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Flood Risk Management Plan for the Danube River Basin

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[1] Mechanical, Electrical, Instrumentation, Control and Automation assessment of existing flood defences

CONTENTS

LIST OF ABBREVIATIONS

APSFR	Area of Potential Significant Flood Risk
Art.	Article
BCR	Benefit/Cost ratio
CBA	Cost Benefit Analysis
CIS	Common Implementation Strategy (EU)
CLC	Corine Land Cover
CORINE	Co-ORdinated INformation on the Environment
CPA	Capital Projects Administration
DEM	Digital Elevation Model
DRB	Danube River Basin
DTM	Digital Terrain Model
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EC	European Commission
EPCG	Elektroprivreda Crne Gore AD
EU	European Union
EUR	Euros
FD	EU Floods Directive (2007/60/EC)
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
GDP	Gross Domestic Product
GIS	Geographic Information System
GIZ	German Development Agency - Deutsche Gesellschaft für Internationale Zusammenarbeit
GWB	Groundwater Body
H	Height
ha	Hectare
HEC-HMS	Hydrologic modelling program that allows to establish rainfall-runoff relationships, based on watershed characteristics
HEC-RAS	Hydrologic Engineering Center River Analysis System developed by the United States Army Corps of Engineers
HQ10	Refers to a 10-year flood which has a 10% chance of being exceeded in any one year.
HQ100	Refers to a 100-year flood which has a 1% chance of being exceeded in any one year.
HQ500	Refers to a 500-year flood which has a 0.2% chance of being exceeded in any one year.
HS	Hydrological Stations
IED	Industrial Emissions Directive (2010/75/EC)
IHMS	Institute of Hydrometeorology and Seismology of Montenegro
IPCC	Intergovernmental Panel on Climate Change

JRC	Joint Research Council (EU)
km	Kilometre
m	Metre
MAFWM	Ministry of Agriculture, Forestry and Water Management
m.a.s.l	Height in meters above sea level
mm	Millimetre
MONSTAT	Statistical Office of Montenegro
ND	No Data
NWRM	Natural Water Retention Measures
NW	North West
OG	Official Gazette of Montenegro
OP	Orthophoto
OSM	Open Street Map
Par	Paragraph
PFRA	Preliminary Flood Risk Assessment
PRTR	Pollution Release and Transfer
Q	Flow rate
QGIS	A Free and Open-Source Geographic Information System
QT	A given flood return period
RAS-Mapper	RAS Mapper module is an interface accessed from the main HEC-RAS program and provides a geospatial visualization of HEC-RAS geometry, simulation results, and other pertinent geospatial data to assist users to efficiently create river hydraulic models.
RBD	River Basin District
RBMP	River Basin Management Plan
s	Seconds
SE	South East
SEA	Strategic Environmental Assessment
shp	Shapefile format. A geospatial vector data format for geographic information system
SWB	Surface Water Body
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTM	Universal Transverse Mercator, a plane coordinate grid system named for the map projection on which it is based
VAT	Value Added Tax
WFD	EU Water Framework Directive (2000/60/EC)
WGS	World Geodetic System

EXECUTIVE SUMMARY

The EU Flood Risk Management Directive (2007/60/EC) has been fully transposed into the national legislative framework through the Water Law and the Rulebook on the Detailed Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan.

The PFRA covers historical flood events and the potential for future flood events that may have a significant adverse consequence on either, human health, the environment, cultural heritage, or economic activity.

For the purpose of producing the PFRA, available data from 21 selected existing and historical hydrological stations in the Danube River Basin was used to calculate the probability of return periods of 10, 100 and 500 years. The results were calibrated based on the 2010 flood data, which are considered to be the largest floods recorded.

During the assessment, the expected impacts of climate change were considered by applying one extreme flood scenario (recovery period ≥ 500 years), which included all proven or known, or estimated future impacts, including climate change impacts. The impacts of climate change on the identification of areas with potentially significant flood risk are fully covered by working on scenarios of extreme flood events.

With respect to future flooding, in general, it can be concluded that flood events will be both more frequent and more intense, as a consequence of climate change. Thus, although the reduction of total annual precipitation in most parts of the Danube River Basin is expected, in the future, short heavy rainfall, often combined with snowmelt and soil saturation, is expected to cause a higher risk of torrential floods caused by an increase in surface runoff.

Based on the analysis of the above data, 19 Areas of Potential Significant Flood Risk (APSFR) in the Danube River basin area were defined[2] and represented in GIS format. The APSFR are located in the following Sub-Basins: Ibar River Sub-Basin (4), Lim Sub-Basin (11), Tara River Sub-Basin (2), Ćehotina River Sub-Basin (1) and Piva Sub-Basin (1).

Flood hazard and flood risk maps detail the affected areas in 19 APSFR in the Danube River Basin. A description of the potential risks/assets in the area of the flooding together with the significance of the potential risks in relation to human health, environmental, economic and cultural criteria are presented for a flooding event of high (HQ10), medium (HQ100) and low risk (HQ500) probability for each APSFR. For the Danube River Basin as a whole, the following information was calculated:

- **High probability flood event** (HQ10): a total of 646 hectares would be inundated with 4,753 inhabitants, 890 dwellings, 22 commercial businesses and 1 cultural object at risk.
- **Medium probability flood event** (HQ100): a total of 880 hectares would be inundated with 5,898 inhabitants, 1,302 dwellings, 35 commercial businesses and 3 cultural objects at risk.
- **Low probability flood event** (HQ500): a total of 966 hectares would be inundated with 6,657 inhabitants, 1,637 dwellings, 56 commercial businesses and 5 cultural objects at risk.

[2] Nomenclature for national coding agreed by MAFWM and Water Administration.

The risk assessment for each APSFR, which is based on significance criteria and threshold values, identified potentially significant issues in each APSFR related to human health, economic values, environmental risks and risks to cultural heritage sites. The data clearly shows that all APSFR are at risk with respect to inhabitants and settlement areas. 5 of the 19 APSFR show a risk to industrial objects. Three APSFR are at risk for cultural heritage sites. No environmental risks were determined.

Increased urbanization in one of the APSFR, which covers Hareme, Rudes and Talum in Berane, would be expected to have a negative impact in the event of future floods. Therefore, this information should be taken seriously in future spatial planning.

A programme of measures for each APSFR, which incorporates flood prevention, flood protection and preparedness has been designed to include:

- measures that aim to prevent/avoid increasing flood risk (e.g. measures related to planning);
- measures that protect from flooding by using natural flood management;
- measure that protect from flooding by using more traditional engineering methods;
- measures that prepare for flooding should it occur (e.g. flood warning, awareness raising, emergency response plans).

The total estimated investment costs of measures planned for Danube River Basin amount to 48,452,000 EUR, while maintenance costs are equal to 1,313,040 EUR per year.

Cost Benefit Analysis was conducted to evaluate the relationship between benefits and costs for each investment decision (mitigation measure). The benefit/cost ratio is 1.36[3], which means the proposed intervention (investment in flood measures) in the Danube River Basin is worth the investment in economic terms.

[3] The first condition an intervention should meet is that the benefit-cost ratio is higher than 1.0.

1 INTRODUCTION

1.1 Overall Objective

Directive 2007/60/EC on the assessment and management of flood risks (EU Floods Directive, FD) entered into force on 26 November 2007. This Directive now requires Member States to assess if all water courses are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. The Directive also reinforces the rights of the public to access this information and to have input in the planning process. Although Montenegro is not yet a member of the EU, it has made significant efforts to fully transpose this Directive into national law and thus take a step towards joining the European Union.

Montenegro has defined its territories for the purposes of River Basin management in accordance with the EU Water Framework Directive (WFD, 2000/60/EC), within 2 River Basin districts (RBDs) (‘Adriatic River Basin District’ and the ‘Danube River Basin District’). The country must therefore produce 2 Flood Risk Management Plans (FRMPs), which are harmonized, in accordance with Article 9 of the EU Flood Directive (FD, 2007/60/EC) with its 2 River Basin Management Plans (RBMPs) prepared under the EU WFD. This Flood Risk Management Plan concerns the Danube River Basin.

The process by which the FRMP is prepared is prescribed both in the EU FD and in Montenegro’s Law on Water. Regulation No. 069/15 of 14 December 2015 defines the specific requirements of the Floods Directive related to the preparation of the FRMPs into Montenegrin law.

In short, the EU FD requires 3 distinct preparatory stages which are:

- **Stage 1**. Preliminary Flood Risk Assessment
  Article 4 of the EU FD requires a Preliminary Flood Risk Assessment (PFRA) for each River Basin district. In the PFRA, areas which have the most significant flood risk or potential flood risk, known as Areas of Potentially Significant Flood Risk (APSFR) are identified. These areas then become the focus for more detailed mapping and planning in the next two stages.

- **Stage 2**. Flood Hazard and Risk Mapping
  Article 6 of the EU FD requires the preparation of Flood Hazard and Flood Risk Maps for all APSFR identified in Stage 1.

- **Stage 3**. The Flood Risk Management Planning
  Article 7 of the EU FD requires the preparation of FRMPs for each River Basin district that will include inter-alia a programme of measures that will be undertaken to address the flood risks.

Phase 1, which includes the analysis of the existing flood protection infrastructure, together with the preparation of the Preliminary Flood Risk Assessment. The proposal for APSFR for the Danube River Basin was adopted in December 2021 and is summarised in this document. Stages 2 and 3, which encompasses the preparation of the Flood Hazard and Risk Maps and Flood Risk Management Plans, are detailed in this document.

1.2 Structure of the Flood Risk Management plan in the Danube River Basin

The format and content of the FRMP Report is prescribed both in Annex 1 of the EU Floods Directive (2007/60/EC) and in the CIS Guidance Notes[4]. Along with relevant background information, the FRMP for the Danube River Basin includes the general components as detailed in Annex 1 of the Floods Directive, which are summarised below:

- Conclusions of the preliminary flood risk assessment (PFRA), in the form of a summary map of the RBD delineating the areas of potential significant flood risk (APSFR);
- Flood Hazard maps and Flood Risk maps;
- Description of the objectives;
- Summary of measures and their prioritisation;
- Description of the cost-benefit methodology;
- Summary of public information and consultation (to be included following SEA);
- List of competent authorities (included in the legal review);
- Description of the co-ordination process in international RBD:
- Description of the coordination process with the WFD (Directive 2000/60/EC).

[4] Guidance for Reporting under the Floods Directive (2007/60/EC). Guidance Document No. 29. 2013.

2 LEGAL OVERVIEW

2.1 Introduction

The prime objective of this section is to provide a legal assessment of all relevant questions pertaining to transposition of the EU requirements on the preparation of the Flood Hazard and Risk Maps and Flood Risk Management Plans into national legislation in Montenegro. This section also provides an analysis of the main points of alignment of the national legislative acts with Directive 2007/60/EC on the assessment and management of flood risks, as the EU umbrella act on flood risk management.

With the aim of providing an all-encompassing legal overview, all relevant primary and secondary pieces of national legislation have been scrutinized as well as other policy papers which do not formally fall under legal acts, such as the Nation Plan of Protection and Rescue from Flooding etc.

The main points of entry for the transposition of the applicable provisions from the Directive 2007/60/EC have been identified in accordance with the chapters of the said act. Also, the Table of Transposition Relevance has been provided as the channel of the overview of the relevance of the concrete national acts with the specific requirements from the Directive.

2.2 Legal and Policy Acts

- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
- Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control.
- Law on Waters ("Official Gazette of Montenegro", no. 32/11, 47/11 48/15, 52/16, 02/17, 80/17, 84/18).
- Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan ("Official Gazette of Montenegro", no. 69/15).
- Rulebook on the Content of Operational Instructions for Retention Management Intended for Protection Against Floods ("Official Gazette of Montenegro", no. 3/18)
- Nation Plan of Protection and Rescue from Flooding, December 2019.
- Water Management Strategy, 2017.
- Strategy for Disaster Risk Reduction with a Dynamic Action Plan for Implementing the Strategy for the Period 2018-2023

2.3 Definition of Terms

The Directive introduces only two authentic definitions of terms:

- ’’flood’’ means the temporary covering by water of land not normally covered by water. This shall include floods from rivers, mountain torrents.

- ’’flood risk’’ means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage, and economic activity associated with a flood event.

At the same time, the Directive refers to terms ’’river’’, ’’River Basin’’, ’’Sub-Basin’ and ’’River Basin district’’ as defined in the Article 2 of Directive 2000/60/EC of 23 October 2000 establishing a framework for Community action in the field of water policy.

Both of aforementioned terms have been directly transposed into Article 5 of the Law, which prescribes the meaning of the terms. This has been achieved in the following manner:

- Article 5, paragraph 1, subsection 49 of the Law defines flood as the temporary water cover of land, which is not normally covered by water, including floods (in the DRB) caused by rivers, torrents, occasional watercourses, and lakes, except floods from sewage systems.
- Article 5, paragraph 1, subsection 50 of the Law defines flood risk as a combination of the probability of a flood event and the potential adverse effects of a flood event on human health, the environment, cultural heritage, and economic activities.

It is noteworthy that the Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan introduces additional flood related terms, such as:

- ''area significantly endangered by floods'' is an area where floods can cause significant harmful consequences for human health, the environment, cultural heritage, and economic activities.
- ''floods of low probability'' are floods from running waters with a flow of water for a return period of at least 500 years or floods from standing water with a water level for a return period of at least 500 years.
- ''floods of medium probability'' are floods from running waters with a water flow for a return period of 100 years or floods from standing waters with a water level for a return period of 100 years.
- ''floods of high probability'' are floods from running waters with a flow of water for a return period of ten years or floods from standing waters with a water level for a return period of ten years.

Overall, it may be concluded that all authentic terms from the Directive have been fully and accurately transposed into national legislation.

2.4 Preliminary Flood Risk Assessment

Chapter 2 of the Directive, consisting of Article 4 and Article 5, deals with assessment in regard to the preliminary flood risk assessment.

The preliminary flood risk assessment is to be performed for each River Basin district, unit of management or the portion of an international River Basin district lying within the territory of a certain state. This obligation is included in the Law through Article 95b by which preliminary flood risk assessment is to be done by the competent state authority for each water area. The Law defines water area in Article 5 (for the Danube River Basin) as the area of land, which consists of one or more adjacent River Basins, that is Sub-Basins, on the territory of Montenegro, with associated groundwater, in accordance with Article 21 of this Law, which is defined as the basic water management unit. Article 21 determines that the water areas in the Danube River Basin as the following:

- The water area of the Danube basin is a part of the international water area of the Danube on the territory of Montenegro, which includes the basins: Ibar, Lim, Ćehotina, Tara and Piva, with the corresponding groundwater.

Also, Article 95b of the Law introduces mandatory 6-year revisions period for all prepared assessment with special focus on the impact of the climate changes on potential flooding in the basin covered by any specific assessment. In this way, the flooding precautionary measures tap into the broader scope of protection from adverse effect of climate change.

Article 4 of the Directive goes on to provide through guidelines on the content of the preliminary flood risk assessment. Based on the said Article, such content should entail following:

- Maps of the River Basin district at the appropriate scale including the borders of the River Basins, Sub-Basins, showing topography and land use.
- Description of the floods which have occurred in the past, and which had significant adverse impacts on human health, the environment, cultural heritage, and economic activity and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed.
- Description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged.

In addition to the aforesaid, should specifically needs of the state require so, assessment might also include information on the potential adverse consequences of future floods for human health, the environment, cultural heritage, and economic activity.

The stipulations on the content of the preliminary assessment have been incorporated into Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan. Article 3 of the said Act specifies that the assessment should include following:

- Maps of water areas in the appropriate scale, with the boundaries of Sub-Basins showing the topography and land use.
- Description of floods that have occurred in the past, which have had significant adverse effects on human health, the environment, cultural heritage, and economic activities and are likely to recur in the future, considering the extent of the floods, runoff routes flood waters and an assessment of the adverse effects of the floods.
- Description of significant floods in the past in areas where due to changes in conditions (urbanization, declaring areas protected) significant damage may recur.
- The impact of climate change on the occurrence of floods.
- Assessment of potential harmful consequences of future floods on human health, environment, cultural heritage, and economic activities, considering the topography, position of the watercourse and its hydrological and geomorphological characteristics, floodplains as natural retention areas, efficiency of existing flood defence facilities, the

location of populated areas, areas of economic activity and long-term development plans, as appropriate.
- Used data (records, long-term development studies).
- Conclusions on flood risks.

The Rulebook incorporates all three major Directive’s guidelines on the content of preliminary assessments. Also, it includes the optional guideline on the information on the potential adverse consequences of flooding. Finally, the scope of the requited information is broadened by the inclusion of data related to impact of climate change on the occurrence of floods. The Rulebook provides thorough and comprehensive guidance on the information and data that is to be included in the preliminary assessments mirroring the requirements from the Article 4 of the Directive and in some instances going even beyond them. Therefore, it can be concluded that all the stipulations on the content of the preliminary flood assessment have been successfully incorporated into national legislative framework though the provisions of the said Rulebook.

Article 4(3) of the Directive establishes obligation of the cooperation of the states in the exchange or relevant information in the case of international River Basins. In line with that, Article 95b of the Law prescribes that when preliminary assessments are prepared for the River Basin districts which are part of an international River Basin districts, exchange of information with the countries within whose territories such basins are lying shall be provided.

Obligation of the state, based on the preliminary assessments, to identify areas for which, potential significant flood risks is existent or might be considered likely to occur is set by the Article 5.1 of the Directive. This obligation is included in the Law though Article 95c. By the said Article the Government is to determine areas for which there are significant flood risk, or their occurrence may be considered probable by using the findings from preliminary flood risk assessments. In addition to this, Article 5.1 sets obligation of the states to coordinate their efforts in identifying areas under potential significant flood risk when it comes to international basins. This obligation is also incorporated in the Article 95c of the Law (paragraph two of the said Article) by which determining of the international River Basin areas endangered by floods, shall be done through coordinated activates with the states on whose territory parts of that River Basin district are located. Both stipulations of the Article 5, regarding the identification of the endangered areas and cooperation of the states when identifying such areas for international basins, have been adequately transposed in the national legislative framework through Article 95c of the Law.

Given the above elaboration, it can be derived that all applicable stipulations on the preliminary flood risk assessments set by the articles comprising the Chapter 2 of the Directive have been fully and accurately transposed into relevant national legislative acts.

2.5 Flood Hazard Maps and Flood Risk Maps

Chapter 3 of the Directive, consisting of Article 6, deals with preparation of the flood hazard and risk maps.

Article 6 of the Directive defines the obligation of Member States, at the level of the river basin district, or unit of management referred to in Article 3(2)(b) of Directives, prepare flood hazard maps and flood risk map.

All the provisions of Article 6 of the Directive have been transposed into national legislation. Article 95d of the Law on Waters specifies the following:

- For the areas under significant flood risk, competent administrative body shall draft flood hazard maps and flood risk maps, for each river basin separately.
- Flood hazard maps and flood risk maps shall be drafted for:
  - low probability floods;
  - medium probability floods (return period 100 years);
  - high probability floods, as necessary.
- Drafting the flood hazard maps and flood risk maps for areas under significant flood risk that include territories of neighbouring countries shall be done based on information exchange with those countries.
- Flood hazard maps and flood risk maps shall be revised upon the expiry of six years following their drafting, i.e. revision.

In Article 2 of the Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan certain expressions shall have the following meaning are defined:

1. Area of potential significant flood risk (APSFR) is an area where flood can cause significant harmful effects for human health, environment, cultural heritage and economic activities;
2. Low-probability floods are floods caused by running waters with return period of at least 500 years, or floods caused by still waters with water levels with return period of at least 500 years;
3. Medium-probability floods are floods caused by running waters with return period of 100 years, or floods caused by still waters with water levels with return period of 100 years;
4. High-probability floods are floods caused by running waters with return period of ten years, or floods caused by still waters with water levels with return period of ten years.

Article 4 of the Rulebook describes the contents that must be shown on flood hazard maps for floods of low, medium and high probability. For flood risk maps the content is described in Article 6. Flood Risk Management Plans (See Section 6.1).

Chapter 4 of the Directive, consisting of Article 7 and 8, deals with preparation of the flood risk management plans.

Art 7 FD requires member states to prepare flood risk management plans for all areas identified as being at potentially significant flood risk (APSFR) under article 5 or article 13.1(a), and areas covered by article 13.1(b), on the basis of the maps prepared under article 6.

The flood risk management plans (FRMP) must set out appropriate objectives for the management of flood risk within the areas covered by the plan. The objectives must focus on reducing the adverse consequences of flooding for human health, the environment, cultural heritage and economic activity. Where appropriate, the plans should focus on reducing the likelihood of flooding and/or on using non-structural measures, including flood forecasting and raising awareness of flooding (art 7.2). The flood risk management plans shall include measures for achieving identified objectives (art 7.3).

Flood risk management plans shall include the components as detailed in the annex (Part 1) of the EU Floods Directive:

- Conclusions of the preliminary flood risk assessment, as required in Chapter II in the form of a summary map of the RBD/UoM delineating the areas of potential significant flood risk (Annex part A.I.1);
- Flood hazard maps and flood risk maps (Annex part A.I.2);
- Description of the objectives (Annex part A.I.3);
- Summary of measures and their prioritisation, including those taken under other Community acts (such as EIA, SEA, WFD), aiming to achieve the objectives (Annex part A.I.4);
- Description of the cost-benefit methodology, when available, used in transnational context (Annex part A.I.5);
- Description of how implementation progress will be monitored (Annex part A.II.1);
- Summary of public information and consultation (Annex part A.II.2);
- List of competent authorities (Annex part A.II.3);
- Description of the co-ordination process in international river basin districts/other unit of management (Annex part A.II.3);
- Description of the coordination process with the WFD (Directive 2000/60/EC) (Annex part A.II.3).

The flood risk management plan sets appropriate objectives for flood risk management at the national level but must be complementary to the objectives defined for the entire Danube catchment area.

All the provisions of Article 6 of the Directive have been transposed into national legislation. Article 95e of the Law on Waters specifies the following:

- For areas under significant flood risk, a FRMP shall be drafted at the level of a river basin district, in accordance with water management plan referred to in Article 24 of this Law.
- Flood Risk Management Plans can be developed for other areas as necessary.
- Flood Risk Management Plans shall be adopted by the Government.
- The Plan referred to in paragraph 1 of this Article for a river basin district that makes part of an international river basin shall be drafted as a joint flood risk management plan for the countries in territories of which portions of that river basin are located.
- Unless the Plan referred to in paragraph 4 of this Article has been drafted, a FRMP shall be drafted for a part of the international river basin located in the territory of Montenegro in cooperation with the countries in territories of which portions of that river basin are located.
- Flood Risk Management Plans shall be revised upon the expiry of six years from the date of their drafting or revision, considering the impact of climate change on the occurrence of floods.
- Flood Risk Management Plans shall be submitted by the competent administrative authority to the European Commission within three months from the date of the publication thereof, and PFRA, flood hazard maps and flood risk maps within three months from the date of drafting thereof.

According to the Article 8 of the Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan shall contain:

1. Water basin map, containing the area significantly threatened by floods, defined in compliance with conclusions of the Preliminary Flood Risk Assessment;
2. Flood hazard maps and flood risk maps with conclusions;
3. fFood risk management goals for the areas significantly threatened by floods, aimed at reducing adverse impacts of floods to human health, environment, cultural heritage and economic activities;
4. Measures that will be implemented according to priorities with the aim of managing flood risks, measures that will be implemented in order to achieve compliance between the Plan and the Water Basin Management Plan referred to in Article 24 of the Law on Waters, and measures that will be implemented based on regulations on environmental impact assessment, strategic environmental impact assessment, industrial accidents and water management, provided those measures do not increase flood risks upstream or downstream in other countries at the same river basin or sub-basin, except in cases when countries have concorded such measures;
5. Financial means for implementation of measures with cost-benefit analysis (CBA), depending on the size of flood event, run-off ways for flood waters, areas that can retain flood waters, environmental and land and water management goals, in compliance with spatial-planning documents;
6. Manner of flood risk management, focused on prevention and protection, including flood forecasting and early warning systems, depending on river basin or sub-basin characteristics;
7. Manner of promoting sustainable land use, better water retention and controlled flooding of certain areas in case of floods;
8. Description of methodology used for cost-benefit analysis and assessment of measures with international effects for river basins and sub-basins shared with other countries, if necessary.

2.6 Reviews, Reports and Final Provisions

Chapter VII of the Directive, consisting of Article 14 and 15, deals with reviews of the preliminary flood risk assessment, flood hazard and risk maps and flood risk management plan(s); Reports and Final Provisions. The likely impact of climate change on the occurrence of floods shall be taken into account in the reviews.

All the provisions of Article 14 of the Directive have been transposed into national legislation.

Article 95b of the Law on Waters specifies that the Preliminary Flood Risk Assessment shall be revised upon the expiry of six years from its drafting, i.e. revision, considering impact of climate change to the occurrence of floods.

Article 95d of this Law specifies that the Flood hazard maps and flood risk maps shall be revised upon the expiry of six years following their drafting, i.e. revision.

Article 95e of this Law specifies that the Flood Risk Management Plans shall be revised upon the expiry of six years from the date of their drafting or revision, considering the impact of climate change on the occurrence of floods.

Articles 9 of the Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan determines the manner of the Plan updating. The Plan shall be updated if there are changes in data defined by the Plan, taking into account impact of climate change on occurrence of floods.

Article 15 of the Directive prescribes that the Member States shall make available the preliminary flood risk assessment, the flood hazard maps, the flood risk maps and flood risk management plans, as well as their review and, where applicable, their updates to the Commission within three months after the dates indicated respectively in Articles 4(4), 6(8), 7(5) and 14. Member States shall inform the Commission of the decisions taken in accordance with Article 13(1), (2) and (3) and make available the relevant information thereon by the dates indicated respectively in Articles 4(4), 6(8) and 7(5).

All the provisions of Article 15 of the Directive have been transposed into national legislation through the Article 95e of the Law on waters, which says the Flood Risk Management Plans shall be submitted by the competent administrative authority to the European Commission within three months from the date of the publication thereof, and PFRA, flood hazard maps and flood risk maps within three months from the date of drafting thereof.

2.7 Retention management intended for protection against floods

In accordance with the Law on Water the regulation of watercourses and other waters is considered to be works on the construction and maintenance of regulatory facilities in the watercourse bed and on the water property, maintenance of the stability of the banks and watercourse beds and other works which enable the controlled and harmless flow of water, ice and sediment as well as construction and maintenance of water facilities and systems of various purposes.

Following activities are considered as maintenance of watercourses, water assets and water facilities:

- Works on the maintenance of natural and artificial watercourses;
- Earthworks and similar works on the arrangement and maintenance of banks, earthworks in the inundation zone;
- Maintenance of regulatory and protective water facilities and
- Maintenance of water facilities for amelioration drainage.

In accordance with the said Law general and operational plans for protection against harmful effects of water are to be adopted in order to enable adequate protection against harmful effects of waters which are regarded as of national importance as well as for waters regarded as of local importance.

The General Plan of protection against the harmful effects of water for waters of national importance for the Republic, is adopted by the Government for the period of six years. The General Plan for protection for waters of local importance is adopted by the competent body of local self-government, also for a period of six years.

The general plan for protection against the harmful effects of water, both at national and local level, includes following:

- Works and measures that are taken preventively and during the period of high water for protection against floods, protection against erosion and torrents and removal of the consequences of such effects of water;

- The way of institutional organization of defence against the harmful effects of water;
- Duties, responsibilities and powers of the head of protection against harmful effects of water, institutions and other persons responsible for protection against harmful effects of water;
- Way of observing and recording data;
- Announcement of occurrences and notifications.

As for Operational Plans for protection against the harmful effects of water they are to be prepared for period of one year, both at the national and at the local level. National Operational Plan is adopted by the Ministry in charge of water management whilst at the local level it shall be prepared competent local administration body.

The Operational Plan for protection data and measures necessary for the effective implementation of protection against the harmful effects of water, including:

- Authoritative water levels;
- Criteria for declaring regular and extraordinary defence against floods;
- Names of managers of protection against the harmful effects of water;
- Headquarters for protection against the harmful effects of water;
- The name of the body, i.e. the company and other legal entity that implements the protection against the harmful effects of water and
- The means for the operational implementation of the protection

Article 101 of the Law on Waters sets legal basis for the adoption of the Regulation on the content of operational instructions for retention management intended for protection against floods

In accordance with the said Article companies and other legal entities that manage accumulation and retention basins are obliged to maintain and use them in a way that ensures the acceptance of flood waves. In doing so, companies and other entities, are obliged to submit to the state administration body responsible for hydrometeorological affairs and the chief manager of protection against the harmful effects of water data on the condition and degree of filling of storage basins once a week, and daily during the period of emergency flood protection.

For the management of reservoirs intended for flood protection, and especially multi-purpose reservoirs, said entities are obliged to prepare operational instructions. The content of such operations is determined by the aforesaid Regulation.

As said-above the Rulebook is adopted for the purpose of providing data that operational instructions for reservoir management intended for protection against floods. Hence, the main purpose of the Rulebook book is to define information which operational instructions prepared by the entities in charge of reservoirs must include.

The Rulebook introduces two types of reservoirs:

- Retention reservoirs and
- Multi-purpose reservoirs

Retention reservoirs have a sole purpose of protection against floods and are envisaged as a facility or regulated area in a river basin intended for shorter retention of water aimed at protecting against floods, serving to retain and slow down the flood wave.

As for multi-purpose reservoirs they can be used for additional purposes, beyond reduction of flood waves, such as electricity generations, water supply to population, water supply to industry, irrigation etc.

In accordance with the Article 3 of the Rulebook operational instructions for reservoir management must include following information:

- Operational timetable of managing and expert persons with data about:
    - organizational scheme with duties of facility operators in case of flood;
    - responsible person in case of flood and his/her deputy;
    - person responsible for communication with headquarters for the protection against harmful effects of waters;
    - leader of the protection against harmful effects of waters and authority responsible for hydrometeorological affairs.
- Description of technical systems:
    - observation and control of the facility status;
    - informing and alerting procedures.
- Manner and frequency of control and recording of data of importance for the facility functioning:
    - water level in the reservoir or retention;
    - water recharge of the reservoir or retention;
    - water discharge from the reservoir or retention;
    - evacuation operation (overflows and discharges);
    - securing the dam in compliance with specific regulation;
    - visual data about the facility during the flood event;
    - specific data depending on the type of facility.
- Diagrams of recharging and discharging of a retention, i.e. part of a reservoir intended for receipt of flood wave, for different types of flood waves;
- Procedures, depending on the proclaimed degree of flood hazard;
- Diagrams of flood wave propagation in case damages are made to the dam or if the dam collapses, with inserted boundaries of flood wave impacts on downstream areas;
- Procedures in case damages are made to the dam or if the dam collapses, and ways of informing and alerting the population in threatened areas downstream the dam, for the sake of timely evacuation;
- Instructions for protection against floods depending on type of reservoir or retention.

EU regards Natural Water Retention Measures (NWRM) as measures that aim to safeguard and enhance the water storage potential of landscape, soil, and aquifers, by restoring ecosystems, natural features and characteristics of water courses and using natural processes.

NWRMs are multi-functional measures that aim to protect and manage water resources using natural means and processes, therefore building up Green Infrastructure, for example, by restoring ecosystems and changing land use. NWRM have the potential to provide multiple benefits, including flood risk reduction, water quality improvement, groundwater recharge and habitat improvement. As such, they can help achieve the goals of key EU policies such as the Water Framework Directive (WFD), the Floods Directive (FD) and Habitats and Birds Directive.

In line with the Blueprint proposals in the 2013-2015 CIS Work Program, the Water Directors adopted a policy document in 2014: EU policy document on Natural Water Retention Measures. This policy document explains the policy relevance and promotes its uptake in water management.

2.8 Table of Transposition

It can be concluded that high level of the transposition of requirements from the Directive into national legislative framework on the preliminary flood risk assessment in Montenegro has been achieved in all relevant areas. The table of transposition with relevance to the PFRA is shown in Annex 1. Some additional work may be done regarding the content of information on adverse consequences and alignment with stipulations set by the Annex I of the Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control. However, this can be regarded as just a minor omission that does not influence overall successful level of transposition.

Apart from strictly legislative framework, there is a clear need for better alignment and consistency in regard to the within national framework of strategic policy papers. Proposals of policy interventions and correlated implementation of activities pertaining to the management of flood risks are scattered in several policy papers, without clearly defined synchronization or interdependence of those documents. Flood risk management measures and policy interventions are foremost set by the National Plan of Protection and Rescue from Flooding, December 2019, and the Water Management Strategy from 2017. However, even recommendations from these two most prominent policy papers lack mutual synchronization. In addition to the said two policies, objectives pertaining or relating to flood risk management are defined in several other strategic document such as and a Strategy to reduce the risk of disaster with the Dynamic Action Plan for the period 2018-2023 and National Strategy for Sustainable Development until 2030. Most of these documents have been prepared at the different points in time when the levels of the transposition of EU requirements varied. For that reason, they have different starting points which may result in different recommendations. Accordingly, the objectives and measures from the mentioned documents should be harmonized to the extent possible, as these documents address floods from the perspective of their respective competences. All other strategy documents should be aligned with the objectives set by the chosen overarching policy and update regularly in accordance with latest amendments of such policy.

2.9 Institutional Responsibilities

Institutional competencies for flood risk management are divided between Ministry of Agriculture, Forestry and Water Management, which is mostly in charge of policy level, and the side Government and the Water Administration as the state authorities charged with executive responsibilities.

The Ministry of Agriculture, Forestry and Water Management is in charge of adopting relevant procedures by prescribing more detailed rules pertaining to content of the preliminary flood risk assessment content and manner of making flood hazard maps and flood risk maps as well as the content of the risk management plan. This has to be carried out through adoption of the Rulebook on the detailed content of preliminary flood risk assessments and the flood risk management plan ("Official Gazette of Montenegro" No. 69/15).

As for the execution, in accordance with Law on Waters ("Official Gazette of Montenegro", Nos. 32/11, 47/11 48/15, 52/16, 02/17, 80/17, 84/18) the flood risk management plan is developed on the basis of:

- A preliminary flood risk assessment,
- Identified areas significantly endangered by floods and
- Hazard maps and flood risk maps.

A Preliminary Flood Risk Assessment for each river basin district is prepared by the competent administrative body which is in this case the Water Administration. Based on a preliminary flood risk assessment, the Government identifies areas for which there are significant flood risks or their occurrence may be considered probable.

Grounded on the findings from the Preliminary Flood Risk Assessment the Government identifies areas significantly endangered by floods, or within which the occurrence of floods is considered probable.

Following the identification of the endangered areas, the Water Administration is in charge of preparing flood hazard maps and flood risk maps for selected areas, taking into consideration each river basin district separately.

Finally, for areas deemed as endangered by floods the Government shall adopt Flood Risk Management Plan which is to be developed at the level of the river basin district. It is worth noting that the Flood Risk Management Plans need to be aligned with River Basin Water Management Plans.

In accordance with the procedure set by the aforementioned Decree, Flood Risk Management Plan shall be updated if there is a change in the data determined by the Plan, taking into account the impact of climate change on the occurrence of floods.

The implementation of the Flood Risk Management Plan is done in accordance with the Action Program, which is an integral part of the plan and contains priorities for the implementation of the plan with deadlines, actions to be taken to inform and consult the public and competent authorities for the implementation of the plan.

For a river basin district which is part of an international river basin district, Flood Risk Management Plan shall be drawn up as a jointly with others states in whose territory parts of that river basin district are located.

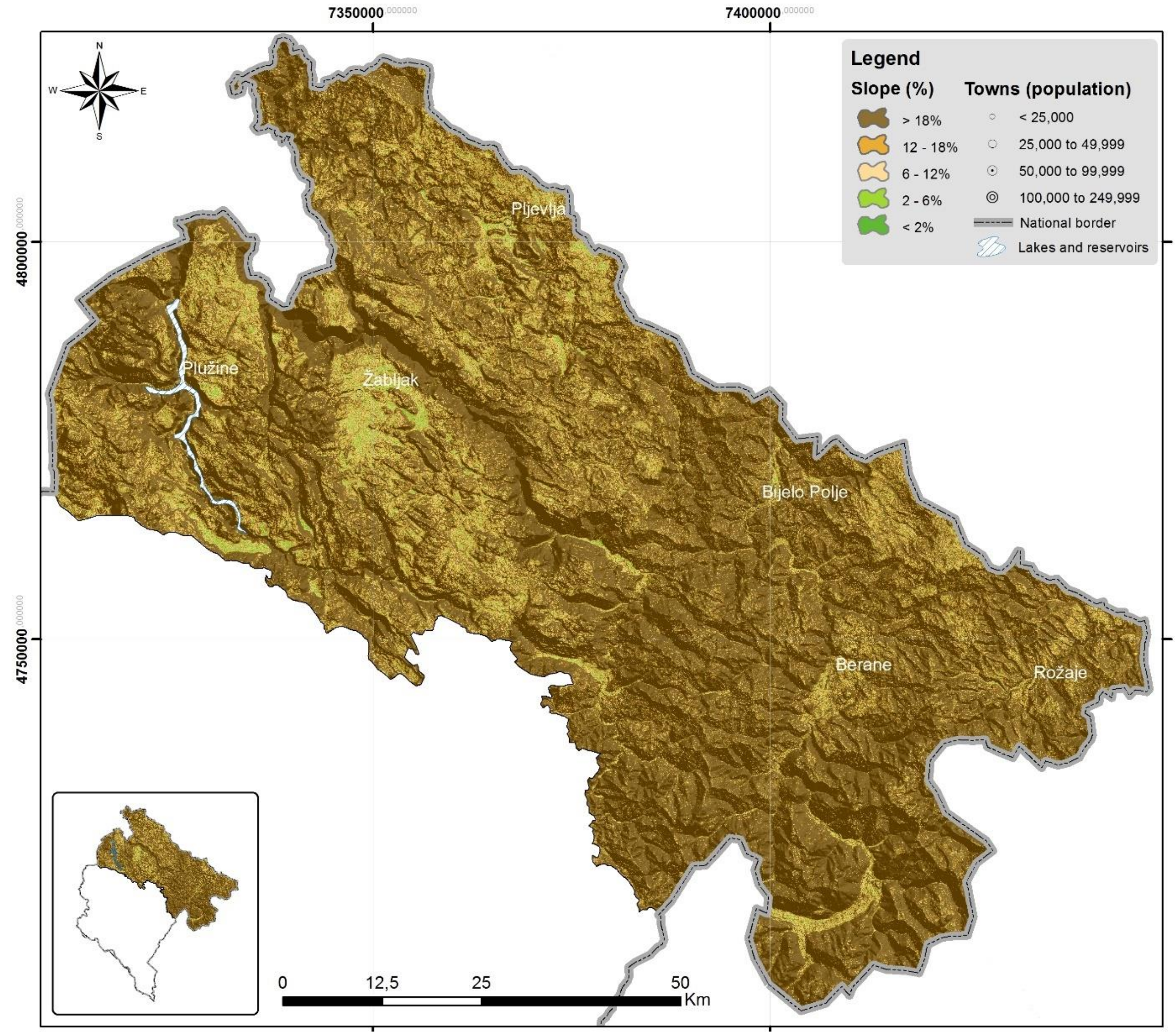
3 DESCRIPTION OF THE DANUBE RIVER BASIN IN MONTENEGRO

3.1 Relief and topography

The terrain of Montenegro ranges from high mountains along its borders with Kosovo and Albania, through a segment of the karst of the western Balkan Peninsula, to a narrow coastal plain that is only one to four miles wide.

Montenegro's section of the karst lies generally at elevations of 1000 meters above sea level-although some areas rise to more than 2000 meters above sea level. Sudden elevation changes over a relatively short distance are a specificity of the relief of Montenegro. The slope map of the Danube River Basin is shown in Figure 3.1.

Figure 3.1. The slope map of the Danube River Basin



The whole territory of Montenegro belongs to just one large geo-structural unit – Dinarides. The Dinaric system (Dinarides) represents a geologically heterogeneous, south European orogenic belt of the Alpine mountain chain (Alpides). The main orientation of the system is NW-SE, parallel to the Adriatic Sea. It is a long, mostly mountainous structure with numerous intermountain depressions, large karst poljes or valleys created by numerous perennials or sinking streams.[5,6]

Dinaric carbonate rock complex is the result of the Alpine orogenic phase with the most intensive tectonic movements during the Tertiary. Tectonic events resulted in a complex system of faults and fractures as privileged subterranean water paths. Moreover, climatic conditions, particularly the successions of wet and warm periods, significantly contributed to karstification.

The total surface of Danube watershed in 7,260 km^2 or 52.5% of state territory. The Danube watershed in Montenegro is the southernmost part of the Black Sea drainage basin.

3.2 Land cover and land use in the River Basin

According to data from the Corine Land Cover (CLC) database as well as the MONSTAT Statistical Yearbook, 64% of the total territory of Montenegro is covered by forests, 14% is arable land and 9% is pastures.

Land use in the Danube River Basin was analysed based on the European Corine Land Cover dataset (2012) showed on Figure 3.2. The Corine Land Cover classes are shown in Table 3.1 and Figure 3.3.

The first class includes all artificial surfaces, mostly related to urban areas, industries, or mining activities. Class 1 covers all urban, industrial and construction activities. Class 2 covers the agricultural activities, irrigated and non-irrigated arable lands, vineyards, orchards as well those including pastures and non-intensive agricultural practices. The third class incorporates the types, such as forest covers, bare rocks and natural areas. Classes 4 and 5 refer to inland wetland and inland waters.

Forest and semi-natural areas are the main land use types in mountainous regions. In river valleys land is used for agricultural production. The big number of cities and villages are situated along the rivers.

[5] Radulović M., 2000: Karst hydrogeology of Montenegro. Sep. issue of Geological Bulletin, vol. XVIII, Spec. ed. Geol. Survey of Montenegro, Podgorica, 271 p.

[6] Stevanović Z., Kukurić, N., Pekaš, Ž., Jolović B., Pambuku A., Radojević D., 2016: Dinaric Karst Aquifer – One of the world's largest transboundary systems and an ideal location for applying innovative and integrated water management. In: Karst Without Boundaries, Stevanović Z., Kresic N., Kukuric N. (eds.), CRC Press/Balkema, Taylor & Francis Group, London, 3-25.

Table 3.1. Corine Land Cover classes

Corine Land Cover Class Code (2012)	Nomenclature
1	Artificial areas
2.1	Arable land
2.2	Permanent crops
2.3	Pastures
3.1	Forested and Semi-Natural Areas
3.2	Semi-natural vegetation
3.3	Open spaces and bare soil
4.1	Wetlands
5.1	Inland waters

Figure 3.2. Land use map of the Danube River Basin (Corine Land Cover classes)

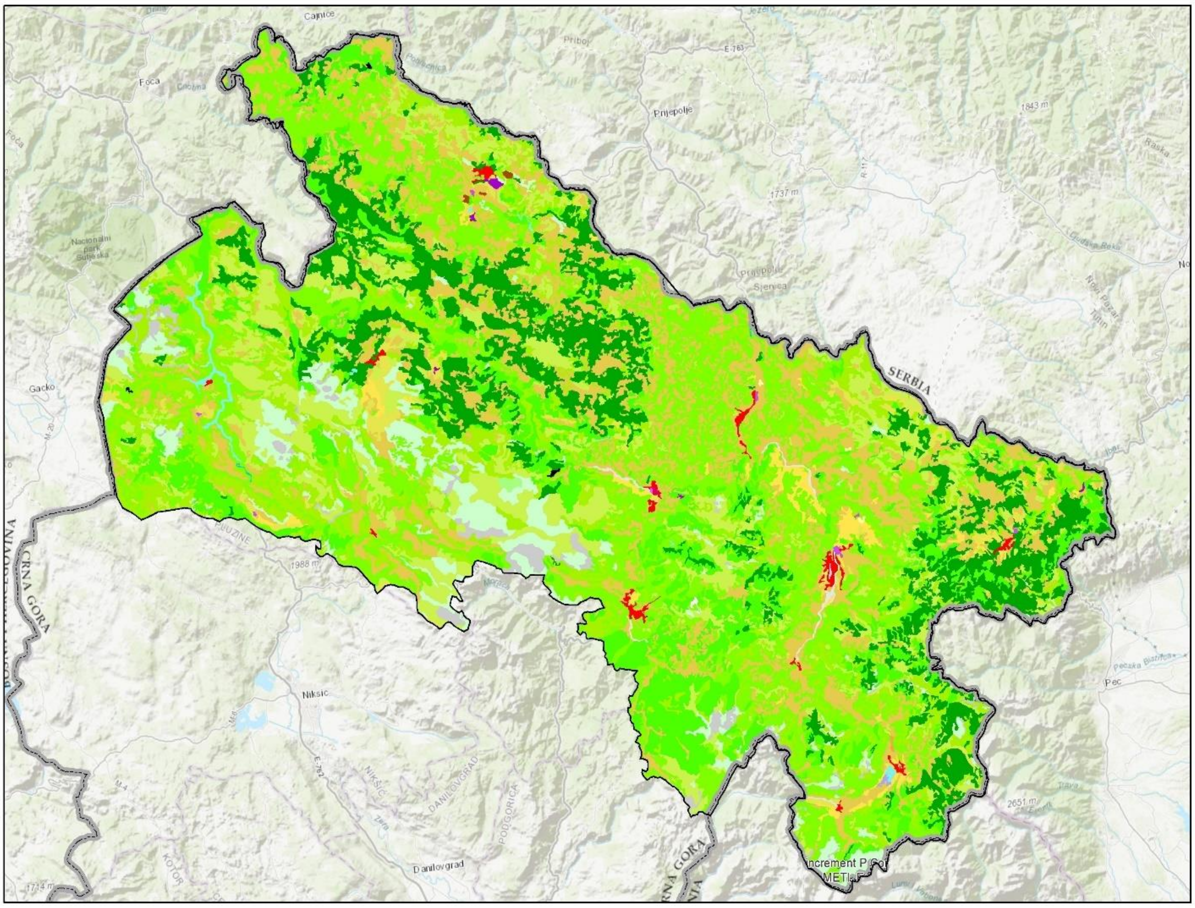


Figure 3.3. Map legend - Corine Land Cover classes

The European Corine Land Cover dataset (2012) was not suitable for land use analysis having in mind the scale of the flood risk maps. In the absence of the appropriate available data set, the municipality's spatial planning data was used with necessary improvements applied based on the Orthophoto base map.

For the risk assessment, land use data was summarised into 4 classes of different vulnerability values – low, medium and high, following the GIZ Guidebook for Hazard and Risk mapping for the Drim – Bojana River Basin[7]:

- Class I – agricultural areas, forests and vegetation (green areas)
- Class II – settlement
- Class III – Industry
- Class IV - Other

A more detailed explanation related to land use data analysis for flood risk assessment is provided in Section 6.

3.3 Demographics

According to the 2011 census, the population of Montenegro was 620,029, which gives a population density of 44.9 inhabitants per square km. The annual population growth is negative when compared to the 2003 population census; statistics show a negative growth rate of about 0.02%. Of the total population, 306,236 are male and 313,793 are female. The most recent statistics show that in mid-2018 there were 622,227 inhabitants in Montenegro, composed of:

- Children (0–17 years) make up 21.9% (136,357) of the total population;
- People aged 15–64 make up 66.9% (416,557) of the total population;
- People aged 65 or over make up 6.5% (40,381 people) of the total population. Life expectancy at birth in 2018 was 77 years.

According to preliminary results from the 2023 census, Montenegro has a population of 633,158. Detailed population data is not yet available.

The surface of the Danube River Basin (DRB) covers 7,260 km^2 or 52.5% of the national territory with 177,837 inhabitants (Census, 2011), which is 28.6% of the total population (Table 3.2).

The density of population in the Danube River Basin is, on average value, 25 inhabitants per km^2, which is smaller than the average value for the whole country of 45 (Census 2011) and below the value for EU27.

The State territory is administratively divided into 25 municipalities, with municipal centres that are bearers of local self-government. There are 13 main municipalities in the Danube River Basin. 10 municipalities are located completely in the Danube River Basin. Kolašin (53%), Plužine (95.5%) and Šavnik (98.9%) are also located in the Danube River Basin but with some territory in the Adriatic River Basin. Similarly, the municipalities of Niksic and Podgorica also reside in the Danube River Basin although only at 4% and 11.8%, respectively. The difference between administrative boundaries and river basin boundaries adds some

[7] Flood Hazard and Risk Mapping for the Drin/Drim – Buna/Bojana River Basin, Guidebook. Prepared within the Climate Change Adaptation through Transboundary Flood Risk Management in the Western Balkans. GIZ (2022).

presently unresolvable complications when it comes to determining the exact density of the population inside of the Danube River Basin. The figures in Table 3.2 below do not take into account these differences.

Table 3.2. Number of inhabitants and population density in the Danube River Basin

Municipality	Surface (km^2)	Population[24]	Density (Inhabitants/km^2)
Andrijevica	283	5,071	18
Berane	544	27,284	51
Bijelo Polje	924	46,051	50
Gusinje	157	4,027	26
Kolašin[8]	479	8,380	9
Mojkovac	367	8,622	23
Niksic[9]	103	No data	No data
Petnjica	173	6,686	34
Plav	328	9,081	28
Pljevlja	1,346	30,786	23
Plužine[10]	853	3,246	4
Podgorica[11]	136	No data	No data
Rožaje	432	22,964	53
Šavnik[12]	556	2,070	4
Žabljak	445	3,569	8
Danube River Basin	**7,260[13]**	**177,837**	**25**
Montenegro	**13,910**	**620,030**	**45**

[8] 53% of Kolašin Municipality is inside the Danube River Basin. The accurate calculation of the population residing in the Danube River Basin is not possible.

[9] 4% of the Niksic Municipality is inside the Danube River Basin. The accurate calculation of the population residing in the Danube River Basin is not possible. The Rules on the borders of the sub-floor areas and the small-basin areas ("Official Gazette of Montenegro", No. 015/16 of 03.03.2016) did not precisely define the boundaries of individual sub-watersheds and it is not possible to determine affiliation with a particular river basin district. This is the reason why this Regulation requires revision.

[10] 95% Plužine Municipality has the vast majority of its territory in the Danube River Basin.

[11] 11.8% of the Podgorica Municipality is partly within the Danube River Basin.

[12] Šavnik Municipality has the vast majority of its territory in the Danube River basin (99.9%)

[13] Official figure, GIS shape files provided by MAFWM are slightly less (2%) in total area.

3.4 Hydrographic and hydrologic characteristics

The Danube watershed in Montenegro is the southernmost part of the Black Sea drainage basin encompassing the main Sub-Basins of the Ćehotina, Ibar, Lim, Piva and Tara rivers (Figure 3.4). The Ibar river flows into the Western Morava while the Tara, Piva, Lim and Ćehotina rivers flow into the Drina River (Table 3.3)

Figure 3.4. Sub-Basin and small basins in river network the Danube River Basin

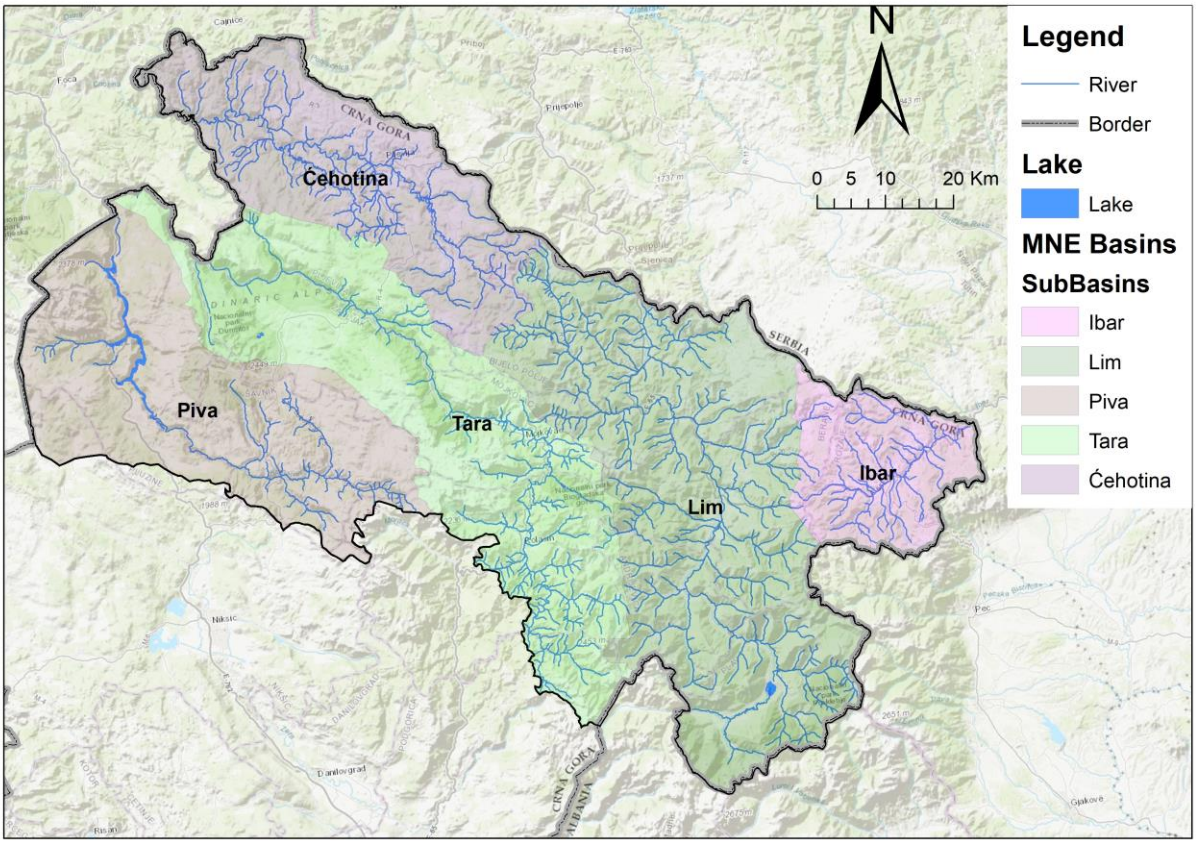


Table 3.3. Major rivers[14] and Lakes within the Danube River Basin

River/Lake Name	Length (km)	Catchment Area (km^2)
Tara	148	2,040
Ćehotina	99*	810*
Lim	98*	2,280*
Piva	85	1,784
Ibar	35*	413*

*length and surface area within MNE

[14] Rivers over 30km in length.

The Tara River springs below the peaks of Maglić Kariman (about 2,400 m above sea level). From the source to the mouth of river Drcka, the right bank of the Tara River is much more developed than the left. The larger left tributaries are Opasanica, Pčinja, Plašnica, Štitarica, Ravnjak and the spring of Ljutica. On the right side, the Tara receives Drcka, Skrbuša, Svinjača, Jezerštica, Rudnjiča, Bjelojevićka and Selačko rivers. The surface of the Tara River Basin is 2,040 km^2. The length is 148 km.

The Ćehotina River originates from beneath the Stožer mountain. After the Lim river it is the largest tributary of the Drina river. Ćehotine's influences the are Koričić, Maočnica, Vezišnica and Voloder. The surface of the Ćehotina basin to H.S. Gradac is 809.8 km^2.

The Lim River originates from the Plavsko Lake, although its source is the Vruja and Grnčar Rivers, which are forming the Ljuča river and bring almost all water in Lake Plavsko. Prior to Andrijevica on the left side in Lim flows Murinska and Zlorečica rivers, while the right are the tributaries are Đurička, Rženička, Velička and Komarača rivers. From Andrijevica to Berane, the Lim receives left tributaries Kraštica, Trebić, Ševarinska and Bistrica rivers, while the right tributaries are Šekularska and Kaludra rivers. From Berane to Bijelo Polje, there are the Brzava and Ljuboviđa tributaries on left side while from the right side there are Dapsićka and Lješnica rivers. From Bijelo Polje to Dobrakov on the left side there is the Bjelopoljska Lješnica river and on the right side the Bjelopoljska Bistrica river. The total length of Lim within MNE is 98 km with drainage area of 2,280 km^2.

The Piva River is formed from the high Montenegrin mountain ranges. This river, along the stream, has several names. Its source, under the south-western slopes of Durmitor, to Šavnik, is called Bukovica. Merging with Bijela in Šavnik, the watercourse continues under the name Pridvorica, retaining the name to the mouth of the Upper Komarnica in Pridvorica. The further downstream watercourse continues under the name Komarnice until the Pivski Monastery, where it receives the tributary of the Sinjaci and change of the name to Piva. The watercourse flows to Šćepan Polje, where it meets the Tara River and from there begins the Drina River. The surface of the Piva River Basin is estimated at about 1,784 km^2 to Šćepan Polje. The upper Komarnica springs from under Durmitor and then runs through a canyon with a depth of 600 m and about 4 km long. Along the Komarnica stream there are pronounced karst phenomena, with insufficiently studied underground leakage and numerous hot springs.

The Ibar River originates from the north-eastern slopes of Hajla mountain at an altitude of 1,760 m. The main tributaries are the Županica, Limnička, Ibarac, Grahovska, Bukovačka, Baltička, Crnja and Bačka rivers. The shape of the Ibar basin to the hydrological station Bać is in a form of array with very prominent hydrography and possibilities for rapid formation of flood waves. The surface of the Ibar basin within MNE up from hydrological station at Bać is 413 km^2 while the length of flow within MNE is 35 km.

Lake Plavsko is the biggest glacial (mountain) lake in Montenegro. It is placed in Plav/Gusinje valley at an altitude of 906 m. The average depth of this lake is about 4m while the biggest dept is 10m in central part of the lake. The shoreline is about 8 km while the surface is 2 km^2. It fills with water from river Ljuča, which brings water from surrounding Prokletije massif, and it empties with Lim River which starts from this Lake. It is ellipse like shaped with length of 2.1 km and width of 1 km.

Lake Crno is one of the highest mountain lakes placed on Durmitor massif on altitude 1,416 m above sea level. It consists of two parts, small and big Crno lake kidney shaped subunits. The smaller subunit is deeper with maximum depth of 49 m, while the largest part is shallower with maximum depth of 24 m. The total length of the whole lake (both subunits) is 1.15 km with a maximal width is 0.6 km. It fills with water from the well called Čeline, several smaller underwater wells as well as from the several smaller mountain brooks. The water from lakes goes underground and appears in two regions as wells in Tara and Komarnica valleys. It is placed in National Park "Durmitor".

Lake Biogradsko is situated at an altitude of 1100 m on the Bjelasica mountain. It is surrounded with Biogradska gora ancient-forest and it is one of the most beautiful mountain lakes in MNE. The lake is 1.1 km in length and 0.41 km in width with average depth of 4.5 m. The maximum dept is about 12 m in central part of the Lake. It is fed with water from the small Biogradska river and from the Bendovac brook while from the Lake it flows out small river Jezerštica which ends into the Tara River. It is placed in National Park "Biogradska Gora".

Table 3.4. Natural lakes in the Danube River Basin

Lake Name	Lake Surface Area (km^2)	Lake Type
Lake Plavsko	2	Glacial (mountain)
Lake Crno	0.53	Glacial (mountain)
Lake Biogradsko	0.27	Glacial (mountain)

3.5 Climate

Montenegro is located in the central part of a moderately warm zone in the Northern Hemisphere (41°52' and 43°32' latitude North and 18°26' and 19°22' longitude East). Owing to its latitude, i.e. its proximity to the Adriatic and Mediterranean Seas, it has a Mediterranean climate with warm and somewhat dry summers and mild and rather humid winters.

Large bodies of water, its altitude and the position of its coastal mountains, along with the relief of its terrain affect both its local and regional climates; thus, within a small area there are big differences between the climates in the coastal and high mountains regions. There are also numerous transitional local climates in-between these areas.

The average annual air temperature ranges from 4.6°C at altitudes of 1,450 m above sea level, to 15.8°C on the coast. The average annual precipitation ranges from 800 mm in the north to around 5,000 mm in the far southwest.

On average, the annual number of days with precipitation is about 115-130 on the coast and around 172 in the north of Montenegro. The rainiest month on the coast is November, while July is the driest. Snow cover is formed at altitudes above 400 meters. On the high land it snows much more frequently in spring than in autumn.

Table 3.5. Average temperature in the Danube River Basin[15]

Station	Temperature (°C)			
	Average minimum	Average maximum	Average total	Measured since (year)
Kolasin	2.3	14.0	7.5	1947
Berane	3.7	16.3	9.5	1950
Bijelo Polje	4.1	16.2	9.4	1950
Zabljak	0.6	10.6	5.3	1958
Pljevlja	3.1	15.2	8.7	1948

Table 3.6. Average monthly temperature in the Danube River Basin[16]

Station	Monthly temperature (°C)											
	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Kolasin												
max	3.1	4.5	8.3	13.0	18.0	21.8	24.5	24.9	20.3	15.2	9.3	4.2
min	-5.7	-4.6	-2.0	1.4	5.3	8.4	9.6	9.2	6.7	3.2	-0.2	-3.9
avg.	-1.6	-0.4	2.5	6.8	11.3	14.7	16.5	16.1	12.3	8.2	3.9	-0.1
Berane												
max	3.9	7.0	11.4	16.0	21.0	24.6	27.1	27.6	22.8	17.8	11.1	4.6
min	-5.2	-3.8	-0.6	3.0	7.0	10.3	11.7	11.2	8.1	4.1	0.5	-3.3
avg.	-1.1	1.1	4.9	9.4	13.9	17.3	13.2	18.9	14.5	9.9	4.9	0.4
Bijelo Polje												
max	3.5	6.9	11.6	16.4	21.1	24.7	27.1	27.6	23.0	17.4	10.3	4.3
min	-4.8	-3.4	-0.3	3.4	7.5	10.8	12.2	11.9	9.0	5.0	1.0	-3.0
avg.	-1.1	1.2	5.1	9.7	13.9	17.2	18.9	18.7	14.8	9.9	4.9	0.3
Zabljak												
max	1.2	1.8	4.5	8.6	14.0	17.8	20.4	20.8	16.4	12.1	6.9	2.5
min	-8.1	-7.4	-4.6	-0.7	3.7	7.2	8.7	8.7	5.4	1.9	-1.9	-6.1
avg.	-3.9	-3.2	-0.4	3.7	9.0	12.8	14.8	14.5	10.4	6.2	1.8	-2.2
Pljevlja												
max	2.8	5.9	10.2	14.8	19.9	23.4	25.7	26.3	21.9	16.9	10.1	3.8
min	-6.2	-4.6	-1.4	2.5	6.6	9.9	11.2	10.9	7.9	4.0	0.2	-4.0
avg.	-2.2	0.0	3.8	8.4	13.1	16.3	18.2	18.1	14.0	4.4	4.4	-0.5

[15] Source: Institute of Hydrometeorology and Seismology
[16] Source: Institute of Hydrometeorology and Seismology

Climate Change

Monitoring and evaluation of climate shows that the Montenegrin climate has changed due to global climate changes and variability. The clearest indicators include: a significant increase in air temperature, an increase in both surface and mean sea level temperatures, and changes in extreme weather and climatic events.

The valley of the River Zeta has the hottest summers in Montenegro, mainly due to having the highest number of clear days. The highest mean summer temperature is in Podgorica, 29.2°C with the highest maximum daily temperature of up to 44.8°C recorded in August 2007. The lowest minimum daily temperature was -32°C, recorded in Rožaje in January 1985.

During the period 1949–2018 changes in mean annual temperature and precipitation were observed at the national level. Measurements indicate a trend towards an increase in temperature throughout most of the territory of Montenegro since the second half of the 20th century. Summers have become very hot, especially over the last 20 years. For the summer period from 1991 to 2018, average temperature deviations from the climatological norm ranged from 90% to 98%.

The extreme temperature indicators show that in the northern region of Montenegro (Danube River Basin) the number of summer and tropical days and nights has changed significantly compared to the reference period of 1961–1990. The same applies to warm days and nights, the length of heat waves, and the number of frosty days. Significant changes in the length of the growing season were recorded only in Žabljak.

The decadal view of the change in mean annual precipitation for the period 1951–2017 shows that the decade 2011–2020 is expected to have a lower average annual precipitation compared to the previous decade, primarily due to hydrological droughts during 2011, 2012, 2017, 2018, and 2019.

In order to design climate projects for Montenegro, the Third National Communication of Montenegro (2020) used the regional GHG emission scenario RCP8.5 established by the IPCC – AR5 (IPCC, 2014).

The results from the climate projections show an increase in the annual temperature of 1.5° C to 2° C by 2040 throughout the country. The increase in the temperature during the winter months December–January–February (DJF) is expected to be between 2°C and 2.5°C, and in the summer months June–July–August (JJA) it is expected to be on average around 2°C.

For the period 2041–2070 the deviations of the mean annual temperature range from 2.5°C to 3° C. The predicted warming in winter and summer is on average the same, with a more prominent increase in the north in winter and in the south in summer.

For the period 2017–2100, the deviation in the mean annual temperature over most of the territory is around 5.5°C. In the southern, coastal part, at lower altitudes, the increase in temperature will be higher by 6°C.

The predicted increase in temperature during winter months is expected to lead to a decrease in the total accumulation of snow, but also to a decrease in the number of days with snowfall in the territory of Montenegro.

The results from the climate projections show a decrease in rainfall especially during the summer months and increase in winter months in some parts of the country.

For the period 2011–2040, the north of the country is expected to experience an increase in rainfall of up to +5%, while in the southern part of the country the rainfall it is expected to decrease by up to -5%. For the DJF season, rainfall is expected to increase by up to +5%, with a slightly more pronounced change in the north, while for the JJA season the rainfall is expected to decrease slightly, especially in the southeast regions.

For the period 2041–2070, the country is expected to experience a decrease of up to 20% in the mean annual rainfall throughout the territory. The changes during the winter are similar to the annual deviations during the period 2011–2040, while the summer season is characterized by a decrease of rainfall of up to -45%.

For the period 2017–2100, the mean annual rainfall is expected to decrease by up to -20% over most of the country. The rainfall can be expected to increase by about +20% on average in winter, while in summer there is a clear decrease with values more than -45%.

In the case of the RCP8.5 scenario, during this century, in most of the territory of Montenegro a decrease in the number of episodes when five-day rainfall exceeds 60 mm can be excepted, but also an increase in accumulations during individual episodes. Although the number of such episodes will be smaller, the accumulated precipitation during individual episodes will be on average higher. This change can be particularly important when analysing the risk of torrential floods, triggering landslides, and landslides.

In the period 2011–2040 in the north of the country, the change in the average number of consecutive days without precipitation ranges by around -5% both in the summer and all-year-round. A positive change, with a maximum value of around 30%, is expected in the south-eastern part of the country, and is slightly higher for the summer season than on a yearly basis. An increase in the number of consecutive non-precipitation days throughout the territory of Montenegro is expected over the remaining two analysed periods. The change will be greater for the period 2071–2100 and will range from 30% to over 70% during the summer season. The drastic increase in the number of consecutive days predicted without rainfall by the end of the century clearly shows that in the future there will be an increased risk of droughts.

3.6 Precipitation and runoff

The following tables show precipitation values taken from the Institute of Hydrometeorology and Seismology (IHMS), measured over the period of 60-70 years. The distribution of precipitation is uneven, reaching the higher values in Kolasin and Zabljak and lowest in the Pljevlja and Berane. The snowfall is characteristic for the northern and part of the central region of Montenegro. The highest snow cover is registered in Zabljak.

Data provided by the Institute of Hydrometeorology and Seismology was used in Tables 3.7 to 3.10 to show the annual precipitation, snow cover 24 hour and monthly precipitation, respectively.

Table 3.7. Annual participation in the Danube River Basin

Measuring Station	Annual precipitation (mm)		
	Average	Maximum	Minimum
Kolasin	2079.2	3290.9	927.7
Berane	906.7	1443.2	486.8
Bijelo Polje	898.2	1310.1	517.5
Zabljak	1492.2	2255.8	1017.6
Pljevlja	787.1	1038.8	542.2

Table 3.8. Average snow cover in the Danube River Basin

Measuring Station	Snow cover (cm)	
	Average	Measured since (year)
Kolasin	6	1949
Berane	2	1954
Bijelo Polje	2	1950
Zabljak	20	1958
Pljevlja	2	1950

Table 3.9. 24-hour precipitation in the Danube River Basin

Measuring Station	24-hour precipitation (mm)	
	Average	Measured since (year)
Kolasin	5.7	1949
Berane	2.5	1950
Bijelo Polje	2.5	1950
Zabljak	4.1	1958
Pljevlja	2.2	1949

Table 3.10. Monthly precipitation in the Danube Basin

Station	Monthly precipitation (mm)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Kolasin	214.5	201.5	180.3	171.4	129.5	98.9	71.8	75.9	144.3	207.9	297.6	285.8
Berane	74.6	69.3	67.3	72.7	78.5	66.9	59.6	50.4	75.9	86.0	108.0	97.6
Bijelo Polje	71.7	72.2	63.0	71.6	78.0	72.0	65.6	55.8	74.4	81.6	103.2	88.9
Zabljak	115.3	115.4	115.0	121.2	105.5	97.2	80.6	72.2	114.4	164.1	213.1	175.2
Pljevlja	52.4	54.6	51.0	58.9	72.6	85.6	71.5	60.5	67.4	70.1	76.9	65.7

The long-term analysis of hydrological stations in the Danube River Basin is shown in Table 3.11. The annual discharge trend and periodicity analysis suggests that long-term changes are taking place on all hydrological stations in the Danube River Basin, and that they exert significant influence on estimation of average discharges.

Discharge downtrends were registered on all stations for the measured periods. A statistically significant trend was registered in the upper course of the Lim River. The majority of hydrological stations registered annual discharge trend close to the confidence threshold α= 0.05. Negative annual discharge trends in the basins of South-East Europe have presented similar findings.

Table 3.11. Long-term analysis of hydrological stations in the Danube River Basin

River	Station	Area (km^2)	Period	Flows (m^3/s)				
				Q_{min}	$Q_{min\ avg.}$	$Q_{avg.}$	$Q_{max\ avg.}$	Q_{max}
Lim	Plav	364	1948-2012	0.244	3.212	19.23	145.5	324
	Bijelo Polje	2183	1948-2014	8.20	12.14	57.14	512.8	1 077
Tara	Crna Poljana	247	1957-2014	0.72	1.448	12.01	175.7	468
	Trebaljevo	506	1959-2014	1.55	2.668	24.64	307.8	701
Ćehotina	Ćirovići	120	1978-2006	0.248	0.487	2.117	38.41	106
	Pljevlja	361	1948-2007	0.320	1.274	6.31	65.11	145
	Gradac	810	1963-2011	2.10	3.737	12.90	160.6	414

4 FLOOD PROTECTION IN THE DANUBE RIVER BASIN

4.1 High water and significant floods

The task of hydrological analysis of high waters is to determine the probable occurrence of critical events. High water analyses and calculations depend on the statistical analysis of available data. On insufficiently studied basins it is necessary for high waters to be accounted for based primarily on precipitation data, i.e., based on the rainfall.

Statistical analysis of high waters is a tool for linking the size of high waters to the probability of appearance. In practice, this is most commonly conducted on a series of maximum annual flows/water levels. The probable occurrence of high waters is most often expressed as the annual probable to overcome p(x) i.e., the average of the annual maximum exceeds x. The return period (in years) T(x) is the reciprocal value of this probable and represents the expected number of years for which flow/water level x will be exceeded at least once. The underlying problem in the statistical analysis of high waters is the short historical sequences and processing period, on which the values of the high waters depend. Another significant problem is the incurability in the low- probable high-water ratings, the occurrence of the extraction of the high water scattered beyond the range of observed values.

For the purpose of producing the PFRA, 21 hydrological stations (HS) from the Danube Basin have been selected. Data from existing and historical hydrological stations (Figure 4.1) were used for the analysis of high-water levels (Table 4.1). The data for the selected HS has been provided by the Institute of Hydrometeorology and Seismology of Montenegro. In the preparation of this analysis, it was necessary to consult experts from the Hydrological Analysis Department of IHMS, as the information relating to the history of the HS work, the method of measurement and observation were of crucial importance for the preparation of this study. For certain HS input sequences are shorter than the actual available. The reason for this was to take account of the change in the location of the certain stations, as well as the evident disturbed natural flow regime on certain profiles.

After the final adoption of the data for the calculation, a statistical analysis was performed using the method of annual extremes to calculate the probability that 10%, 1% and 0.2%, i.e., return periods of 10, 100 and 500 years. To describe the law of distributing maximum annual data, multiple theoretical distribution functions (Log Pearson III, Pearson III, In, Gumbel and GEV) were used. Statistical analysis of hydrological extremes yielded models (probability distributions) that describe the X-P relationship well enough in the observed data set. The adopted values of the water level and flow for all 21 hydrological stations, which were obtained by statistical analysis, are shown In Table 4.1. The calculated return periods for watercourse locations together with the expected flooding mechanism are provided in Table 4.2.

Further analysis yielded the required computational flows HQ10, HQ100 and HQ500 for all listed measurement profiles. The correlation of the calculated values of HQ10, HQ100 and HQ500 on the measuring profile with the characteristic upstream downstream profiles was performed by a rational method.

The hydraulic model HEC-RAS was used to calculate the flood lines. Data on the geometry of the riverbed (topography of the main riverbed and inundation) were obtained from a digital terrain model (resolution 5m) (source: Real Estate Administration of Montenegro). The model does not include river regulations, or any other work performed after the development of the subject DEM. Calibration of the model was performed based on 2010 flood data. Using a cross-section of the water mirror plane with a digital terrain model, spatial data was obtained for the display of flooded areas, in the form of polygons, and the display of depths, in raster form. This data was used (as shape files) for further processing in the Quantum GIS program. It is important to note that the accuracy of the hydraulic watercourse model largely depends on the resolution of the digital terrain model (DTM).

Figure 4.1. Hydrological stations in the Danube River Basin

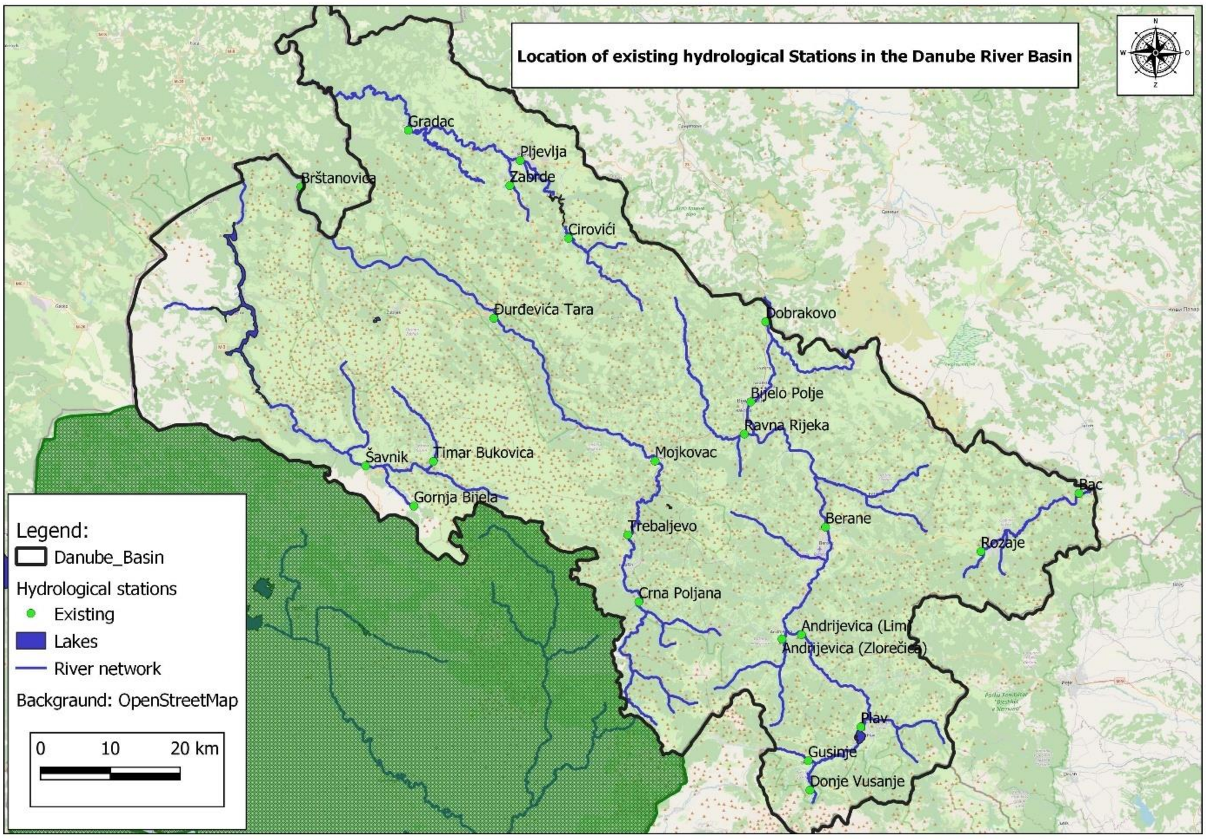


Table 4.1. Hydrological stations in the Danube River Basin used for computational flow analysis

Adopted values of water level (H) / flow (Q) obtained by statistical analysis for the annual probability of occurrence of 10, 1 and 0.2% (T = 10 years; T = 100 years; T = 500 year)

Station	Watercourse	River Basin	Longitude	Latitude	m.a.s.l[17]	H(cm)			Q(m³/s)		
						10%	1%	0.2%	10%	1%	0.2%
Plav	Lim	Drina	42° 36' 28"	19° 55' 58"	906.58	242	309	352	231	363	461
Andrijevica	Zlorečica	Lim	42° 43' 24"	19° 47' 55"	742	225	268	289	142	223	275
Andrijevica	Lim	Drina	42° 43' 49"	19° 48' 24"	744.39	280	364	421	341	470	555
Berane	Lim	Drina	42° 52' 03"	19° 52' 49"	658.05	423	524	580	492	620	690
Zaton	Lim	Drina	42° 58' 57"	19° 46' 16"	583.9	302	366	403	629	894	1079
Bijelo Polje	Lim	Drina	43° 01' 52"	19° 45' 05"	559.67	336	434	496	758	1099	1338
Gubavač	Bjelopoljska Bistrica	Drina	43° 06' 09"	19° 47' 54"	545	209	277	322	47.4	65.0	77.4
Dobrakovo	Lim	Drina	43° 08' 13"	19° 46' 55"	531.61	419	574	687	950	1356	1631
Crna Poljana	Tara	Drina	42° 46' 32"	19° 33' 01"	965.8	291	370	418	302	496	636
Mateševo	Drcka	Tara	42° 45' 14"	19° 34' 33"	1015	188	225	247	100	132	147
Trebaljevo	Tara	Drina	42° 51' 44"	19° 31' 54"	894.08	388	529	617	503	746	901
Podbišće	Štitarica	Tara	42° 55' 15"	19° 34' 09"	839.73	154	213	251	63.9	143	202
Bistrica	Tara	Drina	43° 00' 16"	19° 27' 00"	736	528	688	788	655	956	1149
Pljevlja	Ćehotina	Drina	43° 20' 29"	19° 21' 47"	754.99	210	276	316	99.7	161	211
Zabrđe	Vezišnica	Ćehotina	43° 08' 46"	19° 18' 30"	770	239	297	328	71	96.3	110
Rozaje	Ibar (pvr)	Zapadna Morava	42° 45' 55"	20° 08' 59"	1035.14	147	204	250	54.7	107	155
Vusanje	Grlja	Vruja	42° 30' 30"	19° 50' 00"	960	151	204	243	57.4	89.2	113
Gusinje	Vruja	Ljuča	42° 33' 25"	19° 50' 34"	920	178	227	260	118	176	217
Gusinje	Grnčar	Ljuča	43° 33' 53"	19° 50' 13"	918	179	213	230	ND[18]	ND	ND
Šavnik	Bijela	Pridvorica	42° 56' 59"	19° 5' 58"	832.01	198	291	356	70	166	240
Šavnik	Bukovica	Pridvorica	42° 57' 27"	19° 6' 11"	819.08	226	283	318	115	179	225

[17] Height in metres above sea level.

[18] ND: Not Determined. Water Flow measurements were not recorded at Gusinje HS.

