

The World Bank

## Technical Assistance - Improving Resilience and Safety of the Local Roads Transport Network in the Republic of Serbia

Application of Practical Guidelines and Tool to assess risks at pilot LSGs and Development of Investment Plan Options at pilot LSGs

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## Contents

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1.	<b>Introduction</b>	2
2.	<b>Prioritization</b>	5
2.1	Priority scoring	6
3.	<b>Investment planning</b>	11
3.1	Utilization of MaPLoRds application tool	11
3.2	Data assessment	14
3.3	Development of an Investment Planning Option	16
3.4	Investment Plan Options for pilot LSGs	18

### Tables

Table 1	Budgets planned for Kraljevo and Aleksandrovac for years 2020, 2021, 2022	3
Table 2	Kraljevo vs. Aleksandrovac, size and local roads length	4
Table 3	Preliminary priority matrix derivation	9
Table 4	Final (reclassified) priority matrix	10
Table 5	Investment framework	15
Table 6	Investment planning options, Kraljevo	A-1
Table 7	Investment planning options, Aleksandrovac	A-9

### Figures

Figure 1	Methodology workflow (simplified)	5
Figure 2	Landslides scoring system	6
Figure 3	Rockfall scoring system <sup>2</sup>	7
Figure 4	Flood scoring system <sup>2</sup>	7
Figure 5	Flash flood scoring system <sup>2</sup>	8
Figure 6	Traffic scoring system <sup>2</sup>	8
Figure 7	Infrastructure scoring system <sup>2</sup>	9
Figure 8	Point observation sorted by priority score	12
Figure 9	Link data sorted by priority score	13
Figure 10	Observation point scoring overview	14
Figure 11	OSM map of Kraljevo with local roads highlighted	A-5
Figure 12	Short- and mid-term priority links 1-15 with indicated investment value in EUR for Kraljevo (Bogutovac area zoomed-in in the inset); ; Links are ranked by priority indicated in the first number, followed by the estimated investment value	A-6
Figure 13	Type of investment for prioritized links 1-15 for Kraljevo (Bogutovac area zoomed-in in the inset); Links are ranked by priority indicated in the first number, followed by the estimated investment value	A-7
Figure 14	Prioritized links (1-15) traffic features for Kraljevo (Bogutovac area zoomed-in in the inset); Links are ranked by priority indicated in the first number, followed by YES or NO for presence of alternative route, and public transport, respectively	A-8
Figure 15	OSM map of Aleksandrovac with local roads highlighted	A-16

Figure 16	Short- and mid-term priority links 1-24 with indicated investment value in EUR for Aleksandrovac (urban area zoomed-in in the incepts); Links are ranked by priority indicated in the first number, followed by the estimated investment value	A-17
Figure 17	Type of investment for prioritized links 1-24 for Aleksandrovac (urban area zoomed-in in the incepts); Links are ranked by priority indicated in the first number, followed by the estimated investment value	A-18
Figure 18	Prioritized links (1-24) traffic features for Aleksandrovac (urban area zoomed-in in the incepts); Links are ranked by priority indicated in the first number, followed by YES or NO for presence of alternative route, and public transport, respectively	A-19

## Appendices

Appendix A	A-1
Investment planning options for pilot LSGs	A-1

# Abbreviations

Abbreviation list	Meaning
GIS	Geographic Information System
F	Floods
FF	Flash floods
I	Infrastructure
L	Landslide
KPI	Key Performance Indicator
LSG	Local Self Government
MaPLoRds	Local Road Transport Network Resilience Diagnostic Tool
R	Rockfalls
T	Traffic
WB	World Bank

# 1. Introduction

Investment planning in a local road network involves strategic decision-making to allocate resources effectively for maintenance and upgrading. In recent years, the impact of climate change on infrastructure, including roads, has become increasingly evident. Local roads are particularly vulnerable to climate-related hazards such as landslides, rockfalls, floods and flash floods.

By integrating climate resilience into investment planning for local roads, communities can improve their preparedness and reduce the long-term costs associated with climate-related damage. By prioritizing maintenance, upgrading infrastructure, and engaging stakeholders, investment plans can address the challenges posed by climate-related hazards and help create more resilient local road networks.

## Investment Plan for transport infrastructure

An Investment Plan provides a link between municipality's/city's strategic development vision, their land use and maintenance plans, and their annual budgets. In Serbia, municipal/city fiscal management includes an annual exercise of preparing an investment plan for transport infrastructure. In addition, larger and more developed municipalities formulate capital investment plans for a period of up to three years. These plans aim to identify key projects that will support the development of the local community and enhance infrastructure.

A well-developed investment plan should also identify public transport infrastructure investment projects together with the financing approach. It describes the financial ability to manage the investment needs. Investment plans might include fiscal metrics which for example can be a percentage of the annual budget to be committed to the transport infrastructure projects or it can be defined in terms of the limit of the total debt.

If properly developed and monitored, an Investment Plan can enable implementing agencies to increase organizational, asset and network performance, but also to invest the money where the highest benefits are expected for the society.

Every 6 months or 1 year, the investment plan itself should be re-assessed in order to:

- take into consideration the changes in the main scheme of the road network,
- consider all recent changes on the local road network, and
- incorporate new intervention policies, both in terms of maintenance or major rehabilitation/reconstruction works.

Multiannual investment plans provide many benefits to the LSG, implementing agency and society. First, they promote effective planning and management of public infrastructure assets. Secondly, multiannual planning encourages LSGs to consider funding requirements, prioritization, timing and costs of core required investments. And thirdly, it allows LSGs to seek an external funding to cover any shortfalls.

This advisory report derives the investment plan options from the limited data provided by the LSGs needed for the assessment of the state and needs of the local transport network. It could serve to LSGs as a good and innovative example in the process of the investment plan development which could save lot of efforts of the LSG staff. Furthermore, this approach encourages the active participation of trained municipal employees, empowering them to accomplish the task without the need for external consultant.

It's important to ensure accuracy and completeness when entering the information into an investment plan, as it serves as a crucial guide for decision-making and resource allocation in road infrastructure management.

## Road hazard related investment planning

One of the project's key outcomes is the development of Investment Plan Options for pilot LSGs (Kraljevo and Aleksandrovac) based on field data entered into the MaPLoRds application tool. These data pertain to specific locations on the local road network where the impacts of various climate hazards have been identified. By utilizing the information gathered through MaPLoRds, investment planning can be

customized to address the vulnerabilities and risks associated with these road locations. This includes targeted maintenance, infrastructure upgrades, and resilience measures.

The MaPLoRds application has been developed with a user-friendly interface to cater to a wider range of users, making it accessible and intuitive. It is designed to be easily navigable and adaptable for desktop work.

After data collection, the application facilitates data processing and practical implementation for various purposes, including the development of investment planning options and the creation of a road hazard related database. This stage requires relevant expertise and prior experience in the relevant field necessary for effective data processing, decision-making, and database management.

### Investment capacities of pilot LSGs to local roads network

The annual planning of investments in pilot LSGs in road infrastructure is conducted at the municipal level, utilizing the allocated funds from the budget. To support the municipal budget, each road managing authority develops a comprehensive and detailed plan and program to efficiently allocate these funds.

Furthermore, in Kraljevo, capital investment plans for a three-year period are formulated by leveraging information provided by the finance department. However, it is important to acknowledge that these plans might not completely align with the precise requirements of the road infrastructure, but instead reflect projected possibilities and financial considerations.

Conversely, the absence of long-term planning mechanisms in Aleksandrovac highlights a potential deficiency in strategic planning for road infrastructure over an extended time horizon.

According to the available documents, planned municipal budget allocations for the past three years in pilot LSGs are presented in Table 1.

**Table 1 Budgets planned for Kraljevo and Aleksandrovac for years 2020, 2021, 2022**

Year	Kraljevo Budget (mil EUR <sup>1</sup> )		Aleksandrovac Budget (mil EUR)	
	Overall	Transport infrastructure*	Overall	Transport infrastructure
2020	37.747	7.276	8.884	2.982
2021	39.298	6.925	8.412	1.805
2022	41.528	5.355	7.742	1.375

\* This budget portion includes management and maintenance of transport infrastructure

Based on the presented data, it can be observed that both municipalities have experienced a significant decrease in funding for their local road networks. Kraljevo allocated approximately 30% less funds in 2022 compared to 2020, while the situation in Aleksandrovac is even more alarming, with a reduction in investments in the same period exceeding 50%.

This decline raises concerns about the ability to maintain and improve road infrastructure, potentially leading to deteriorating conditions, increased safety risks, and higher long-term maintenance costs. Efforts should be made to identify the reasons behind the funding reduction and explore strategies to mitigate its impact, such as seeking additional funding sources and optimizing budget allocation. It is crucial to prioritize adequate investment in the local road network to ensure safe and efficient transportation and support the overall development of these municipalities.

Furthermore, if we look at the relationship between the size and length of the road networks managed by these two municipalities (Table 2), considering that Kraljevo is 4-5 times larger both in terms of area and population, we can conclude that Aleksandrovac is in a rather unfavorable situation when it comes to investing in the road network.

<sup>1</sup> Converted from RSD (official data) into EUR, currency used: 1 EUR eq. to 117,3 RSD

**Table 2 Kraljevo vs. Aleksandrovac, size and local roads length**

Parameter	Kraljevo	Aleksandrovac
Area (km <sup>2</sup> )	1,529	387
Population	111,491	22,339
Local roads network length (km)	<b>326.2</b> total <b>200.2 (61%)</b> paved with asphalt	<b>407.4</b> total <b>218.1 (53%)</b> paved with asphalt

**Disclaimer**

Investment plan options exemplified in this document for target LSGs are only for illustrative purposes, showing investment planning procedure and planning options, and are not meant for direct implementation. They have been generated using limited field data and include only a sample of the inputs available at the time of the analysis conducted for finalizing the project. It's worth noting that ongoing data collection has been taking place in the target LSGs, which could potentially impact the analysis and outcomes.



## 2. Prioritization

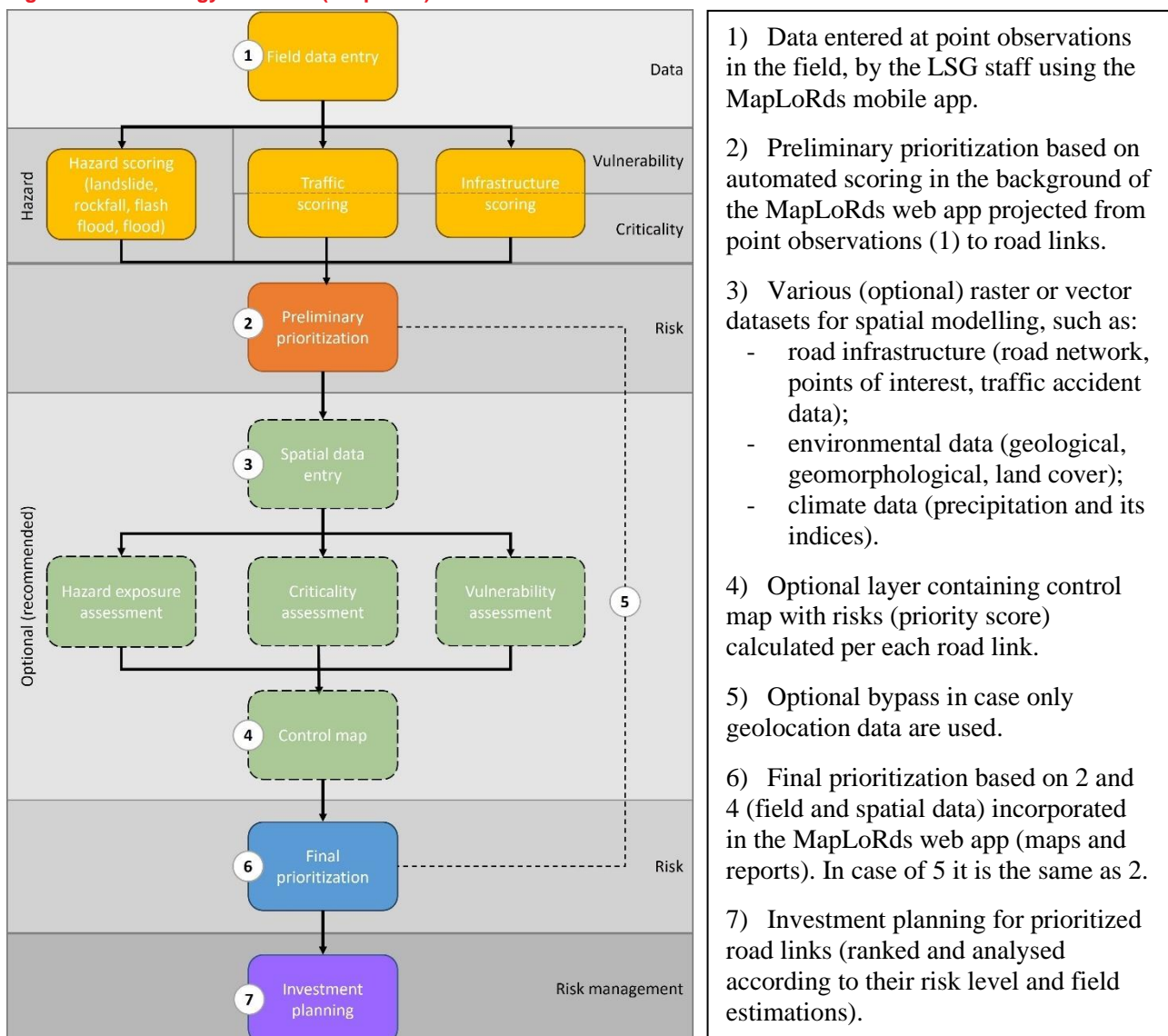
This section provides an overview of the prioritization process occurring within the application, aiming to enhance comprehension. The prioritization is done according to the level of risk/priority, as elaborated and exemplified in the Methodology Report (Chapter 4, Appendix A).

The prioritization process is fully automated and executed in the background of the MaPLoRds application. In brief, it involves the utilization of predefined criteria matrices to evaluate each individual input item (Figure 1). The application generates a prioritized assessment for every geolocation (which can contain multiple observations, e.g., several hazard types at the same location) and road link based on the assigned criteria (please refer to example in the Methodology Report, Appendix A).

