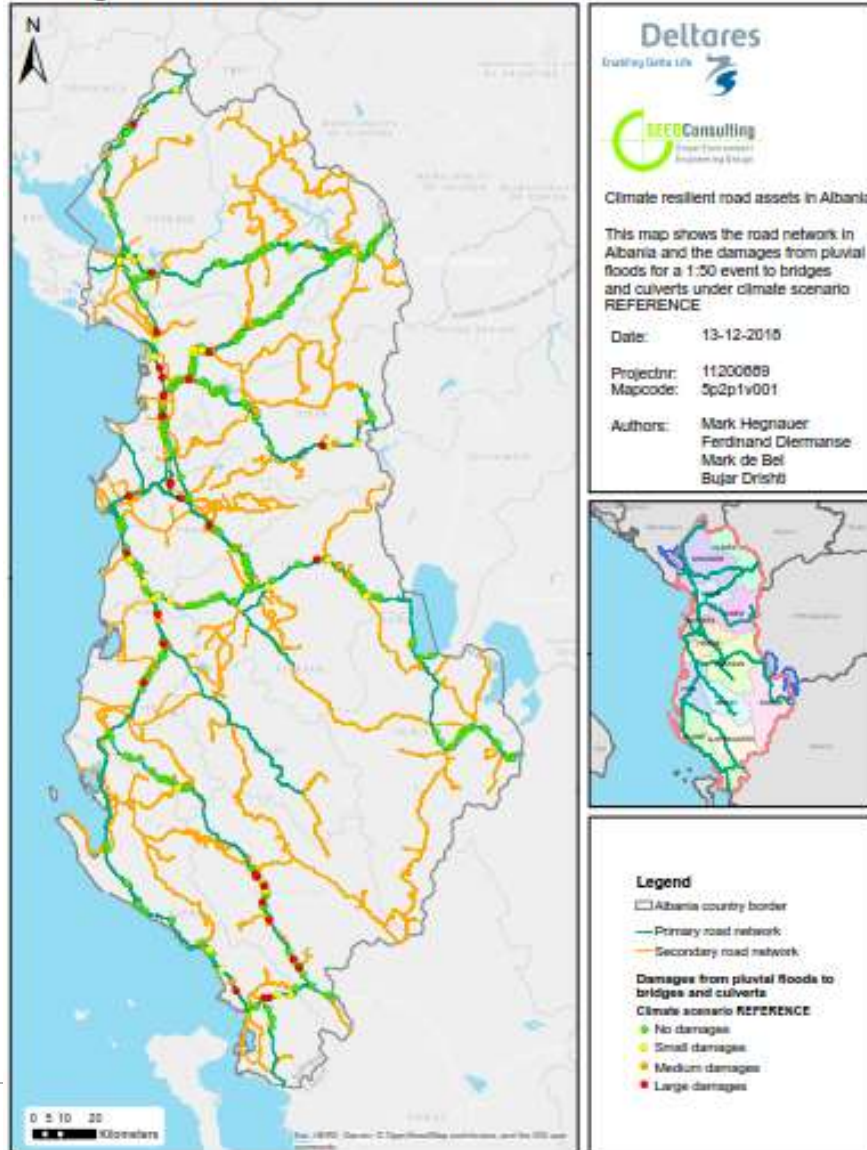
- Pluvial flooding only hazard that is effected by climate change
- Insufficient 'future change' to warrant a pathways/ DMU approach
 - Amount of CC in combination with damage functions shows little change in AED
 - Many culverts currently insufficient → take action NOW
 - Focus on main outliers!
- Economic growth (= traffic growth) leads to increase in capacity before any tipping points can be reached!
- Choose **cost efficient, robust measure**



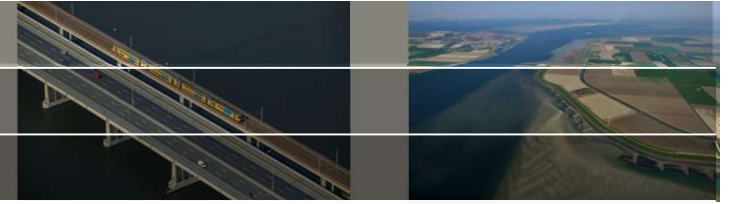
Pluvial flooding – hazard



5.2.1 Damages from pluvial floods to bridges and culverts under current climate



Landslides



The downward movement of a mass of rock, earth, or artificial fill on a slope, often induced (started) by prolonged or heavy rainfall.