Table 4.2. Return periods calculated for all hydrological stations in the Danube River Basin

Year	Expected Flooding Mechanism[19]	Calculated Return Period (Years)
Watercourse Location: Grlja, "Vusanje"		
1960	Large Scale Floods	30
1962	Outflow from the riverbed	10
1968	Outflow from the riverbed	10
1969	Outflow from the riverbed	10
1974	Large Scale Floods	30
1979	Outflow from the riverbed	10
2009	Outflow from the riverbed	10
2010	Large Scale Floods	50-60
2012	Outflow from the riverbed	10
Watercourse Location: Vruja, "Gusinje"		
1960	Outflow from the riverbed	10
1963	Large Scale Floods	20
1968	Outflow from the riverbed	10
1969	Outflow from the riverbed	10
1974	Large Scale Floods	30-50
1979	Large Scale Floods	20-30
1995	Outflow from the riverbed	10-20
1999	Outflow from the riverbed	10-20
Watercourse Location: Grnčar,"Gusinje"		
1968	Outflow from the riverbed	10
1969	Outflow from the riverbed	10
1986	Large Scale Floods	10
1990	Outflow from the riverbed	10
1991	Outflow from the riverbed	10
1999	Outflow from the riverbed	10
2003	Outflow from the riverbed	10
Watercourse Location: Lim, "Plav"		
1952	Outflow from the riverbed	10
1963	Outflow from the riverbed	10
1968	Outflow from the riverbed	10
1979	Large Scale Floods	40-50
1995	Outflow from the riverbed	10
1999	Outflow from the riverbed	10
2000	Large Scale Floods	10
2003	Large Scale Floods	10
2008	Outflow from the riverbed	10

[19] The mechanism of flooding has been described based on the and the topography of the region.

Year	Expected Flooding Mechanism[19]	Calculated Return Period (Years)
2010	Large Scale Floods	10
2016	Outflow from the riverbed	10
Watercourse Location: Zlorečica, ”Andrijevica”		
1995	Outflow from the riverbed	10
1998	Outflow from the riverbed	10
2000	Outflow from the riverbed	10
2003	Outflow from the riverbed	10
2010	Outflow from the riverbed	10
Watercourse Location: Lim, ”Andrijevica”		
1952	Large Scale Floods	20-30
1955	Outflow from the riverbed	10-20
1962	Outflow from the riverbed	10
1963	Large Scale Floods	20-30
1968	Large Scale Floods	20-30
1970	Large Scale Floods	20
1974	Large Scale Floods	N/A
1977	Outflow from the riverbed	10
1979	Outflow from the riverbed	10
1980	Outflow from the riverbed	10
1981	Outflow from the riverbed	10
1985	Outflow from the riverbed	10
1994	Outflow from the riverbed	10
1995	Outflow from the riverbed	10
1998	Outflow from the riverbed	10
1999	Outflow from the riverbed	10
2000	Outflow from the riverbed	10
2003	Outflow from the riverbed	10
2010	Large Scale Floods	10
Watercourse Location: Lim, “Berane”		
1968	Outflow from the riverbed	10
2000	Outflow from the riverbed	10
2010	Large Scale Floods	10
1968	Outflow from the riverbed	10
1970	Outflow from the riverbed	10
1974	Large Scale Floods	20-30
1979	Large Scale Floods	100
1985	Outflow from the riverbed	10
1995	Large Scale Floods	10
2000	Outflow from the riverbed	10
Watercourse Location: Lim, “Bijelo Polje”		
1952	Large Scale Floods	100
1963	Outflow from the riverbed	10
1968	Outflow from the riverbed	10

Year	Expected Flooding Mechanism[19]	Calculated Return Period (Years)
1970	Outflow from the riverbed	10
1974	Outflow from the riverbed	20
1979	Large Scale Floods	40
1985	Outflow from the riverbed	10
1994	Outflow from the riverbed	10
1995	Outflow from the riverbed	10
2000	Outflow from the riverbed	10-20
2010	Large Scale Floods	20-30
2016	Outflow from the riverbed	10-20
Watercourse Location: Bistrica, "Gubavač"		
1949	Outflow from the riverbed	10
1952	Outflow from the riverbed	10
1955	Outflow from the riverbed	10
1958	Outflow from the riverbed	10
1977	Outflow from the riverbed	10
1979	Large Scale Floods	100
1981	Outflow from the riverbed	10
1984	Large Scale Floods	30
1988	Outflow from the riverbed	10
Watercourse Location: Lim, "Dobrakovo"		
1963	Outflow from the riverbed	10
1970	Outflow from the riverbed	10
1974	Outflow from the riverbed	10
1979	Large Scale Floods	100
1985	Outflow from the riverbed	10
2016	Outflow from the riverbed	10
Watercourse Location: Tara, "Crna poljana"		
1970	Outflow from the riverbed	10
1974	Outflow from the riverbed	10
1979	Outflow from the riverbed	10
1992	Large Scale Floods	30
1995	Outflow from the riverbed	10
1999	Outflow from the riverbed	10
2000	Outflow from the riverbed	10
2003	Outflow from the riverbed	10
2004	Outflow from the riverbed	20
2007	Outflow from the riverbed	10
2010	Outflow from the riverbed	10
2016	Large Scale Floods	20-30
Watercourse Location: Tara, "Trebaljevo"		
1963	Outflow from the riverbed	10
1970	Outflow from the riverbed	10
1974	Outflow from the riverbed	10-20

Year	Expected Flooding Mechanism[19]	Calculated Return Period (Years)
1979	Outflow from the riverbed	10
1992	Large Scale Floods	30
1999	Outflow from the riverbed	10
2000	Outflow from the riverbed	10-20
2004	Outflow from the riverbed	10
2010	Outflow from the riverbed	20
2016	Outflow from the riverbed	10-20
2018	Outflow from the riverbed	10
Watercourse Location: Štitarica, "Podbišće"		
1968	Outflow from the riverbed	10-20
1974	Outflow from the riverbed	10-20
1979	Outflow from the riverbed	10
1990	Outflow from the riverbed	10
1991	Large Scale Floods	100
1992	Outflow from the riverbed	10
Watercourse Location: Tara, "Bistrica"		
1963	Outflow from the riverbed	10-20
1968	Outflow from the riverbed	10
1974	Large Scale Floods	20-30
1979	Outflow from the riverbed	10-20
1992	Large Scale Floods	20-30
1999	Large Scale Floods	20-30
Watercourse Location: Ćehotina, "Pljevlja"		
1968	Outflow from the riverbed	10
1969	Outflow from the riverbed	10
1974	Large Scale Floods	20-30
1979	Large Scale Floods	30
1985	Outflow from the riverbed	10
1989	Outflow from the riverbed	10
1994	Outflow from the riverbed	10-20
1997	Outflow from the riverbed	10-20
2000	Outflow from the riverbed	10-20
2006	Outflow from the riverbed	10
2010	Large Scale Floods	10
Watercourse Location: Ibar, "Rožaje"		
1972	Large Scale Floods	100
1973	Outflow from the riverbed	10
1979	Outflow from the riverbed	10
2010	Large Scale Floods	10
2016	Outflow from the riverbed	20
2017	Outflow from the riverbed	10
2019	Outflow from the riverbed	10

Year	Expected Flooding Mechanism[19]	Calculated Return Period (Years)
Watercourse Location: Bukovica, "Šavnik"		
1952	Outflow from the riverbed	20
1964	Outflow from the riverbed	20
1968	Large Scale Floods	40
1974	Outflow from the riverbed	10
1979	Outflow from the riverbed	10
1985	Outflow from the riverbed	10
1987	Outflow from the riverbed	10
Watercourse Location: Bijela, "Šavnik"		
1952	Outflow from the riverbed	10
1970	Outflow from the riverbed	10-20
1974	Outflow from the riverbed	10

Given the geomorphological characteristics of the territory of the Danube River Basin, floods can endanger settlements, agricultural areas, and roads in river valleys. A large number of towns and settlements in Montenegro are located on the banks of larger rivers (Kolašin, Mojkovac, Pljevlja, Plav, Berane, Bijelo Polje, Rožaje) and most of them are potentially endangered by the overflow of large waters from riverbeds.

Historical hydrological data related to the recorded high (potential) flood waters on the network of hydrological stations in Montenegro were analysed from 1952 when water level measurements began on rivers. The complete set of data relating to the exact dates (years) of the high-water flows and the calculated return periods for each of the hydraulic stations in the Danube River Basin is summarised in Table 4.3. Since 1952, six events have been registered with flows of a calculated return period of 100 years. The most common high-water flows in the Danube basin are calculated with a 10-year return period, occurring 146 times since 1952.

Apart from the historical hydrological data there are no other official data detailing the extent of the inundated areas of flood waters or damage to property caused in the past other than those that occurred in 2010.

Table 4.3. Registrations of floods since 1952 for return periods of 10 to 100 years measured at hydrological stations in the Danube River Basin

Watercourse, location HS[20]	Return Period[21]		
	≥ 10 < 50 Years	≥50 < 100 Years	≥ 100 Years
Grlja, "Vusanje"	8	1	-
Vruja, "Gusinje"	7	1	-
Grnčar,"Gusinje	7	-	-
Lim, "Plav"	10	1	-
Zlorečica, "Andrijevica	5	-	-
Lim, "Andrijevica	18	-	-
Lim, "Berane"	2	-	-
Lim "Zaton"	6	-	1
Lim "Bijelo Polje"	11	-	1
Bistrica, "Gubavač"	8	-	1
Lim, "Dobrakovo	5	-	1
Tara, "Crna poljana"	12	-	-
Tara, "Trebaljevo"	11	-	-
Štitarica, "Podbišće"	5	-	1
Tara, "Bistrica"	6	-	-
Ćehotina, "Pljevlja"	10	-	-
Ibar, "Rožaje"	5	-	1
Bukovica, "Šavnik"	7	-	-
Bijela, "Šavnik"	3	-	-
Total	**146**	**3**	**6**

4.1.1 High waters registered in late 2010/early 2011

Despite the hydrological data assessment, which indicates that flooding in the Danube basin would have occurred on multiple occasions, the only information available that could be included for the PFRA relates to the historical flooding event that occurred in 2010. Despite the paucity of detailed data to document historical flood events, the data from 2010 is invaluable for the PFRA. After the 2010 floods, major damage was recorded to housing, bridges, and road infrastructure, as illustrated in Figure 4.2.

Data and information on the November 2010 /January 2011 flood events are available in the Flood Protection and Rescue Plans prepared by the municipalities in 2012. These data are summarized in Table 4.4 for the 8 municipalities encompassing 23 distinctly individual affected areas in total[22]. 4 areas were located in the Ibar Sub-Basin, 13 in the Lim Sub-Basin, 4 in the Tara Sub-Basin and 2 in the Ćehotina Sub-Basin.

[20] HS: Hydrological stations

[21] A 10-year flood has a 1/10 = 0.1 or 10% chance of being exceeded in any one year. A 50-year flood has a 0.02 or 2% chance of being exceeded in any one year. A 100-year flood has a 0.01 or 1% chance of being exceeded in any one year.

[22] Further details of all 23 affected areas are provided in the Preliminary Flood Risk Assessment

In total, during the November 2010 /January 2011 flood event, a minimum surface area of 7.98 km^2 (798 hectares) in the Danube River Basin was inundated by the flood waters, which directly affected 4,600 people and caused damage to 1,205 dwellings and 60 small businesses[23]. Fortunately, there were no fatalities. 2,785 people were affected in the Lim River Sub-Basin and 1,153 people were affected in the Ibar River Sub-Basin. 615 and 47 people were affected in the Tara River and Ćehotina River Sub-Basins, respectively. 2 drinking water supplies were affected in the Lim River Sub-Basin. 2 cultural assets were damaged in the Ibar Sub-Basin.

Figure 4.2. Damage from floods in late 2010/early 2011

River Lim-location Rijeka Marsenića, Andrijevica

River Lim, location Donji Talum, Berane

River Lim, Main road Berane - Bijelo Polje

River Lim, Settlement “Riversajd

[23] The number of small business affected is underestimated since in many affected areas the data was not recorded.

Table 4.4. Summary of data from municipal flood protection plans for the floods in November 2010 to January 2011

Catchment Area	Municipality	Flood source[24]	Flood mechanism/ characteristics[25]	Affected Regions / locations
Ibar	Rozaje	A11, A12	A21/A31, A34	Locations in the Rožaje city, Suho Polje, Županica, Ibarac. Hurije, Donja Lovnica, Kalače, Skarepača, Koljeno, Rasadnik
Lim (Tributaries Grnčar, Vruja, Dolja,Ljuča)	Plav	A11, A12	A21/A34	• River Lim: Settlements: Brezojevice, Rambalovi lugovi, • River Grnčar: Dosuđe, • River Duricka: Prnjavor, Bogajiće, Malo selo, Jesenice • River Ljuča: Hakanje, Vojno Selo, Martinoviće, Hakanje • Plav river and lake: Urban area, Prnjavor, Novšiće, Gornja Ržanica i Mašnica
Lim (Tributaries Zlorečica, Kraštica, Trepačka)	Andrijevica	A11, A12	A21/A34	Seoce, Zoriće, Prljnije, Košutiće, Kuti, Bradavac, Furune, Andželate, Djuliće, Trepča, Trešnjevo, Slatina, Prljanije, Luge, Ulotina
Lim	Berane	A11, A12	A21/A34	Vinicka, Buče, Ulica Mira i slobode, Hareme, Gornji i Donji Talum, Riversajd, Donje Zaostro, Skakavac, Crvljevine, Štitari – Lukavica, Bioča

[24] Flood source is based on guidance for reporting under the EU Floods Directive; EU 2013. Technical Report-2013-071. A11: Fluvial; A12: Pluvial; A13 Groundwater (further details are given in Annex 2).

[25] Flood mechanism and flood characteristics are based on guidance for reporting under the EU Floods Directive; EU 2013. Technical Report-2013-071. A21: Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands; A22: Defence Exceedance: Flooding of land due to floodwaters overtopping flood defences; A31: Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (Annex 2).

Catchment Area	Municipality	Flood source[24]	Flood mechanism/ characteristics[25]	Affected Regions / locations
Lim	Bijelo Polje	A11, A12	A21/A40	Bioča, Srđevac, Šćepanica, Zaton, Loznice, Strojtanica, Voljavac, Dobrakovo, Boljanina, Mokri Lug, Kahve, Lug, Presečenik, Ušanovići, Voljavac, Pavino Polje
Tara	Kolasin	A11, A12	A21/A31	Urban area of Kolasin, Bećovoj Bara, Luge, Uvač, Han, Garančići, Jabuka, Jasen, Mateševo, Bijeli Potok, Skrbuša, Pješčanica, Donja Breza, Trebaljeva, Sjerogošte
Tara	Mojkovac	A11, A12	A21/A31	Zakršnica, Barice, Ambarine, Podbišće, Uroševina, Slatina, Polja, Gojakovići, Štitarica, Rudnica, Lepenac, Babića Polje
Ćehotina	Pljevlja	A11, A12	A21/A34	Ševari, Židovići

4.1.2 High waters registered after 2010

Hydrological data clearly indicates that following the 2010 flooding events, further high-water events occurred in the Danube River Basin during 2012, 2016, 2017, 2018 and 2019 (Table 4.5). Despite the recorded high waters, data for recorded floods is not available. However, the hydrological data have been considered for the identification of areas of potential significant flood risk (Section 6).

Table 4.5. High waters registered at hydrological stations in the Danube River Basin after 2010

Year	Calculated Return Period (Years)
Watercourse/HS[26] : Grlja, "Vusanje"	
2012	10
Watercourse/HS: Lim, "Plav"	
2016	10
Watercourse/HS: Lim, "Bijelo Polje"	
2016	10-20
Watercourse/HS: Lim, "Dobrakovo"	
2016	10
Watercourse/HS: Tara, "Crna poljana"	
2016	20-30
Watercourse/HS: Tara, "Trebaljevo"	
2016	10-20
2018	10
Watercourse/HS: Ibar, "Rožaje"	
2016	20
2017	10
2019	10

4.2 Analysis of existing protection infrastructure from floods in the water area of the Danube basin

In the process of preparation of the Flood Risk Management Plan, i.e., Preliminary Flood Risk Assessment, the document inventory of existing flood defence infrastructure was prepared. This document contains all existing information on the built flood protection infrastructure given descriptively and graphically presented in the GIS. A summary of the information in this document is provided below.

[26] HS: Hydrological station

Flood defences are represented by the following:

- **Dyke**: These are regulatory structures outside the riverbed and serve to prevent the spillage of large amounts of water into the inundation, which for some reason has become construction or agricultural land.

- **Embankment**: This is built primarily on the concave side of the curve to the level of medium water, which usually corresponds to the elevation of the shore of the main riverbed. In recent times, elements made of concrete and reinforced concrete are increasingly used.

- **Napper**: This is a transverse structure in a river that is built on a convex bank, in order to narrow the riverbed, the concave bank must be protected from erosion by building an embankment. They reject the flow of the river towards the middle and cause sedimentation between them.

- **Parallel structures**: They are built for the purpose of protecting the concave bend, but in relation to the bank protection, they shift the shoreline and the main river flow towards the opposite convex bank.

- **Riverbed regulation**: This includes measures and works on maintaining riverbed flow and flood protection. It may include dredging of the riverbed, construction of embankments and other hydraulic structures.

The scope of work performed so far on the regulation of watercourses and flood defence on all watercourses in Montenegro is very modest and were mostly performed in the 1970s. Due to the partial approach to this issue, most of the constructed facilities are of a local character, so that the lengths of defensive embankments, fortifications and regulated riverbeds are very short - from a few hundred meters to 1-2 kilometres.

At the end of 2010, great consequences were caused by floods in the valley of the river Lim from Gusinje to Zaton, on the river Tara near Kolašin and Mojkovac, the river Ćehotina near Pljevlja and in the valley of the river Ibar in Rožaje. Flood protection systems were built in the period 2011-2015 in order to repair the consequences of the catastrophic floods that occurred in 2010, and as a prevention of future floods.

Since 2011, the Public Works Directorate has been implementing the project "Emergency Aid and Flood Prevention", which is financed from the credit funds of the European Investment Bank. Within this project, in the period from 2011 until today, 61 projects have been realized. In addition to the construction of 3 bridges on the river Lim, the reconstruction of the main city bridge in Berane and the bridge on the Marsenića river, the riverbed was regulated, i.e., the construction of stone embankments in the length of approximately 10 km.

Table 4.6 summarizes the overview of existing facilities for flood defence in the Danube River Basin. The locations of the flood defence are shown in Figures 4.3 to 4.7.

Table 4.6. Summary of existing facilities for flood protection in the Danube catchment area

	No.[27]	Watercourses	Location	Type of infrastructure	Year of construction
1	1.1	Ibar	Rožaje	Regulation[28] 500m+700m	1979, 2018
2	2.1	Lim	Plav	Regulation of Plav river 300m	2013-2014
	2.2	Lim	Gusinje	Regulation Grnčar rijeke 200m	2012-2015
	2.3	Lim	Gusinje	Regulation of river Vruje 1015m	2012-2014
	2.4	Lim	Andrijevica	Regulation of river Lim 660m	2012-2014
	2.5	Lim	Andrijevica	Regulation of river Zlorečice 350m	2012-2014
	2.6	Lim	Berane	Regulation of river Lim 1200m	2012-2014
3	3.1	Ćehotina	Pljevlja	Regulation of river Breznice 300m	2005-2008
	3.2 - 3.6	Ćehotina	Pljevlja	Relocation of the Ćehotina riverbed near the coal mine Potrlica	
4	4.1	Tara	Kolašin	River dykes 3000m; River dykes Svinjače 355m	2012-2014
	4.2	Tara	Mojkovac	Tailing's protection Brskovo -Tara 600m	2012-2014
	4.3	Tara	Mojkovac	Regulation Rudnice, tributaries of the Tara River 1.000m	2013

The constructed facilities were built in urban areas only on the most critical sections where human lives and material goods are most endangered. Although in the period after 2010, at some hydrological stations related to the flood prevention works, Q10 or above were evident (see Table 4.5) although floods were not registered. It can be concluded that where flood defence infrastructure was located after 2010, a positive effect was observed on the protection of urban areas in the Ćehotina, Ibar, Lim and Tara River Sub-Basins. However, this does not mean that further flood defences are not required in the Danube River Basin. Flood hazard and flood risk analysis and mapping were used to clearly identify areas where further flood defence investment is needed together with the type of flood protection required (see Section 8).

[27] The numbers 1.1 to 4.3 are referenced in Figures 4.3 to 4.7.

[28] Riverbed regulation: This includes measures and works on maintaining riverbed flow and flood protection. It may include dredging of the riverbed, construction of embankments and other hydraulic structures.

Figure 4.3. Existing flood protection facilities on the rivers Ibar, Plavska, Grnčar and Vruja

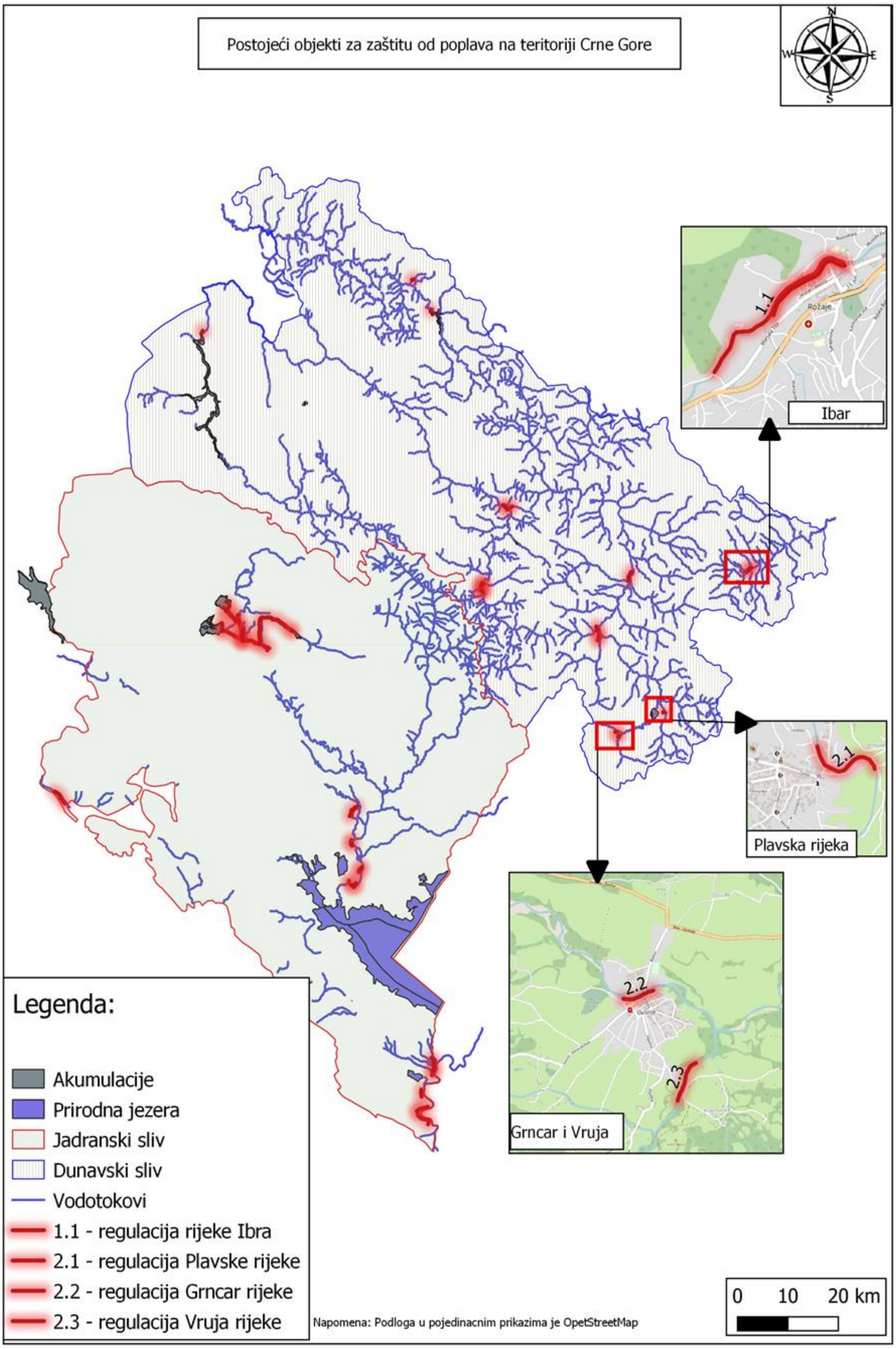


Figure 4.4. Existing flood protection facilities on the Lim River

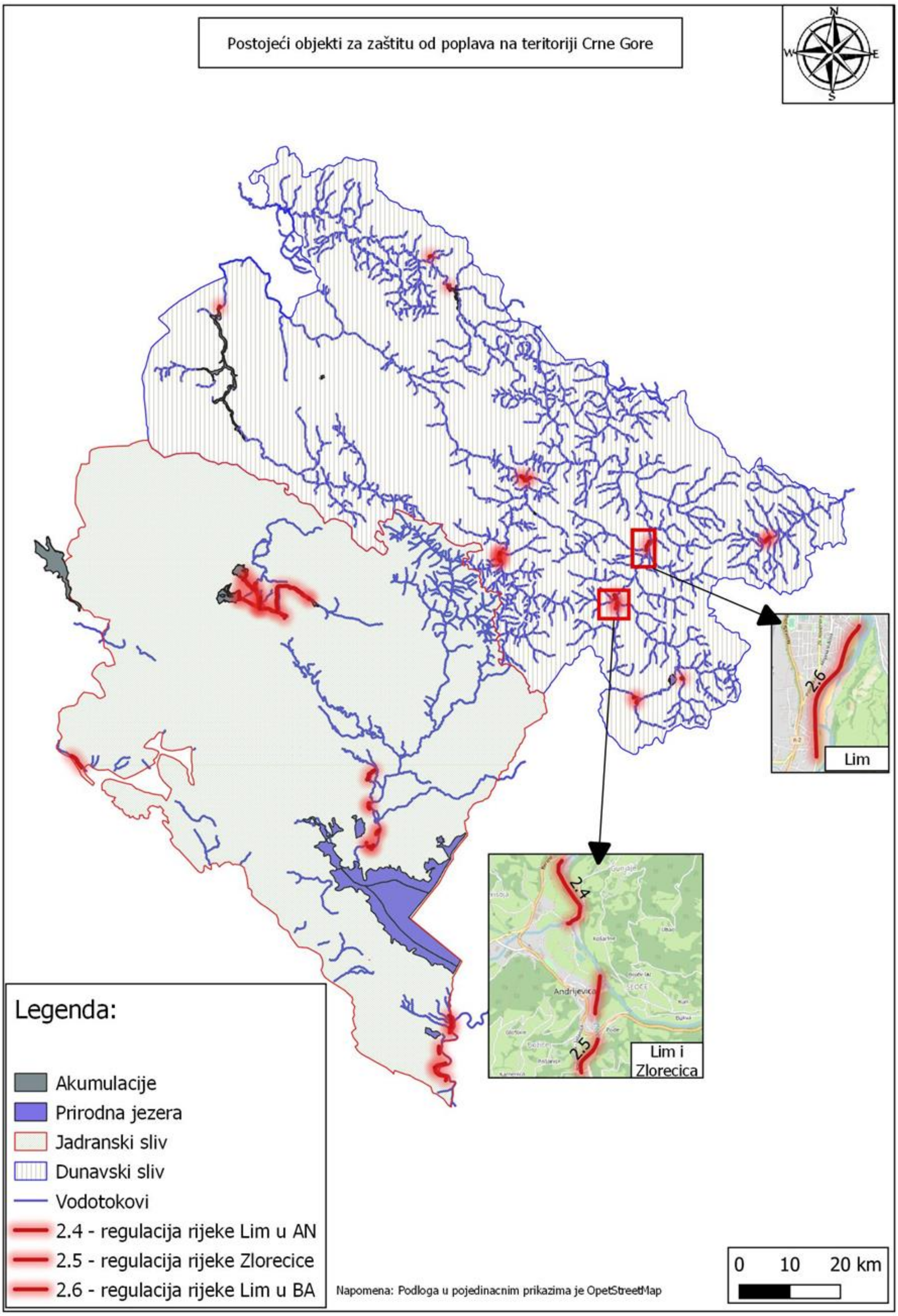


Figure 4.5. Existing flood protection facilities on the rivers Piva, Ćehotina and Breznica

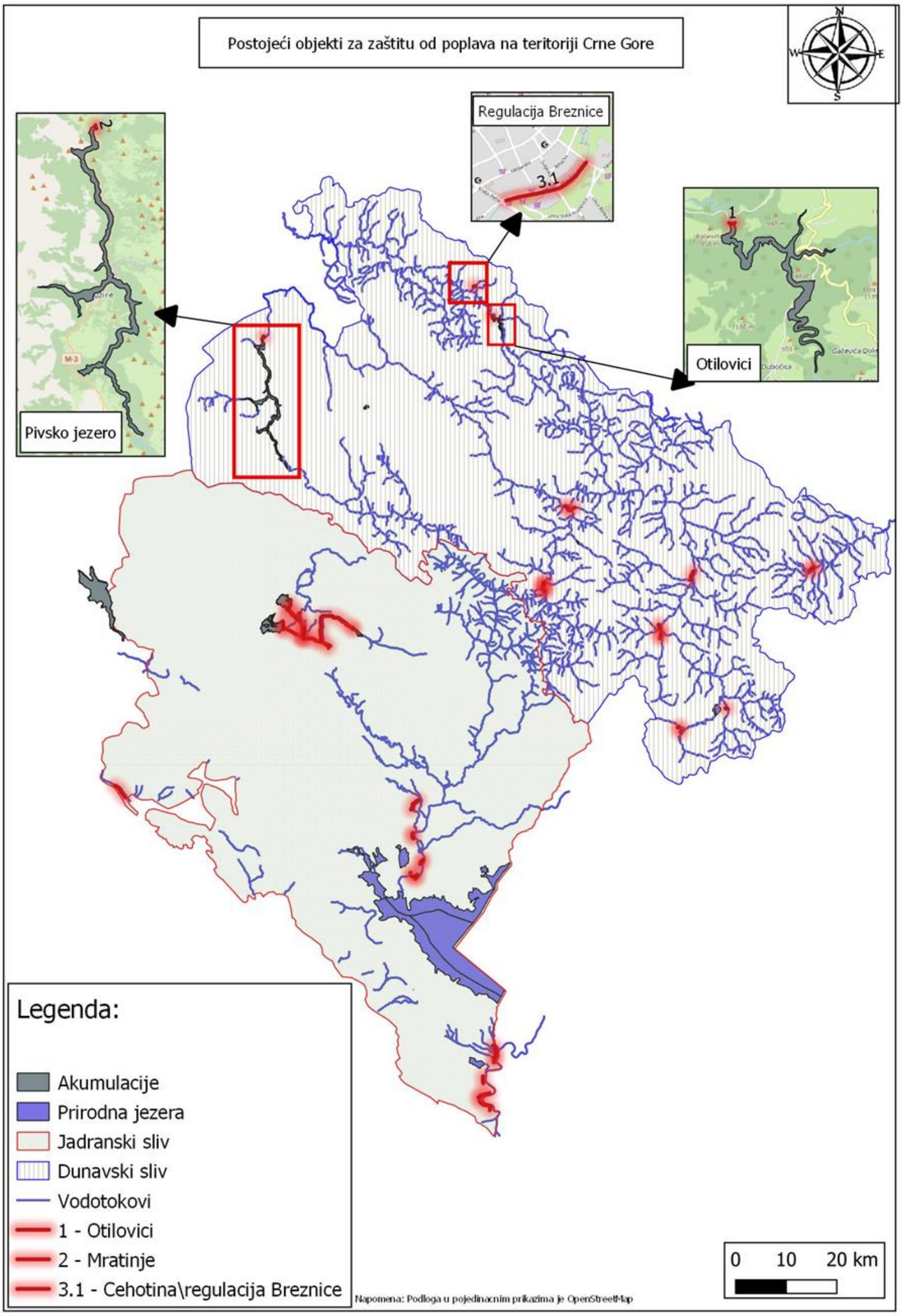


Figure 4.6. Existing flood protection facilities on the Ćehotina River

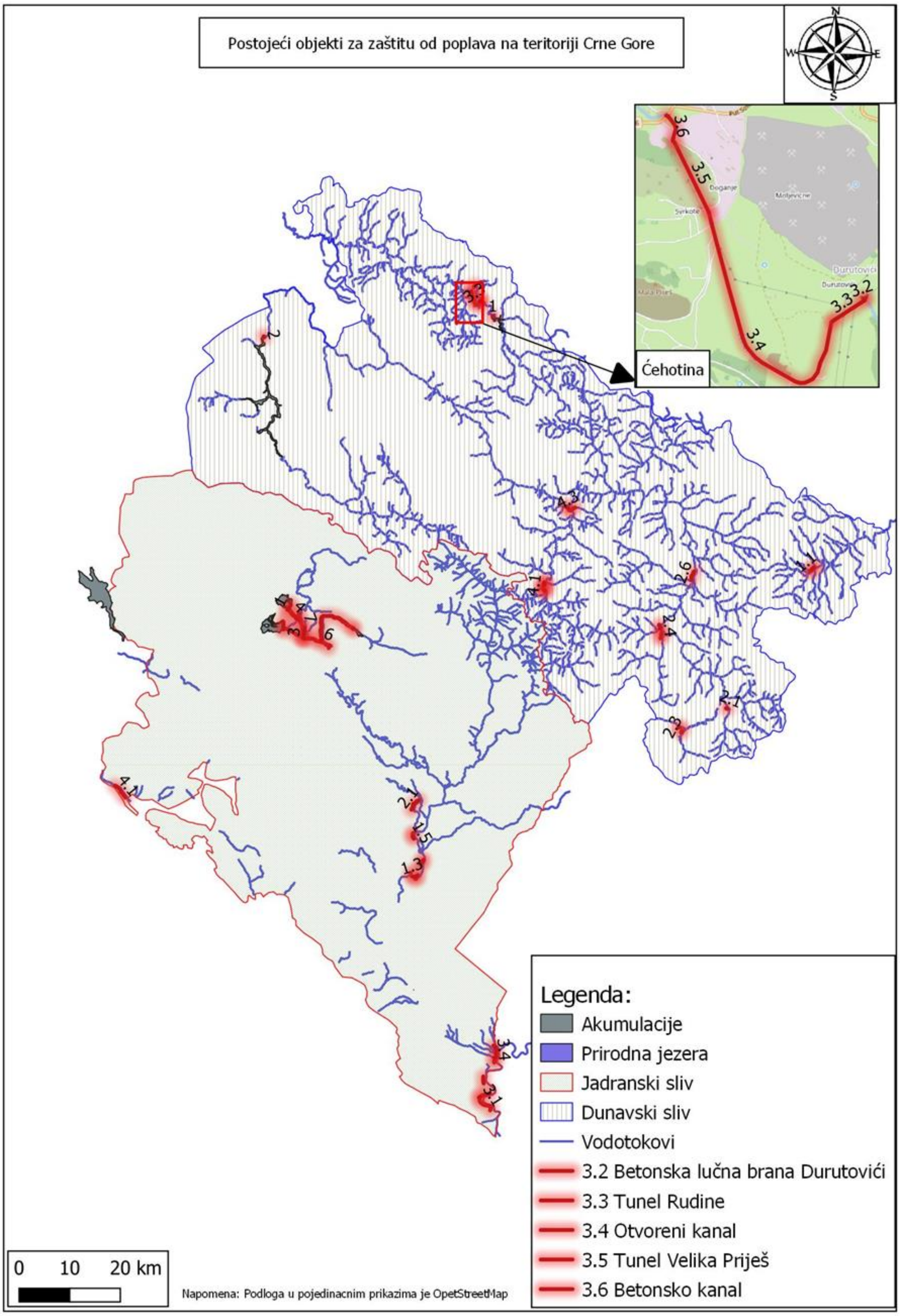
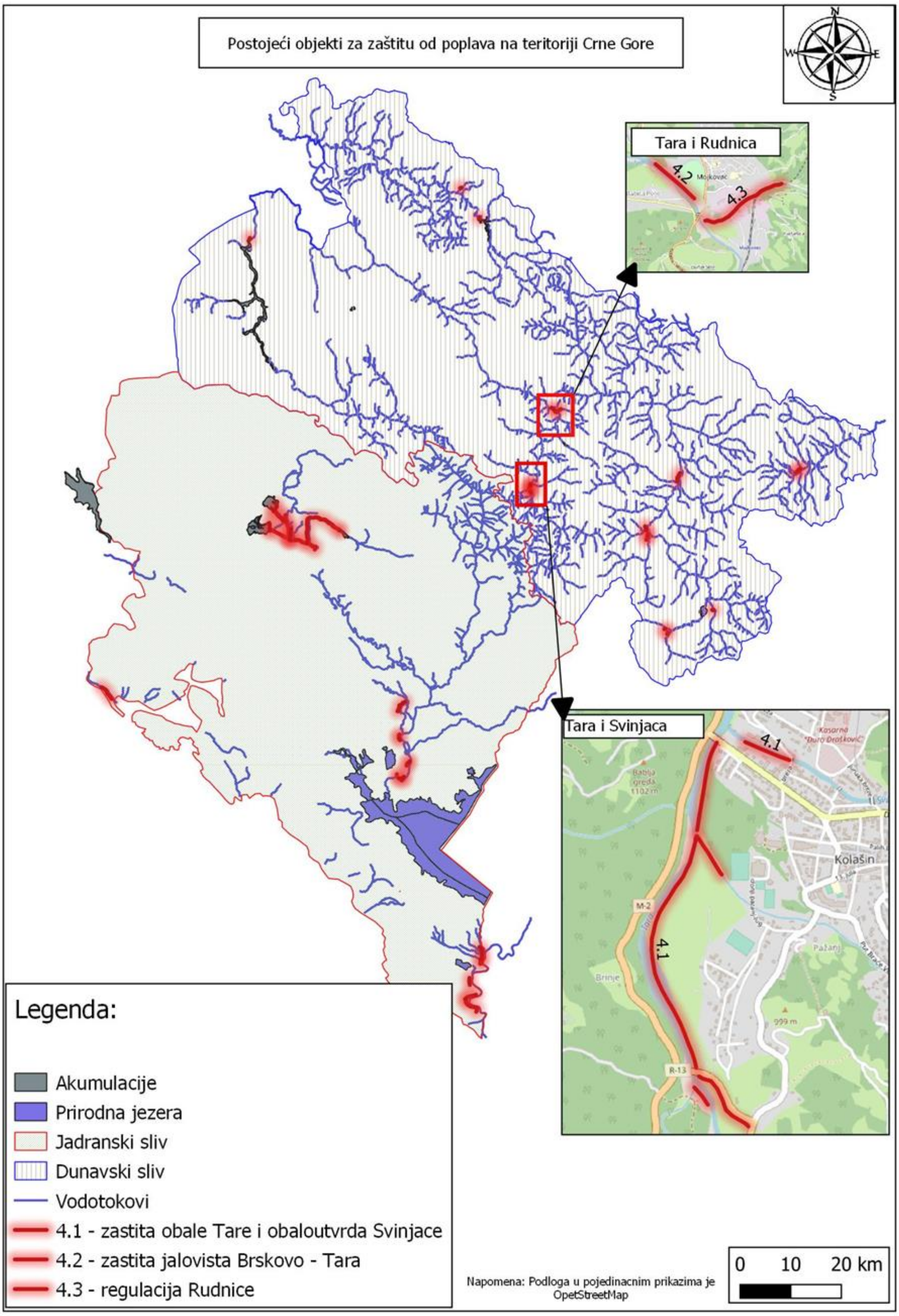


Figure 4.7. Existing flood protection facilities on the Tara River



5 PRELIMINARY FLOOD RISK ASSESSMENT

5.1 Introduction

This section is focussed on Stage 1 of the implementation of the EU FD, which encompasses the analysis of existing flood infrastructure in the Danube River Basin, together with the preparation of the Preliminary Flood Risk Assessment and the proposal for APSFR.

Article 3 of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("Official Gazette of Montenegro", No. 069/15 of 14.12.2015) describes the legal requirements with respect to the content of the preliminary flood risk assessment. Table 5.1 shows the content of the PFRA in relation to the legal national requirements.

Table 5.1. Content of the PRFA in relation to the legal national requirements

Content Required[29]	Rulebook (Article)	PFRA[30] (Section)
River Basin maps in appropriate proportion with Sub-Basin boundaries with topography and land use details	3 (1)	Section 3
Description of past flood events which had significant adverse impacts on human health, the environment, cultural heritage, and economic activity, for which it is probable to occur again in the future, considering the severity of flood events, runoff directions and assessment of adverse impacts caused by such events.	3 (2)	Section 4
Description of floods that occurred in the past in areas where significant adverse impacts can occur in the future due to changed conditions (urban development, proclamation of protected areas).	3 (3)	Section 4
Impact of climate change on occurrence of floods.	3 (4)	Section 5
Assessment of potential harmful impacts of future floods on human health, environment, cultural heritage, and economic activities, considering topography, position of water courses and their hydrological and geo-morphological characteristics, flood plains as natural retentions, efficiency of the existing flood protection facilities, position of settlements, areas of economic activities and long-term development plans, as necessary.	3 (5)	Section 6[31]

[29] Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("Official Gazette of Montenegro", No. 069/15 of 14.12.2015).
[30] Sections of the PFRA document approved by the Steering Committee of the Project "Support for the Implementation and Monitoring of Water Management in Montenegro" in December 2021.
[31] Existing flood protection facilities are included in Section 4.4 of the PFRA.

Content Required[29]	Rulebook (Article)	PFRA[30] (Section)
Conclusions on flood risks.	3 (7)	Section 7
Used data (records, long-term data sets)	3 (6)	Annex 1

The Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("Official Gazette of Montenegro", No. 069/15 of 14.12.2015) also specifies the following requirements with respect to the description of past flood and the adverse impacts which could occur with future flooding events:

- Description of past flood events which had significant adverse impacts on human health, the environment, cultural heritage, and economic activity, for which it is probable to occur again in the future, considering the severity of flood events, runoff directions and assessment of adverse impacts caused by such events. This has been included in Section 4.4 of the PFRA.

- Description of floods that occurred in the past in areas where significant adverse impacts can occur in the future due to changed conditions (urban development, proclamation of protected areas). This has also been included in Section 4.4 of the PFRA.

- The Impact of climate change on occurrence of floods (included in Section 5 of the PFRA).

- Assessment of potential harmful impacts of future floods on human health, environment, cultural heritage, and economic activities, considering topography, position of water courses and their hydrological and geo-morphological characteristics, flood plains as natural retentions, efficiency of the existing flood protection facilities, position of settlements, areas of economic activities and long-term development plans, as necessary (included in Section 6 of the PFRA).

5.1.1 Definition and source of floods

The following types of floods (or: "source of flood") shown in Table 5.2 have been considered in the Danube River Basin when identifying the areas of potential significant flood risk.

The primary focus of the PFRA was agreed during a Working Group meeting in June 2020 to be focused on the potential risks resulting through floods along surface waters from rivers and streams (fluvial).

In addition to the types of floods presented in the Guidance for reporting under the EU Floods Directive, the PFRA takes account of the specificities of the terrain in the Danube River Basin and therefore an adequate representation of the types of flooding reflecting the natural conditions.

Table 5.2. Source of floods in the Danube River Basin

Type / Source[32]	Description[33]
Fluvial	Flooding of land by waters originating from part of a natural drainage system, including natural or modified drainage channels. This source could include flooding from rivers, streams, drainage channels, mountain torrents and ephemeral watercourses, lakes and floods arising from snow melt.
Pluvial	Flooding of land directly from rainfall water falling on, or flowing over, the land. This source could include urban storm water, rural overland flow or excess water, or overland floods arising from snowmelt.
Groundwater	Flooding of land by waters from underground rising to above the land surface. This source could include rising groundwater and underground flow from elevated surface waters.
Artificial Water-Bearing Infrastructure	Flooding of land by water arising from artificial, water-bearing infrastructure or failure of such infrastructure. This source could include flooding arising from sewerage systems (including storm water, combined and foul sewers), water supply and wastewater treatment systems, artificial navigation canals and impoundments (e.g., dams and reservoirs) and activation of landslides.

5.1.2 Pluvial / heavy rain / flash flooding

For the rivers of the Danube River Basin (Lim, Tara Ćehotina, Ibar) pluvial floods are not modelled and thus a systematic risk assessment is not possible based on existing information. However, due to the importance of this type of flood, according to the increasing damages in recent years, flash flood events are documented and considered in the evaluation of potential risk areas. If recurrent past events occur in one location or one region this is regarded as a significant risk in the light of this PFRA.

The determination of flash floods in the context of the study was based on the characteristic of the specific location in which the flood occurs. If the size of the catchment that drains water to this location is <20 km², and no permanent river or stream exists, and if there is a rapid response (less than 6-8 hours) of runoff to precipitation in the basin, it is defined as a heavy rain event or flash flood. If the catchment is >20 km² and a permanent river or stream exists, it is defined as river flood.[34]

5.1.3 Groundwaters

Risks from groundwater often occur in lowland areas, marshland or meadows that are at the same time regularly flooded from rivers (fluvial floods). Thus, the potential risk areas are already identified under fluvial floods. If large areas that are not flooded from rivers have been flooded just from groundwater, and if these events have been recorded, those areas

[32] Guidance for reporting under the EU Floods Directive; EU 2013. Technical Report-2013-071.
[33] The possible mechanisms of previous flooding events in the Danube River Basin based on hydrological data are shown in Table 4.2 (Section 4.1).
[34] Guidelines for reporting according to the Floods Directive; EU 2013. Technical Report-2013-071

are additionally documented and evaluated according to the significance criteria. In the PFRA for the rivers of the Danube River Basin no such areas were identified.

5.1.4 Artificial water-bearing infrastructure

Damage due to dam failure is especially high due to the high speed of the flood water. Demolition often occurs within hours of the first visible signs of dam failure, leaving little or no time to evacuate.

The technical working group agreed that it considers the risk of dam failure to be significant risk, as the probability of dam failure is less than 1:10,000, according to the dam design and dam failure studies. Compared to the probabilities of fluvial floods (1:100, 1:500), this cannot be called significant in the PFRA methodology for determining the APSFR for flood risk management. However, there is a risk of structural failure of dams in the Danube part of the basin in Montenegro (Mratinje-Piva, Otilovići-Ćehotina). This risk should be regularly assessed (dam failure studies) and considered in maintenance plans and risk management scenarios. Retroactive effects of reservoir management upstream of the reservoir (increase in water levels upstream as a result of low water consumption in HPPs in wet seasons) are considered as fluvial floods due to rising lake/reservoir levels. The effects of reservoir management downstream (discharge of water from reservoirs in flood situations) are also considered with fluvial floods, as downstream reservoir channels are also the focus of fluvial flood risk below dams. Drainage channels are considered fluvial floods because they are closely related to water levels and floods in the riverbed and create areas of additional risk.

5.2 Determination of Areas of Potential Significant Flood Risk

The PFRA provides a high-level summary of significant flood risk for the RBD, based on available and readily derivable information. The PFRA is the first step in delivering a FRMP. The PFRA should cover historical flood events and the potential for future flood events that may have a significant adverse consequence on either, human health, the environment, cultural heritage, or economic activity. Flood-specific data such as historical flood information, geographic data, urban planning information, population statistics, economic activities, digital terrain models (DTM), hydrological and meteorological information, civil protection information and other national data was used to prepare the PFRA. This information is then used to identify the Areas of Potential Significant Flood Risk (APSFR), which are the areas that will be the priority for more detailed flood risk management assessment in the flood maps and FRMP stages.

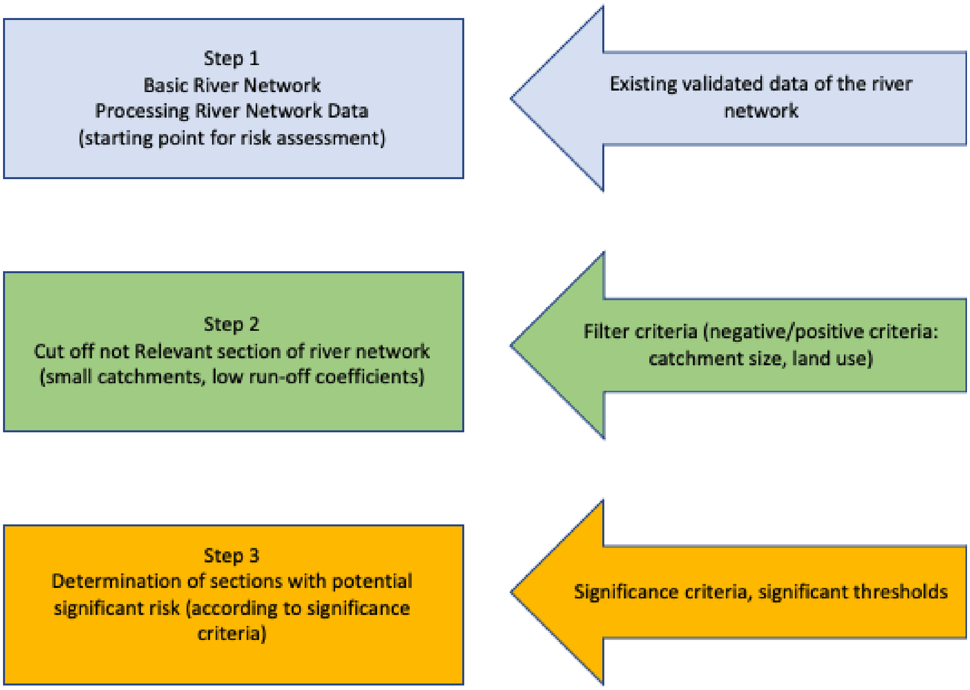
Generally, the identification of areas at potential significant flood risk follows three main working steps (Figure 5.1):

1. Determination of the initial river network: the river network is taken from the Danube River Basin Management Plan. In addition, a validation with Open Street Map (OSM) data and with satellite images ensured the correctness. The whole relevant river network is processed in one GIS project and validated to be used for the further filtering process.

2. Determination of the river network that might have flood risk (filtering out not relevant river stretches according to negative criteria like size of the catchment, length of the stretch or characteristics of the riverbanks or flood plains (very steep or canyons, only 100% rural land uses). Here the threshold for the relevant catchment area was determined in an iteration using 50 km², 30 km², 20 km² and 10 km². The threshold of 10 km² results in a river network including many stretches which are dry for most of the year. So, 20 km² was determined as an adequate threshold for relevant river stretches. Nevertheless, smaller river sections were evaluated. All flooding along river stretches with catchments <20 km² the flood event can be defined as flash flooding or heavy rain event, while >20 km² is defined as river floods.

3. Assessment of the remaining river network in terms of potentially affected assets at risk, land uses or risk of pollution in case of floods and comparison with agreed significance criteria. The results are river stretches at potential risk, named: "Areas of Potential Significant Flood Risk" (APSFR).

Figure 5.1. Work steps of the preliminary flood risk assessment for the identification of areas with potential significant flood risk



The determination of the APSFR is based on the analyses of the river sections, for which, from recent events, damage potential has to be expected and added by those stretches of the river network in which floods may have adverse consequences on human life, economy, ecology, or cultural heritage. For the single assets at risk, the significance of the risk is checked stepwise.

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For the assessment steps the significance criteria are used, which cover all considerable assets at risk. Each step is linked to one criterion. Thus, the potential significant risk in each area is systematically checked and documented with the respective criteria in fact sheets[35].

According to the specifications of the Floods Directive, four groups of assets at risk shall be considered in flood risk management and in the PFRA. The risk assessment and consequent risk reduction measures were focussed on all four groups of receptors and according to indicators, as shown in Table 5.3.

Table 5.3. Risk receptors and risk indicators

Risks	Example for flood risk indicators
Human Health	• Number of residential properties. • Critical services (Hospitals, Police/Fire/Ambulance Stations, Schools, Nursing Homes, etc.).
Economic Activity	• Number of non-residential properties. • Length of road or rail. • Area of agricultural land.
Environment	Designated sites (water protection areas, areas with water pollutant substances) and flora / fauna according to the EU-habitat directive
Cultural Heritage	Cultural heritage sites (e.g., World Heritage Sites).

Assets at risk were determined to identify potential significant risks for all risk receptors. Significance criteria and the threshold define what is identified as potential significant (Table 5.4).

For all areas in which floods have ever been observed and in which flood risk can be expected, evaluations were performed to assess if the risk for one of the receptors exceeds the threshold (= significant, coloured in red) on not (= not significant, coloured in green).

[35] In November 2018, the document Preliminary Flood Risk Assessment for the Drim / Drin - Buna / Bojana River Basin was adopted. This document was prepared by GIZ within the project Climate Change Adaptation in Transboundary Flood Risk Management for the Western Balkans. At the meeting of the project Working Group on 4th June 2020, it was adopted that the same criteria will be used in the preparation of the Danube River Basin PFRA, as used by the GIZ in the preparation of its document.

Table 5.4. Significance criteria for the PFRA

Assets at Risk and Significance Criteria	Receptors				Significance Criteria	Threshold of Significance
	Human Health	Economic Activity	Environment	Cultural Heritage		
A) Human Health, economic values						
No. of houses	x	x			Existing area or area in the flood area of the extreme event	≥ 10
Settlement area	x	x				≥ 0.5 ha
Industrial objects		x				≥ 1
Industrial area		x				≥ 0.5 ha
Critical/valuable agricultural assets		x				Case to case
B) Environmental Risks						
B1) - Water Polluting Substances / Sites						
Contaminated sites			x		Existing object at risk (extreme event scenario)	≥ 1
Locations dealing with specific substances			x			≥ 1
B2) – Protected Areas						
Nature protected areas (e.g. Natura 2000 etc.)			x		Existing assets at risk (extreme event scenario)	≥ 1
Drinking water supply	x		x			≥ 1
Bathing waters	x					≥ 1
C) Risk for Cultural Heritage Sites						
UNESCO heritage sites				x	Existing assets at risk (extreme event scenario)	≥ 1
Other relevant cultural heritage sites				x		≥ 1

Significance criteria for human health and economic values

An essential factor for the assessment of adverse consequences of flood events and their significance according to the FD Directive is the extent of risks for settlements, trade, and industry areas. This also reflects the respective damage potential in the areas.

To determine the significance threshold for human health and economic values the economic damage potential – if assessments are existing – may be used. Alternatively, here a threshold of ca. €250,000 is used with the assumption that this damage can be reached by flooding 10 or more houses (leaving water depth and damage functions out of the estimations). If only housing area size can be assessed the approximate of 0.05 ha per house, consequently 0.5 ha of housing area is considered to be the threshold for a potential significant risk.

In addition, risk for agricultural areas or agricultural assets is determined significant when in local or regional context substantial economic damage is possible that can ruin the basis for the existence of farmers. This includes vulnerable special crops, animals, and machinery. The assessment of these criteria was carried out by expert judgement (significant agricultural risk areas or objects).

A fixed threshold or limit for the flood agricultural area or economic risk for agriculture is not used in the PFRA because:

- Economic data are not available (especially not for the whole River Basin).
- Damage values in agriculture depend, like for all other land uses, but here much more, on the induvial situation: grassland, cropping or special cultures or even structures cannot be assessed by the size of the inundated area.
- The individual agricultural land use can change from year to year and can consequently not be used as criteria for a flood risk management process that is determined to take 6 years.
- If agricultural land use would be used as a significance criterion almost all inundated areas in a River Basin would have to be determined as significant. This would result in the need of a very large hazard and risk mapping plan area and flood risk management plans accordingly.

Retrospectively, based on different risk area assessments, it can be stated that no APSFR would have added or reduced due to the aspect agricultural values at risk, according to the expert assessments.

Specific damage potentials result from different factors like population density, specific real estate values and added value and differ from location to location. These aspects need to be considered when preparing detailed risk maps. For the PFRA, the use of the named indicators is sufficient to determine areas of potential significant flood risk.

Significance criteria for environmental risk

Adverse consequences of flooding for a River Basin mainly occur if water polluting substances are mobilised by flood water entering rivers or lakes. Thus, the most important assets at risk in this respect are contaminated sites (soil) and locations for storing or using water pollutant substances. The highest environmental risk can be found if water pollutions meet most vulnerable natural areas, like nature conservation areas or protected natural sites. Thus, the assessment of significant risks includes the steps B1 “River sections with locations or facilities to store water polluting substances" and B2 "River sections with significant risk for protected areas".

Significance criteria for cultural heritage

In the course of the verification step C "River sections with important or UNESCO cultural heritage" the significance of the risk of flood events is assessed by:

- UNESCO world heritage sites are classified as significant if damage as consequence of flooding is possible.
- River sections with at least one cultural heritage site or object with special regional or national importance if damage as consequence of flooding is possible.

Collection and documentation of risk information for the APSFR

Based on the evaluation of recorded and documented past flood events and including local knowledge and expert judgement areas or stretches of rivers with damages in flood events or potential (observed) risk were identified. For these areas all available information and data on flooding, land use, objects at risk and urban or infrastructure planning were collected and analysed. The data were assessed and compared with the significance criteria shown in Table 5.4 above.

For the whole River Basin, the river network is analysed (based on the available digital terrain model - DTM), to identify all river sections with a catchment area >20 km². For the remaining parts the potential flood corridor was constructed. Land use and assets at risk according to the significance criteria were evaluated for the inundation areas. Thus, a second set of data was created for all potential risk areas to prove or validate the data and results collected for the fact sheets.

Based on the comprehensive documentation of hazard information, risk information and assessment steps, the determination of each single APSFR is made transparent.

5.3 APSFR identified in the Danube River Basin

Based on the analysis described above, 19 APSFR in the Danube basin area have been defined. These areas were designated by the Decision on Determining Areas Significantly Endangered by Floods ("Official Gazette of Montenegro," No. 030/22 of 21.03.2022). A summary overview of the location of each APSFR in the Danube River Basin is presented in Figure 5.2.

Table 5.5 provides a summary of each APSFR according to the coding schema for EU guidelines for reporting APSFR for the preliminary flood risk assessment[36]. The schema includes specific coding to characterise the following: the cause of floods, flood mechanisms, and the impact of flood events on risk receptors of human health, environment, cultural heritage, and economic activity. A description of each code is presented in Annex 2.

Figures 5.3 to 5.16 indicate the APSFR zones, which incorporate the calculated extent of the 500-year return period[37].

[36] Technical Support in Relation to the Implementation of the Floods Directive (2007/60/EC) June 2013.
[37] The area modelled for the 500-year flood return period is referred to as Scenario 2 in Figures 5.3 to 5.8.

Figure 5.2. A summary overview of all APSFR in the Danube River Basin

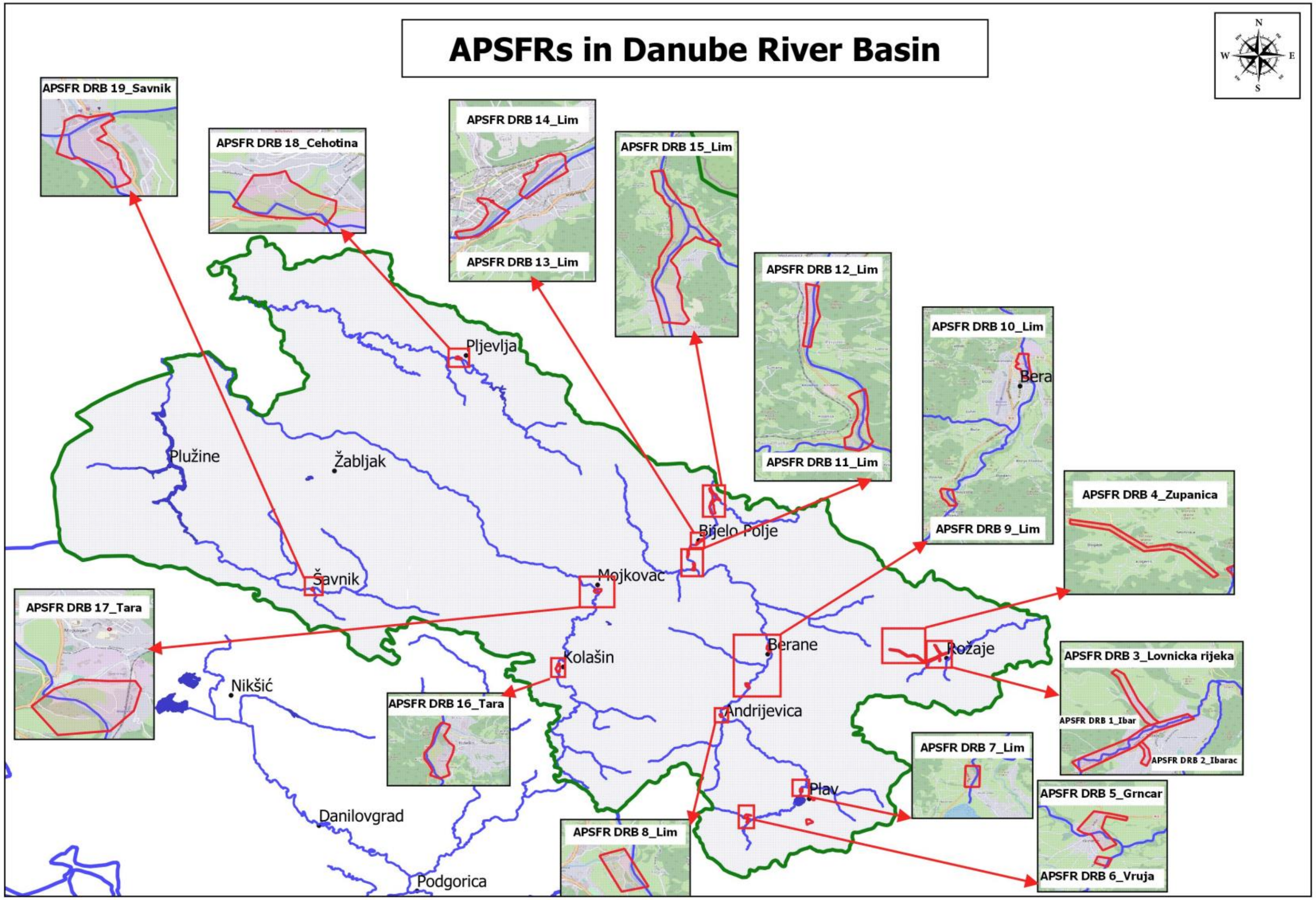


Table 5.5. APSFR for Danube River Basin classified according to the EU Schema[38]

Approved APSFR Code[39] (PRFA Code)[40]	Catchment area	River / Tributary	Flood Sources	Flood Mechanism	Flood Characteristics	Affected Regions / locations	Settlement/ village	Human Health	Environment	Cultural Heritage	Economic Activity
1 APSFR01_DRB_Ibar01 (APSFR DRB1_Ibar)	Ibar	Ibar	A11	A21	A31 A34	Municipality Rožaje	Rožaje-Suho Polje -Zeleni	B11	B25	B31	B41 B42 B44
2 APSFR02_DRB_Ibarac01 (APSFR DRB2_Ibarac)	Ibar	Ibarac	A11	A21	A31 A34	Municipality Rožaje	Rožaje-Ibarac	B11	B25	B34	B41 B42 B44
3 APSFR03_DRB_Lovnička rijeka01 (APSFR DRB 3_Lovnicka rijeka)	Ibar	Lovnička	A11	A21	A31 A34	Municipality Rožaje	Hurije,Donja Lovnica	B11	B25	B31	B41 B42 B43 B44
4APSFR04_DRB_Županica01 (APSFR DRB 4_Zupanica)	Ibar	Županica	A11	A21	A31 A34	Municipality Rožaje	Kalače Skarepača Koljeno Rasadnik	B11 B12	B25	B34	B41 B42 B43 B44
5 APSFR05_DRB_Grnčar01 (APSFR DRB 5_Grncar)	Lim	Grnčar	A11 A12	A21	A34	Municipality Gusinje	Gusinje Grnčar Dosuđe	B11	B25	B34	B41

[38] Technical Support in Relation to the Implementation of the Floods Directive (2007/60/EC) June 2013.
[39] Codes for each APSFR were approved by MAFWM and the Water Administration.
[40] Codes used to identify APSFR in the PFRA are included on the maps of each APSFR in Figures 5.3 to 5.16.

Approved APSFR Code[39] (PRFA Code)[40]	Catchment area	River / Tributary	Flood Sources	Flood Mechanism	Flood Characteristics	Affected Regions / locations	Settlement/ village	Human Health	Environment	Cultural Heritage	Economic Activity
6 APSFR06_DRB_Vruja01 (APSFR DRB 6_Vruja)	Lim	Vruja	A11	A21	A34	Municipality of Gusinje	Gusinje: Koljenovići Kruševo Vusanje	B11	B25	B34	B41
7 APSFR07_DRB_Lim01 (APSFR DRB 7_ Brezojevica)	Lim	Lim	A11 A12	A21	A34	Municipality of Plav	Plav, Brezojevica Rambalovi lugovi	B11	B25	B34	B41
8 APSFR08_DRB_Lim02 (APSFR DRB LIM 8_ Prljanija-Andrijevica)	Lim	Lim	A11 A12	A21	A34	Municipality of Andrijevica	Andrijevica Prljnije	B11	B25	B34	B41
9 APSFR09_DRB_Lim03 (APSFR DRB LIM 9_ Vinicka)	Lim	Lim	A11 A12	A21	A34	Municipality of Berane	Navotina Vinicka	B11	B25	B31	B41 B44
10 APSFR10_DRB_Lim04 (APSFR DRB 10_Lim)	Lim	Lim	A11 A12	A21	A34	Municipality of Berane	Berane Talum Riversajd Rudeš Hareme	B11	B25	B34	B41
11 APSFR11_DRB_Lim05 (APSFR DRB 11_ Ribarevina)	Lim	Lim	A11 A12	A21	A40	Municipality of Bijelo Polje	Ribarevina	B11	B25	B31	B41
12 APSFR12_DRB_Lim06 (APSFR DRB LIM 12_ Rakonje)	Lim	Lim	A11 A12	A21	A40	Municipality of Bijelo Polje	Rakonje	B11	B25	B34	B41

Approved APSFR Code[39] (PRFA Code)[40]	Catchment area	River / Tributary	Flood Sources	Flood Mechanism	Flood Characteristics	Affected Regions / locations	Settlement/ village	Human Health	Environment	Cultural Heritage	Economic Activity
13 APSFR13_DRB_Lim07 (APSFR DRB LIM _13)	Lim	Lim	A11 A12	A21	A40	Municipality of Bijelo Polje	Ljesnica, Rijeka	B11	B25	B34	B41 B44
14 APSFR14_DRB_Lim08 (APFSR DRB LIM_14)	Lim	Lim	A11 A12	A21	A40	Municipality of Bijelo Polje	Lipnica	B11	B25	B34	B41
15 APSFR15_DRB_Lim09 (APFSR DRB LIM_15)	Lim	Lim	A11 A12	A21	A40	Municipality of Bijelo Polje	Oljue Sutivan Gubavač Konatari	B14	B25	B31	B46
16 APSFR16_DRB_Tara01 (APSFR DRB TARA 16 _ Kolašin)	Tara	Tara	A11 A12	A21	A31	Municipality of Kolašin	Kolašin – Donji Razanj	B11	B25	B34	B41 B44
17 APSFR17_DRB_Tara02 (APSFR DRB 17_ Mojkovac)	Tara	Tara	A11 A12	A21	A31	Municipality of Mojkovac	Podbišće, Ambarine	B11	B25	B34	B41 B44
18APSFR18_DRB_Breznica01 (APSFR DRB 18_ Ćehotina)	Ćehotina	Breznica	A11 A12	A21	A34	Municipalty of Pljevlja	Ševari	B11	B25	B34	B43
19 APSFR19_DRB_Bukovica i Bijela01 (APSFR DRB 19_ Savnik)	Piva	Bukovica i Bijela	A11	A21	A40	Municipality of Šavnik	Šavnik	B11	B25	B34	B41