In order to facilitate the process of hazard assessment and risk (priority) analysis, a kind of wizard or pipeline is developed for the proposed mobile and web GIS system. The pipeline is designed to collect and integrate various types of data, including hazard data such as landslides, rockfall, flood, flash flood, and climate data. In addition, hazard exposure data is obtained from road network vector data, which is overlaid with the hazard data. Vulnerability is assessed using road characteristics data, such as road type and condition.

The risk, which is the base for the priority assessment, is calculated by combining hazard and vulnerability data. Remediation and prevention costs are required to prioritize the risks.

**Figure 1 Methodology workflow (simplified)**



- 1) Data entered at point observations in the field, by the LSG staff using the MapLoRds mobile app.
- 2) Preliminary prioritization based on automated scoring in the background of the MapLoRds web app projected from point observations (1) to road links.
- 3) Various (optional) raster or vector datasets for spatial modelling, such as:
  - road infrastructure (road network, points of interest, traffic accident data);
  - environmental data (geological, geomorphological, land cover);
  - climate data (precipitation and its indices).
- 4) Optional layer containing control map with risks (priority score) calculated per each road link.
- 5) Optional bypass in case only geolocation data are used.
- 6) Final prioritization based on 2 and 4 (field and spatial data) incorporated in the MapLoRds web app (maps and reports). In case of 5 it is the same as 2.
- 7) Investment planning for prioritized road links (ranked and analysed according to their risk level and field estimations).

## 2.1 Priority scoring

The scoring process is applied to each input parameter value, which is collected by the LSG field team. This includes both required and optional parameters, as well as automatically generated data derived from previously entered information, such as calculating surface area from length and width.

The priority matrix is based on scoring system that will be described in this section. For each group of data parameters are assigned, including scores from a set of seven score classes (from 0 to 5):

- 0.5 (c\_05); 0.75 (c\_075) and 1 (c\_1), are used only for parameters assigned to remediation, and include ponder values related to each class respectively: 0.5; 0.75 and 1
- All other parameters (excluding remediation) are scored by class (c\_1); 2 (c\_2); 3 (c\_3); 4 (c\_4) or 5 (c\_5), where c\_1 is lowest (1) and c\_5 is highest score (5), indicating a greater hazard.

For numerical and quantitative parameters such as length, width, and depth, each score class is defined by a range of values. For example, quantitative value: Length of landslide smaller than 10 has score 1, while over 500m has highest score 5.

For descriptive and qualitative values such as frequency and activity, specific values are listed for each score class. For parameters that are not self-explanatory additional descriptions are provided to help clarify the scoring system. It is important to note that the scoring system is stored in a database, and is not hardcoded, meaning that there is flexibility to make changes to scoring ranges and options through a web interface.

Figure 2 presents a scoring system for landslides comprising of 12 parameters. It includes:

- 7 mandatory quantitative values numbered from 101 to 107,
- 3 qualitative values numbered from 108 to 110, and
- 2 optional data related to remediation.

In the remediation section, a score of 0.5 is assigned if the remediation time is less than one year, a score of 0.75 is assigned if the time period is between 1 to 5 years, and a score of 1 is given if the remediation is not done or if it is older than 5 years.

**Figure 2 Landslides scoring system<sup>2</sup>**

ordinal number	process type	param	description	c_0	c_075	c_1	c_2	c_3	c_4	c_5
101	landslide	Length (m)				0-10	10-50	50-200	200-500	500-...
102	landslide	Width (m)				0-5	5-10	10-50	50-200	200-...
103	landslide	Depth (m)				0-5	5-10	10-20	20-30	30-...
104	landslide	Visible scarp				0-1				1-...
105	landslide	Main scarp height (m)				0-0.5	0.5-1	1-2	2-3	3-...
106	landslide	Area (m2)				0-50	50-500	500-10000	10000-100000	100000-...
107	landslide	Volume (m3)				0-250	250-5000	5000-200000	200000-3000000	3000000-...
108	landslide	Frequency	number of occurrences per unit of time			once in a few years		once in a year		more than once in a year
109	landslide	Landslide trigger				erosion of the base	human activity (undercutting, overloading...)	snow melt	rainfall	earthquake
110	landslide	Activity	indication of whether process is currently engaged in some form of activity or not			suspended/re mediated		dormant/historic		active
111	landslide	Approximate remediation date		0-1	1-5	5-...				
112	landslide	Approximate remediation cost (€)		0-500	500-3000000	3000000-...				

A scoring system for rockfall is presented in Figure 3, which consists of 6 required and 2 optional parameters, including:

- 3 quantitative values numbered from 201 to 203,

<sup>2</sup> Legend:

ordinal number – number given to mandatory quantitative value

process type – hazard type

param – parameter related to relevant hazard

description – more detailed description provided

c\_05 – c\_5 – score classes

- 3 qualitative values numbered from 204 to 206, and
- 2 optional parameters related to remediation.

This system is similar to the previously explained scoring system used for landslides.

**Figure 3 Rockfall scoring system<sup>2</sup>**

ordin num1	process type	param	description	c_075	c_1	c_2	c_3	c_4	c_5
201	rockfall	Runout distance (m)			0-50	50-100	100-300	300-1000	1000-...
202	rockfall	Release height (m)			0-5	5-10	10-50	50-100	100-...
203	rockfall	Block volume (m3)			0-0.3	0.3-1	1-5	5-10	10-...
204	rockfall	Frequency	number of occurrences per unit of time		once in a few years		once in a year		more than once in a
205	rockfall	Rockfall trigger	factors that cause a rockfall, which can include weathering, seismic activity, soil/vegetation removal, human activity, and		icing, plant roots	human activity (undercutting, overloading...)	snow melt	rainfall	earthquake
206	rockfall	Activity	indication of whether process is currently engaged in some form of activity or not		suspended/r emediated		dormant/historic		active
207	rockfall	Approximate remediation date		0-1	1-5	5-...			
208	rockfall	Approximate remediation cost (€)		0-500	500-3000000	3000000-...			

Figure 4 presents a flood scoring system that comprises 4 quantitative (301 – 304) and 3 qualitative (305 – 307) parameters as required data, along with 2 optional parameters related to remediation.

**Figure 4 Flood scoring system<sup>2</sup>**

ordin num1	process type	param	description	c_075	c_1	c_2	c_3	c_4	c_5
301	flood	Floodway width (m)			0-10		10-50		50-...
302	flood	Flood fringe width (m)			0-50		50-300		300-...
303	flood	Level above normal (m)			0-2		2-5		5-...
304	flood	Level above/below the road (m)			...-2		-2-0		0-...
305	flood	Frequency	number of occurrences per unit of time		once in a few years		once in a year		more than once in a
306	flood	Flood cause	factors that lead to a flood, which can include heavy rainfall, snowmelt, coastal storms, dam or levee failures, urbanization, and other human activities that alter natural drainage patterns or increase		external floodwave	downstream river damming	rainfall	snow melt	upstream dyke breach
307	flood	Protection status	level of security or safety measures that are in place to protect a particular object, system, or entity from harm or		regulated		damaged protection		no flood protection installed
308	flood	Approximate remediation date		0-1	1-5	5-...			
309	flood	Approximate remediation cost (€)		0-500	500-3000000	3000000-...			

Figure 5 presents a flash flood scoring system that consists of 4 quantitative (401 – 404) and 3 qualitative (405 – 407) parameters as required data, along with 2 optional remediation parameters.

Figure 5 Flash flood scoring system<sup>2</sup>

ordin numl	process type	param	description	c_075	c_1	c_2	c_3	c_4	c_5
401	flash flood	Width (m)			0-50	50-100	100-...		
402	flash flood	Runout distance (m)			0-0.5	0.5-1	1-3	3.okt	10-...
403	flash flood	Level above ground (m)			0-2		2-5		5-...
404	flash flood	Level above/below the road (m)			...-2	-2-0	0-...		
405	flash flood	Frequency	number of occurrences per unit of time		once in a few years		once in a year		more than once in a
406	flash flood	Flashflood cause	factors that lead to a flash flood, which can include heavy rainfall, sudden snowmelt, dam or levee failures, and other events that cause rapid and intense runoff, often in urban or mountainous areas		upstream barrier breach	snow melt	rainfall		
407	flash flood	Protection status	level of security or safety measures that are in place to protect a particular object, system, or entity from harm or		regulated		damaged protection		no flood protection installed
408	flash flood	Approximate remediation date		0-1	1-5	5-...			
409	flash flood	Approximate remediation cost (€)		0-500	500-3000000	3000000-...			

Hazard score is a weighted sum of landslides, rockfall, flood, and flash flood scores. For landslide, the minimal score value is 11 and the maximal score is 50, while the weight (ponder) is 5. For rockfall, the minimal score value is 7 and the maximal score is 30, while weight (ponder) is 2. For flood minimal score value is 8 and maximal score is 35, while weight (ponder) is 3. For flash flood minimal value is 8 and the maximal score is 30, while weight (ponder) is 4.

Furthermore, Traffic and Infrastructure scoring systems have elements of both vulnerability (intrinsic properties of the road elements) and criticality (social and economic aspects), as they both take into account impact on structural and functional aspects of the road. In addition, Infrastructure scoring is more oriented toward determining level of investment, while Traffic score is closer to representing criticality. However, once their scoring is completed, it represents vulnerability as opposed to hazard on the other side of the priority (risk) matrix.

Figure 6 presents a traffic impact scoring system that includes 3 qualitative parameters (501 – 503) as required data, along with 2 optional data related to alternative routes and estimated detour length.

Figure 6 Traffic scoring system<sup>2</sup>

ordin numl	process type	param	description	c_075	c_1	c_2	c_3	c_4	c_5
501	Traffic	Road function	purpose or intended use of a particular roadway or transportation route		Urban - other		Public transport	Rural - transit	Rural - connecting villages
502	Traffic	Traffic interruption	temporary or permanent disruption of transportation flow, usually due to an		no effect		reduced speed	one direction	both directions
503	Traffic	Traffic flow	movement of vehicles, pedestrians, or goods along a transportation network, such as a road, highway, or sidewalk		no public transport				public transport included
504	Traffic	Alternative routes			1-...				0-1
505	Traffic	Estimated detour length			0-1	1-5	5-...		

Approach for score calculation of infrastructure-based vulnerability and criticality is a different set-up as presented further in Figure 7.

The scoring approach depends on the type of investment - light, medium, or heavy. For each type of investment, a list of infrastructure features is consulted, and the maximum score from the list is taken. If infrastructure data are not available, then a score value of 2 is assigned.

The weighting factors that are used to combine the scores are specified within a stored procedure in the database, rather than within the application code. This approach makes it easier to modify the weighting factors, if necessary, without requiring changes to the application code. All values used in this process are consistent with the methodology document that outlines the approach.

Figure 7 Infrastructure scoring system<sup>2</sup>

ordin numt	process type	param	description	c_075	c_1	c_2	c_3	c_4	c_5
601	Infrastructure	light investment	91,92,93,96,97,104,105						
602	Infrastructure	medium investment	98,100, 102						
603	Infrastructure	heavy investment	94,95,99,101,103						

ID	En	Score
91	pavement, asphalt layers	2
92	pavement, concrete layer	2
93	pavement, cobbled stone	2
94	pavement, all layers	4
95	embankment, damage of embankment	4
96	drainage, cleaning or repair of light drainage elements	2
97	bridge, light surface repair	3
98	bridge, structure repair	4
99	bridge, new bridge	5

ID	En	Score
100	retaining wall, wall repair	4
101	retaining wall, new wall (sections)	5
102	drainage, repair of culverts	4
103	third party utilities, Interruption of existing roadside infrastructure	5
104	earthworks, removal of soil	1
105	scaling, rock scaling	1
106	households, endangered households	null
107	casualties , dead or injured	null
108	endagered stream	null

Vulnerability assessment is a weighted sum of Traffic and Infrastructure scores. For Traffic minimal value is 5 and maximal score is 23, while weight (ponder) is 5. For Infrastructure minimal value is 0 and maximal score is 12, while weight (ponder) is 2.

Calculated scores are normalized for Hazards, Traffic and Infrastructure and finally Hazard and Vulnerability scores are multiplied giving priority value for observed geolocation. Namely, when all scoring is completed at a single site location, it is necessary to pair the scores of Traffic impact (T) and Infrastructure vulnerability (I) against Hazard scores (for landslides (L), rockfalls I, floods (F), and flash floods (FF)) and define the preliminary priority (risk) classes.

Beforehand, it is needed to sum up scores of Traffic impact and Infrastructure vulnerability scores (T+I) and then normalize the sum (using max=2, min=0). Thereby the value will be maintained in the 0-1 range.

Repeat the same normalizing procedure for all four Hz scores (L+R+F+FF), wherein the sum (max=4, min=0) should range into 0-1 domain after normalization.

Next step is to classify summed and normalized scores *T+I* on one side, and *L+R+F+FF* on the other side, using the standard equal intervals<sup>3</sup> in the following procedure:

- Very low class < 0.2 ⇒ assign value 0.2
- Low class = 0.2-0.4 ⇒ assign value 0.4
- Moderate class = 0.4-0.6 ⇒ assign value 0.6
- High class = 0.6-0.8 ⇒ assign value 0.8
- Very high class ≥ 0.8 ⇒ assign value 1.0

Multiply pairs of scores (*T+I*) x (*L+R+F+FF*) to form the preliminary priority matrix (Table 5).

Table 3 Preliminary priority matrix derivation

Normalized* (T+I)	Class	Priority matrix				
1	Very high	0.20	0.40	0.60	0.80	1.00
0.8	High	0.16	0.32	0.48	0.64	0.80
0.6	Moderate	0.12	0.24	0.36	0.48	0.60
0.4	Low	0.08	0.16	0.24	0.32	0.40
0.2	Very low	0.04	0.08	0.12	0.16	0.20
	Class	Very low	Low	Moderate	High	Very high
	Normalized* (L+R+F+FF)	0.2	0.4	0.6	0.8	1

\* After normalization each score class has been assigned a single value, i.e., the upper bound value  
 Note: All intervals take the lower bound as inclusive while upper bound is exclusive, e.g., class 0.6-0.8 means 0.6 to 0.79.