Landslide – Total risk



Annual damages from interruption of services and repair costs per corridor from landslides (€)

Landslides	Repair Costs (€)	Interuptions (€)	Total (€)
Annual Expected Damages			
01 Milot - Morine New	286,714	37,659	324,373
02 Q. Qele - Puke	109,519	3,289	112,808
03 Milot - Shkoder	38,473	51,567	90,040
04 Tirana - Durres	44,776	71,602	116,378
05 Durres - Fier	150,035	363,272	513,307
06 Tirana- Elbasan	200,240	256,316	456,556
07 Fier - Tepelene	60,806	45,052	105,858
08 Sarande - Greqi	39,453	257	39,710
09 Elbasan - Gramsh	24,677	1,566	26,243
10 Lushnje - Berat	63,581	29,877	93,458
11 Rrogozhine - Elbasan	17,366	11,724	29,090
12 Shkoder - Hani - Hotit	76,293	21,043	97,336
13 Milot - Peshkopi	123,935	74,123	198,058
14 Vlore - Sarande	146,329	32,148	178,477
15 Pogradec - Korce	22,438	44,734	67,172

Landslides

Vulnerability

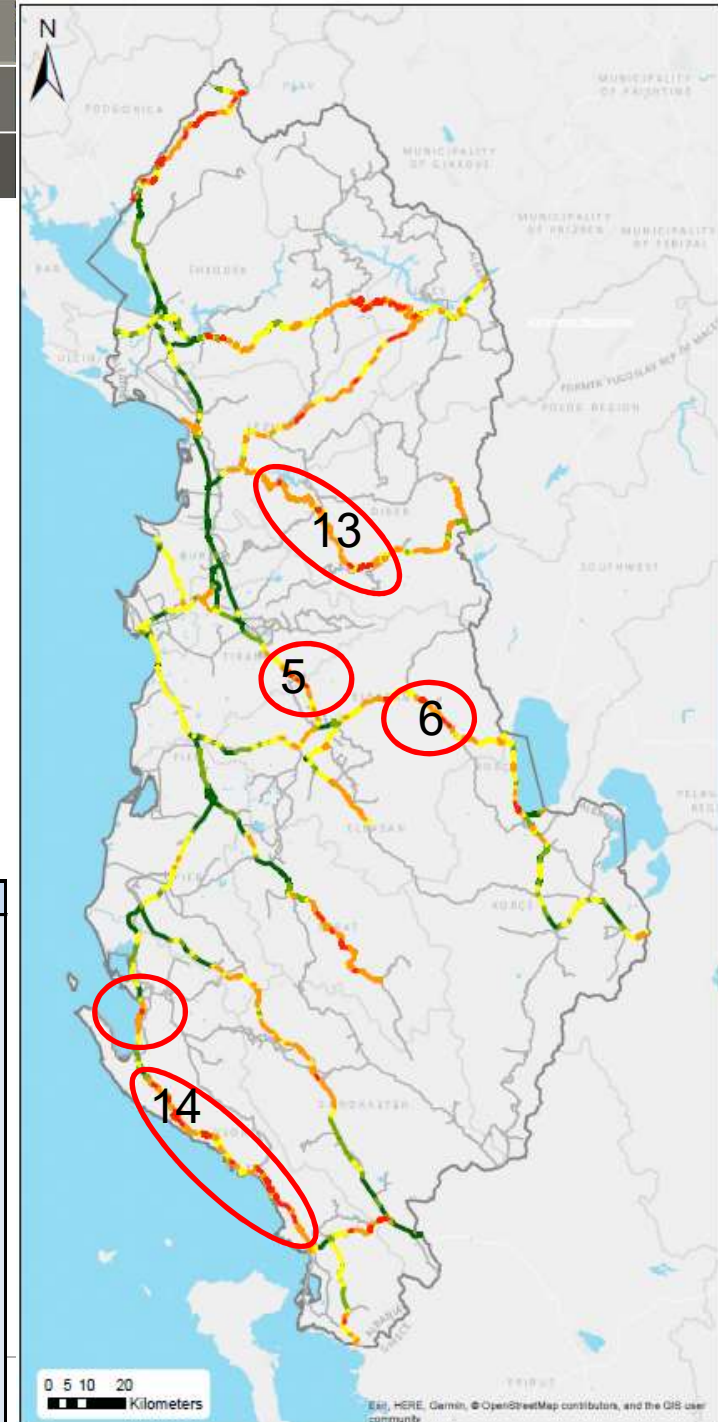
Colours indicate probability of a landslide (**Low**, **High**)

Based on:

- Historic events
- Susceptibility map

○ Indicates location proposed measures

Corridor
01 Milot - Morine New
02 Qele - Puke
03 Milot - Shkoder
04 Tirana - Durres
05 Durres - Fier
06 Tirana - Elbasan
07 Fier - Tepelene
08 Sarande - Greqi
09 Elbasan - Gramsh
10 Lushnje - Gramsh
11 Rrogozhine - Elbasan
12 Shkoder - Hani - Hotit
13 Milot - Peshkopi
14 Vlore - Sarande
15 Pogradec - Korce



Landslides - Typical measures

- **Retaining structures e.g. retaining walls, gabion walls**
- **Stepped slope embankments**
- **Internal slope reinforcement e.g. rock bolts**
- Drainage
- Reforestation
- (Improved) regular/ preventative maintenance
- Better response/ repair plan (i.e. shorter response times)



Landslide - Measures



Proposed measures per corridor, based on:

- Vulnerability
- Terrain conditions

Engineering measures	Cost/10 m (€)	05 Durres - Fier		06 Tirana- Elbasan		13 Milot - Peshkopi		14 Vlore - Sarande	
		Length	Cost	Length	Cost	Length	Cost	Length	Cost
Road Edge failure Retaining Wall	11,000	100	110,000	-	-	7,000	7,700,000	10,000	11,000,000
Soft rock Retaining Wall	11,000	200	220,000	3,100	3,410,000	20,000	22,000,000	-	-
Stepped slope embankement	42,000	-	-	500	2,100,000	-	-	-	-
Slope protection	14,000	400	560,000	500	700,000	-	-	-	-
Hard rock Slope protection	121,000	450	5,445,000	100	1,210,000	200	2,420,000	-	-
TOTAL			6,335,000		7,420,000		32,120,000		11,000,000

Landslides - Cost Benefit Analysis

Corridor	Investments	Benefits	B/C ratio
01 Milot - Morine New			
02 Q. Qele - Puke			
03 Milot - Shkoder			
04 Tirana - Durres			
05 Durres - Fier	6,335,000	6,699,804	1.1
06 Tirana- Elbasan	7,420,000	5,959,086	0.8
07 Fier - Tepelene			
08 Sarande - Greqi			
09 Elbasan - Gramsh			
10 Lushnje - Berat			
11 Rrogozhine - Elbasan			
12 Shkoder - Hani - Hotit			
13 Milot - Peshkopi	32,120,000	2,585,097	0.1
14 Vlore - Sarande	11,000,000	2,329,525	0.2
15 Pogradec - Korce			

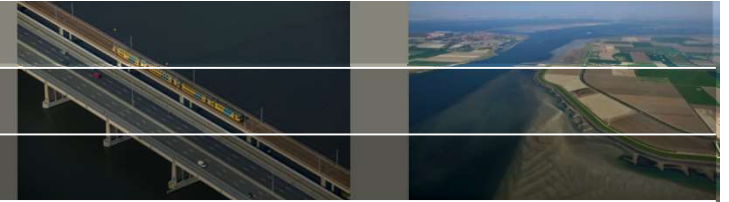
Example:
 AED: € 513.307
 Over 25years: > 13M€
 50% efficiency: ~ €7M€

So in the future, the losses will increase!

Based on Cost effectiveness:

- Assuming measures will reduce AED by 50 %,
 - (over 25 years at 4 % net discount rate as benefit, and a traffic growth of 4 %)
- Corridors 5 and 6, positive decision on investments
- Corridors 13 and 14, negative decision on investments

Sensitivity Landslides



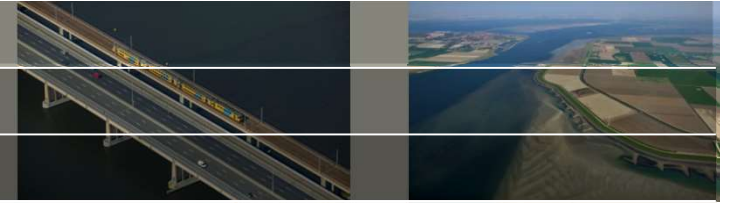
Sensitivity to effectiveness to measures (B/C ratio)

Corridor	25%	33%	50%	66%	75%
05 Durres - Fier	0.5	0.7	1.1	1.4	1.6
06 Tirana- Elbasan	0.4	0.5	0.8	1.1	1.2
13 Milot - Peshkopi	0.0	0.1	0.1	0.1	0.1
14 Vlore - Sarande	0.1	0.1	0.2	0.3	0.3