Figure 5.3. APSFR01_DRB_Ibar01

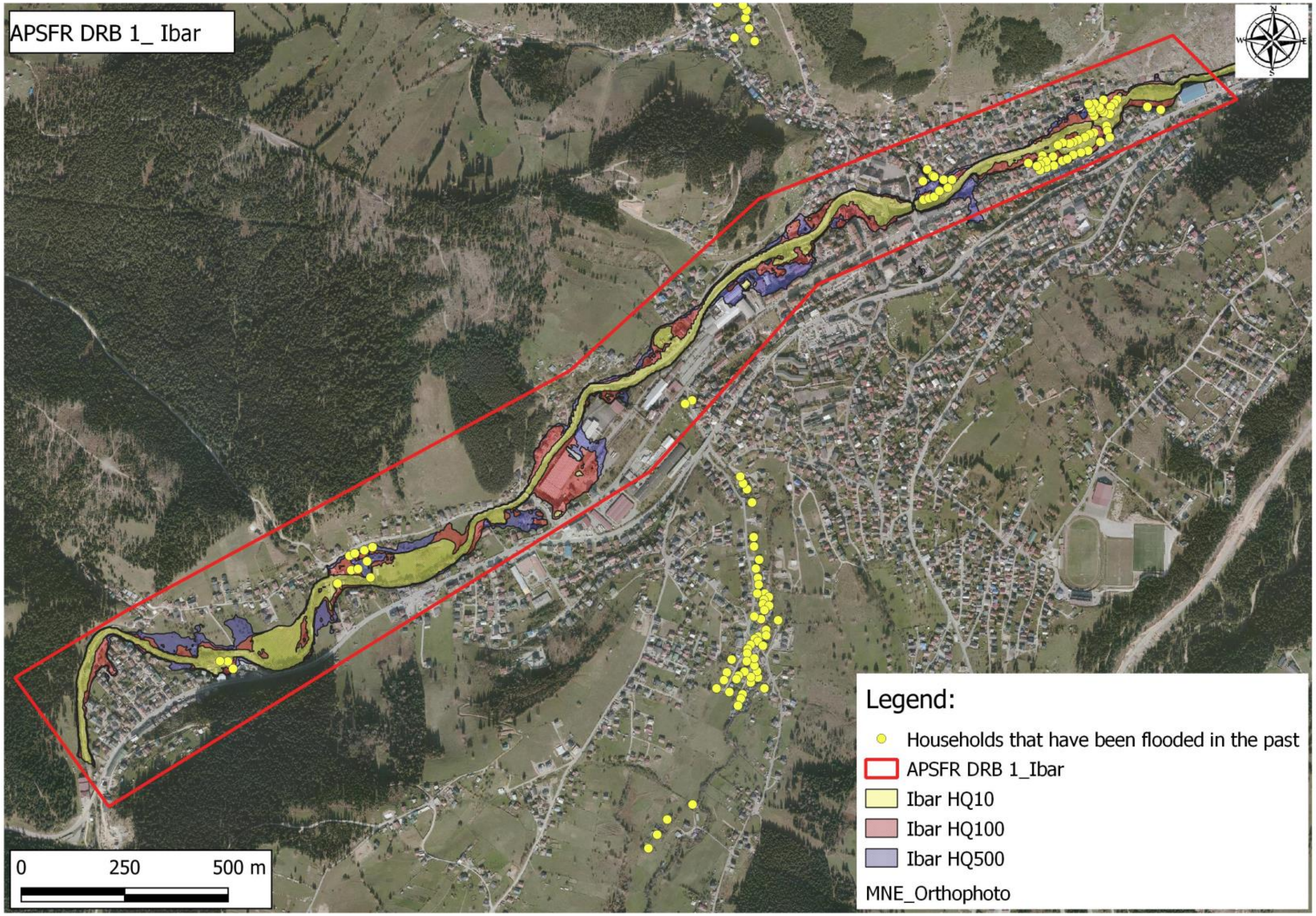


Figure 5.4. APSFR02_DRB_Ibarec01

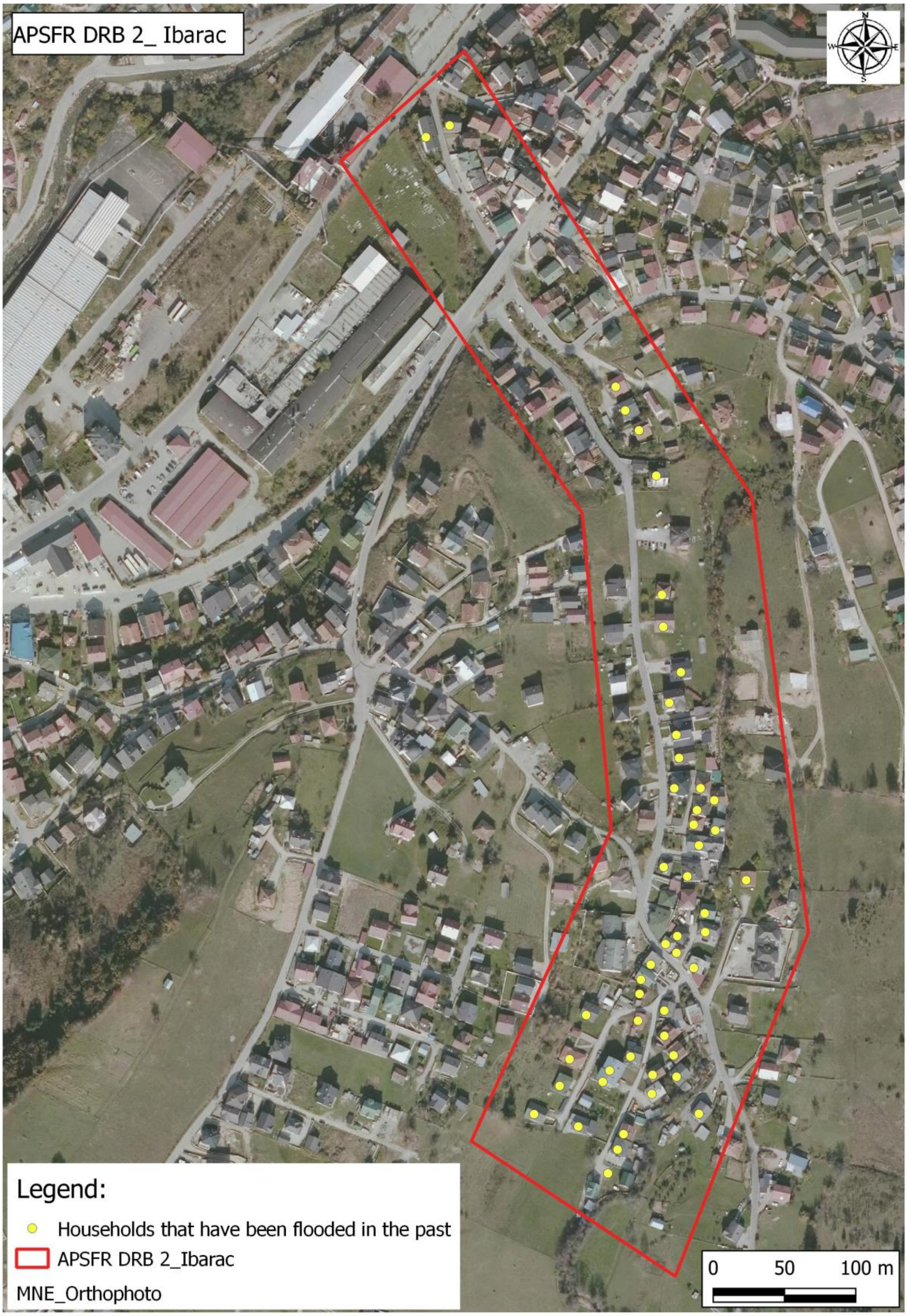


Figure 5.5. APSFR03_DRB_Lovnička rijeka01

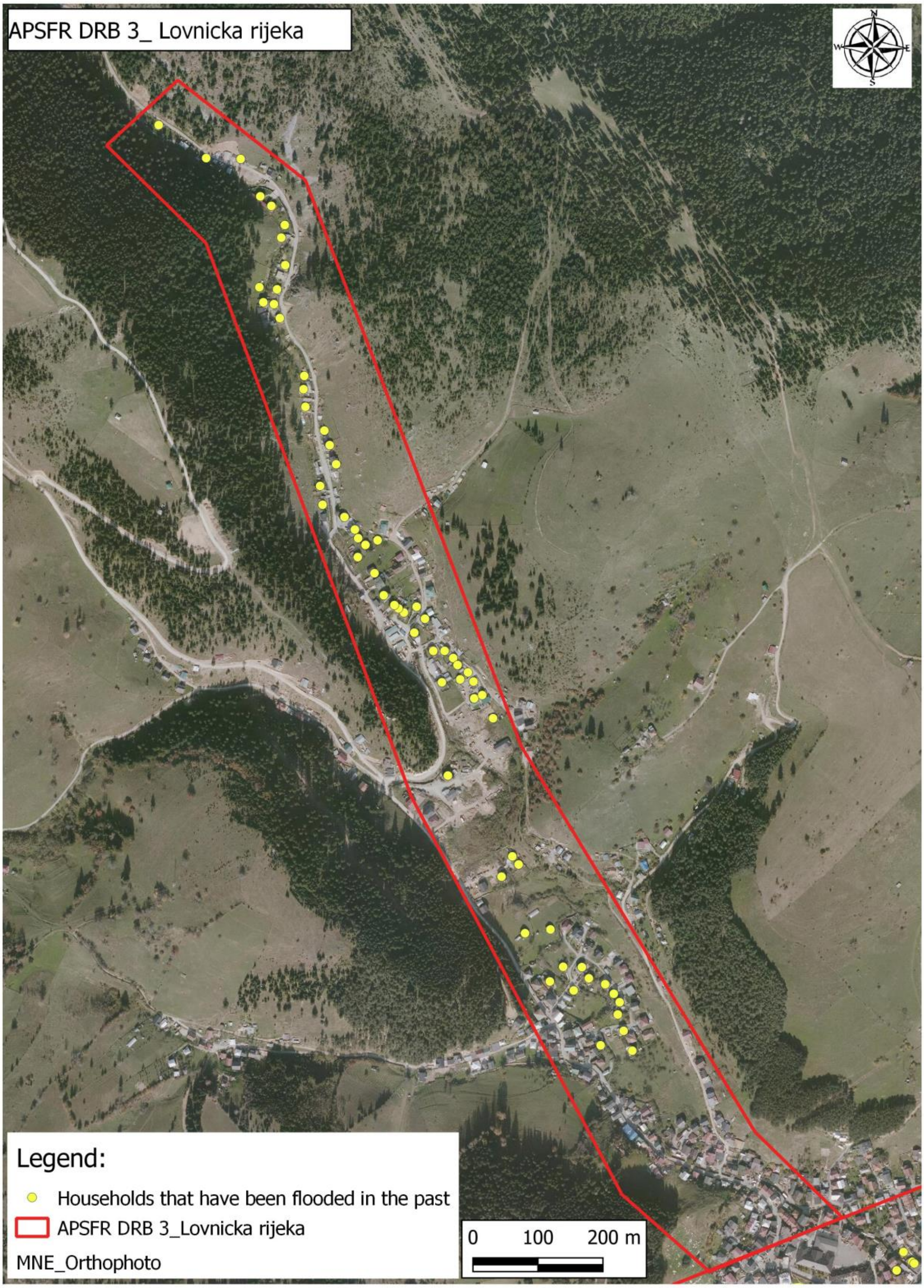


Figure 5.6. APSFR04_DRB_Županica01

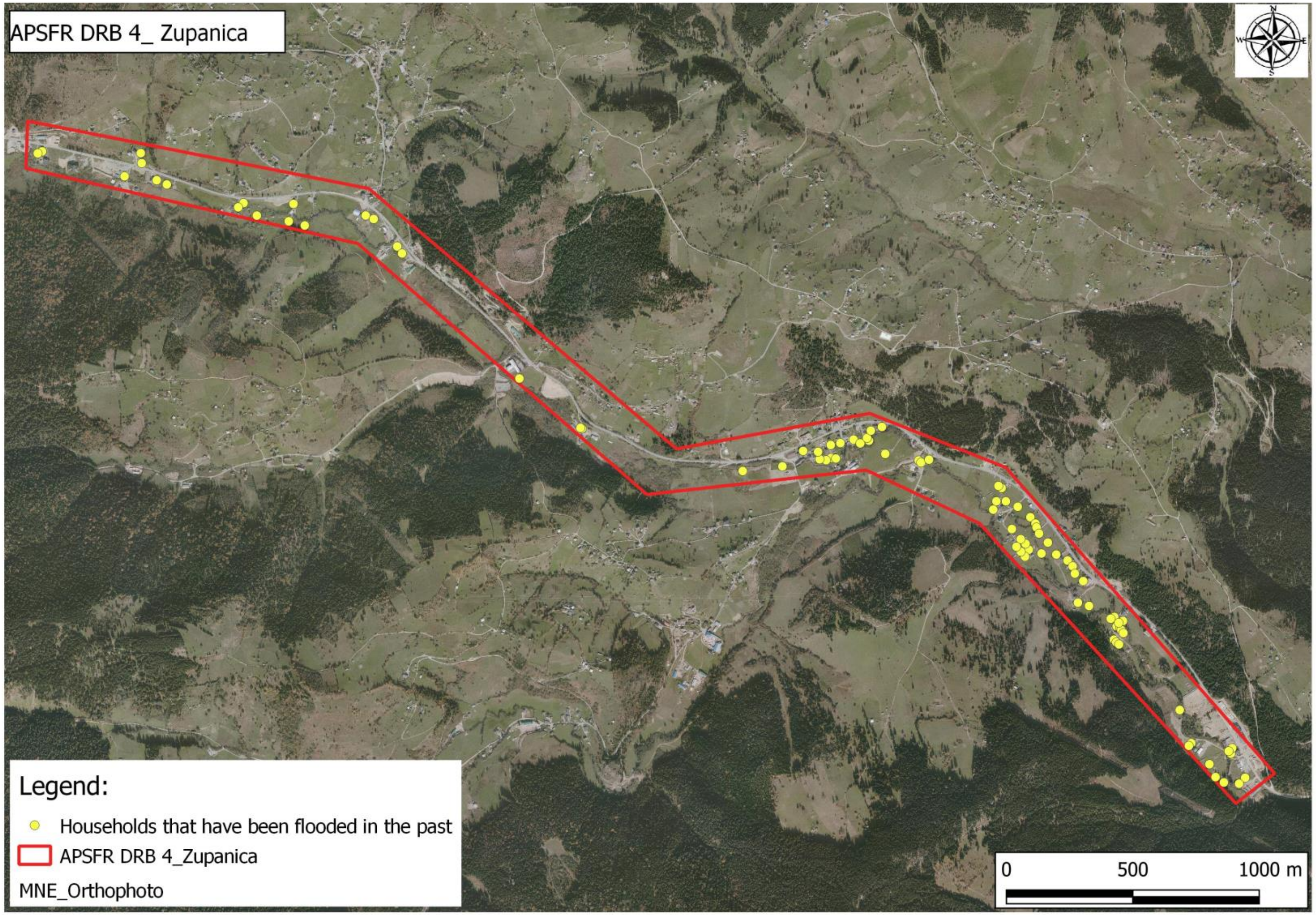


Figure 5.7. APSFR05_DRB_Grnčar01

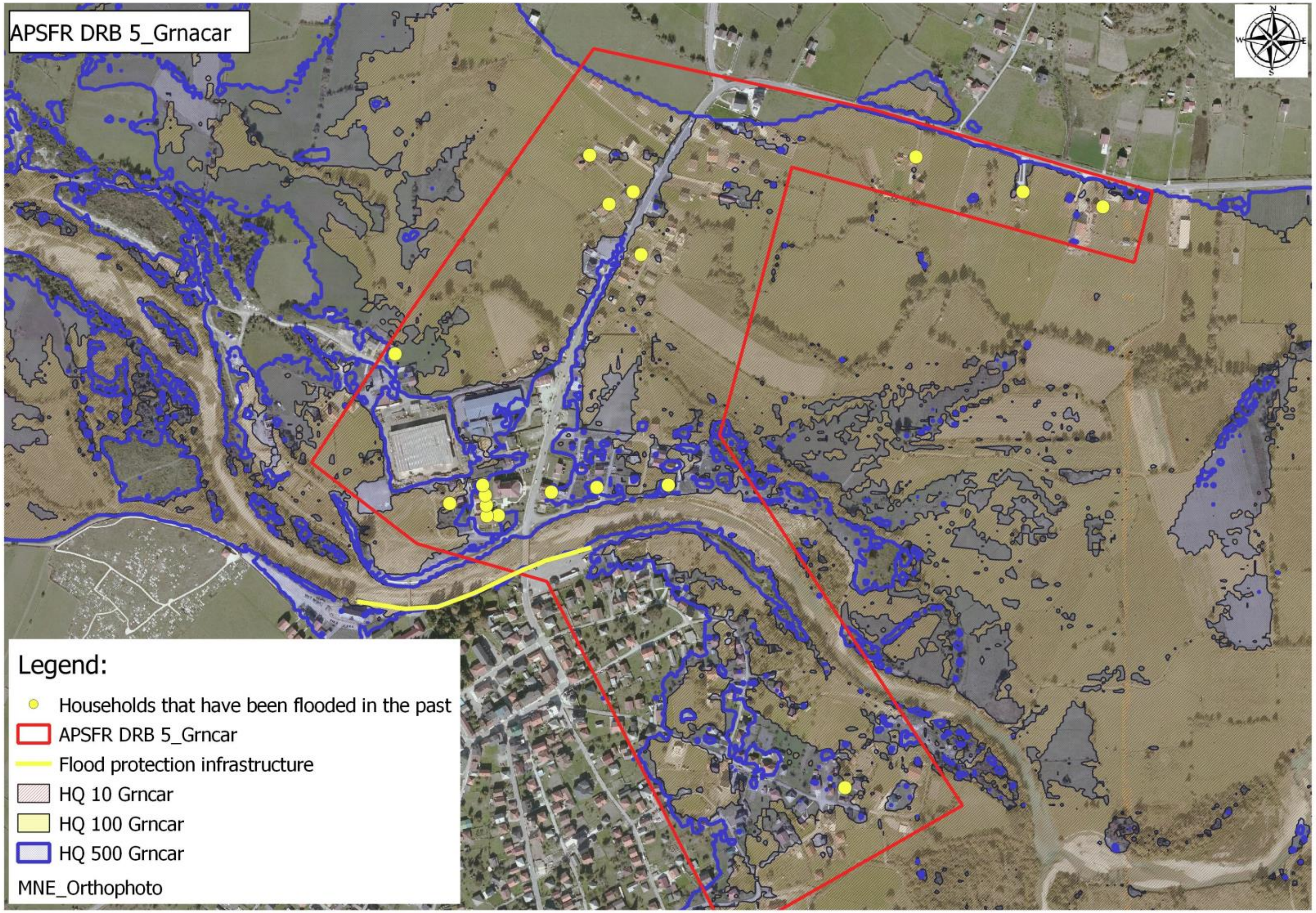


Figure 5.8. APSFR06_DRB_Vruja01

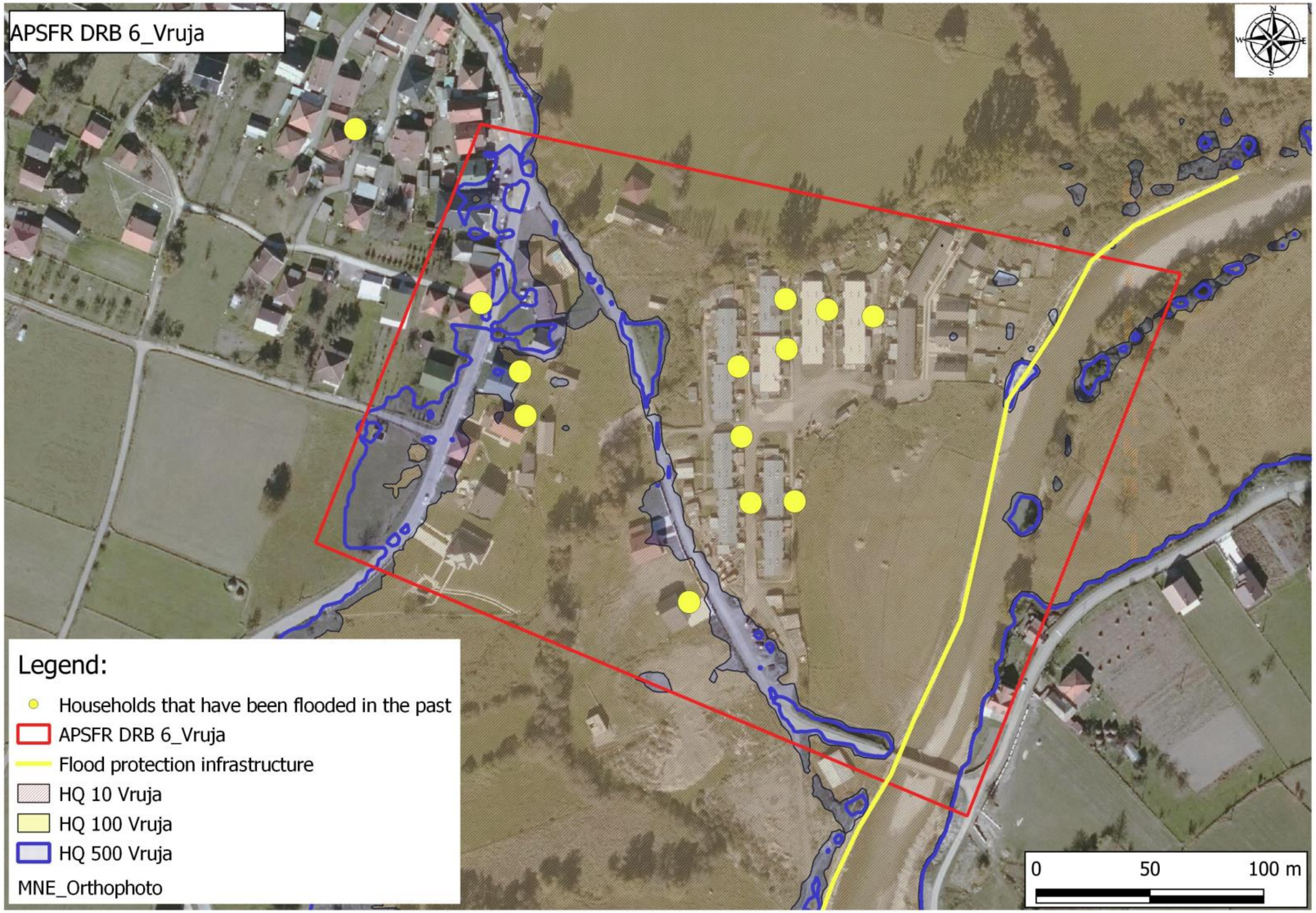


Figure 5.9. APSFR07_DRB_Lim01

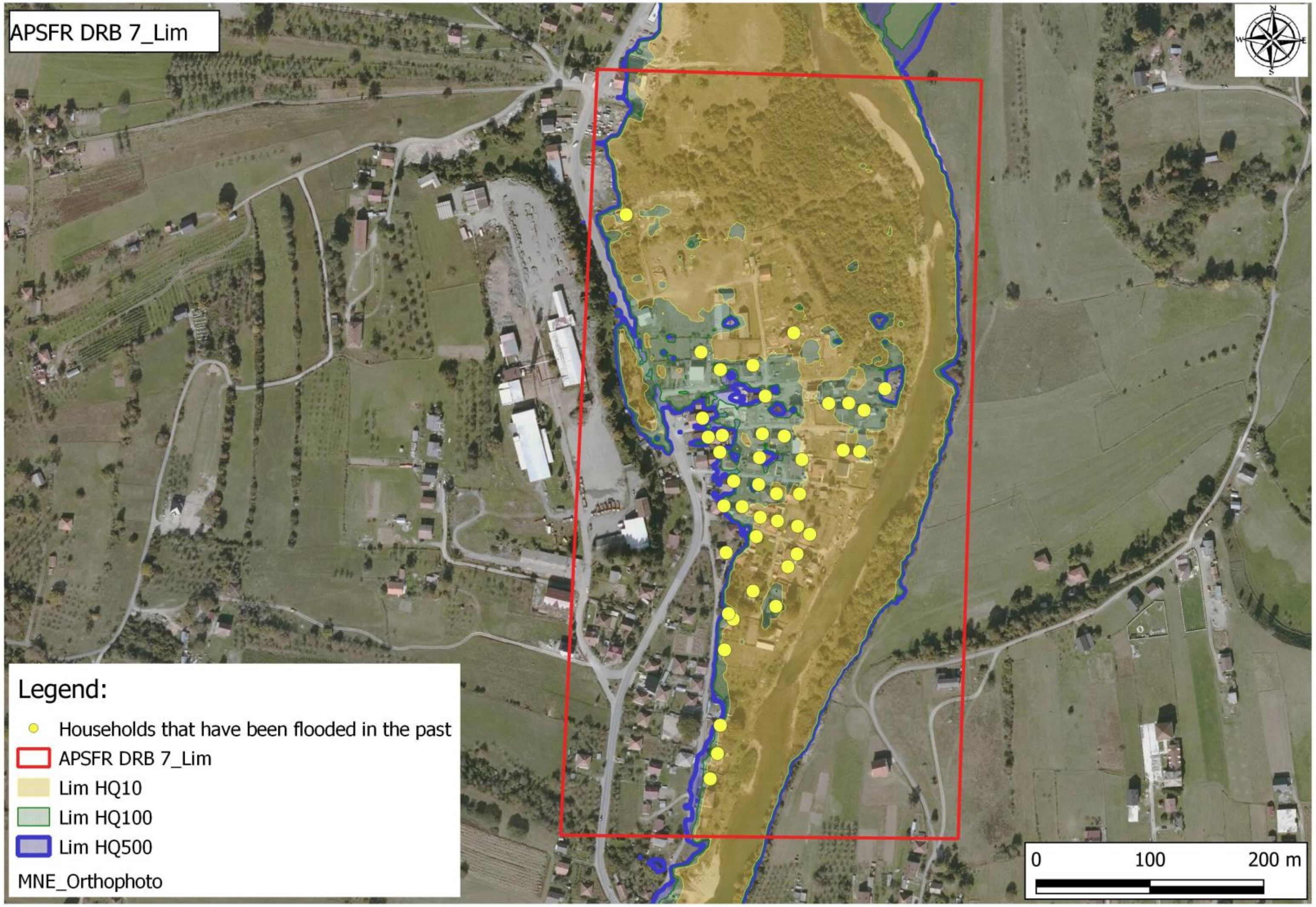


Figure 5.10. APSFR08_DRB_Lim02

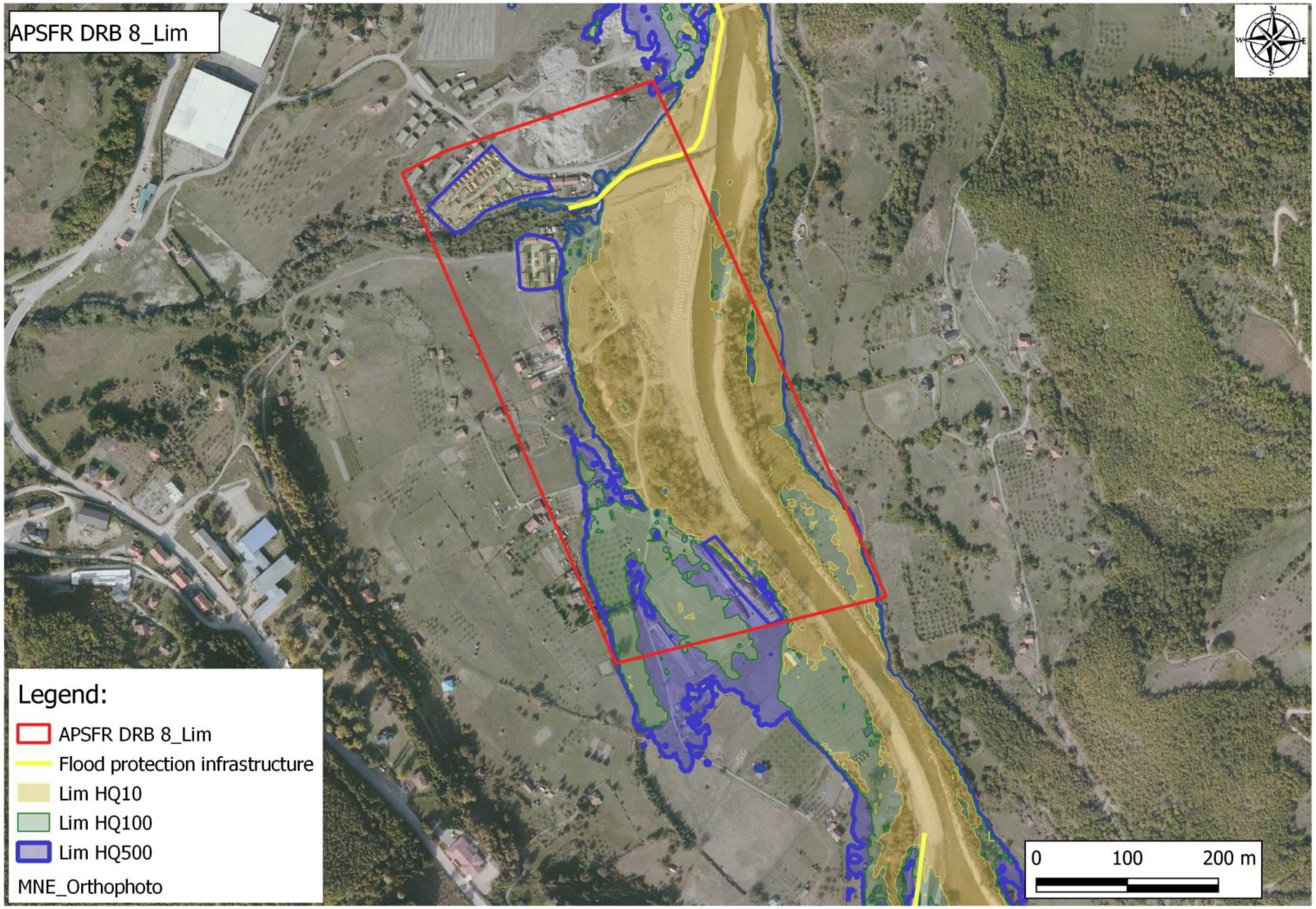


Figure 5.11. APSFR09_DRB_Lim03

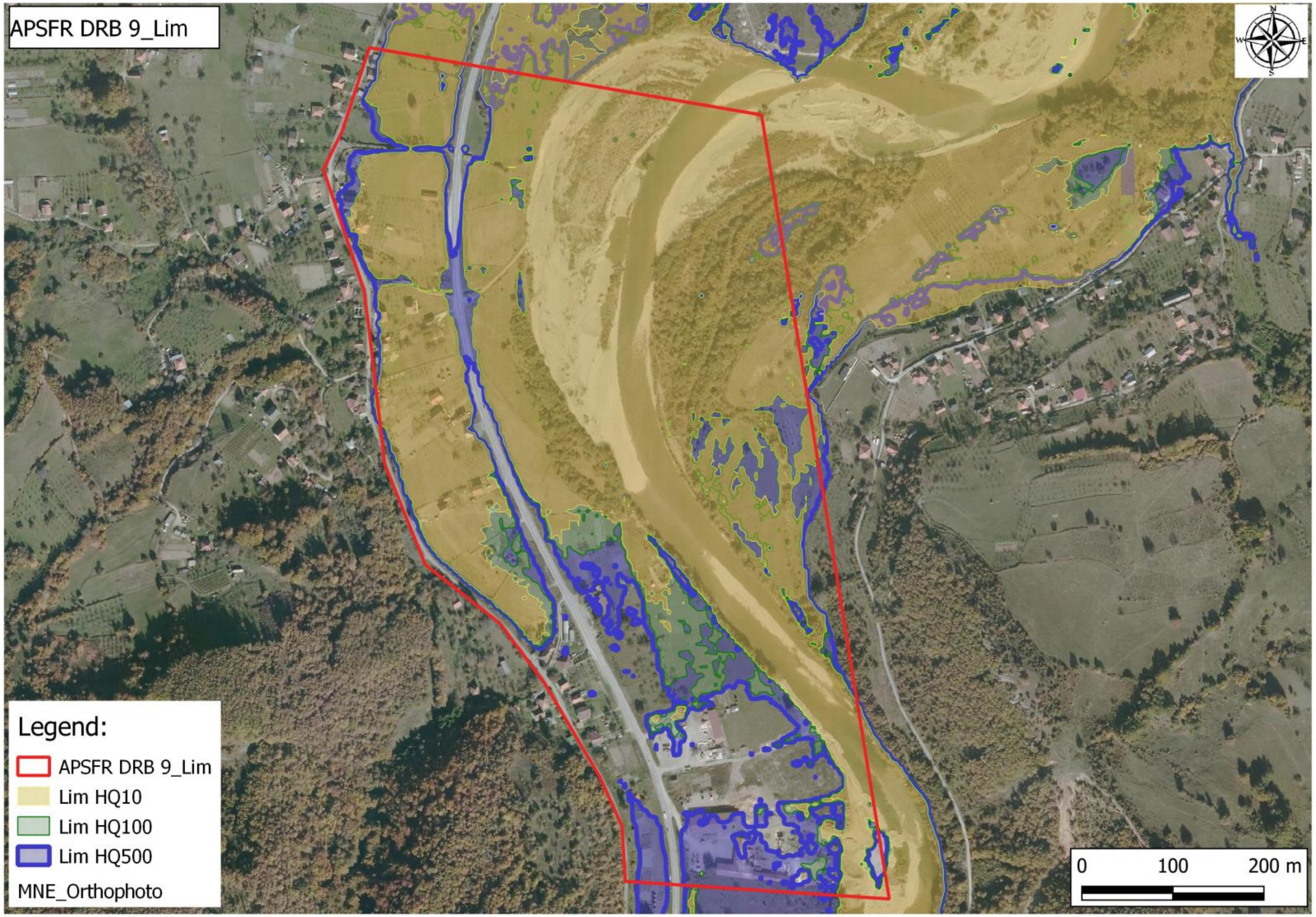


Figure 5.12. APSFR10_DRB_Lim04

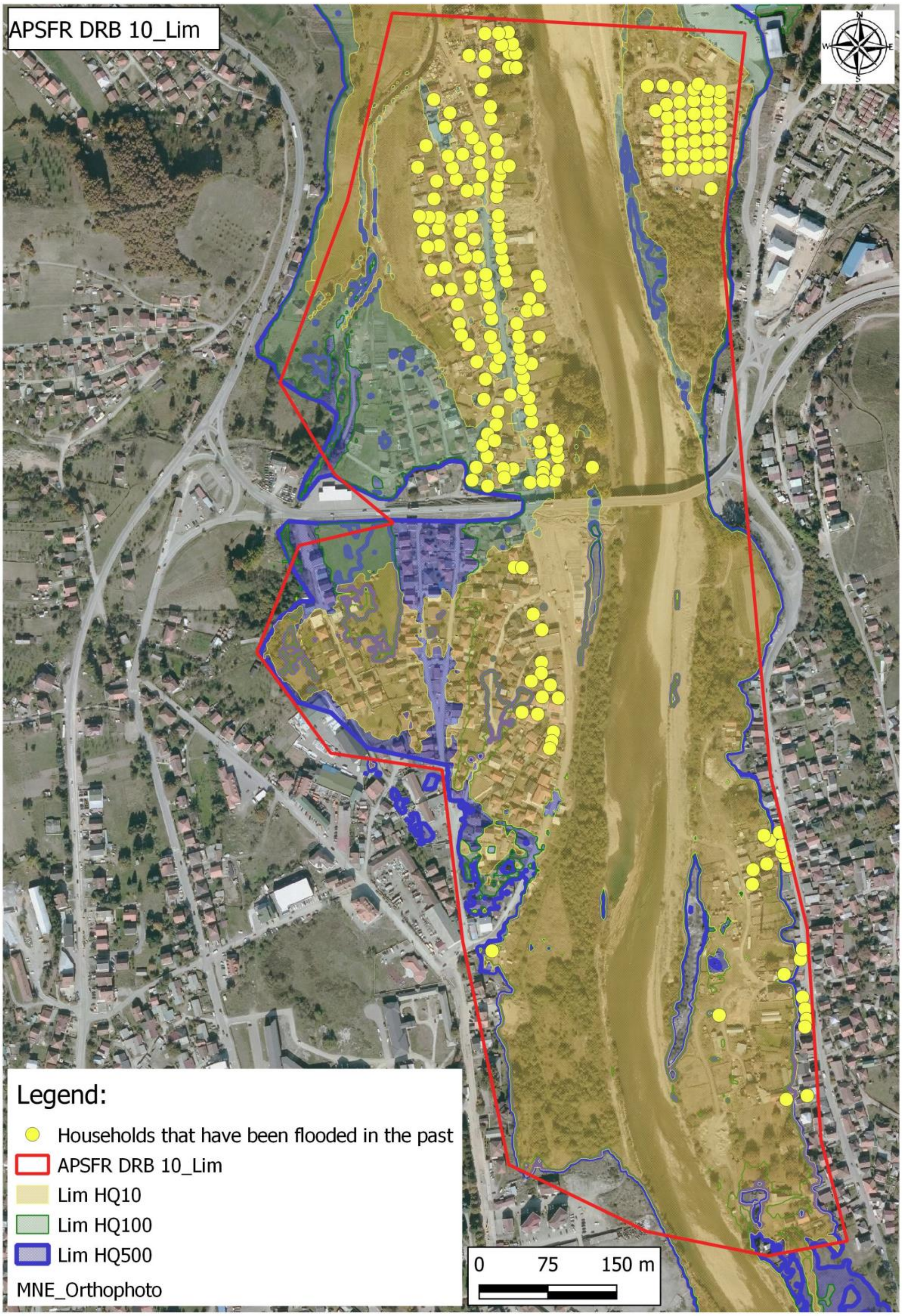


Figure 5.13. APSFR11_DRB_Lim05

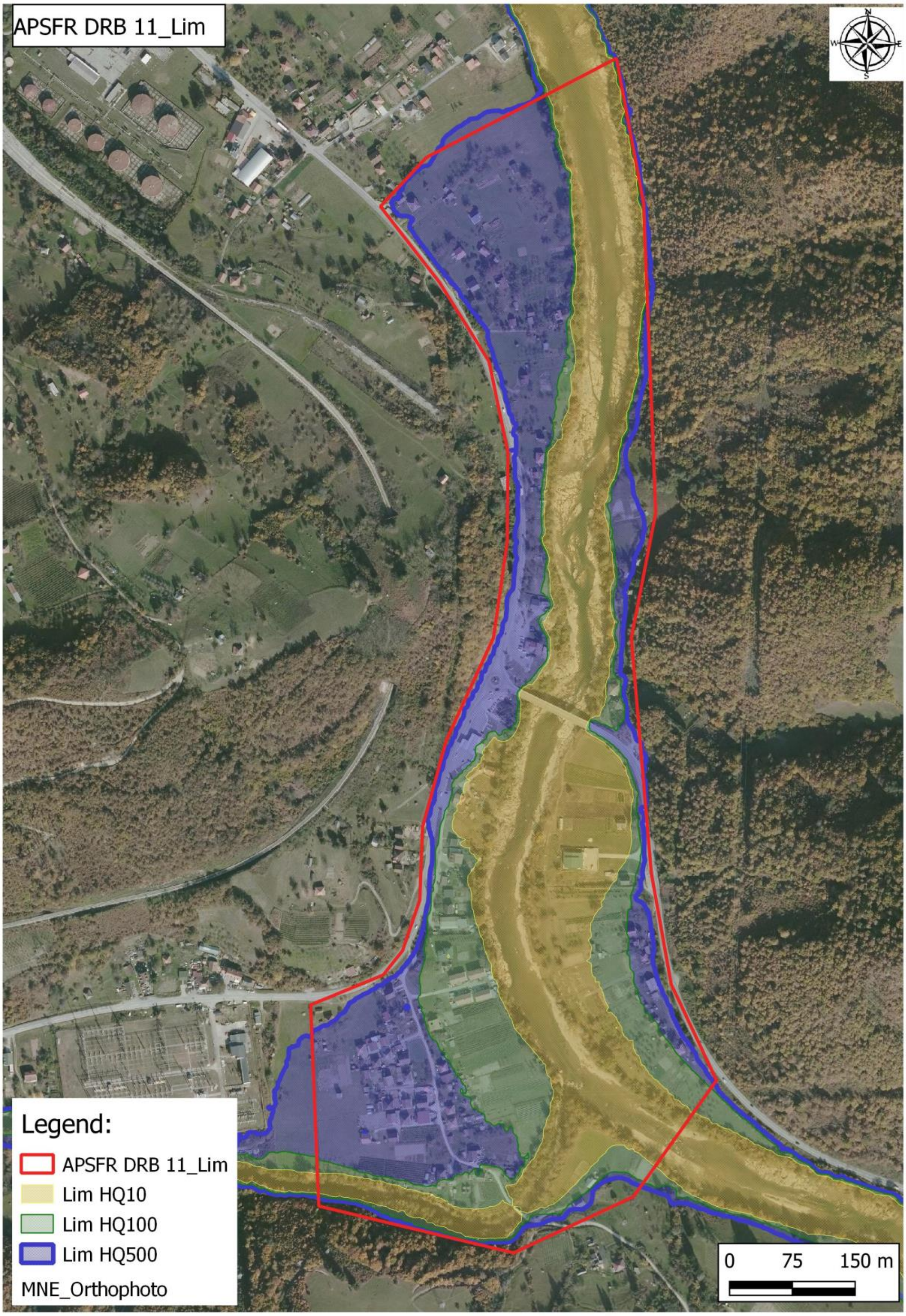


Figure 5.14. APSFR12_DRB_Lim06

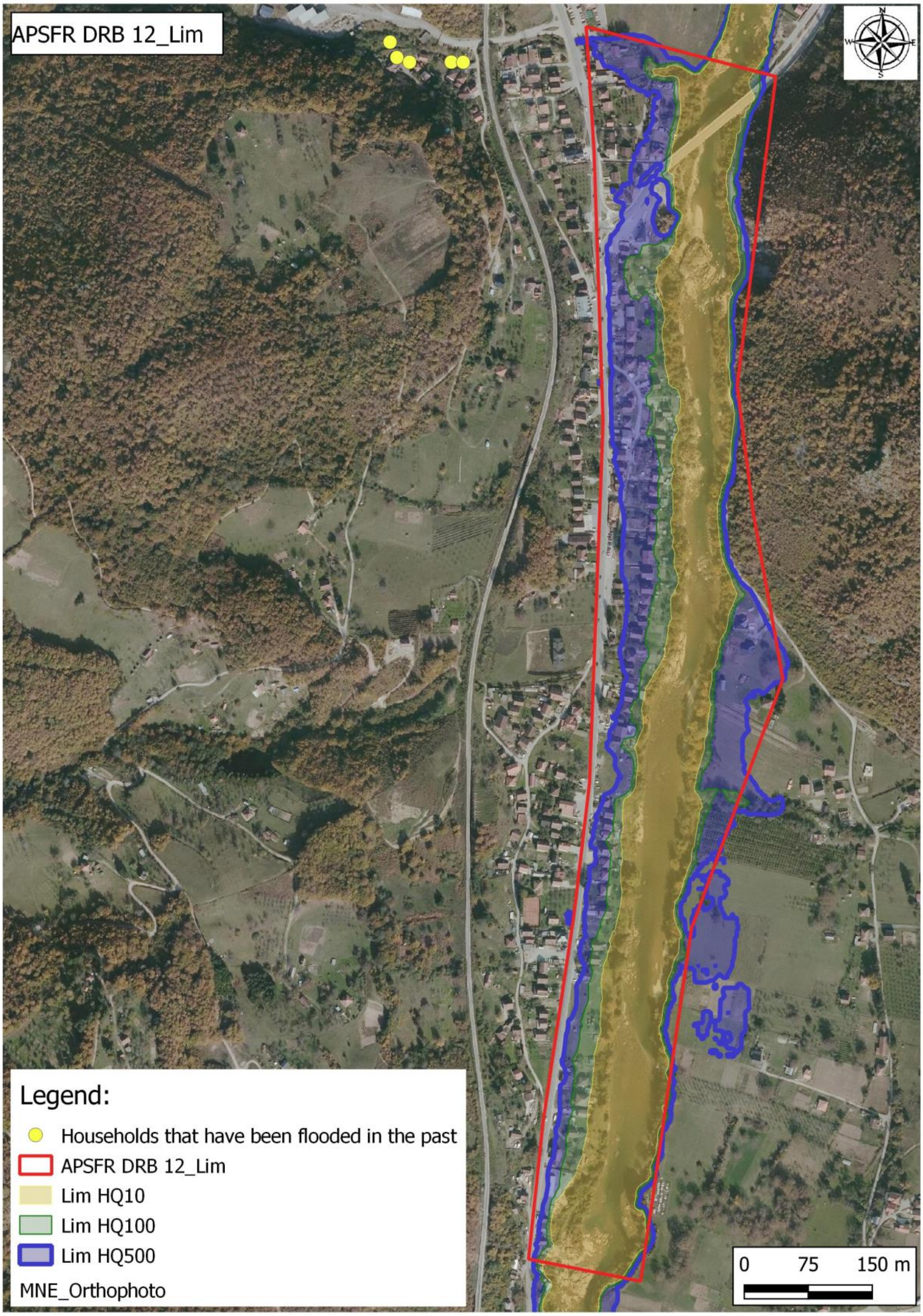


Figure 5.15. APSFR13_DRB_Lim07

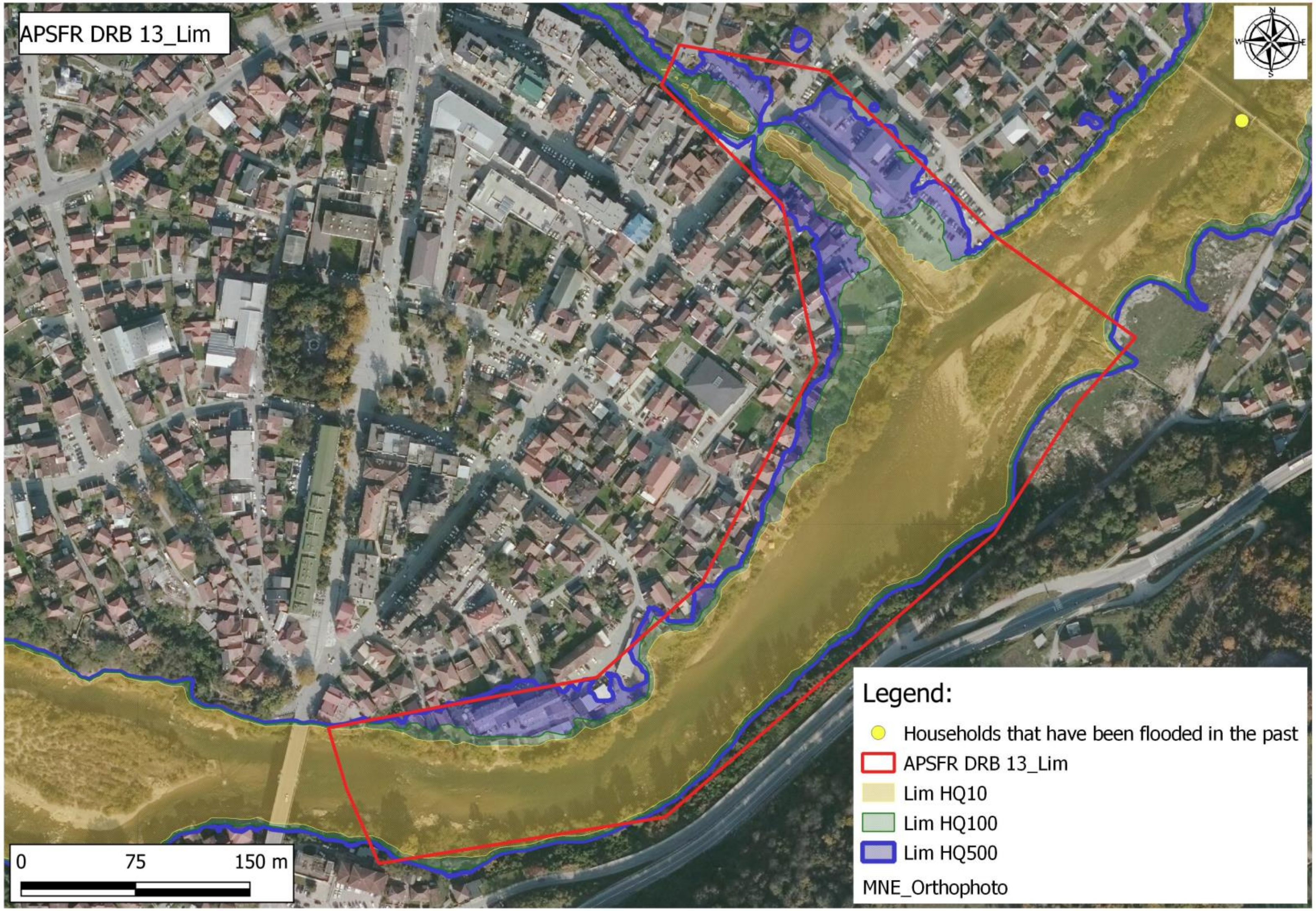


Figure 5.16. APSFR14_DRB_Lim08

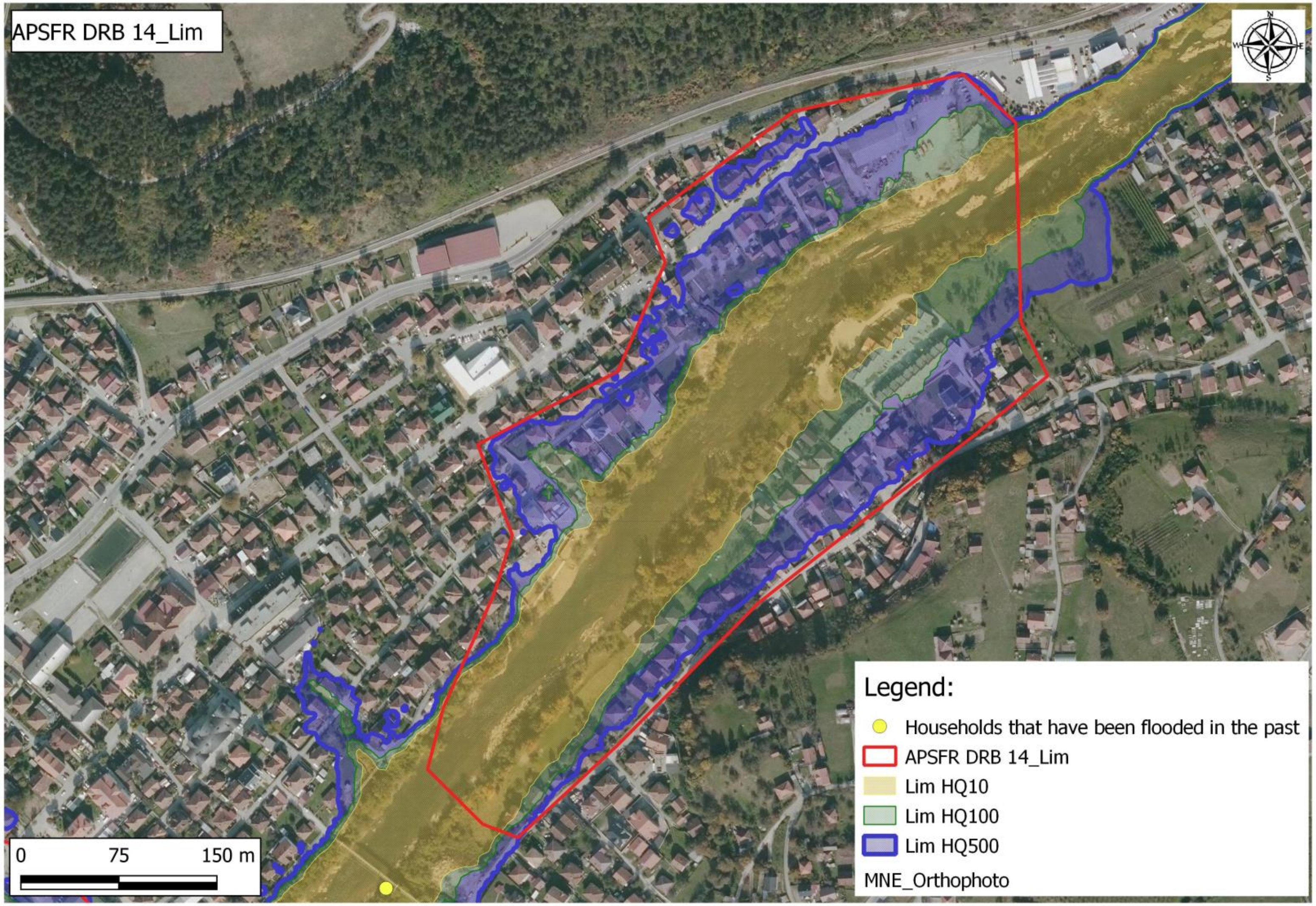


Figure 5.17. APSFR15_DRB_Lim09

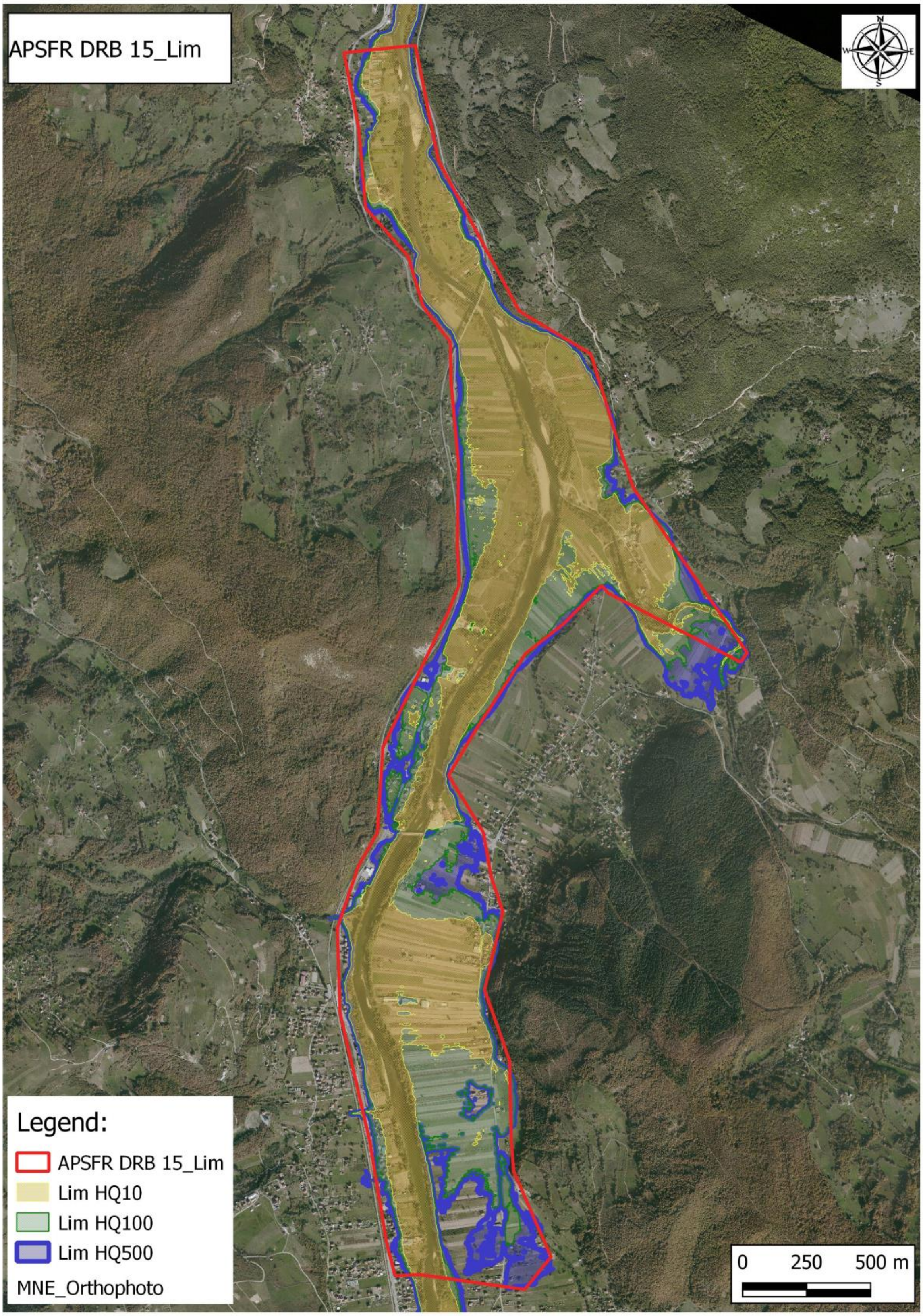


Figure 5.18. APSFR16_DRB_Tara01

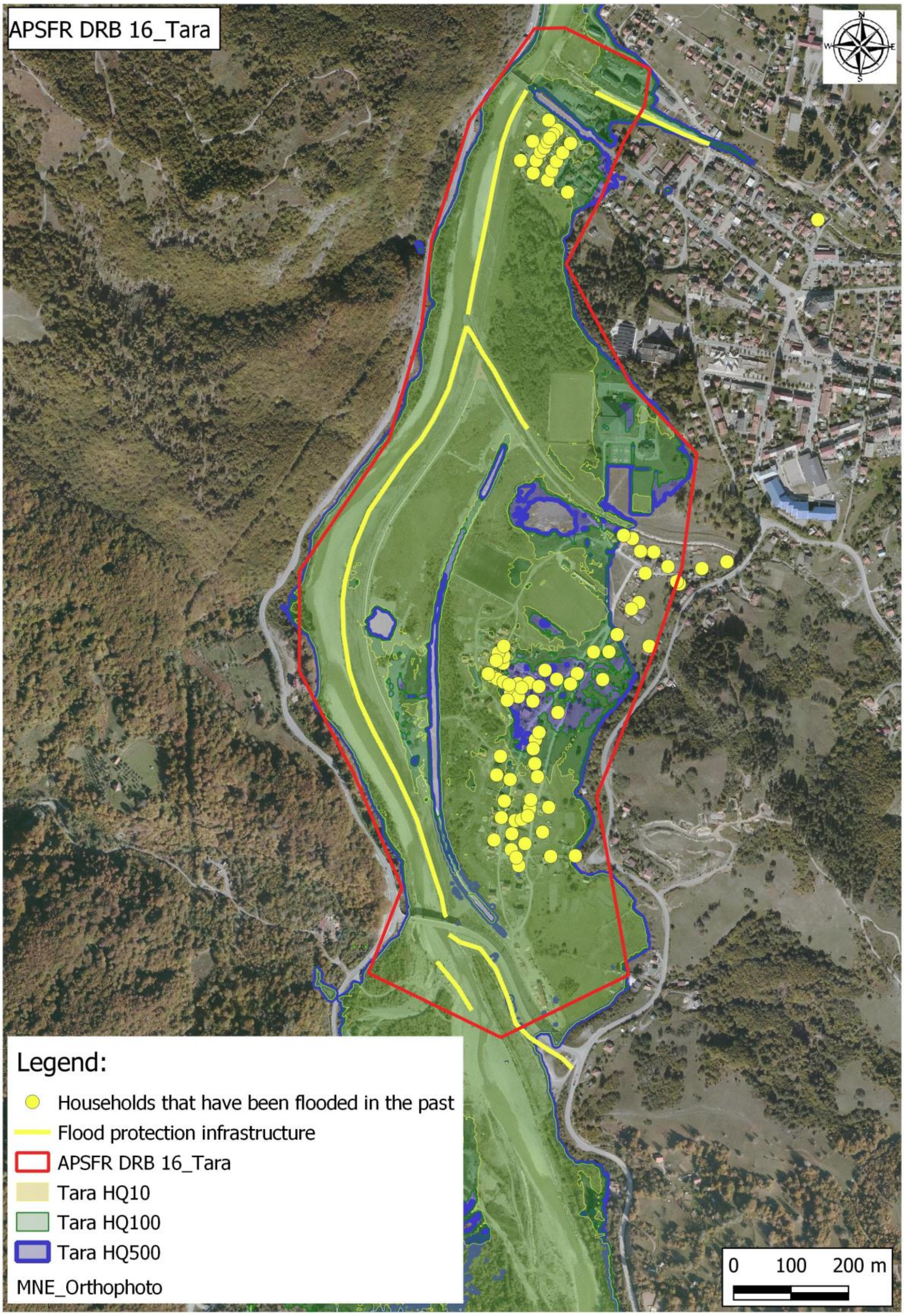


Figure 5.19. APSFR17_DRB_Tara02

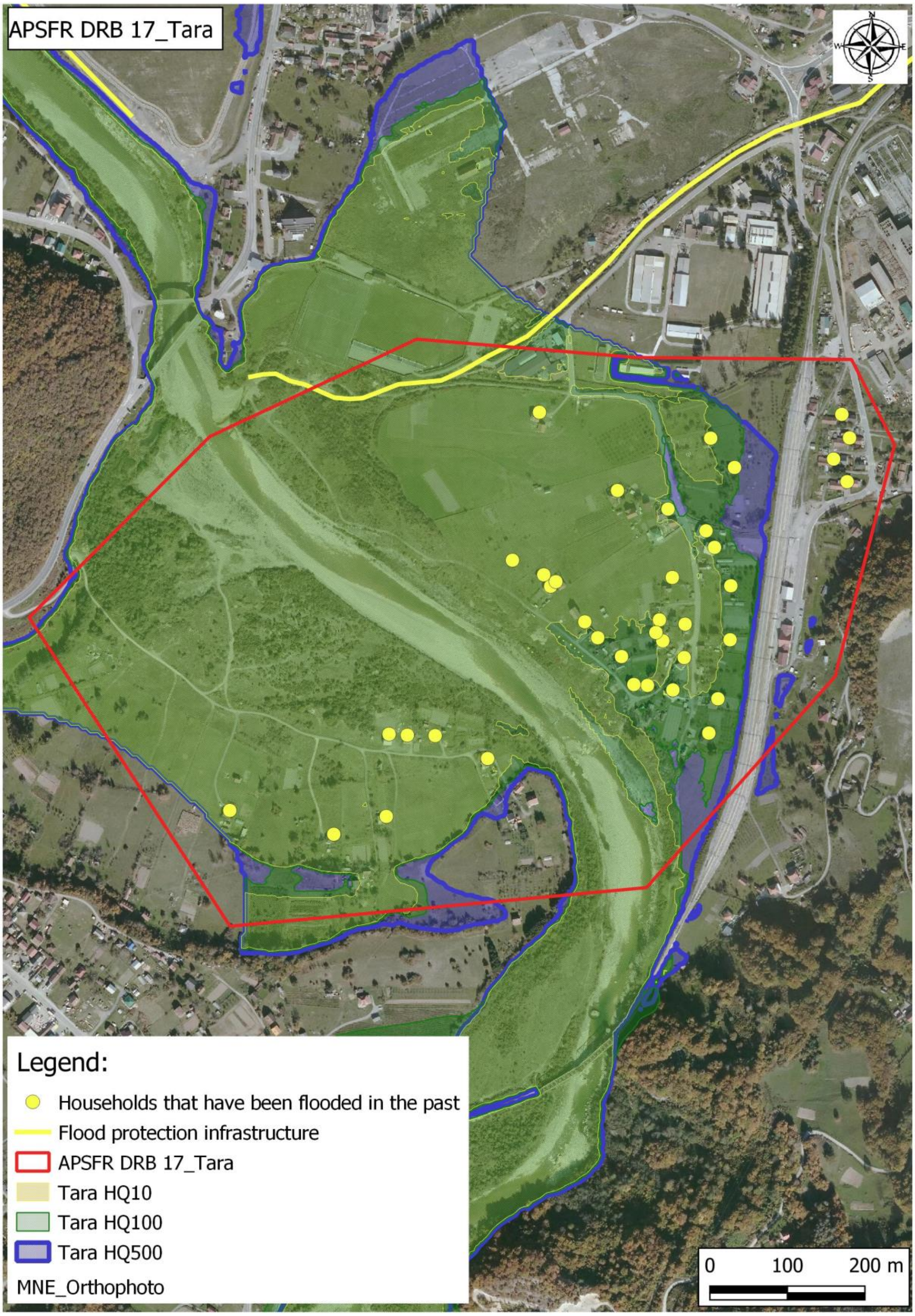


Figure 5.20. APSFR18_DRB_Breznica01

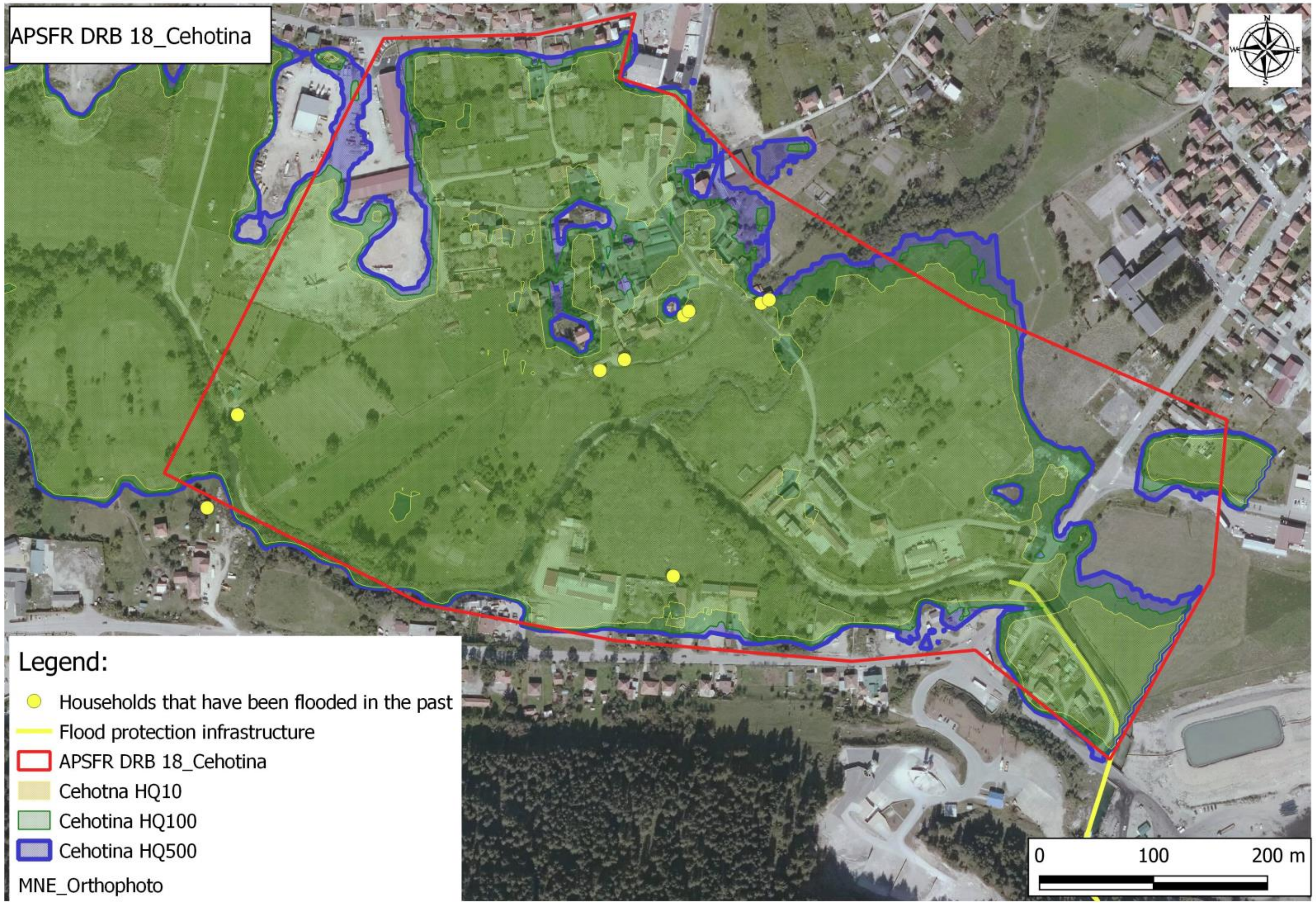
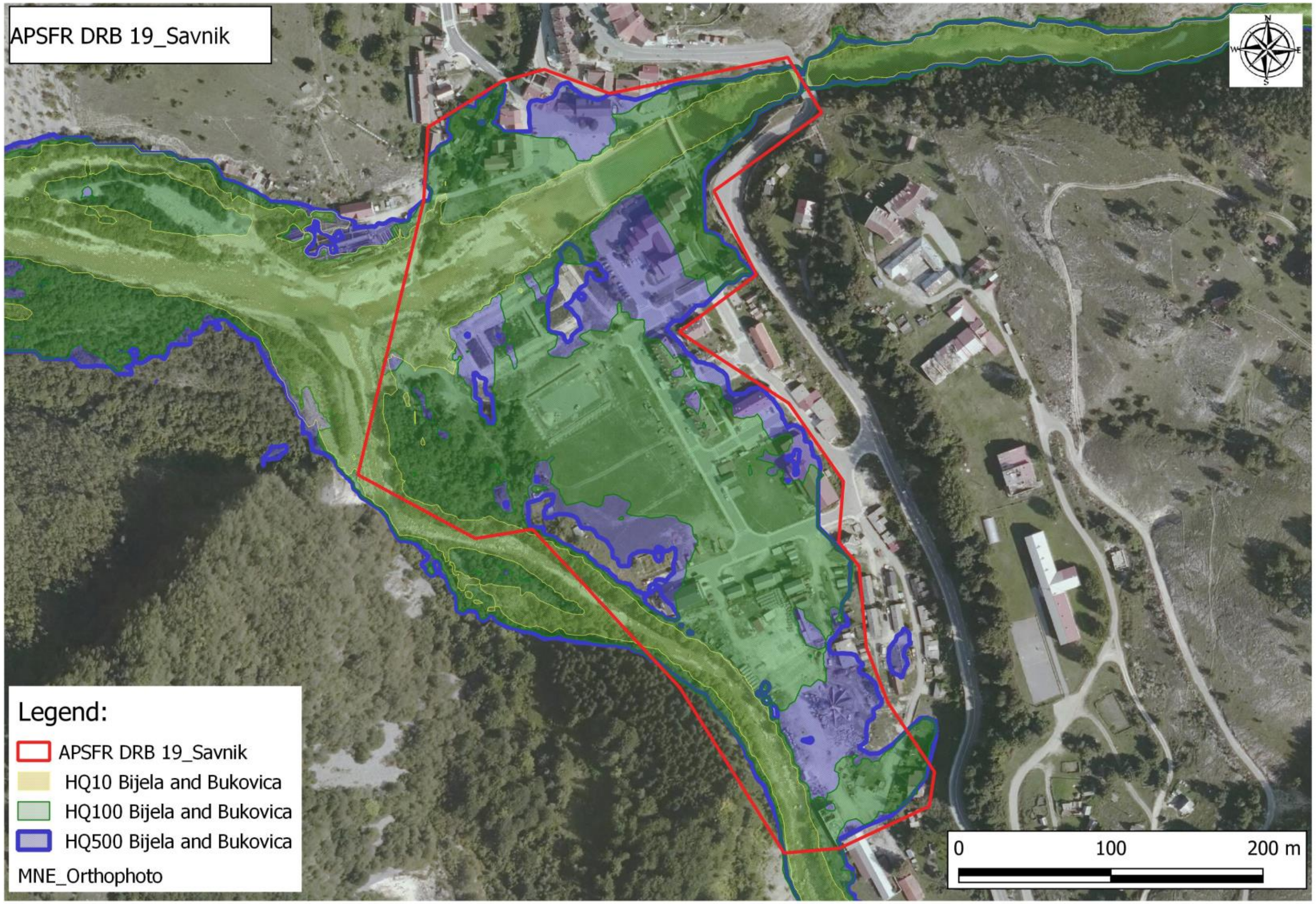


Figure 5.21. APSFR19_DRB_Bukovica i Bijela01



5.4 Conclusions from the PFRA

The following conclusion can be drawn from the Preliminary Flood Risk Assessment of the Danube River Basin:

1. The legal Basis for undertaking the Preliminary Flood Risk Assessment

Based on a legal review It can be concluded that the transposition of requirements from the EU Floods Directive into national legislative framework for the Preliminary Flood Risk Assessment in Montenegro has been achieved in all relevant areas.

The objectives and measures from the National Flood Protection and Rescue Plan and the Water Management Strategy should be harmonized to the extent possible, as these two strategic documents address floods from the perspective of their respective competences.All other strategy documents should be aligned with the objectives set by the chosen overarching policy and update regularly in accordance with latest amendments of such policy.

2. The adequacy of data required to conduct the PFRA

The PFRA should cover historical flood events and the potential for future flood events that may have a significant adverse consequence on either, human health, the environment, cultural heritage, or economic activity. Flood-specific data such as historical flood information, geographic data, urban planning information, population statistics, economic activities, digital terrain models (DTM), meteorological information, civil protection information and other national data is required to prepare the PFRA. This information is then used to identify the Areas of Potential Significant Flood Risk (APSFR), which are the areas that will be the priority for subsequent detailed flood risk management assessment in the flood maps and FRMP stages.

Historical hydrological data related to the recorded high (potential) flood waters on the network of hydrological stations in the Danube River Basin were analysed from 1952 when water level measurements began on rivers. Since the early 1950s, six events have been registered with flows of a calculated return period of 100 years. However, the most common high-water flows in the Danube basin were calculated with a 10-year return period, occurring 146 times to date.

Despite the fact that the historical hydrological data assessment indicates that flooding in the Danube basin would have occurred on multiple occasions in the past, there are no official data before 2010 detailing the extent of the inundated areas of flood waters or damage to property.

The only information available that can be included for the PFRA relates to the historical flooding event that occurred in late 2010/early 2011 where flood events were recorded within 8 municipalities encompassing 23 distinctly individual affected areas. 4 areas were located in the Ibar Sub-Basin, 13 in the Lim Sub-Basin, 4 in the Tara Sub-Basin and 2 in the Ćehotina Sub-Basin.

The recorded data of late 2010/early 2011 include the areas of inundation caused by flood waters, the number of persons affected, a description of the damage to residential and business properties together with a record of the damage to cultural assets in the area. The recorded data thereby allow for the determination of the significance of the potential risks in relation to human health, environmental and cultural criteria at each location of recorded flooding.

Notwithstanding the lack of detailed data to document historical flood events, the data from late 2010/early 2011 is invaluable for the Preliminary Flood Risk Assessment.

For the purpose of producing the PFRA, 21 existing and historical hydrological stations (HS) the Danube Basin relating to the major rivers were chosen as relevant for analysis. A statistical analysis was performed using the method of annual extremes to calculate the probability that 10%, 1% and 0.2%, i.e., return periods of 10, 100 and 500 years. The HEC-RAS model was used to calculate the flood lines. Data on the geometry of the riverbed (topography of the main riverbed and inundation) were obtained from a digital terrain model (resolution 5m). Calibration of the model was performed based on 2010 flood data. Using a cross-section of the water mirror plane with a digital terrain model, spatial data for the display of flooded areas was obtained, in the form of polygons, and the display of depths, in raster form. This data was used (as shape files) for further processing in the Quantum GIS program.

Of the other existing data, historical data were emphasized, i.e., locations of houses that were flooded during the highest recorded floods during 2010-2011. Data obtained during the earlier phase of this project related to flood protection infrastructure were also used. An Orthophoto image of Montenegro, obtained from the Real Estate Administration of Montenegro, was used as a basis for presenting and comparing data.

A topographic map of Montenegro with a scale of 1:25,000, as well as available data available on the Internet (Open Street Map (OSM), Google Maps) were used for analysis, but the Orthophoto image of Montenegro was presented as the most useful as a background. Data relating to Corine Land Cover were also considered during the data analysis.

Based on the analysis of all the above data, 19 APSFR in the Danube Basin area were defined and represented in GIS format.

3. Forecasting of future flood Events

Based on climate precipitation projections, in general, it can be concluded that flood events will be both more frequent and more intense, as a consequence of climate change. Thus, although the reduction of total annual precipitation in most parts of the Danube River Basin is expected, in the future, short heavy rainfall, often combined with snowmelt and soil saturation, is expected to cause a higher risk of torrential floods caused by an increase in surface runoff.

During the flood risk assessment, the expected impacts of climate change were considered by applying one extreme flood scenario (extreme flood recovery period ≥ 500 years), which included all proven or known, or estimated future impacts, including climate change impacts. The impacts of climate change on the identification of areas with potentially significant flood risk are fully covered by working on scenarios of extreme flood events.

6 FLOOD HAZARD MAPS AND FLOOD RISK MAPS

6.1 Introduction

According to Article 4 of the Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan ("Official Gazette of Montenegro", no. 69/15), flood hazard maps for floods of low, medium and high probability shall contain data on:

- size of the event;
- water depth and/or water level;
- water course speed and/or water flow speed, as necessary.

The size of the flood event for still and running water is shown on the maps in form of graphs, containing data on boundaries of areas under flood risk.

The size of flood events on the flood hazard maps is shown by colours:

- low probability floods in light blue;
- medium probability floods in blue;
- high probability floods in dark blue.

Water depths are presented on flood hazard maps for running and still waters for the following depths:

- < 0.5 m (light green colour);
- from 0.5 m to 1.5 m (green colour);
- > 1.5 m (dark green colour).

Flow speed is presented at flood hazard maps for speeds of v > 1 m/s by an interrupted line.

Contents of the flood risk maps is described in Article 6. Flood risk maps for low, medium and high probability floods shall contain data on:

- number of potentially affected population;
- types of economic activities in potentially affected area;
- potential sources of pollution, activities and installations that could cause sudden pollution in case of floods;
- potential hazard for protected areas referred to in Articles 74a paragraph 2, items 1, 3 and 5 of the Law on Waters;
- areas where floods can occur with high content of transported sediments and other sources of pollution.

6.2 Methodology for preparation of maps

6.2.1 Hydraulic modelling

For the purposes of creating flood hazard and flood risk maps, three scenarios were considered:

- Floods of low probability of occurrence (HQ500 years)

- Floods of medium probability of occurrence (HQ100 years)
- Floods with a high probability of occurrence (HQ10 years)

For all three scenarios, the maps show:

- Limits of floodplains
  Water depths (0m-0.5m, 0.5m-1.5m and ≥1.5m hazard maps and 0m-0.5m, 0.5m-1m, 1m-5m and ≥5m flood risk maps)
- Water velocities (0 and ≥1m/s)

Available Data

In the process of assessing the value of relevant large waters for the specified probabilities of occurrence and creating hydraulic models for 19 APFSRs from the Danube River Basin, the following data were available:

- Maximum annual water levels and flows on the profiles of the hydrological measuring stations available from IHMS.
- Terrain data were taken from the Real Estate Administration - a digital terrain model (DEM) for the area of Montenegro with a resolution of 5m x 5m.
- Historical data was also available - recorded maximum water levels in the floods of 2010/2011 and the objects that were threatened when those waters appeared.

Processing of Hydrological Data

Different types of hydrological analyses were used in the process of defining the relevant large bodies of water.

By statistical analysis of the maximum annual flows and water levels on the profiles of the hydrological stations, the numerical values of the maximum water levels and flows of different probabilities of occurrence according to different distribution curves[41] were obtained.

In the absence of data on flow and water level measurements, the concept of a complex synthetic hydrograph was applied to assess large waters, which is widely used in practice in similar situations. For the purposes of determining high water levels, the maximum precipitation, as well as precipitation of shorter duration in the considered area, was analysed. During these analyses, the existing documentation for the nearest hydrological station and the digital terrain model of Montenegro were used. Short-term precipitation was obtained based on the probability of one-day maximum precipitation, which was published in the Water Management Base of Montenegro. Data were obtained using empirical patterns through reduction coefficients.

The HEC-HMS software package was used for data processing. The input parameters for defining large waters were:

- Short-term precipitation characteristic probabilities (mm)
- Effective precipitation amounts of characteristic probabilities (mm)

Formation of hydraulic models

Calculations were made in the HEC-RAS hydrodynamic model. In the work methodology, a 2D flow calculation model was adopted and a 3D terrain model was used. The geometry of

[41] Pearson III, Log-normal, Log-Pearson III and Gumbelova I GEV

the model was formed using available geodetic data (DEM resolution 5m x 5m). A 2D calculation area is marked in the model and a mesh is generated within it. The figure shows an example of a marked 2D area and a generated mesh.

After entering the geometric and hydraulic elements, initial and boundary conditions were entered and calculations were made for unsteady flow.

Results of the hydraulic models

The results of the hydraulic modelling provided:

- Limits of floodplains
- Water depths (0m-0.5m, 0.5m-1.5m and ≥1.5m for hazard maps and 0m-0.5m, 0.5m-1m, 1m-5m and ≥5m for flood risk maps) and
- Water velocities (0 and ≥1m/s)

For each APSFR three scenarios were considered:

- Low probability flood event (HQ500 years)
- Flood event of medium probability of occurrence (HQ100 years)
- Flood event with high probability of occurrence (HQ10 years)

Data export was managed via RAS-Mapper as a .shp file to be further processed in QGIS software.

Creation of flood hazard maps (HQ10, HQ100 and HQ500)

For the purpose of creating hazard maps, inundation depths and flow velocities obtained from the hydrological model for return periods of 10, 100 and 500 years were used as input data. For each of the return periods, data were obtained in .shp format for three classes of inundation depth and two classes of flow velocity. The data obtained in .shp format were imported into the GIS program, where the reference system WGS 1984 UTM zone 34N was assigned to them.

Based on the obtained data, the hazard map shows three classes of inundation depth:

- 0-0.5m, 0.5-1.5m, >1.5m

Of the two flow rate classes, 0m/s and 1m/s, on the hazard maps, only the boundary of the second class is shown, which indicates speeds greater than 1m/s (v>1m/s), while the symbolism of the speed display was also based on the examples of maps made in the previous cycle (in accordance with the PFRA Closer View Regulations).

OSM (OpenStreet Map, source: www.OpenStreetMap.com) and OP (Orthophoto recordings from 2018, source: geoportal.co.me) were used as base maps for all APSFR. Topographic maps were also prepared for all APSFR. Therefore, for each of the return periods (HQ10, HQ100 and HQ500) three maps were created, resulting in a total of nine hazard maps prepared for one APSFR area.

Data available on the geoportal platform were used to display the objects located in the flood area.

6.2.2 Risk Assessment Methodology

For the purpose of the assessment of flood risk, the risk matrix method is applied, as suggested in Flood Hazard and Risk Mapping (for the Drim-Bojana River Basin) Guidebook. The Guidebook resulted from the project Climate Change Adaptation through Transboundary Flood Risk Management in the Western Balkans.

As determined in Article 2 of the EU FD - flood risk means the combination of the hazard (the probability of a flood event) and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event (European Parliament and Council 2007). The resulting risk of flooding is derived from the interaction between the hazard and damage.

The EU FD does not specify a method for risk assessment. Depending on the different data availability there are different types of possible methodological approaches. Given the data accessibility, the risk matrix method was chosen in order to calculate the risk levels. The following description provides insight into the manner in which hazard of flooding and damage potential are defined and combined according to this method.

Hazard of Flooding

The probability of an adverse event (floods in this case), as well as its intensity (flood depths) are analysed through intensity classes for selected return periods. For flood risk assessment in Montenegro, floods of three different return periods are considered: 10, 100 and 500 years. These correspond to scenarios of high (10%), medium (1%) and low (0.2%) probability. Since flood depths are needed to define intensity classes, two-dimensional hydraulic models have been developed for each of the APSFRs. Through independent simulations of all three scenarios – flood extents and flood depths are computed for every APSFR. Depending on the model results, the flooded area could be divided (for each return period separately) into four zones of different intensity class, depending on the calculated inundation depths. Therefore, values of the intensity classes vary from 1 to 4, according to Table 6.1.

Table 6.1. Classification of intensities

Water Depth	Class
Less than 0.5 m	1
0.5-1m	2
1-5 m	3
More than 5 m	4

Damage potential

Potential adverse consequences and damages induced by flooding depend on the land use of the areas within the flood extent, on their vulnerability and fragility of assets of risk located in these areas. This means that for the same intensity class value (e.g. the flood depth of an area is greater than 5m, with 1% exceedance probability), the risk level will depend on the type of the objects exposed to flooding (for that same zone - the level of risk will not be the same if there are only e.g. meadows or open fields, in relation to the level of risk if a hospital, fire department, power plant, or any other facility of importance for the settlement were to be located on that same area). According to this, flooded areas are divided by their land use, based on which the vulnerability values (classes) are assigned. Possible vulnerability values are: 1 (low vulnerability level), 2 (medium vulnerability level) and 3 (high vulnerability level). Vulnerability classes were assigned according to Table 6.2.

Table 6.2. Vulnerability classification

Land Use Class	Vulnerability Value		
	Low	Medium	High
Agriculture	Pasture	Irrigated field	Greenhouse
	Orchard		Special crop
			Agricultural building or stable
Forest	Normal forest	Park	Protected national park
Settlement	Single house, multi-storey	Single house, single-storey	Dense settlement
		Low value houses	Construction without water resistant building materials
		High value houses	
Industry and production	Production with low water sensitivity	Normal factory	Airport
	Sawmill	Wastewater plant	High technology
			Chemical industry
			Energy supply
			IPPC installation
Service and trade	Shop	Large commercial centre	Logistic hubs
	Restaurant	University	Hospital
		Jail	Fire brigade
		School	Kindergarten, retirement home
		Administration	Police station
			Government building
		Waste disposal, water supply, wastewater treatment	
Traffic and transport	Local road	Regional road	Motorway
		Local and regional railroad	High speed train line
		Small railway station	Medium and large railway station
		Bridge	Tunnel entrance
Others (Culture, sport, recreation)	Park	Museum	Cultural heritage
		Art gallery, sports building	UNESCO site
		Worship sites	
	Bathing place		

Risk matrix development

The flood risk (impact) level for a specific APSFR, for one return period, is derived by combining the hazard (intensity class values) and damage potential (vulnerability class values) in a risk (impact) matrix. The possible combinations are displayed in Table 6.3. The impact level, derived from the matrix, may be: minor (1), moderate (2) and high (3). This calculation is done for each return period separately.

The impact matrix may be developed in different ways. The combined impact can be developed for all categories in one matrix, as shown in Table 6.3, which means that suggested symbology for impact levels (3 colours in total) would not provide insight into the type of the affected area (e.g. agricultural area and industrial zone would be denoted with the same colour on the map if the calculated impact level were the same).

Alternatively, the flooded area (with assigned vulnerability values) could be divided into four land use classes:

1. Forestry and agriculture (forest, orchard, pasture, national park, agricultural building/ stable, greenhouse, irrigated field, etc.)
2. Industry (factory, sawmill, wastewater plant, chemical industry, energy supply, high tech industry, warehouse, etc.)
3. Settlement (residential and non-residential buildings, service and trade facilities, traffic and transport infrastructure, governmental buildings, etc.)
4. Other (unknown land use, construction site, without current use)

The impact is calculated by developing a separate matrix for each of the four land use classes, where intensity classes (flood depths that occur over a certain land use class) are combined with vulnerability values assigned to areas belonging to a specific land use class (for example, a pasture, part of the first land use class – Forestry and agriculture, would have a low vulnerability value, whereas greenhouses and stables, also part of the first land use class, would have high vulnerability value). As a result, the impact levels are assessed individually for each land use class, through one of the four developed impact matrix, and displayed on the final maps in corresponding colour shades, as shown in Table 6.4. In this way, if an area belongs to Forestry and agriculture for example, and has a high impact level, it will be displayed in the darkest yellow shade on the map, whereas the industrial area with the same impact level would be displayed with a different colour (darkest shade of purple). Due to its clearer and more distinctive approach in result visualisation, as well as more comprehensible map interpretation, the second method for matrix development has been adopted, regardless of the fact that it requires additional steps in terms of the area division into 4 land use classes and formation of 4 separate risk matrices.

Table 6.3: Impact matrix for all land use classes in one matrix

		Vulnerability Value		
		Low	**Medium**	**High**
Intensity	>5 m or >2 m/s	moderate (2)	high (3)	high (3)
	1 m – 5 m	moderate (2)	moderate (2)	high (3)
	0.5 m – 1 m	minor (1)	moderate (2)	moderate (2)
	0 – 0.5 m	minor (1)	minor (1)	moderate (2)

Table 6.4: Impact matrix formation for different land use classes

Forestry and Agriculture				
Intensity		Vulnerability Value		
		Low	Medium	High
	>5 m or >2 m/s			
	1 m – 5 m			
	0.5 m – 1 m			
	0 – 0.5 m			

Industry				
Intensity		Vulnerability Value		
		Low	Medium	High
	>5 m or >2 m/s			
	1 m – 5 m			
	0.5 m – 1 m			
	0 – 0.5 m			

Settlement				
Intensity		Vulnerability Value		
		Low	Medium	High
	>5 m or >2 m/s			
	1 m – 5 m			
	0.5 m – 1 m			
	0 – 0.5 m			

Other				
Intensity		Vulnerability Value		
		Low	Medium	High
	>5 m or >2 m/s			
	1 m – 5 m			
	0.5 m – 1 m			
	0 – 0.5 m			

Methodology for the Number of Inhabitants at Risk[42]

For each settlement in the Danube River Basin, which is affected, that is, falls within the boundaries of the flood zone, two population densities were calculated: the population density of the urban part of the settlement and the population density of the rural part of the settlement. The assumption was adopted - that 80% of the total number of residents in the settlement live in the urban zone, and the remaining 20% in the rural zone. For the purposes of this calculation the following data were used: data on the total number of

[42] The methodology was agreed upon for the calculation of the number of inhabitants at risk, given the available data and the given deadlines, at a meeting held on 13th June 2022, which was attended by: Prof. Ivana Ćipranić, Dr. Patrick Reynolds, Rolf Baur and Milena Ostojić.

inhabitants per settlement in Montenegro, settlement boundaries in vector format (in order to enable software to overlap them with flood zones obtained), the borders of the urbanized zones by settlements in vector format (to establish (overlapping with the flood zones) how much of the "urbanized" area is flooded).

When the population density of the rural zone is multiplied by the flooded area of the rural zone - the endangered number of inhabitants in the rural zone for a given settlement is obtained. Analogously, when the population density of an urban zone is multiplied by the flooded surface of the urban zone - the number of inhabitants in the urban zone of that settlement is at risk. When the endangered number of inhabitants of the rural zone and the endangered number of inhabitants of the urban zone are added - the total number of endangered inhabitants for that settlement is obtained.

Creation of Risk Maps

For the purposes of creating risk maps, data obtained from the hydrological model for return periods of 10, 100 and 500 years were used as input data (which were also used during the creation of hazard maps).

Risk calculations based on risk levels expressed in three risk levels (low, medium and high), for four categories (settlement, forestry - agriculture, industry and others) were also used to create risk maps. Obtained data in .shp format for four classes of inundation depth.

The data obtained in .shp format were imported into the GIS program, where the reference system WGS 1984 UTM zone 34N was assigned to them.

Data available on the geoportal platform were used to display the objects located in the flood area. The colour code of the objects is also aligned with the colour of the objects that was used when creating the hazard and risk in the previous cycle. The maps show objects at risk, namely individual objects (settlements) and commercial objects. It is also shown by the types of economic activities in the potentially affected area.

OSM (Open Street Map, source: www.OpenStreetMap.com), OP (Orthophoto images from 2018, source: geoportal.co.me) and topographic base (source: service.arcgis.online.com/ arcgis) were used as base maps/services). For each APSFR, for each of the return periods (HQ10, HQ100 and HQ500), three maps were created (one with OSM as base map, one with OP as base map and one with topographic map as background), i.e. 9 maps were created for each APSFR.

The risk map, as a sum of impacts, reflects the impact of all scenarios. The maps were prepared according to the EU Directive on floods as well as the Rulebook on the Closer Look of the PFRA and the Flood Risk Management Plan.

Presentation of Flood Hazard and Flood Risk Maps

For each APSFR (Sections 6.3 to 6.21), the following data are presented:

- Map of the location of the APSFR in the Danube River Basin.
- Flood Hazards: flood source, flood mechanism, flood characteristics, affected regions/towns and settlements.