<sup>3</sup> All intervals take the lower bound as inclusive while upper bound is exclusive, e.g., class 0.2-0.4 means 0.2 to 0.399.

From calculated priority value, priority class is assigned:

- 1 for priority value < 0.2
- 2 for priority value 0.2-0.4
- 3 for priority value 0.4-0.6
- 4 for priority value 0.6-0.8, and
- 5 for priority value  $\geq 0.8$ .

For more straightforward visualization and easier later fusion with background model (Control map) outputs it is convenient to reclassify preliminary matrix values by using 1 – 5 value intervals (Table 6):

- Very low class = 1
- Low class = 2
- Moderate class = 3
- High class = 4
- Very high class = 5

**Table 4 Final (reclassified) priority matrix**

<b>(T+I) Class</b>	<b>Priority matrix</b>				
<b>Very high</b>	3	4	4	5	5
<b>High</b>	2	3	4	4	5
<b>Moderate</b>	2	3	3	4	4
<b>Low</b>	1	2	3	3	4
<b>Very low</b>	1	1	2	2	3
<b>(L+R+F+FF) Class</b>	<b>Very low</b>	<b>Low</b>	<b>Moderate</b>	<b>High</b>	<b>Very high</b>

The calculation of link scores relies on normalized values derived from observed geolocation data associated with the links. The automated process identifies all observed geolocations that intersect or overlap with a link, using a specified tolerance parameter (typically set to a default value of 50 meters). It then aggregates the calculated priority values and normalizes them by considering the length of the respective link.

The subsequent classification process is identical to that used for geolocation, employing classes 1-5. The final priority score is determined as the truncated average of these two values, with truncation configured to eliminate decimal places. For example, if a link has been classified as 4 based on field observations and class 3 according to the Control map, the truncated average of 3.5 results in a final classification of 4.

It's evident that during the automated translation of geolocation priority score values onto links, only the priority values are retained. Consequently, the visibility of hazard exposure is not represented by numerical values but is factored into the spatial operation itself.



## 3. Investment planning

This chapter provides an overview of how the output data from developed MaPLoRds application are utilized for the creation of an investment plan option. The technical aspects of leveraging the data will be explored, and the obtained results will be demonstrated. Furthermore, particular investment planning options for pilot LSGs will be presented based on the specific observations entered by their representatives during their fieldwork within the project's timeframe.

### 3.1 Utilization of MaPLoRds application tool

One of the main objectives of the mobile and web based MaPLoRds application tool is to streamline the process of developing a particular investment planning option, specifically focusing on measures to improve climate change resilience in the local road network. It provides valuable output data that can be utilized directly or descriptively for various purposes within the planning process.

Utilization of MaPLoRds application tool in the creation of an investment planning option involves leveraging its output data for project identification/ listing, assessing implementation steps and timeframe, and estimating budget requirements for successful project realization.

The application provides several different reports as output, which can be valuable for LSGs in investment planning as well as in any other process involving the preparation of plans and programs or the management of databases by LSGs. All these reports are comprehensively presented and explained in the Practical Guidelines document. Specifically, for the preparation of an investment planning option, we will analyze the data provided in the following reports:

1. Reporting on geolocation (point) observations connected to links,
2. Reporting on links, and
3. Detailed reporting on observed geolocations.

All Reports are available on MaPLoRds web application and can be exported in an Excel table as well. Further in the text, the reports will be presented as an Excel document (output). It should be noted that the column layout in the web application<sup>4</sup> remains identical, ensuring a consistent reading approach.

#### Reporting on geolocation (point) observations

In this report are presented aggregated data on geolocation (point) observations, as shown Figure 8. Each row of the report presents a single observation point, with accompanying information about the road link provided. The report has been sorted in descending order according to score, which reflects the prioritization of each observation point.

- Column A: road\_name, name of the road according to Open Street Map
- Column B: road\_link, code (number) of the road link according to Open Street Map
- Column C: length\_km, automatically calculated length of the link
- Column D: location, user description of the location
- Column E: coord\_x, coordinate X in UTM 34N (EPSG: 32634)
- Column F: coord\_y, coordinate Y in UTM 34N (EPSG: 32634)
- Column G: landslide, description of key feature values for landslides
- Column H: rockfall, description of key feature values for rockfalls
- Column I: flood, description of key feature values for floods
- Column J: flash flood, description of key feature values for flash floods
- Column K: traffic, description of key feature values for traffic
- Column L: infrastructure, description of key feature values for infrastructure

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<sup>4</sup> <http://maplords.rgf.bg.ac.rs/Reports>

- Column M: investment\_category, derived investment category according to infrastructure input data
- Column N: priority\_score, calculated priority score in range 0-1, 1 means higher priority, 0 low priority.
- Column O: priorit\_class, 1-5 class derived from priority, 1 low priority, 5 high priority.

**Figure 8** Point observation sorted by priority score

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
road name	road	length(km)	location	coord x	coord y	landslide	rockfall	Road	flashflood	traffic	infrastructure	Investment category	Priority score	Priority class
	10049	6.89	lokacija 14 Latkovac Crveni breg	500476.65	4813388.37		1: Dimensions: 6x4x, more than once in a year, rainfall, icing, plant roots,			Rural - connecting villages, one direction, no public transport, .	pavement, asphalt layers, drainage, cleaning or repair of light drainage elements,	light investment:1	0	1
	10059	5.28	Drenca	504605.17	4813576.14		1: Dimensions: 5x6x, more than once in a year,			Public transport, reduced speed, public transport	pavement, asphalt layers, earthworks, removal of soil,	light investment:4;	0.03	1
	10059	5.28	Velja glava Filipivici	502831.97	4815017.66		Dimensions: 11x3x2, once in a few years, rainfall, erosion of			Rural - transit, reduced speed, no public transport, .	pavement, all layers, drainage, cleaning or repair of light pavement, asphalt layers,	light investment:4;	0.03	1
	10059	5.28	Drenca Velja Glava	503194.18	4814600.57		1: Dimensions: 10x7x, more than once in a year,			Rural - transit, one direction, public transport included, .	earthworks, removal of soil, pavement, asphalt layers,	light investment:4;	0.03	1
	10059	5.28	Drenca Velja glava	503230.69	4814631.68		1: Dimensions: 7x10x, more than once in a year,			Rural - transit, one direction, public transport included, .	earthworks, removal of soil, pavement, asphalt layers,	light investment:4;	0.03	1
	10059	5.28	Drenca Crkva	504657.44	4813616.71		1: Dimensions: 5x6x, more than once in a year, rainfall, plant roots, snow			Public transport, reduced speed, public transport included, .	pavement, asphalt layers, drainage, cleaning or repair of light drainage elements,	heavy investment:4;	0.03	1
	10060	0.97	lokacija 8 Kozetin Nade Milutinovic	503306.18	4812123.11		Dimensions: 15x3x3, once in a few years, rainfall, snow melt, active.			Urban - other, both directions, no public transport, .	drainage, cleaning or repair of light drainage elements, third party utilities, Interruption of	heavy investment:1	0.03	1
Mijajla Kostića	10063	2.97	Kruševica	504805.65	4810299.37		Dimensions: 20x1x3, once in a few years, rainfall, erosion of the base, human activity			Rural - connecting villages, one direction, no public transport, .	pavement, cobbled stone, embankment, damage of	heavy investment:1;	0.03	1
Mijajla Kostića	10063	2.97	Kusevica	504801.84	4810301.46		Dimensions: 20x1x3, once in a few years, rainfall, erosion of			Rural - connecting villages, one direction, no public	pavement, cobbled stone, drainage, repair of culverts,	medium investment:1;	0.03	1
	10071	0.25	lokacija 10 vitkovo pumpa	507682.36	4811633.03					1: Dimensions: 45x45, once in a few years, rainfall, snow melt, external floodwave, no	pavement, asphalt layers, drainage, cleaning or repair of light drainage elements,	heavy investment:1;	0.27	3

### Reporting on links

The most important report is general overview of links, which has been sorted by priority score in descending order, see Figure 9. Each row of the report presents values for a single road link, providing a clear picture of its importance and priority level.

- Column A: road\_name, name of the road according to Open Street Map
- Column B: road\_link, code (number) of the road link according to Open Street Map
- Column C: start\_x, starting point of link coordinate X in UTM 34N
- Column D: start\_y, starting point of link coordinate Y in UTM 34N
- Column E: end\_x, ending point of link coordinate X in UTM 34N
- Column F: end\_y, ending point of link coordinate Y in UTM 34N
- Column G: length\_km, automatically calculated length of the link
- Column H: surface\_course, derived from all surface course for all points on link
- Column I: road\_function, derived from all road function for all points on link
- Column J: hazard\_type, observations number plus all hazard types (landslides, rockfalls, floods, flash floods) derived from all surface course for all points on link
- Column K: affected\_road, derived from infrastructure part from all points on link
- Column L: investment\_category derived from infrastructure part from all points on link
- Column M: priority\_score, calculate from all points on the link
- Column N: priorit\_class, derived from the link priority score
- Column O: Bg. base class, derived from background spatial modeling for actual time period
- Column P: Bg. 2050 class, derived from background spatial modeling predicted for 2050. year
- Column Q: Bg. 2100 class, derived from background spatial modeling predicted for 2100. year



Figure 9 Link data sorted by priority score

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Road Name	Road Link	Start X	Start Y	End X	End Y	Length (m)	Surface Course	Road Function	Hazard type	Affected road	Investment category	Priority score	Priority class	Bg. base class	Bg. 2050 class	Bg. 2100 class
	10348	503794.2	4811888	4811872.3	4811872.3	0.02	asphalt	Urban - other	1, landslide:1	Observations: drainage, cleaning or repair of light drainage elements:1; earthworks, removal of soil:1	light investment:1	1	5	4	5	5
	10286	508678.4	4805010.1	4805122.8	4805122.8	0.14	asphalt	Rural - transit	1, flash flood:2	Observations: drainage, cleaning or repair of light drainage elements:1; earthworks, removal of soil:1; retaining wall, new wall (sections):1	heavy investment:1	0.95	5	2	1	1
	10347	503789.2	4811872.3	4811831.7	4811831.7	0.04	asphalt	Urban - other	2, landslide:2	Observations: drainage, cleaning or repair of light drainage elements:2; earthworks, removal of soil:2; pavement, asphalt layers:1	light investment:2	0.83	5	4	4	4
Rakljanska	10324	503675.2	4811597.7	4811451	4811451	0.27	asphalt, macadam	Public transport, Rural - transit	4, landslide:3; flash flood:1	Observations: earthworks, removal of soil:4; embankment, damage of embankment:1; households, endangered households:2; pavement, all layers:3; pavement, asphalt layers:1	light investment:1; heavy investment:3	0.52	4	2	2	2
Doktora Milana Mirkovića	10100	504310.2	4811593.6	4811280	4811280	0.32	asphalt	Rural - transit, Urban - other	2, flood:1; flash flood:1	Observations: bridge, light surface repair:1; bridge, structure repair:2; drainage, cleaning or repair of light drainage elements:2; drainage, repair of culverts:1; earthworks, removal of soil:2; households, endangered households:2; pavement, asphalt layers:2; third party utilities, Interruption of existing roadside infrastructure:2	heavy investment:2	0.48	4	2	2	2
	10544	497780	4814929.9	4815054.5	4815054.5	0.52	asphalt	Rural - connecting villages	1, flash flood:2	Observations: earthworks, removal of soil:1; embankment, damage of embankment:1; households, endangered households:1; pavement, all layers:1; pavement, asphalt layers:1	heavy investment:1	0.32	3	1	1	1
	10071	507739.6	4811665.2	4811445.4	4811445.4	0.25	asphalt	Rural - transit	2, flood:2	Observations: earthworks, removal of soil:1; embankment, damage of embankment:1; households, endangered households:2; pavement, all layers:1; pavement, asphalt layers:1	medium investment:1; heavy investment:1	0.27	3	3	3	3
	10518	508312.7	4805284.1	4805122.8	4805122.8	0.69	concrete	Rural - connecting	2, landslide:2	Observations: bridge, new bridge:2	heavy investment:2	0.22	3	2	2	2
	10606	504567.7	4813585.3	4813735.8	4813735.8	0.19	asphalt	Public transport	1, rockfall:1	Observations: earthworks, removal of soil:1; pavement, asphalt layers:1; scaling, rock scaling:1	light investment:1	0.14	2	2	4	4
Vukašina Toskića	10321	504282.1	4811476.7	4811211.5	4811211.5	0.8	asphalt	Urban - other	2, landslide:3	Observations: drainage, cleaning or repair of light drainage elements:2; earthworks, removal of soil:2; embankment, damage of embankment:2; pavement, all layers:2; pavement, asphalt layers:2	heavy investment:2	0.13	2	2	2	2

### Detailed reporting on observed geolocations

Very detailed reporting for the observed location is aimed to make an overview of all data recorded in database related to scoring and prioritization, see Figure 10.

- Column A: location identification
- Column B: the observation number will be a sequence number within one location, the last observation is the current (active), while remaining are the archive that does not affect scoring (prioritization)
- Column C: the numbers will be an ordinal number within one observation, having in mind that one observation can have more than one landslide (landslide 1, landslide 2, ...)
- Column D: name of the parameter and measurements unit if applicable
- Column E: value of the parameter
- Column F: point parameters according to the matrix from the methodology
- Column G: total points for one hazard (landslide, rockfall, ...)
- Column H: total points for one type of hazard (for all landslides, all landslides, ...) in these examples there is one each, so it's the same
- Column I: normalized value according to formulas

Additional columns might be introduced if user specification from the field requires. The report can be obtained for the whole LSG, or per selected point. Sorting for the whole LSG can be by the prioritization of the point.

User can also easily use filtering in all reports to put a threshold for preview.