Conclusion

- Effectiveness of measures should at least be 50 %
- Only measures for corridors 5 and 6 are economically feasible

Sensitivity Landslides



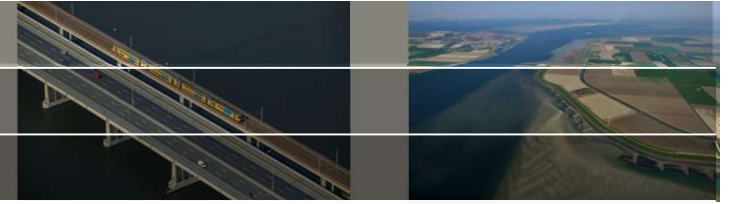
Sensitivity to increase in traffic density from traffic growth

Corridor	B/C ratio			
	2%	4%	8%	12%
05 Durres - Fier	0.8	1.1	2.1	4.4
06 Tirana- Elbasan	0.6	0.8	1.6	3.3
13 Milot - Peshkopi	0.1	0.1	0.2	0.3
14 Vlore - Sarande	0.2	0.2	0.4	0.9

Conclusion

- Measures for corridors 14 are only economically feasible at 12 % traffic growth

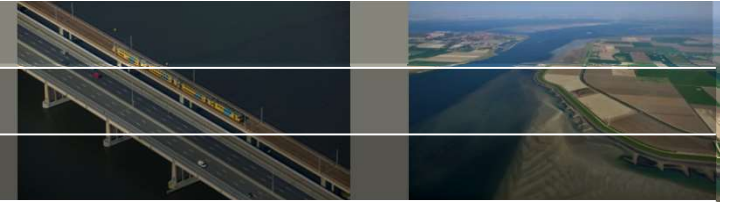
Flooding - Description



Fluvial, or riverine flooding, occurs when excessive rainfall over an extended period of time causes a river to exceed (its capacity or) the capacity of a culvert or bridge.



Floods - Impact



Selected (17) bridges and culverts

- With significant damages (AED)
- Return periods (5, 20, 50 and 100 years)
- Per corridor

ID	Corridor	Capacity (m3/s)	R_5	R_20	R_50	R_100	Damage categories	
B_0210	02 Qele - Puke	30.1	66.83	95.1	113.02	126.44	Large	
C_0375	05 Durres - Fier	0.56	0.77	1.1	1.3	1.46	Medium	
C_0505	05 Durres - Fier	1.58	4.85	6.89	8.17	9.14	Small	
C_3099	05 Durres - Fier	0	1.38	1.87	2.18	2.41	None	
C_1014	06 Tirana- Elbasan	3.54	43.91	61.14	72.07	80.25		
C_3603	07 Fier - Tepelene	0.56	0.39	1.59	2.38	2.59		
C_2988	07 Fier - Tepelene	1.58	39.58	69.25	88.37	97.74		
C_2995	07 Fier - Tepelene	6	13.27	25.05	32.67	36.08		
C_3502	07 Fier - Tepelene	0.26	9.77	14.26	17.12	19.04		
C_3527	07 Fier - Tepelene	8	16.75	26.19	32.23	35.91		
C_3601	07 Fier - Tepelene	0.56	1.81	3.54	4.65	5.19		
C_3613	07 Fier - Tepelene	6	21.98	36.07	45.14	49.78		
C_0083	12 Shkoder - Hani - Hotit	1.58	1.81	2.76	3.36	3.81		
C_2855	13 Milot - Peshkopi	1.58	7.82	13.14	16.54	18.59		
C_2871	13 Milot - Peshkopi	1.58	1.18	2.84	3.91	4.43		
C_2724	14 Vlore - Sarande	1.58	2.6	6.67	9.32	10.18		
C_2703	14 Vlore - Sarande	1.58	10.43	14.94	17.8	19.94		