- Flood Risk: Effect on human health, environment, cultural heritage and economic activity (according to EU coding system[43]).
- Links for download of flood hazard maps (as Orthophoto, OpenStreet and topographic maps) for a) flood extent HQ10, 100 and 500 (combined map), and b) inundation depths for HQ10, 100 and 500 (individual maps).
- Links for download of Links for download of flood risk maps (as Orthophoto, OpenStreet and topographic maps) for HQ10, 100 and 500 (individual maps).
- Map of flood extent HQ10, 100 and 500 (combined topographic map).
- Map of Inundation Depths for HQ500 (topographic map).
- Map of flood risk for HQ500 (topographic map).
- Summary table for flood risks at HQ10, HQ100 and HQ500, which includes the following information:
    - Name of Sub-Basin, tributary, administrative region.
    - Settlements at risk.
    - Area at risk (km^2).
    - Number of inhabitants at risk.
    - Number of dwellings at risk.
    - Number of Business (commercial and industrial) at risk.
    - Number of cultural buildings at risk.
    - Source of flooding (types).
    - Historical damage caused by the flooding.
    - Possibility of future significant damage as the of a) increased urbanisation, b) declaring the area protected, and c) other reasons.
    - Risk assessment: significance of potential risks for human health, economic values, water polluting substances/sites, protected areas and cultural heritage sites.[44]

[43] Based on guidance for reporting under the EU Floods Directive; EU 2013. Technical Report-2013-071
[44] Colour code for risk assessment above or below the threshold criteria are listed in Table 5.4

6.3 APSFR01_DRB_Ibar01

The location of APSFR01_DRB_Ibar01 in Danube River Basin is shown in Figure 6.1.

Figure 6.1. Location of APSFR01_DRB_Ibar01

The APSFR, which is defined by the historical floods, is distinguished as follows[45]:

Catchment Area: Ibar; **River Tributary**: Ibar

Flood Hazard	
Flood Source	Fluvial (A11)
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	▪ Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (A31). ▪ Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Rožaje
Towns/Settlements	Rožaje-Suho, Polje-Zeleni

[45] All codes in parenthesis refer to the coding schema for EU guidelines for reporting APSFR for the preliminary flood risk assessment shown in in Annex 2.

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	Cultural Assets: Adverse consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings (B31).
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage, and communication (B42). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.5 below and are available for download via Google Drive for review[46,47]. Symbols included on the flood maps are shown in Annex 4.

Table 6.5. Flood hazard maps and flood risk maps prepared for APSFR01_DRB_Ibar01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.2 to 6.4 below provide examples of the flood hazard and flood risk maps for APSFR1_DRB_Ibar01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.2 together with inundations based on the HQ500 (Figure 6.3). The flood risk map for HQ500 is shown in Figure 6.4. A summary of all potential risks are shown in Table 6.6.

[46] Orthophoto and OpenStreet map files are presented in PDF format. Topographic maps are in JPG (picture) format.
[47] After review and approval of all maps by the Floods Working group, the files will be removed from Google Drive and provided to the Client as a single Annex (Map Atlas) to the FRMP.

Figure 6.2. Flood Extent for APSFR01_DRB_Ibar01

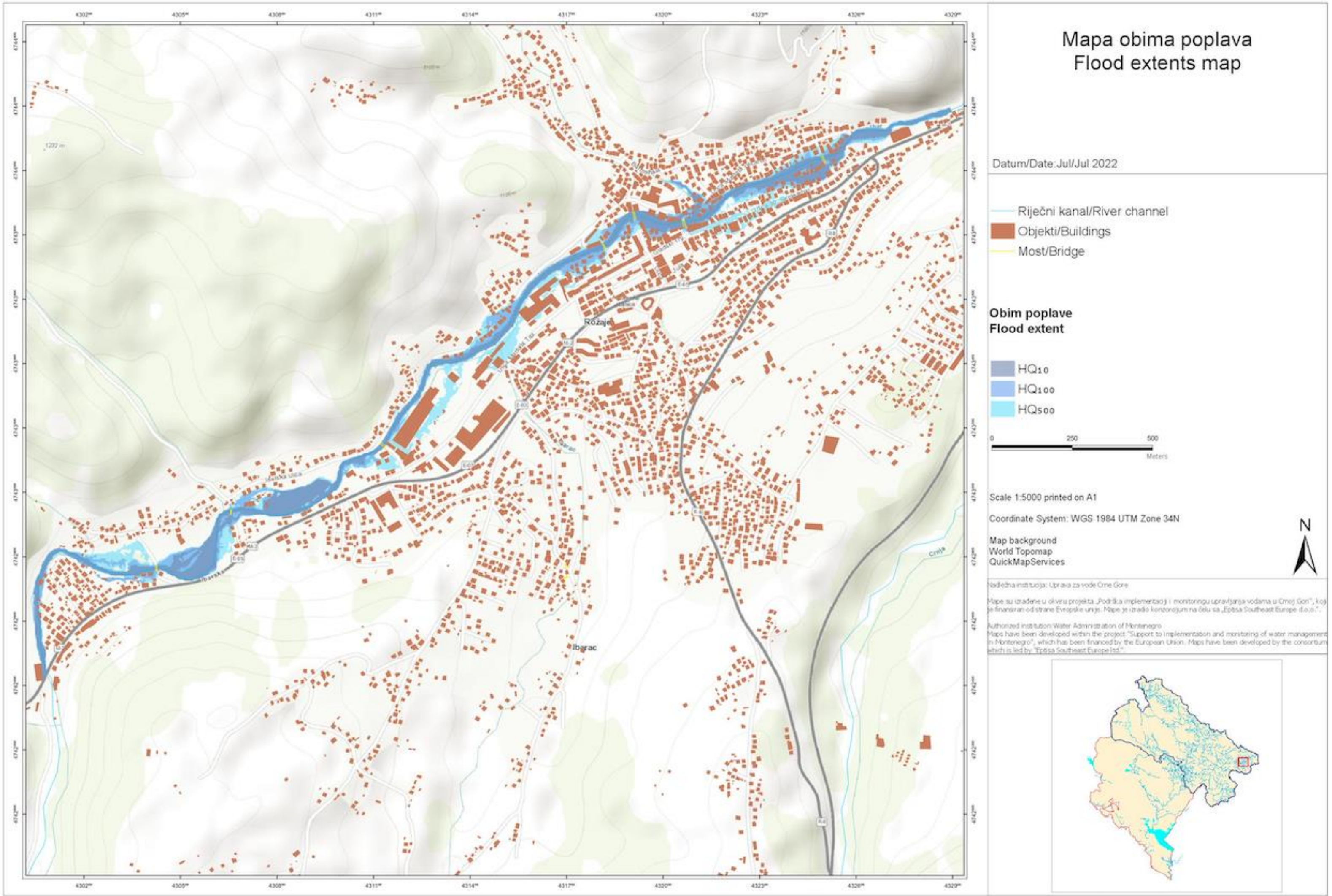


Figure 6.3. Inundation Depth (HQ500) for APSFR01_DRB_Ibar01

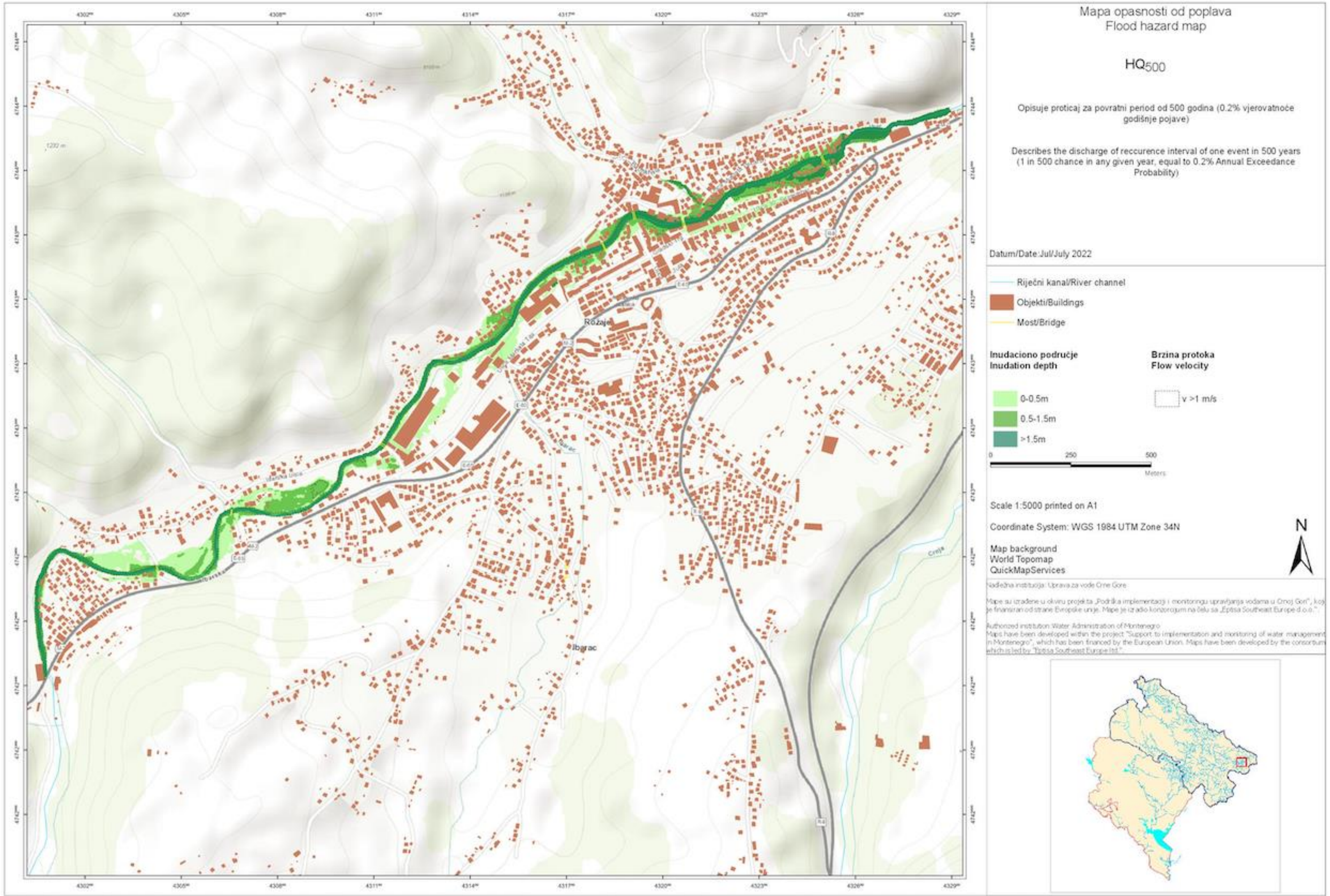


Figure 6.4. Flood Risk (HQ500) for APSFR01_DRB_Ibar01

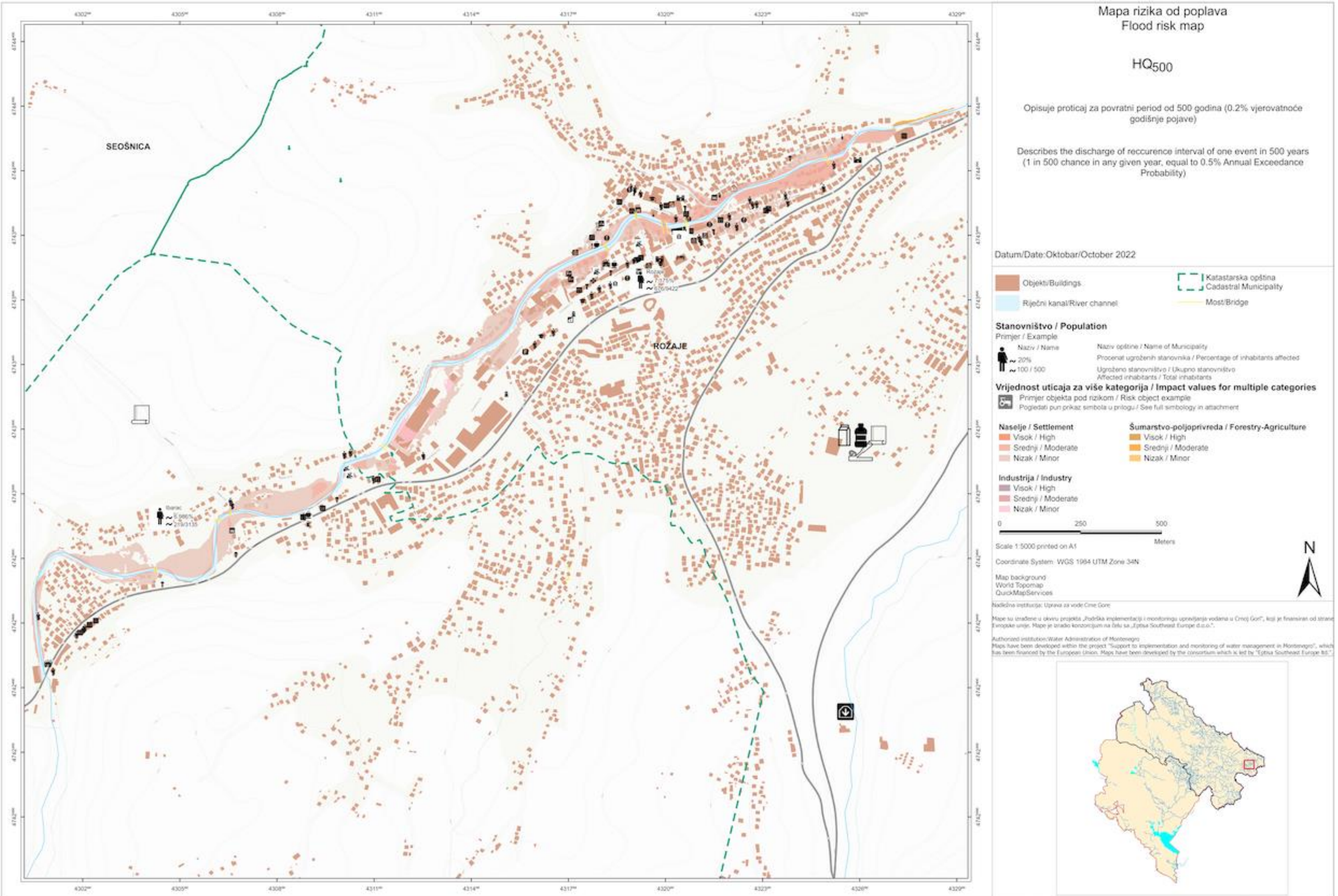


Table 6.6. Summary of flood risk in APSFR01_DRB_Ibar01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of dwellings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Ibar	Ibar	Rožaje	Rožaje-Suho, Polje-Zeleni	**HQ10**	9.85	363	45	7	0
				HQ100	14.76	564	57	10	1
				HQ500	22.38	895	180	24	3

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11; **M** - A21; **C** - A31, A34

Description of historical damage: Previous floods endangered residential and business facilities, road, sewage, and underground PTT infrastructure. The potential risk area is about 12 -15 ha. In the flood zone, there are 89 residential addresses, the Cultural and Historical Monument of Ganić Tower and the Religious Building - Mosque. Also, in this zone is the Furniture Factory and some other business and commercial facilities.

Possibility of future significant damage[48]:	Urbanization[49]: No	Declaring the area protected: No	Other Reasons: No

Risk assessment / Significance of potential risks[50]:

A) Human health, economic values		B1) Water polluting substances / sites		B2) Protected areas		C) Risk for cultural heritage sites	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[48] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[49] Determination if significant adverse impacts would occur in the future due to urban development.
[50] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.4 APSFR02_DRB_ Ibarac01

The location of APSFR02_DRB_Ibarac01 in Danube River Basin is shown in Figure 6.5.

Figure 6.5. Location of APSFR02_DRB_Ibarac01

The APSFR is determined by the historical floods. Hydrological data are not available for this zone. The river Ibarac is a tributary of the river Ibar, into which it flows in the town of Rožaje. The watercourse Ibarac in its lower course, in the length of about 1500 meters, can cause extensive damage to buildings and local infrastructure during flood events, which is due to the narrow and shallow riverbed, pronounced slope of the terrain, as well as torrential character, and unplanned buildings in the settlement of Ibarac.

The APSFR is distinguished as follows:

Catchment Area: Ibar; **River Tributary**: Ibarac

Flood Hazard	
Flood Source	Fluvial (A11)
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).

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Flood Hazard	
Flood Characteristics	▪ Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (A31). ▪ Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Rožaje
Towns/Settlements	Rožaje-Ibarac

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage, and communication (B42). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.7 below and are available for download (via Google Drive).

Table 6.7. Flood hazard maps and flood risk maps prepared for APSFR02_DRB_Ibarac01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.6 to 6.8 below provide examples of the flood hazard and flood risk maps for APSFR02_DRB_Ibarac01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.6 together with inundations based on the HQ500 (Figure 6.7). The flood risk map for HQ500 is shown in Figure 6.8.

A summary of all potential risks are shown in Table 6.8.

Figure 6.6. Flood Extent for APSFR02_DRB_Ibarac01

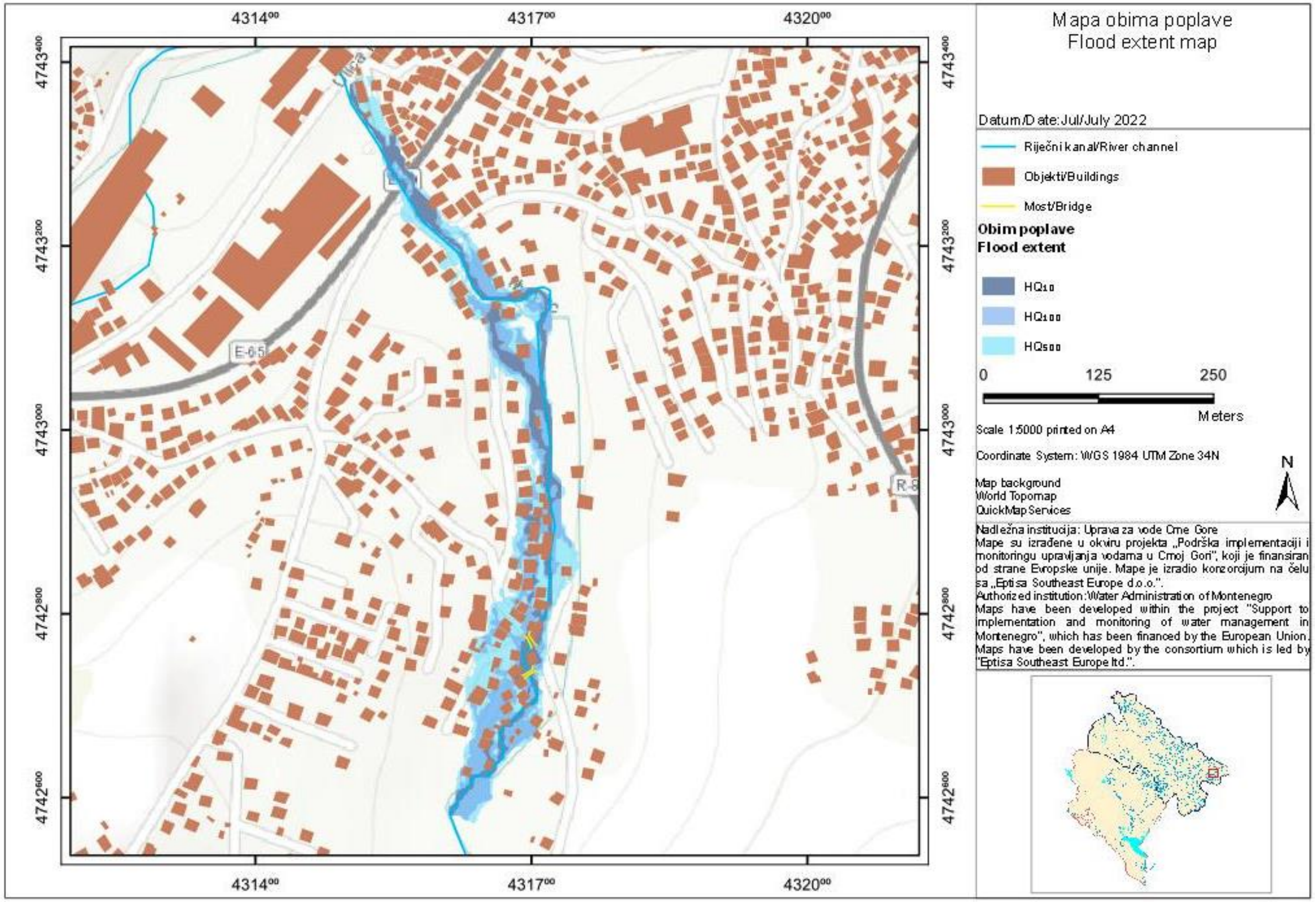

Figure 6.7. Inundation Depth (HQ500) for APSFR02_DRB_Ibarac01

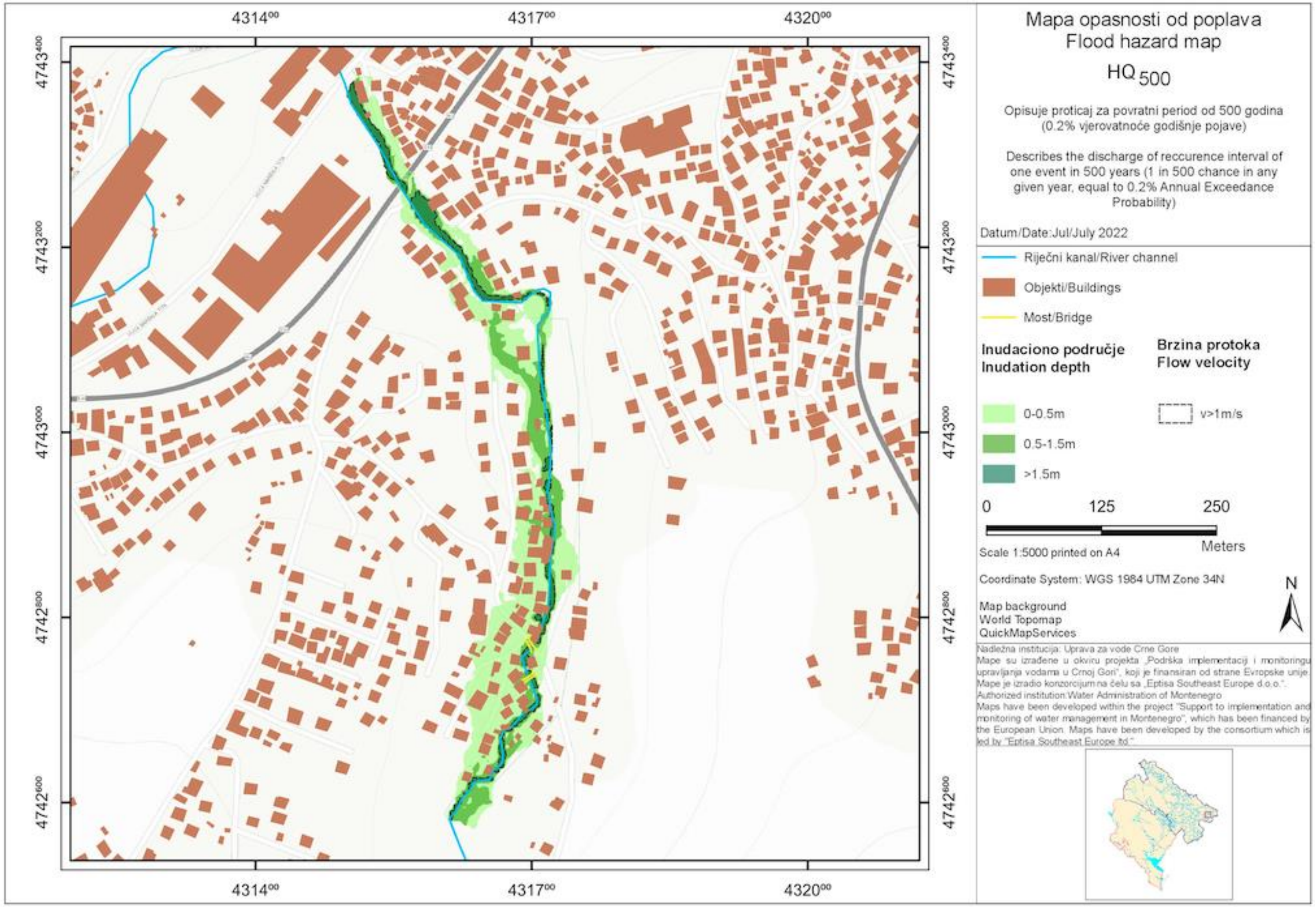

Figure 6.8. Flood Risk (HQ500) for APSFR02_DRB_Ibarac01

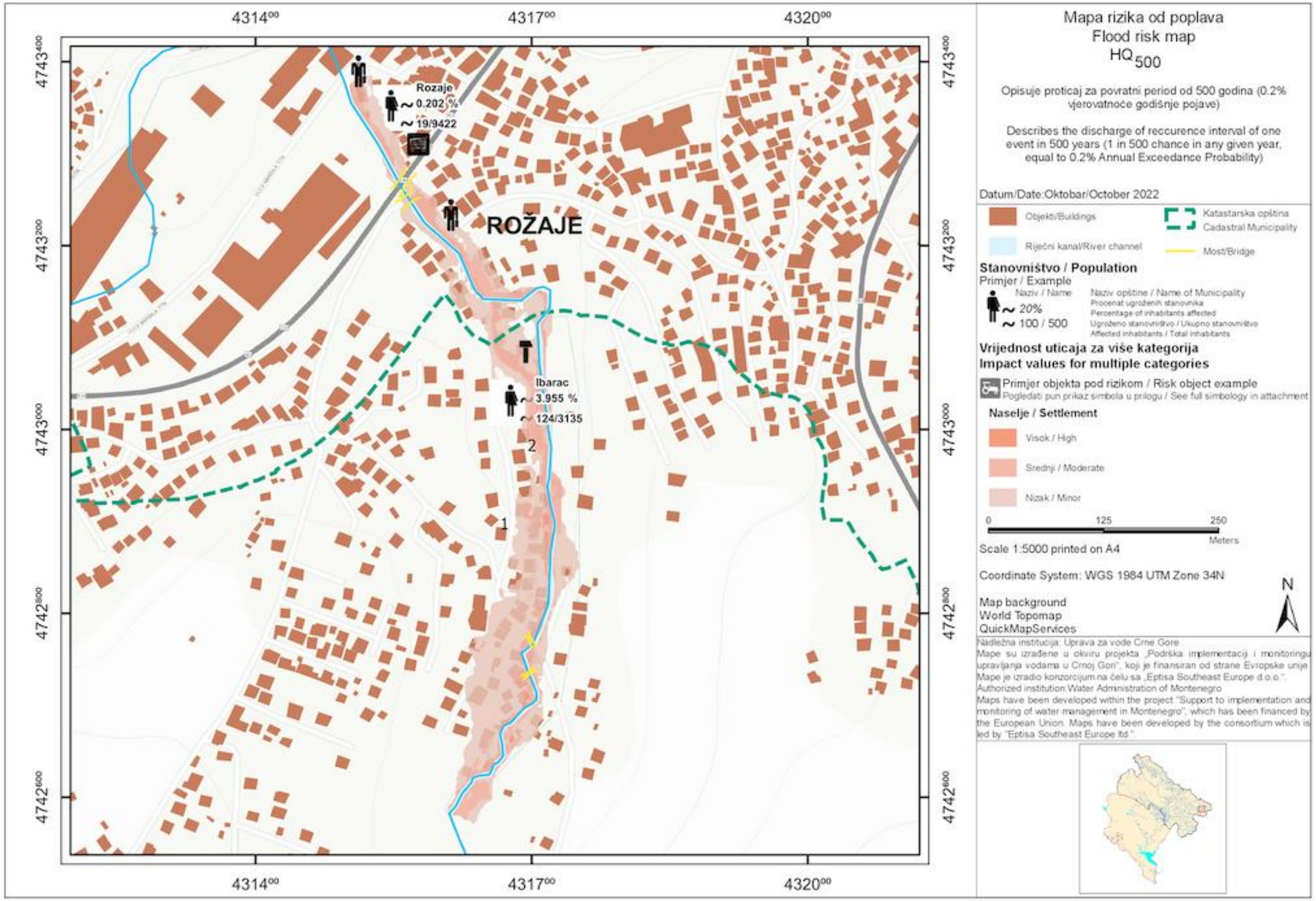

Table 6.8. Summary of flood risk in APSFR02_DRB_Ibarac01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of dwellings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Ibar	Ibarac	Rožaje	Rožaje-Ibarac	**HQ10**	0.96	30	27	0	0
				HQ100	2.45	81	57	1	0
				HQ500	3.98	143	72	1	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11; **M** - A21; **C** - A31, A34

Description of Damage: The river Ibarac in the length of about 1500 meters overflows on both banks and causes damage in the settlement of Ibarac on residential and auxiliary facilities, local road, sewage, and PTT infrastructure and on agricultural land.

Possibility of future significant damage[51]:	Urbanization[52]: No	Declaring the area protected: No	Other Reasons: No

Risk assessment / Significance of potential risks[53]:

A) Human health, economic values		B1) Water polluting substances / sites		B2) Protected areas		C) Risk for cultural heritage sites	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[51] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[52] Determination if significant adverse impacts would occur in the future due to urban development.
[53] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.5 APSFR03_DRB_Lovnička rijeka01

The location of APSFR03_DRB_Lovnička rijeka01 in the Danube River Basin is shown in Figure 6.9.

Figure 6.9. Location of APSFR03_DRB_Lovnička rijeka01

The APSFR for the Ibarac01 is determined based on historical flooding. Hydrological data are not available for this zone. The Lovnička river causes damage in its middle and lower course during flood events, up to its confluence with the Ibar.

The APSFR is distinguished as follows:

Catchment Area: Ibar; **River Tributary**: Lovnička

Flood Hazard	
Flood Source	Fluvial (A11)
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	▪ Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (A31). ▪ Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Rožaje
Towns/Settlements	Hurije, Donja Lovnica

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	Cultural Assets: Adverse consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings (B31).
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage, and communication (B42). ▪ Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction, and fishing (B43). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.9 below and are available for download (via Google Drive).

Table 6.9. Flood hazard maps and flood risk maps prepared for APSFR03_DRB_Lovnička rijeka01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.10 to 6.12 below provide examples of the flood hazard and flood risk maps for APSFR03_DRB_Lovnička rijeka01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.10 together with inundations based on the HQ500 (Figure 6.11). The flood risk map for HQ500 is shown in Figure 6.12.

A summary of all potential risks are shown in Table 6.10.

Figure 6.10. Flood Extent for APSFR03_DRB_Lovnička rijeka01

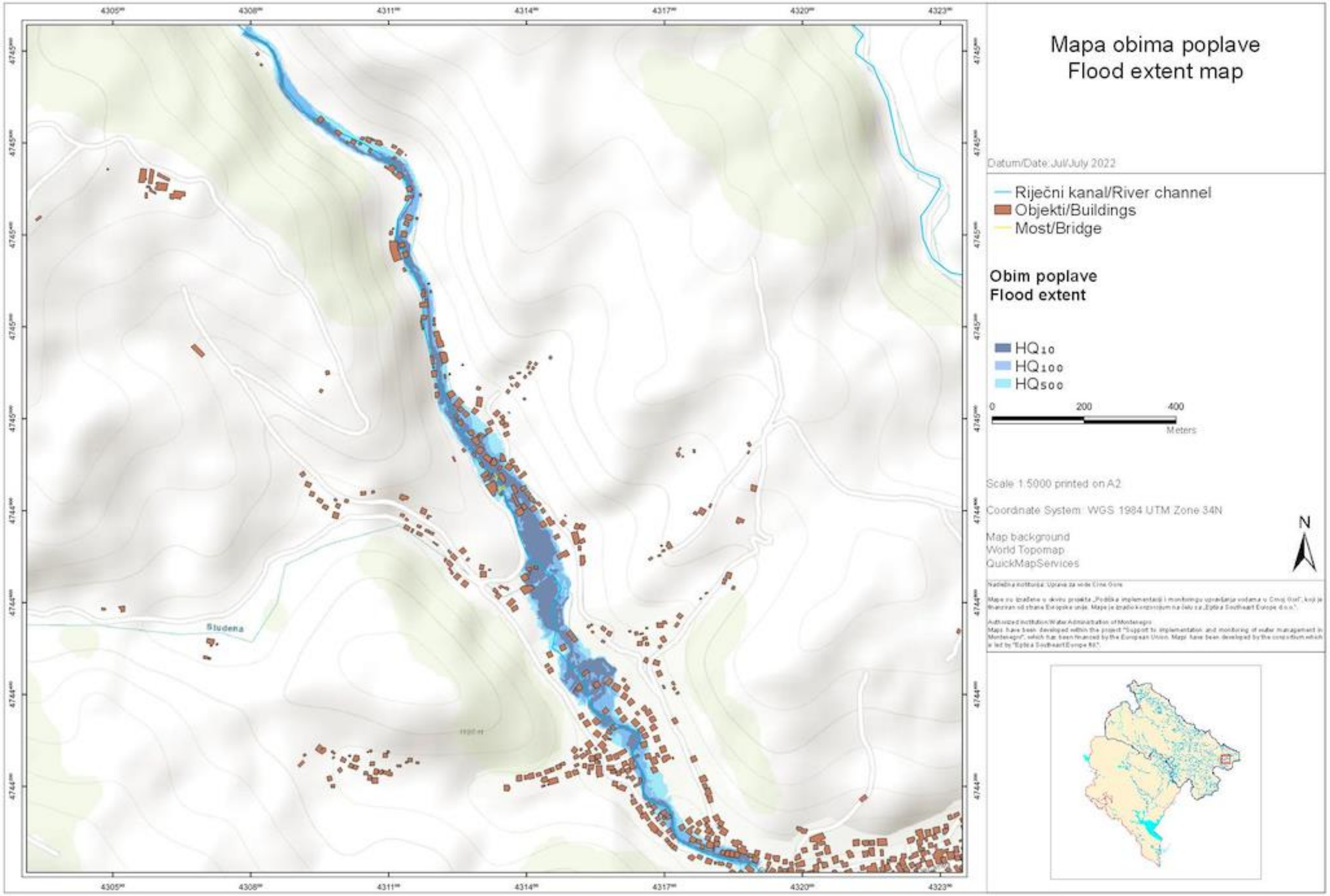

Figure 6.11. Inundation Depth (HQ500) for APSFR03_DRB_Lovnička rijeka01

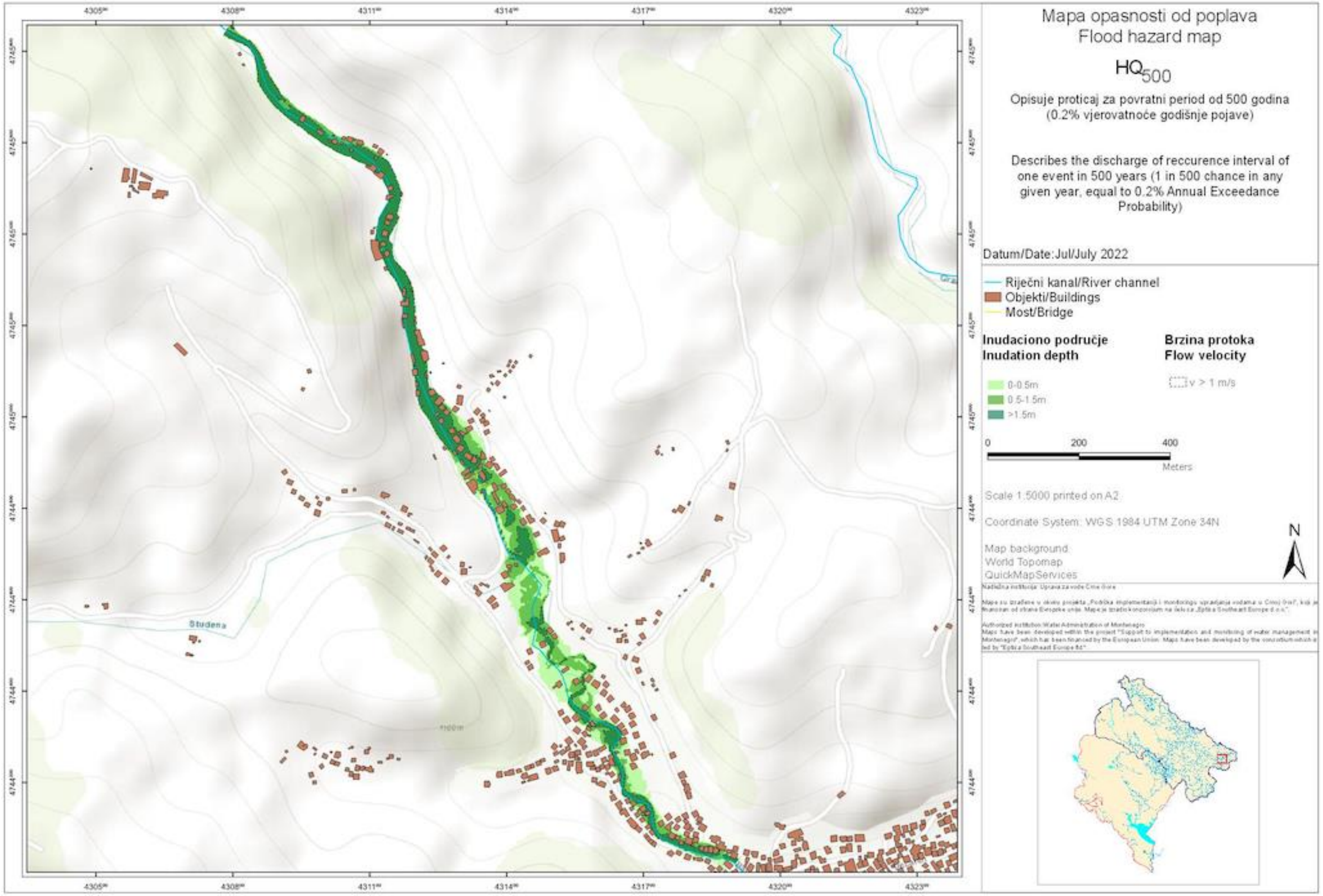

Figure 6.12. Flood Risk (HQ500) for APSFR03_DRB_Lovnička rijeka01

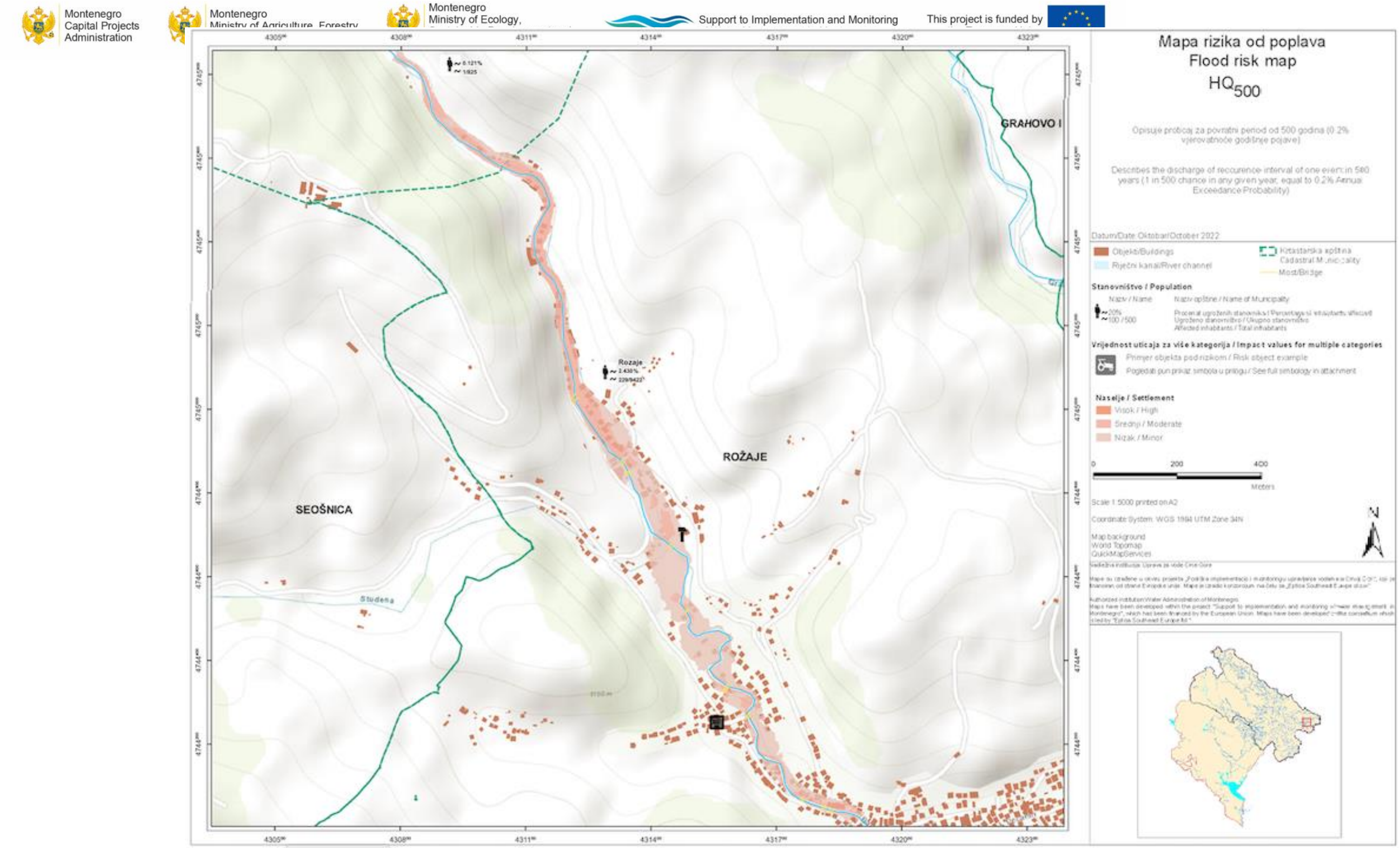

Table 6.10. Summary of flood risk in APSFR03_DRB_Lovnička rijeka01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Ibar	Lovnička	Rožaje	Hurije, Donja Lovnica	**HQ10**	4.57	89	68	0	0
				HQ100	7.96	168	106	2	1
				HQ500	10.87	230	134	2	1

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11; **M** - A21; **C** - A31, A34

Description of historical damage: In the settlement of Hurije, Lovnička rijeka the biggest problems to the population were caused by flooding residential and auxiliary facilities, private plants for primary wood processing, road infrastructure, agricultural land. In the settlement of Donja Lovnica, the river flooded agricultural land, individual residential and auxiliary facilities, a plant for the production of concrete elements, a village mosque and road infrastructure.

Possibility of future significant damage[54]:	**Urbanization[55]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[56]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[54] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[55] Determination if significant adverse impacts would occur in the future due to urban development.
[56] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

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6.6 APSFR04_DRB_Županica01

The location of APSFR04_DRB_Županica01 in the Danube River Basin is shown in Figure 6.13.

Figure 6.13. Location of APSFR04_DRB_Županica01

This area is determined by the historical floods. Hydrological data are not available for this zone. The APSFR is distinguished as follows:

Catchment Area: Ibar; **River Tributary**: Županica

Flood Hazard	
Flood Source	Fluvial (A11)
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	▪ Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (A31). ▪ Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Rožaje
Towns/Settlements	Kalače, Skarepača, Koljeno, Rasadnik

Flood Risk	
Human Health	▪ Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11). ▪ Community: Adverse consequences to the community, such as detrimental impacts on local governance and public administration, emergency response, education, health, and social work facilities such as hospitals (B12).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage, and communication (B42). ▪ Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction, and fishing (B43). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.11 below and are available for download (via Google Drive).

Table 6.11. Flood hazard maps and flood risk maps prepared for APSFR04_DRB_Županica01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.14 to 6.16 below provide examples of the flood hazard and flood risk maps for APSFR04_DRB_Županica01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.14 together with inundations based on the HQ500 (Figure 6.15). The flood risk map for HQ500 is shown in Figure 6.16.

A summary of all potential risks are shown in Table 6.12

Figure 6.14. Flood Extent for APSFR04_DRB_Županica01

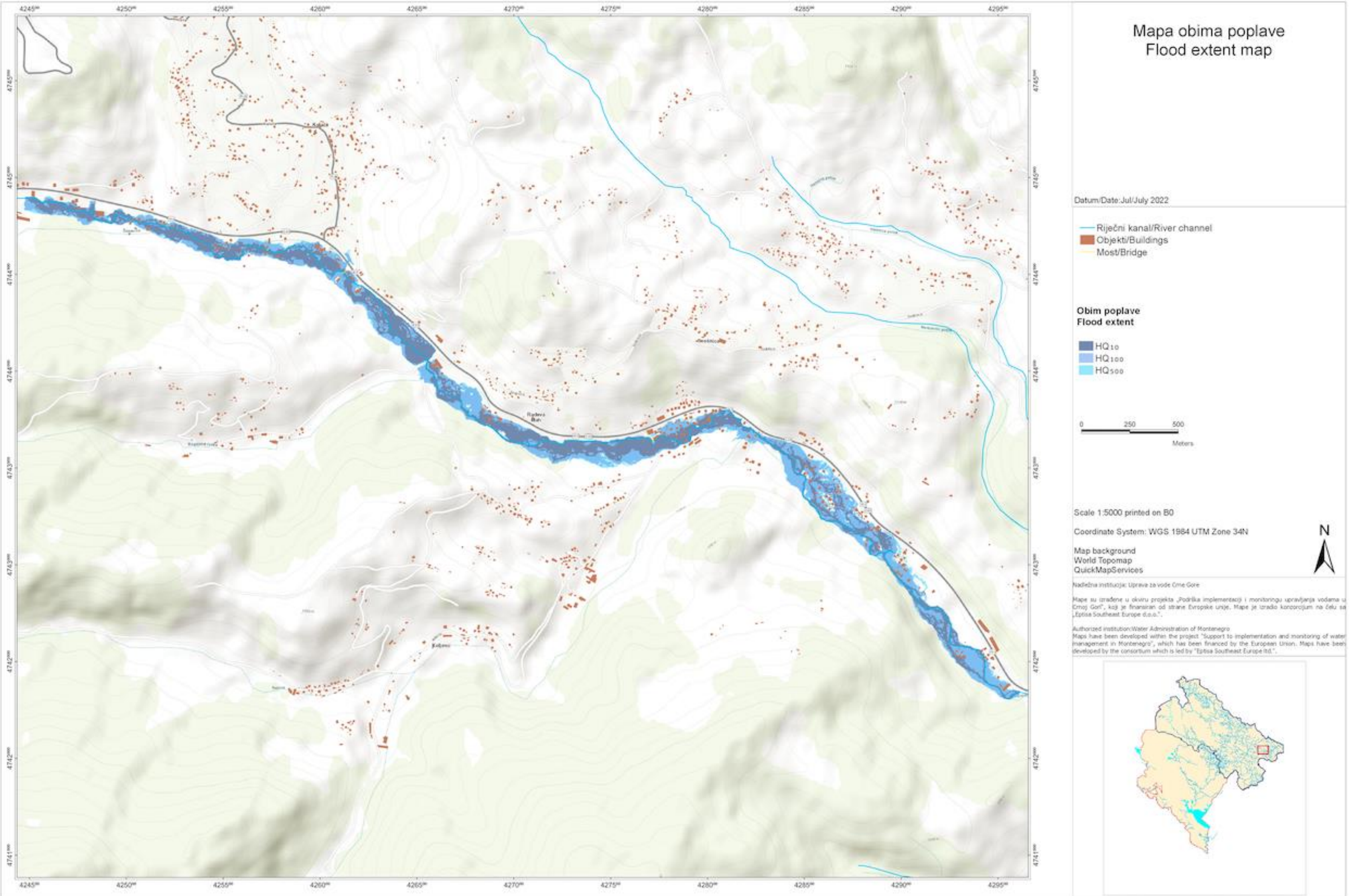

Figure 6.15. Inundation Depth (HQ500) for APSFR04_DRB_Županica01

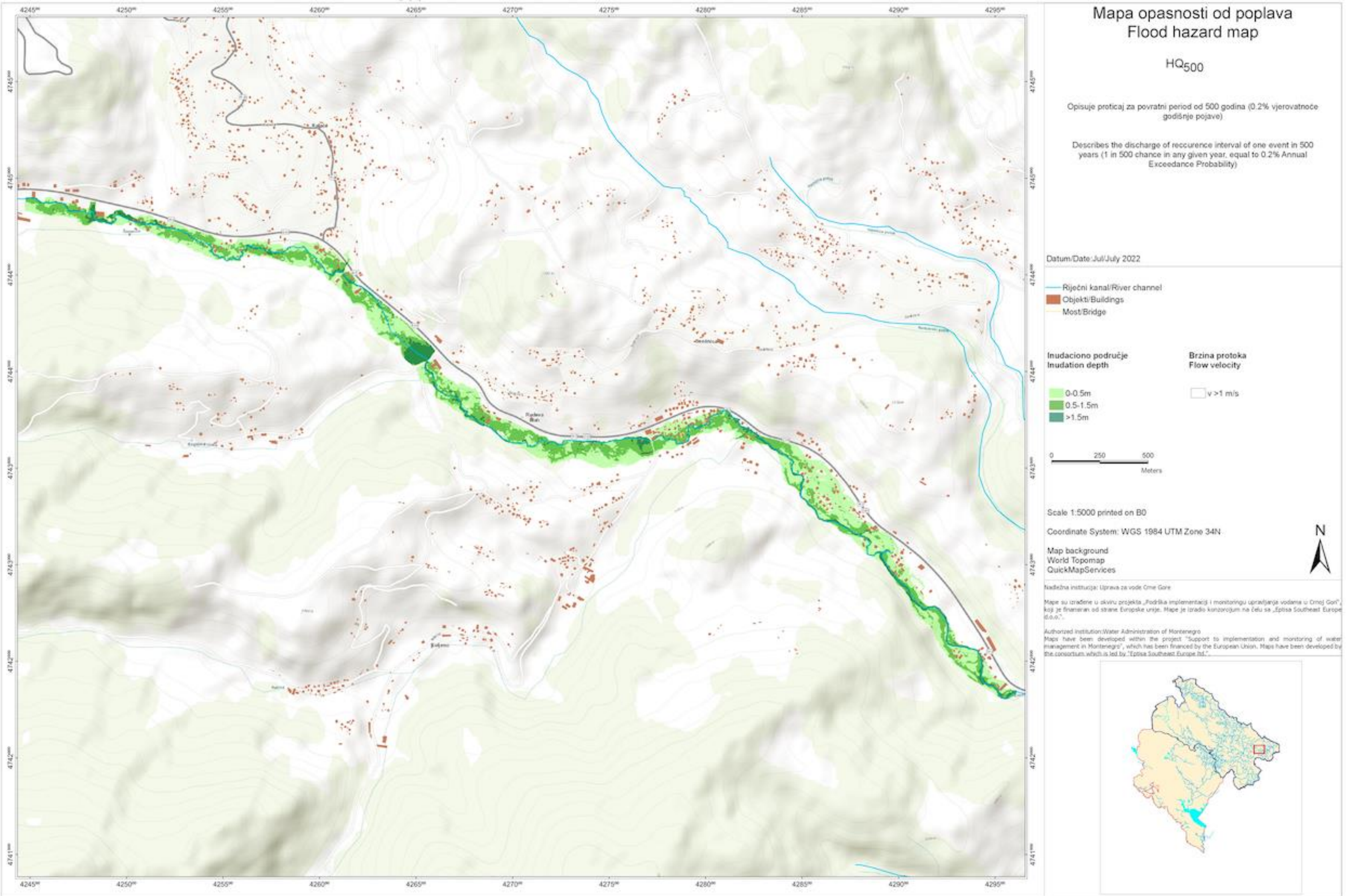

Figure 6.16. Flood Risk (HQ500) for APSFR04_DRB_Županica01

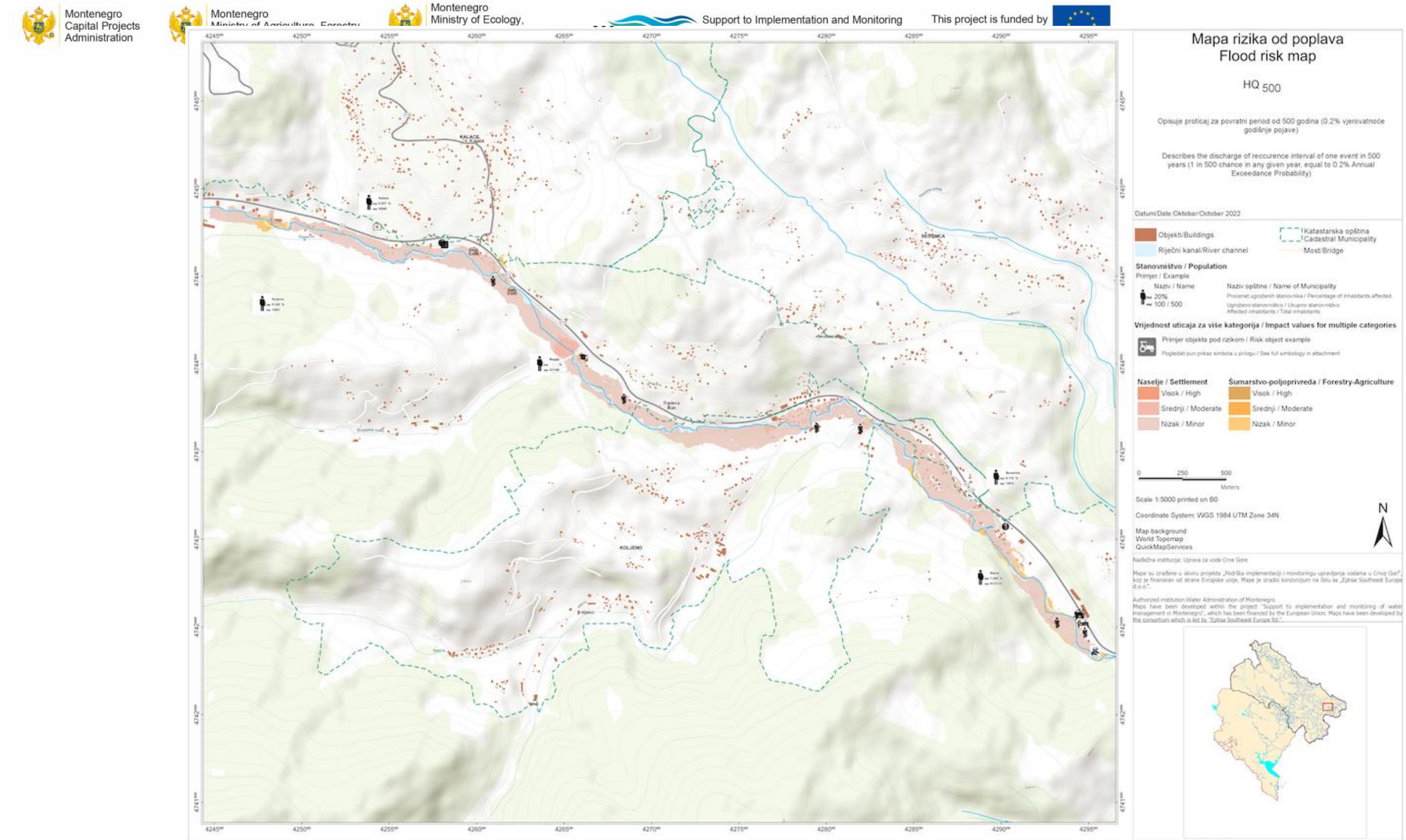

Table 6.12. Summary of flood risk in APSFR04_DRB_Županica01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
ibar	Županica	Rožaje	Kalače, Skarepača, Koljeno, Rasadnik	**HQ10**	32.04	38	25	1	0
				HQ100	59.14	81	56	3	0
				HQ500	63.53	95	59	3	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11; **M** - A21; **C** - A31, A34

Description of historical damage: The Županica River, in its length of about 6 km, threatens individual residential buildings, agricultural areas, wood processing plants, local road infrastructure and the underground PTT network by overflowing from the riverbed.

Possibility of future significant damage[57]:	**Urbanization[58]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[59]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

57 In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).

58 Determination if significant adverse impacts would occur in the future due to urban development.

59 According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

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6.7 APSFR05_DRB_Grnčar01

The location of APSFR05_DRB_Grnčar01 in the Danube River Basin is shown in Figure 6.17.

Figure 6.17. Location of APSFR05_DRB_Grnčar01

This area is determined by the historical floods. The zones covered by the historical flood and the hydrological data coincide. From 1968 to 2003, 7 flood episodes were recorded (based on hydrological data), practically every five years.

The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Grnčar

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Gusinje
Towns/Settlements	Grnčar, Gusinje, Dolja, Dosuđe

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.13 below and are available for download (via Google Drive).

Table 6.13. Flood hazard maps and flood risk maps prepared for APSFR05_DRB_Grnčar01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.18 to 6.20 below provide examples of the flood hazard and flood risk maps for APSFR05_DRB_Grnčar01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.18 together with inundations based on the HQ500 (Figure 6.19). The flood risk map for HQ500 is shown in Figure 6.20.

A summary of all potential risks are shown in Table 6.14.

Figure 6.18. Flood Extent for APSFR05_DRB_Grnčar01

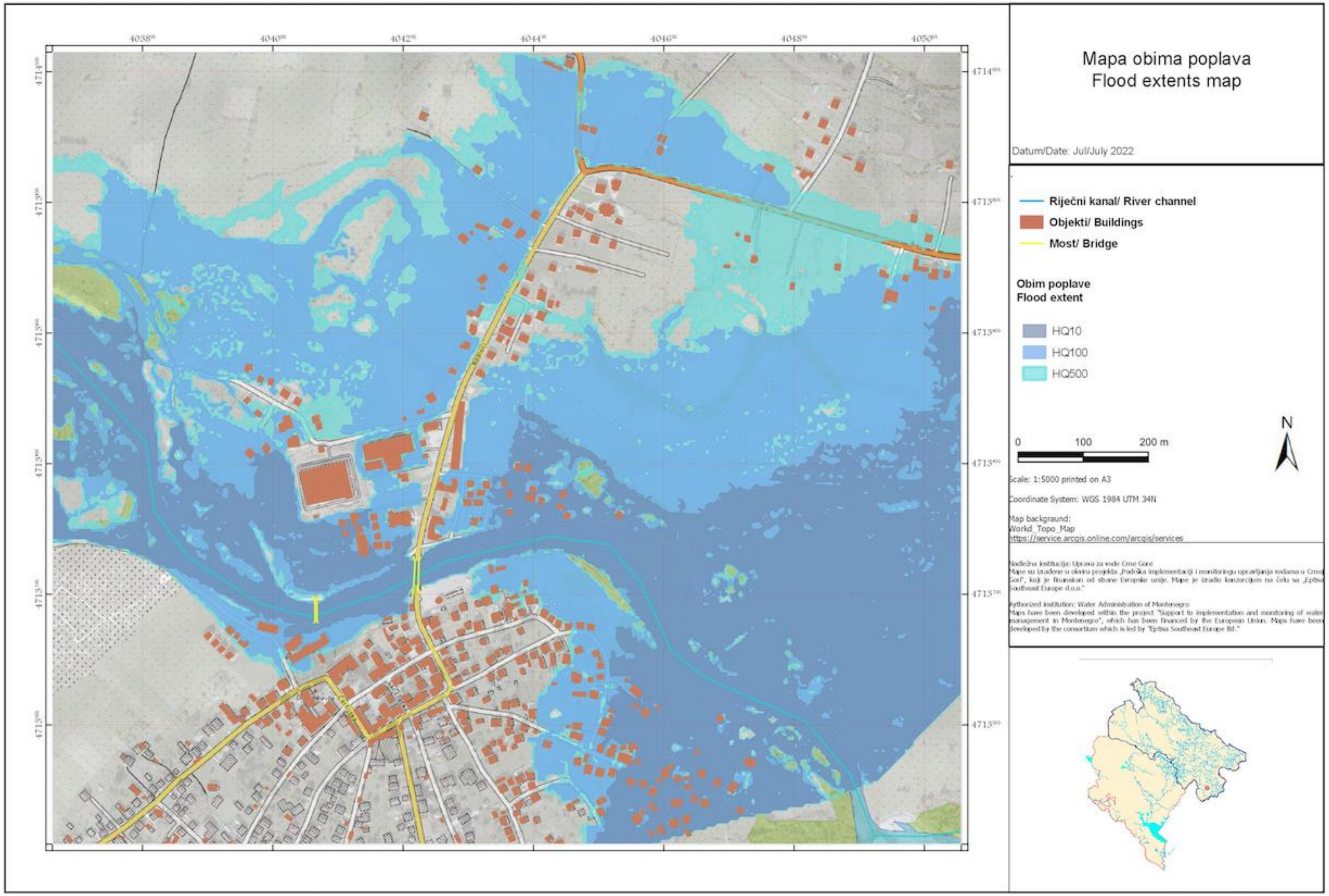

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Figure 6.19. Inundation Depth (HQ500) for APSFR05_DRB_Grnčar01

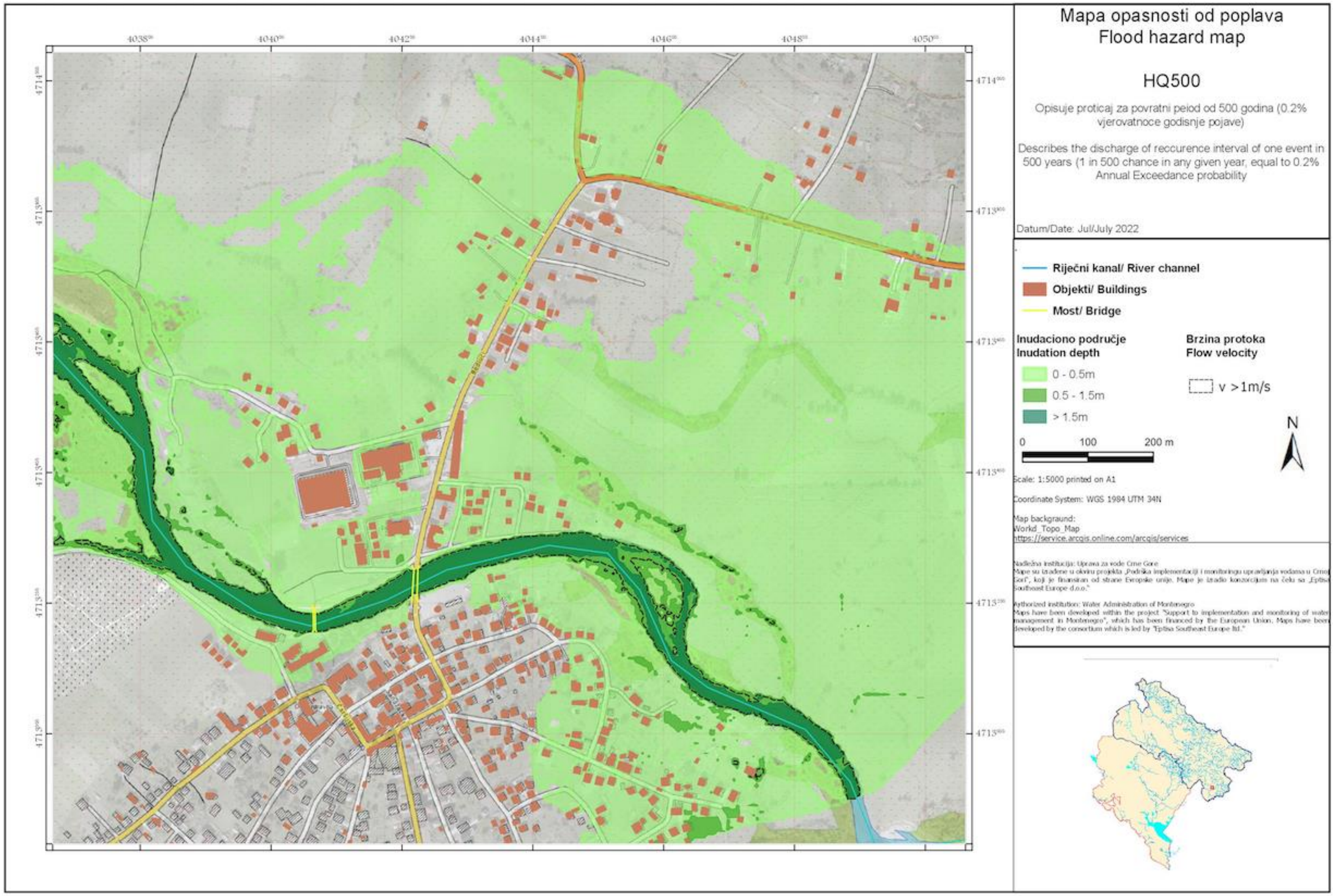

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Figure 6.20. Flood Risk (HQ500) for APSFR05_DRB_Grnčar01

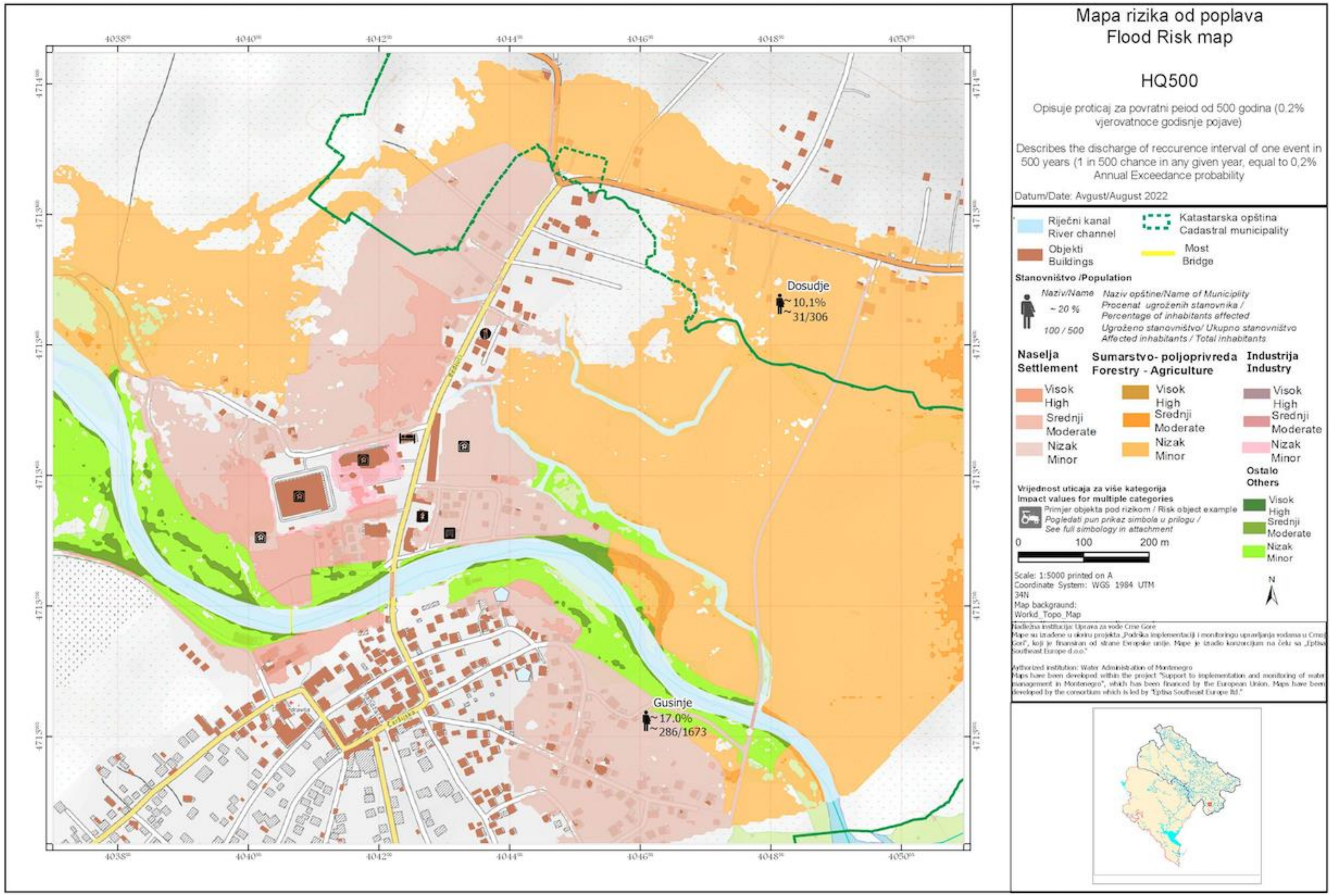

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Table 6.14. Summary of flood risk in APSFR05_DRB_Grnčar01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Lim	Grnčar	Gusinje	Grnčar, Gusinje, Dolja, Dosuđe	**HQ10**	56.60	150	63	0	0
				HQ100	107.17	289	128	1	0
				HQ500	123.13	318	175	1	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A34

Description of historical damage: The Rivers Grnčar, Vruja and Dolja in the town of Gusinje endanger the town centre and the refugee settlement of Vruja (80 residential buildings.The village of Grnčar - the river Grnčar floods the left and right banks and endangers 40 residential buildings. The village of Dosuđe - the river Grnčar endangers 15 residential buildings. The village of Dolja - the river Dolja endangers 10 residencies.

Possibility of future significant damage[60]:	**Urbanization[61]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[62]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[60] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[61] Determination if significant adverse impacts would occur in the future due to urban development.
[62] According to threshold of significance criteria detailed in Section 5 (Table 5.4).. The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.8 APSFR06_DRB_Vruja01

The location of APSFR06_DRB_Vruja01 in the Danube River Basin is shown in Figure 6.21.

Figure 6.21. Location of APSFR06_DRB_Vruja01

This area is determined by the historical floods. The zones covered by the historical flood and the hydrological data coincide. From 1968 to 2003, 7 flood episodes were recorded (based on hydrological data), practically every five years.

The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Vruja

Flood Hazard	
Flood Source	Fluvial (A11)
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Gusinje
Towns/Settlements	Gusinje: Koljenovići, Kruševo and Vusanje

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Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.15 below and are available for download (via Google Drive).

Table 6.15. Flood hazard maps and flood risk maps prepared for APSFR06_DRB_Vruja01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.22 to 6.24 below provide examples of the flood hazard and flood risk maps for APSFR06_DRB_Vruja01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.22 together with inundations based on the HQ500 (Figure 6.23). The flood risk map for HQ500 is shown in Figure 6.24.

A summary of all potential risks are shown in Table 6.16.

Figure 6.22. Flood Extent for APSFR06_DRB_Vruja01

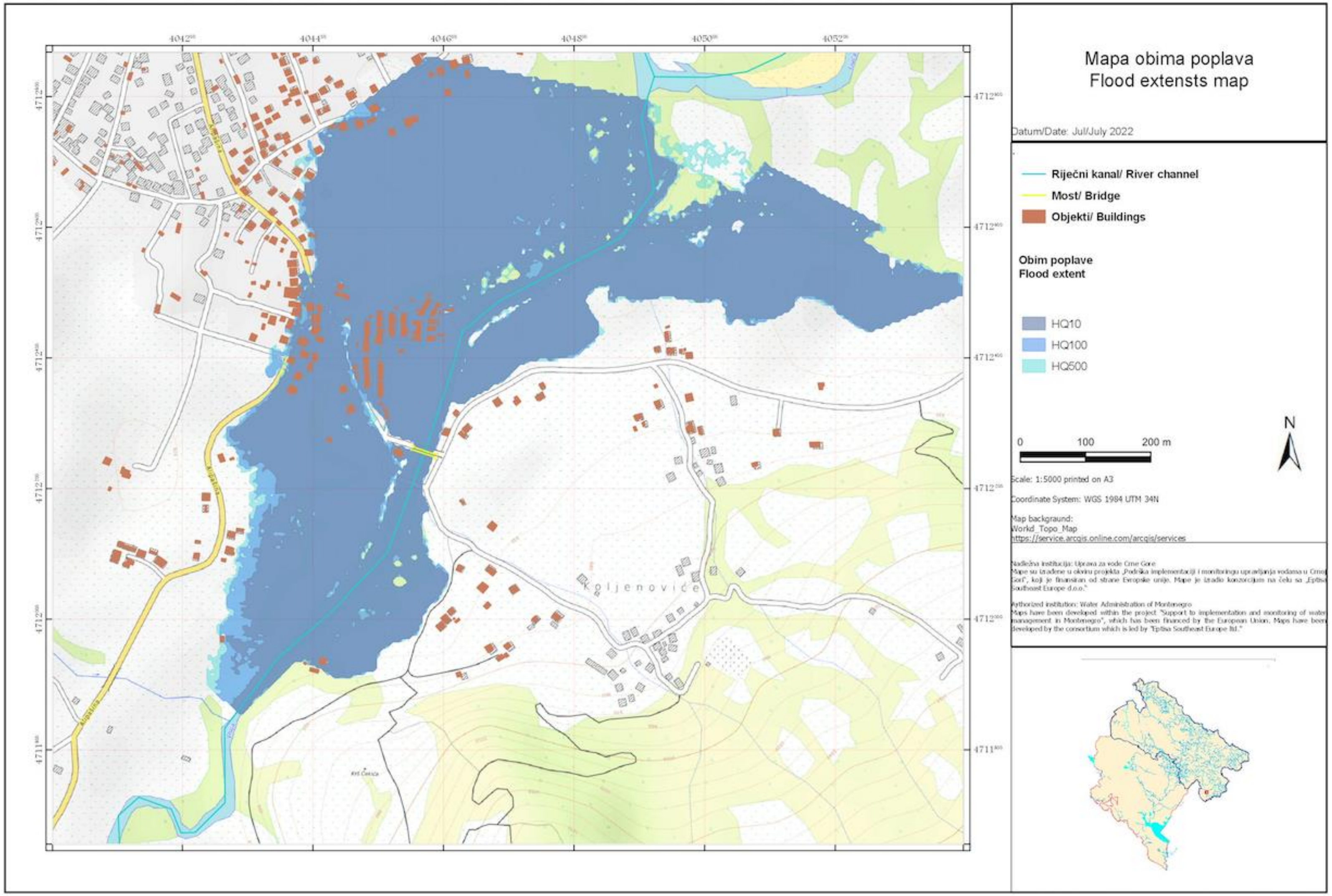

Figure 6.23. Inundation Depth (HQ500) for APSFR06_DRB_Vruja01

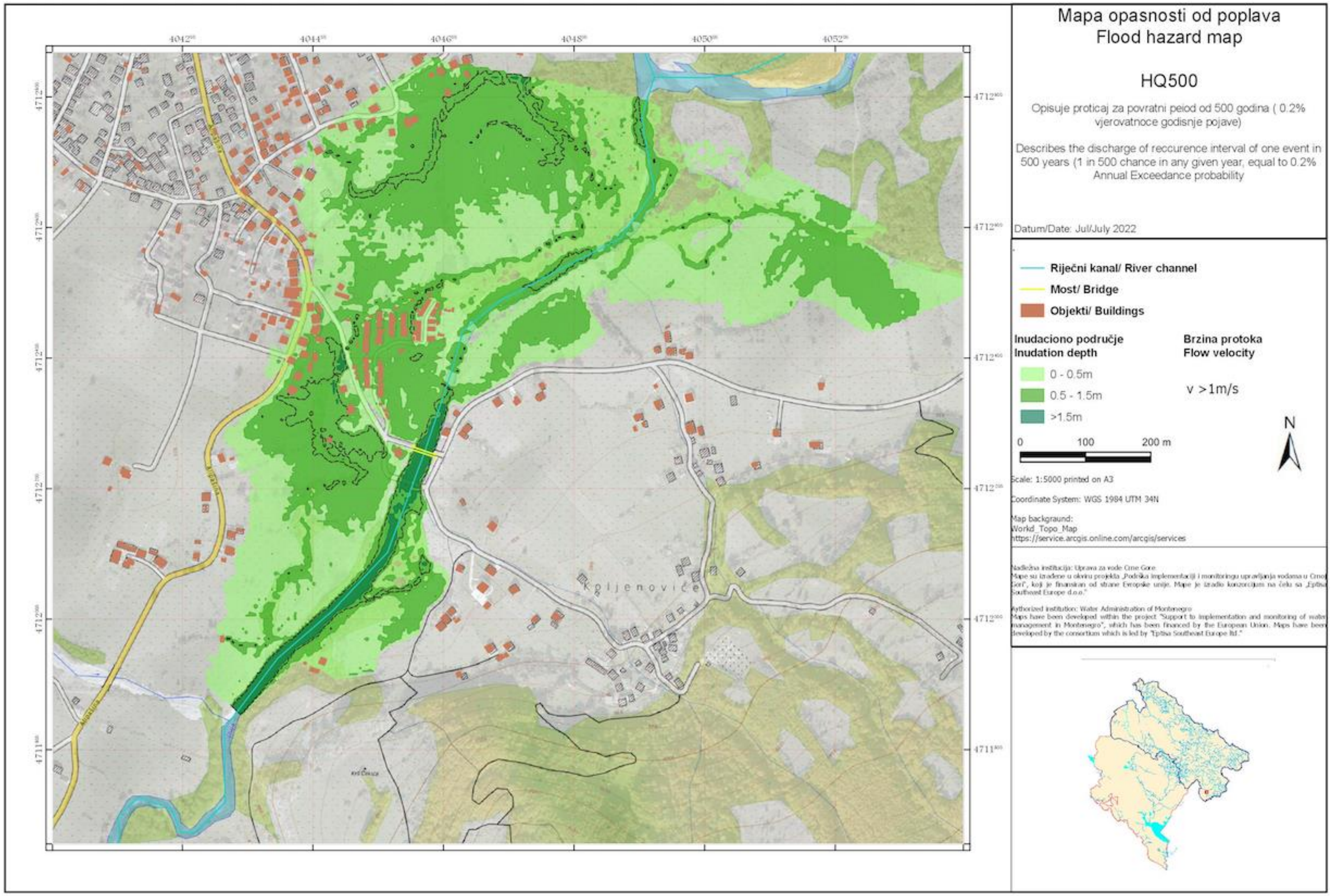

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Figure 6.24. Flood Risk (HQ500) for APSFR06_DRB_Vruja01

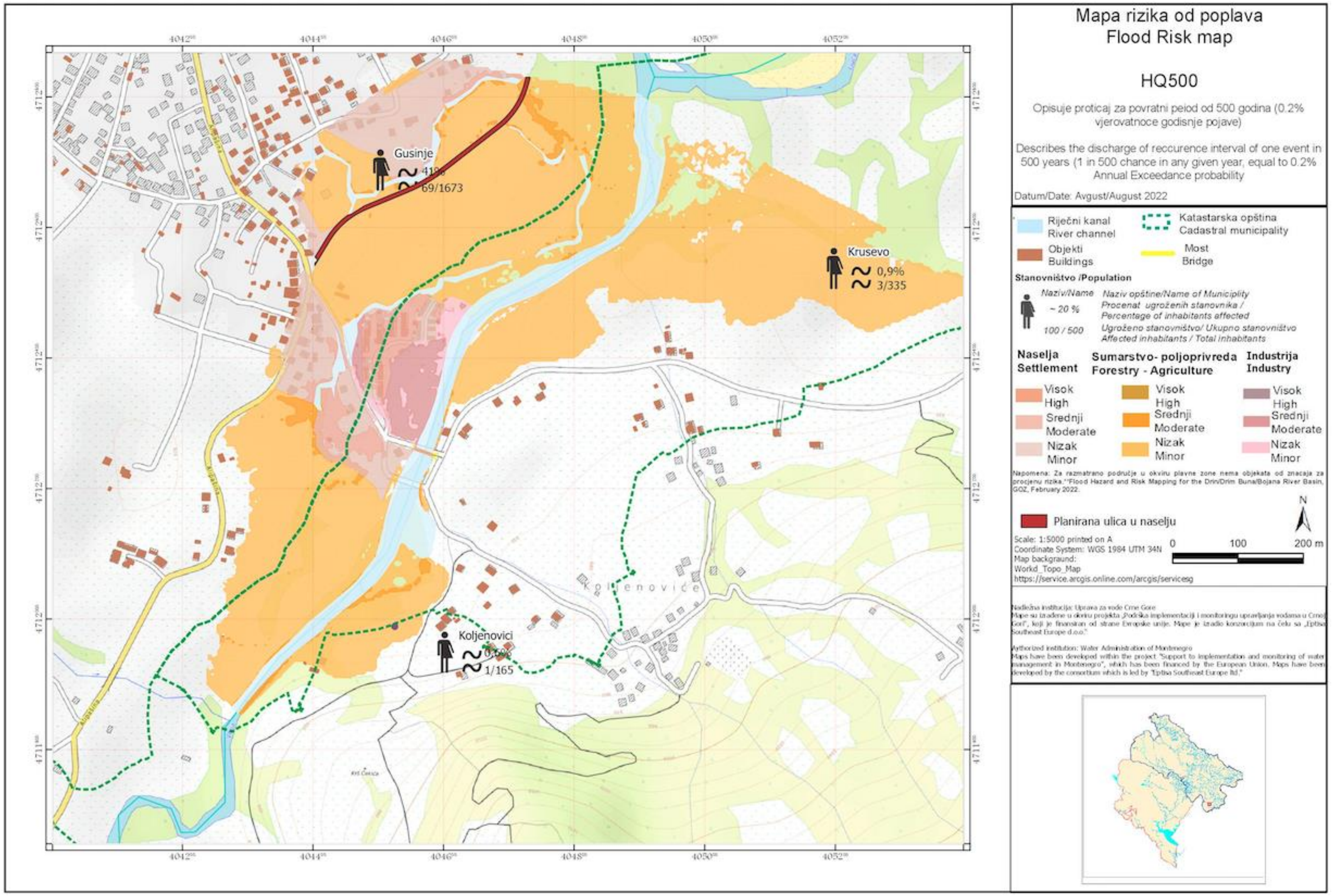

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Table 6.16. Summary of flood risk in APSFR06_DRB_Vruja01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Lim	Vruja	Gusinje	Gusinje, Koljenovići, Kruševo and Vusanje	**HQ10**	39.61	59	43	0	0
				HQ100	42.07	70	45	0	0
				HQ500	43.32	73	47	0	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11; **M** - A21; **C** - A34

Description of historical damage: The village of Vusanje - the river Vrulja endangers residential buildings. The villages of Kruševo and Koljenovići - Potoci flows into Ljuća Grnčar endangering residential buildings.