**Figure 10 Observation point scoring overview**

A	B	C	D	E	F	G	H	I
coloca	observa	Type	Parameter	Value	Sorel	ScoreH	ScoreO	Normal
1	1	landslide 1	Length (m)	50	3	32	32	0.54
			Width (m)	100	4			
			Depth (m)	0	1			
			Visible scarp	TRUE	5			
			Main scarp height (m)	0	1			
			Area (m <sup>2</sup> )	5000	3			
			Volume (m <sup>3</sup> )	10000	3			
			Frequency	once in a few years	1			
			Landslide trigger	rainfall, earthquake	5			
			Activity	active	5			
			Approximate remediation date (year or exact date if applicable)	dat.: 2022-03-04	0.5			
		Approximate remediation cost (x 1000 EUR)	100	0.5				
		rockfall 1	Runout distance (m)	30	1	18	18	0.48
			Release height (m)	10	3			
			Block volume (m <sup>3</sup> )	1	3			
			Frequency	once in a year	3			
			Rockfall trigger	rainfall	4			
			Activity	dormant/historic	3			
			Approximate remediation date (year or exact date if applicable)	dat.: 2022-03-04	0.5			
		Approximate remediation cost (x 1000 EUR)	100	0.5				
		flood 1	Floodway width (m)	30	3	20	20	0.44
			Flood fringe width (m)	20	1			
			Level above normal (m)	2	3			
			Level above/below the road (m)	-0.5	3			
			Frequency	once in a few years	1			
			Flood cause	snow melt	4			
		Protection status	no flood protection installed	5				
		flash_flood 1	Width (m)	30	1	16	16	0.36
			Runout distance (m)	20	5			
			Level above ground (m)	2	3			
			Level above/below the road (m)	-0.5	2			
			Frequency	once in a few years	1			
		Flashflood cause	upstream barrier breach	1				
Protection status	damaged protection	3						
traffic	Road function	Urban (other)	1	12	12	0.39		
	Traffic interruption	one direction	4					
	Traffic flow	public transport included	5					
	Alternative routes	TRUE	1					
Infrastructure	Estimated detour length (km)	0.9	1	7	7	0.58		
	light investment	pavement, asphalt layers	2					
	heavy investment	retaining wall, new wall (sections)	5					

To analyze the data from the application, the reports need to be red in the following order:

- Report on links** – use priority order of road links and acknowledge information from columns:
  - B - road link number
  - H - surface course type
  - I - road function
  - J - hazard type where number of observations for the link is indicated as well as list of all hazards identified
  - K –summarized description of affected road for all observations
  - L – investment category where number of identified light, medium and heavy investments is recorded
- Report on geolocation (point) observations** – filter road link number in column B to list all observations recorded to each road link and get more information from columns:
  - E/F – x/y coordinate of each observation (hazard) location
  - G – landslide (dimension, frequency, cause of occurrence, status)
  - H – rockfall (dimension, frequency, cause of occurrence, status)
  - I – flood (dimension, frequency, cause of occurrence, status)
  - J – flash flood (dimension, frequency, cause of occurrence, status)
  - K – summary of traffic related issues
  - L – summary of affected road infrastructure
- Detailed report on observed geolocations** – filter observation by coordinate x or y (taken from above report on observations) to see all detail inputs for each observation.

### 3.2 Data assessment

As previously mentioned, the application utilizes data entered and applies predefined criteria and mathematical operations in the background to prioritize links. The output result is a list of links sorted in order of priority, from highest to lowest. This prioritization process ensures that the most critical links are identified and given the highest priority in the investment plan. By systematically organizing the links based

on their importance, decision-makers can effectively allocate resources and implement targeted measures to enhance the local road network's resilience to climate change hazards.

Furthermore, within the application, each link has already been assigned investment category related to light, medium, or heavy investments, generally following the rule:

- **Light investment** - involving repairs of non-structural elements of bridges, cleaning and repair of drainage elements, cleaning of the road and drainage elements from deposited earth material, repair/replacement of wearing course layer, rock scaling and alike.
- **Medium investment** - involving repairs/reconstruction of culverts, retaining walls, structural bridge elements and alike.
- **Heavy investment** - involving construction of a new bridge, retaining wall, repair of embankment and landslides, construction of new pavement layers, slope stabilization, repair of interrupted third-party utilities and alike.

Based on previous experience in the road sector and analysis of existing budget investments in the local road network, as well as the experience from the floods in 2014, each investment will be assigned a specific budget framework, as follows:

**Table 5 Investment framework**

Investment type	Investment framework
Light	< 10,000 euro
Medium	10,000 - 100,000 euro
Heavy	> 100,000 euro

Additionally, through the analysis of descriptive data from the application, such as road characteristics, number and type of identified hazards, characteristics and frequency of each individual hazard, impact of hazards on road functionality (traffic and road elements), alternative routes in case of traffic disruption, priority assessment, and type of investment, an investment type is assigned to each road link:

- **Routine Maintenance** (solely involves light investments)
- **Periodic Maintenance** (may involve some of the proposed light, medium, or heavy investments)
- **Capital Investment** (solely involves heavy investments).

Finally, after assigning the investment type and defining the necessary procedural steps, the implementation timeframe is estimated. According to the following criteria, each road link (location) is assigned a timeframe (short-term, medium-term, long-term):

- **Short-term:** Refers to investments that can be implemented within a relatively short period, typically within a year or less. These may include immediate repairs, minor maintenance tasks, or addressing hazards that pose an immediate risk to safety or functionality.
- **Medium-term:** Refers to investments that require a moderate timeframe for planning and implementation, typically ranging from one to three years. These may include more extensive repairs, periodic maintenance activities, or even some capital investments addressing hazards that have a moderate impact on road functionality.
- **Long-term:** Refers to investments that involve comprehensive planning and implementation over a longer period, typically spanning more than three years. These may include major reconstruction projects, capital investments, or addressing hazards that require substantial resources and time for resolution.

It's important to note that the specific timeframe assigned to each road link may vary based on the nature and complexity of the project, available resources, and prioritization criteria established by relevant authorities.

### 3.3 Development of an Investment Planning Option

After conducting previous analysis of the output data from the application and taking into account expert knowledge and experience in the road sector, the next step is to proceed with completing the preparation of an investment planning option.

An investment planning option is structured as a comprehensive table, arranged to prioritize short-term, medium-term, and long-term investments. It includes the following columns, where the corresponding information needs to be entered:

#### No.

Enter number in ascending order, starting from number 1.

#### Priority No.

Enter priority class number from **Report on links** (see Figure 9), column O.

First, short-term investments are entered in descending order of priority class. Similarly, sections for identified medium-term and long-term investments are then filled out in the same manner, following a descending order of priority.

#### Project name/ Investment field

Assign a project name to cover briefly type of investment, road code/name, location, length/area.

*Example: Regular maintenance of 2 landslides in Nade Milutinovic Street, Kozetin*

#### Type of investment

Enter all identified procedural steps that include planning, design, execution of works, procurement, and similar processes.

*Example: Procurement for works/ Maintenance works*

#### Rationale for proposed investment

Provide brief explanation of the need for proposed investment.

*Example: Due to the active landslides once in a few years road section becomes dangerous, and road capacity physically reduced.*

*Regular monitoring and maintenance should be implemented to prevent soil material on road surface. In addition, cleaning and repair of drainage elements and resurfacing of asphalt wearing course should be included.*

#### Length of the section (chainage from-to or km)/ Area (m<sup>2</sup>)

Provide information on chainages from -to or the total length in km. If it covers more road sections, all should be described. Quantification of area covered is needed if length cannot be presented.

First read road link number from **Report on links**, column B. Then, go to **Report on geolocation (point) observations** (see Figure 8), and filter all observations recorded for that road link number.

When you are there enter road link length from column C. From the same report enter area or dimensions for each recorded hazard (columns G – J) and start/end location coordinates from columns E and F.

*Example: Landslide No.1: 5x2x2m; Landslide No.2: 10x2x2m; road link length: 0.04m; coord X1: 503819.11; coord Y1: 4811831.37; coord X2: 503779.92; coord Y2: 4811838.79*

#### Project cost (EUR)

If an approximate cost value has already been entered in the application, place it within the investment framework and enter it into the table. If not, enter nominated investment framework after previously conducted analysis, as explained in the previous section.

Each observation is assigned an investment framework. By aggregating observations on a specific road link, the investment framework for that link is obtained.

*Example: < 20,000*

### Rate of return (%)

Expected rate of return needs to be entered by the LSGs employees later based on the available data.

### Maturity of project documentation

Insert all relevant answers, which will show current level of the design documentation readiness.

- A. Project documentation not needed
- B. Spatial planning:
  - B.1 Completed
  - B.2 Needed
  - B.3 Not needed
- C. Design documentation:
  - C.1 Completed
  - C.2 Needed
  - C.3 Not needed
- D. Environmental permit:
  - D.1 Issued
  - D.2 Needed
  - D.3 Not needed
- E. Construction permit:
  - E.1 Issued
  - E.2 Needed
  - E.3 Not needed

*Example: some light investments/repairs could be A, B3, C3, E3*

### Responsible agency

Responsible agency should be set for all needed activities.

(e.g. Spatial planning, Design, Supply, Implementation).

### Funding agency

If secured, insert name of the agency (all involved agencies to be mentioned)

(e.g. for service, supply, works, etc)

If there are more funding sources for one project, please list them all and share of their contribution.

(e.g. State budget 15,6%, World Bank 84,4%)

If not secured, please state that funding is not secured yet.

### Year of implementation

Planned year for implementation of the type of investment (if there are more types of investment, the year should be stated for all). Phase construction to be mentioned if needed.

Also, when considering year of implementation, procurement procedures need to be considered based on the funding agency procurement procedures, which can require more time than needed as per local procedures.

### Monitoring indicators

Key performance indicator (KPI) defined for monitoring of implementation.

(e.g. length of improved sections in km, CO2 reduction saved, marginal savings (travel time, vehicle operation costs, maintenance costs), etc.)

### 3.4 Investment Plan Options for pilot LSGs

Based on observations (locations) entered in the application for pilot LSGs of Kraljevo and Aleksandrovac, draft investment planning options have been prepared and are presented in detail Appendix A (Table 6 and Figure 14). Prioritized links (1-15) traffic features for Kraljevo (Bogutovac area zoomed-in in the inset); Links are ranked by priority indicated in the first number, followed by YES or NO for presence of alternative route, and public transport, respectively



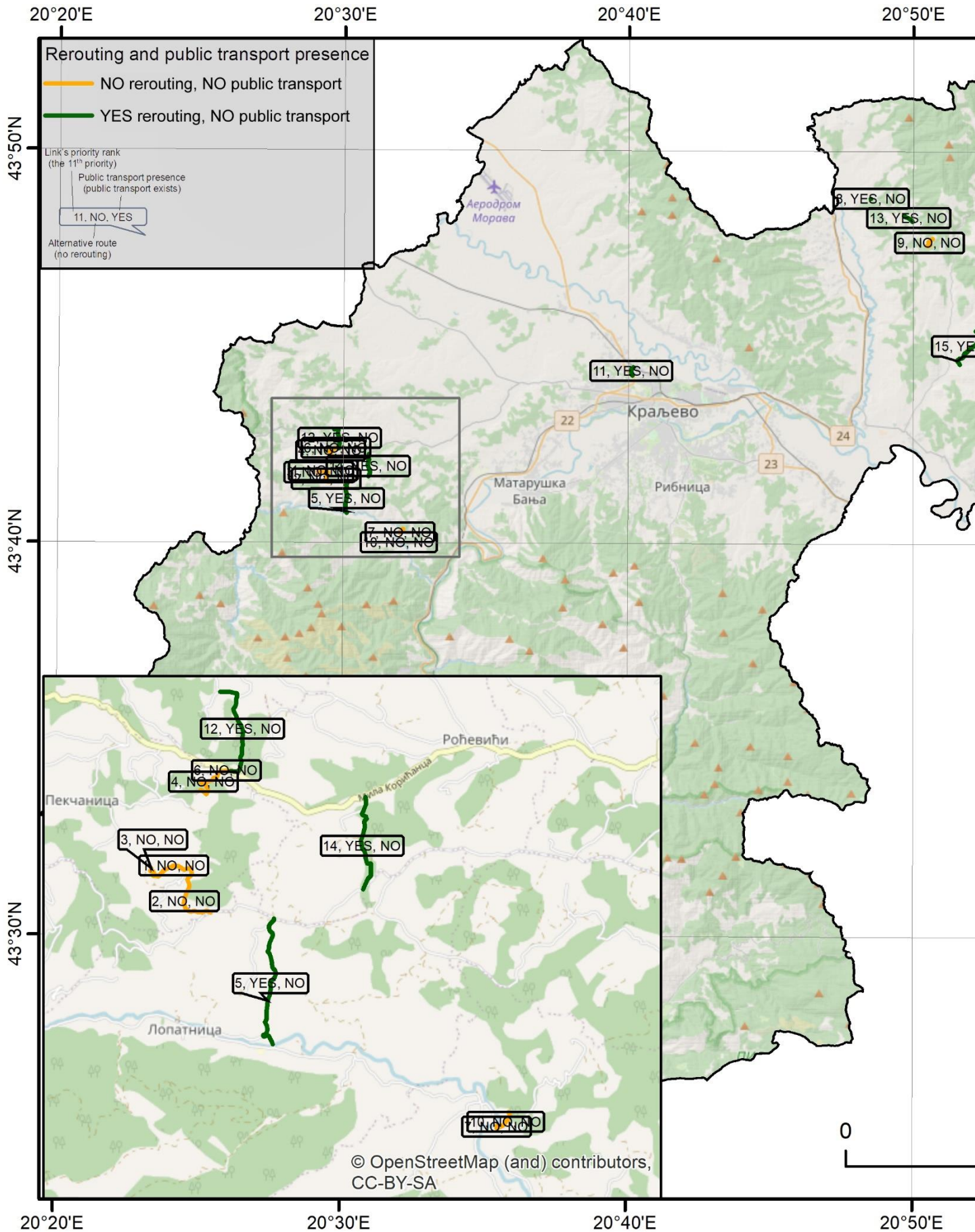


Table 7). Furthermore, Appendix A provides graphical presentation of background data used for elaboration process of investment planning options.

Summary of the two investment planning options is as follows:

<b>Pilot LSG</b>	<b>Kraljevo</b>	<b>Aleksandrovac</b>
<b>Item</b>	<b>Value</b>	
<b>Number of observations</b>	22	49
<b>Number of road links</b>	16	24
<b>Investment framework (EUR)</b>	<b>&gt; 1,870,000</b>	<b>&gt; 4,100,000</b>
Short-term (EUR)	< 50,000	< 40,000
Medium-term (EUR)	> 1,820,000	> 4,060,000
Long-term (EUR)	n.a.	n.a.