Floods - Risks

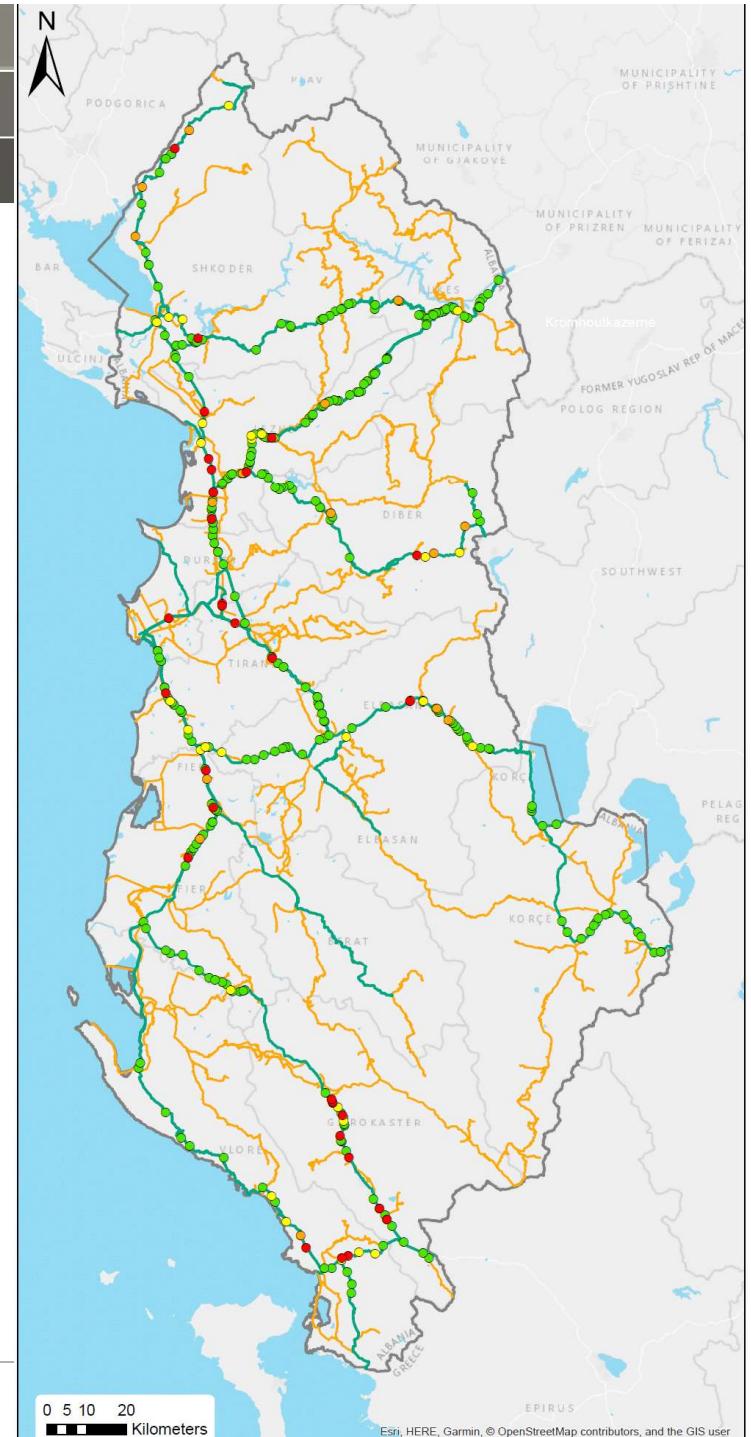
Vulnerability

Dots indicate culvert and bridge failures
(High, Low)

Based on:

- Modelled discharges
- Design capacities

Intervention on 17 red locations (~ 20 %)