Possibility of future significant damage[63]**:**	**Urbanization**[64]: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[65]**:**

A) Human health, economic values	**B1) Water polluting substances / sites**	**B2) Protected areas**	**C) Risk for cultural heritage sites**
No. of houses	Contaminated sites	Nature Protected areas	UNESCO heritage sites
Settlement area	Locations of substances	Drinking Water supply areas	Other cultural heritage sites
Industrial objects	IED / PRTR-location	Bathing waters	
Industrial area			

[63] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[64] Determination if significant adverse impacts would occur in the future due to urban development.
[65] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.9 APSFR07_DRB_Lim01

The location of APSFR07_DRB_Lim01 in the Danube River Basin is shown in Figure 6.25.

Figure 6.25. Location of APSFR07_DRB_Lim01

Hydrological data cover the APSFR, which indicates the potential for flooding events. The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Plav
Towns/Settlements	Plav, Brezojevica, Rambalovi lugovi.

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.17 below and are available for download (via Google Drive).

Table 6.17. Flood hazard maps and flood risk maps prepared for APSFR07_DRB_Lim01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.26 to 6.28 below provide examples of the flood hazard and flood risk maps for APSFR07_DRB_Lim01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.266 together with inundations based on the HQ500 (Figure 6.27). The flood risk map for HQ500 is shown in Figure 6.28.

A summary of all potential risks are shown in Table 6.18.

Figure 6.26. Flood Extent for APSFR07_DRB_Lim01

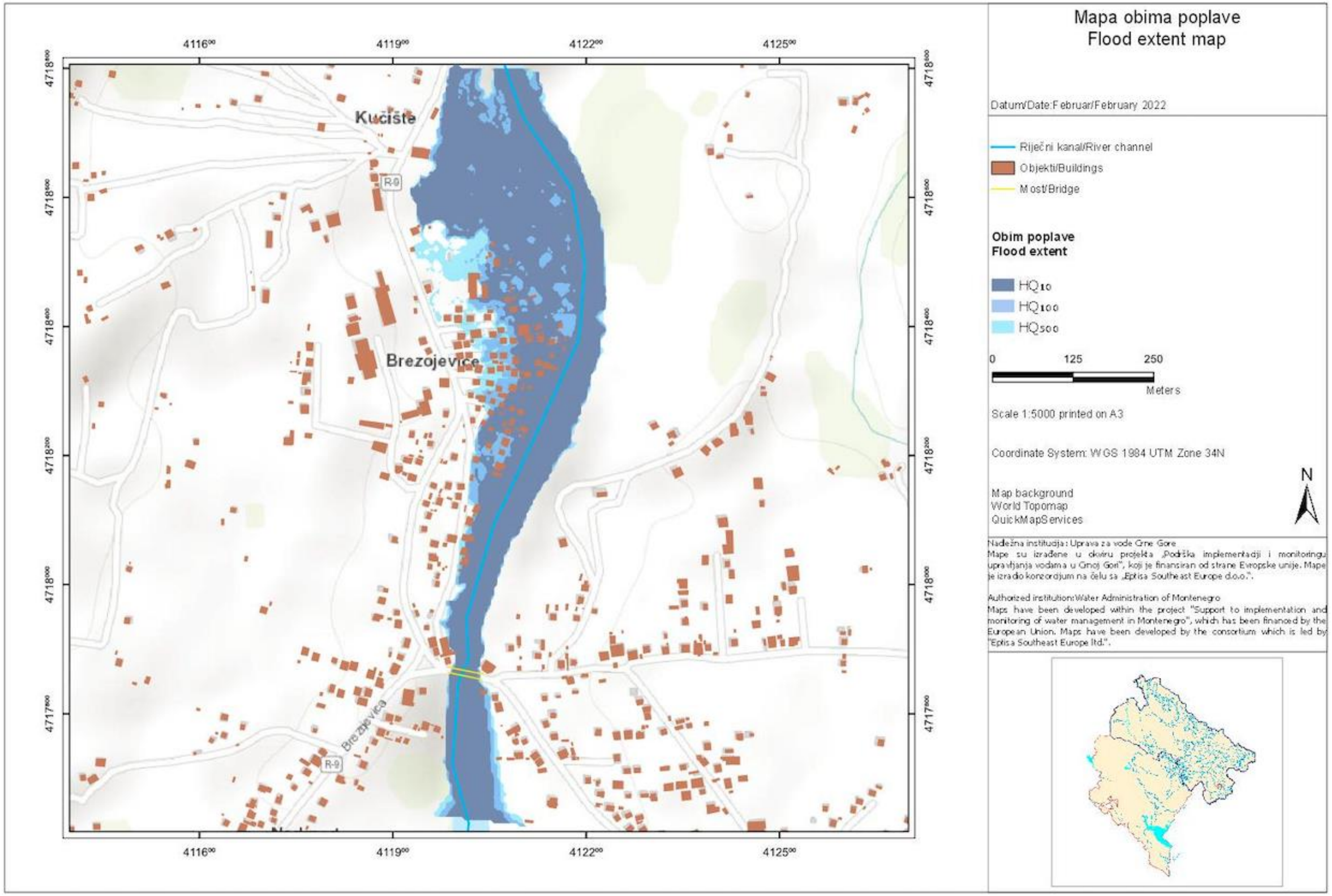


Figure 6.27. Inundation Depth (HQ500) for APSFR07_DRB_Lim01

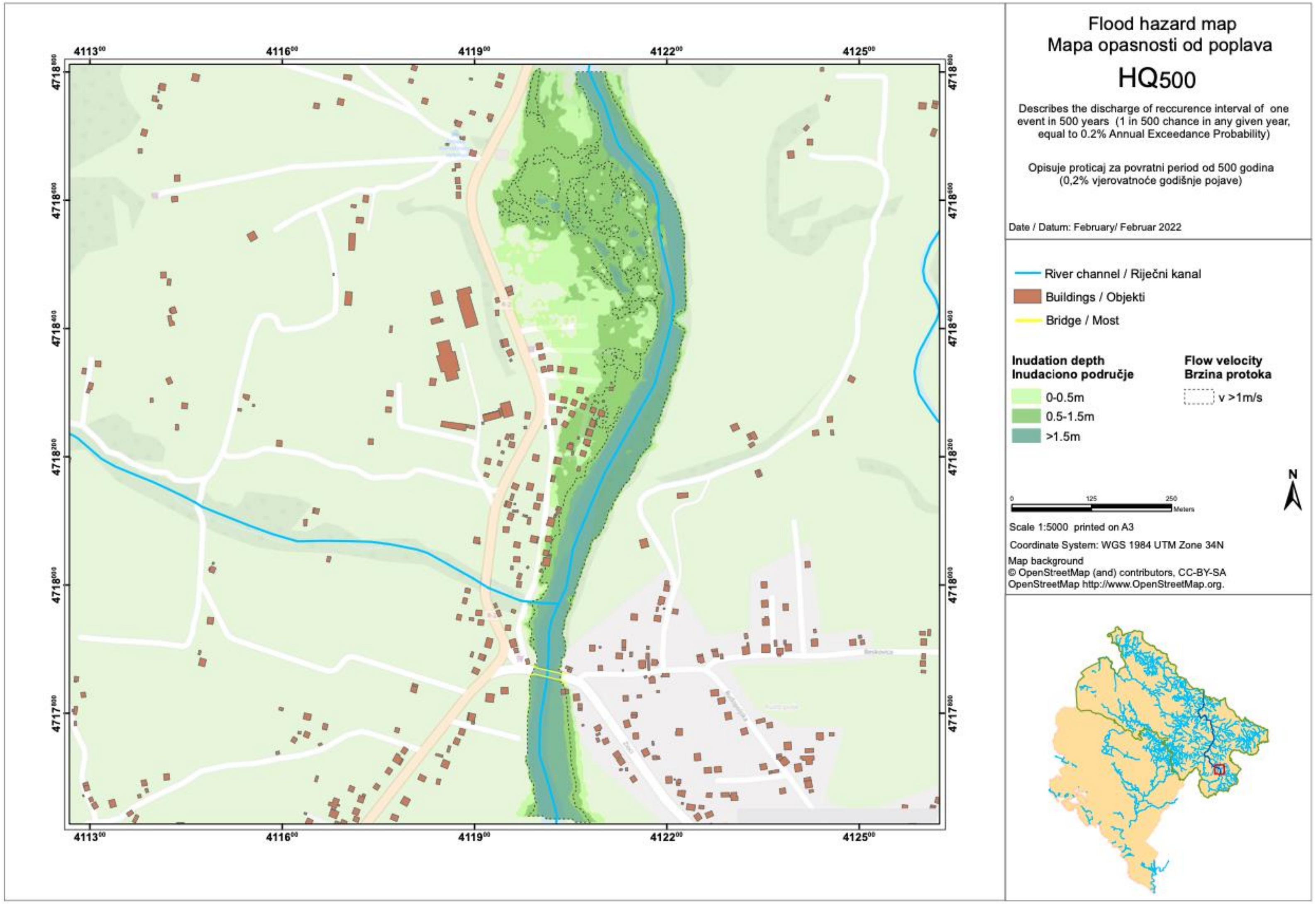


Figure 6.28. Flood Risk (HQ500) for APSFR07_DRB_Lim01

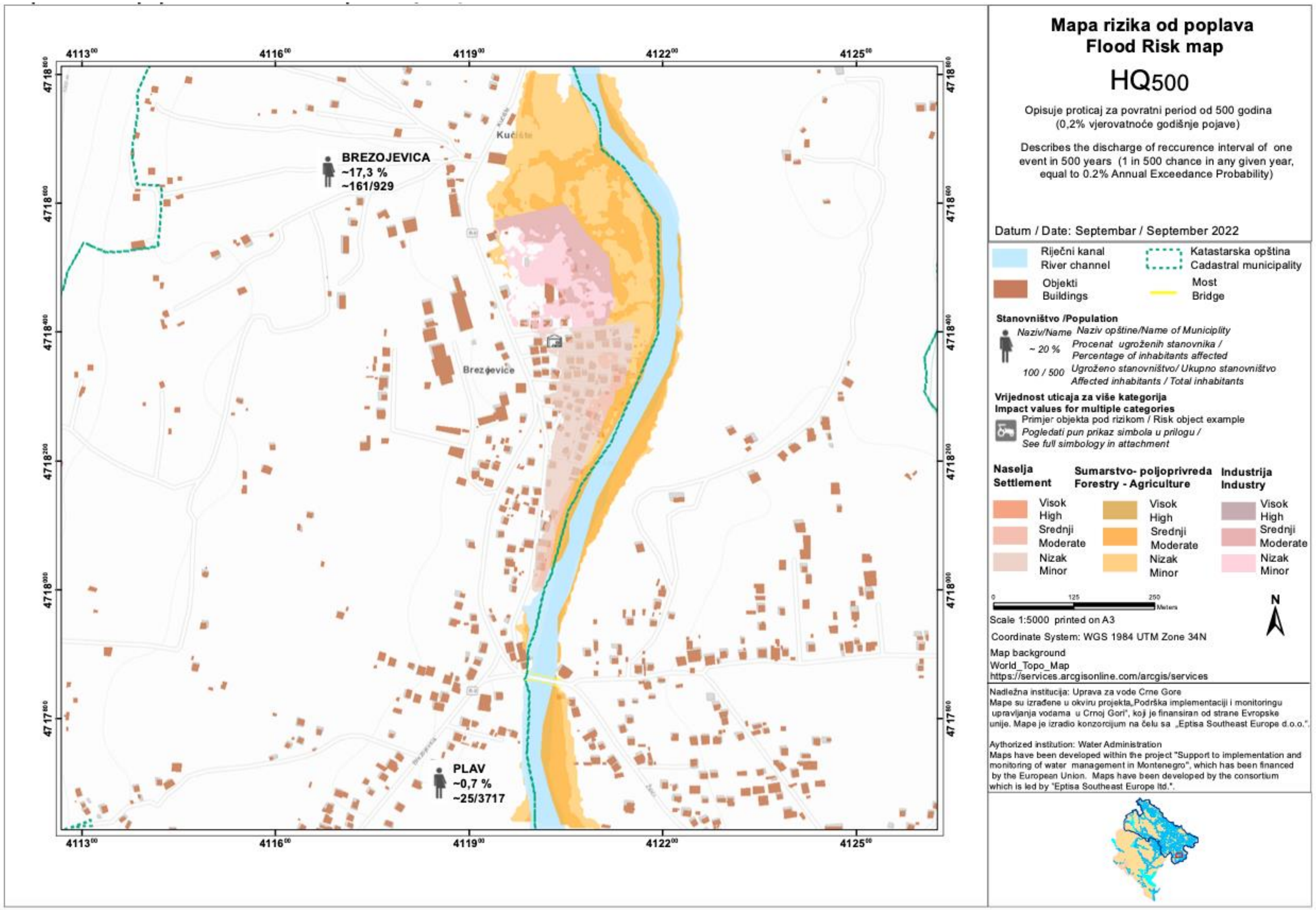


Table 6.18. Summary of flood risk in APSFR07_DRB_Lim01

<table>
<tr><th>Sub-Basin</th><th>River/Tributary</th><th>Admin. Region</th><th>Settlements/ villages at risk</th><th>Flood Return Period</th><th>Area at risk (ha)</th><th>No. of inhabitants at risk</th><th>No. of buildings at risk</th><th>No of commercial businesses at risk</th><th>No. of cultural objects at risk</th></tr>
<tr><td rowspan="3">Lim</td><td rowspan="3">Lim</td><td rowspan="3">Plav</td><td rowspan="3">Plav, Brezojevica, Rambalovi lugovi.</td><td>HQ10</td><td>13.29</td><td>113</td><td>43</td><td>0</td><td>0</td></tr>
<tr><td>HQ100</td><td>15.32</td><td>151</td><td>59</td><td>0</td><td>0</td></tr>
<tr><td>HQ500</td><td>16.72</td><td>186</td><td>81</td><td>0</td><td>0</td></tr>
<tr><td colspan="10">Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; M - A21; C - A34</td></tr>
<tr><td colspan="10">Description of Damage: The Lim River caused previous damage to residential buildings in the village of Brezojevica and the settlement "Rambalovi lugovi".</td></tr>
<tr><td colspan="3">Possibility of future significant damage[66]:</td><td colspan="2">Urbanization[67]: No</td><td colspan="3">Declaring the area protected: No</td><td colspan="2">Other Reasons: No</td></tr>
<tr><td colspan="10">Risk assessment / Significance of potential risks[68]:</td></tr>
<tr><td colspan="3">A) Human health, economic values</td><td colspan="2">B1) Water polluting substances / sites</td><td colspan="3">B2) Protected areas</td><td colspan="2">C) Risk for cultural heritage sites</td></tr>
<tr><td colspan="2">No. of houses</td><td></td><td>Contaminated sites</td><td></td><td colspan="2">Nature Protected areas</td><td></td><td>UNESCO heritage sites</td><td></td></tr>
<tr><td colspan="2">Settlement area</td><td></td><td>Locations of substances</td><td></td><td colspan="2">Drinking Water supply areas</td><td></td><td>Other cultural heritage sites</td><td></td></tr>
<tr><td colspan="2">Industrial objects</td><td></td><td>IED / PRTR-location</td><td></td><td colspan="2">Bathing waters</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Industrial area</td><td></td><td colspan="7"></td></tr>
</table>

[66] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).

[67] Determination if significant adverse impacts would occur in the future due to urban development.

[68] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.10 APSFR08_DRB_Lim02

The location of APSFR08_DRB_Lim02 in the Danube River Basin is shown in Figure 6.29.

Figure 6.29. Location of APSFR08_DRB_Lim02

Hydrological data cover the APSFR, which indicates the potential for flooding events. The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Andrijevica
Towns/Settlements	Andrijevica, Prljanije

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.19 below and are available for download (via Google Drive).

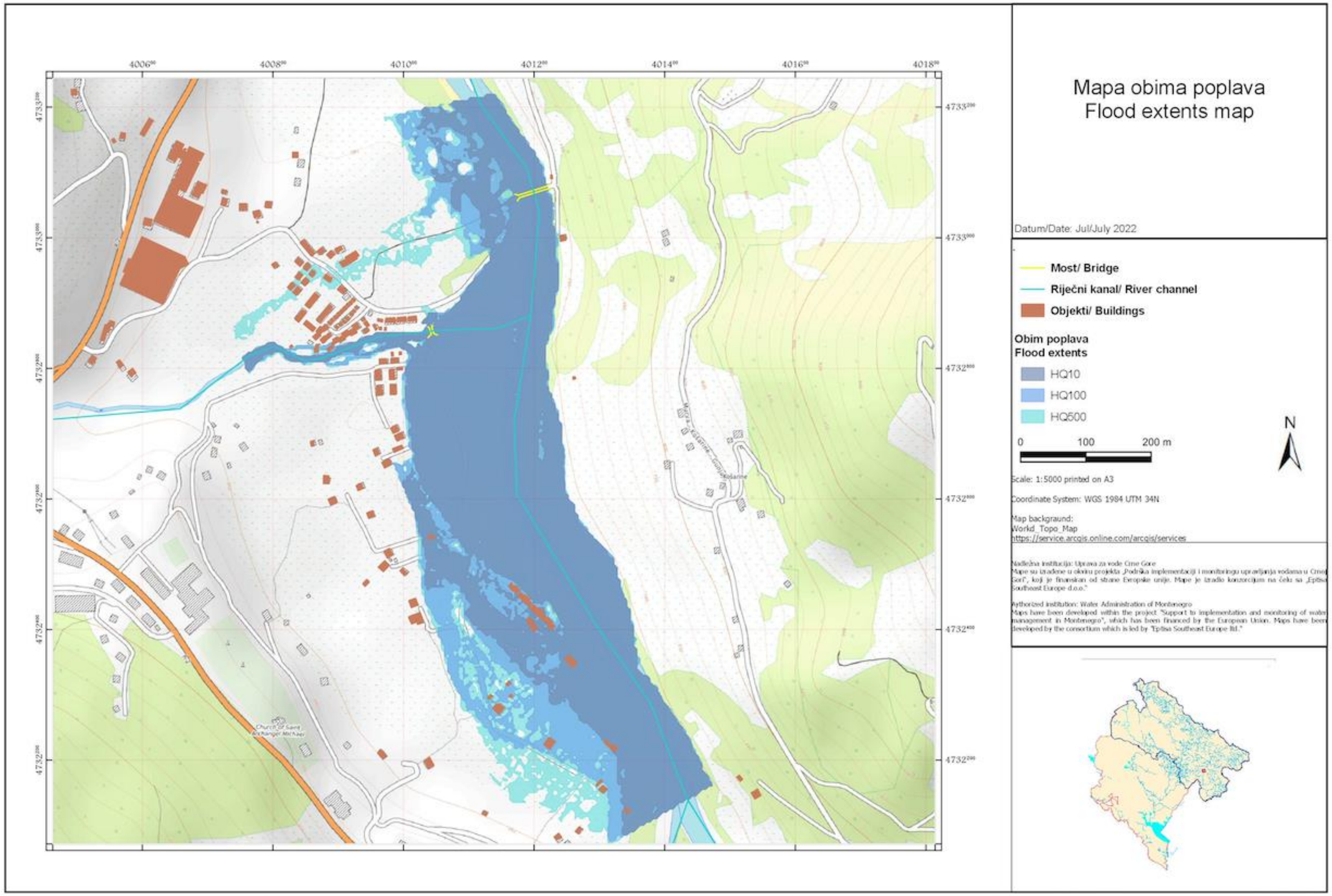
Table 6.19. Flood hazard maps and flood risk maps prepared for APSFR08_DRB_Lim02

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.30 to 6.32 below provide examples of the flood hazard and flood risk maps for APSFR08_DRB_Lim02, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.30 together with inundations based on the HQ500 (Figure 6.31). The flood risk map for HQ500 is shown in Figure 6.32.

A summary of all potential risks are shown in Table 6.20.

Figure 6.30. Flood Extent for APSFR08_DRB_Lim02



Implemented by the consortium:

Figure 6.31. Inundation Depth (HQ500) for APSFR08_DRB_Lim02

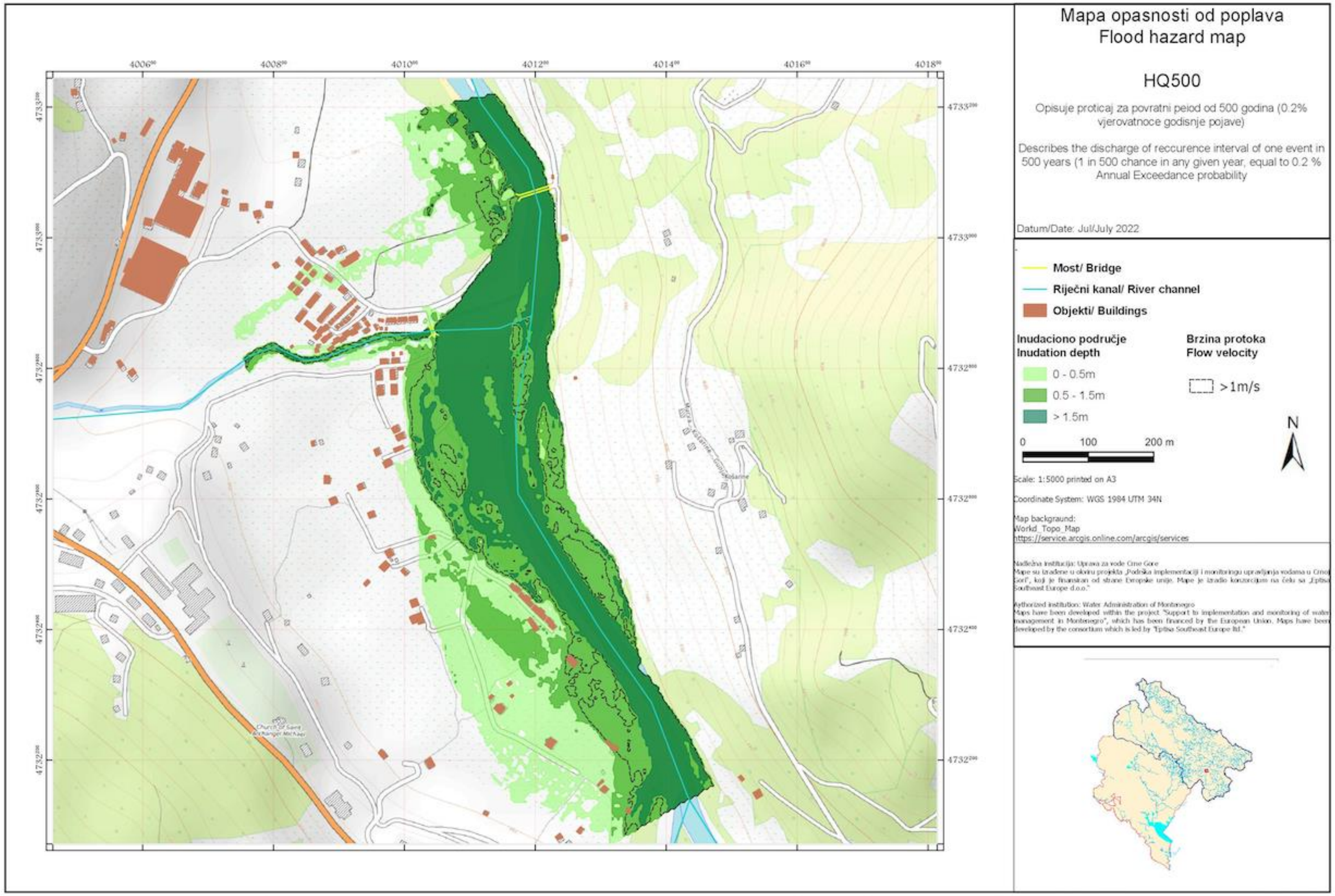


Figure 6.32. Flood Risk (HQ500) for APSFR08_DRB_Lim02

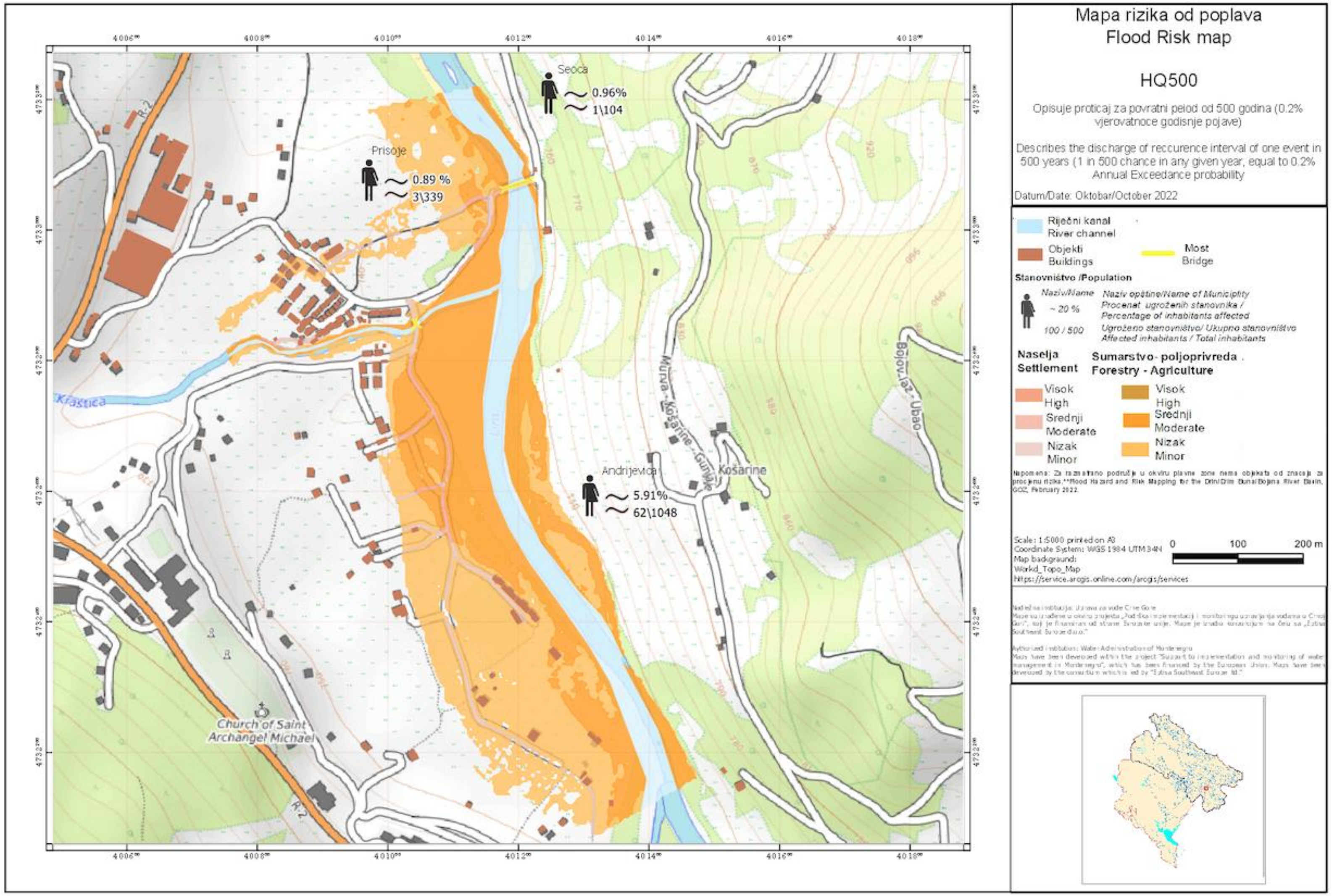


Table 6.20. Summary of flood risk in APSFR08_DRB_Lim02

Sub-Basin	River/ Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
LIm	LIm	Andrijevica	Andrijevica, Prljanije	**HQ10**	19.08	49	11	0	0
				HQ100	23.71	59	15	0	0
				HQ500	26.92	66	25	0	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A34

Description of historical damage: The Lim River, by leaving its bed, significantly endangered the residential buildings in the settlement of Prljnije. There was a flooding of private residential and auxiliary buildings and there was a danger that the refugee settlement 'Lim2' would be completely washed away.

Possibility of future significant damage[69]:	Urbanization[70]: No	Declaring the area protected: No	Other Reasons: No

Risk assessment / Significance of potential risks[71]:

A) Human health, economic values		B1) Water polluting substances / sites		B2) Protected areas		C) Risk for cultural heritage sites	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[69] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[70] Determination if significant adverse impacts would occur in the future due to urban development.
[71] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.11 APSFR09_DRB_Lim03

The location of APSFR09_DRB_Lim03 in the Danube River Basin is shown in Figure 6.33.

Figure 6.33. Location of APSFR09_DRB_Lim03

Hydrological data cover the zone. Previous data on flooding of these terrains at high waters of Lim and its tributary Vinica river, identify several rural households with agricultural production in the vilages Vinica and Navotina. This location is designated as an area of significant flood risk.

The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Berane
Towns/Settlements	Navotina, Vinicka

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	Cultural Assets: Adverse consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings (B31).
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.21 below and are available for download (via Google Drive).

Table 6.21. Flood hazard maps and flood risk maps prepared for APSFR09_DRB_Lim03

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.34 to 6.36 below provide examples of the flood hazard and flood risk maps for APSFR09_DRB_Lim03, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.34 together with inundations based on the HQ500 (Figure 6.35). The flood risk map for HQ500 is shown in Figure 6.36.

A summary of all potential risks are shown in Table 6.22.

Figure 6.34. Flood Extent for APSFR09_DRB_Lim03

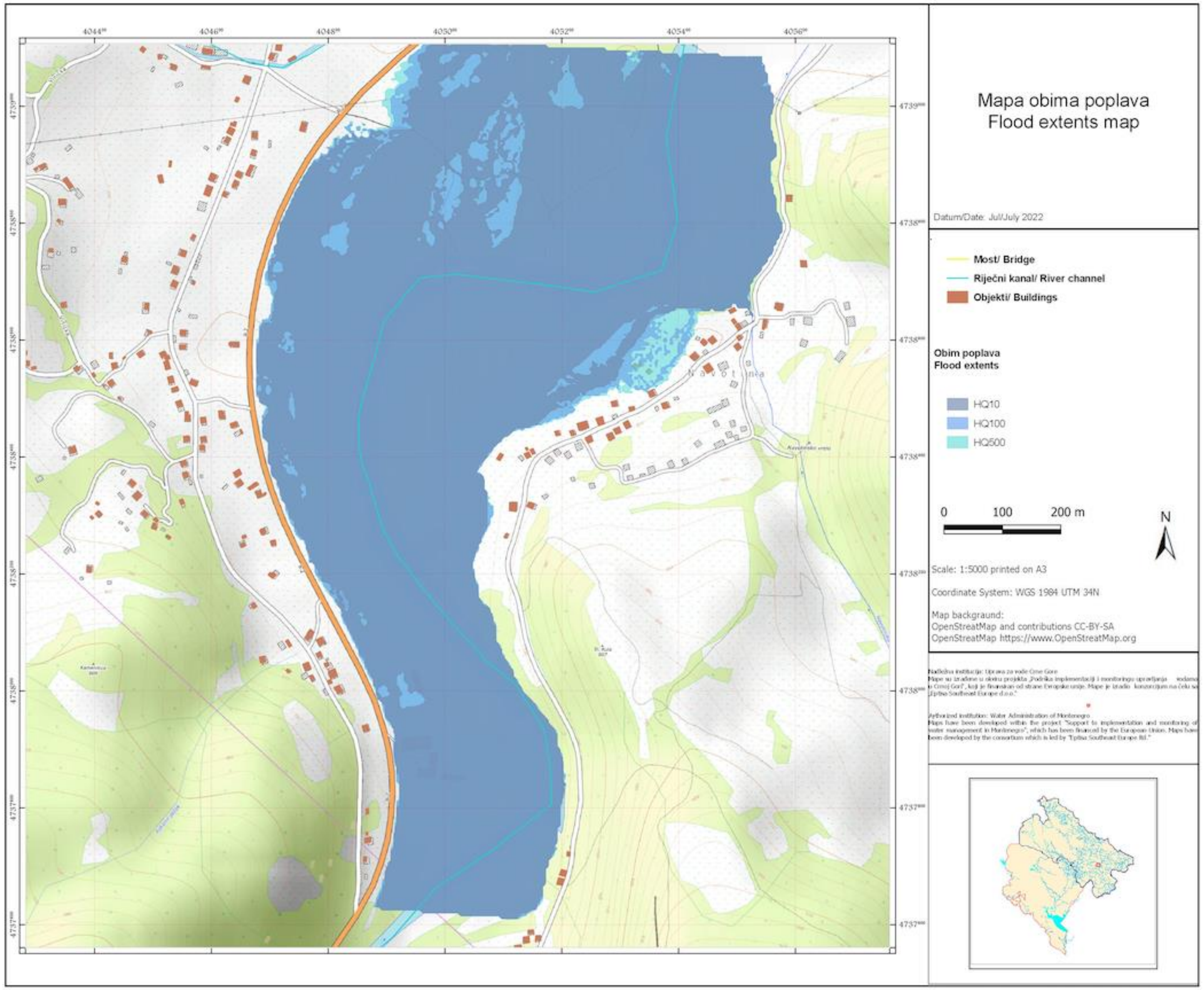


Figure 6.35. Inundation Depth (HQ500) for APSFR09_DRB_Lim03

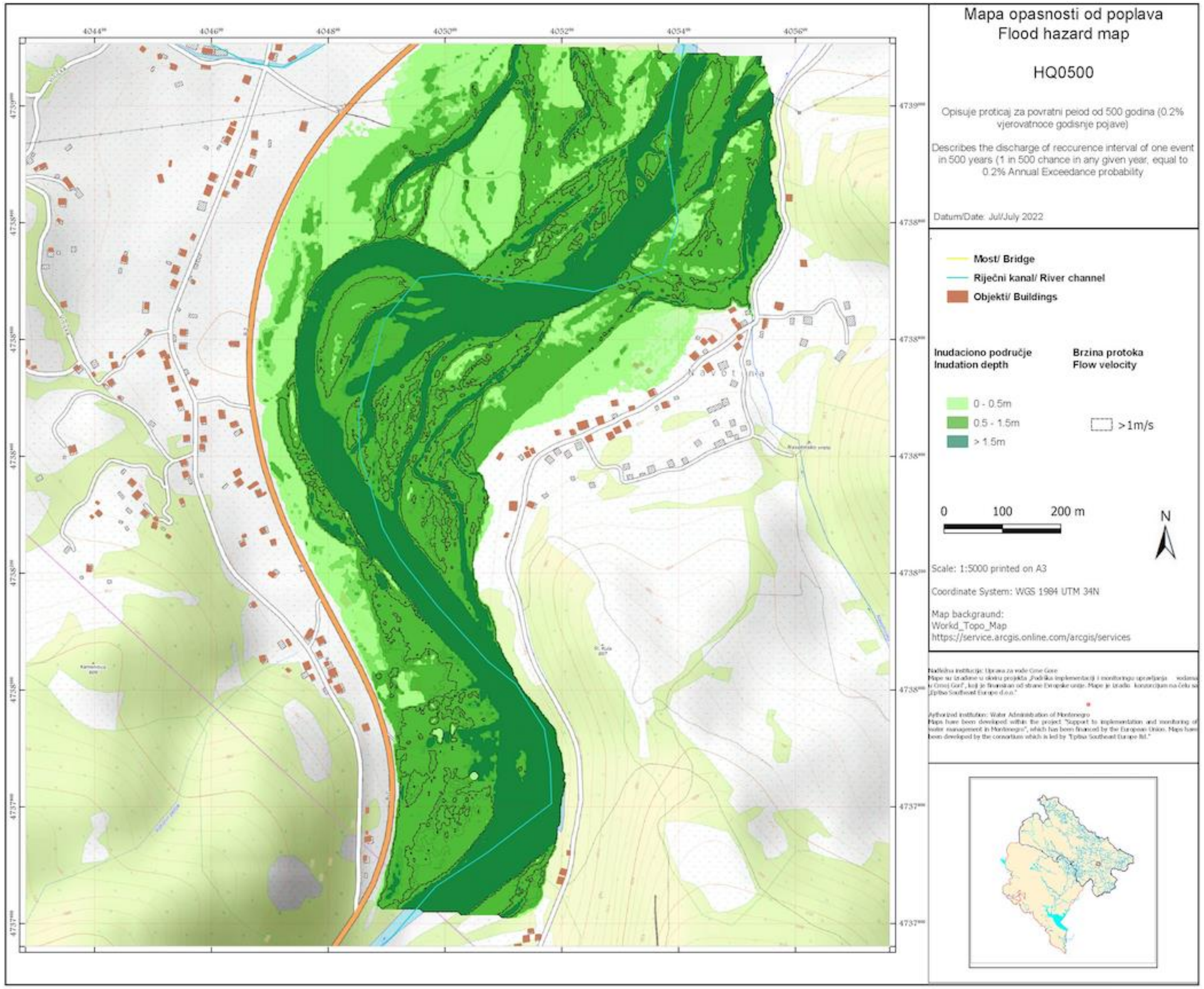


Figure 6.36. Flood Risk (HQ500) for APSFR09_DRB_Lim03

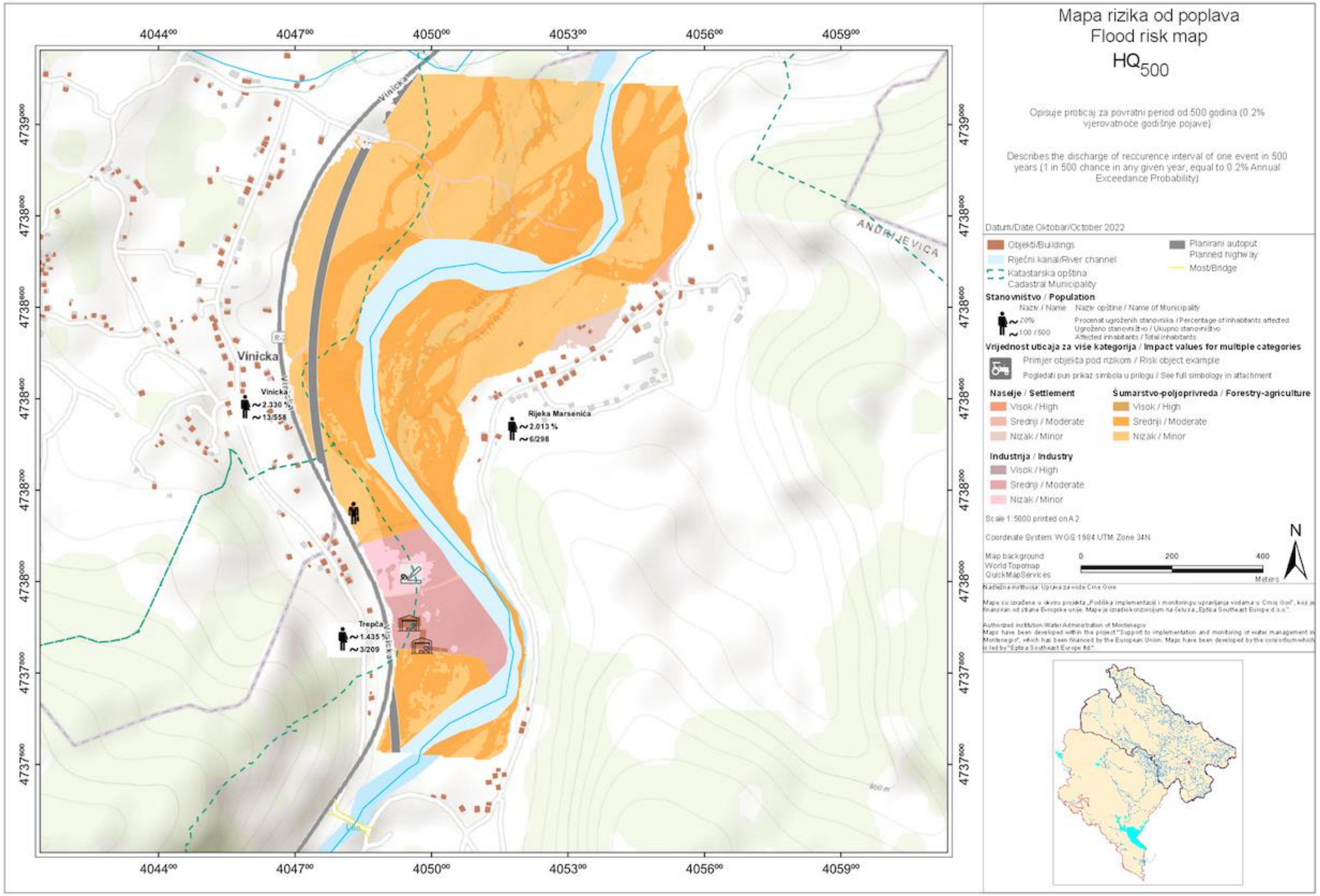


Table 6.22. Summary of flood risk in APSFR09_DRB_Lim03

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
LIm	Lim	Berane	Navotina, Vinicka,	**HQ10**	66.00	21	4	1	0
				HQ100	70.67	22	4	2	0
				HQ500	71.78	22	9	2	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A34							
Description of historical damage: No information available.							
Possibility of future significant damage[72]:		**Urbanization[73]**: No		**Declaring the area protected**: No		**Other Reasons**: No	
Risk assessment / Significance of potential risks[74]:							
A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[72] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).

[73] Determination if significant adverse impacts would occur in the future due to urban development.

[74] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.12 APSFR10_DRB_Lim04

The location of APSFR10_DRB_Lim04 in the Danube River Basin is shown in Figure 6.37.

Figure 6.37. Location of APSFR10_DRB_Lim04

Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34).
Affected regions	Municipality of Berane
Towns/Settlements	Berane, Hareme, Riversajd, Rudeš, Talum

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.23 below and are available for download (via Google Drive).

Table 6.23. Flood hazard maps and flood risk maps prepared for APSFR10_DRB_Lim04

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.38 to 6.40 below provide examples of the flood hazard and flood risk maps for APSFR10_DRB_Lim04, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.38 together with inundations based on the HQ500 (Figure 6.39). The flood risk map for HQ500 is shown in Figure 6.40.

A summary of all potential risks are shown in Table 6.24.

Figure 6.38. Flood Extent for APSFR10_DRB_Lim04

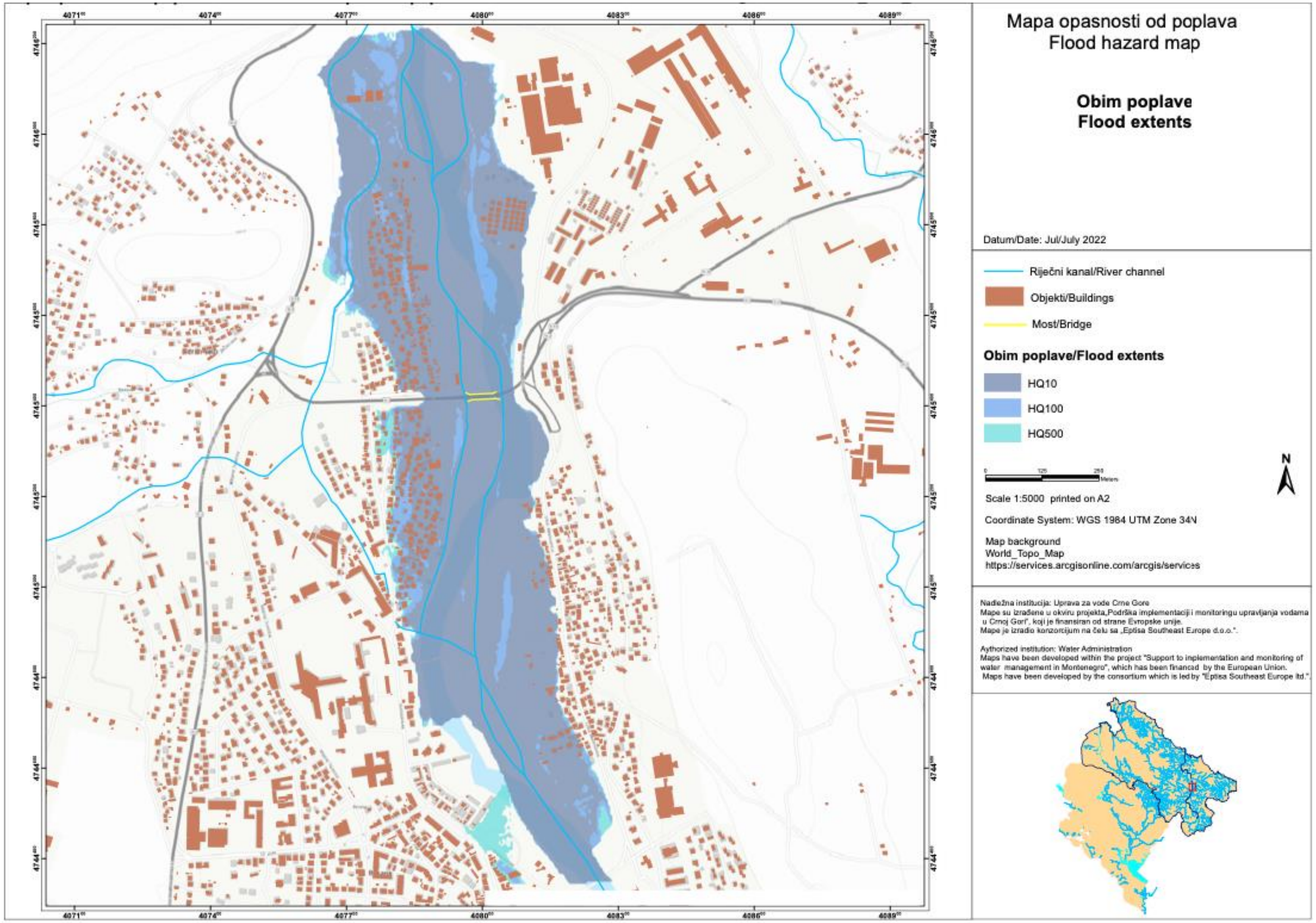


Figure 6.39. Inundation Depth (HQ500) for APSFR10_DRB_Lim04

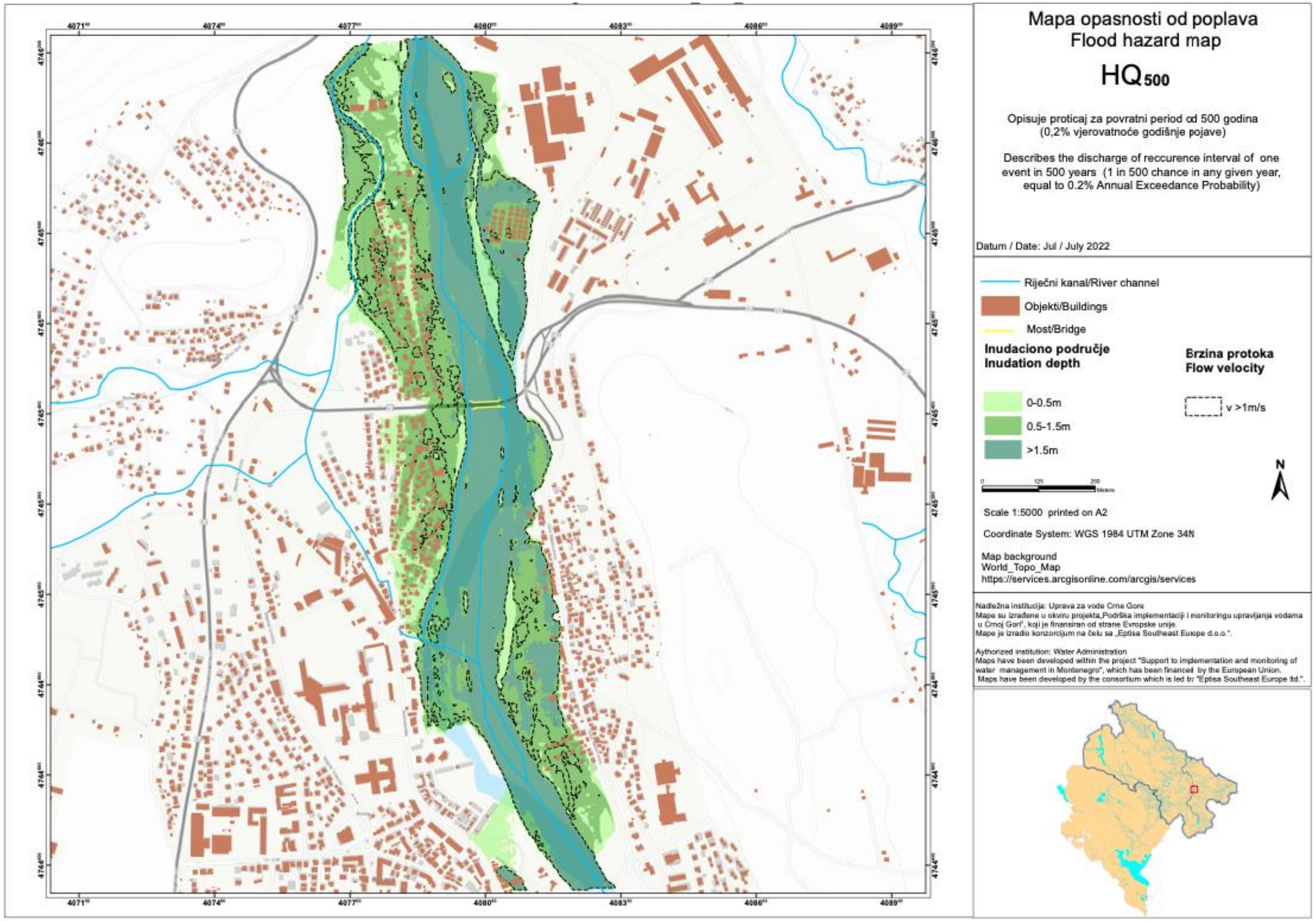


Figure 6.40. Flood Risk (HQ500) for APSFR10_DRB_Lim04

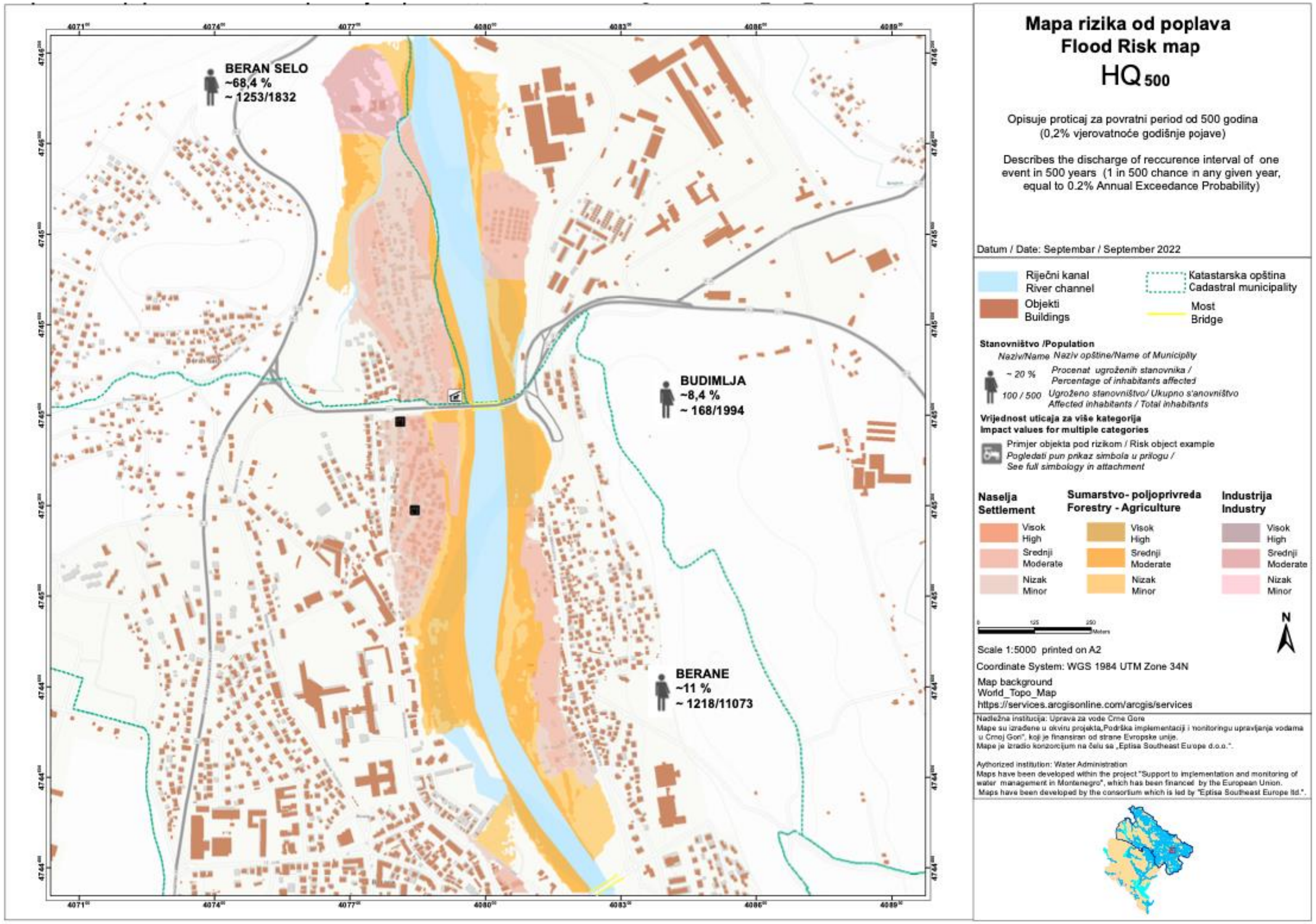


Table 6.24. Summary of flood risk in APSFR10_DRB_Lim04

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Lim	Lim	Berane	Berane: Hareme, Riversajd, Rudeš, Talum	**HQ10**	52.92	2393	300	2	0
				HQ100	57.52	2556	334	2	0
				HQ500	59.61	2639	344	2	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A34

Description of historical damage: In the settlement of Hareme on the right bank of the river Lim, 18 residential buildings with 75 people are endangered. In the settlements of the upper and lower Talum, on the left bank of the Lima, 131 residential buildings are endangered, in which a total of 809 people live. In addition to residential buildings, a total of about 13 ancillary buildings (private zoo, garages, barns, pantries, etc.) are endangered at this location. The Riversajd refugee settlement is located on the right bank of the Lima and is completely endangered by floods. At this location there are 43 residential buildings, in which 279 people live. The entire settlement was flooded in 2010, although a gabion fortification was built upstream from it earlier, in the length of 200 m. In addition to the high-water level, groundwater also contributes to the flooding of the settlement to a good extent.

Possibility of future significant damage[75]:	**Urbanization[76]**: Yes	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[77]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[75] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[76] Determination if significant adverse impacts would occur in the future due to urban development.
[77] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.13 APSFR11_DRB_Lim05

The location of APSFR11_DRB_Lim05 in the Danube River Basin is shown in Figure 6.41.

Figure 6.41. Location of APSFR11_DRB_Lim05

Hydrological data cover the proposed zone. Having in mind the previous data on flooding of these terrains at high waters of Lim and its tributaries, with several rural households with agricultural production, catering and business facilities, endangerment of even the main road infrastructure, this location is defined as an area of significant flood risk. Extreme waters, according to the conducted calculations, could potentially reach the fences of a large electric power plant of exceptional importance for the supply of electricity in this part of Montenegro.

The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands

Flood Hazard	
	(A21).
Flood Characteristics	No data (A40).
Affected regions	Municipality of Bijelo Polje
Towns/Settlements	Ribarevina

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.25 below and are available for download (via Google Drive).

Table 6.25. Flood hazard maps and flood risk maps prepared for APSFR11_DRB_Lim05

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.42 to 6.44 below provide examples of the flood hazard and flood risk maps for APSFR11_DRB_Lim05, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.42 together with inundations based on the HQ500 (Figure 6.43). The flood risk map for HQ500 is shown in Figure 6.44.

A summary of all potential risks are shown in Table 6.26.

Figure 6.42. Flood Extent for APSFR11_DRB_Lim05

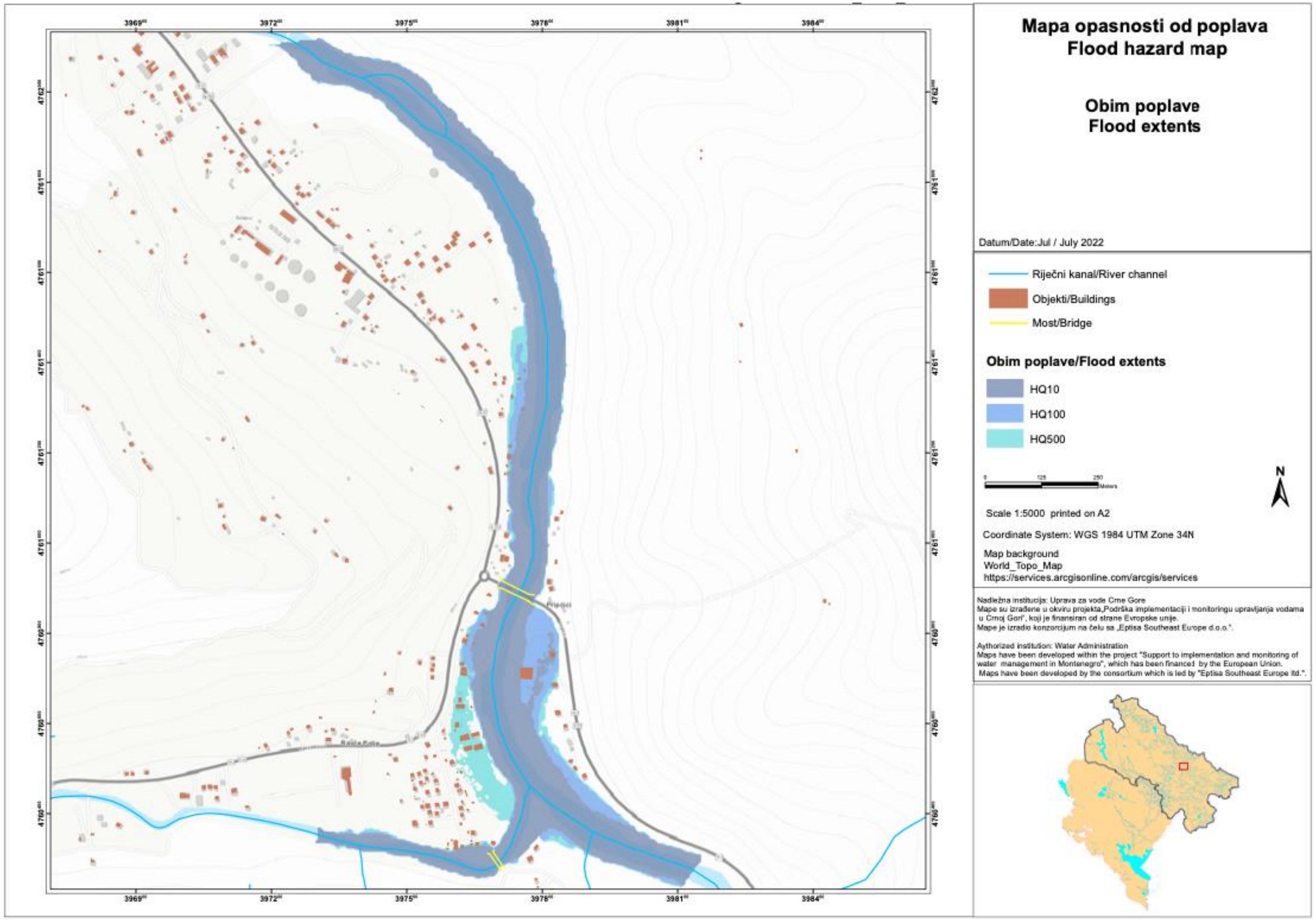


Figure 6.43. Inundation Depth (HQ500) for APSFR11_DRB_Lim05

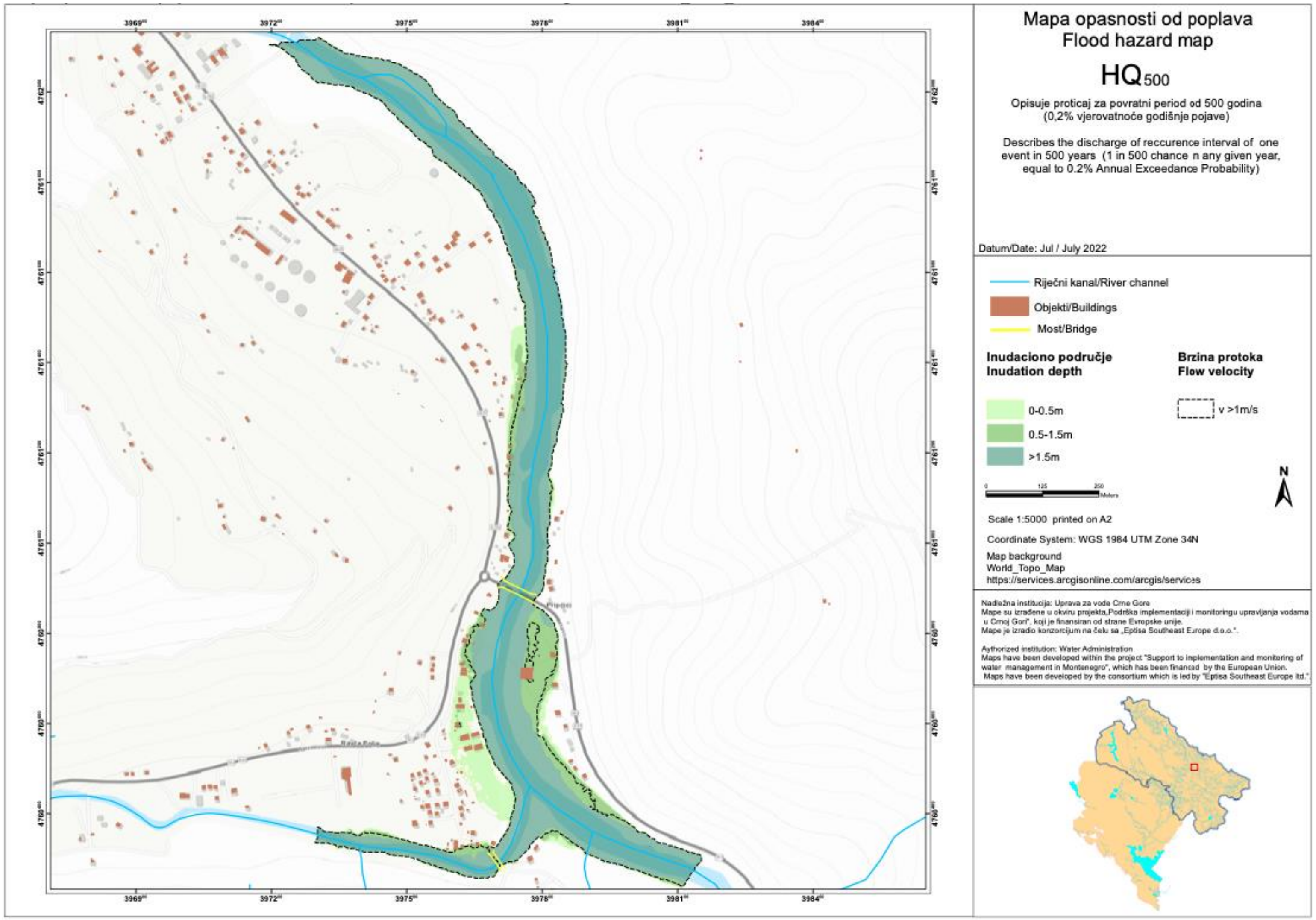


Figure 6.44. Flood Risk (HQ500) for APSFR11_DRB_Lim05

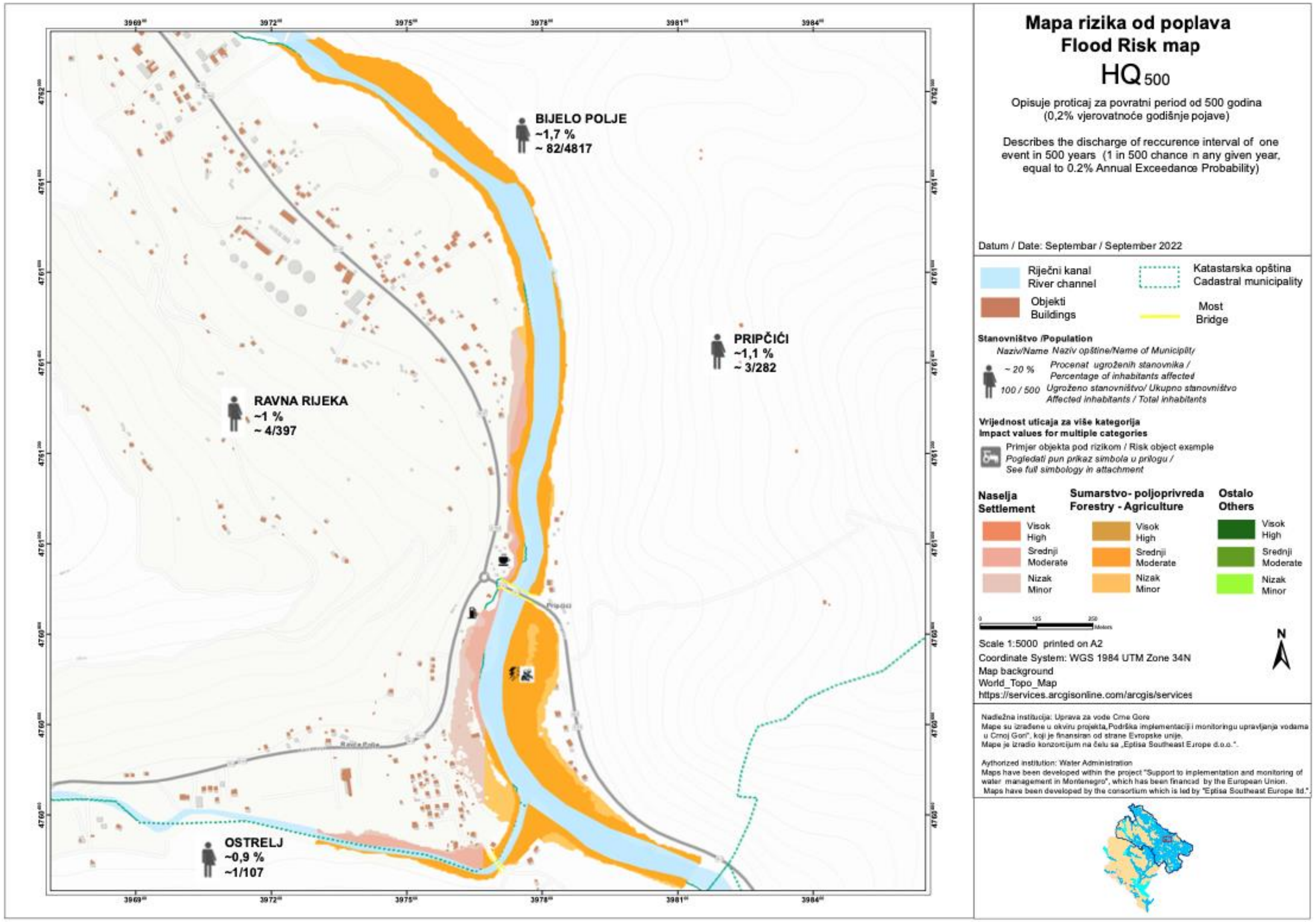


Table 6.26. Summary of flood risk in APSFR11_DRB_Lim05

<table>
<tr><th>Sub-Basin</th><th>River/Tributary</th><th>Admin. Region</th><th>Settlements/ villages at risk</th><th>Flood Return Period</th><th>Area at risk (ha)</th><th>No. of inhabitants at risk</th><th>No. of buildings at risk</th><th>No of commercial businesses at risk</th><th>No. of cultural objects at risk</th></tr>
<tr><td rowspan="3">Lim</td><td rowspan="3">Lim</td><td rowspan="3">Bijelo Polje</td><td rowspan="3">Ribarevina</td><td>HQ10</td><td>23.42</td><td>86</td><td>8</td><td>0</td><td>0</td></tr>
<tr><td>HQ100</td><td>26.81</td><td>88</td><td>21</td><td>1</td><td>0</td></tr>
<tr><td>HQ500</td><td>29.83</td><td>90</td><td>35</td><td>1</td><td>0</td></tr>
<tr><td colspan="10">Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; M - A21; C – A40</td></tr>
<tr><td colspan="10">Description of historical damage: No information available</td></tr>
<tr><td colspan="3">Possibility of future significant damage[78]:</td><td colspan="2">Urbanization[79]: No</td><td colspan="3">Declaring the area protected: No</td><td colspan="2">Other Reasons: No</td></tr>
<tr><td colspan="10">Risk assessment / Significance of potential risks[80]:</td></tr>
<tr><td colspan="3">A) Human health, economic values</td><td colspan="2">B1) Water polluting substances / sites</td><td colspan="3">B2) Protected areas</td><td colspan="2">C) Risk for cultural heritage sites</td></tr>
<tr><td colspan="2">No. of houses</td><td>red</td><td>Contaminated sites</td><td>green</td><td colspan="2">Nature Protected areas</td><td>green</td><td>UNESCO heritage sites</td><td>green</td></tr>
<tr><td colspan="2">Settlement area</td><td>red</td><td>Locations of substances</td><td>green</td><td colspan="2">Drinking Water supply areas</td><td>green</td><td>Other cultural heritage sites</td><td>green</td></tr>
<tr><td colspan="2">Industrial objects</td><td>red</td><td>IED / PRTR-location</td><td>green</td><td colspan="2">Bathing waters</td><td>green</td><td colspan="2"></td></tr>
<tr><td colspan="2">Industrial area</td><td>green</td><td colspan="7"></td></tr>
</table>

[78] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[79] Determination if significant adverse impacts would occur in the future due to urban development.
[80] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.14 APSFR12_DRB_Lim06

The location of APSFR12_DRB_Lim06 in the Danube River Basin is shown in Figure 6.45.

Figure 6.45. Location of APSFR12_DRB_Lim06

Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	No data (A40).
Affected regions	Municipality of Bijelo Polje
Towns/Settlements	Rakonje

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.27 below and are available for download (via Google Drive).

Table 6.27. Flood hazard maps and flood risk maps prepared for APSFR12_DRB_Lim06

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.46 to 6.48 below provide examples of the flood hazard and flood risk maps for APSFR12_DRB_Lim06, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.46 together with inundations based on the HQ500 (Figure 6.47). The flood risk map for HQ500 is shown in Figure 6.48.

A summary of all potential risks are shown in Table 6.28.

Figure 6.46. Flood Extent for APSFR12_DRB_Lim06

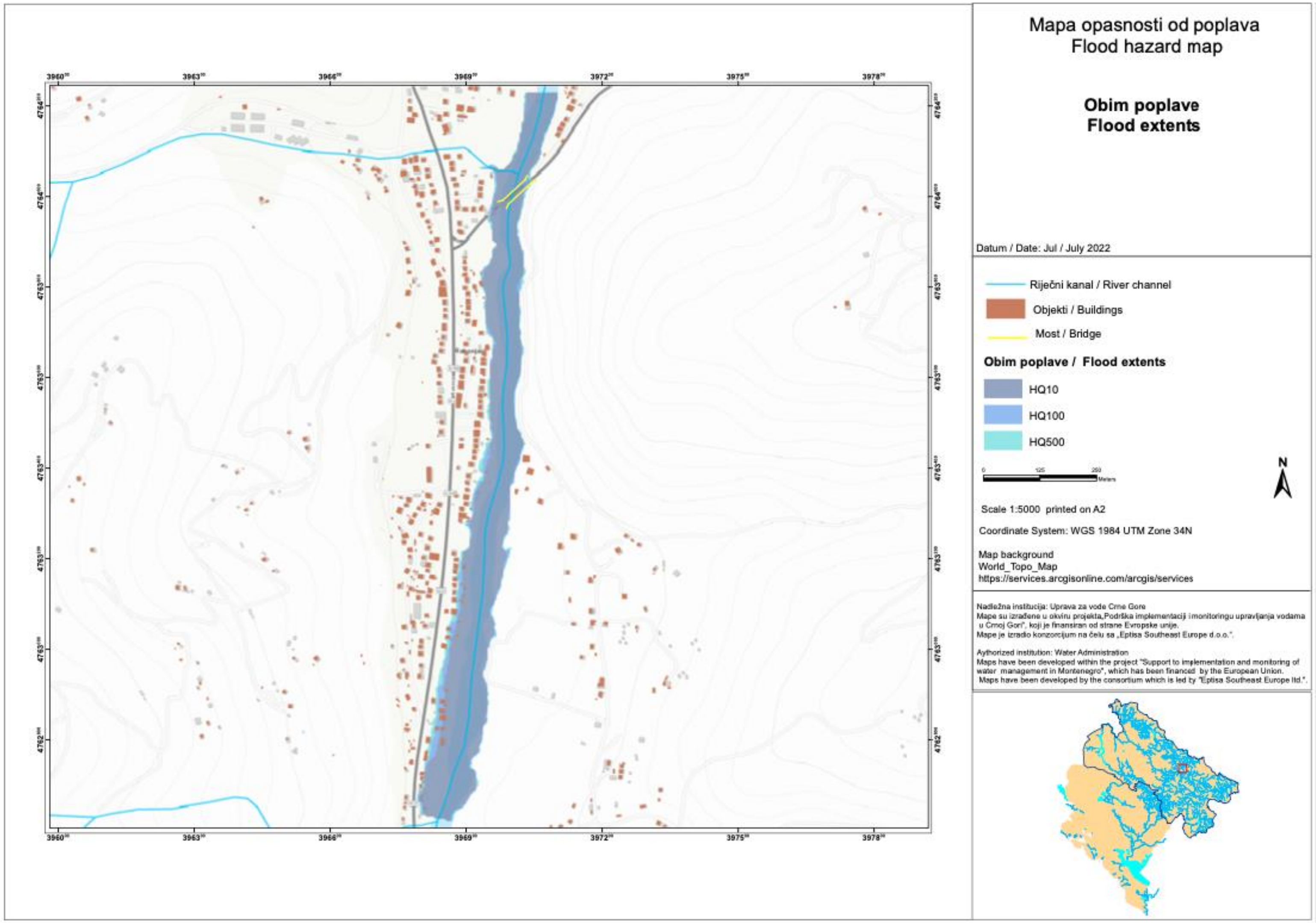


Figure 6.47. Inundation Depth (HQ500) for APSFR12_DRB_Lim06

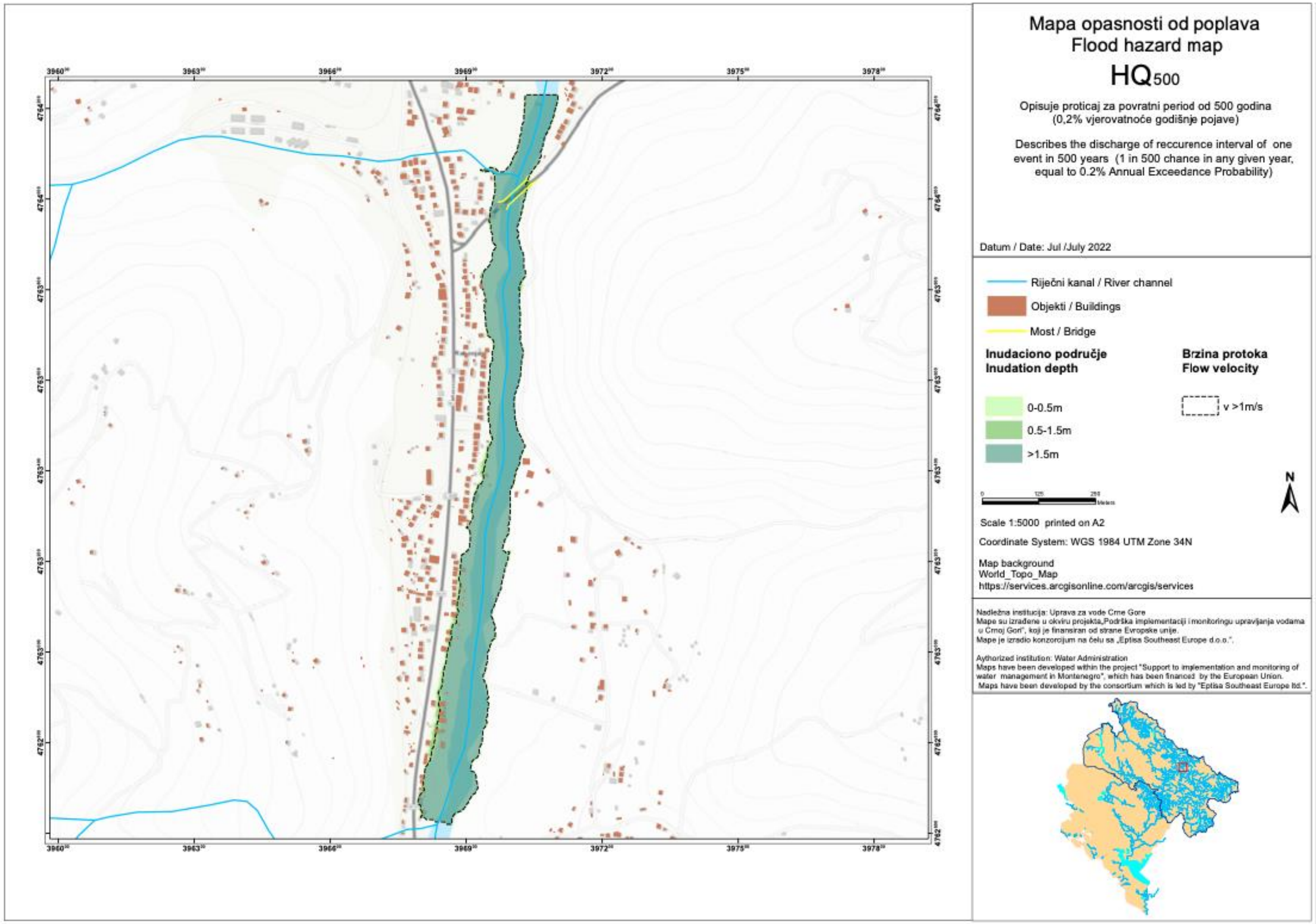


Figure 6.48. Flood Risk (HQ500) for APSFR12_DRB_Lim06

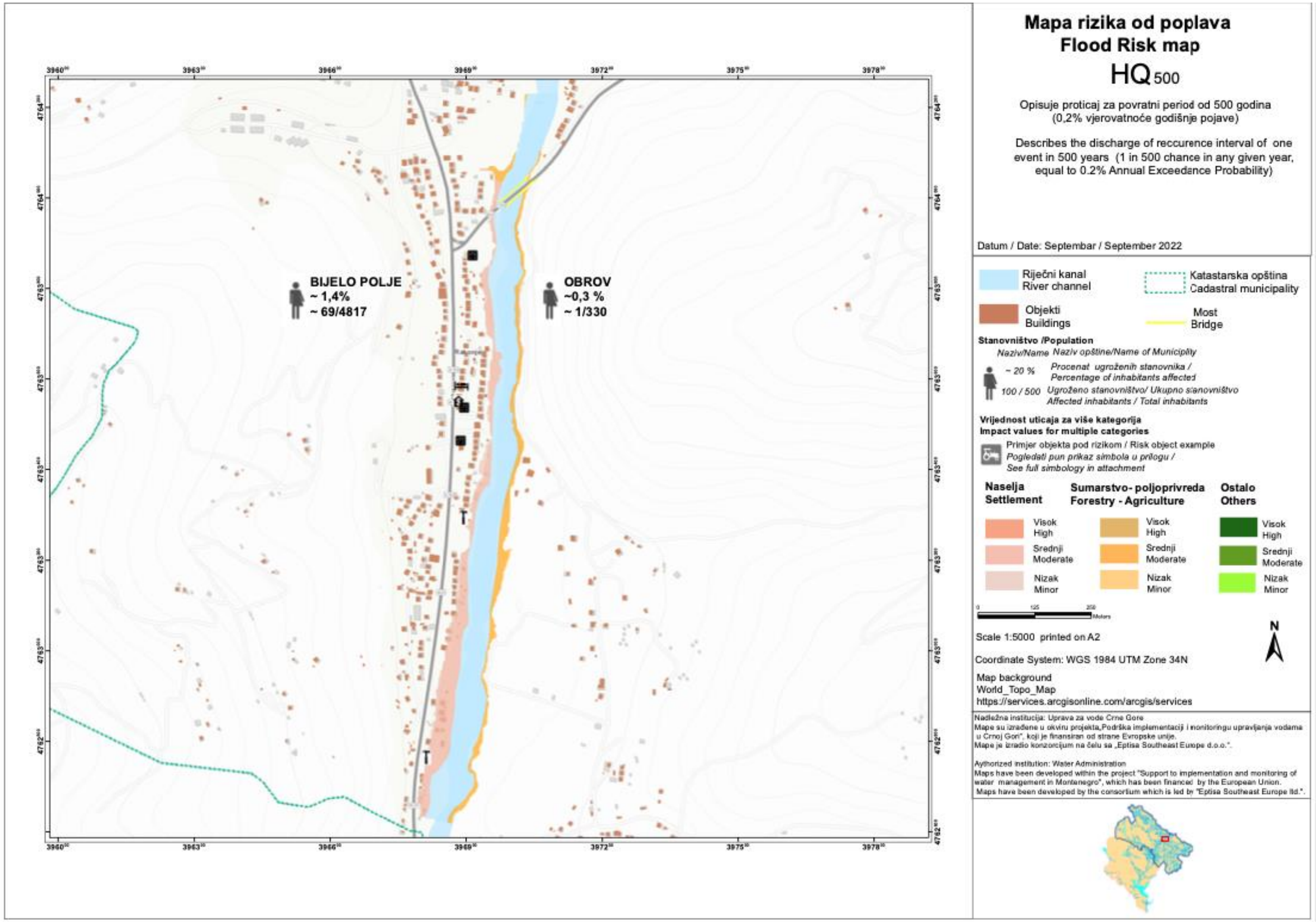


Table 6.28. Summary of flood risk in APSFR12_DRB_Lim06

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
LIm	Lim	Bijelo Polje	Rakonje	**HQ10**	11.93	59	17	0	0
				HQ100	12.92	65	25	0	0
				HQ500	13.62	70	36	0	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** – A40

Description of historical damage: No information is available

Possibility of future significant damage[81]:	**Urbanization[82]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[83]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[81] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[82] Determination if significant adverse impacts would occur in the future due to urban development.
[83] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.15 APSFR13_DRB_Lim07

The location of APSFR13_DRB_Lim07 in the Danube River Basin is shown in Figure 6.49.