To conclude, investment option measures aimed at hazard mitigation offer several key benefits to local communities:

- **Improved Traffic:** These investments lead to smoother traffic flow by fortifying vulnerable infrastructure, ensuring uninterrupted access to services during crises.
- **Enhanced Connectivity:** Hazard-focused investments strengthen connections within communities, facilitating access to vital services and emergency routes.
- **Reduced Criticality Risks:** By minimizing vulnerabilities, these measures decrease the likelihood and impact of critical events, saving lives and reducing economic losses.
- **Sustainability and Resilience:** They align with sustainability goals, contributing to long-term resilience and stable growth.
- **Public Confidence:** Proactive hazard mitigation builds public trust and support, fostering a united front for community resilience.



# Appendix A

## Investment planning options for pilot LSGs

Table 6 Investment planning options, Kraljevo

No.	Priority No.	Project Name/ Investment filed	Type of investment	Rational for proposed investment	Length of the section (chainage from-to or km)/ Area (m2)	Project cost (EUR) (or local currency)	Rate of return (%) (to be included by LSG staff)	Maturity of project documentation A. Project documentation not needed B. Spatial planning: B.1 Completed B.2 Needed B.3 Not needed C. Design documentation: C.1 Completed C.2 Needed C.3 Not needed D. Environmental permit: D.1 Issued D.2 Needed D.3 Not needed E. Construction permit: E.1 Issued E.2 Needed E.3 Not needed	Responsible agency for implementation	Funding agency (apart from municipal budget add other agencies if funding secured)	Year of implementation (implementation period indicated, to be updated as per actual start of implementation of the actual adopted Investment Plan)	Monitoring indicator (to be specified by the LSG staff to serve their needs and capacities)
<b>SHORT TERM (&lt; 1 year)</b>												
1	1	Regular maintenance of landslide in Jajinci, Pekcanica 100	Maintenance works	Due to activation of landslide once in a few years, and rainfall road section becomes dangerous, vehicles speeds significantly reduced, and road closure could be affected. No alternative route. Currently this landslide is suspended/remediated. Regular monitoring and maintenance should be implemented to prevent damage of road embankment.	Landslide: 3x100x20m road link length: 0.42km coord X: 458649.15 coord Y: 4838332.76	< 10,000		A C3 E3	Public Utility Company "Putevi" Kraljevo	PE for Land Development, Kraljevo	within 1 year	
2	1	Regular maintenance of landslide in Jajinci, Pekcanica 100	Maintenance works	Due to activation of landslide once in a few years, and rainfall road section becomes dangerous, and road capacity physically reduced. No alternative route. Currently this landslide is suspended/remediated. Regular monitoring and maintenance should be implemented to prevent damage of road embankment and interruption of roadside.	Landslide: 500x300x80m road link length: 0.79km coord X: 458914.1 coord Y: 4837925.21	< 10,000		A C3 E3	Public Utility Company "Putevi" Kraljevo	PE for Land Development, Kraljevo	within 1 year	
3	1	Regular maintenance of road section slope in Pekcanica	Maintenance works	Due to rockfalls once in a few years, and rainfall road section becomes dangerous, vehicles speeds significantly reduced, and road closure could be affected. No alternative route.	Rockfall: 30x5m road link length: 0.18km coord X: 458537.14 coord Y: 4838314.67	< 10,000		A C3 E3	Public Utility Company "Putevi" Kraljevo	PE for Land Development, Kraljevo	within 1 year	

				Regular monitoring and maintenance should be implemented to prevent damages of embankment.								
4	1	Regular maintenance of landslide at Jasenova road section towards Stanci in Rocevici	Maintenance works	Due to activation of landslide once in a few years, and rainfall, snow melt, road section becomes dangerous, and road capacity physically reduced. No alternative route. Currently this landslide is dormant. Regular monitoring and maintenance should be implemented to prevent damages of embankment and to secure nearby households.	Landslide: 100x50x2m road link length: 0.57km coord X: 459134.29 coord Y: 4839213.67	< 10,000		A C3 E3	Public Utility Company "Putevi" Kraljevo	PE for Land Development, Kraljevo	within 1 year	
5	1	Regular maintenance of road section at Jovacka road	Maintenance works	Due to active rockfall once in a year, and human activity (undercutting, overloading...), road section becomes dangerous, vehicles speeds significantly reduced, and road capacity physically reduced. Regular monitoring and maintenance should be implemented to prevent earth material on the road surface.	Rackfall: 8x10m road link length: 1.62km coord X: 459822.04 coord Y: 4836738.51	< 10,000		A C3 E3	Public Utility Company "Putevi" Kraljevo	PE for Land Development, Kraljevo	within 1 year	
<b>MEDIUM TERM (1 - 3 years)</b>												
6	5	Capital investment for road reconstruction in Rocevici, road to village Stanca	Procurement for design and works/ Design/ Construction works	Due to floods once a year and rainfall, snow melt, no flood protection installed road section becomes dangerous and road capacity physically reduced. Alternative route is 12 km long. Main works to be implemented: Construction of a new retaining wall, bridge structure repair and embankment repair.	Floods: 5x50m road link length: 0.08km coord X: 459388.39 coord Y: 4839469.22	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	
7	5	Capital investment for road reconstruction in Bogutovac, ethnic village Bogut	Procurement for design and works/ Design/ Construction works	Due to floods once a year and rainfall, no flood protection installed road section becomes dangerous and road capacity physically reduced as well as nearby households endangered. No alternative route. Main works to be implemented: Construction of a new bridge and new pavement layers.	Floods: 20x50m road link length: 0.03km coord X: 462371.12 coord Y: 4835478.1	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	
8	4	Capital investment for road reconstruction in Drlupa, road for village Godacica	Procurement for design and works/ Design/ Construction works	Even with protection measures installed due to floods once a year road section becomes dangerous and road capacity physically reduced. Main works to be implemented: Construction of a new retaining wall and new pavement layers, repair of embankment and removal of soil material from road surface.	Floods: 5x2m road link length: 0.01km coord X: 484639.5 coord Y: 4851195.01	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	

9	3	Capital investment for remediation of 6 landslides in Studenica, Cara Lazara Street	Procurement for design and works/ Design/ Construction works	Due to the active landslides more than once a year, and rainfall, earthquake, erosion of the base road section becomes dangerous and road capacity physically reduced. Public transport route is affected. Alternative route is 35 km long. Main works to be implemented: Construction of new retaining walls and repair of existing walls, light repair of non-structural bridge elements, repair of interrupted roadside infrastructure, resurfacing of asphalt wearing course and removal of soil material from road surface.	Landslide No.1: 100x45x3m Landslide No.2: 100x45x3m Landslide No.3: 100x45x3m Landslide No.4: 50x30x5m Landslide No.5: 100x45x3m Landslide No.6: 30x10x10m road link length: 0.94m coord X1: 475009.37 coord Y1: 4841212.25 coord X2: 475000.75 coord Y2: 4841218.2 coord X3: 474995.83 coord Y3: 4841214.58 coord X4: 474996.05 coord Y4: 4841216.99 coord X5: 475003.18 coord Y5: 4841218.75 coord X6: 474999.12 coord Y6: 4841219.32	> 600,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	
10	2	Capital investment for remediation of 2 landslides at Zdravke i Danila road, Godacica-Drlupa road	Procurement for design and works/ Design/ Construction works	Due to the active landslides once in a few years, and rainfall, road section becomes dangerous and road capacity physically reduced. When landslide 1 is active road capacity is physically reduced No alternative route. Main works to be implemented: Construction of new pavement layers and removal of soil material from road surface.	Landslide No.1: 50x20x10m Landslide No.2: 100x20x10m road link length: 0.63km coord X1: 487218.02 coord Y1: 4848990.91 coord X2: 487259.89 coord Y2: 4848969.6	> 110,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	
11	2	Capital investment for road reconstruction in Bogutovac, ethnic village Bogut, Kano Buče road	Procurement for design and works/ Design/ Construction works	Due to floods once in a few years and rainfall, no flood protection installed road section becomes dangerous and road capacity physically reduced as well as nearby households endangered. No alternative route. Main works to be implemented: Construction of a new bridge and new pavement layers.	Floods: 20x50m road link length: 0.25km coord X: 462371.12 coord Y: 4835478.1	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	
12	1	Periodic maintenance for road section in	Procurement for works/ Maintenance works	Due to floods more than once in a year and rainfall, snow melt, no flood protection installed road section becomes dangerous and road	Floods No.1: 20x50m Floods No.2: 20x50m Floods No.3: 20x50m road link length: 0.48km	> 210,000		C.2 (traffic regulation design, technical description of works,	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 0 - 1.5)	

		Grdica, Živojina Lazića road		capacity physically reduced. No alternative route. Main works to be implemented: Repair of culverts and third-party utilities interrupted, cleaning and repair of drainage elements, resurfacing of asphalt wearing course.	coord X1: 473290.69 coord Y1: 4843199.07 coord X2: 473284.69 coord Y2: 4843183.54 coord X3: 473330.98 coord Y3: 4843187.97			BoQ E.2				
13	1	Capital investment for road reconstruction in Simovska Kosa - Rocevici, road to village Stanca	Procurement for design and works/ Design/ Construction works	Due to floods once in a few years and rainfall, snow melt, no flood protection installed, road section becomes dangerous and road capacity physically reduced. Alternative route is 12km long. Main works to be implemented: Construction of a new retaining wall, repair of structural bridge elements and repair of embankment.	Floods: 5x50m road link length: 1.20km coord X: 459388.39 coord Y: 4839469.22	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 1.5-3)	
14	1	Capital investment for remediation of 1 landslide location at Patrijarha Pavla road	Procurement for design and works/ Design/ Construction works	Due to the active landslide once in a few years, and rainfall, road section becomes dangerous, and road capacity physically reduced. No alternative route. Main works to be implemented: Repair of embankment and removal of soil material from road surface.	Landslide: 30x20x3m road link length: 0.50km coord X: 486485.82 coord Y: 4850193.1	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 1.5-3)	
15	1	Capital investment for Mihajla Pupina road reconstruction, Rocevici - Lopatnica section	Procurement for design and works/ Design/ Construction works	Due to floods once in a few years and rainfall, snow melt, no flood protection installed, road section becomes dangerous and road capacity physically reduced. Alternative route is 10km long. Main works to be implemented: Repair of both structural and non-structural bridge elements, construction of new pavement layers.	Floods: 6x30m road link length: 1.16km coord X: 460923.93 coord Y: 4839068.3	> 100,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 1.5-3)	
16	1	Capital investment for remediation of 1 landslide and road reconstruction Ravanica, Mirkovacki potok	Procurement for design and works/ Design/ Construction works	Due to the active landslides and flood event once in a few years, and rainfall, road section becomes dangerous, and road capacity physically reduced. Alternative route is 5km long. Main works to be implemented: Construction of a new bridge, regulation of a stream, construction of new pavement layers and repair of interrupted third-party utilities.	Landslide: 2000x10m Flood No.2: 4x1m road link length: 2.6km coord X1: 489221.81 coord Y1: 4844084.44 coord X2: 489114.86 coord Y2: 4843983.98	> 200,000		C.2 E.2	As per tender results	PE for Land Development, Kraljevo	within 1.5 year (year 1.5-3)	
<b>LONG TERM (&gt; 3 years)</b>												
17	n.a.											
...	...											



Figure 11 OSM map of Kraljevo with local roads highlighted

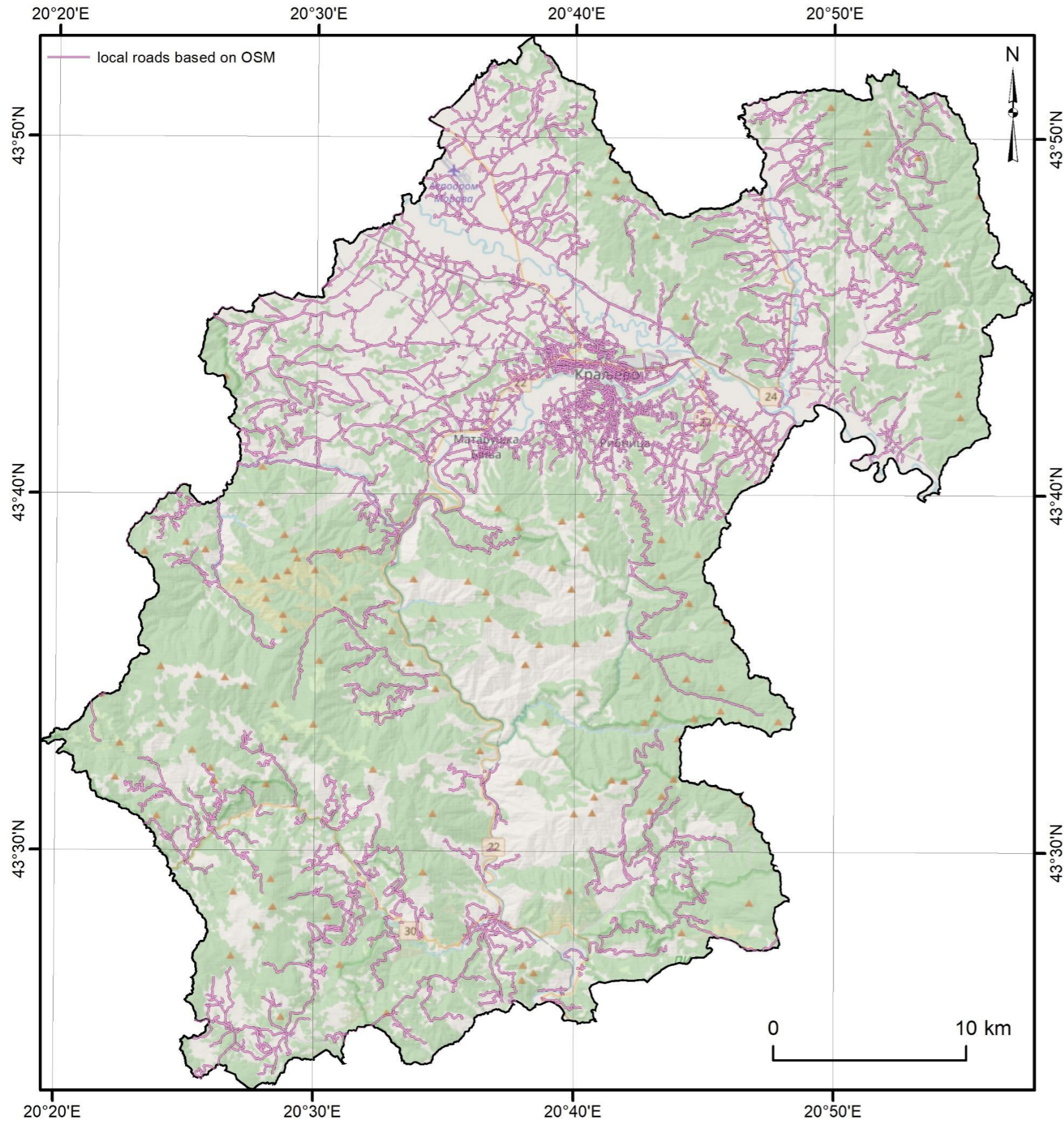




Figure 12 Short- and mid-term priority links 1-15 with indicated investment value in EUR for Kraljevo (Bogutovac area zoomed-in in the inset); ; Links are ranked by priority indicated in the first number, followed by the estimated investment value