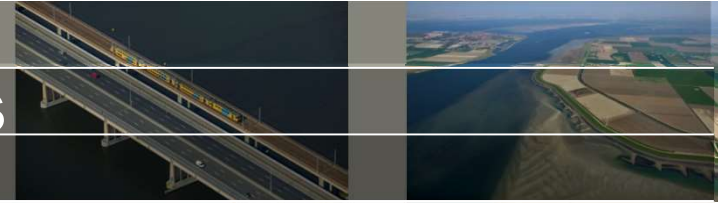


Flooding rivers – Economic damages

Annual Expected Damages (AED) for floods

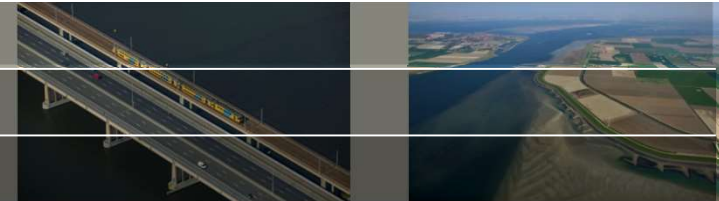
Annual Expected Damages	Length (km)	Interuption	Repairs	Total	€/km
		Sub-tot	Sub-tot		
01 Milot - Morine New	104	53,840	293,348	347,188	3,328
02 Q. Qele - Puke	126	9,105	131,294	140,398	1,118
03 Milot - Shkoder	127	1,354,587	453,430	1,808,017	14,189
04 Tirana - Durres	32	1,920,023	180,968	2,100,991	65,058
05 Durres - Fier	152	10,426,924	418,245	10,845,169	71,289
06 Tirana- Elbasan	139	3,241,456	347,439	3,588,895	25,839
07 Fier - Tepelene	128	1,100,059	319,431	1,419,491	11,071
08 Sarande - Greqi	58	2,133	84,056	86,189	1,477
09 Elbasan - Gramsh	41	2,804	51,639	54,444	1,343
10 Lushnje - Berat	86	262,826	126,969	389,796	4,555
11 Rrogozhine - Elbasan	40	37,618	47,740	85,357	2,128
12 Shkoder - Hani - Hotit	125	172,553	146,513	319,066	2,562
13 Milot - Peshkopi	136	558,937	183,738	742,675	5,459
14 Vlore - Sarande	131	151,425	186,587	338,012	2,587
15 Pogradec - Korce	69	83,671	69,554	153,225	2,222

Floods - Suggested measures



- **Increase capacity culverts**
- Reduce peak flow (retention ponds/reforestation)
- (Improved) regular/ preventative maintenance
- Erosion protection
- Better repair plan (i.e. shorter to reaction times)
- Build back better based on improved/ updated design criteria and performance standards

Floods - Measures



Bill of quantity for culvert replacement (0.75; 2.5; 16 or 50 m³/s)

Corridor	Q50	Q16	Q2.5	Q0.75	Q50	Q16	Q2.5	Q0.75	Investment (€)
01 Milot - Morine New	0	0	0	0	-	-	-	-	-
02 Q. Qele - Puke	1				75,000	-	-	-	75,000
03 Milot - Shkoder					-	-	-	-	-
04 Tirana - Durres					-	-	-	-	-
05 Durres - Fier		1	2		-	42,000	16,000	-	58,000
06 Tirana- Elbasan	1				75,000	-	-	-	75,000
07 Fier - Tepelene	4	1	2	0	300,000	42,000	16,000	-	358,000
08 Sarande - Greqi					-	-	-	-	-
09 Elbasan - Gramsh					-	-	-	-	-
10 Lushnje - Berat		1			-	42,000	-	-	42,000
11 Rogozhine - Elbasan					-	-	-	-	-
12 Shkoder - Hani - Hotit		1			-	42,000	-	-	42,000
13 Milot - Peshkopi		1	1		-	42,000	8,000	-	50,000
14 Vlore - Sarande		1	1		-	42,000	8,000	-	50,000
15 Pogradec - Korce					-	-	-	-	-

Costs of culverts replacements per corridor

- Per capacity
- Total per corridor

Floods - Effect of measures



ID	Corridor	Old Capacity (m3/s)	New Capacity (m3/s)	return values of discharge (m3/s) current climate				Damage categories	
				R_5	R_20	R_50	R_100		
B_0210	02 Qele - Puke	30.1	50	66.83	95.1	113.02	126.44	Large	
C_0375	05 Durres - Fier	0.56	2.5	0.77	1.1	1.3	1.46	Medium	
C_0505	05 Durres - Fier	1.58	16	4.85	6.89	8.17	9.14	Large	
C_3099	05 Durres - Fier	0	2.5	1.38	1.87	2.18	2.41	Large	
C_1014	06 Tirana- Elbasan	3.54	50	43.91	61.14	72.07	80.25	Large	
C_3603	07 Fier - Tepelene	0.56	2.5	0.39	1.59	2.38	2.59	Medium	
C_2988	07 Fier - Tepelene	1.58	50	39.58	69.25	88.37	97.74	Large	
C_2995	07 Fier - Tepelene	6	50	13.27	25.05	32.67	36.08	Large	
C_3502	07 Fier - Tepelene	0.26	16	9.77	14.26	17.12	19.04	Large	
C_3527	07 Fier - Tepelene	8	50	16.75	26.19	32.23	35.91	Large	
C_3601	07 Fier - Tepelene	0.56	2.5	1.81	3.54	4.65	5.19	Large	
C_3613	07 Fier - Tepelene	6	50	21.98	36.07	45.14	49.78	Large	
C_0083	12 Shkoder - Hani - Hotit	1.58	16	1.81	2.76	3.36	3.81	Medium	
C_2855	13 Milot - Peshkopi	1.58	2.5	7.82	13.14	16.54	18.59	Large	
C_2871	13 Milot - Peshkopi	1.58	16	1.18	2.84	3.91	4.43	Medium	
C_2724	14 Vlore - Sarande	1.58	2.5	2.6	6.67	9.32	10.18	Large	
C_2703	14 Vlore - Sarande	1.58	16	10.43	14.94	17.8	19.94	Large	