Figure 6.49. Location of APSFR13_DRB_Lim07

Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	No data (A40).
Affected regions	Municipality of Bijelo Polje
Towns/Settlements	Lješnica, Rijeka

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.29 below and are available for download (via Google Drive).

Table 6.29. Flood hazard maps and flood risk maps prepared for APSFR13_DRB_Lim07

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.50 to 6.52 below provide examples of the flood hazard and flood risk maps for APSFR13_DRB_Lim07, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.50 together with inundations based on the HQ500 (Figure 6.51). The flood risk map for HQ500 is shown in Figure 6.52.

A summary of all potential risks are shown in Table 6.30.

Figure 6.50. Flood Extent for APSFR13_DRB_Lim07

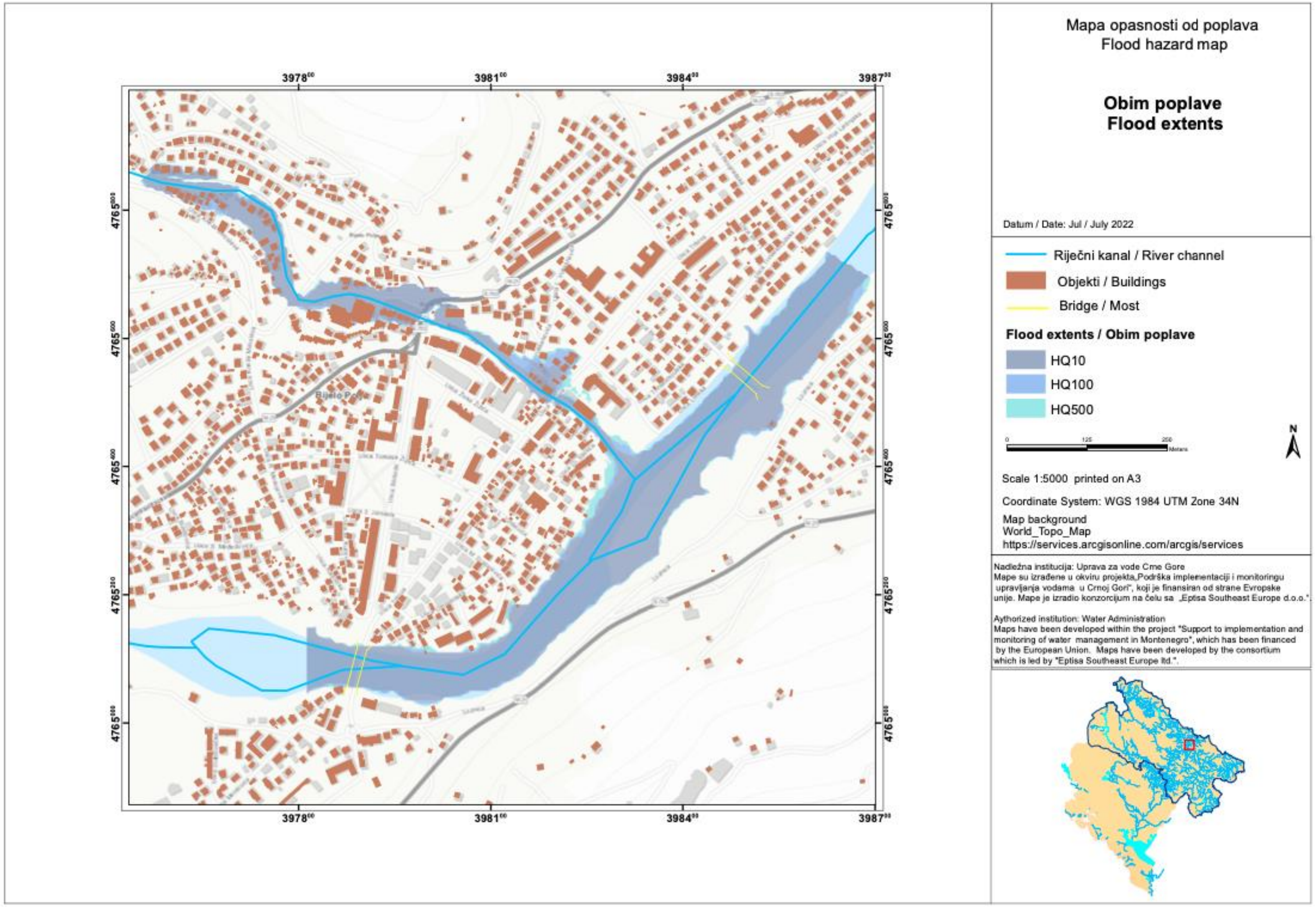


Figure 6.51. Inundation Depth (HQ500) for APSFR13_DRB_Lim07

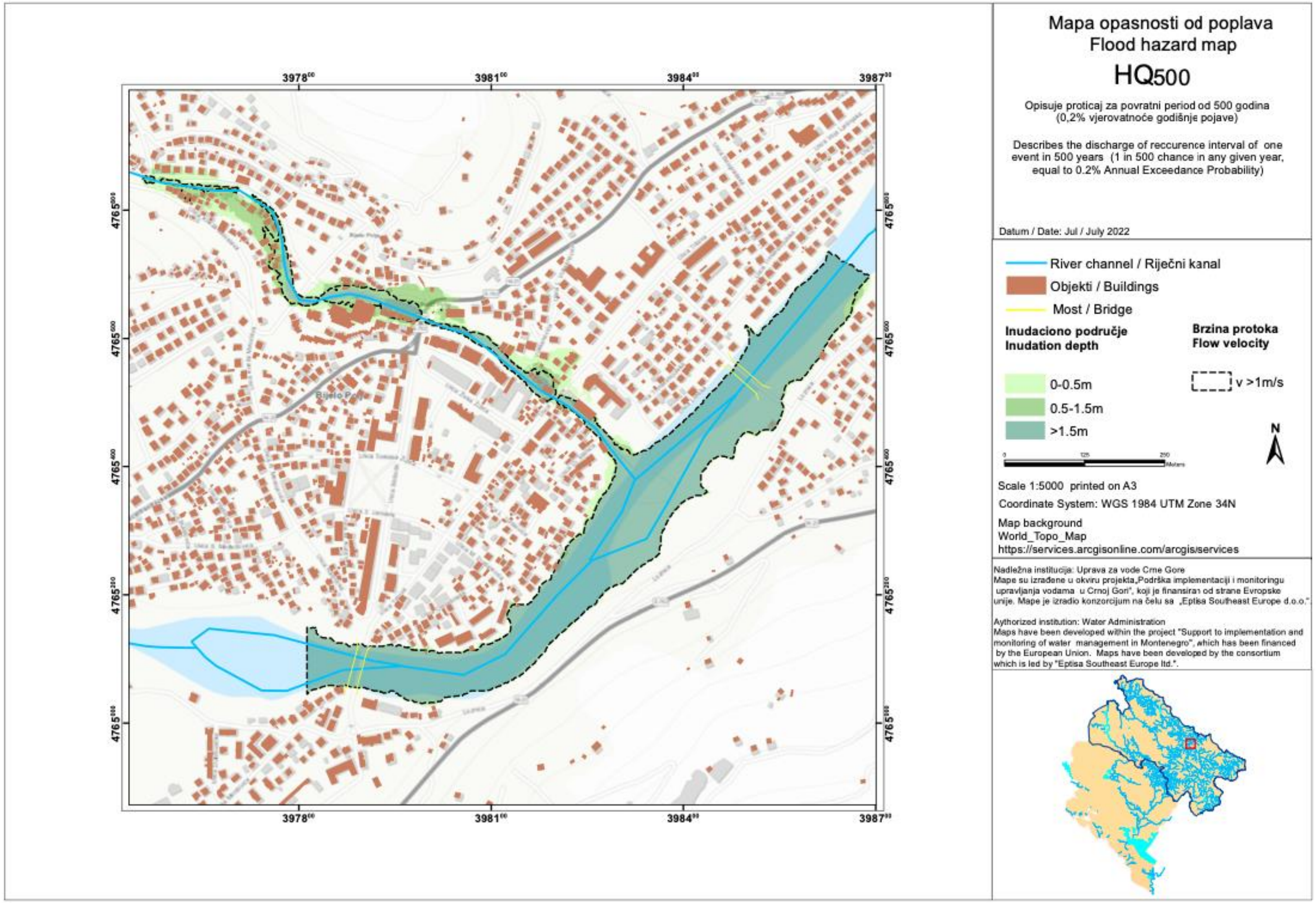


Figure 6.52. Flood Risk (HQ500) for APSFR13_DRB_Lim07

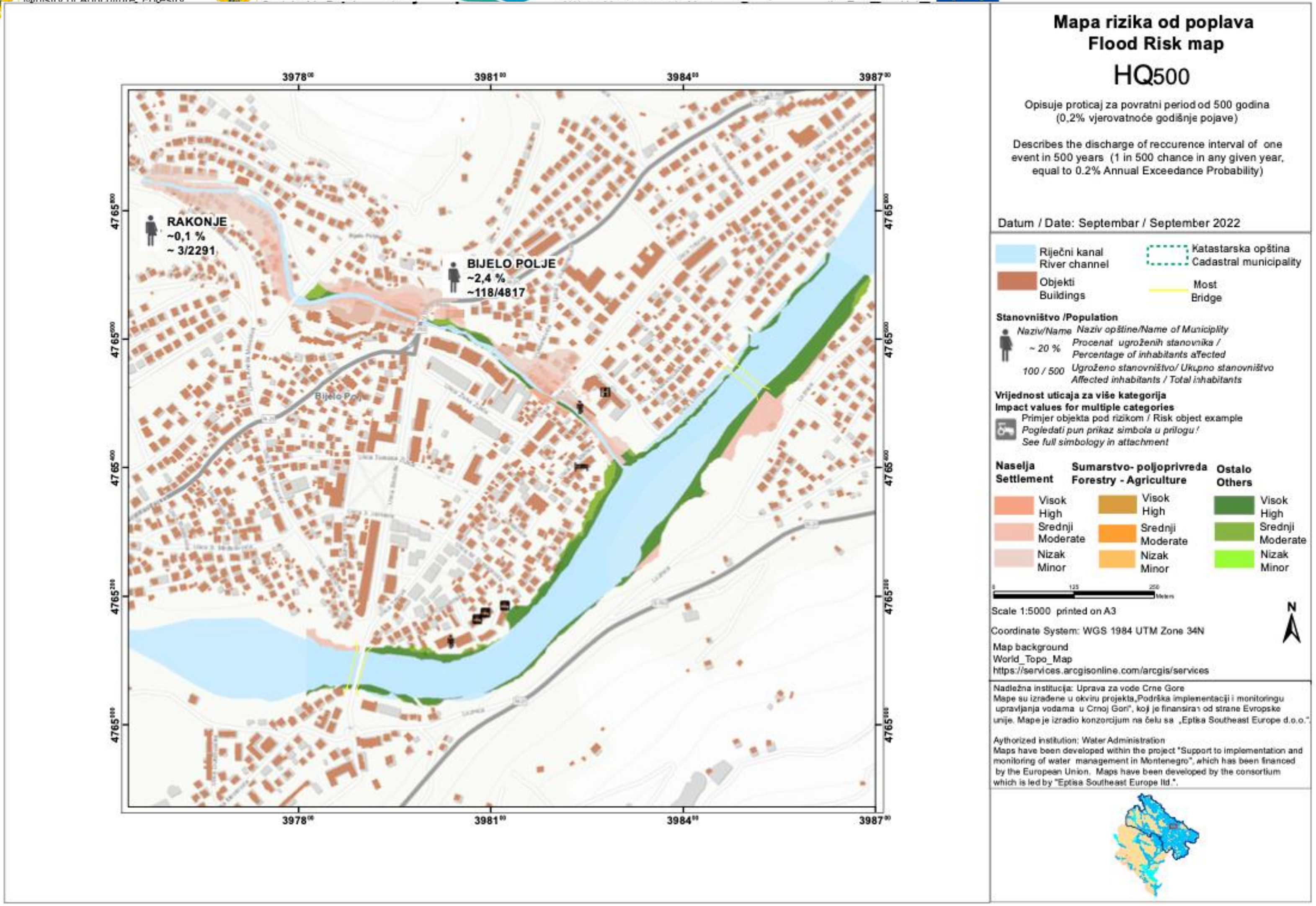


Table 6.30. Summary of flood risk in APSFR13_DRB_Lim07

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Lim	Lim	Bijelo Polje	Lješnica, Rijeka	**HQ10**	12.37	100	66	0	0
				HQ100	13.33	112	82	1	0
				HQ500	14.04	121	84	1	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** – A40

Description of historical damage: The river Lješnica causes problems in the lower course in the last 3 km, in the urban settlements of Lješnica and Rijeka.

Possibility of future significant damage[84]:	**Urbanization[85]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[86]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses	red	Contaminated sites	green	Nature Protected areas	green	UNESCO heritage sites	green
Settlement area	red	Locations of substances	green	Drinking Water supply areas	green	Other cultural heritage sites	green
Industrial objects	red	IED / PRTR-location	green	Bathing waters	green		
Industrial area	green						

[84] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[85] Determination if significant adverse impacts would occur in the future due to urban development.
[86] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.16 APSFR14_DRB_Lim08

The location of APSFR14_DRB_Lim08 in the Danube River Basin is shown in Figure 6.53.

Figure 6.53. Location of APSFR14_DRB_Lim08

Hydrological data cover the proposed zone. This was partially confirmed by the historical floods. Settlements at the mouth of the river Lipnica are endangered The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	No data (A40).
Affected regions	Municipality of Bijelo Polje
Towns/Settlements	Lipnica

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.31 below and are available for download (via Google Drive).

Table 6.31. Flood hazard maps and flood risk maps prepared for APSFR14_DRB_Lim08

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.54 to 6.56 below provide examples of the flood hazard and flood risk maps for APSFR14_DRB_Lim08, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.54 together with inundations based on the HQ500 (Figure 6.55). The flood risk map for HQ500 is shown in Figure 6.56.

A summary of all potential risks are shown in Table 6.32.

Figure 6.54. Flood Extent for APSFR14_DRB_Lim08

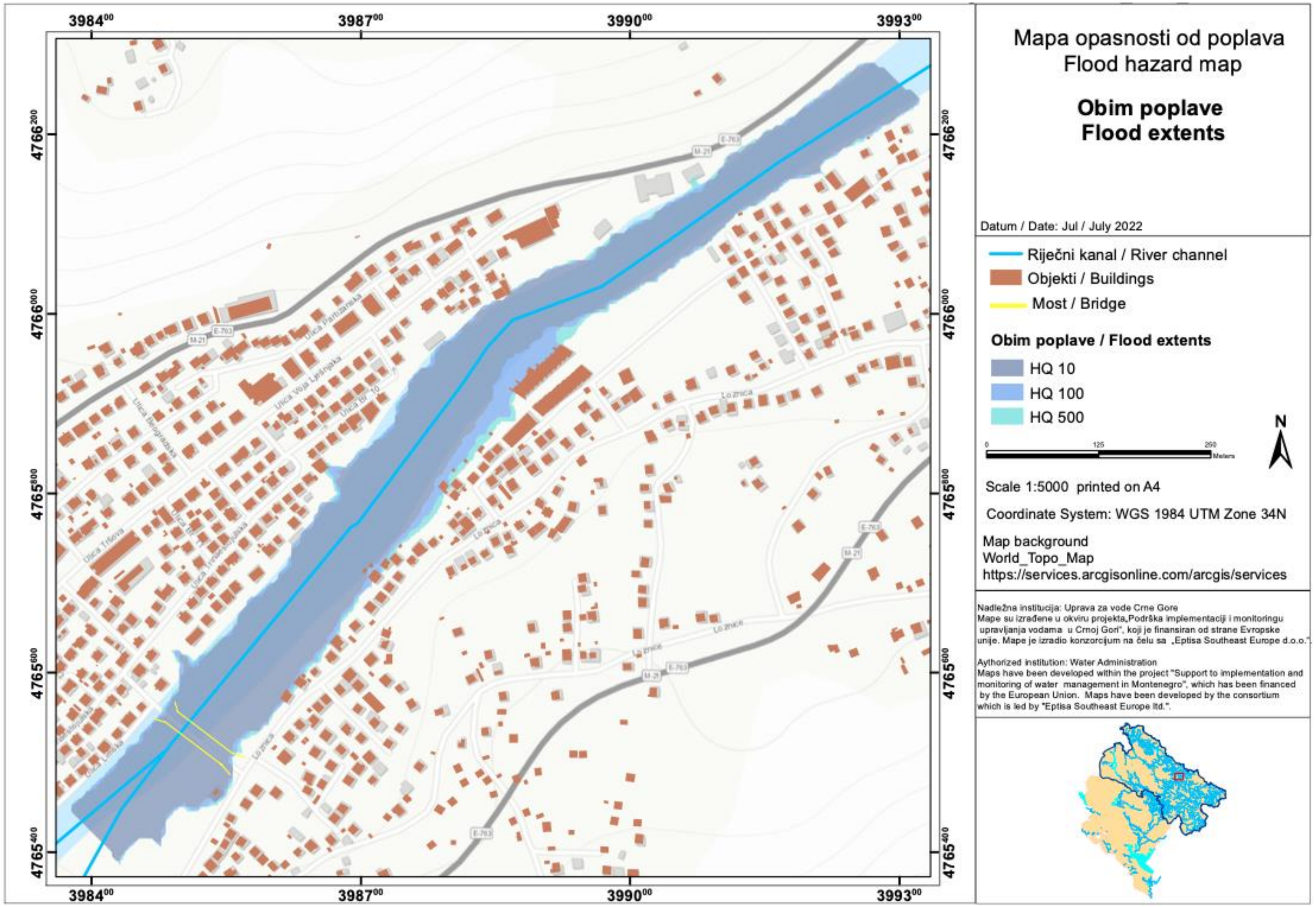


Figure 6.55. Inundation Depth (HQ500) for APSFR14_DRB_Lim08

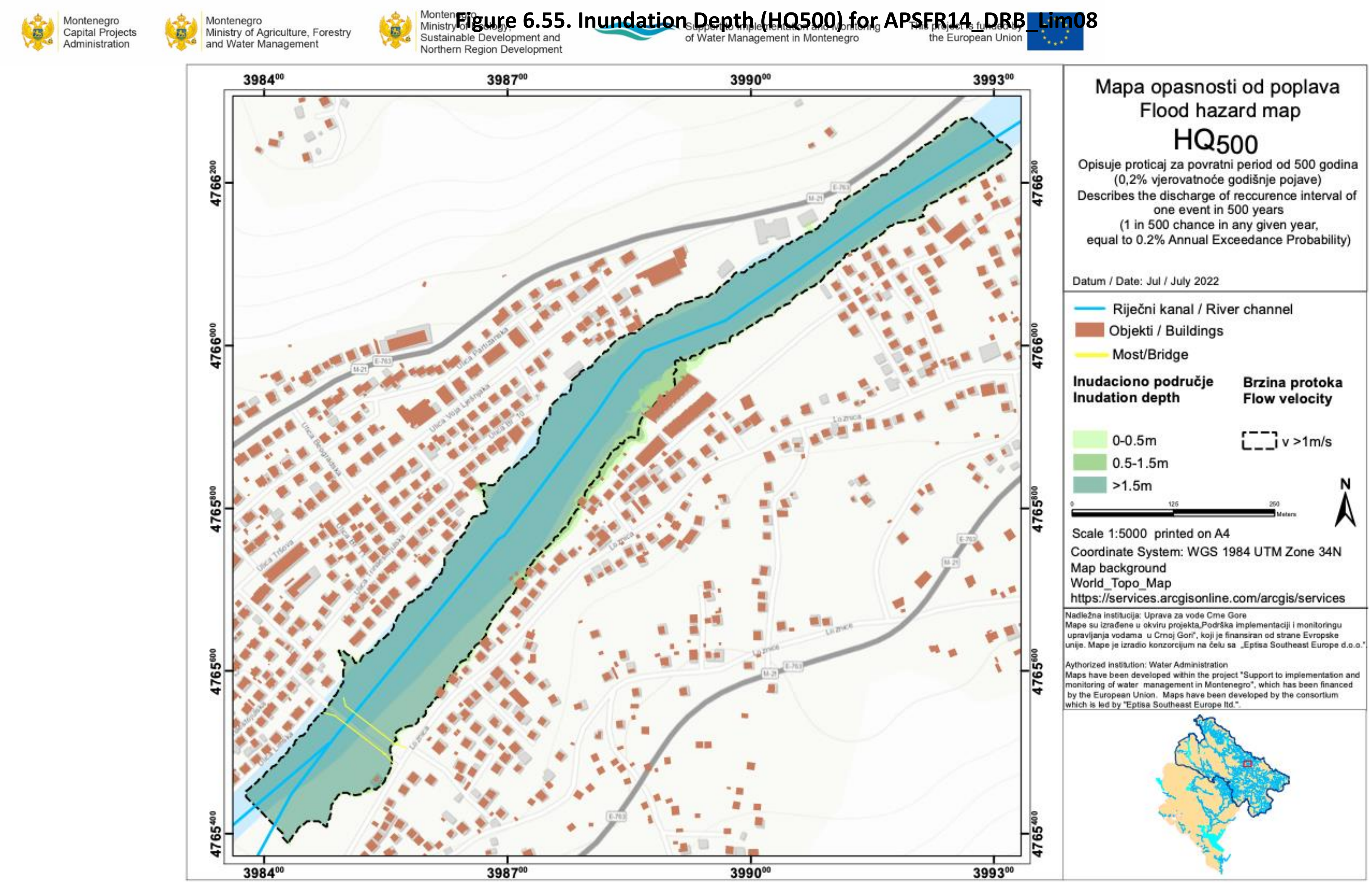


Figure 6.56. Flood Risk (HQ500) for APSFR14_DRB_Lim08

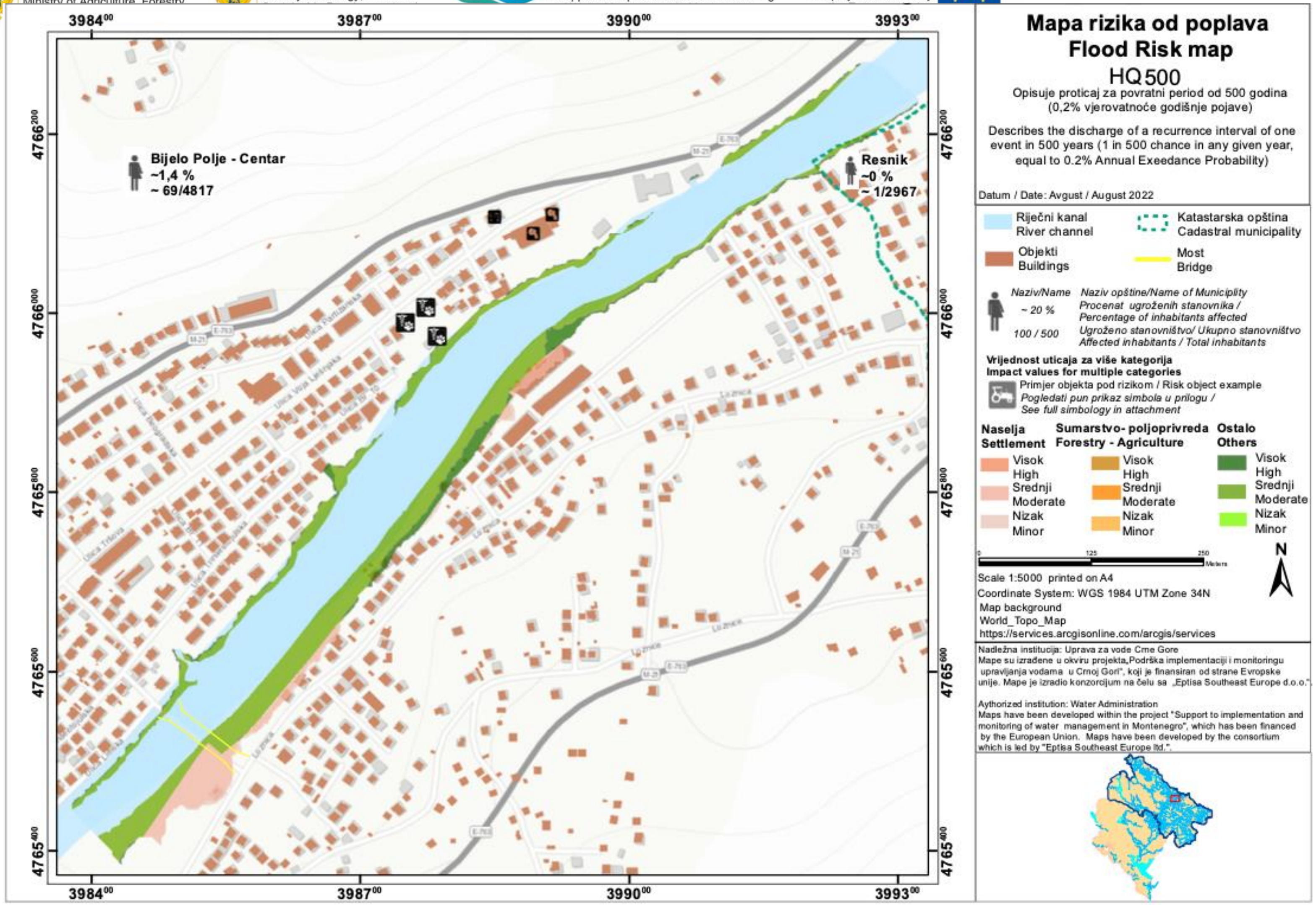


Table 6.32. Summary of flood risk in APSFR14_DRB_Lim08

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
LIm	LIm	Bijelo Polje	Lipnica	**HQ10**	9.31	53	11	0	0
				HQ100	10.28	64	19	0	0
				HQ500	10.76	70	27	0	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** – A40

Description of historical damage: No information available

Possibility of future significant damage[87]:	**Urbanization[88]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[89]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[87] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[88] Determination if significant adverse impacts would occur in the future due to urban development.
[89] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.17 APSFR15_DRB_Lim09

The location of APSFR15_DRB_Lim09 in the Danube River Basin is shown in Figure 6.57.

Figure 6.57. Location of APSFR15_DRB_Lim09

Hydrological data cover the proposed zone, which is the lowest part of Lim in Montenegro at the confluence with a large tributary of the river Bistrica. The APSFR is distinguished as follows:

Catchment Area: Lim; **River Tributary**: Lim

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	No data (A40).
Affected regions	Municipality of Bijelo Polje
Towns/Settlements	Gubavač, Konatari, Oljue, Sutivan

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.33 below and are available for download (via Google Drive).

Table 6.33. Flood hazard maps and flood risk maps prepared for APSFR15_DRB_Lim09

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.58 to 6.60 below provide examples of the flood hazard and flood risk maps for APSFR15_DRB_Lim09, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.58 together with inundations based on the HQ500 (Figure 6.59). The flood risk map for HQ500 is shown in Figure 6.60.

A summary of all potential risks are shown in Table 6.34.

Figure 6.58. Flood Extent for APSFR15_DRB_Lim09

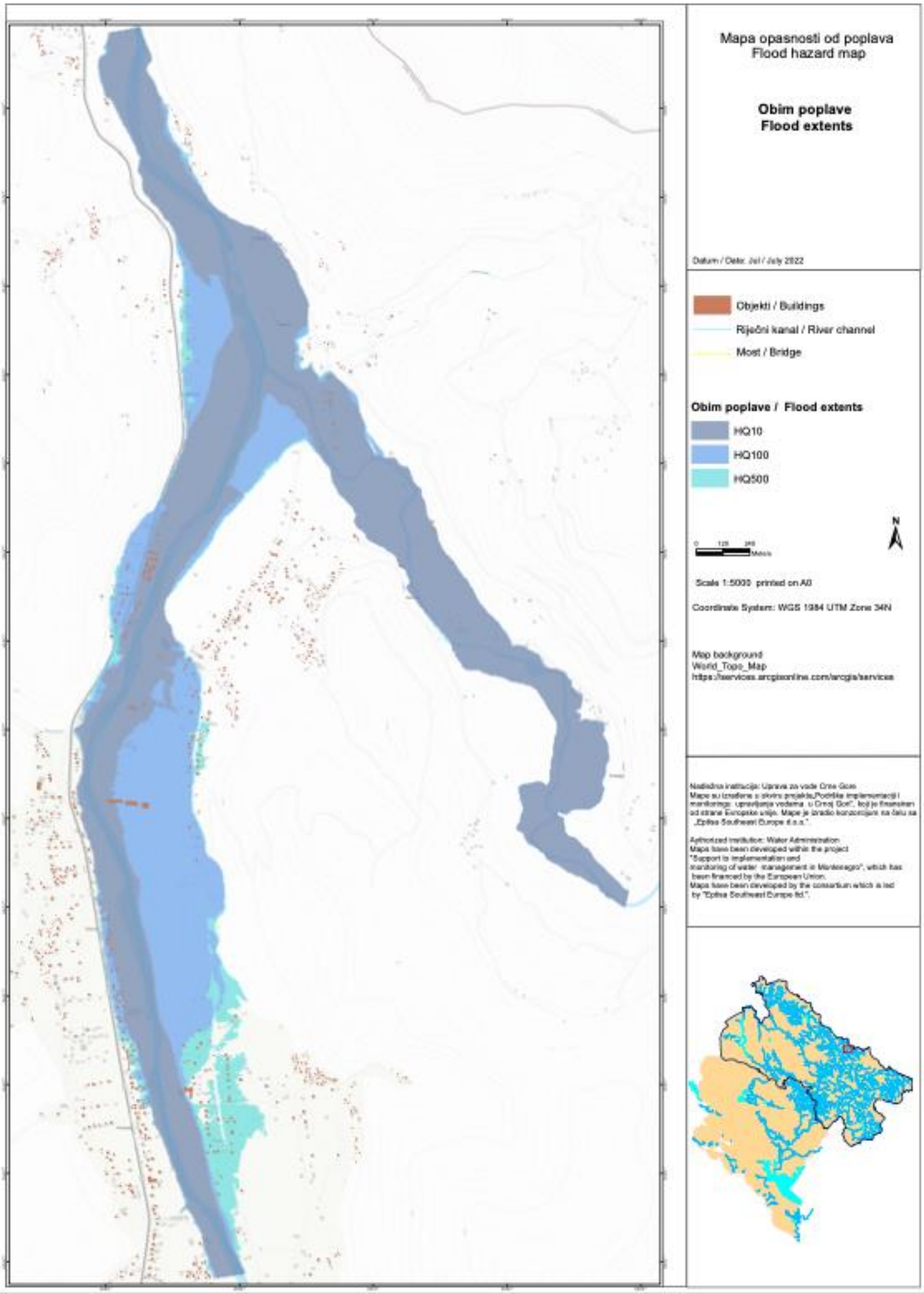


Figure 6.59. Inundation Depth (HQ500) for APSFR15_DRB_Lim09

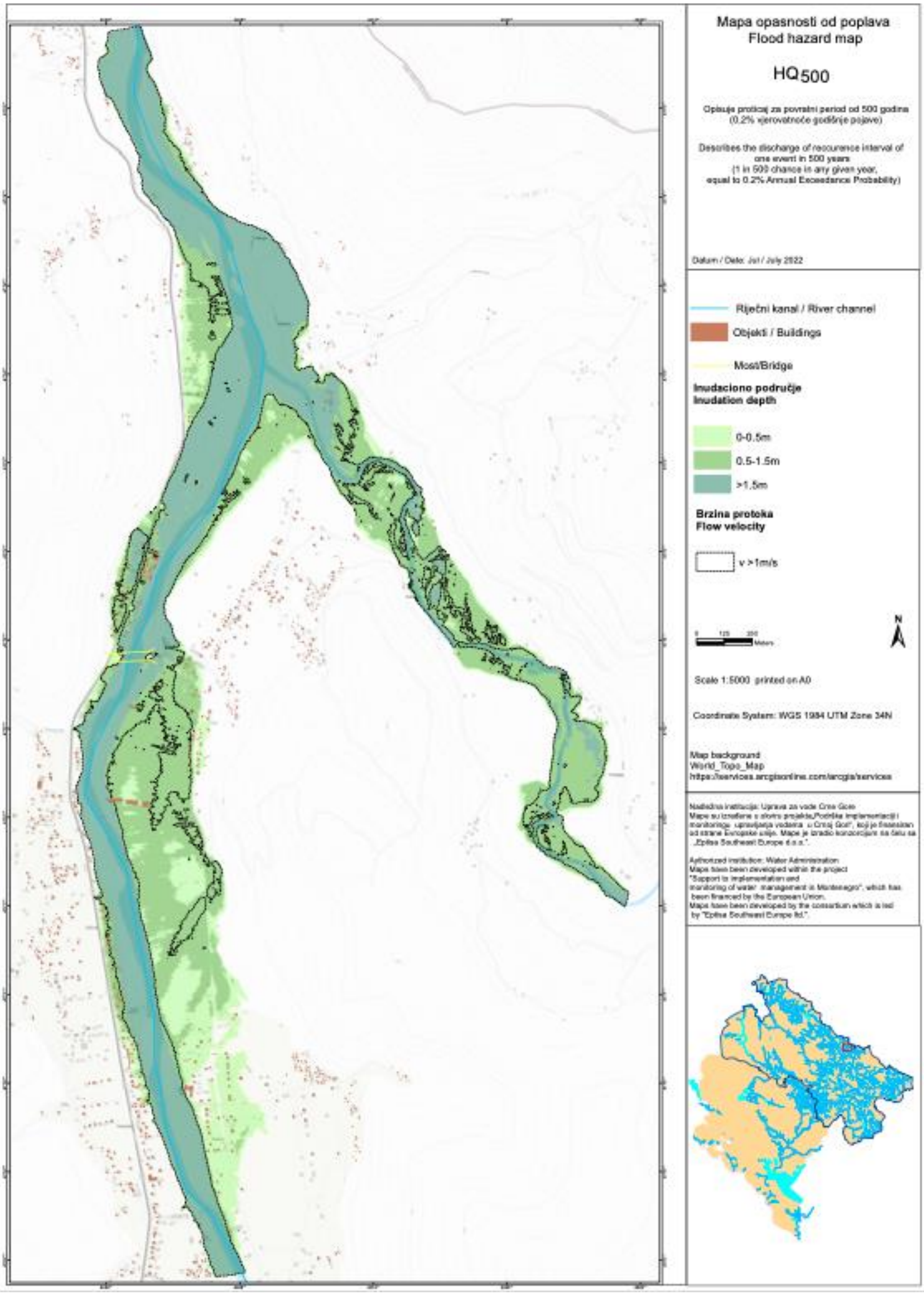


Figure 6.60. Flood Risk (HQ500) for APSFR15_DRB_Lim09

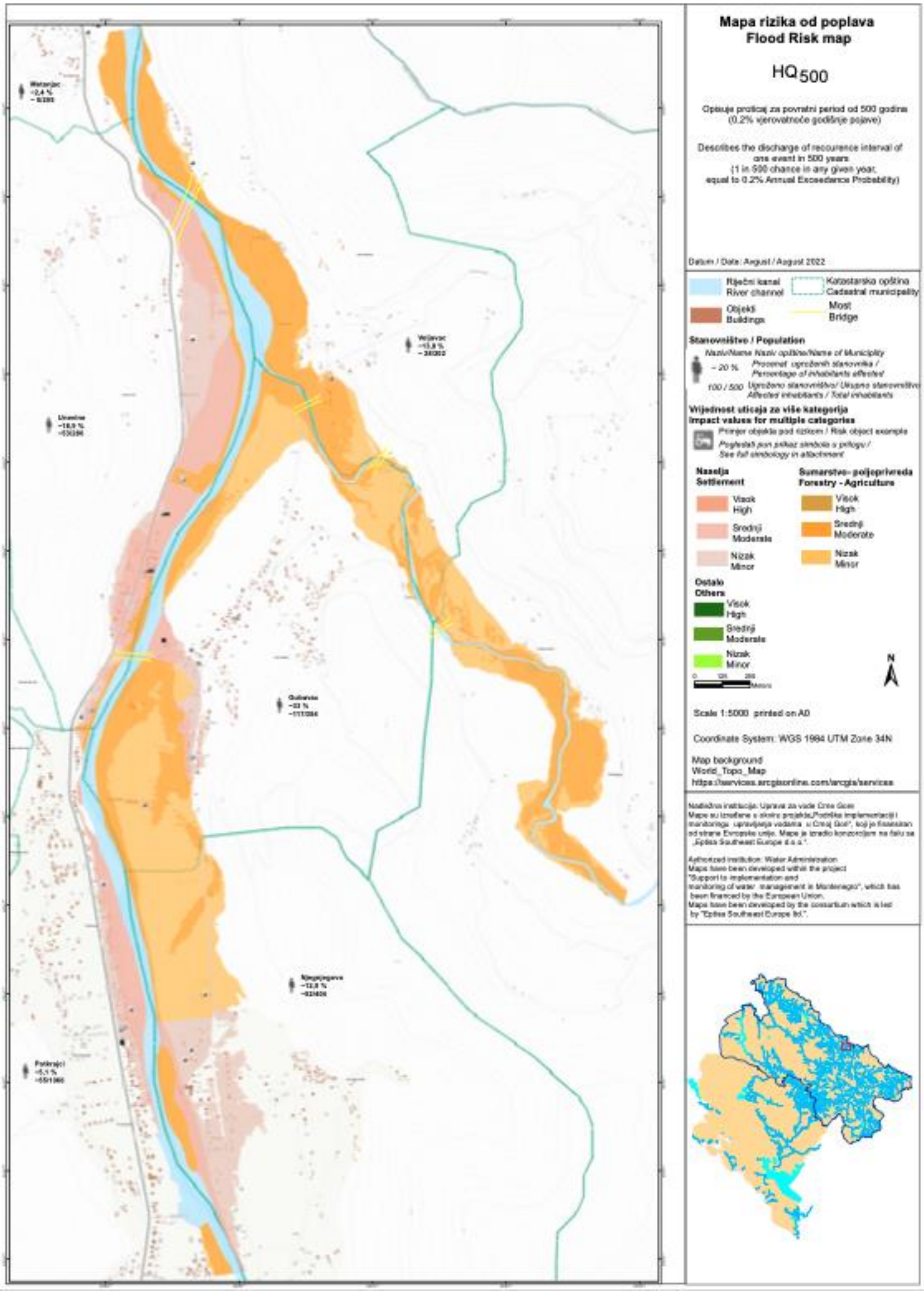


Table 6.34. Summary of flood risk in APSFR15_DRB_Lim09

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Lim	Lim	Bijelo Polje	Gubaac, Konatari, Oljue, Sutivan	**HQ10**	187.84	197	47	2	1
				HQ100	268.69	297	141	2	1
				HQ500	292.27	322	160	7	1

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** – A40

Description of historical damage: No information available

Possibility of future significant damage[90]:	**Urbanization[91]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[92]:

A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses	red	Contaminated sites	green	Nature Protected areas	green	UNESCO heritage sites	green
Settlement area	red	Locations of substances	green	Drinking Water supply areas	green	Other cultural heritage sites	red
Industrial objects	red	IED / PRTR-location	green	Bathing waters	green		
Industrial area	green						

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[90] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).

[91] Determination if significant adverse impacts would occur in the future due to urban development.

[92] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.18 APSFR16_DRB_Tara01

The location of APSFR16_DRB_Tara01 in the Danube River Basin is shown in Figure 6.61.

Figure 6.61. Location of APSFR16_DRB_Tara01

Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Tara; **River Tributary**: Tara

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (A31)
Affected regions	Municipality of Kolašin
Towns/Settlements	Kolašin, Donji Pažanj

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. (B44).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.35 below and are available for download (via Google Drive).

Table 6.35. Flood hazard maps and flood risk maps prepared for APSFR16_DRB_Tara01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.62 to 6.64 below provide examples of the flood hazard and flood risk maps for APSFR16_DRB_Tara01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.62 together with inundations based on the HQ500 (Figure 6.63). The flood risk map for HQ500 is shown in Figure 6.64.

A summary of all potential risks are shown in Table 6.36.

Figure 6.62. Flood Extent for APSFR16_DRB_Tara01

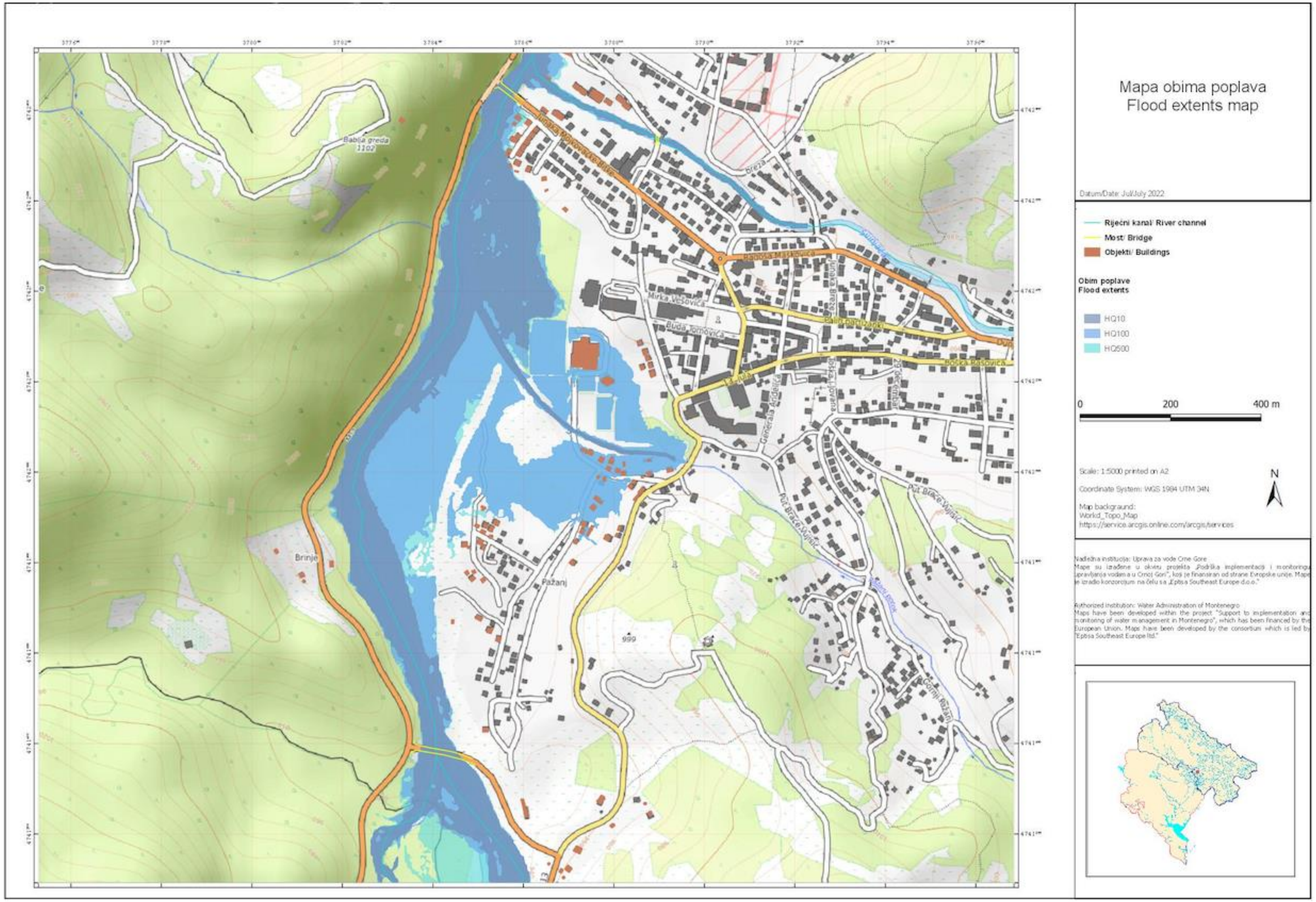


Figure 6.63. Inundation Depth (HQ500) for APSFR16_DRB_Tara01

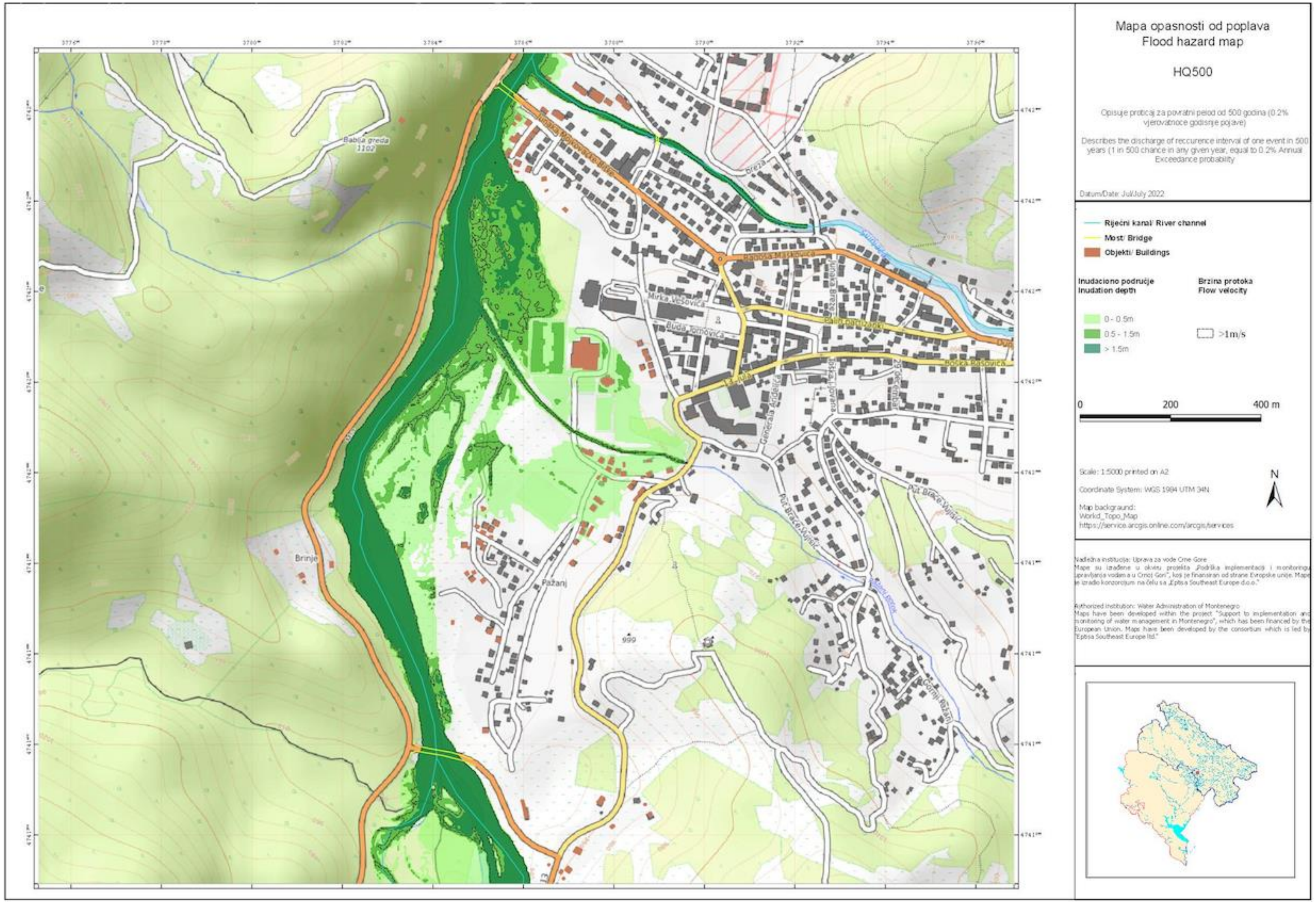


Figure 6.64. Flood Risk (HQ500) for APSFR16_DRB_Tara01

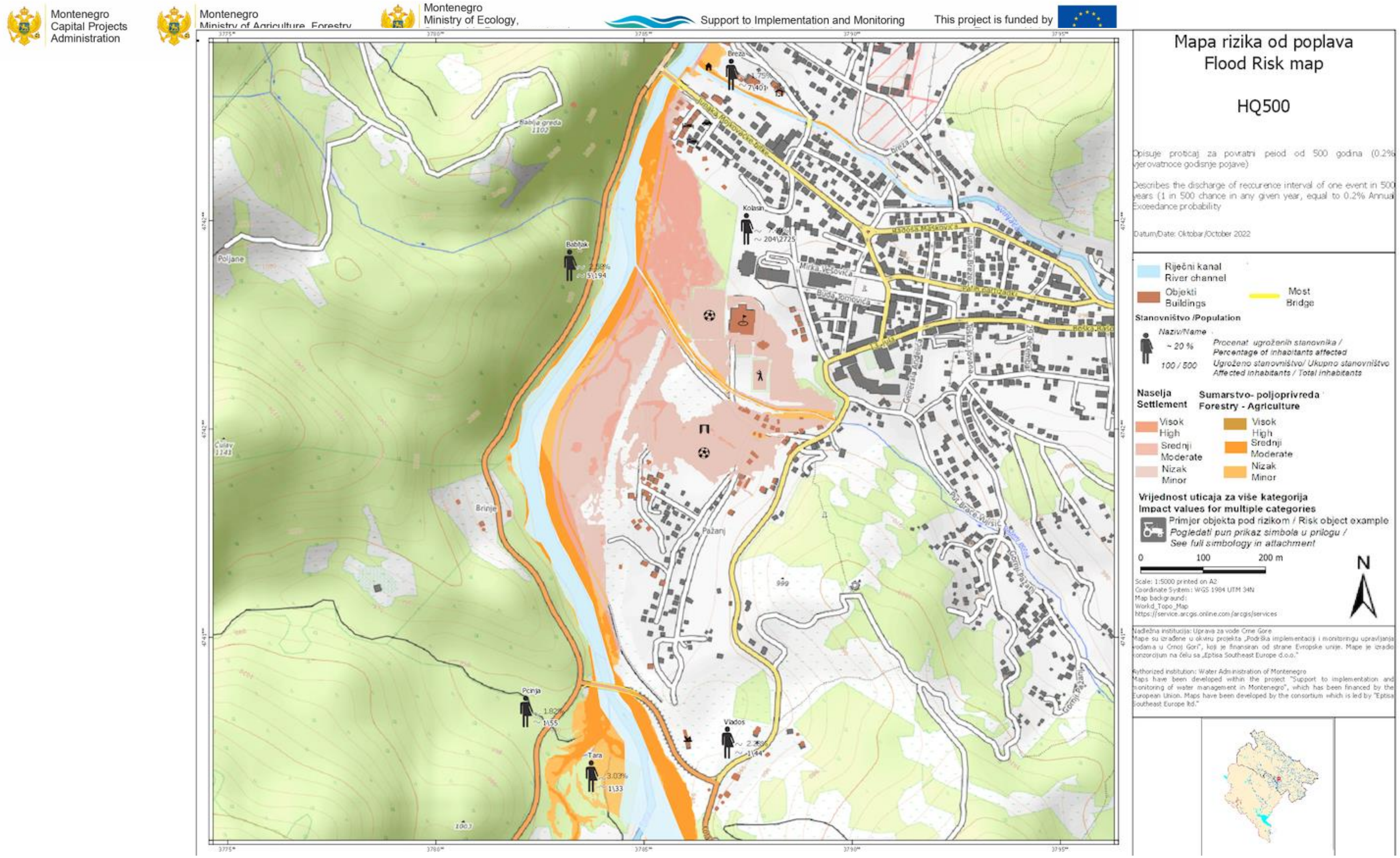


Table 6.36. Summary of flood risk in for APSFR16_DRB_Tara01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Tara	Tara	Kolašin	Kolašin, Donji Pažanj	**HQ10**	27.57	62	10	0	0
				HQ100	48.37	210	35	1	0
				HQ500	52.42	219	38	2	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A31

Description of historical damage: The settlement on Lug with about 50 residential buildings is endangered by the floods, as well as the sports zone with a sports hall and football and tennis courts. Also, the settlement near the bridge on Tara with about 15 residential buildings is endangered.

Possibility of future significant damage[93]:	Urbanization[94]: No	Declaring the area protected: No	Other Reasons: No

Risk assessment / Significance of potential risks[95]:

A) Human health, economic values		B1) Water polluting substances / sites		B2) Protected areas		C) Risk for cultural heritage sites	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

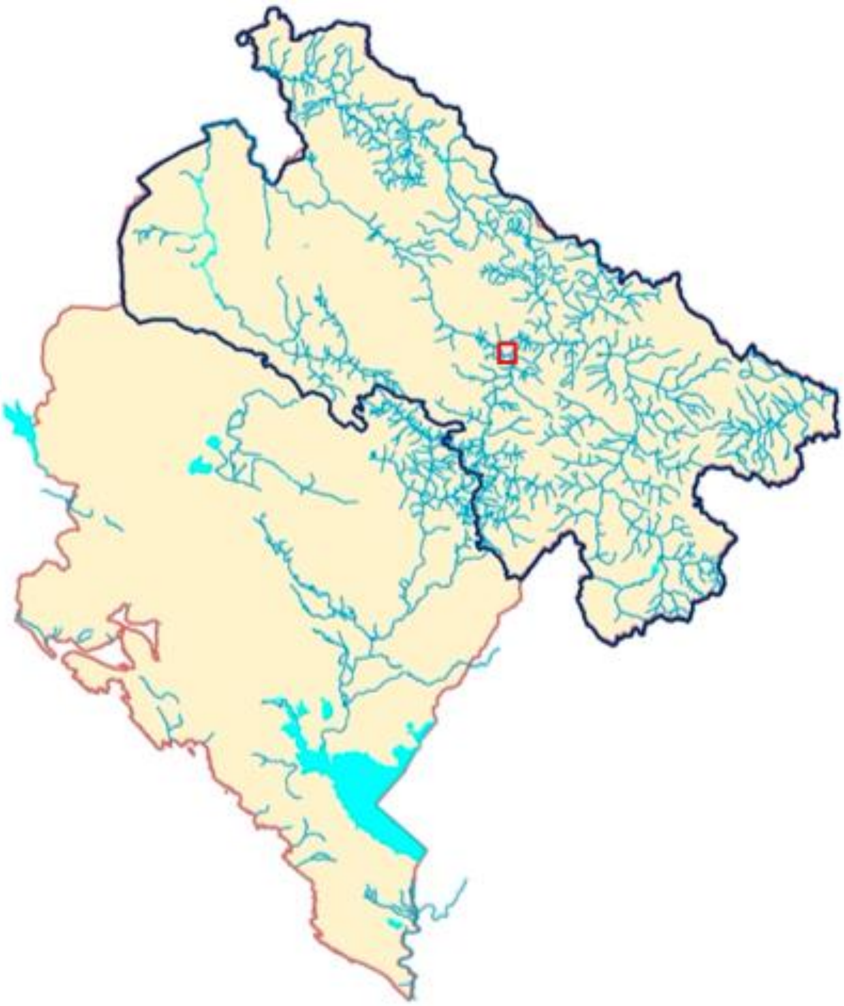
[93] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[94] Determination if significant adverse impacts would occur in the future due to urban development.
[95] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

Implemented by the consortium:

6.19 APSFR17_DRB_Tara02

The location of APSFR17_DRB_Tara02 in the Danube River Basin is shown in Figure 6.65.

Figure 6.65. Location of APSFR17_DRB_Tara02



Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Tara; **River Tributary**: Tara

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area (A31)
Affected regions	Municipality of Mojkovac
Towns/Settlements	Podbišće, Ambarine

Flood Risk	
Human Health	▪ Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction and fishing (B43)

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.37 below and are available for download (via Google Drive).

Table 6.37. Flood hazard maps and flood risk maps prepared for APSFR17_DRB_Tara02

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.66 to 6.68 below provide examples of the flood hazard and flood risk maps for APSFR17_DRB_Tara02, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.66 together with inundations based on the HQ500 (Figure 6.67). The flood risk map for HQ500 is shown in Figure 6.68.

A summary of all potential risks are shown in Table 6.38.

Figure 6.66. Flood Extent for APSFR17_DRB_Tara02

Figure 6.67. Inundation Depth (HQ500) for APSFR17_DRB_Tara02

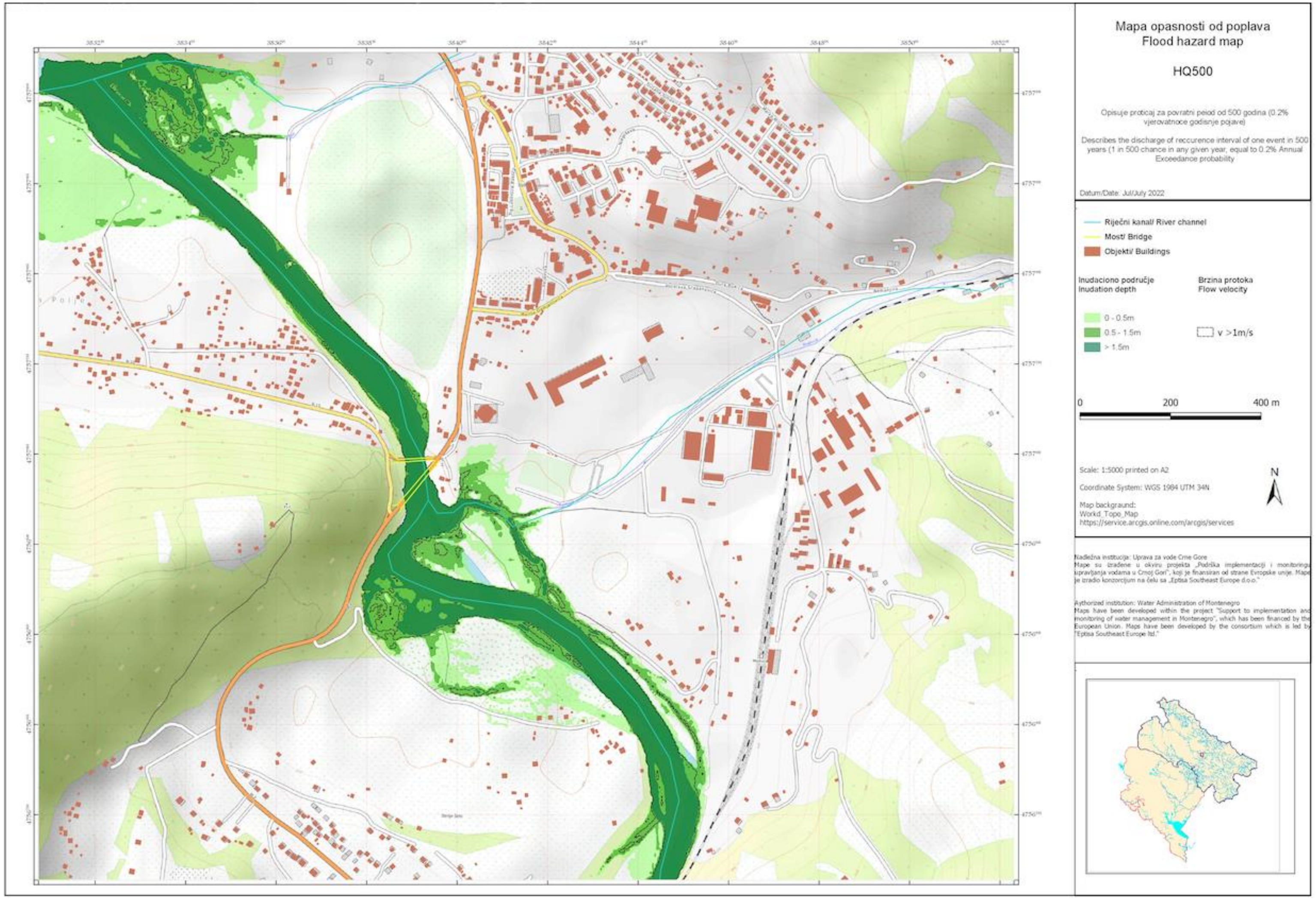


Figure 6.68. Flood Risk (HQ500) for APSFR17_DRB_Tara02

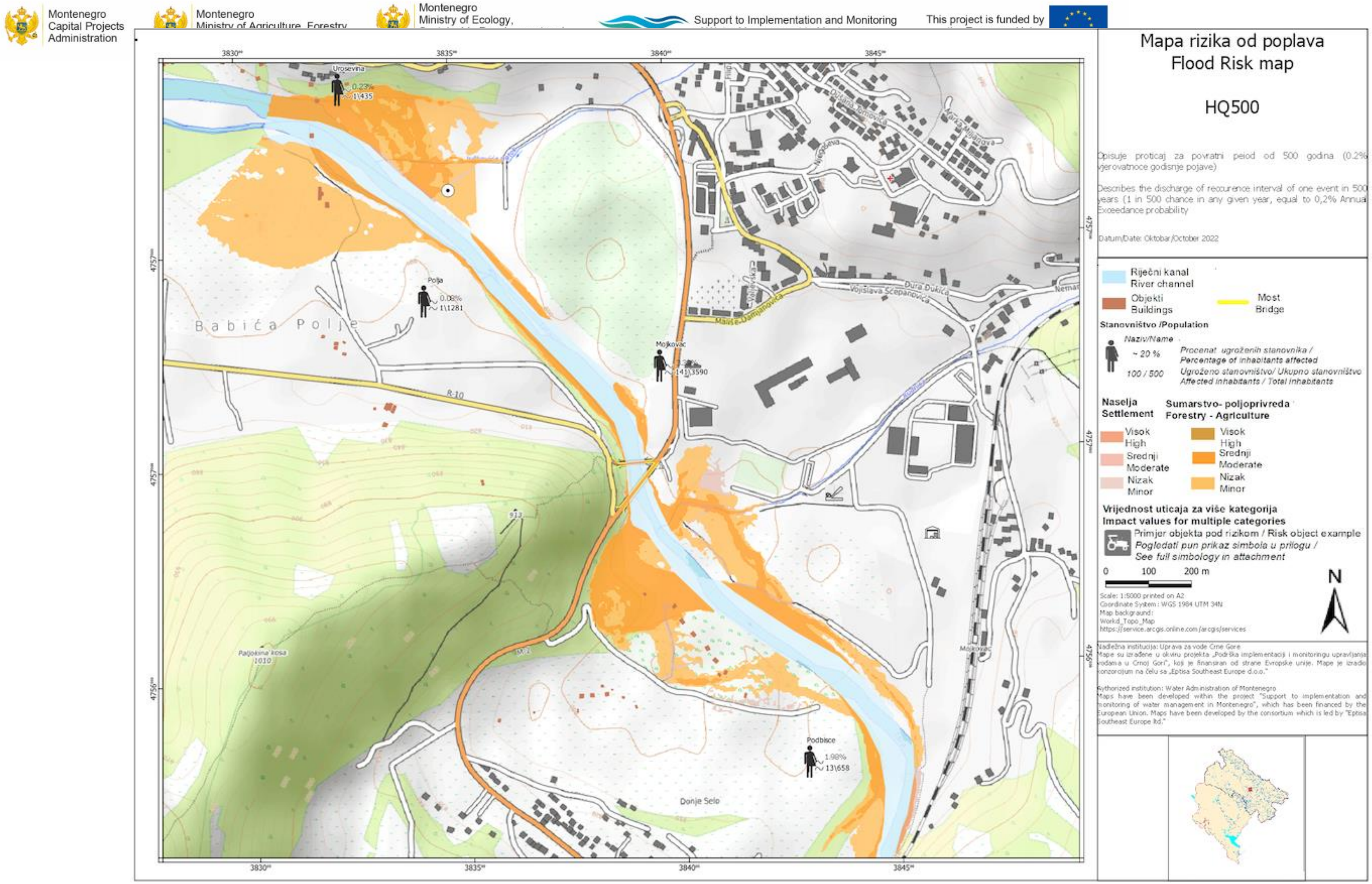


Table 6.38. Summary of flood risk in APSFR17_DRB_Tara02

Sub-Basin	River/ Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Tara	Tara	Mojkovac	Podbišće, Ambarine	**HQ10**	26.38	89	9	0	0
				HQ100	38.96	128	13	0	0
				HQ500	46.82	156	16	0	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A31

Description of historical damage: At the Podbišće location, six buildings may be endangered in the event of the Tara River overflowing. Borovnjački potok often knows how to swell, thus endangering the local road Mojkovac - Podbišće, five residential buildings and a small part of agricultural land. Due to the failure to maintain the culvert, there is a possibility of endangering the railway. In Ambarine a settlement above the railway with 15 apartments was flooded by stream that passes through that settlement. Also in Ambarine a settlement with 26 residential buildings may be endangered due to the overflow of the river Tara.

Possibility of future significant damage[96]:	Urbanization[97]: No	Declaring the area protected: No	Other Reasons: No

Risk assessment / Significance of potential risks[98]:

A) Human health, economic values		B1) Water polluting substances / sites		B2) Protected areas		C) Risk for cultural heritage sites	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

96 In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).

97 Determination if significant adverse impacts would occur in the future due to urban development.

98 According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.20 APSFR18_DRB_Breznica01

The location of APSFR18_DRB_Breznica01 in the Danube River Basin is shown in Figure 6.69.

Figure 6.69. Location of APSFR18_DRB_ Breznica01

Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Ćehotina; **River Tributary**: Breznica

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12).
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood (A34)
Affected regions	Municipality of Pljevlja
Towns/Settlements	Ševari

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	▪ Property: Adverse consequences to property, which could include homes (B41). ▪ Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction and fishing (B43)

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.39 below and are available for download (via Google Drive).

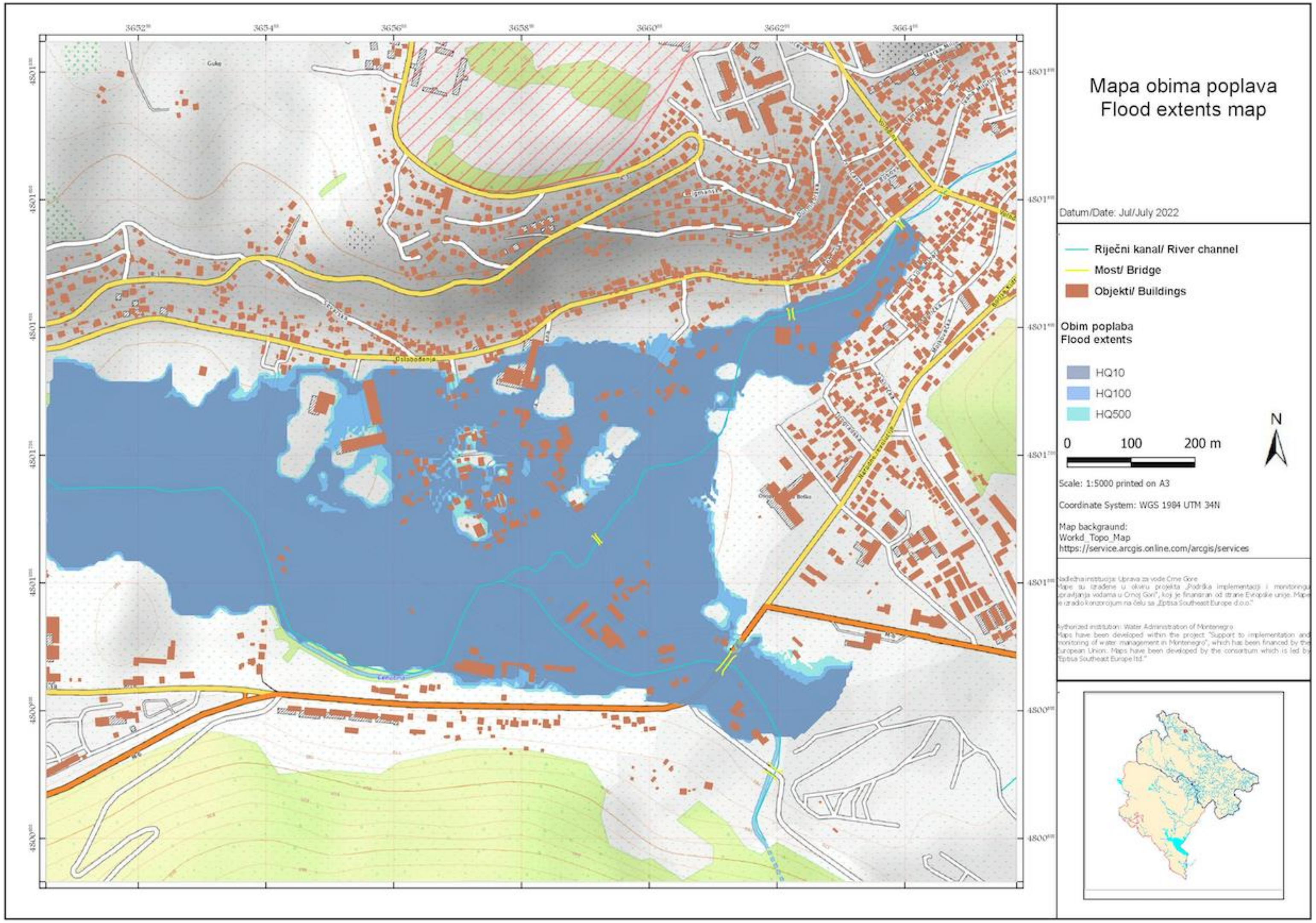
Table 6.39. Flood hazard maps and flood risk maps prepared for APSFR18_DRB_Breznica01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.70 to 6.72 below provide examples of the flood hazard and flood risk maps for APSFR18_DRB_Breznica01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.70 together with inundations based on the HQ500 (Figure 6.71). The flood risk map for HQ500 is shown in Figure 6.72.

A summary of all potential risks are shown in Table 6.40.

Figure 6.70. Flood Extent for APSFR18_DRB_Breznica01



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eptisa eptisa Southeast Europe d.o.o. suez

Figure 6.71. Inundation Depth (HQ500) for APSFR18_DRB_Breznica01

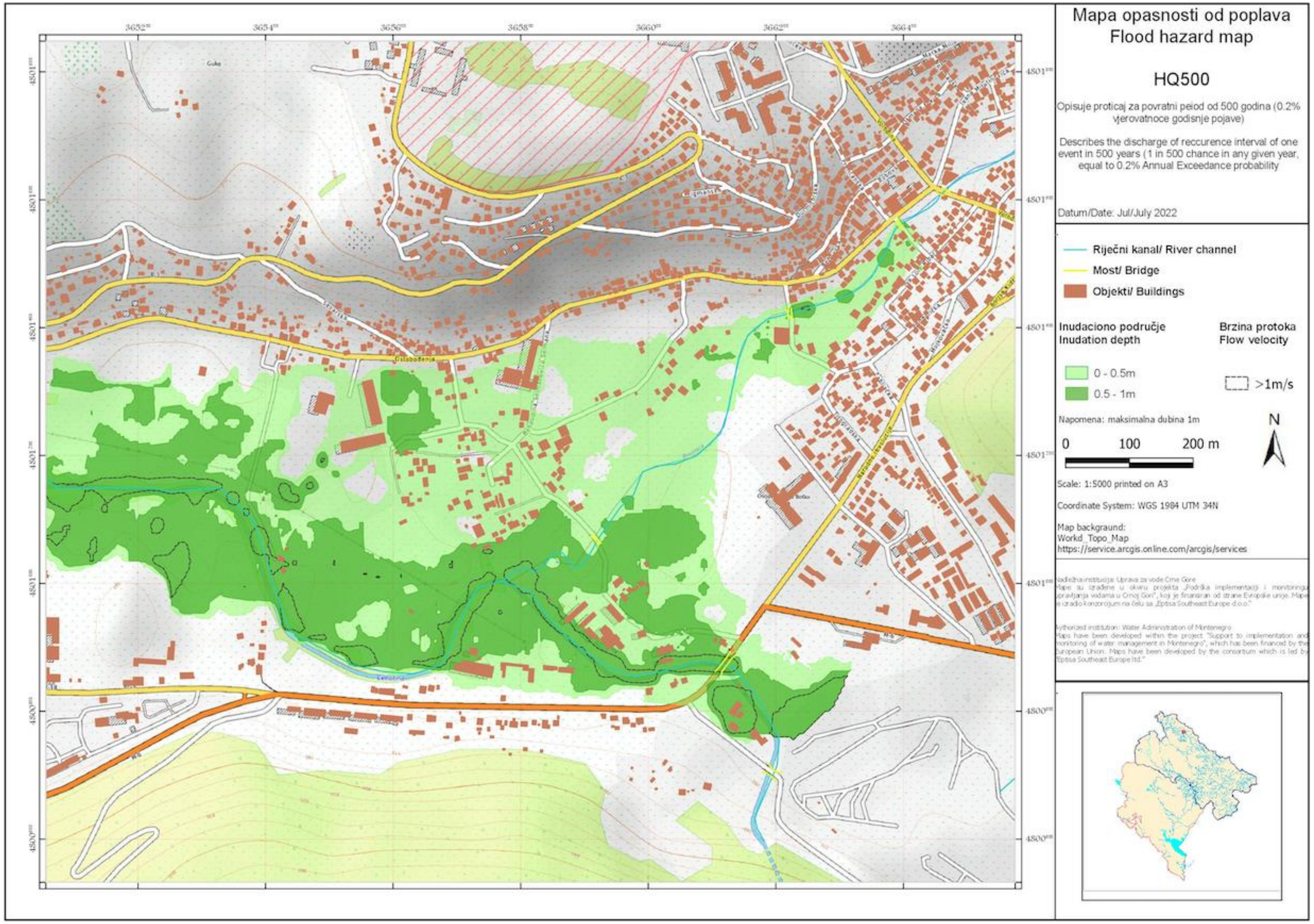

Figure 6.72. Flood Risk (HQ500) for APSFR18_DRB_Breznica01

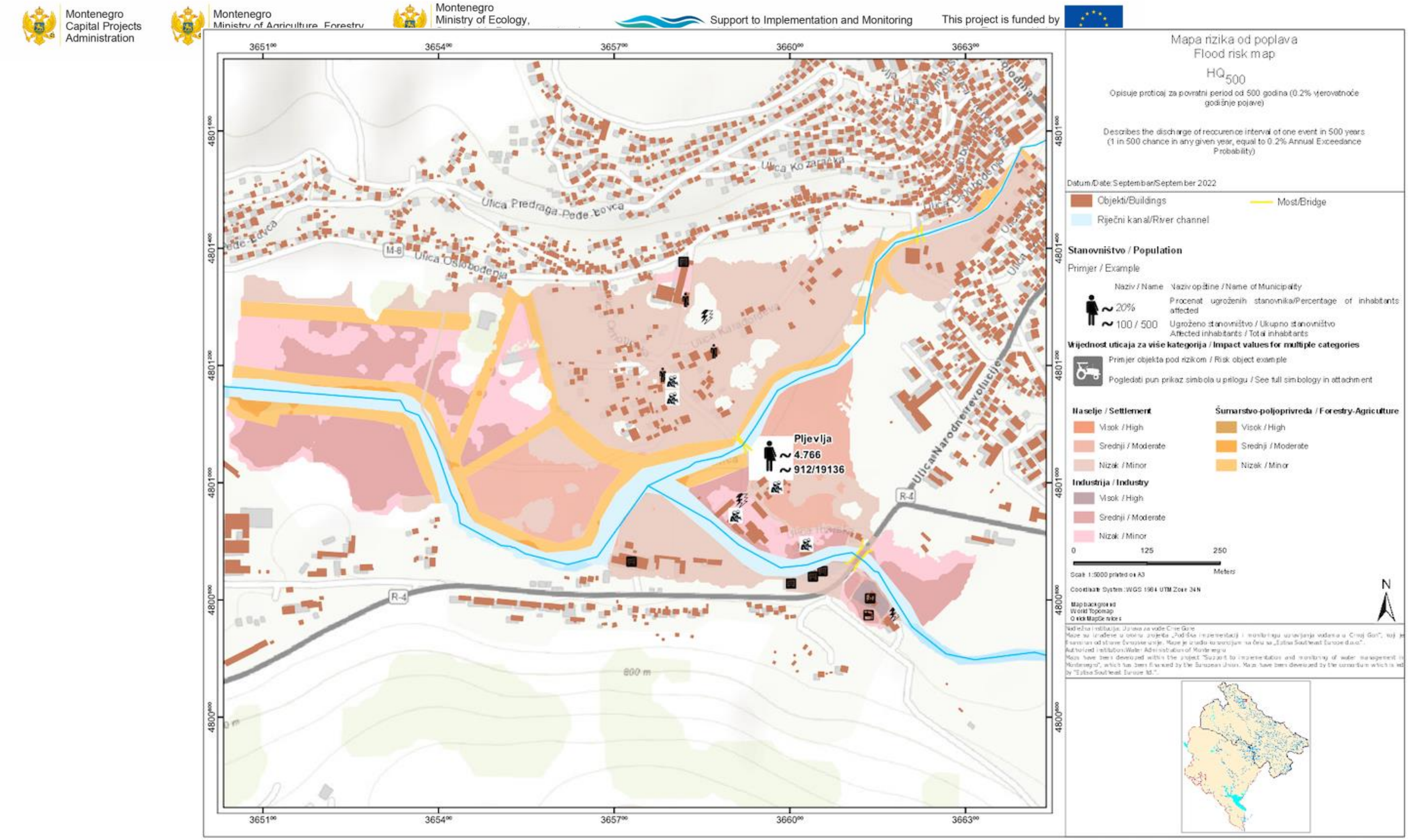

Table 6.40. Summary of flood risk in APSFR18_DRB_Breznica01

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Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Ćehotina	Breznica	Pljevlja	Ševari	**HQ10**	45.02	788	90	9	0
				HQ100	48.70	871	100	9	0
				HQ500	50.37	912	102	10	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; **M** - A21; **C** - A34

Description of historical damage: River Breznica in the part of the settlement Ševari in the length of 1300 m floods arable land, meadows, orchards, auxiliary and residential buildings owned by locals.