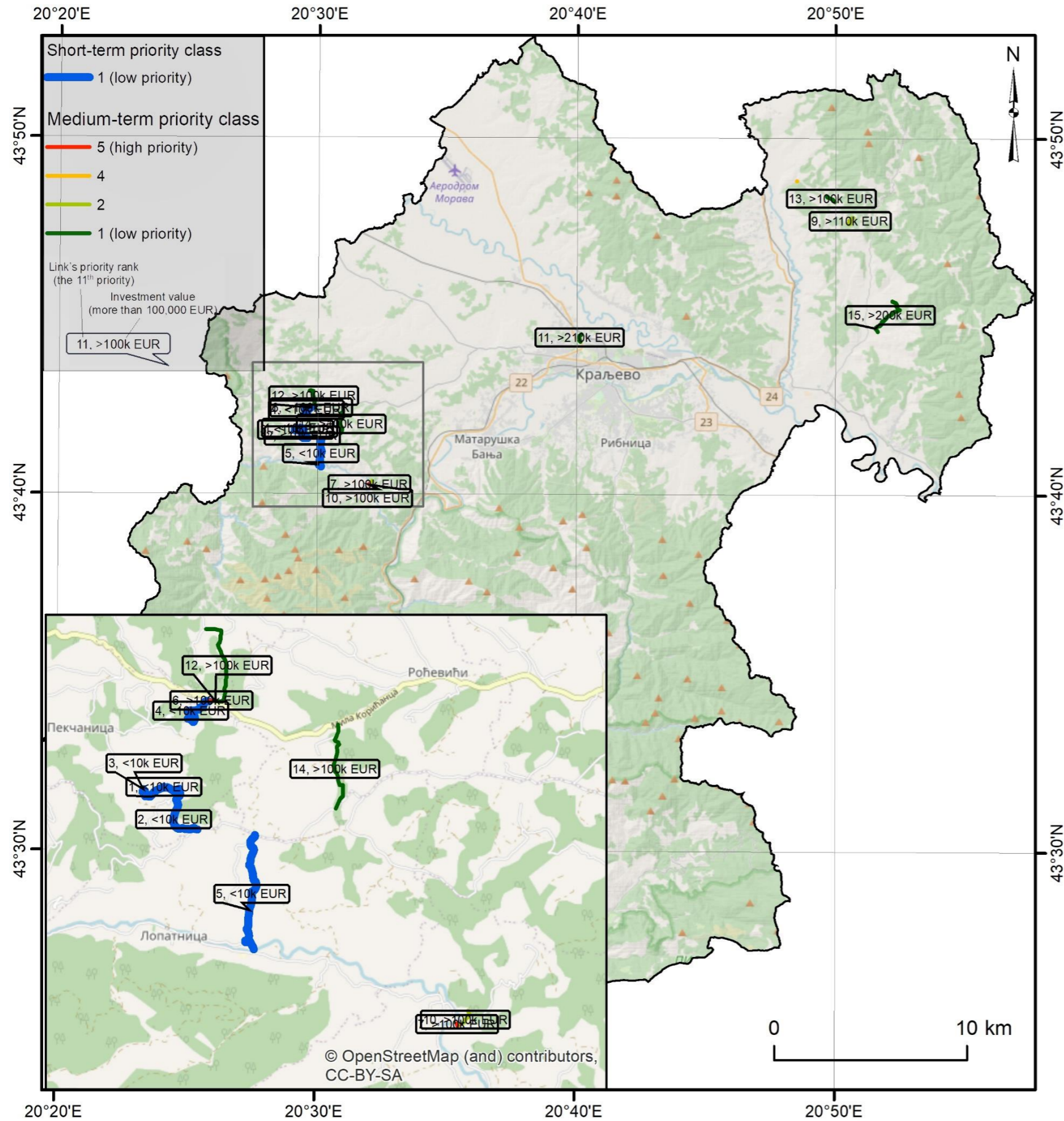




Figure 13 Type of investment for prioritized links 1-15 for Kraljevo (Bogutovac area zoomed-in in the inset); Links are ranked by priority indicated in the first number, followed by the estimated investment value

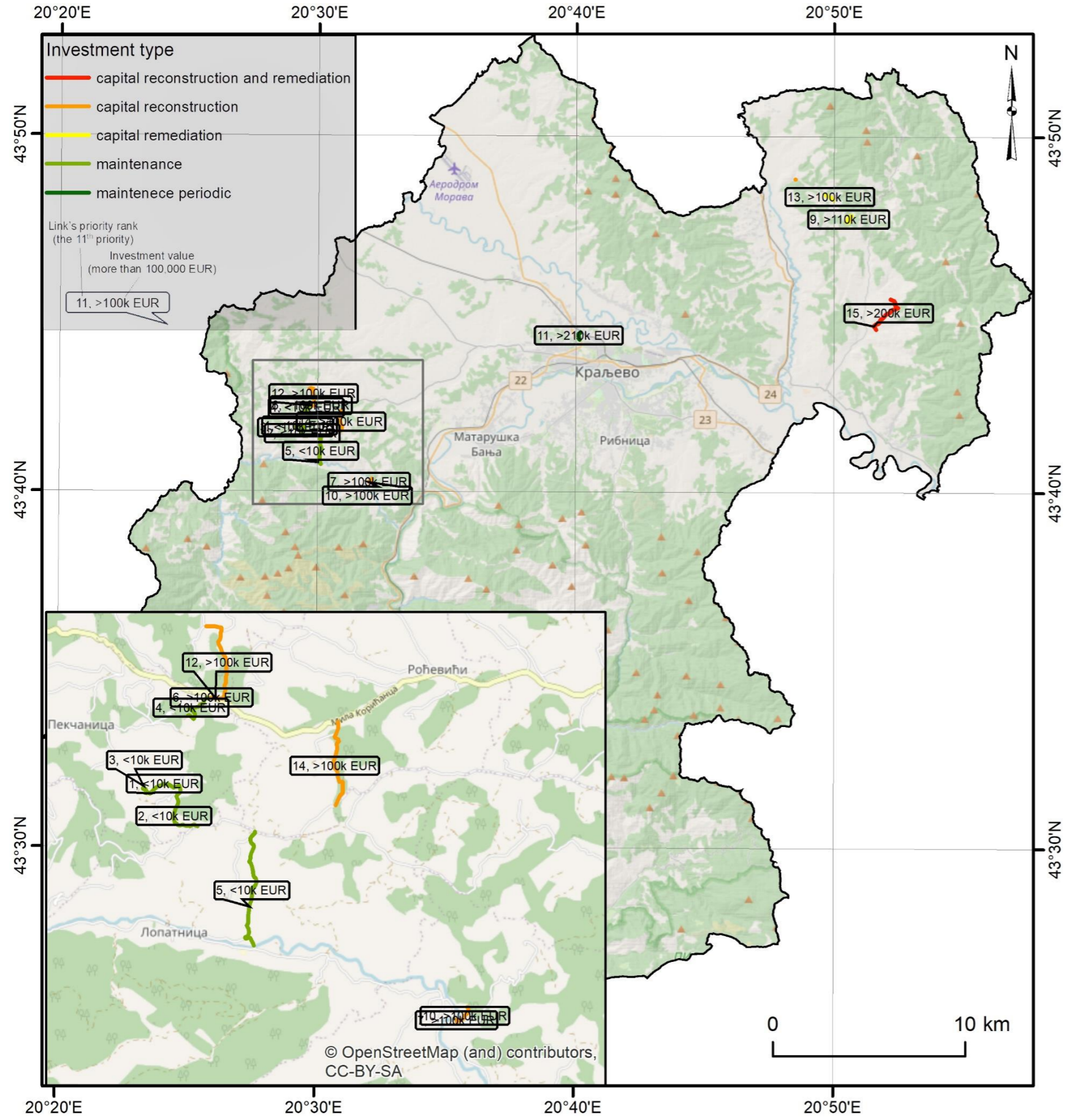




Figure 14 Prioritized links (1-15) traffic features for Kraljevo (Bogutovac area zoomed-in in the inset); Links are ranked by priority indicated in the first number, followed by YES or NO for presence of alternative route, and public transport, respectively

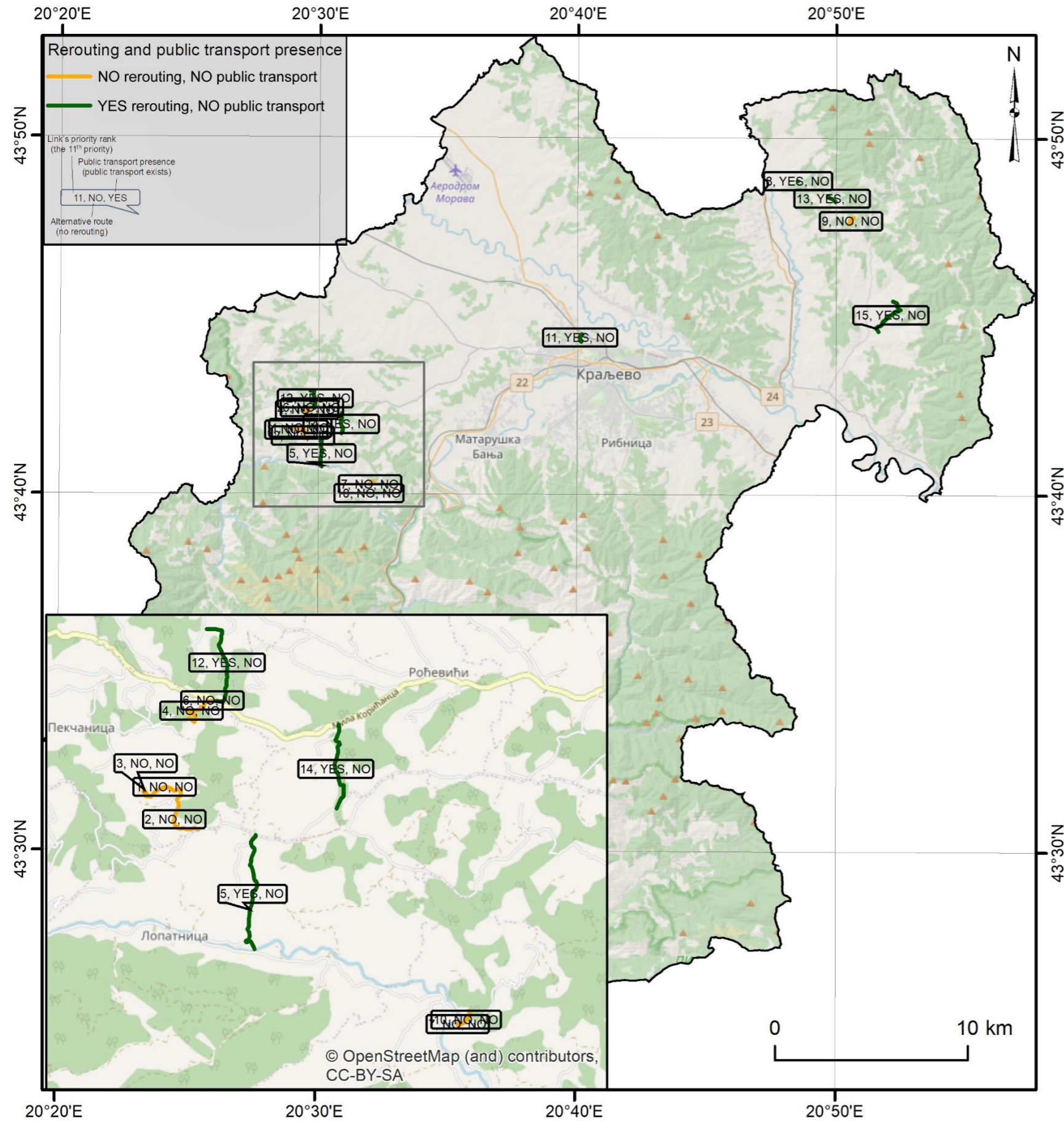


Table 7 Investment planning options, Aleksandrovac

No.	Priority No.	Project Name/ Investment filed	Type of investment	Rational for proposed investment	Length of the section (chainage from-to or km)/ Area (m2)	Project cost (EUR) (or local currency)	Rate of return (%) (to be included by LSG staff)	Maturity of project documentation A. Project documentation not needed B. Spatial planning: B.1 Completed B.2 Needed B.3 Not needed C. Design documentation: C.1 Completed C.2 Needed C.3 Not needed D. Environmental permit: D.1 Issued D.2 Needed D.3 Not needed E. Construction permit: E.1 Issued E.2 Needed E.3 Not needed	Responsible agency for implementation	Funding agency (apart from municipal budget add other agencies if funding secured)	Year of implementation (implementation period indicated, to be updated as per actual start of implementation of the actual adopted Investment Plan)	Monitoring indicator (to be specified by the LSG staff to serve their needs and capacities)
<b>SHORT TERM (&lt; 1 year)</b>												
1	4	Regular maintenance of landslide in Nade Milutinovic Street, Kozetin	Procurement for works/ Maintenance works	Due to the active landslides once in a few years road section becomes dangerous, and vehicle speeds significantly reduced. Regular monitoring and maintenance should be implemented to prevent soil material on road surface. In addition, cleaning and repair of drainage elements should be included.	Landslide: 10x2x2m road link length: 0.02km coord X: 503779.92 coord Y: 4811838.79	< 10,000		A C3 E3	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1 year	
2	3	Regular maintenance of 2 landslides in Nade Milutinovic Street, Kozetin	Procurement for works/ Maintenance works	Due to the active landslides once in a few years road section becomes dangerous, and road capacity physically reduced. Regular monitoring and maintenance should be implemented to prevent soil material on road surface. In addition, cleaning and repair of drainage elements and resurfacing of asphalt wearing course should be included.	Landslide No.1: 5x2x2m Landslide No.2: 10x2x2m road link length: 0.04km coord X1: 503819.11 coord Y1: 4811831.37 coord X2: 503779.92 coord Y2: 4811838.79	< 20,000		A C3 E3	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1 year	
3	1	Regular maintenance of location with rockfalls in Drenca	Procurement for works/ Maintenance works	Due to rockfalls more than once a year public transport is affected, and vehicle speeds significantly reduced. Regular monitoring and maintenance should be implemented to prevent soil material on road surface. In addition, rock scaling and	Rockfall: 5x6m road link length: 0.19km coord X: 504605.17 coord Y: 4813576.14	< 10,000		A C3 E3	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1 year	