Flooding – Cost Benefit Analysis of measures

B/C ratio: Repair costs only

Corridor	Investment (€)	Benefits (€)	B/C ratio
01 Milot - Morine New	-	-	-
02 Qele - Puke	75,000	46,800	0.6
03 Milot - Shkoder	-	-	-
04 Tirana - Durres	-	-	-
05 Durres - Fier	58,000	1,079,520	19
06 Tirana- Elbasan	75,000	616,590	8
07 Fier - Tepelene	358,000	2,831,790	8
08 Sarande - Greqi	-	-	-
09 Elbasan - Gramsh	-	-	-
10 Lushnje - Gramsh	42,000	624,000	15
11 Rrogozhine - Elbasan	-	-	-
12 Shkoder - Hani - Hotit	42,000	621,270	15
13 Milot - Peshkopi	50,000	640,770	13
14 Vlore - Sarande	50,000	409,500	8
15 Pogradec - Korce	-	-	-

B/C ratio: Interruptions and repair costs

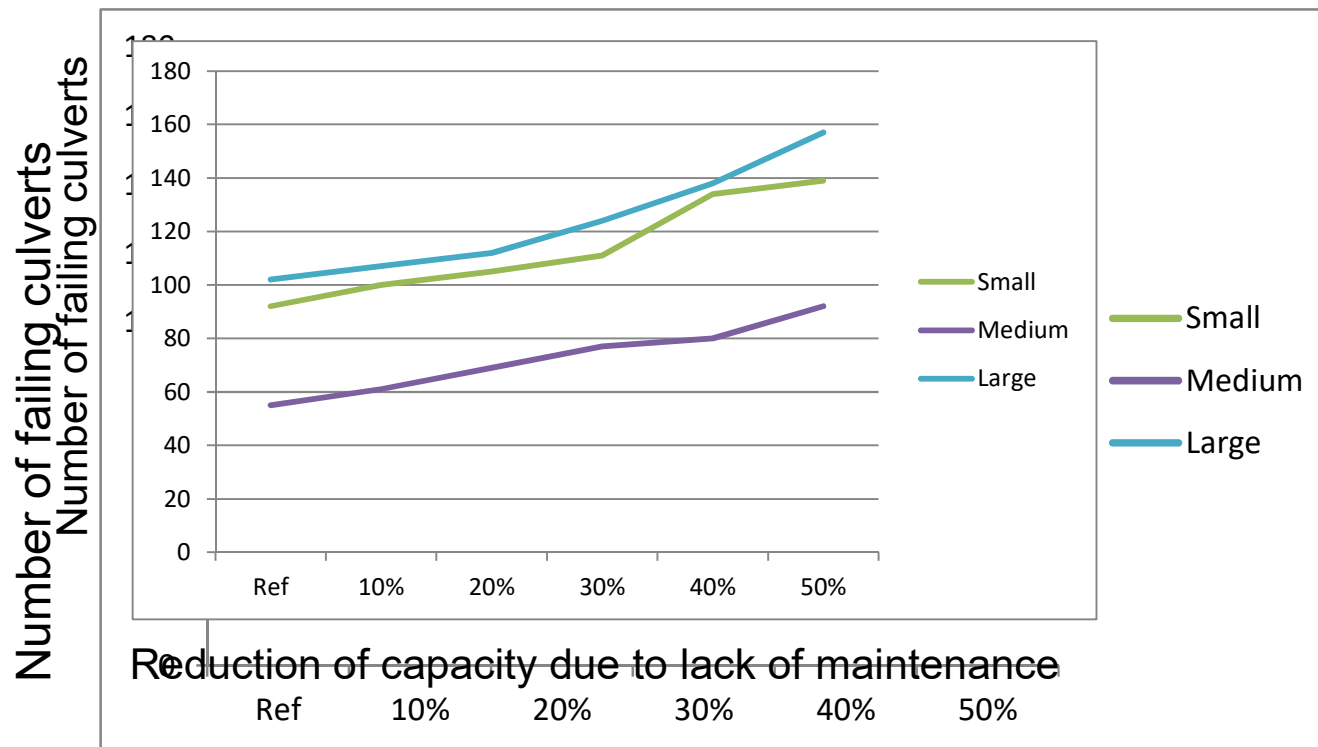
Corridor	Investment (€)	Benefits (€)	B/C ratio (Growth)
01 Milot - Morine New	-	0	-
02 Qele - Puke	75,000	106,729	1.4
03 Milot - Shkoder	-	-	-
04 Tirana - Durres	-	-	-
05 Durres - Fier	58,000	141,296,775	2,436
06 Tirana- Elbasan	75,000	27,429,674	366
07 Fier - Tepelene	358,000	21,242,387	59
08 Sarande - Greqi	-	-	-
09 Elbasan - Gramsh	-	-	-
10 Lushnje - Gramsh	42,000	6,273,880	149
11 Rrogozhine - Elbasan	-	-	-
12 Shkoder - Hani - Hotit	42,000	4,223,510	101
13 Milot - Peshkopi	50,000	10,532,861	211
14 Vlore - Sarande	50,000	3,196,637	64
15 Pogradec - Korce	-	-	-