Possibility of future significant damage[99]:	**Urbanization[100]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[101]:

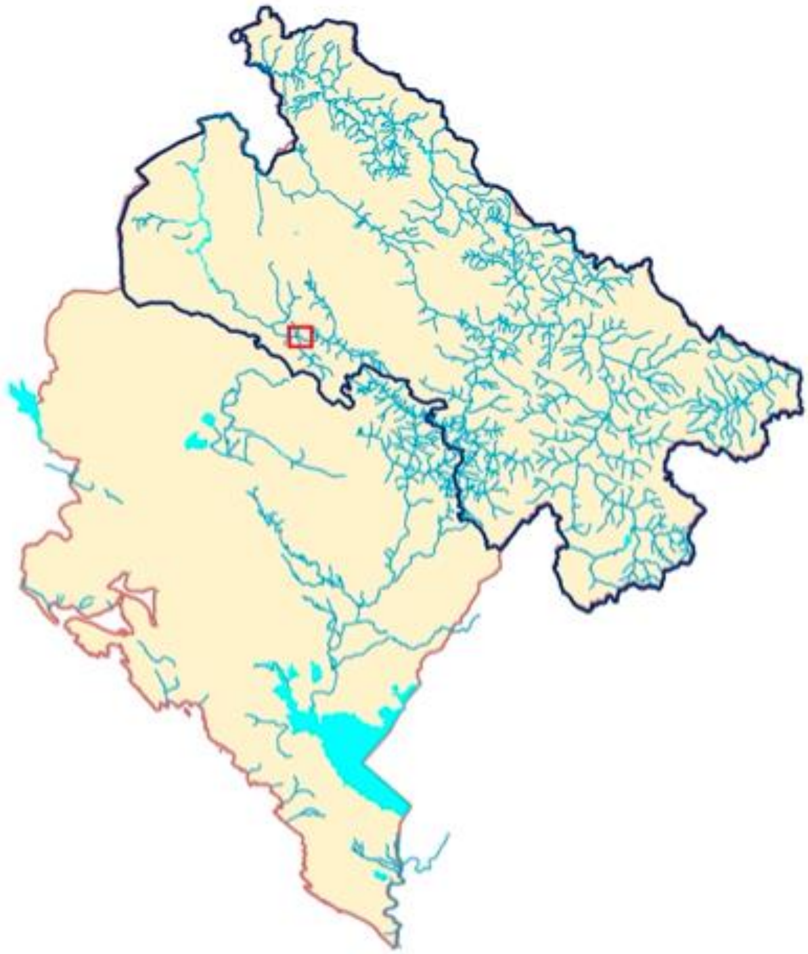
A) Human health, economic values		**B1) Water polluting substances / sites**		**B2) Protected areas**		**C) Risk for cultural heritage sites**	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

99 In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
100 Determination if significant adverse impacts would occur in the future due to urban development.
101 According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

6.21 APSFR19_DRB_Bukovica i Bijela01

The location of APSFR19_DRB_Bukovica and Bijela01 in the Danube River Basin is shown in Figure 6.73.

Figure 6.73. Location of APSFR19_DRB_Bukovica i Bijela01



Hydrological data cover the APSFR, which is distinguished as follows:

Catchment Area: Piva; **River Tributary**: Bukovica i Bijelac

Flood Hazard	
Flood Source	Fluvial (A11)
Flood Mechanism	Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands (A21).
Flood Characteristics	No data (A40).
Affected regions	Municipality of Šavnik
Towns/Settlements	Šavnik

Flood Risk	
Human Health	Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities (B11).
Environment	N/A
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

Flood risk and flood hazard maps at a scale of 1:5,000 have been prepared according to Table 6.41 below and are available for download (via Google Drive).

Table 6.41. Flood hazard maps and flood risk maps prepared for APSFR19_DRB_Bukovica and Bijela01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps			
Flood Extent			
HQ10, 100 and 500 Combined	Download	Download	Download
Inundation Depth			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download

Figures 6.74 to 6.76 below provide examples of the flood hazard and flood risk maps for APSFR19_DRB_Bukovica and Bijela01, which includes the combined flood extent at HQ10, HQ100 and HQ500 shown in Figure 6.74 together with inundations based on the HQ500 (Figure 6.75). The flood risk map for HQ500 is shown in Figure 6.76.

A summary of all potential risks are shown in Table 6.42.

Figure 6.74. Flood Extent for APSFR19_DRB_Bukovica i Bijela01

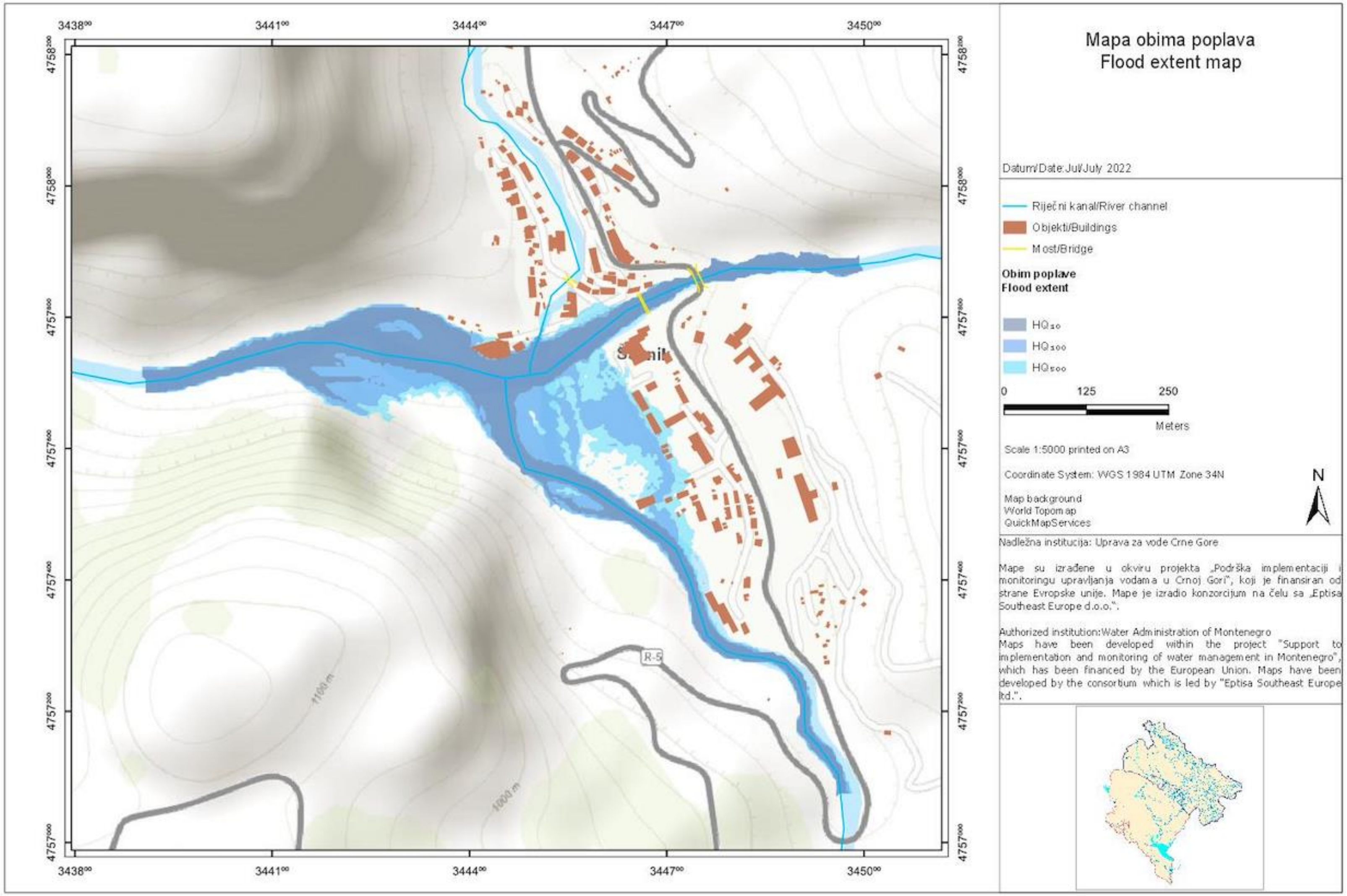


Figure 6.75. Inundation Depth (HQ500) for APSFR19_DRB_Bukovica i Bijela01

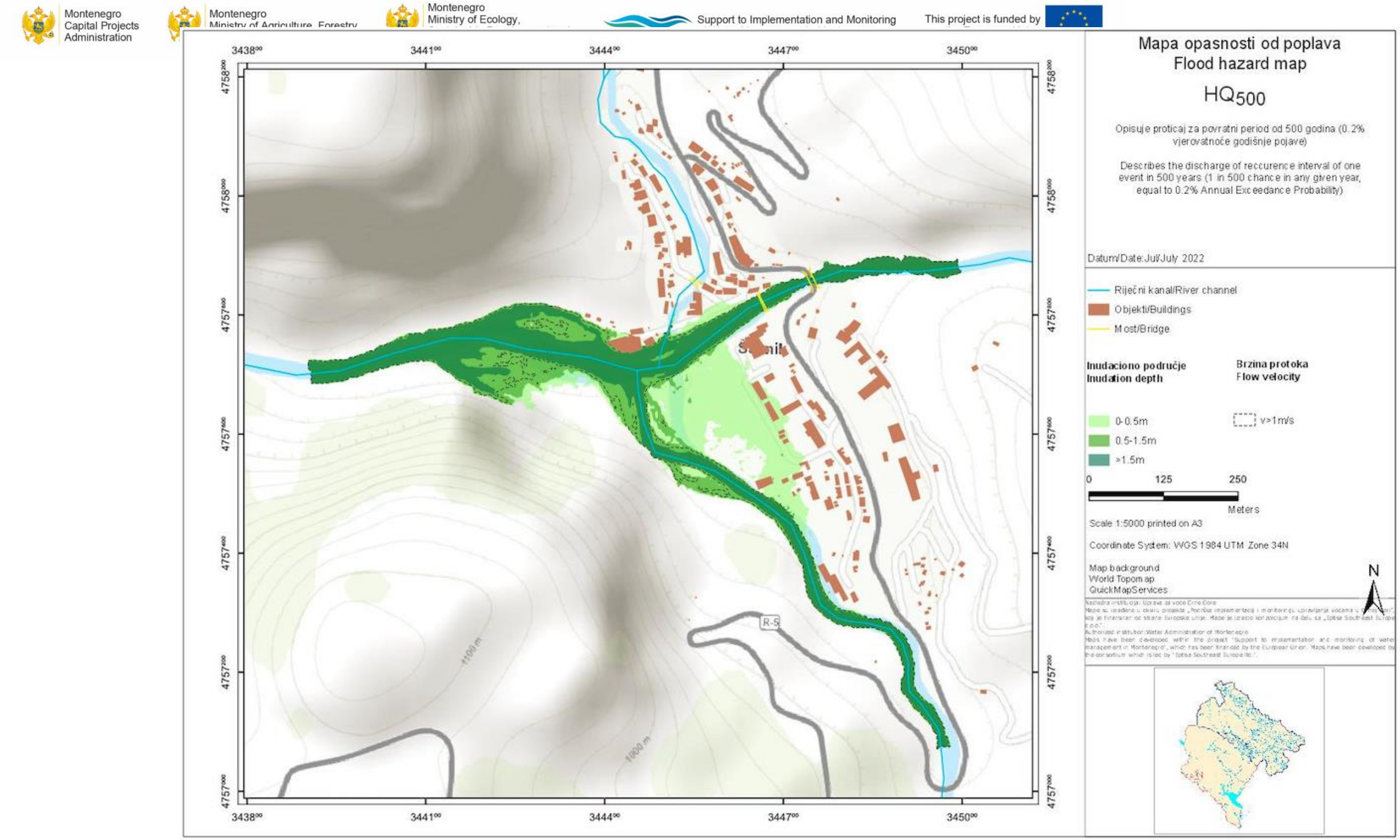


Figure 6.76. Flood Risk (HQ500) for APSFR19_DRB_Bukovica i Bijela01

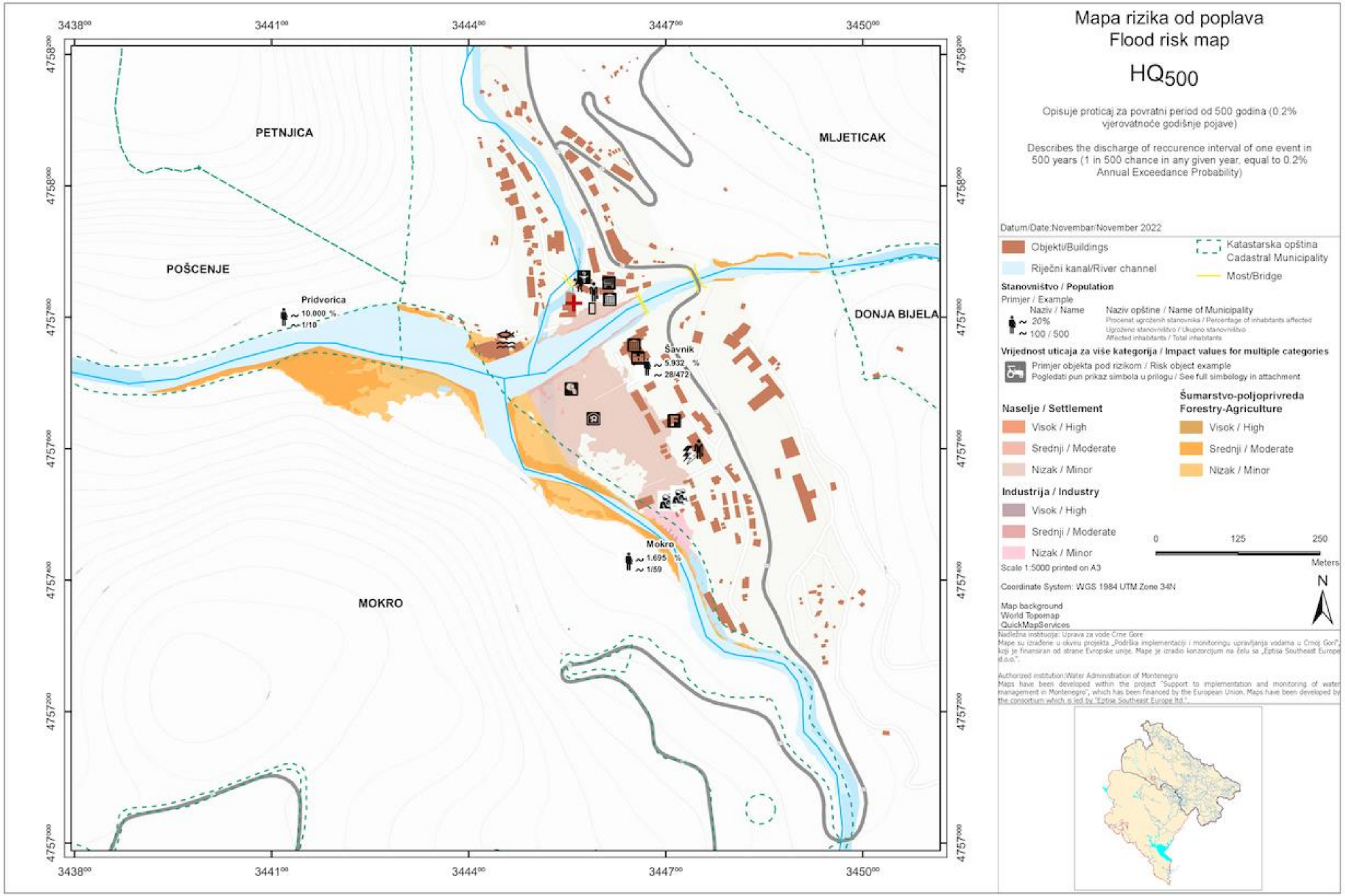


Table 6.42. Summary of flood risk in APSFR19_DRB_Bukovica and Bijela01

Sub-Basin	River/Tributary	Admin. Region	Settlements/ villages at risk	Flood Return Period	Area at risk (ha)	No. of inhabitants at risk	No. of buildings at risk	No of commercial businesses at risk	No. of cultural objects at risk
Piva	Bukovica i Bijela	Šavnik	Šavnik	**HQ10**	7.47	14	3	0	0
				HQ100	11.16	22	5	0	0
				HQ500	13.56	30	13	0	0

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11; **M** - A21; **C** - A40

Description of historical damage: No information available

Possibility of future significant damage[102]:	**Urbanization[103]**: No	**Declaring the area protected**: No	**Other Reasons**: No

Risk assessment / Significance of potential risks[104]:

A) Human health, economic values		B1) Water polluting substances / sites		B2) Protected areas		C) Risk for cultural heritage sites	
No. of houses		Contaminated sites		Nature Protected areas		UNESCO heritage sites	
Settlement area		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		IED / PRTR-location		Bathing waters			
Industrial area							

[102] In accordance with Article 3 (3) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan (OG", No. 069/15).
[103] Determination if significant adverse impacts would occur in the future due to urban development.
[104] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk Assessment and the Flood Risk Management Plan ("OG", No. 069/15 of 14.12.2015).

Implemented by the consortium:

Conclusions drawn from the maps

The flood hazard and flood risk maps detail the affected areas in 19 APSFR in the Danube River Basin. A description of the potential risks/assets in the area of the flooding together with the significance of the potential risks in relation to human health, environmental, economic and cultural criteria are presented for a high (HQ10), medium (HQ100) and low risk (HQ500) flooding event for each APSFR.

Table 6.43 shows the number of inhabitant, dwellings, commercial businesses and cultural objects at risk together with the total surface area inundated in each APSFR for high (HQ10), medium (HQ100) and low probability (HQ500) flooding events. For the Danube River Basin as a whole, the following information was calculated:

- **High probability flood event** (HQ10): a total of 646 hectares would be inundated with 4,753 inhabitants, 890 dwellings, 22 commercial businesses and 1 cultural object at risk.
- **Medium probability flood event** (HQ100): a total of 880 hectares would be inundated with 5,898 inhabitants, 1,302 dwellings, 35 commercial businesses and 3 cultural objects at risk.
- **Low probability flood event** (HQ500): a total of 966 hectares would be inundated with 6,657 inhabitants, 1,637 dwellings, 56 commercial businesses and 5 cultural objects at risk.

Table 6.44 provides a summary of the risk assessment for each APSFR, which is based on significance criteria and threshold values previously defined in Section 5 (Table 5.4). These values identify potentially significant issues in each APSFR related to human health, economic values, environmental risks and risks to cultural heritage sites. Data in Table 6.44 clearly shows that all APSFR are at risk with respect to inhabitants and settlement areas. 5 of the 19 APSFR show a risk to industrial objects. Three APSFR are at risk for cultural heritage sites. No environmental risks are observed.

Increased urbanization in APSFR10_DRB_Lim04, which covers Hareme, Rudeš and Talum in Berane, would be expected to have a negative impact in the event of future floods. Therefore, this information should be taken seriously in future spatial planning.

Table 6.43. Summary of risks to inhabitant, dwellings, commercial businesses and cultural objects at risk together with the total surface area inundated in APSFR for high (HQ10), medium (HQ100) and low risk (HQ500) flooding events.

APSFR	No. of People at Risk			No. of Dwellings at Risk			No. of Commercial Businesses at Risk			No. of Cultural Objects at Risk			Calculated Total Flooded Area (ha)		
	HQ10	HQ100	HQ500	HQ10	HQ100	HQ500	HQ10	HQ100	HQ500	HQ10	HQ100	HQ500	HQ10	HQ100	HQ500
1_DRB_Ibar01	363	564	895	45	57	180	7	10	24	0	1	3	9.85	14.76	22.38
2_DRB_Ibarac01	30	81	143	27	57	72	0	1	1	0	0	0	0.96	2.45	3.98
3_DRB_Lovnička rijeka01	89	168	230	68	106	134	0	2	2	0	1	1	4.57	7.96	10.87
4_DRB_Županica01	38	81	95	25	56	59	1	3	3	0	0	0	32.04	59.14	63.53
5_DRB_Grnčar01	150	289	318	63	128	175	0	1	1	0	0	0	56.6	107.17	123.13
6_DRB_Vruja01	59	70	73	43	45	47	0	0	0	0	0	0	39.61	42.07	43.32
7_DRB_Lim01	113	151	186	43	59	81	0	0	0	0	0	0	13.29	15.32	16.72
8_DRB_Lim02	49	59	66	11	15	25	0	0	0	0	0	0	19.08	23.71	26.92
9_DRB_Lim03	21	22	22	4	4	9	1	2	2	0	0	0	66	70.67	71.78
10_DRB_Lim04	2393	2556	2639	300	334	344	2	2	2	0	0	0	52.92	57.52	59.61
11_DRB_Lim05	86	88	90	8	21	35	0	1	1	0	0	0	23.42	26.81	29.83
12_DRB_Lim06	59	65	70	17	25	36	0	0	0	0	0	0	11.93	12.92	13.62
13_DRB_Lim07	100	112	121	66	82	84	0	1	1	0	0	0	12.37	13.33	14.04
14_DRB_Lim08	53	64	70	11	19	27	0	0	0	0	0	0	9.31	10.28	10.76
15_DRB_Lim09	197	297	322	47	141	160	2	2	7	1	1	1	187.84	268.69	292.27
16_DRB_Tara01	62	210	219	10	35	38	0	1	2	0	0	0	27.57	48.37	52.42
17_DRB_Tara02	89	128	156	9	13	16	0	0	0	0	0	0	26.38	38.96	46.82
18_DRB_Breznica01	788	871	912	90	100	102	9	9	10	0	0	0	45.02	48.7	50.37
19_DRB_Bukovica i Bijela01	14	22	30	3	5	13	0	0	0	0	0	0	7.47	11.16	13.56
Total for Danube River Basin	**4753**	**5898**	**6657**	**890**	**1302**	**1637**	**22**	**35**	**56**	**1**	**3**	**5**	**646.23**	**879.99**	**965.93**

Table 6.44. Summary Risk Assessment[105]

APSFR in Danube River Basin	Human Health, Economic Values				Environmental Risks: Water Polluting Substances / Sites			Environmental Risks: Protected Areas			Risk for Cultural Heritage Sites	
	No. of Houses	Settlement Area	Industrial objects	Industrial Area	Polluted Sites	Location of Specific Substances	IED / PRTR-location	Nature Protected areas	Drinking Water supply areas	Bathing waters	UNESCO heritage sites	Other cultural heritage sites
1_ Ibar01												
2_Ibarac01												
3_Lovnička rijeka01												
4_Županica01												
5_Grnčar01												
6_Vruja01												
7_Lim01												
8_Lim02												
9_Lim03												
10_Lim04												
11_Lim05												
12_Lim06												
13_Lim07												
14_Lim08												
15_Lim09												
16_Tara01												
17_Tara02												
18_Breznica01												
19_Bukovica i Bijela01												

[105] According to threshold of significance criteria detailed in Section 5 (Table 5.4). The **red colour indicates a value equal to or above the threshold criteria, while green indicates a value below the threshold criteria**. Risk assessment is in accordance with Article 3 (2) of the Rulebook on the Closer Content of the Preliminary Flood Risk.

7 OBJECTIVES OF THE FLOOD RISK MANAGEMENT IN THE DANUBE RIVER BASIN

7.1 Introduction

The FRMP needs to set objectives for the management of flood risk from all sources of flooding.

The Objectives set out what needs to be achieved and, in accordance with the requirements of the Floods Directive to:

- Reduce the likelihood of flooding; and,
- Reduce the adverse consequences of flooding for human health, economic activity and the environment including cultural heritage.

The FRMP provides a focus on managing flood risk within the ASPFRs. Based on the FRMP, objectives will be set in consultation with stakeholders to manage flood risk and identify the most sustainable combination of measures to meet the objectives.

Objectives of the Flood risk management of mutual interest on the Danube River Basin level, which are based on the Directive 2007/60/EC on the assessment and management of flood risks, Preliminary Flood Risk Assessment and other relevant documents are as follows:

1. Avoidance of new flood risks
2. Reduction of existing flood risks (during and after the floods)
3. Strengthening resilience, i.e. reducing the likelihood of flooding and reducing the adverse consequences of flooding for human health, economic activity and the environment including cultural heritage.
4. Raising awareness about flood risks
5. Implementing the solidarity principle

7.2 Avoidance of new flood risks

By creating a balance between the development and use of space in areas with the highest flood risk, and cooperation between the competent spatial planning institution - Ministry of ecology, spatial planning and urbanism and flood risk management institutions – Ministry of Agriculture, Forestry and Water Management and Water Administration, it is possible to avoid new risks or to reduce them to an acceptable level. Flood risks and potential risks should be identified and considered at the earliest phase of the planning process.

The 2010/2011 floods showed the need to develop or adjust the existing flood protection programs, as well as planned and ongoing projects for improving flood protection levels. Construction in areas with high flood risks should be prevented, especially in previously flooded zones. Considering that the Spatial plan of Montenegro is in the development phase, it is important to implement the results from hazard and risk maps, starting from the mentioned document, down to the spatial planning documentation at the local level..Areas of Potential Significant Flood Risk (APSFR) identified during the Preliminary Flood Risk assessment are clearly marked and excluded from the future urban development.

Competent authorities should use special conditions and permits to limit construction in areas under flood hazards and lower the flood risk in potential flood areas. In cases where construction cannot be avoided, the risks should be lowered to an acceptable level.

7.3 Reduction of existing flood risks

Reducing the existing risk of floods is achieved by applying structural measures that stop or restrict the spread of floods (maintenance and improvement of flood protection systems), and non-structural measures aimed at reducing vulnerability and exposure of people and communities, property, economic activity, environment and cultural heritage to consequences of floods.

Key objectives, in relation to areas of impact are:

Economic Activity

- To reduce the cost of potential future flood damages to properties and infrastructure;
- To reduce the economic costs caused by the disruption to essential infrastructure and services; and,
- To optimise the economic return on flood risk management investment.

Human Health and Social

- To reduce the risk to life, health and wellbeing.
- To increase awareness and understanding of flooding and its adverse consequences and improve community resilience.
- To reduce the impact on people caused by the disruption to essential infrastructure and services.
- To improve recreation and public amenities.

Environmental

- To consider the impact of Climate Change across all areas of impact;
- To support the objectives of the Water Framework Directive and contribute to the achievement of good ecological potential/status for water bodies;
- To protect and enhance the natural environment

Significant impact on the reduction of existing flood risks in the part related to the reduction of flood exposure is achieved by applying measures that foresee harmonization of flood risk management measures with spatial planning documentation.

Continuing activities to strengthen capacity and implement preventive preparatory actions, immediate flood protection measures and action after the end of regular flood defence will certainly help reduce the existing flood risks. The measures recognised and taken in the countries on the basis of national obligations, as well as those defined through transboundary cooperation, should contribute to reducing the existing flood risks in the Danube River Basin.

Maintenance of flood protection structures should be planned and available on long-term basis. Procedures for approvals related to planning and construction of flood protection structures should be simplified and made quicker. Attention should also be paid to implement these procedures in line with the best European practices, especially having in mind requirements of the Water Framework Directive, as well as other water-related directives.

Safety and operational readiness of systems depends on employees with relevant local and technical knowledge, and therefore overall capacity of the State administration should be built over the time. The knowledge gained during previous flood events should be used for continuous improvements of plans and programs for reducing the risk of floods.

7.4 Strengthening resilience

Strengthening resilience to floods is a multi-sectoral process which includes numerous participants and needs to be undertaken based on their cooperation and coordination. Implementation of solutions for strengthening the resilience in the Danube River Basin should be coordinated between responsible authorities in the country, but also bilaterally with Serbia and Bosnia and Hecegovina through improved joint transboundary actions.

The 2010/2011 floods showed the need for detailed hydrological studies and improved data collection in order to set up the methodology, which would analyse meteorological and hydrological elements important for integrated water and flood risk management in the Danube River Basin.

The efforts should be made to improve the infrastructure for meteorological and hydrological monitoring, including capacity building in competent institutions. Improvements of forecasting and warning systems require qualified staff, training, and constant exchange of experiences.

7.5 Raising awareness about flood risks

Understanding the exposure and vulnerability to flood risk is a key step in preparing and building resilience. Effective solutions for strengthening resilience to floods will need the improvement of stakeholder capacities and increased public understanding in order to be

faster and more flexible when disaster occurs. It also important to recognize the importance of information exchange with the neighbouring countries in the event of floods, especially those with transboundary impact. In order to ensure effective information of professional and general public it is recommended to establish a Geoportal as an information and communication platform

GIS data base should be regularly improved in order to serve as an information source on implementation of measures, and for further public awareness raising about flood risks. Special attention should be given to improving public awareness and quick reaction capacities in case of sudden floods and torrents. Community awareness about flood risks should be improved and maintained, with clear understanding of their role in proper response to emergency situations. Community activities are very important in coordinated evacuation from the affected area, maintaining health and hygienic conditions in flooded areas, as well as to prevent accidental pollution. Organised media communication is also of key importance.

8 PROGRAMME OF MEASURES

8.1 Methodology for preparation of the measures for flood protection

In the preparation of the FRMP, measures are identified that are the specific actions which will deliver the FRMP Objectives. In setting the measures, the FRMP addresses all aspects of flood risk management, focusing on measures for prevention, protection and preparedness, and taking into account the characteristics of the particular river basin, including flood forecasting.

According to guidelines of the EC[106], measures may be structural or non-structural, falling into four categories:

- Measures that aim to prevent / avoid increasing flood risk (e.g. measures related to planning).
- Measures that protect from flooding by using natural flood management.
- Measure that protect from flooding by using more traditional engineering methods.
- Measures that prepare for flooding should it occur (e.g. flood warning, awareness raising, emergency response plans).

As illustrated below in Table 8.1, measures are classified into 18 groups within 6 aspects: no action (M11) flood prevention (M21-M24), flood protection (M31-M35), preparedness (M41-M44), restoration and review (M51-M53).

Table 8.1. Types of measures/group of aggregated measures according to the EC

Aspect of flood risk management	Type	Measure Group	Description
No Action	M11	No Action	No measures are proposed to reduce the flood risk in the APSFR or other defined area
Prevention	M21	Avoidance	Measure to prevent the location of new or additional receptors in flood prone areas (land use planning policies or regulation)
	M22	Removal or relocation	Measures to remove receptors from flood prone areas, or to relocate receptors to areas of lower probability of flooding and /or lower hazard
	M23	Reduction	Measures to adapt receptors to reduce the adverse consequences in the event of a flood actions on buildings, public networks, etc.
	M24	Other prevention measures	Other measures to enhance flood risk prevention (may include flood risk modelling and assessment, flood vulnerability assessment, maintenance programmers' or policies, etc.)
Protection	M31	Natural flood management /	Measures to reduce the flow into natural or artificial drainage systems, such as overland flow interceptors

[106] Guidance for Reporting under the Floods Directive (2007/60/EC): Guidance Document No. 29 (2013).

Aspect of flood risk management	Type	Measure Group	Description
		runoff and catchment management	and / or storage, enhancement of infiltration, etc. and including in-channel, floodplain works and the reforestation of banks, that restore natural systems to help slow flow and store water, extension of floodplains within historical morphological alluvial areas, increase of retention capacities of existing floodplains, establishment of temporary retentions etc; improving methods for ecologically acceptable approach to flood risk reduction
	M32	Water flow regulation	Measures involving physical interventions to regulate flows, such as the construction, modification or removal of water retaining structures (e.g. dams or other on-line storage areas or development of existing flow regulation rules), and which have a significant impact on the hydrological regime
	M33	Channel, riverbanks and floodplain works	Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.
	M34	Surface water management	Measures involving physical interventions to reduce surface water flooding, typically, but not exclusively, in an urban environment, such as enhancing artificial drainage capacities or though sustainable drainage systems
	M35	Other protection measures	Other measures to enhance protection against flooding, which may include flood defence asset maintenance programmes or policies
Preparedness	M41	Flood forecasting and warning	Measures for establish to enhance protection against flooding, which may include flood defence asset maintenance programmes or policies
	M42	Emergency event response planning / contingency planning	Planning activities in case of emergency situations, measures to establish or enhance flood event institutional e emergency response planning
	M43	Public awareness and preparedness	Measures to establish or enhance public awareness and preparedness for flood events
	M44	Other measures for preparedness	Other measures to establish or enhance preparedness for flood events to reduce adverse consequences
Recovery and review	M51	Individual and social recovery	Clean- up and restoration activities (buildings, infrastructures, etc.); Health and mental health supporting actions, incl. managing stress; Disaster financial assistance (grants, tax), incl. disaster legal assistance, disaster unemployment assistance; Temporary or permanent relocation; Other

Aspect of flood risk management	Type	Measure Group	Description
	M52	Environmental recovery	Clean-up and restoration activities (whit several sub-topics as mould protection; well-water safety and securing the disposal sites/landfills for hazardous materials); re-naturalization and revitalization of natural (flood) habitats-zones; Other
	M53	Other recovery measures	Other elements of recovery and review; Lessons learnt from flood events; Insurance policies; Other

Structural and non-structural measures within APSFR in the Danube River Basin were identified with the emphasis on reducing potential adverse consequences on human health, the environment, cultural heritage and economic activity, as well as reduction of flood occurrence.

In the process of preparing / determining the proposed measures, the following have been taken into account:

- Preliminary Flood Risk Assessment;
- Conclusions that can be drawn from the Flood Hazard Maps and Flood Risk Maps;
- Environmental objectives of the Water Framework Directive;
- Cost and benefits of the various options for managing flood risk;
- The opportunity for natural flood plain management; and,
- The impacts of Climate Change.

8.2 Proposed structural and non-structural measures for APSFR

8.2.1 APSFR01_DRB_Ibar01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.3). The areas prone to flooding where mitigation measures have either been constructed in the past or are proposed are shown at a return period of HQ500 in Figure 8.1. The proposed measures for the APSFR are presented in Table 8.2.

Figure 8.1. Identified areas/sections of potential flooding in APSFR01_DRB_Ibar01

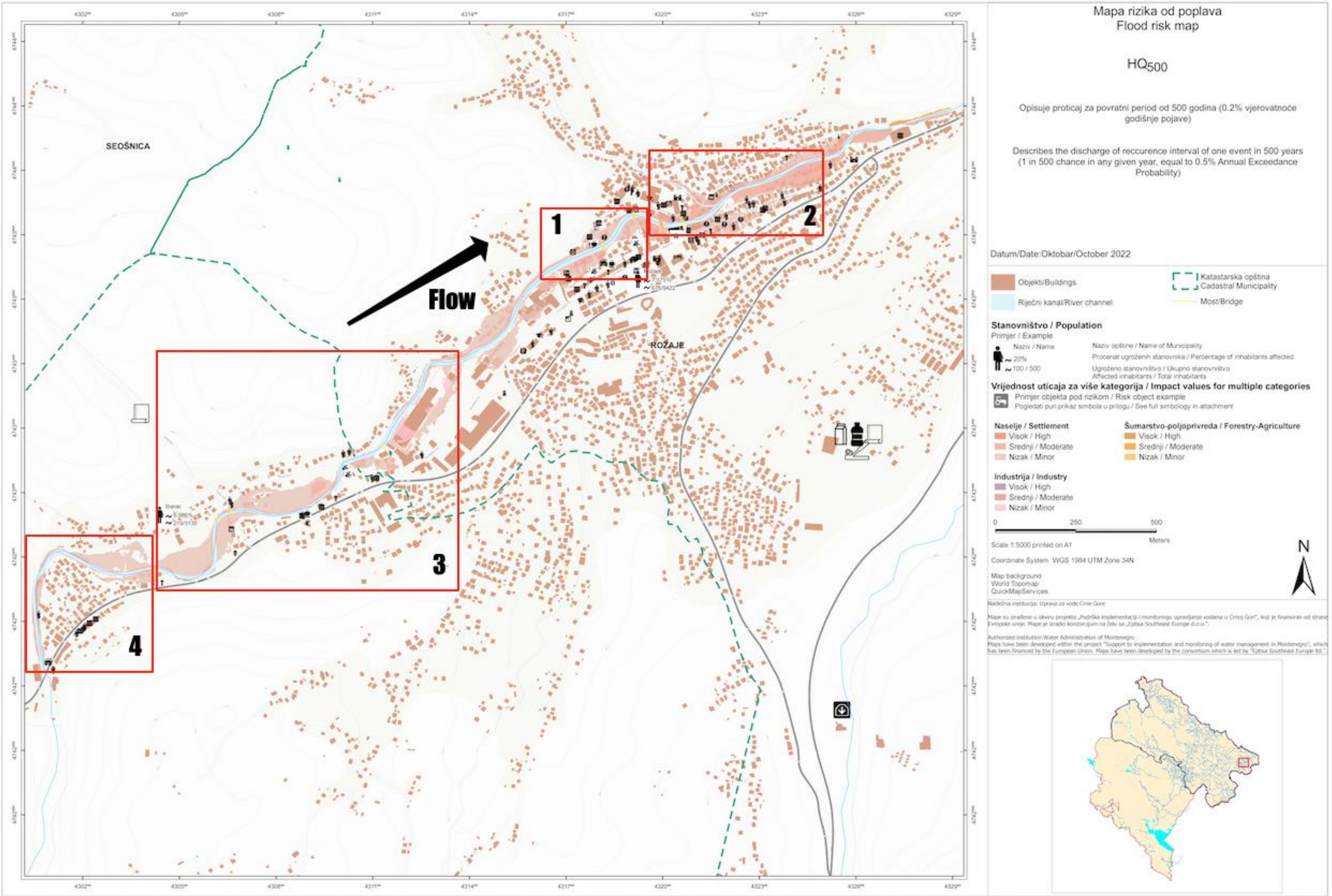
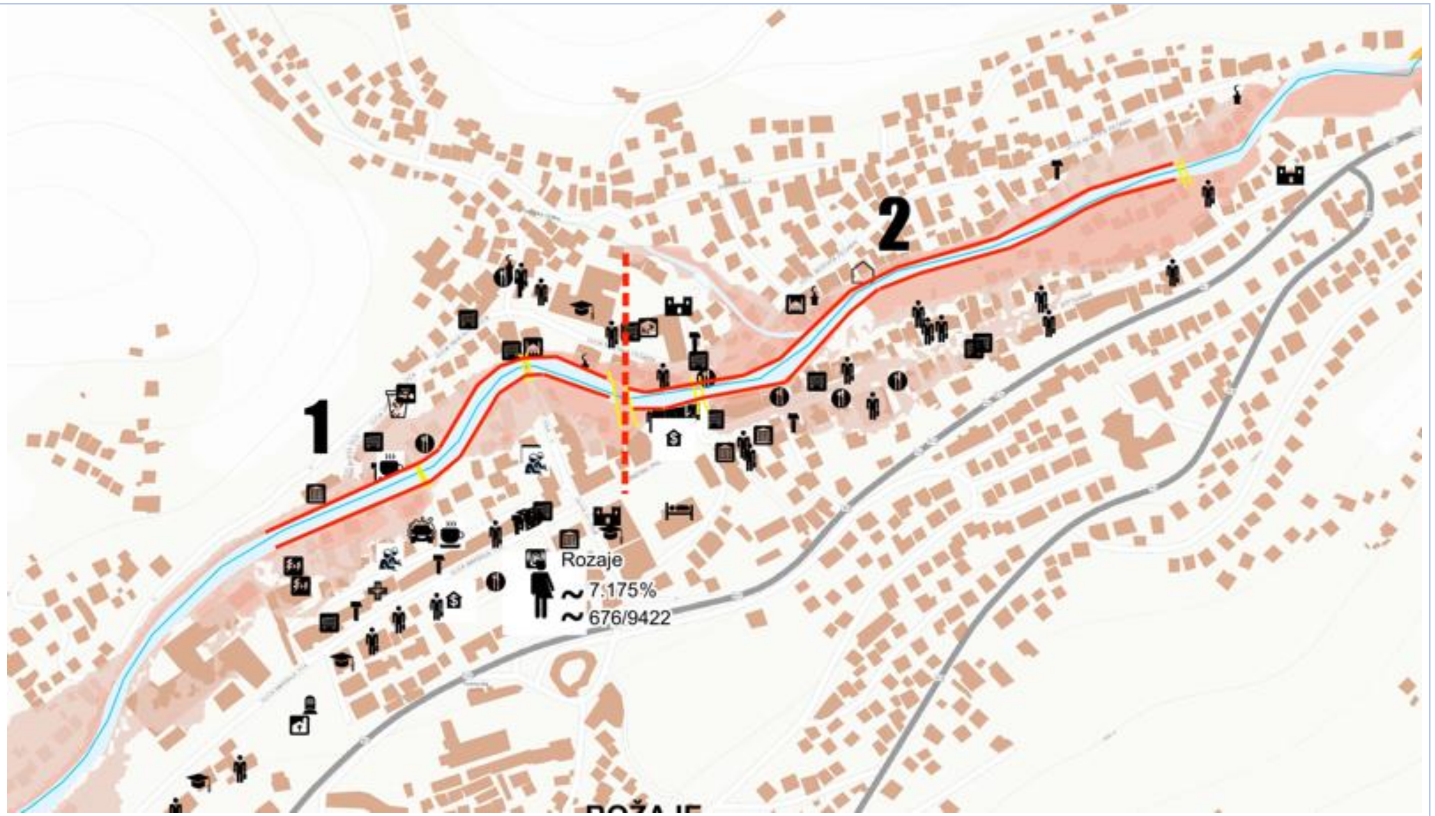


Table 8.2. Measures proposed in APSFR01_DRB_Ibar01

Municipality	Rožaje		
Water body	Ibar		
Watercourse	Ibar		
Surrounding Area	City of Rožaje and settlements Suho Polje and Zeleni		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	363	564	895
Dwellings	45	57	180
Commercial Businesses	7	10	24
Cultural Objects	0	1	3
Inundation (hectares)	9.85	14.76	22.38

Schematic location of Sections 1 and 2 (HQ500) Solid Red lines indicate location of proposed measures in each section	

Schematic location of Sections 3 and 4 (HQ500)	
Description of Measures	The regulation of the Ibar River was drafted in 1979 and certain sections of the regulation were carried out. A fortification was built in the city area with a length of 450m on both banks, as shown in **Section 1** above. In 1995, the main design of the main city sewage collector along the Ibar River in Rožaji was prepared, according to which it was planned that the collectors would be laid on the outside of the fortified wall in the sand path according to the regulation project. This project envisaged the regulation of the left and right banks from the bridge in the center of Rožaje to the next bridge downstream in a length of 700m. These works were carried out during 2018 (**Section 2**). In 2013, the preliminary design of the waste water treatment plant and sewerage network in the

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	Municipality of Rožaje was developed, which also included works on the regulation of the river bed of the Ibar. However, this project could not comply with the concept from the Main Project for the Regulation of the Ibar River Bed (from December 1979), since the Ibar River bed has been encroached on by the construction of residential and commercial buildings. Due to the construction of buildings and the construction of protective fortified walls on the downstream sections, the riverbed has been significantly narrowed. This narrowing and poor maintenance of the upstream (regulated) section led to significant decrease in the overall flow rate. The conceptual design of the waste water treatment plant and sewage network is designed to regulate the left and right banks of the Ibar River in a length of 1700m (**Section 3**). These works have not yet been carried out. Of the total section of 3.7 km, which is defined by the risk map as an area at risk of flooding, no protective measures have yet been designed for the 800m long section shown in **Section 4**.
Key Measures	**M21**: *Measures to prevent the location of new or additional receptors in flood prone areas.* Land use planning policies they should be such that they prevent the urbanization and construction of any buildings in areas that are at risk of flooding. The previous spatial planning documentation was limited to the prohibition of construction on water land, as this was prescribed by the Law on Water, and flood risk maps did not exist. **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Construction and maintenance of riverbank protection structure in the section Rožaje - Suho Polje – Zeleni, approx. 3.7 km in length on both sides.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Rožaje Capital Projects Administration
Status of Implementation	Section 1 - Completed works

	Section 2 - Completed works Section 3 - Preliminary design Section 4 - No status
Investments Costs	Section 3 - Main design and construction works: €3,500,000 Section 4 - Preparation design and construction work: €1,500,000
Maintenance Costs	Section 1 – Maintenance costs: €100,000/year Section 2 - Maintenance costs: €50,000/year
Priority (first / second / third)	First

8.2.2 APSFR02_DRB_Ibarac01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.4). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.2. The proposed measures for the APSFR are presented in Table 8.3.

Figure 8.2. Identified area of potential flooding in APSFR02_DRB_Ibarac01

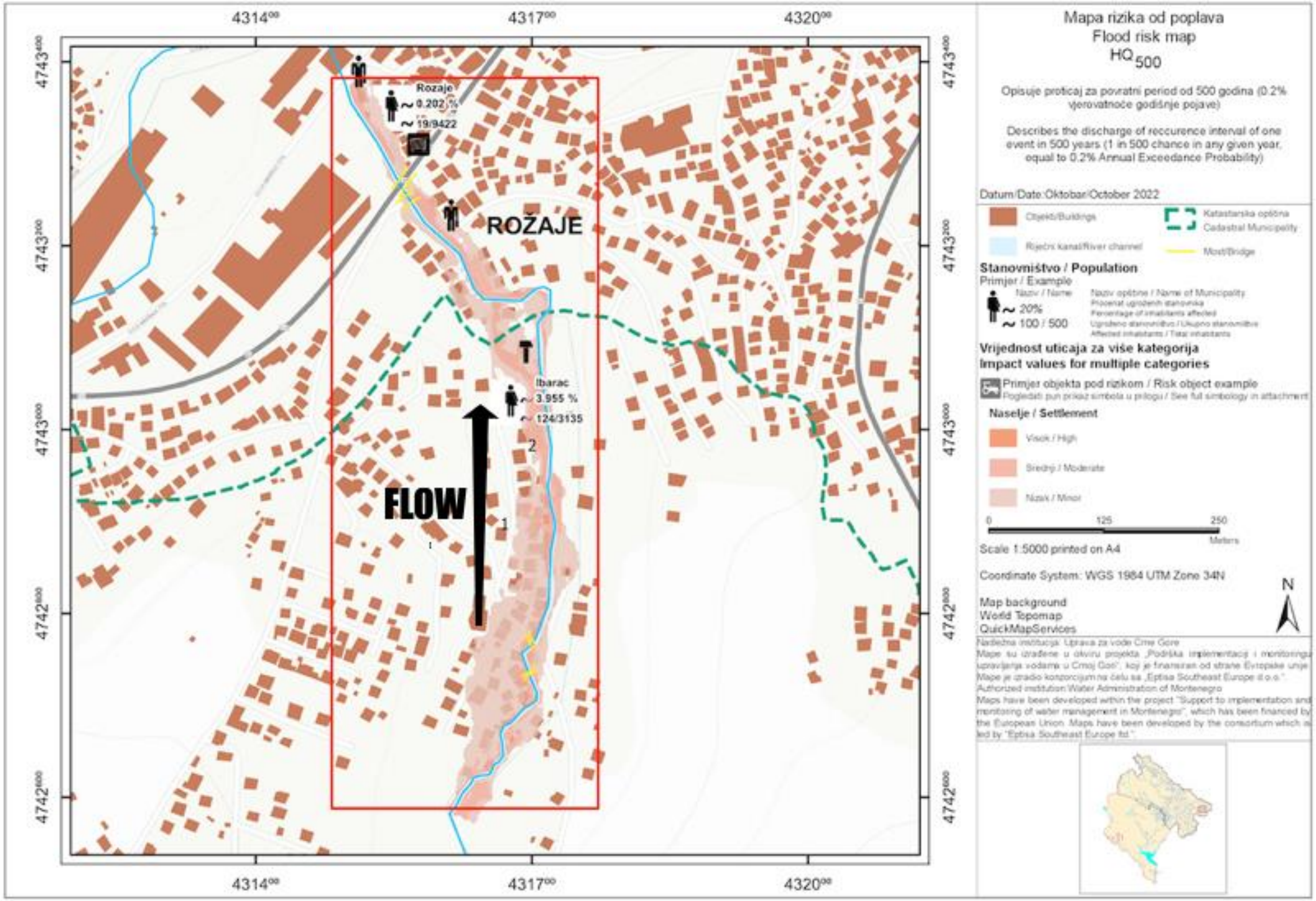

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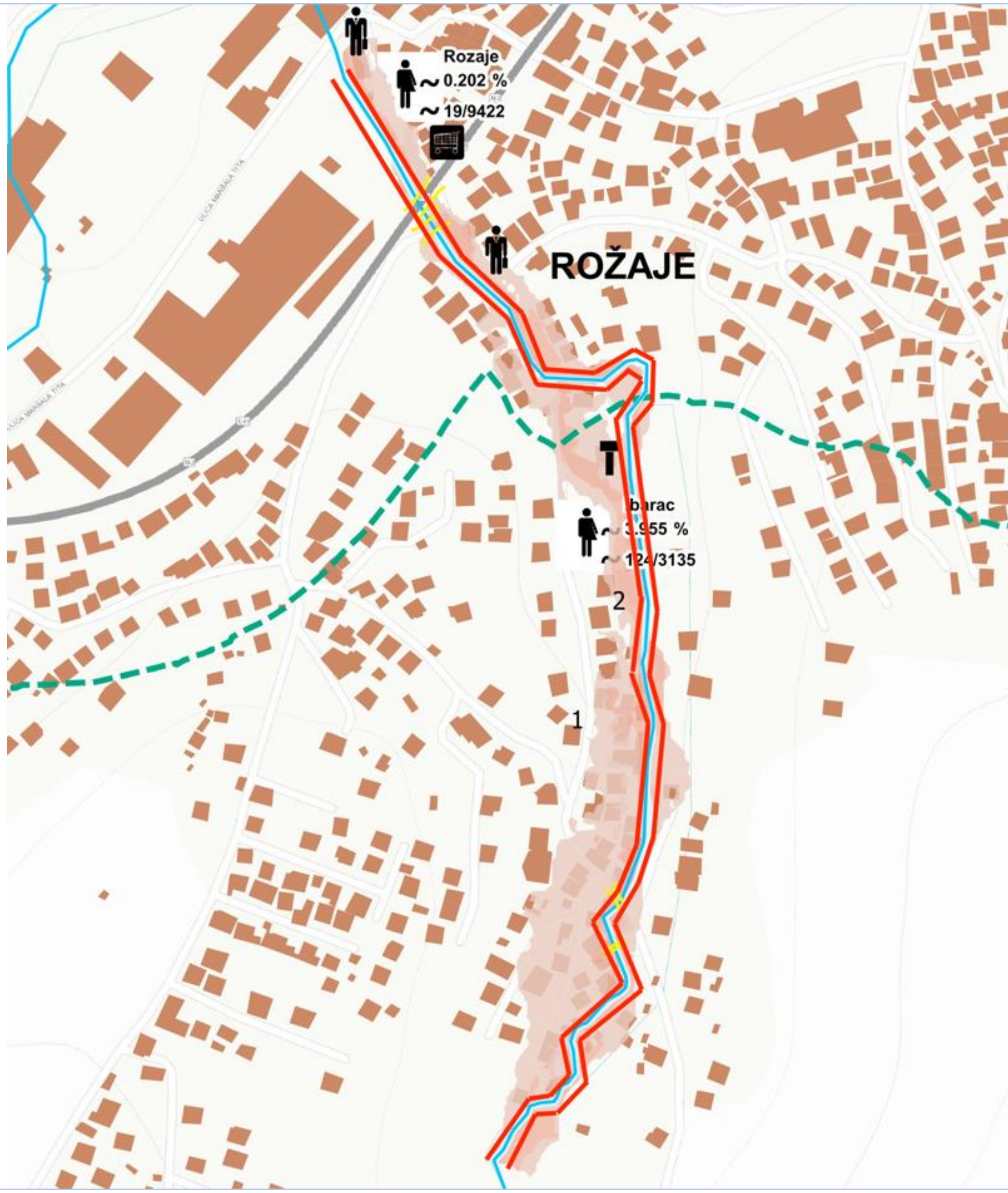
Table 8.3. Measures proposed in APSFR02_DRB_Ibarac01

Municipality	Rožaje		
Water body	Ibar		
Watercourse	Ibarac		
Surrounding Area	City of Rožaje and settlement Ibarac		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	30	81	143
Dwellings	27	57	72
Commercial Businesses	0	1	1
Cultural Objects	0	0	0
Inundation (hectares)	0.96	2.45	3.98

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M21**: *Measures to prevent the location of new or additional receptors in flood prone areas.* Land use planning policies they should be such that they prevent the urbanization and construction of any buildings in areas that are at risk of flooding. The previous spatial planning documentation was limited to the prohibition of construction on water land, as this was prescribed by the Law on Water, and flood risk maps did not exist. **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Construction of riverbank protection structure approx. 1 km in length on both sides of river Ibarac.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Rožaje Capital Projects Administration
Status of Implementation	No status
Investments Costs	Main design and construction works €2,000,000
Priority (first/second/third)	Second

8.2.3 APSFR03_DRB_Lovnička rijeka01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.5). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.3. The proposed measures for the APSFR are presented in Table 8.4.

Figure 8.3. Identified area of potential flooding in APSFR03_DRB_Lovnička rijeka01

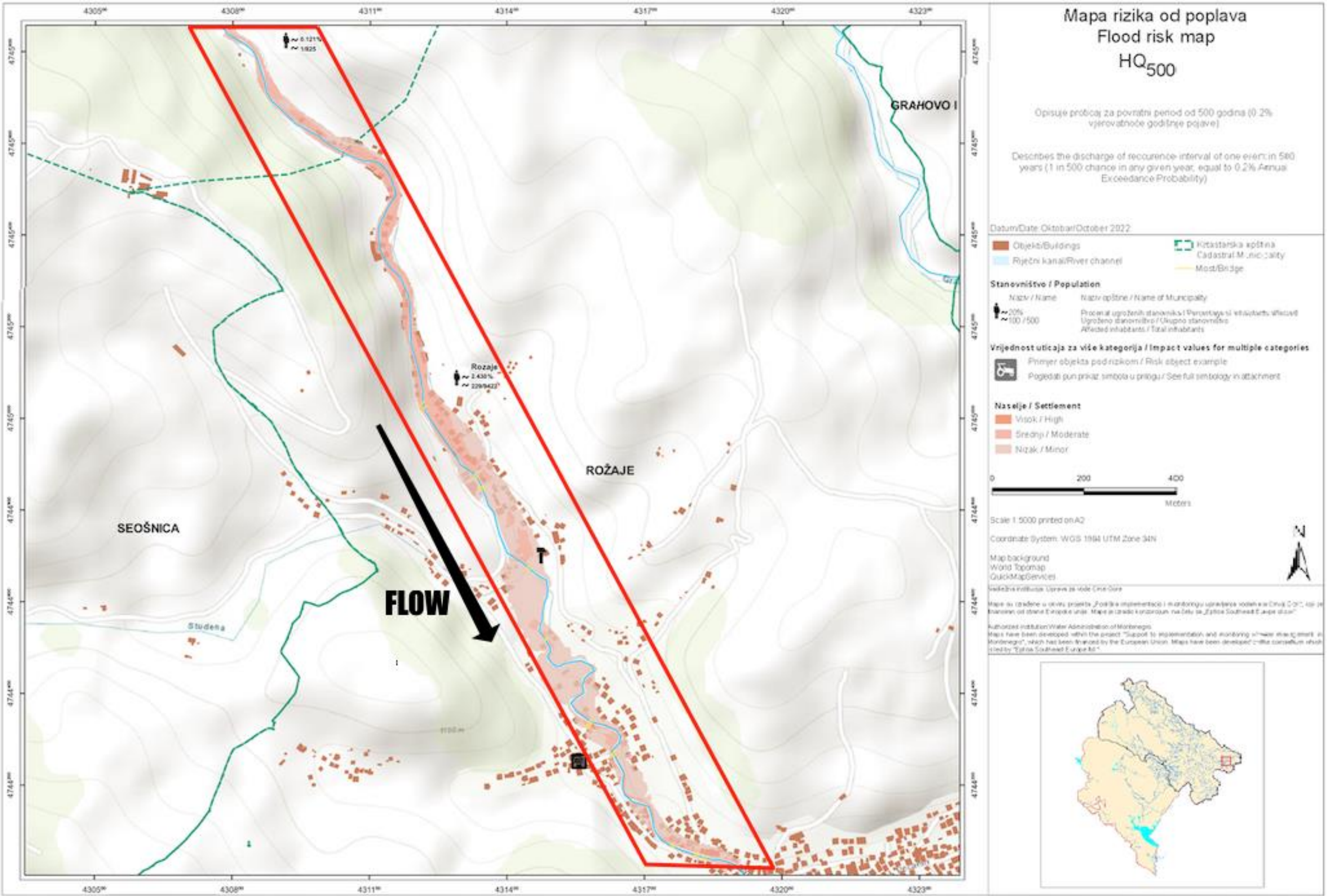


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Table 8.4. Measures proposed in APSFR03_DRB_Lovnička rijeka01

Municipality	Rožaje		
Water body	Ibar		
Watercourse	Lovnička		
Surrounding Area	Settlements Hurije, Donja Lovnica		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	89	168	230
Dwellings	68	106	134
Commercial Businesses	0	2	2
Cultural Objects	0	1	1
Inundation (hectares)	4.57	7.96	10.87
Schematic location of Risk Area (HQ500)	See Figure 8.3 above		
Key Measures	**M21**: *Measures to prevent the location of new or additional receptors in flood prone areas.* Land use planning policies they should be such that they prevent the urbanization and construction of any buildings in areas that are at risk of flooding. The previous spatial planning documentation was limited to the prohibition of construction on water land, as this was prescribed by the Law on Water, and flood risk maps did not exist. **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Considering that a large number of buildings are built on the shore itself, the watercourse is clogged with waste and various objects that are thrown into the river. In order to enable the outflow of large waters, it is necessary to carry out regular cleaning of the river bed, removal of deposits and vegetation.		

	There are approximately 100 buildings on the banks of the Lovnička river in a length of about 2.4 km. Individual mobile protection for buildings on the left and right banks of the river Lovnička where necessary in a length of 600m is recommended. Mobile protection is recommended in a length of 1200m.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Rožaje Capital Projects Administration
Status of Implementation	No status
Investments Costs	Individual mobile protection: €300,000
Maintenance Costs	Maintaining the flow of the riverbed: €50,000/year
Priority (first/second/third)	Second

8.2.4 APSFR04_DRB_Županica01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.6). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.4. The proposed measures for the APSFR are presented in Table 8.5.

Figure 8.4. Identified area of potential flooding in APSFR04_DRB_Županica01

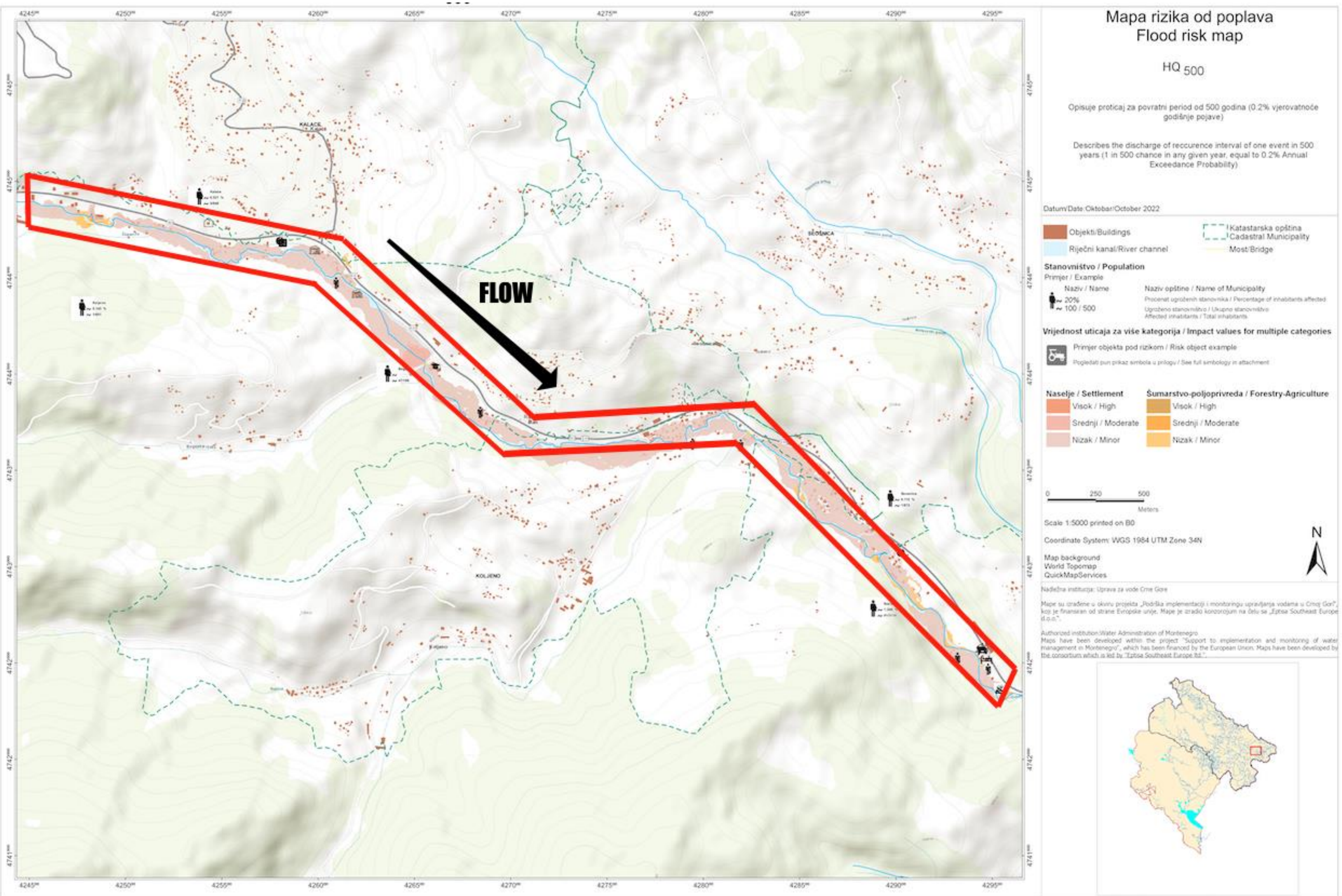

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Table 8.5. Measures proposed in APSFR04_DRB_Županica01

Municipality	Rožaje		
Water body	Ibar		
Watercourse	Županica		
Surrounding Area	Settlements Kalače, Skarepača, Koljeno, Rasadnik		
Type of Area	Urban	☐ Yes	☒ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	38	81	95
Dwellings	25	56	59
Commercial Businesses	1	3	3
Cultural Objects	0	0	0
Inundation (hectares)	32.04	59.14	63.53
Schematic location of Risk Area (HQ500)	See Figure 8.4 above		
Key Measures	**M21**: *Measures to prevent the location of new or additional receptors in flood prone areas.* Land use planning policies they should be such that they prevent the urbanization and construction of any buildings in areas that are at risk of flooding. The previous spatial planning documentation was limited to the prohibition of construction on water land, as this was prescribed by the Law on Water, and flood risk maps did not exist. **M31**: *Measures to reduce the flow into natural or artificial drainage systems.* In order to protect against floods, the regulation of the Županica River with the formation of a green protective belt is recommended. Afforestation and the application of technical and biotechnical works should protect the river bank and prevent or slow down the propagation of flood waves. **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment*		

	dynamics management, dykes, etc. There are approximately 60 buildings at risk on the banks of the Županica river in a length of about 6 km. Individual mobile protection for buildings on the left and right banks of the Županica river where necessary in a length of 2000 m is recommended.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Rožaje Capital Projects Administration
Status of Implementation	No status
Investments Costs	Regulation/afforestation: €100,000 Individual mobile protection: €400,000
Priority (first second/third)	Second

8.2.5 APSFR05_DRB_Grnčar01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.7). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.5. The proposed measures for the APSFR are presented in Table 8.6.

Figure 8.5. Identified area of potential flooding in APSFR05_DRB_Grnčar01

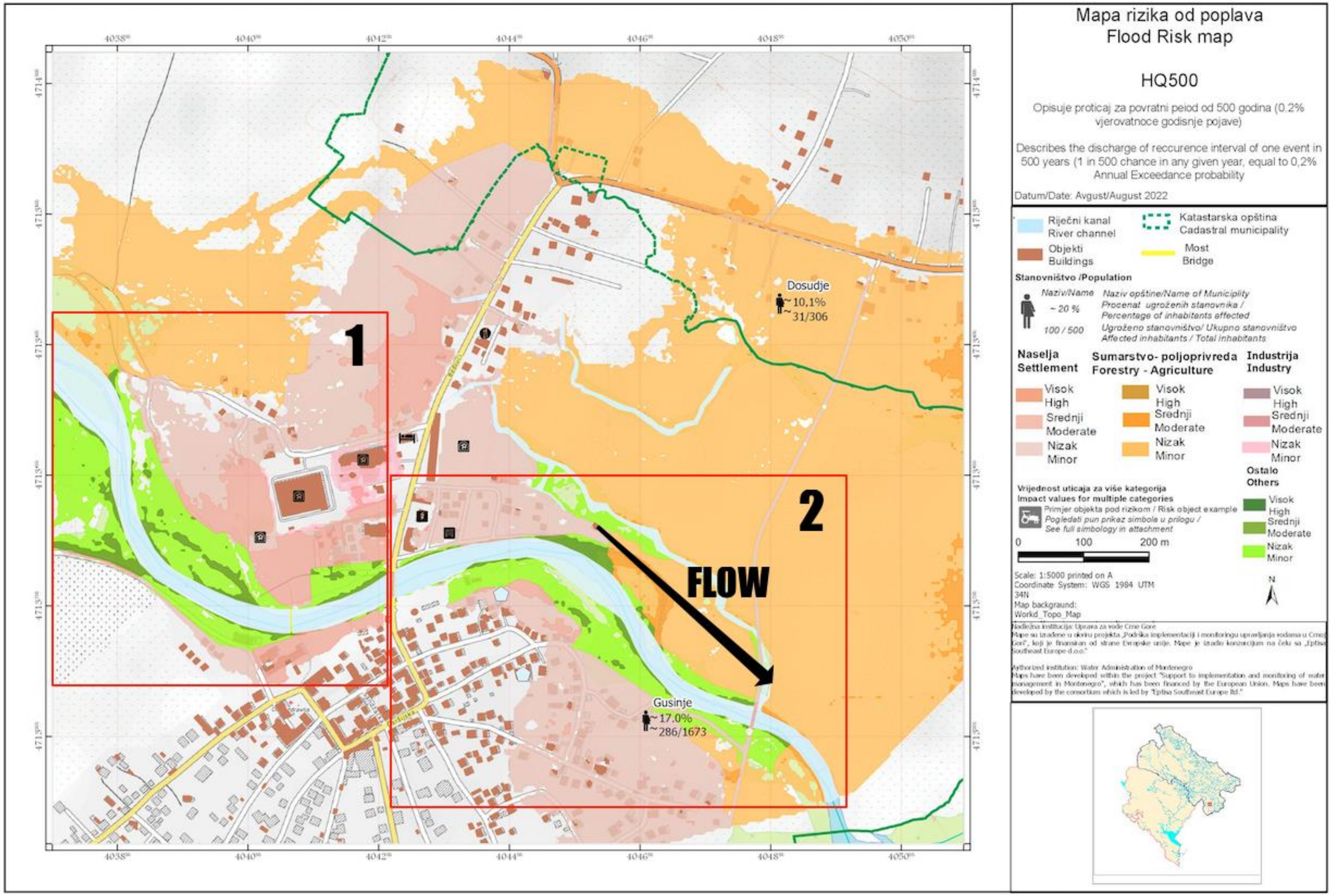

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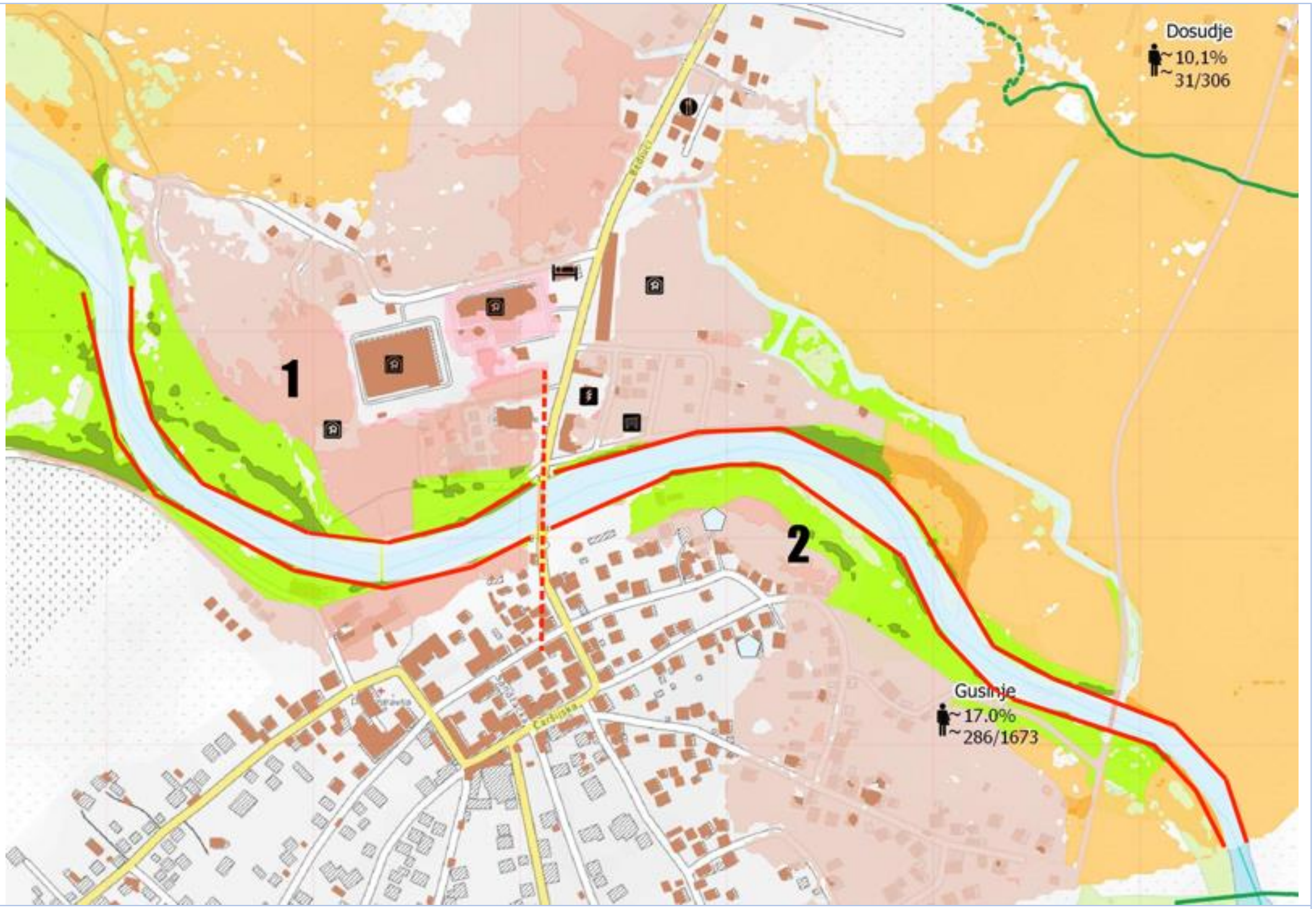
Table 8.6. Measures proposed in APSFR05_DRB_Grnčar01

Municipality	Gusinje		
Water body	Lim		
Watercourse	Grnčar		
Surrounding Area	City of Gusinje and settlements Grnčar, Dolja, Dosuđe		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	150	289	318
Dwellings	63	128	175
Commercial Businesses	0	1	1
Cultural Objects	0	0	0
Inundation (hectares)	56.60	107.17	123.13

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	
Key Measures	The Grnčar River is a torrential watercourse in the basin of which large amounts of sediment are produced. From the border to the town of Gusinje, problems arise, which are reflected in the following: • There is a very extensive deposition of river sediment that the river transports from its upper and middle course.

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	• Due to the formation of banks, the river bed meanders, destroying the land. • Due to the rise of the river bed, with higher flows, floods occur on the surrounding land. Existing poor condition regarding the stability of the riverbed, decreased discharge capacity of the riverbed segments and the vulnerability of surrounding areas during the rainy season, are mainly the product of following factors: • Lack of river training structures for management of flow regime and prevention and mitigation of floods in entire project area; • Previous exploitation of river deposits granted in accordance with state regulations have been conducted without adequate project documentation that would clearly define the obligations and constrains to the concessionaires in order to prevent riverbed degradation. Additional problem was lack of effective control and sanctioning of unauthorized works. • The project documentation was not adequate in terms of minimizing the impact on the sediment regime that results in degradation of riverbed downstream from the concession site. Quantities and type of deposits that can be taken out are generally not determined on the basis of appropriate investigations; • Sediment exploitation has also been carried out illegally. Sub-basins of all tributaries are characterized by steep average slopes that quickly generate high surface discharges after rainfall. In relatively short periods of time, tributary's discharge at the confluence can be greater than the discharge in Lim river which (larger) catchment area generates a flood wave at a slower pace. A large amount of sediment which is deposited by the tributary is also influencing the occurrence of a backwater in the Lim and increased the vulnerability of the upstream river banks. Grnčar River in the border zone with Albania has a significantly higher left bank. As a result, large amounts of water and torrential sediment during seasonal floods are uncontrollably spilled along the right, lower shores endangering the surrounding terrain (mainly agricultural areas). The minor river bed is mostly buried, so the flow is unstable. It can be said that this is the basic characteristic along the entire stream of Grnčar to the city zone of Gusinje. Further, the river passes under the bridge and flows through the urban area. Along the left bank is a low terrain, which includes a wide zone with green areas and agricultural land. On the right bank is a terrain that is sloping towards the part of the settlement with individual housing. This

	part of the settlement is endangered by high water levels at a stretch of about 440 m downstream from the traffic bridge. As can be concluded based on the above, the entire section of the Grnčar river from the border with Albania to the confluence with the Ljuča river is threatened by floods. Considering the above, the following flood protection measures are identified: **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Significant flood protection activities were undertaken in the previous period. The municipality of Gusinje has started the implementation of the embankment construction on the section upstream of the bridge in the length of 1km (**Section 1**). Preparations are project documentation, but unfortunately only 300 m of embankment was built. Also, the construction of the embankment on **Section 2** (in the length of 842 m) is in the realization phase. Namely, development of documentation for flood protection and irrigation in the Lim river basin, with Grnčar River is part of GEF1/SCCF2 funded WBDRB3 project. The Project Development Objective is to improve mechanisms and capacities in Bosnia & Herzegovina, Montenegro and Serbia to plan and manage the trans-boundary Drina River Basin (DRB), incorporating climate change adaptation. On the basis of the prepared project documentation, activities are currently being conducted to prepare and call for tender documentation. Expected end of the project in 2026.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Gusinje Capital Projects Administration
Status of Implementation	Implementation phase underway
Investments Costs	Within the framework of the WBDRB3 project financed by GEF1/SCCF2, the Grnčar river regulation project upstream from the bridge to the border with Albania will be implemented. The project documentation was prepared and revised in 2020. The value of the investment was € 5,630,000 however, this value has in the meantime almost doubled due to the market situation (coronavirus, war in Ukraine) and was calculated at around €10,000,000. This is the reason that the project was transferred to the second phase of the WBDRB3

	project and its realization is expected in 2026.
Priority (first second/third)	First

8.2.6 APSFR06_DRB_Vruja01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.8). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.6. The proposed measures for the APSFR are presented in Table 8.7.

Figure 8.6. Identified area of potential flooding in APSFR06_DRB_Vruja01

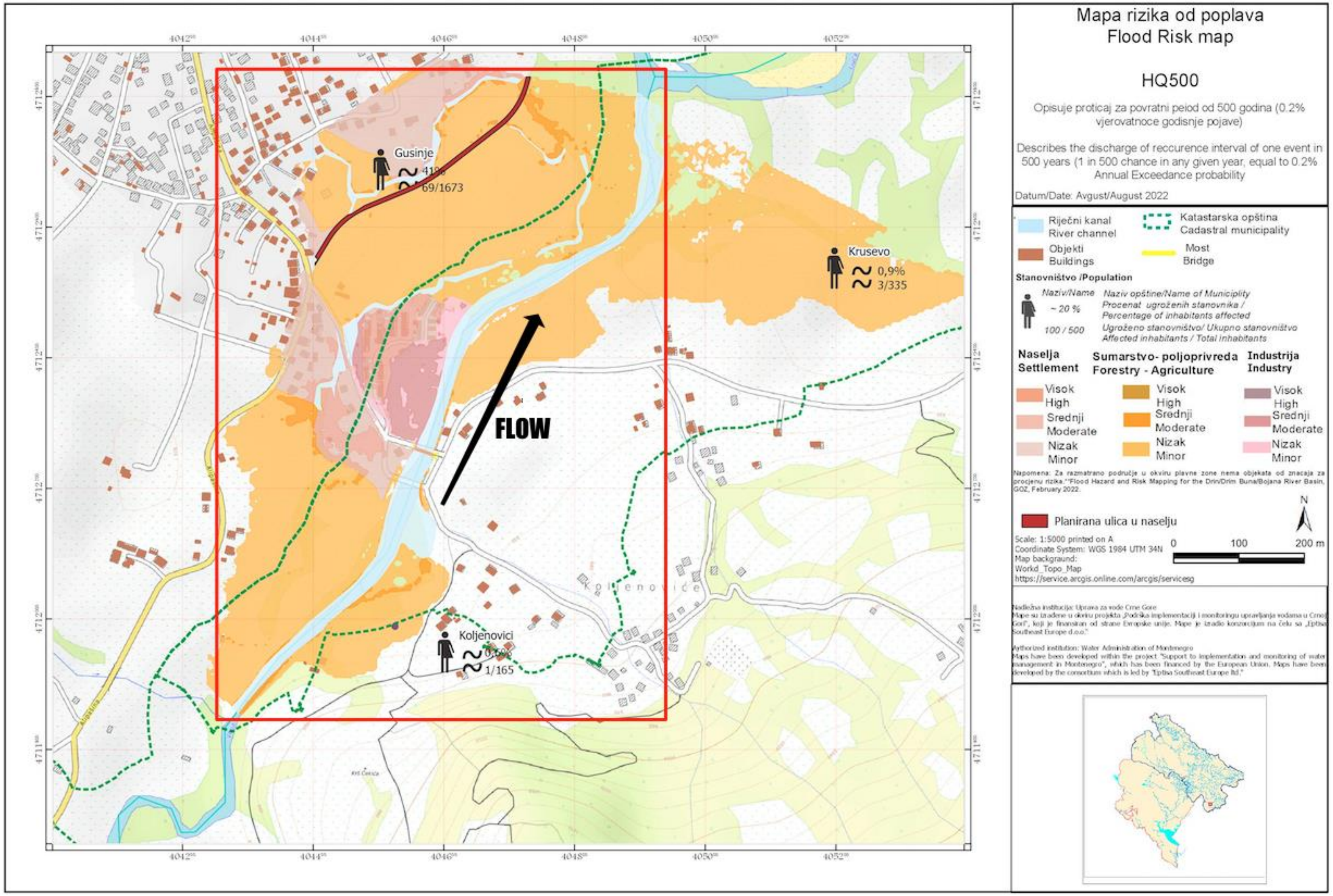


Table 8.7. Measures proposed in APSFR06_DRB_Vruja01

Municipality	Gusinje		
Water body	Lim		
Watercourse	Vruja		
Surrounding Area	Gusinje		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	59	70	73
Dwellings	43	45	47
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	39.61	42.07	43.32

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	The Vruja River causes floods in its most upstream part, i.e. on the section upstream from the mouth of the river Ljuca in a length of about 1200m. The area upstream and downstream of the bridge over the Vruja River is the most endangered. In this area, from 1968 to 2003, 7 flood episodes were recorded (based on hydrological data), practically every five years, and the most intense floods were in 2011. The area is mainly about agricultural land. The most endangered refugee settlement is on the left bank downstream from the bridge on the road section Plav - Vojno selo - Gusinje, in Gusinje. Considering the above, the following flood protection measures are proposed: **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* In the period 2012-2014, works were carried out on the regulation of the riverbed and the construction of the embankment on the left bank upstream and downstream of the bridge on the Vruja in a length of 400m. The trough is stabilized with a protective wall, on the left bank, and an embankment on the left and right banks. These facilities prevent the direct overflow of large waters of the Vruja River, which has a return period of once in 50 years. The value of the investment was 140,000.00€. Regular maintenance of the built infrastructure is suggested so that its role is complete. Also, on the left bank, a smaller stream flows in, which the locals call Vrujica, which also threatens the refugee settlement by flooding. The watercourse is very often covered with garbage and overgrown with vegetation. As a measure, it is necessary to clean it.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Gusinje
Status of Implementation	No status
Investments Costs	-
Maintenance Costs	Regular maintenance of constructed infrastructure €50,000/year
Priority (first/second/third)	First

8.2.7 APSFR07_DRB_Lim01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.9). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.7. The proposed measures for the APSFR are presented in Table 8.8.