				resurfacing of asphalt wearing course should be included.								
<b>MEDIUM TERM (1 - 3 years)</b>												
4	4	Capital investment for road reconstruction	Procurement for design and works/ Design/ Construction works	Due to the flash floods once in a few years road section becomes dangerous, and vehicles speeds significantly reduced.  Main works to be implemented: Construction of a new retaining wall sections and new pavement layers, cleaning and repair of drainage elements and removal of soil material from road surface.	Flashflood: 10x200m road link length: 0.14km coord X: 508654.27 coord Y:4804986.16	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
5	3	Capital investment for remediation of 3 landslide locations in Smolnicka street and 1 flooding location in Skolska Street, Aleksandrovac	Procurement for design and works/ Design/ Construction works	Due to the active landslides once a year, and flash floods more than once a year, road section becomes dangerous, vehicles speeds significantly reduced, it could be affected public transport route, and road closure as well as nearby households endangered.  Main works to be implemented: Construction of new pavement layers, cleaning and repair of drainage elements and removal of soil material from road surface.	Landslide No.1: 130x20x2.5m Landslide No.2: 15x10x4m Landslide No.3: 130x20x2.5m Flashflood No.4: 15x1000m road link length: 0.27km coord X1: 503666.12 coord Y1:4811456.4 coord X2: 503616.18 coord Y2: 4811555.58 coord X3: 503640.76 coord Y3: 4811468.42 coord X4: 503624.83 coord Y4: 4811573.54	> 310,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
6	2	Capital investment for road reconstruction in Aleksandrovac	Procurement for design and works/ Design/ Construction works	Due to the flash floods more than once a year road section becomes dangerous, road capacity physically reduced as well as nearby households endangered.  Main works to be implemented: Construction of new pavement layers, repair of embankment and removal of soil material from road surface.	Flashflood: 5x2000m road link length: 0.52km coord X: 497893.76 coord Y: 4814884.28	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
7	2	Capital investment for road reconstruction in Bolnicka Street, Aleksandrovac	Procurement for design and works/ Design/ Construction works	Due to floods and flash floods more than once a year and flash flood once a year road section becomes closed as well as nearby households endangered. Alternative route is 1km long.  Main works to be implemented: Repair of both structural and non-structural bridge elements, repair of interrupted third-party utilities, cleaning and repair of culverts and other drainage elements, resurfacing of asphalt wearing course and	Flood No.1: 1x5m Flashflood No.2: 20x500m road link length: 0.32km coord X1: 504232.81 coord Y1: 4811296.62 coord X2: 504215.64 coord Y2: 4811291.33	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	



				removal of soil material from road surface.								
8	2	Capital investment for road reconstruction in Vitkovo	Procurement for design and works/ Design/ Construction works	Due to floods more than once a year road section becomes dangerous, vehicles speeds significantly reduced, it could be affected public transport route, and road closure as well as nearby households endangered. No alternative route. Main works to be implemented: Construction of new pavement layers, cleaning and repair of culverts and other drainage elements, removal of soil material from road surface.	Flood No.1: 4.5x4.5m Flood No.2: 4.5x4.5m road link length: 0.25km coord X1: 507709.3 coord Y1: 4811650.09 coord X2: 507682.36 coord Y2: 4811633.03	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
9	2	Capital investment for remediation of 2 landslides in Dobroljupci	Procurement for design and works/ Design/ Construction works	Due to the active landslides more than once a year, road is closed. No alternative route. Main works to be implemented: Construction of a new bridge.	Landslide No.1: 5x2x45m Landslide No.2: 5x2x45m road link length: 0.69km coord X1: 508663.77 coord Y1: 4805366.73 coord X2: 508668.37 coord Y2: 4805358.59	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
10	1	Capital investment for remediation of 2 landslides in Vukasina Toskica	Procurement for design and works/ Design/ Construction works	Due to the active landslides once in a few years s road is closed. Alternative route is 5km long. Main works to be implemented: Construction of new pavement layers, repair of embankment, cleaning and repair of drainage elements and removal of soil material from road surface.	Landslide No.1: 60x6x6m Landslide No.2: 80x6x6m road link length: 0.80m coord X1: 504398.71 coord Y1: 4811440.18 coord X2: 504360.82 coord Y2: 4811434.97	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
11	1	Capital investment for remediation of 1 landslide location at Pleš Ambulanta	Procurement for design and works/ Design/ Construction works	Due to the active landslide once in a few years, and rainfall, erosion of the base, human activity (undercutting, overloading...), road section becomes dangerous, and road capacity physically reduced. No alternative route. Main works to be implemented: Construction of new pavement layers, repair of embankment and removal of soil material from road surface.	Landslide: 10x10x6m road link length: 0.59km coord X: 493325.67 coord Y: 4814544.32	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	
12	1	Capital investment for remediation of 2 landslides and road reconstruction in Dobroljupci	Procurement for design and works/ Design/ Construction works	Due to the active landslides, flood and flash flood events once in a few years, and rainfall, snow melt, erosion of the base, human activity (undercutting, overloading...), road section becomes dangerous, vehicles	Landslide No.1: 14x5x4m Landslide No.2: 14x5x4m Flood No.3: 2x30m Flashflood No.4: 10x200m	> 400,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 0 - 1.5)	

				speeds significantly reduced, and road capacity physically reduced. Main works to be implemented: Construction of a new bridge and new retaining wall sections, construction of new pavement layers, cleaning and repair of culverts and other drainage elements, repair of interrupted third-party utilities and removal of soil material from road surface.	road link length: 2.54km coord X1: 507963.27 coord Y1: 4805091.91 coord X2: 508018.18 coord Y2: 4804974.27 coord X3: 507957.84 coord Y3: 4805101.37 coord X4: 508654.27 coord Y4: 4804986.16						
13	1	Capital investment for road reconstruction in Velika Vrbnica, Gornja Rajševica	Procurement for design and works/ Design/ Construction works	Due to floods more than once a year, and rainfall, external flood wave, no flood protection installed, road section becomes dangerous, vehicles speeds significantly reduced, it could be affected public transport route, and road closure as well as nearby households endangered.  Main works to be implemented: Construction of new pavement layers, repair of embankment, cleaning and repair of culverts and removal of soil material from road surface.	Flood: 5x20m road link length: 0.63km coord X1: 497339.57 coord Y1: 4815387.73	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)
14	1	Capital investment for remediation of 1 landslide and road reconstruction in Dobroljupci	Procurement for design and works/ Design/ Construction works	Due to the active landslides and flood event once in a few years, and rainfall, snow melt, erosion of the base, human activity (undercutting, overloading...), road section becomes dangerous, vehicles speeds significantly reduced, and road capacity physically reduced.  Main works to be implemented: Construction of new bridge, repair of embankment and interrupted third party utilities, cleaning and repair of culverts and removal of soil material from road surface.	Landslide No.1: 14x5x4m Flood No.2: 2x30m road link length: 1.15km coord X1: 507963.27 coord Y1: 4805091.91 coord X2: 507957.84 coord Y2: 4805101.37	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)
15	1	Periodic maintenance of 2 landslide locations in Smonička	Procurement for works/ Maintenance works	Due to the suspended/remediated landslides that occurred once in a year road section becomes dangerous, and road capacity physically reduced. Alternative route is 1km long.  Main works to be implemented: Construction of new pavement layers and removal of soil material from road surface.	Landslide No.1: 130x20x2.5m Landslide No.2: 130x20x2.5m road link length: 1.14km coord X1: 503640.76 coord Y1: 4811468.42 coord X2: 503666.12 coord Y2: 4811456.4	20,000 - 200,000		C.2 (traffic regulation design, technical description of works, BoQ) E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1 year (once in three years as per need) (year 1-2)
16	1	Capital investment for remediation of landslide in Pribojevac	Procurement for design and works/ Design/	Due to the active landslide once in a few years, and rainfall, erosion of the base, road section becomes	Landslide: 90x0.6x1.1m road link length: 1.18km coord X: 503782.62 coord Y: 4810493.23	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for	within 1.5 year (year 1.5-3)

			Construction works	dangerous, and road capacity physically reduced. Main works to be implemented: Construction of new retaining wall sections, construction of new pavement layers, repair of embankment, cleaning and repair of culverts and removal of soil material from road surface.					Urbanism and Construction		
17	1	Capital investment for remediation of 2 landslides at Rogavčina Paklenik	Procurement for design and works/ Design/ Construction works	Due to the active landslides once in a few years, and rainfall, erosion of the base, human activity (undercutting, overloading...), road section becomes dangerous, vehicles speeds significantly reduced and road capacity physically reduced, as well as nearby households endangered.  Main works to be implemented: Construction of new pavement layers, repair of embankment, cleaning and repair of culverts and removal of soil material from road surface.	Landslide No.1: 38x10x5m Landslide No.2: 60x3x2m road link length: 2.75km coord X1: 489489.8 coord Y1: 4817019.83 coord X2: 489152.27 coord Y2: 4817248.22	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)
18	1	Capital investment for road reconstruction in Gornji Vratari and Velika Vrbnica	Procurement for design and works/ Design/ Construction works	Due to floods more than once a year and flash flood more than once in a year, rainfall, external flood wave, no flood protection installed, road section becomes dangerous, vehicles speeds significantly reduced, it could be affected public transport route, and road closure, as well as nearby households endangered.  Main works to be implemented: Construction of new pavement layers, repair of embankment, cleaning and repair of culverts and other drainage elements, repair of interrupted third-party utilities and removal of soil material from road surface.	Folod No.1: 5x10m Folod No.2: 15x7m Folod No.3: 5x20m Folod No.4: 4x30m Flashflood No.5:10x1000m road link length:10.50km coord X1: 497203.03 coord Y1: 4815628.04 coord X2: 498985.56 coord Y2: 4812913.85 coord X3: 497339.57 coord Y3: 4815387.73 coord X4: 497384.91 coord Y4: 4815188.18 coord X5: 500291.14 coord Y5: 4810999.15	> 500,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 2 year (year 1-3)
19	1	Capital investment for remediation of 1 landslide and road reconstruction in Dobroljupci	Procurement for design and works/ Design/ Construction works	Due to the active landslide once in a few years, and rainfall, snow melt, erosion of the base, human activity (undercutting, overloading...), road section becomes dangerous, it could be affected public transport route and road closure. Alternative route is 20km long.  Main works to be implemented: Construction of a new bridge, repair of interrupted third-party utilities	Landslide: 14x5x4m road link length: 1.48km coord X1: 508018.18 coord Y1: 4804974.27	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)

				and resurfacing of asphalt wearing course.							
20	1	Capital investment for remediation of 2 landslides in Kruševica	Procurement for design and works/ Design/ Construction works	Due to the active landslides once in a few years, and rainfall, erosion of the base, human activity (undercutting, overloading...), road section becomes dangerous, vehicles speeds significantly reduced, and road capacity physically reduced. Main works to be implemented: Repair of embankment, cleaning and repair of culverts and removal of soil material from road surface.	Landslide No.1: 20x1x3m Landslide No.2: 20x1x3m road link length: 2.97km coord X1: 504805.65 coord Y1: 4810299.37 coord X2: 504801.84 coord Y2: 4810301.46	> 200,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)
21	1	Capital investment for remediation of 1 landslide in Nade Milutinovic Street, Kozetin	Procurement for design and works/ Design/ Construction works	Due to the active landslide once in a few years, and rainfall, snow melt, road section becomes dangerous, and road capacity physically reduced. Alternative route is 3km long. Main works to be implemented: Repair of interrupted third-party utilities, cleaning and repair of drainage elements and removal of soil material from road surface.	Landslide: 15x3x3m road link length: 0.97km coord X: 503306.18 coord Y: 4812123.11	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)
22	1	Capital investment for remediation of 2 landslide and road reconstruction Krupaja, Velika Vrbnica	Procurement for design and works/ Design/ Construction works	Due to the active landslides and flood events once in a few years, and rainfall, erosion of the base, external flood wave, no flood protection installed, road section becomes dangerous, vehicles speeds significantly reduced and road capacity physically reduced, as well as nearby households. Main works to be implemented: Construction of new pavement layers, repair of embankment, cleaning and repair of culverts and other drainage elements, repair of interrupted third-party utilities and removal of soil material from road surface.	Landslide No.1:15x2x1m Landslide No.2: 10x2x1m Folod No.3: 10x40m Folod No.4: 4x10m Flood No.5: 5x20m road link length: 5.65km coord X1: 496643.72 coord Y1: 4814364.95 coord X2: 497693.19 coord Y2: 4813363.26 coord X3: 496123.95 coord Y3: 4814760.85 coord X4: 496492.66 coord Y4: 4814468.28 coord X5: 497692.63 coord Y5: 4813362.47	> 410,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)
23	1	Capital investment for remediation of 1 landslide in Velja glava, Filipivići	Procurement for design and works/ Design/ Construction works	Due to the active landslide more than once a year, and rainfall, erosion of the base road section becomes dangerous, vehicles speeds significantly reduced, and road closure could be affected. Alternative route is 4 km long. Main works to be implemented: Construction of new pavement layers, cleaning and repair of drainage elements and removal of soil material from road surface.	Landslide: 11x3x2m road link length: 0.67km coord X: 502831.97 coord Y: 4815017.66	> 100,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)

24	1	Capital investment for remediation of 1 landslide and 4 rockfall locations in Velja glava, Drenca	Procurement for design and works/ Design/ Construction works	Due to the active landslide once in a few years and four rockfall locations more than once in a year road section becomes dangerous, vehicles speeds significantly reduced, and road closure could be affected. Alternative route is 4 km long. Main works to be implemented: Rock scaling and stabilisation of slopes from rockfall, resurfacing of asphalt wearing course, cleaning and repair of drainage elements and removal of soil material from road surface.	Landslide No.1: 5x2x2m Rockfall No.2: 10x2x2m Rockfall No.3: 10x2x2m Rockfall No.4: 10x2x2m Rockfall No.5: 10x2x2m road link length: 5.28km coord X1: 502831.97 coord Y1: 4815017.66 coord X2: 504605.17 coord Y2: 4813576.14 coord X3: 503194.18 coord Y3: 4814600.57 coord X4: 503230.69 coord Y4: 4814631.68 coord X5: 504657.44 coord Y5: 4813616.71	> 140,000		C.2 E.2	As per tender results	Municipality administration, Department for Urbanism and Construction	within 1.5 year (year 1.5-3)	
<b>LONG TERM (&gt; 3 years)</b>												
25	n.a.											
...	...											