Measures are economically viable when B/C ratio > 1.0

Sensitivity from lack of maintenance

Assumptions

- Lack of maintenance results in reduced discharge capacity
- Reducing performance of culvert by steps of 10 %



Conclusions:

- Reducing performance to 50% results in 60 % additional failure events
- 10 % of culverts very sensitive to lack of maintenance

Reduction of capacity due to lack of maintenance

Floods - Sensitivity to lack of maintenance

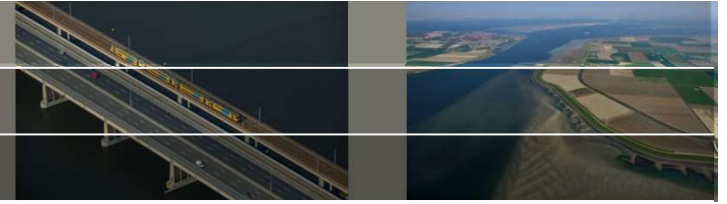
Additional damages at 50 %
reduced discharge capacity

Corridor	Add. Repairs/ year (€)	Add. Econ. Dam./ year (€)	Tot. Add. Dam/ year (€)
01 Milot - Morine New	28,925	106,587	135,512
02 Q. Qele - Puke	32,075	12,884	44,959
03 Milot - Shkoder	44,125	690,354	734,479
04 Tirana - Durres	-	-	-
05 Durres - Fier	56,625	3,524,171	3,580,796
06 Tirana- Elbasan	86,350	601,646	687,996
07 Fier - Tepelene	96,875	381,945	478,820
08 Sarande - Greqi	41,225	1,119	42,344
09 Elbasan - Gramsh	3,500	3,247	6,747
10 Lushnje - Berat	625	4,120	4,745
11 Rrogozhine - Elbasan	4,900	11,657	16,557
12 Shkoder - Hani - Hotit	58,200	77,142	135,342
13 Milot - Peshkopi	70,700	232,106	302,806
14 Vlore - Sarande	19,325	47,995	67,320
15 Pogradec - Korce	1,600	4,718	6,318

Climate resilient transport action plan

Corridor	Length (km)	Criticality	Floods		Land slides			
			Damage	Intervention	Damage	Intervention		
01 Milot - Morine New	104	Yellow			✓		✓	Identified damages and positive economic evaluation of investment
02 Q. Qele - Puke	126	Green	✓	✓	✓		✓	Identified damages and positive economic evaluation of investment under specific conditions
03 Milot - Shkoder	127	Yellow	✓				✗	Identified damages and negative economic evaluation of investment
04 Tirana - Durres	32	Red	✓	✓				
05 Durres - Fier	152	Red	✓	✓	✓	✓		
06 Tirana- Elbasan	139	Yellow	✓	✓	✓	✓		
07 Fier - Tepelene	128	Yellow	✓	✓				
08 Sarande - Greqi	58	Yellow	✓					
09 Elbasan - Gramsh	41	Green						
10 Lushnje - Berat	86	Green	✓	✓				
11 Rrogozhine - Elbasan	40	Yellow						
12 Shkoder - Hani - Hotit	125	Yellow	✓	✓				
13 Milot - Peshkopi	136	Yellow	✓	✓	✓		✗	
14 Vlore - Sarande	131	Yellow	✓	✓	✓		✗	
15 Pogradec - Korce	69	Yellow						

Conclusions



- Study presents first impressions, findings should be verified in the field
- Floods have major impacts, replacements are generally economically feasible, but location of culverts should be verified, more detailed study required
- Adequate maintenance for culverts is important for performance of the road network
- Landslide have significant impact but measures only economically feasible for corridors with high AED