Figure 15 OSM map of Aleksandrovac with local roads highlighted

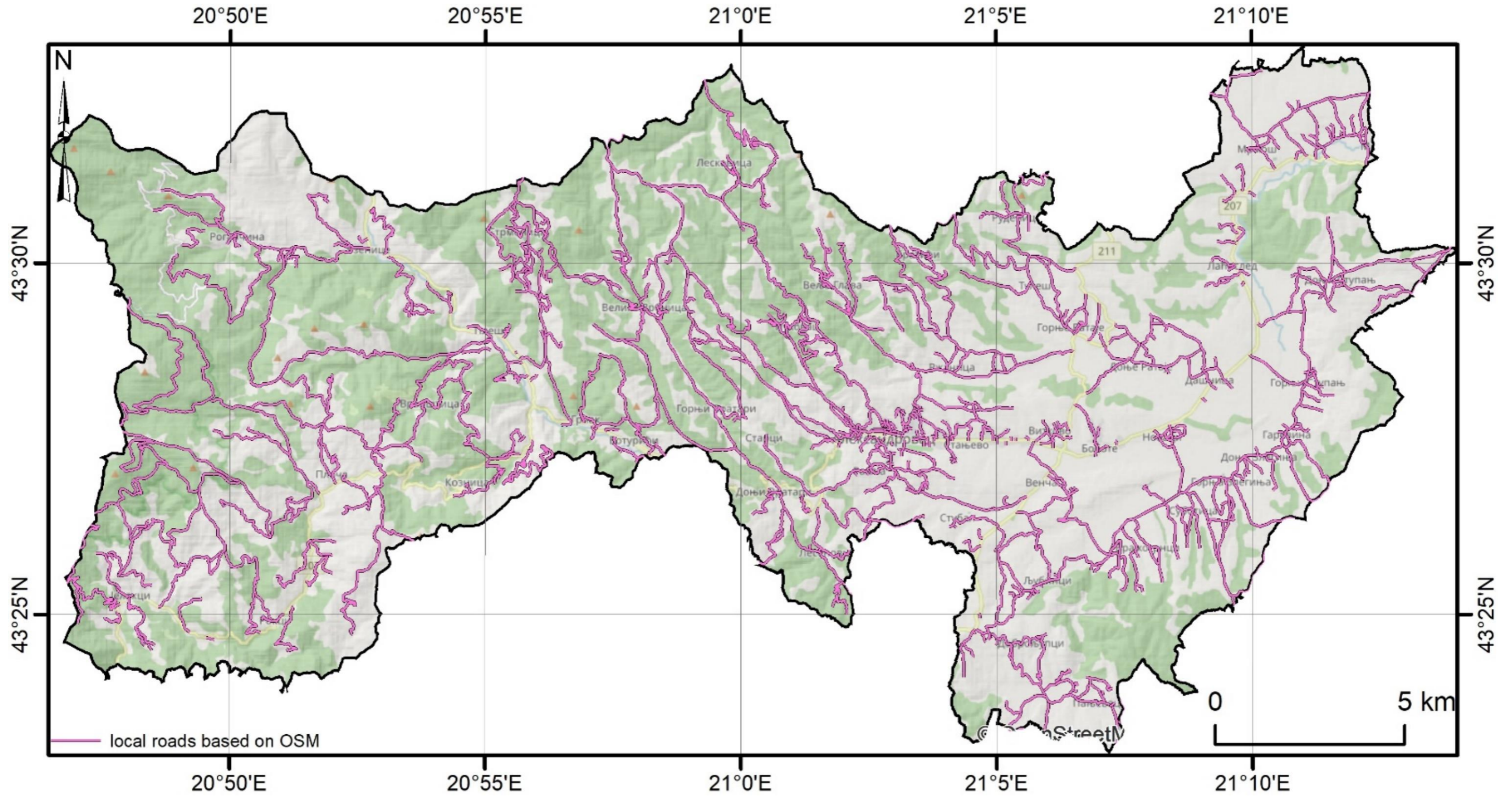




Figure 16 Short- and mid-term priority links 1-24 with indicated investment value in EUR for Aleksandrovac (urban area zoomed-in in the insets); Links are ranked by priority indicated in the first number, followed by the estimated investment value

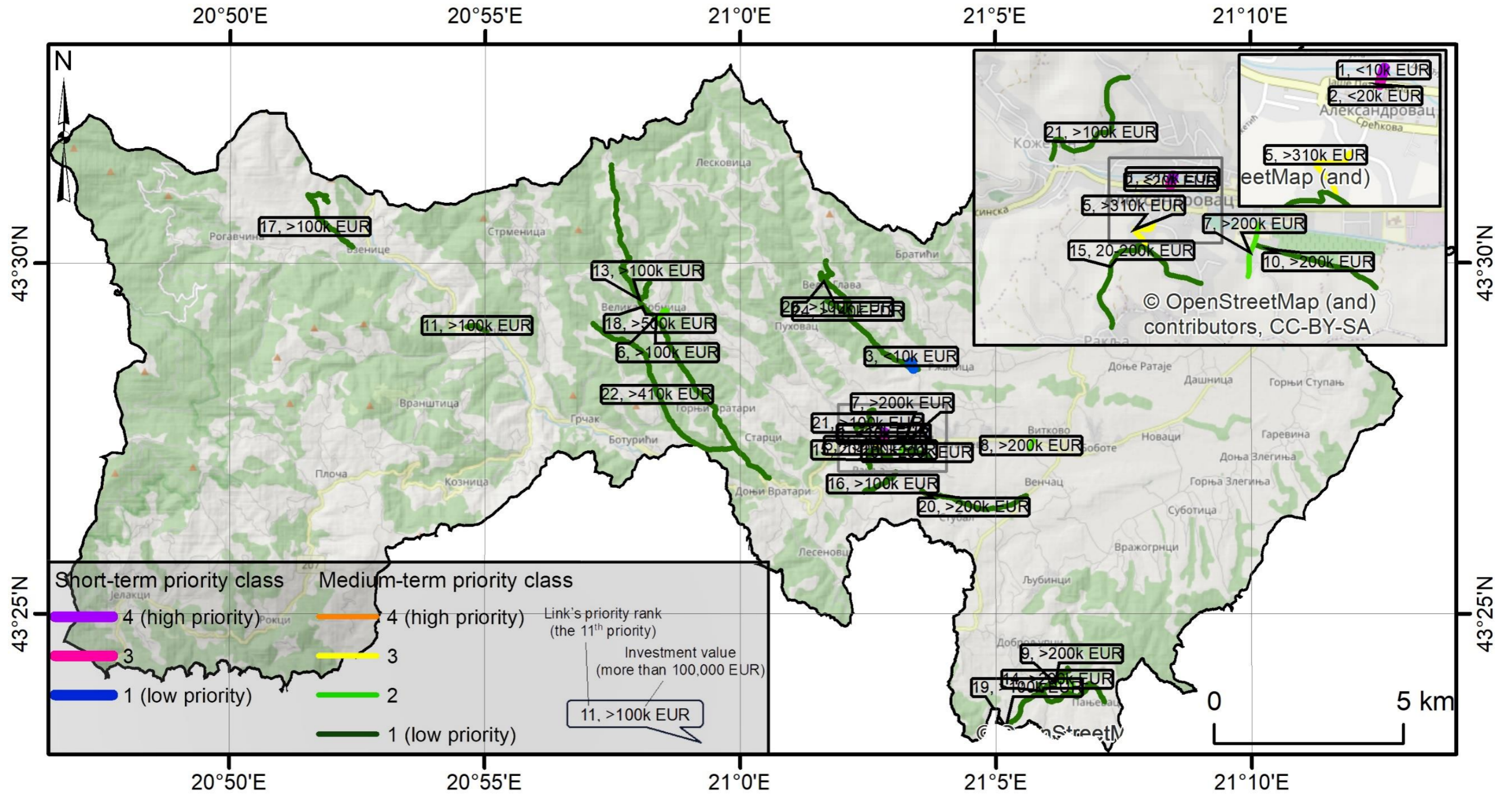




Figure 17 Type of investment for prioritized links 1-24 for Aleksandrovac (urban area zoomed-in in the insets); Links are ranked by priority indicated in the first number, followed by the estimated investment value

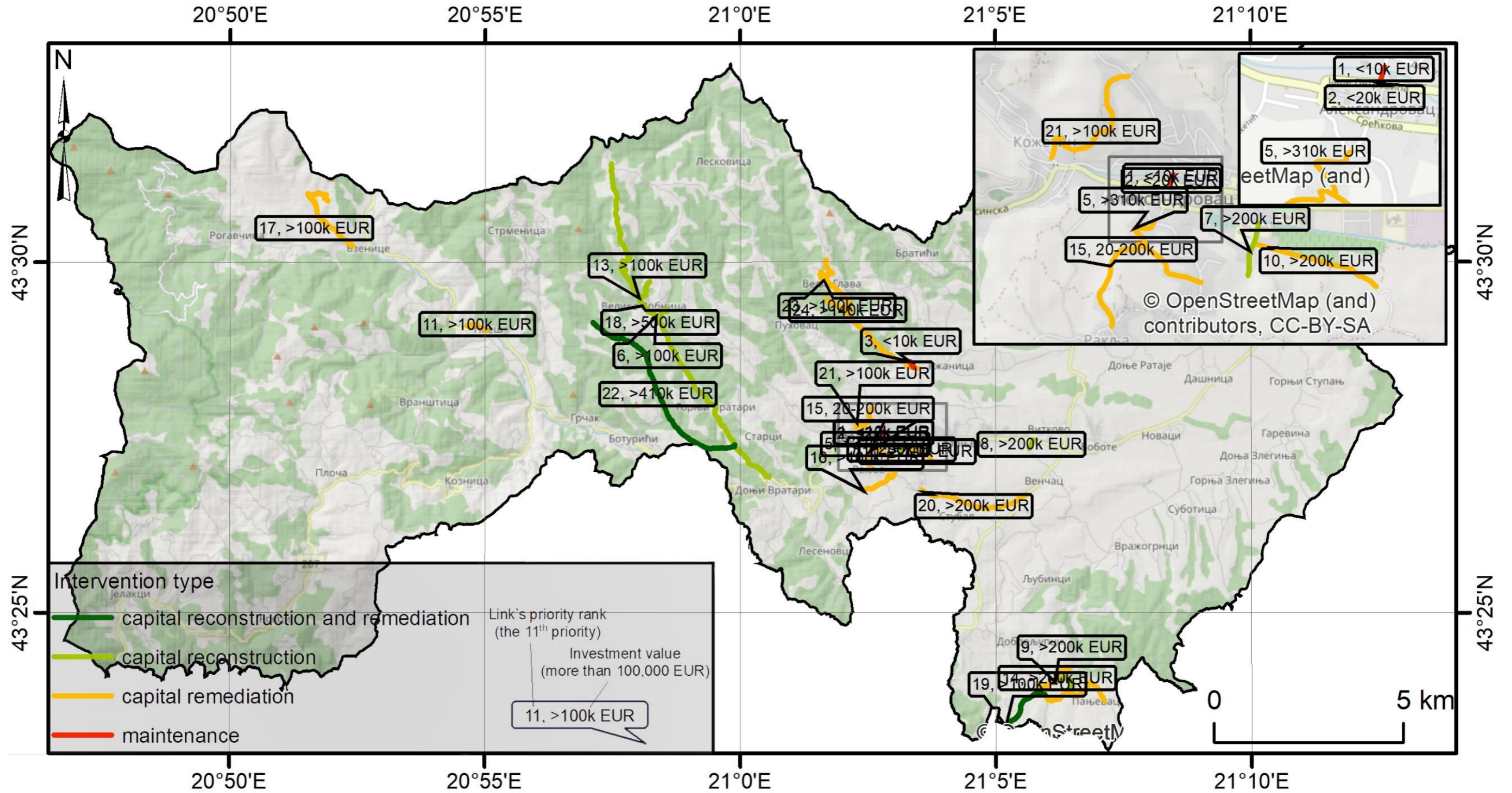




Figure 18 Prioritized links (1-24) traffic features for Aleksandrovac (urban area zoomed-in in the incepts); Links are ranked by priority indicated in the first number, followed by YES or NO for presence of alternative route, and public transport, respectively