Figure 8.7. Identified area of potential flooding in APSFR07_DRB_Lim01

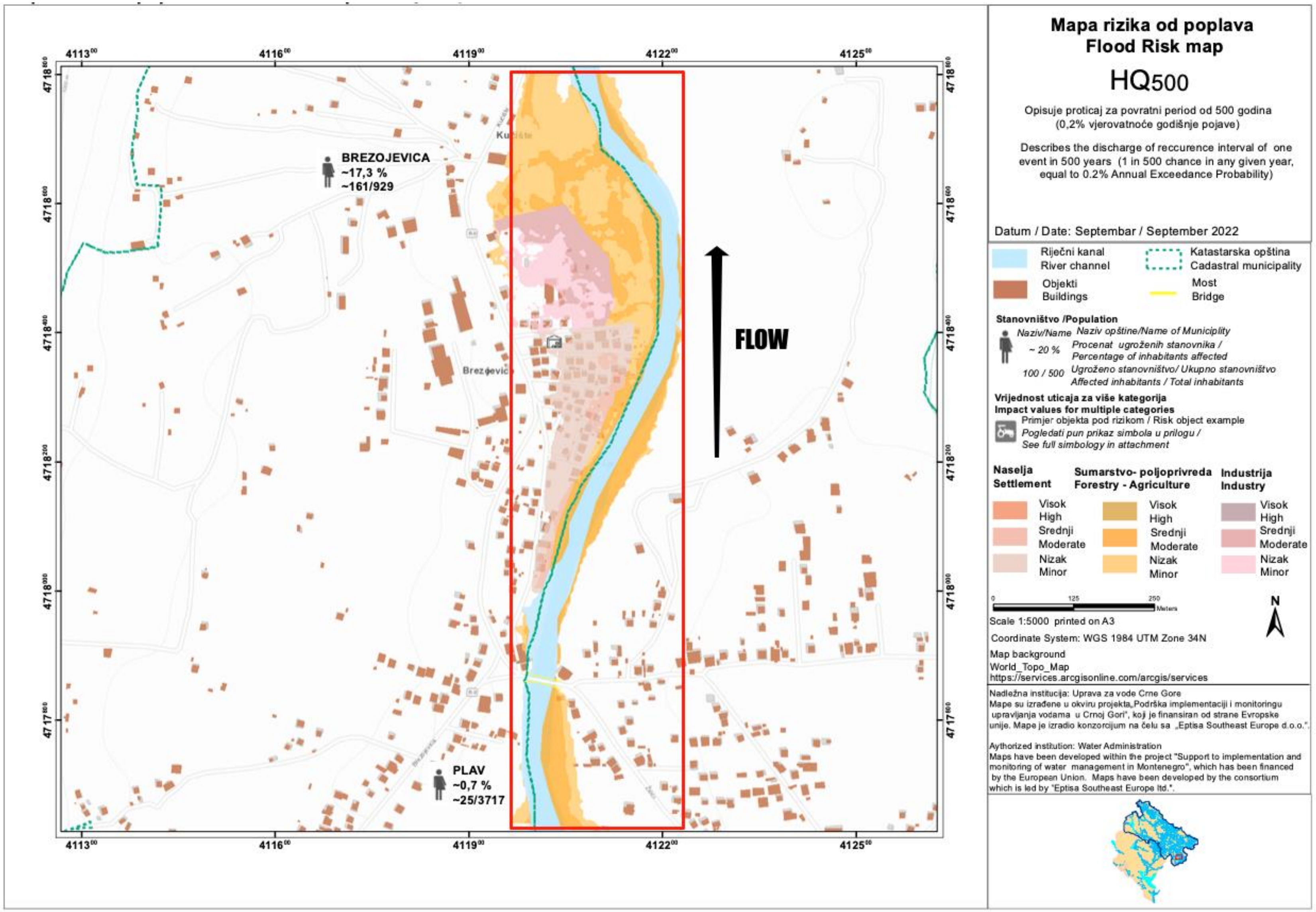
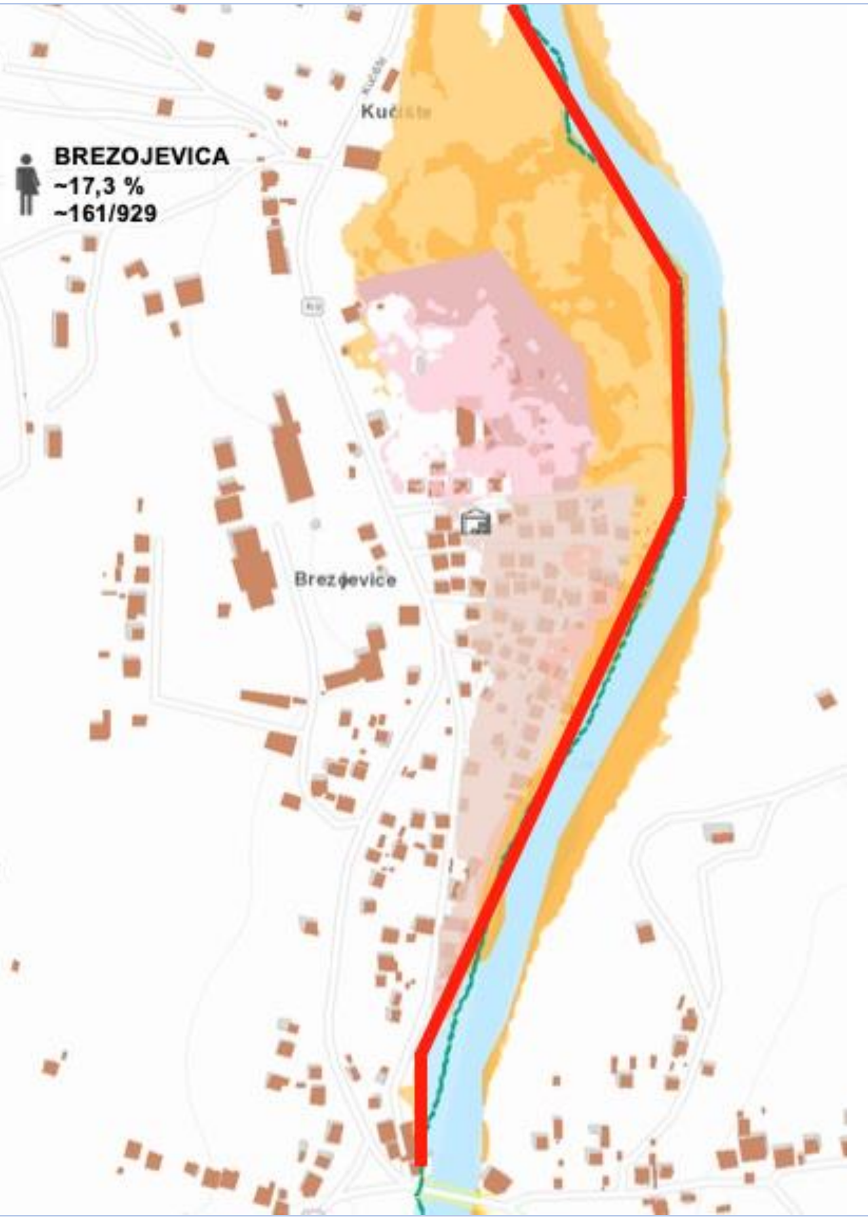


Table 8.8. Measures proposed in APSFR07_DRB_Lim01

Municipality	Plav		
Water body	Lim		
Watercourse	Lim		
Surrounding Area	City of Plav, and settlements Brezojevica, Rambalovi lugovi		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	113	151	186
Dwellings	43	59	81
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	13.29	15.32	16.73

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* This section is characterized by the largest part of the basin, which narrows at the downstream end, between the mouths of the Komaračka and Đurička rivers, as well as the alternation of high and low banks. The left bank is low and subject to flooding every 2-3 years. Significant flood protection activities were undertaken in the previous period. The construction of the embankment is in the realization phase. Namely, development of documentation for flood protection and irrigation in the Lim river basin, with Grnčar River is part of GEF1/SCCF2 funded WBDRB3 project. The Project Development Objective is to improve mechanisms and capacities in Bosnia & Herzegovina, Montenegro and Serbia to plan and manage the transboundary Drina River Basin (DRB), incorporating climate change adaptation. On the basis of the prepared project documentation, the call for tender documentation was expected and completion of works until the end of 2024. However, due to the lack of financial resources project has been rescheduled for the second phase and its completion is expcted to be in 2026. The section of the river Lim, for which regulation is projected, extends from the point at the downstream end which is about 650 m upstream from the inflow of the Đurička river to the profile which is about 43 m downstream from the Plav bridge. The goal is for the regulation at the downstream end to fit into a stable section where it is not possible to "wander" the riverbed, which will prevent the return impact of high waters on the settlement of Brezojevica. The length of the projected section is about 1,315m. On this section, the Lim River receives a torrent tributary from the left - Bijeli potok, about 92 m downstream from the Plav bridge.
Competent Water Authority	Ministry responsible Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Plav
Status of Implementation	Implementation phase underway
Investments Costs	Construction of embankment €1,800,000

Priority (first/second/third)	First

8.2.8 APSFR08_DRB_Lim02

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.10). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.8. The proposed measures for the APSFR are presented in Table 8.9.

Figure 8.8. Identified area of potential flooding in APSFR08_DRB_Lim02

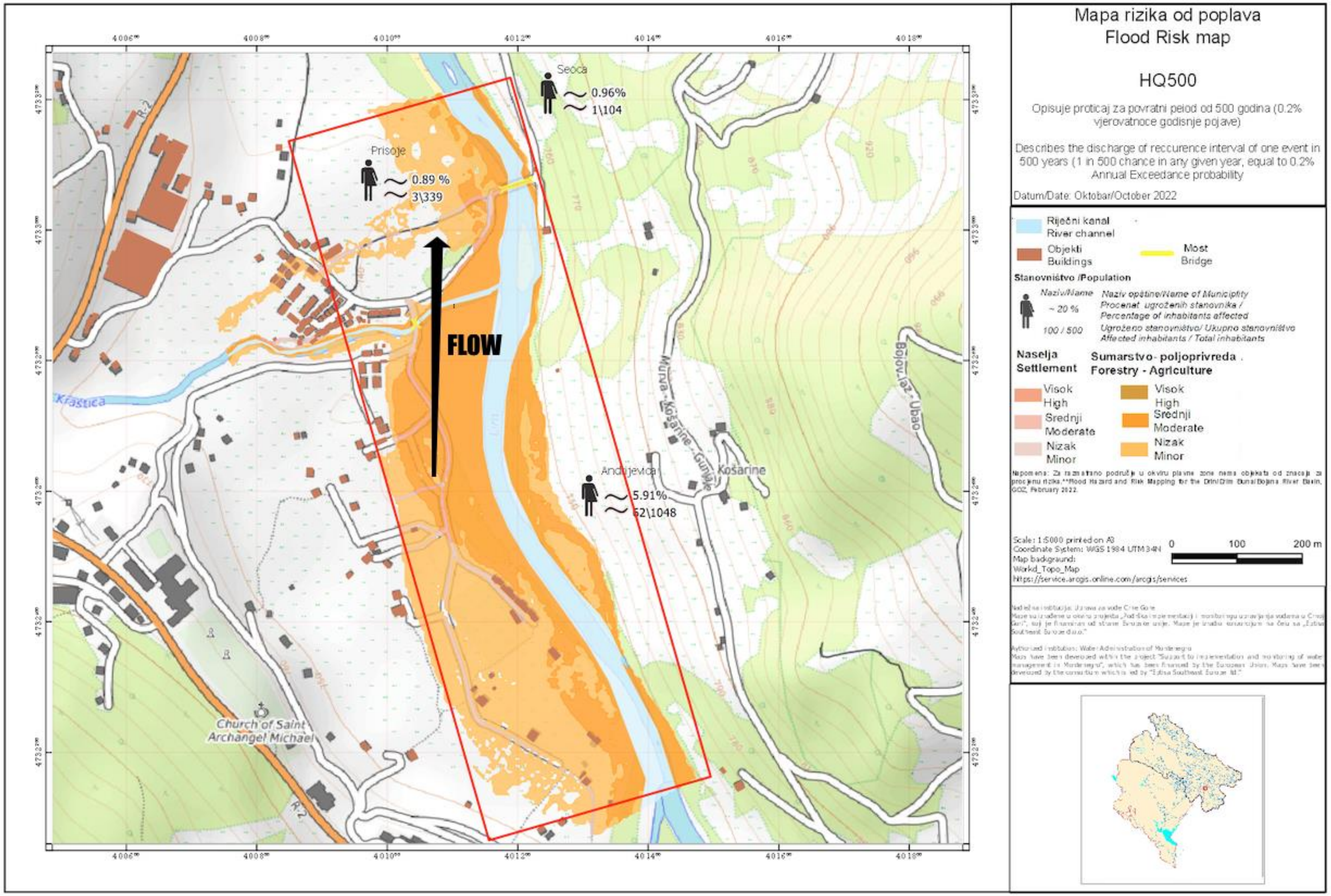


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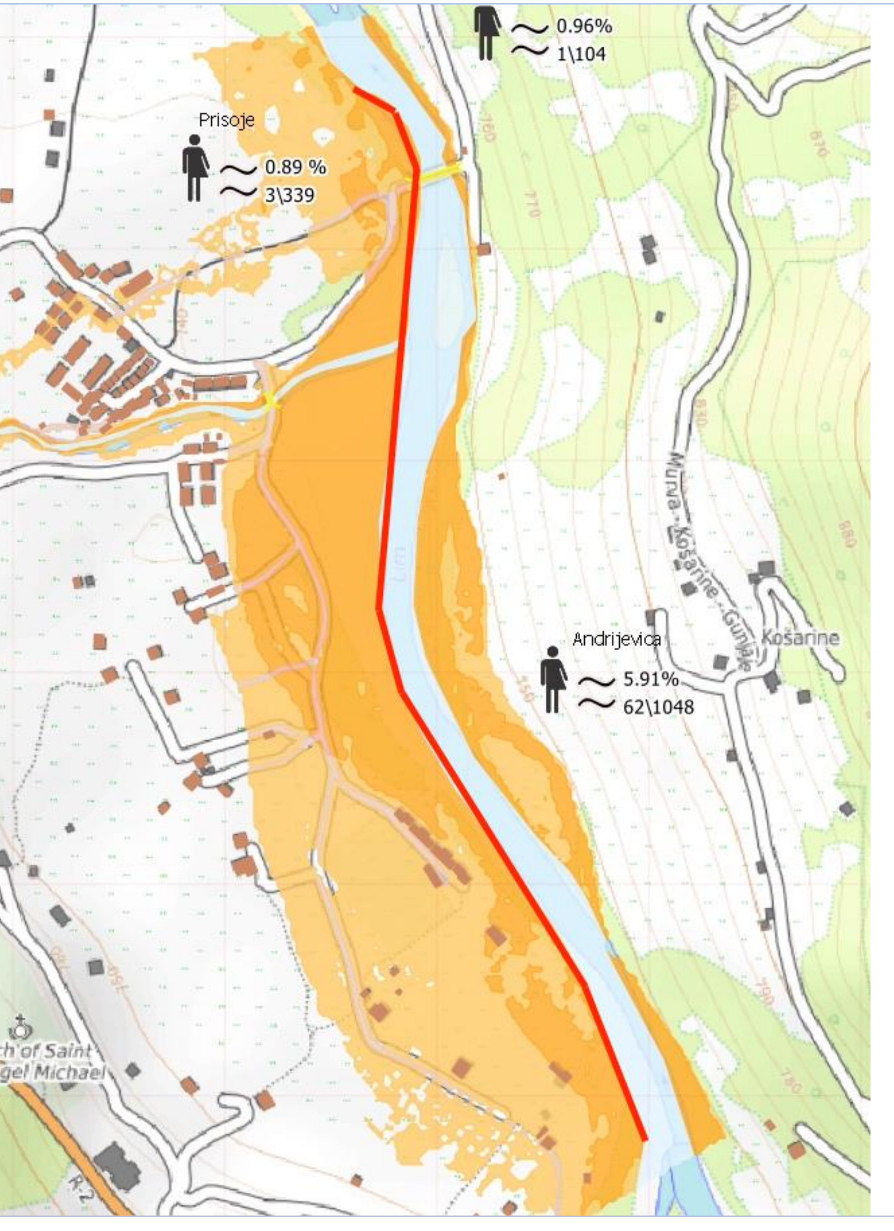
Table 8.9. Measures proposed in APSFR08_DRB_Lim02

Municipality	Andrijevica		
Water body	Lim		
Watercourse	LIm		
Surrounding Area	Andrijevica and settlement Prljanije		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	49	59	66
Dwellings	11	15	25
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	19.08	23.71	26.92

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Intervention regulation works on the river Lim near Andrijevica was carried out in 2014 on the stretch from the mouth of the river Zlorečica to Slatina (above the refugee settlement) for a length of 660m. This represents the regulation of part of the river bed through the city with an embankment on the left bank. The proposed measure involves embankment maintenance and watercourse cleaning work, which should be carried out continuously.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Andrijevica
Status of Implementation	Implementation is underway
Investments Costs	-
Maintenance Costs	Embankment maintenance and clearance of the river bed €50,000/year
Priority (first/second/third)	First

8.2.9 APSFR09_DRB_Lim03

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.11). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.9. The proposed measures for the APSFR are presented in Table 8.10.

Figure 8.9. Identified area of potential flooding in APSFR09_DRB_Lim03

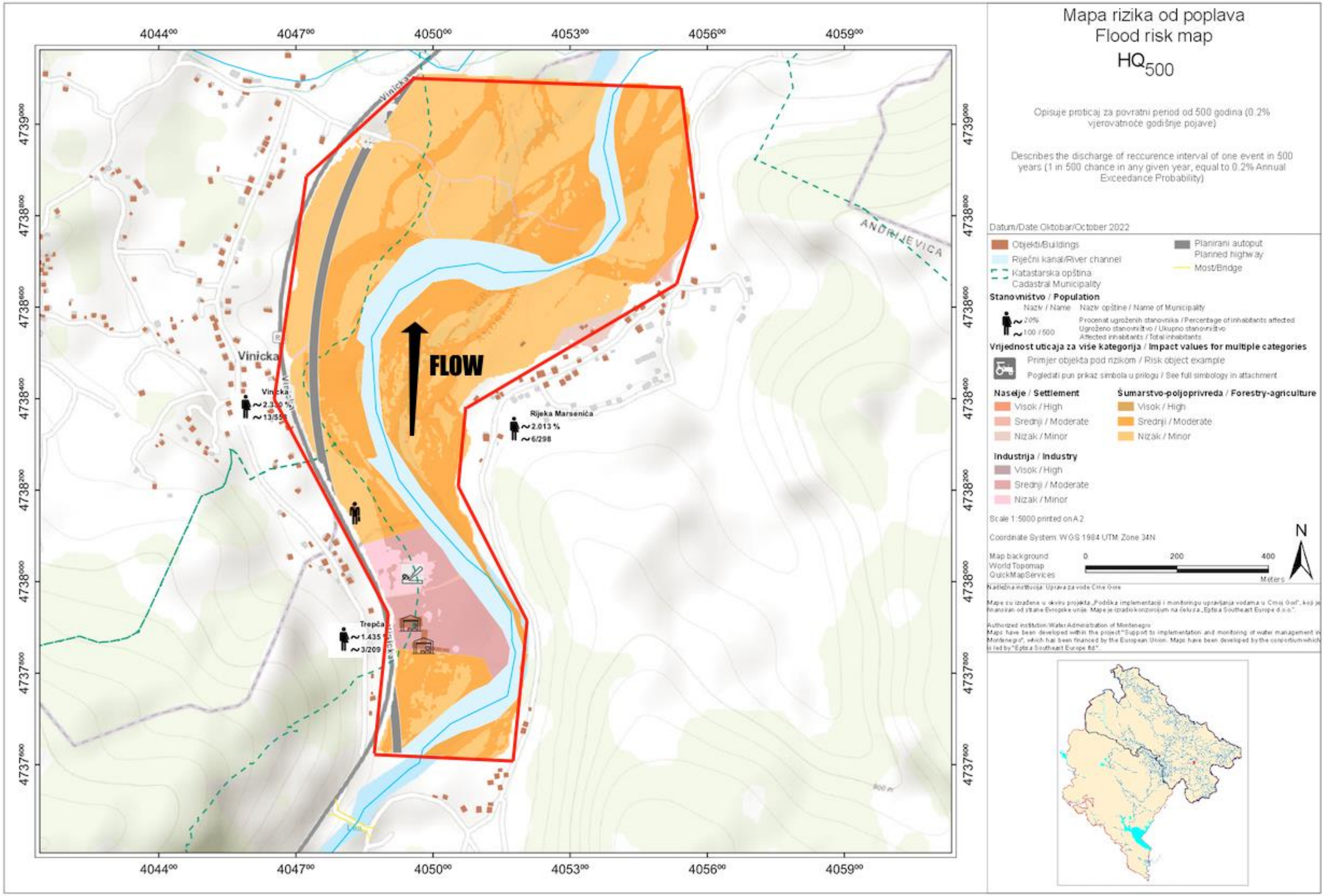
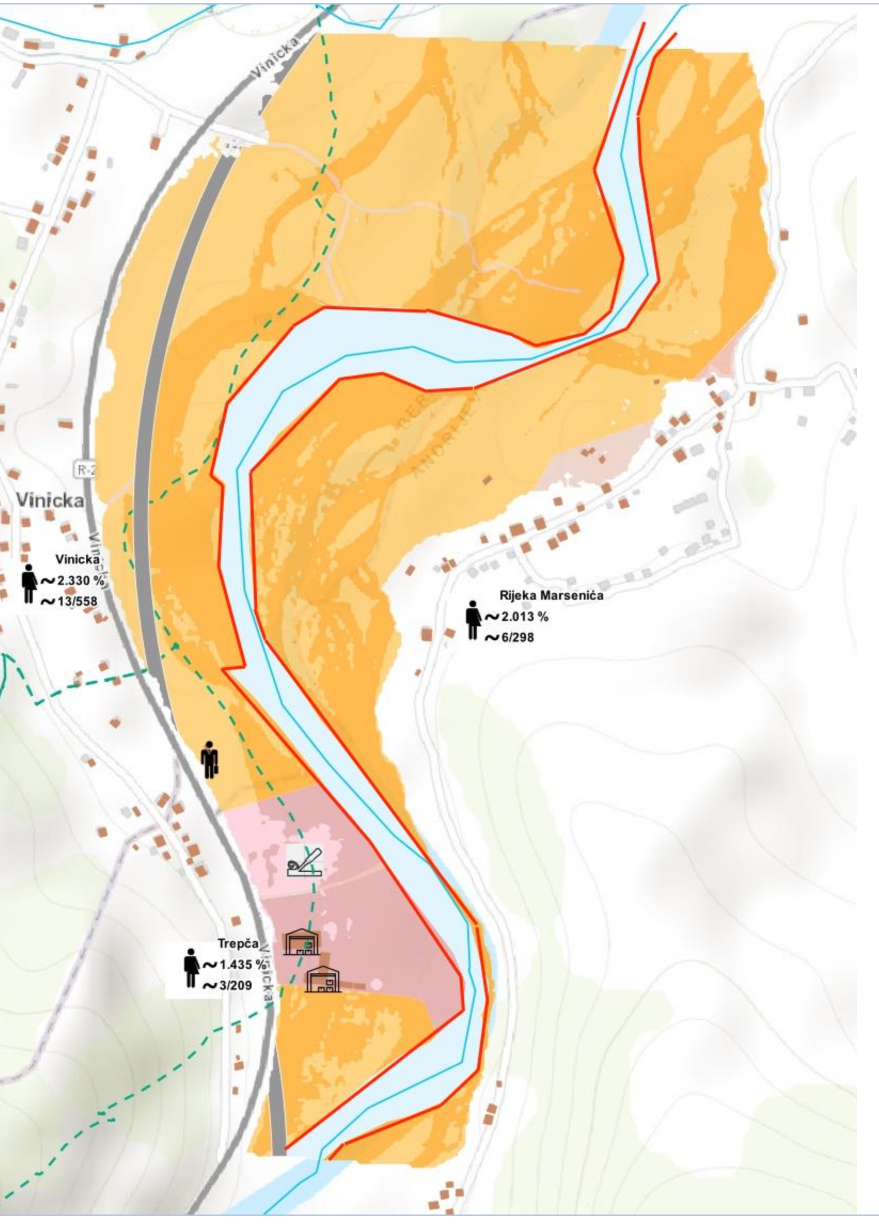


Table 8.10. Measures proposed in APSFR09_DRB_Lim03

Municipality	Berane		
Water body	Lim		
Watercourse	LIm		
Surrounding Area	Settlement Vinicka		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	21	22	22
Dwellings	4	4	9
Commercial Businesses	1	2	2
Cultural Objects	0	0	0
Inundation (hectares)	66.00	70.67	71.78

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* The river Lim upstream from the mouth of the river Vinica in a length of about 4 km has been negatively affected by the exploitation of sand and gravel. The riverbed currently meanders into several branches, reaching a width of up to 200m. This is the reason why the surrounding settlements of Vinicka and Trepca on the left bank and the settlement of Rijeka Maslenica on the right bank are threatened by floods. Although mainly agricultural land is threatened by floods, several commercial buildings, a cemetery in the Rijeka Maslenica settlement and a bridge over the Lim River that leads to this settlement are in the zone of flooding. The road direction Andrijevica - Berane is not threatened, but the route of the planned highway is in the flooding zone. Due to all of the above, it is necessary to carry out regulatory works on the riverbed, which would form minor and major riverbeds upstream from the mouth of the river Vinica and more importantly to strengthen the banks with embankments over a length of approximately 4 km.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Berane Capital Projects Administration
Status of Implementation	No status
Investments Costs	Regulation works and construction of embankment €6,000,000
Priority (first/second/third)	Second

8.2.10 APSFR10_DRB_Lim04

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.12). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.10. The proposed measures for the APSFR are presented in Table 8.11.

Figure 8.10. Identified area of potential flooding in APSFR10_DRB_Lim04

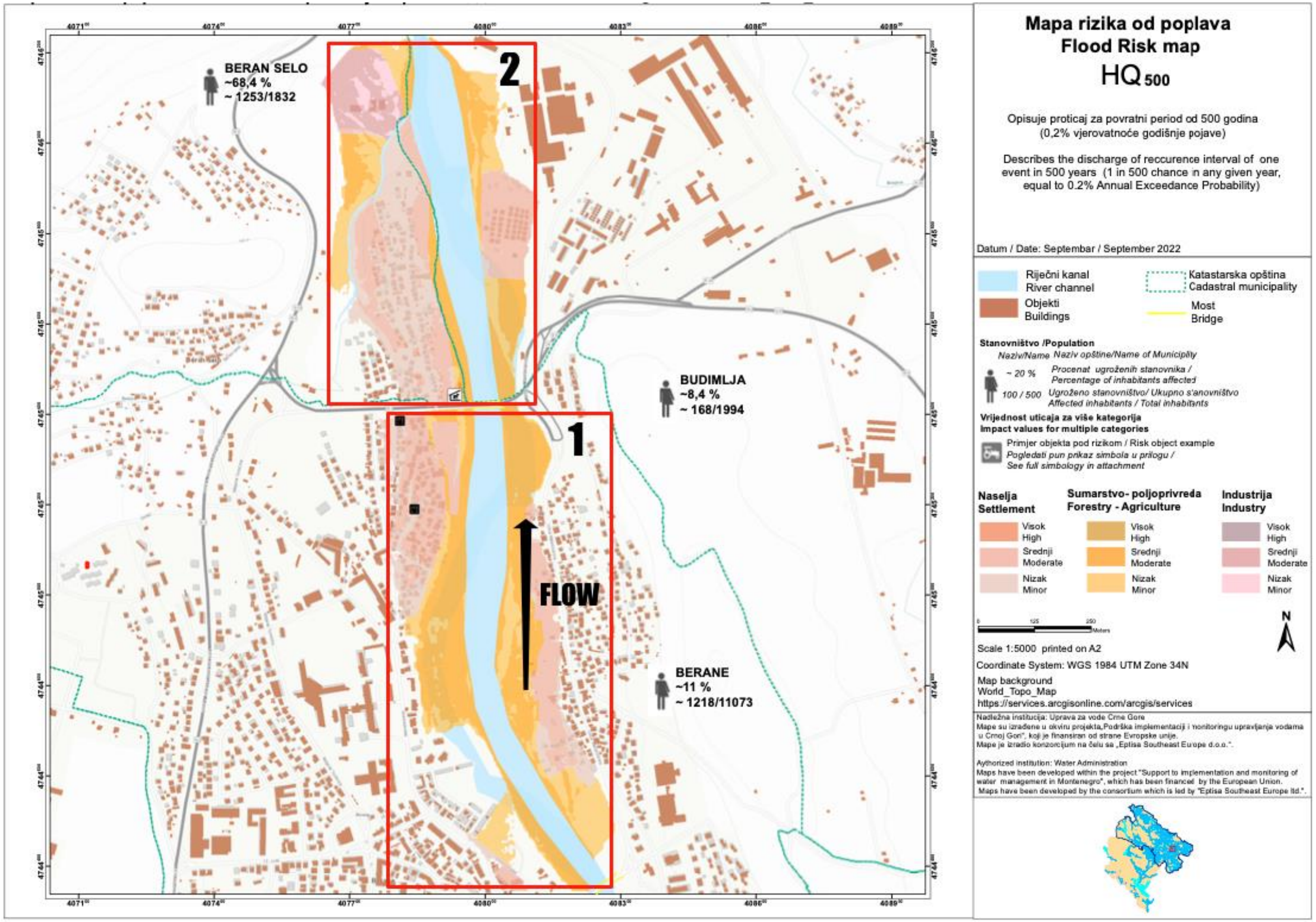
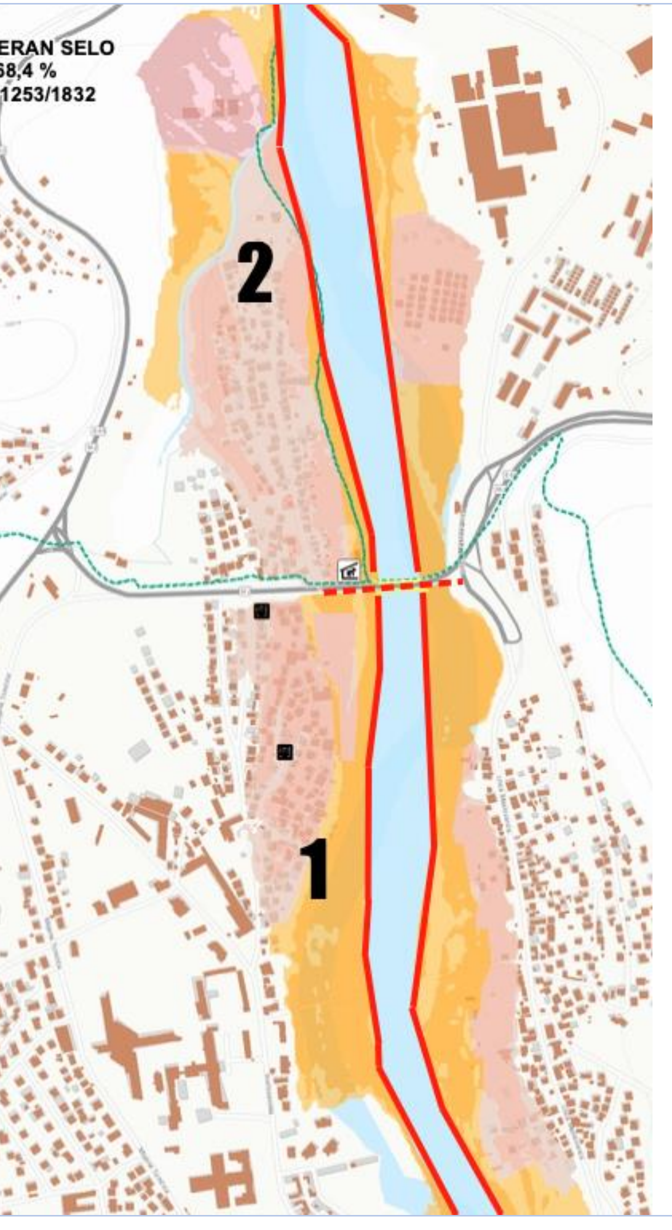


Table 8.11. Measures proposed in APSFR10_DRB_Lim04

Municipality	Berane		
Water body	Lim		
Watercourse	LIm		
Surrounding Area	City of Berane and settlements Talum, Riversajd, Hareme		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	2,393	2,556	2,639
Dwellings	300	334	344
Commercial Businesses	2	2	2
Cultural Objects	0	0	0
Inundation (hectares)	52.92	57.52	59.61

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M21**: *Measures to prevent the location of new or additional receptors in flood prone areas.* Land use planning policies they should be such that they prevent the urbanization and construction of any buildings in areas that are at risk of flooding. The previous spatial planning documentation was limited to the prohibition of construction on water land, as this was prescribed by the Law on Water, and flood risk maps did not exist. **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* On the right and left banks of the watercourse, behind the existing roads, in the section of the current design, there are many residential buildings, business and industrial buildings that are threatened by floods. Around 2,640 inhabitants are also at risk. This is the reason why efforts are being made to protect this area. **Section 1** - Significant flood protection activities were undertaken in the previous period. The construction of the embankment is in the realization phase. Namely, development of documentation for flood protection and irrigation in the Lim river basin, with Grnčar River is part of GEF1/SCCF2 funded WBDRB3 project. The Project Development Objective is to improve mechanisms and capacities in Bosnia & Herzegovina, Montenegro and Serbia to plan and manage the transboundary Drina River Basin (DRB), incorporating climate change adaptation. On the basis of the prepared project documentation, activities are currently being conducted to prepare and call for tender documentation. Expected end of the project in 2025. The existing configuration of the banks of the Lim River on a wider stretch, which including the subject regulation, is characterized by a narrow gorge downstream from the city, and a valley with left lower and right upper banks in the city. Both inundation surfaces are endangered, especially the left one. This section of the river Lim in Berane stretches between two traffic bridges in the total length of 1,234m, in the immediate vicinity of the urban zone of the city. The downstream bridge is on the E-65 road connecting Sušica on the left bank with Maslovarić street on the right bank. The second bridge is the link between the Svetosavska street on the left bank and the Maslovarica street on the right. Technical solution on the entire section covered by the design provides for a uniform flow profile, the so-called "One-sided" riverbed, trapezoidal shape, with the dimensions (width and height/depth) and

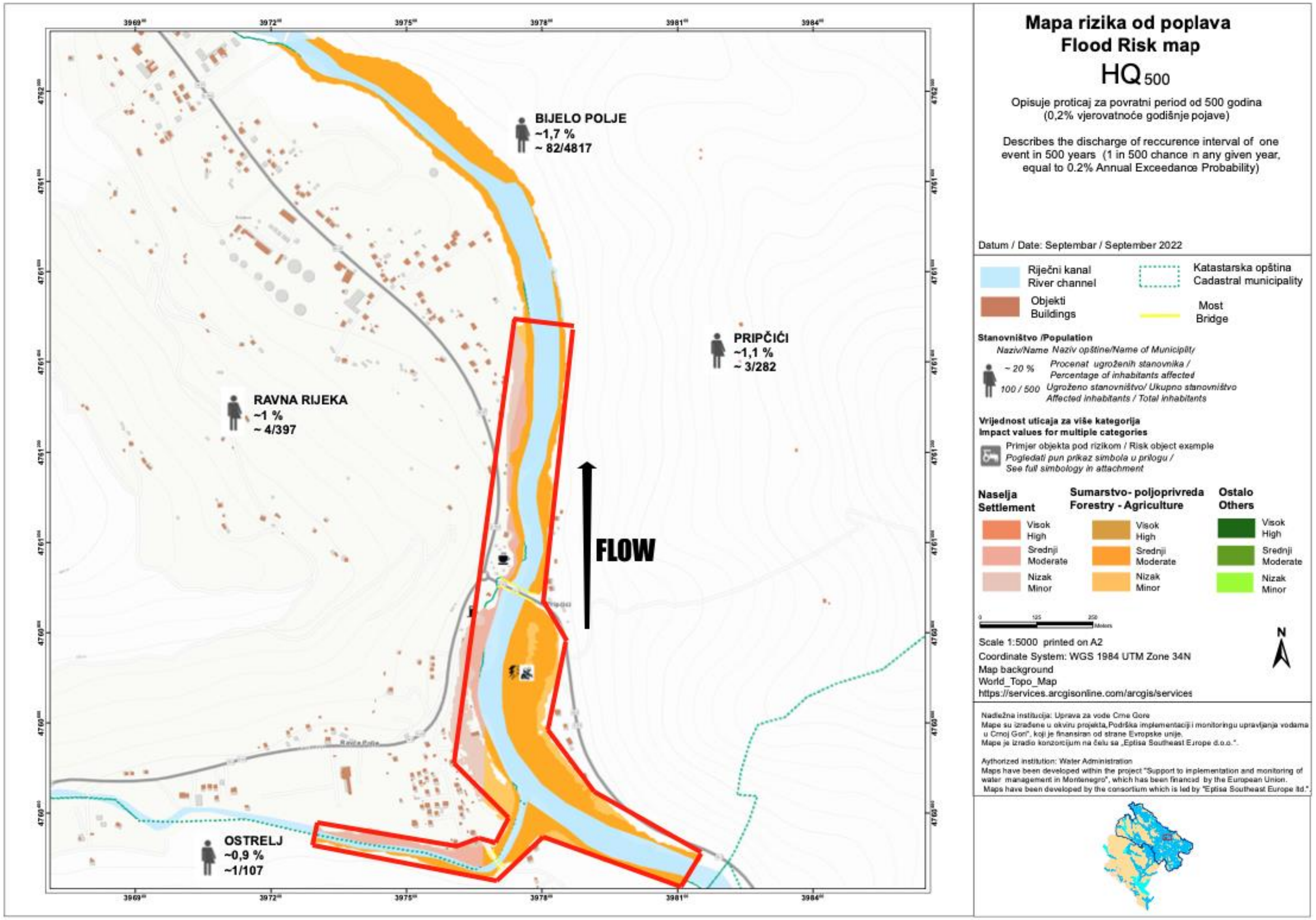
	individual elements (slopes) adapted to the conditions and requirements on the regulated section. The width of the designed riverbed at the bottom amounts to 62 m, the slopes are in the inclination 1:1.15, and the height / depth of the riverbed is 4.0 m. At certain sub-sections, the embankments are envisaged, with a width of 4.0m at the crown, and the outer slopes with the inclination of 1:1.15. The crown of the embankment is planned as a promenade of a 3m wide. **Section 2** – Downstream from the above-mentioned section on the left bank is the settlement of Beran Selo, and on the right is Harem. Over 150 residential buildings in this area are threatened by floods. It is recommended to continue the construction of the embankment in accordance with the upstream section. The length of the section is approximately 900m.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Berane Capital Projects Administration
Status of Implementation	Section 1 - Implementation underway Section 2 - No status.
Investments Costs	Section 1: Construction of embankment €4,145,000 Section 2: Construction of embankment €2,000,000
Priority (first/second/third)	First

Implemented by the consortium: eptisa eptisa Southeast Europe d.o.o. suez

8.2.11 APSFR11_DRB_Lim05

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.13). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.11. The proposed measures for the APSFR are presented in Table 8.12.

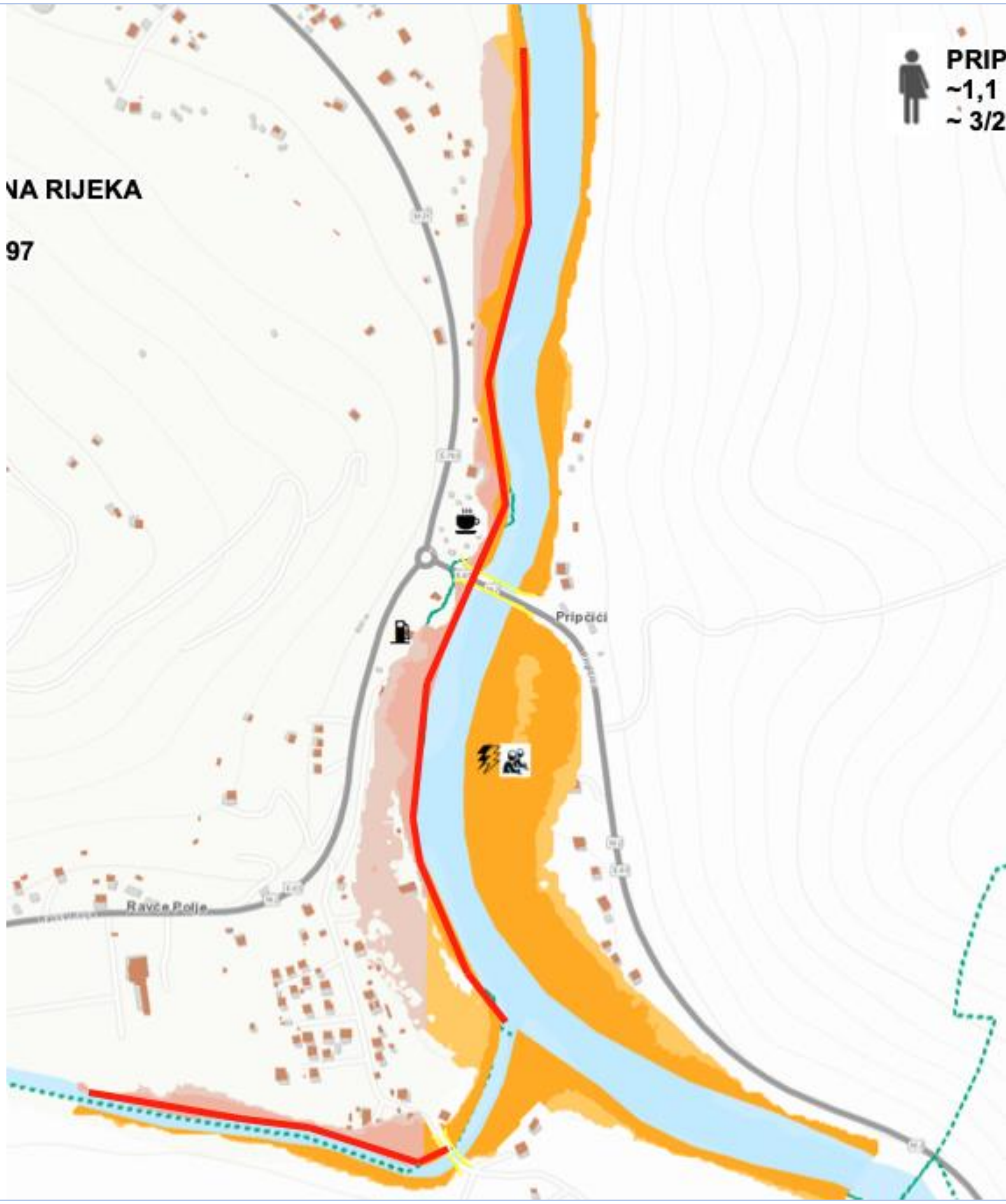
Figure 8.11. Identified area of potential flooding in APSFR11_DRB_Lim05



Implemented by the consortium:
eptisa eptisa suez

Table 8.12. Measures proposed in APSFR11_DRB_Lim05

Municipality	Bijelo Polje		
Water body	Lim		
Watercourse	Lim		
Surrounding Area	Settlement Ribarevina		
Type of Area	Urban	☐ Yes	☒ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	86	88	90
Dwellings	8	21	35
Commercial Businesses	0	1	1
Cultural Objects	0	0	0
Inundation (hectares)	23.42	26.81	29.83

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	The right bank of the section of the Lim River that is the subject of this APFSR is steeper than the left bank. In the vicinity of the threatened area on the left bank, there are important infrastructure facilities such as a highway and a railway leading to Serbia, as well as an electric power plant and TS. All these objects are outside the flood zone. Floods mainly affect agricultural land, within which residential and auxiliary buildings are built, on the left bank of the river Lim upstream of the bridge and downstream of the bridge in a length of 500m. Also, the left bank of the Ljuboviđa tributary, upstream of the mouth, in a length of about 600m, is threatened by floods. Considering the above, the following flood protection measures are proposed: **M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Considering that it is mostly agricultural land, a small percentage of the population (1%) and several buildings are at risk, the use of individual mobile protection at the left bank of river Lim in a length of about 1,200m is recommended. Also, the use of individual mobile protection at the left bank of the river Ljubovida a length of about 300m, is recommended.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Bijelo Polje Capital Projects Administration
Status of Implementation	No status
Investments Costs	Individual mobile protection €300,000
Priority (first/second/third)	Third

8.2.12 APSFR12_DRB_Lim06

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.14). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.12. The proposed measures for the APSFR are presented in Table 8.13.

Figure 8.12. Identified area of potential flooding in APSFR12_DRB_Lim06

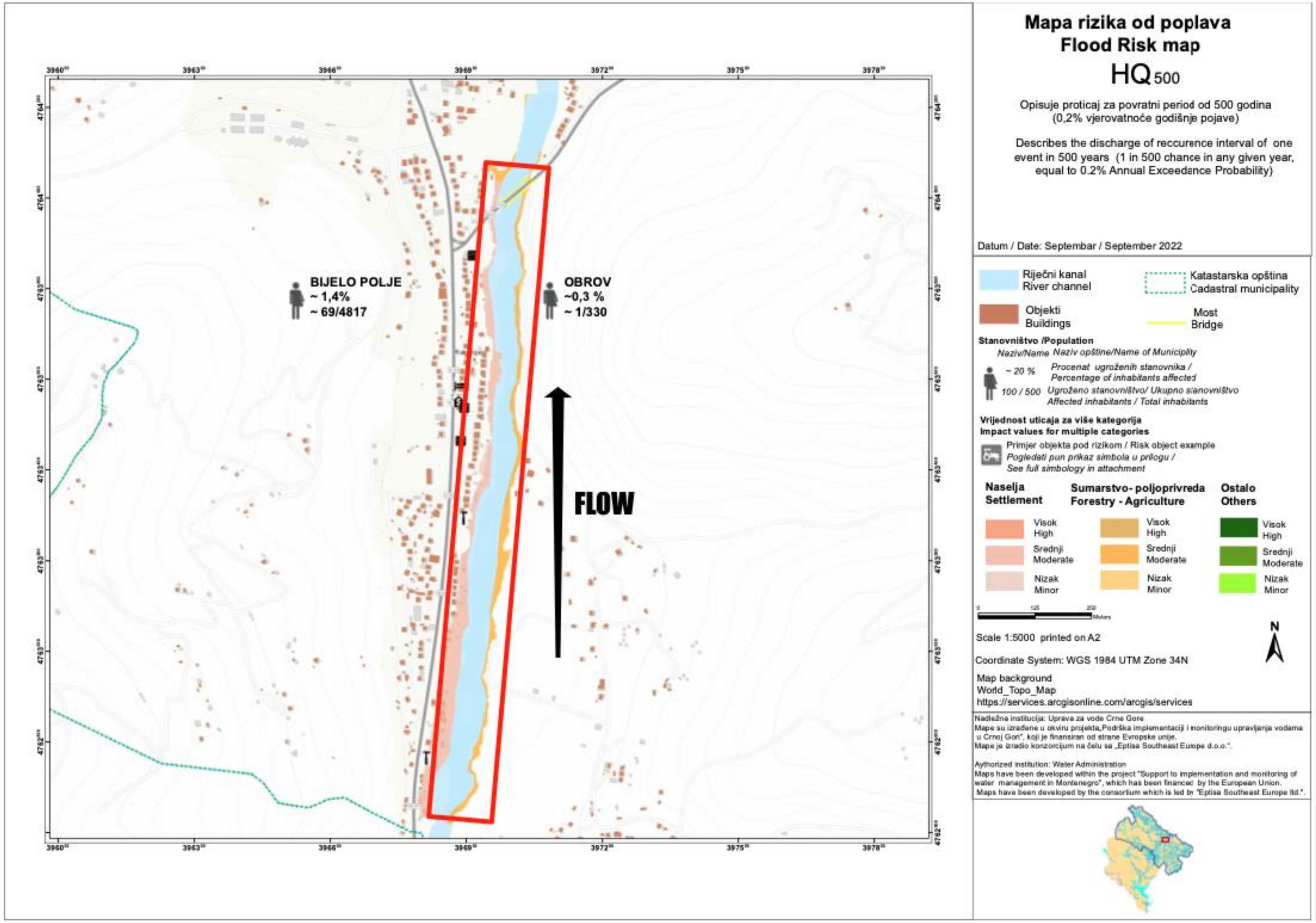


Table 8.13. Measures proposed in APSFR12_DRB_Lim06

Municipality	Bijelo Polje		
Water body	Lim		
Watercourse	Lim		
Surrounding Area	Settlement Rakonje		
Type of Area	Urban	☐ Yes	☒ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	59	65	70
Dwellings	17	25	36
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	11.93	12.92	13.62

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* The affected area is on the left bank of the river Lim, about 600m long. 70 inhabitants and 36 residential and auxiliary buildings have been endangered by floods. This is the reason why it is recommended to build an embankment on this section.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Bijelo Polje, Capital Projects Administration
Status of Implementation	No status
Investments Costs	Construction of embankment €600,000
Priority (first/second/third)	Second

8.2.13 APSFR13_DRB_Lim07

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.15). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.13. The proposed measures for the APSFR are presented in Table 8.14.

Figure 8.13. Identified area of potential flooding in APSFR13_DRB_Lim07

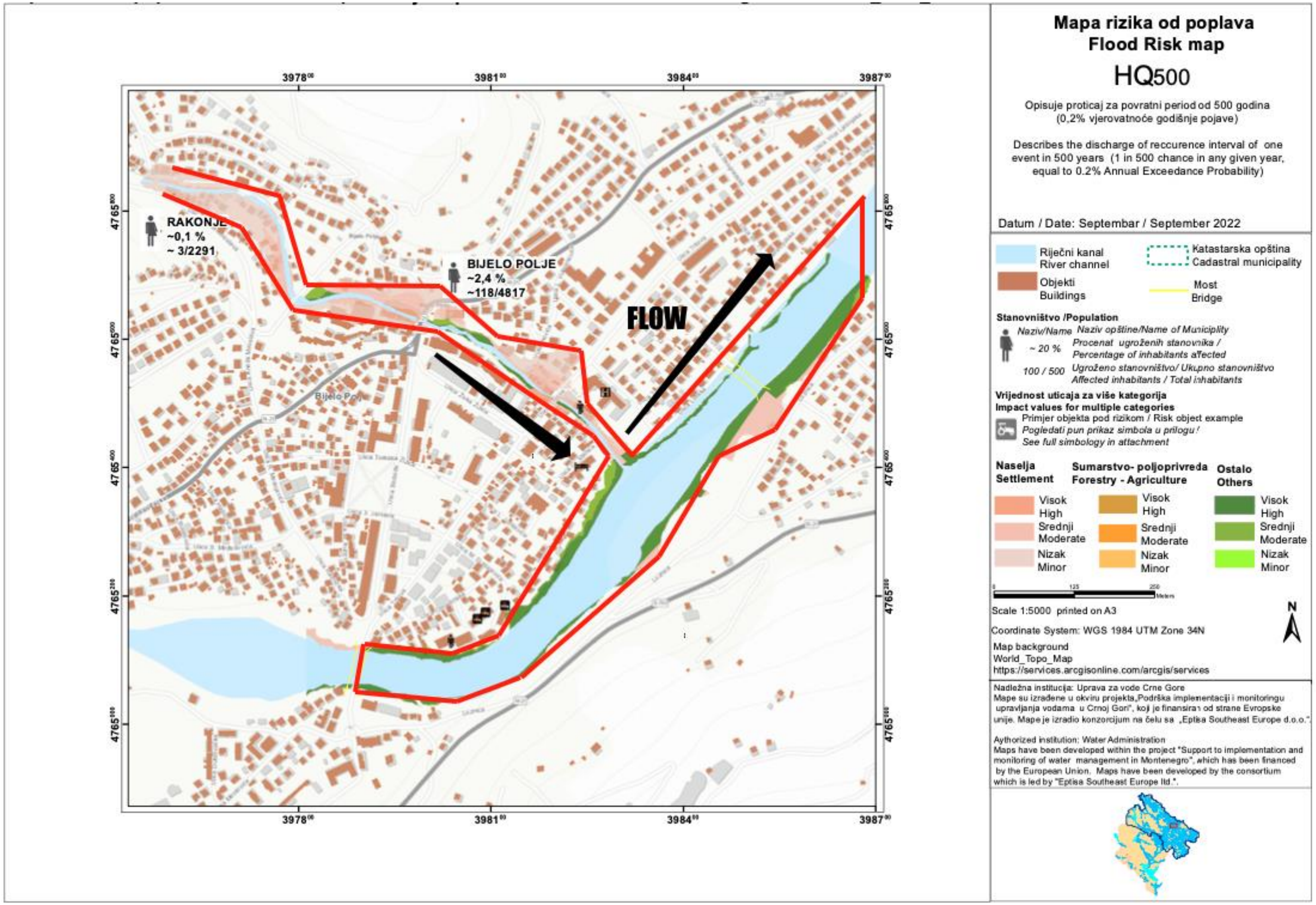
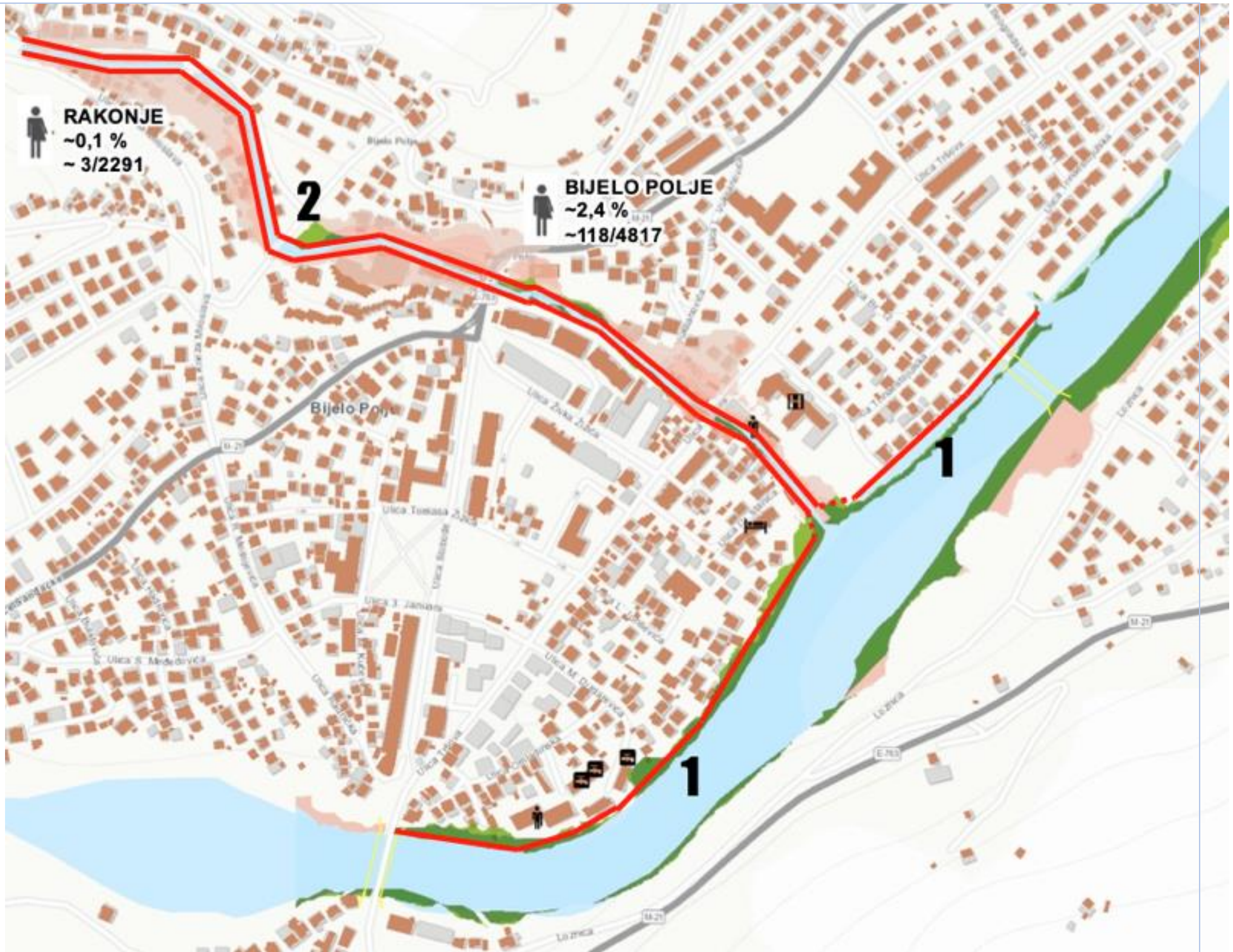


Table 8.14. Measures proposed in APSFR13_DRB_Lim07

Municipality	Bijelo Polje		
Water body	Lim		
Watercourse	Lim		
Surrounding Area	Settlements Lješnica and Rijeke		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	100	112	121
Dwellings	66	82	84
Commercial Businesses	0	1	1
Cultural Objects	0	0	0
Inundation (hectares)	12.37	13.33	14.04

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* **Section 1** - Significant flood protection activities were undertaken in the previous period. The construction of the embankment on Section 1 is in the realization phase. Namely, development of documentation for flood protection and irrigation in the Lim river basin, with Grnčar River is part of GEF1/SCCF2 funded WBDRB3 project. On the basis of the prepared project documentation, activities are currently being conducted to prepare and call for tender documentation. Expected end of the project in 2025. The subject area of this documentation stretches in urban area of Bijelo Polje from the fire station to Limska street. The length of this section is 608m. The Lim River on this section has significant left side tributary river Lješnica. The Lim River bed on the section in question is located between two bridges. The first bridge is pedestrian and is located at about 171m from the beginning of the shoreline that is the subject of the project. The second, traffic bridge is about 9m upstream from the end of the planned embankment. This section of the Lim river is characterized by different configurations of the left and right banks. The terrain on the right bank has a much steeper slope, with higher elevations than the left bank. Accordingly, the left bank was suitable for the formation of the settlement. The majority of objects in the contact zone are for individual housing, with several multi-story buildings. The project area also includes several public facilities: Public Water Supply Agency, Fire Station and pumping station for communal waters next to Lješnica confluence. The entire length of the left bank is overgrown with small to medium trees and bushes. **Section 2** -The bed of the river Lješnica in a stretch of about 60 m from the mouth turns blue at high water levels in Lim. The bed of the river Lješnica in a stretch of about 60 m from the mouth turns blue at high water levels in Lim. Therefore, this section will be included in the development of the left bank of the river Lim on the section between the two bridges. It is recommended that the rest of the section, which is under a moderate risk of flooding in the length of 950 m, should be regularly cleaned and maintained in order to improve runoff, and buildings that may be threatened by flooding should be protected with mobile protection.

Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Bijelo Polje Capital Projects Administration
Status of Implementation	Section 1 - Implementation underway Section 2– No status
Investments Costs	Section 1: Constrution of embankment €4,187,000 Section 2: Mobile protection €600,000
Priority (first/second/third)	First

8.2.14 APSFR14_DRB_Lim08

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.16). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.14. The proposed measures for the APSFR are presented in Table 8.15.

Figure 8.14. Identified area of potential flooding in APSFR14_DRB_Lim08

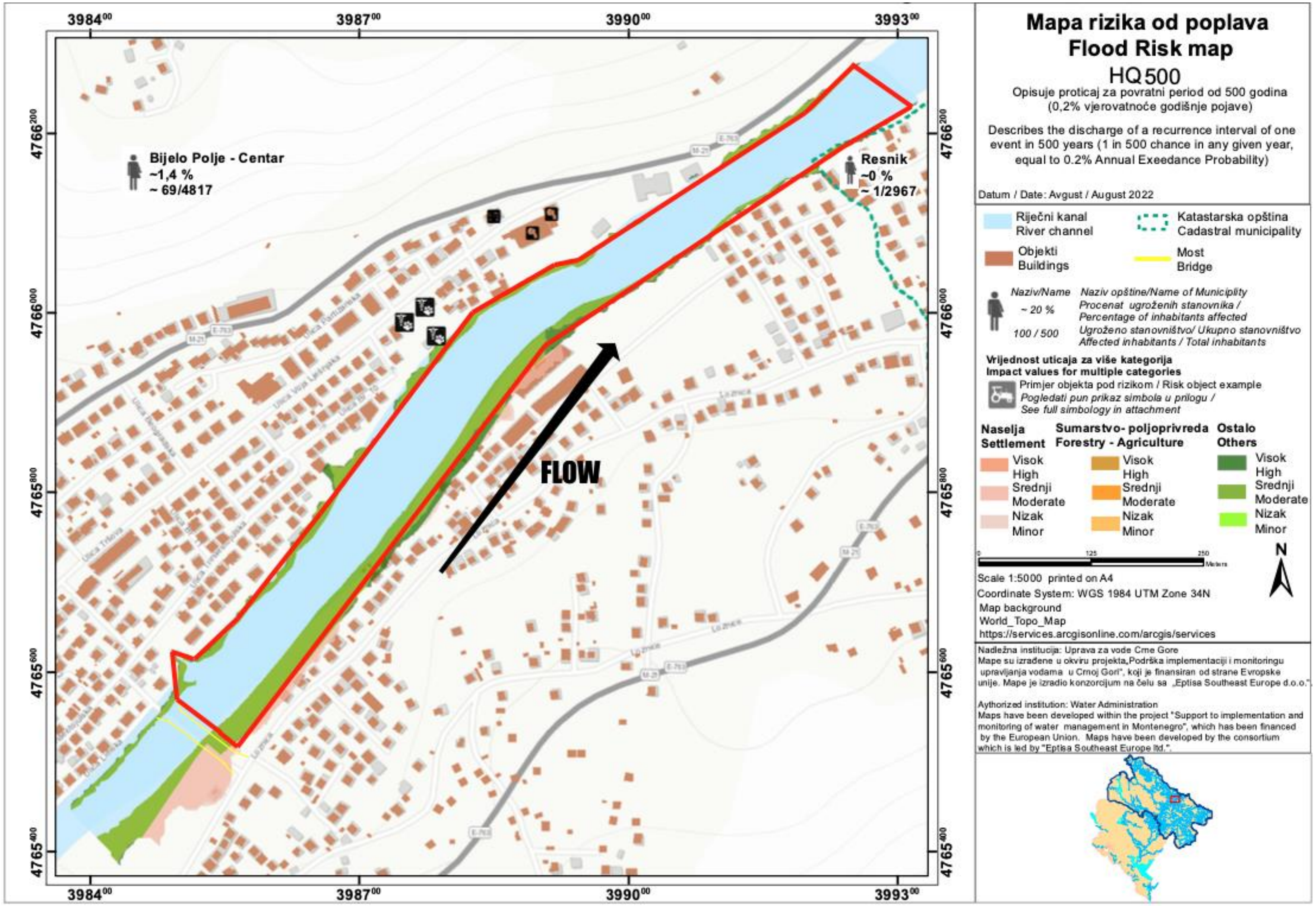
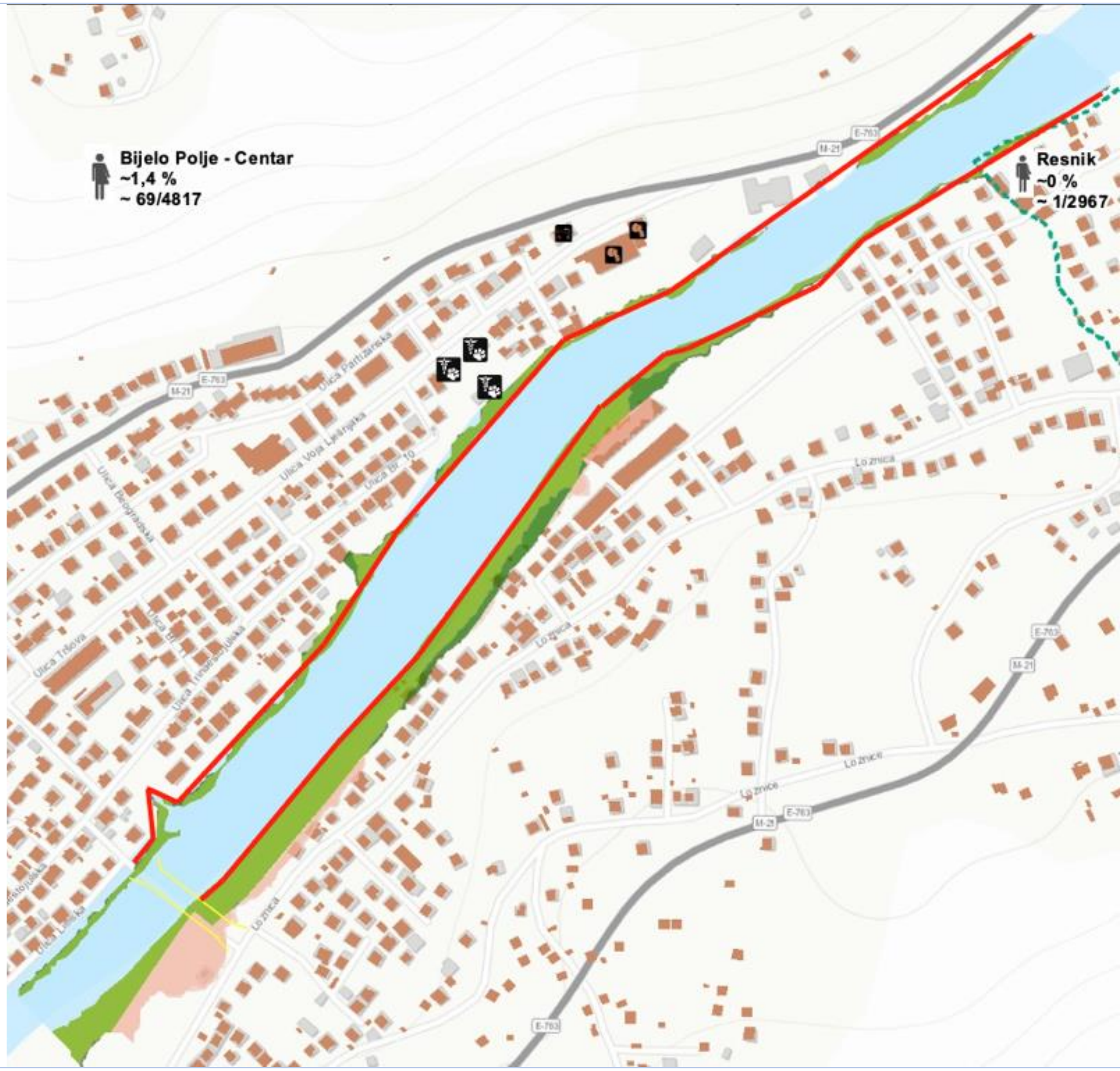


Table 8.15. Measures proposed in APSFR14_DRB_Lim08

Municipality	Bijelo Polje		
Water body	Lim		
Watercourse	Lim		
Surrounding Area	Bijelo Polje, settlement Lipnica		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	53	64	70
Dwellings	11	19	27
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	9.31	10.28	10.76

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* The left and right banks of the river Lim downstream from the pedestrian bridge in a length of about 900m are densely populated. There are a large number of residential and commercial buildings, a gas station, border police administration, etc. It is recommended to continue the construction of the embankment in accordance with the upstream section.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Bijelo Polje Capital Projects Administration
Status of Implementation	No status
Investments Costs	Constrution of embankment €2,000,000
Priority (first/second/third)	Second

8.2.15 APSFR15_DRB_Lim09

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.17). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.15. The proposed measures for the APSFR are presented in Table 8.16.

Figure 8.15. Identified area of potential flooding in APSFR15_DRB_Lim09

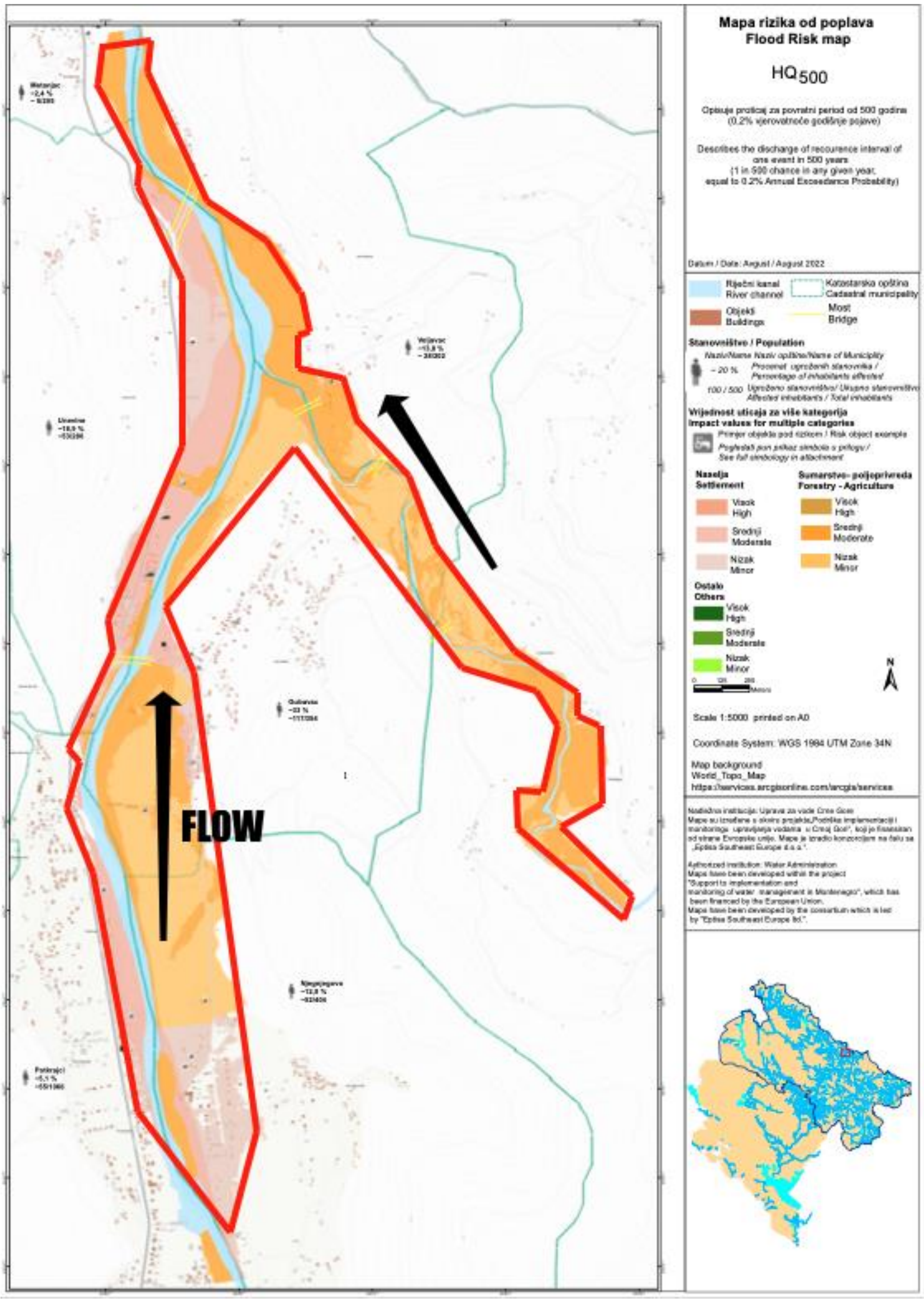
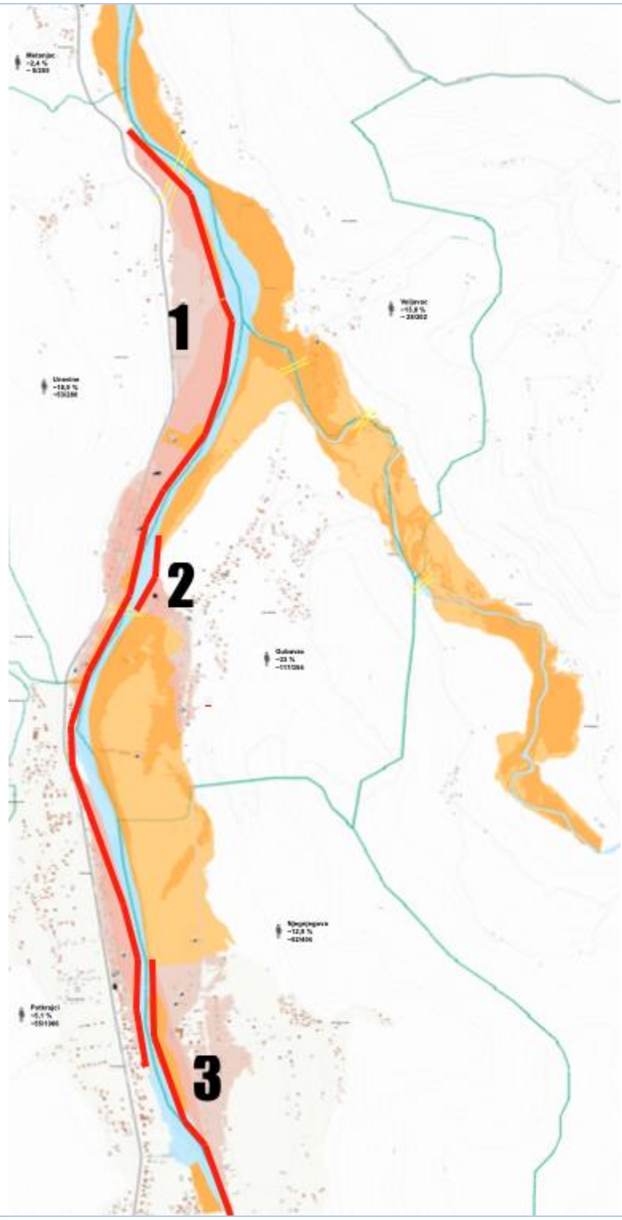


Table 8.16. Measures proposed in APSFR15_DRB_Lim09

Municipality	Bijelo Polje		
Water body	Lim		
Watercourse	Lim		
Surrounding Area	Settlements Oluja, Sutivan, Gubavač, Konatari		
Type of Area	Urban	☐ Yes	☒ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	197	297	322
Dwellings	47	141	160
Commercial Businesses	2	2	7
Cultural Objects	1	1	1
Inundation (hectares)	187.84	268.69	292.27

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* It is recommended to build an embankment on the left bank in the length of 5 km (**Section 1**) and on the right bank in **Section 2** in the length of 300m and **Section 3** in the length of 1200m on the river and Lim. On the river Bistrica, in the upstream part in a length of 1 km, it is recommended to use mobile protection for residential buildings.
Competent Water Authority	Ministry responsible for Water Management (MAFWM) Water Administration (WA)
Other Relevant Authorities	Municipality of Bijelo Polje Capital Projects Administration
Status of Implementation	No status
Investments Costs	Construction of embankment €6,500,000 Mobile protection €600,000
Priority (first/second/third)	Third

8.2.16 APSFR16_DRB_Tara01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.18). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.16. The proposed measures for the APSFR are presented in Table 8.17.

Figure 8.16. Identified area of potential flooding in APSFR16_DRB_Tara01

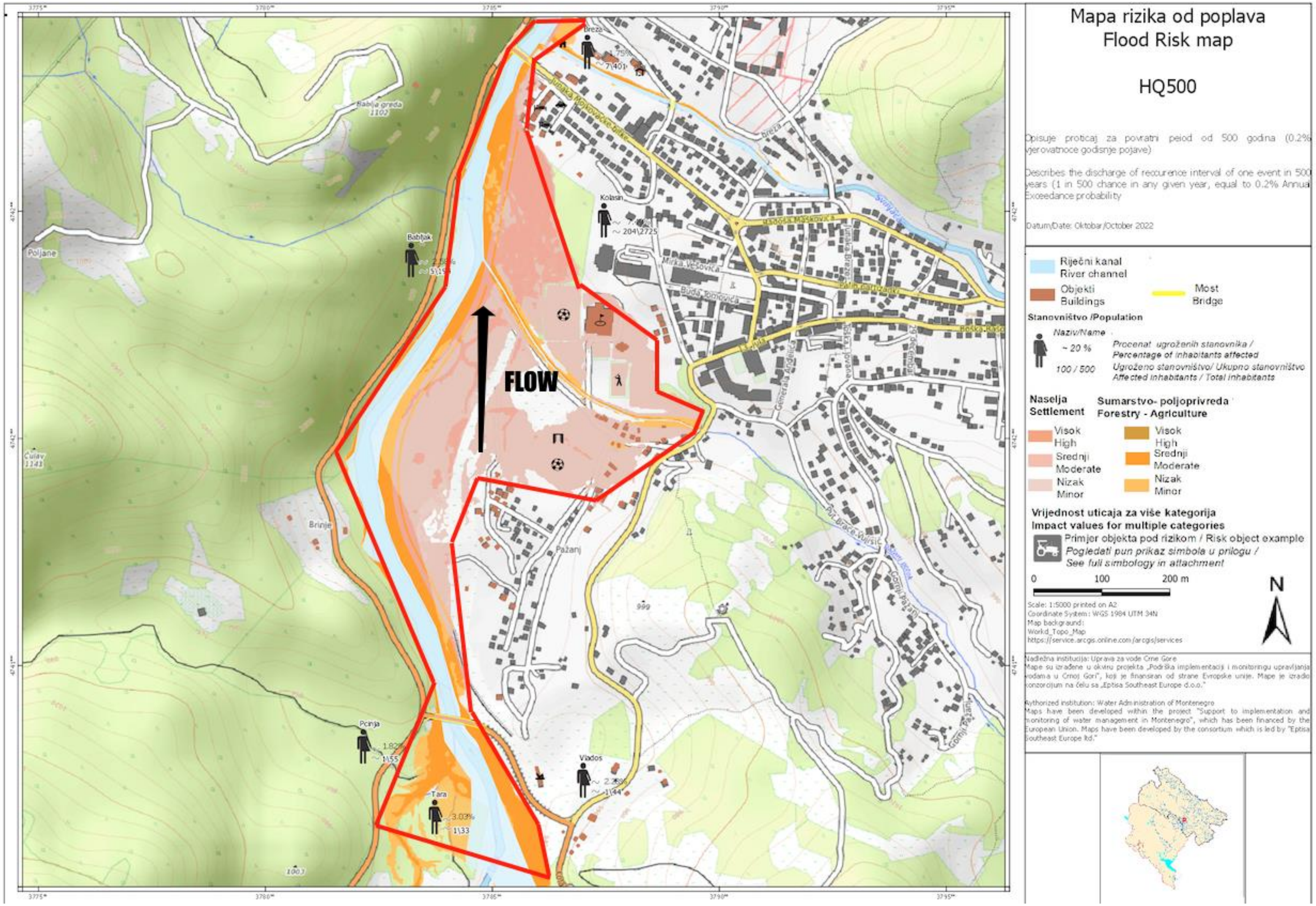
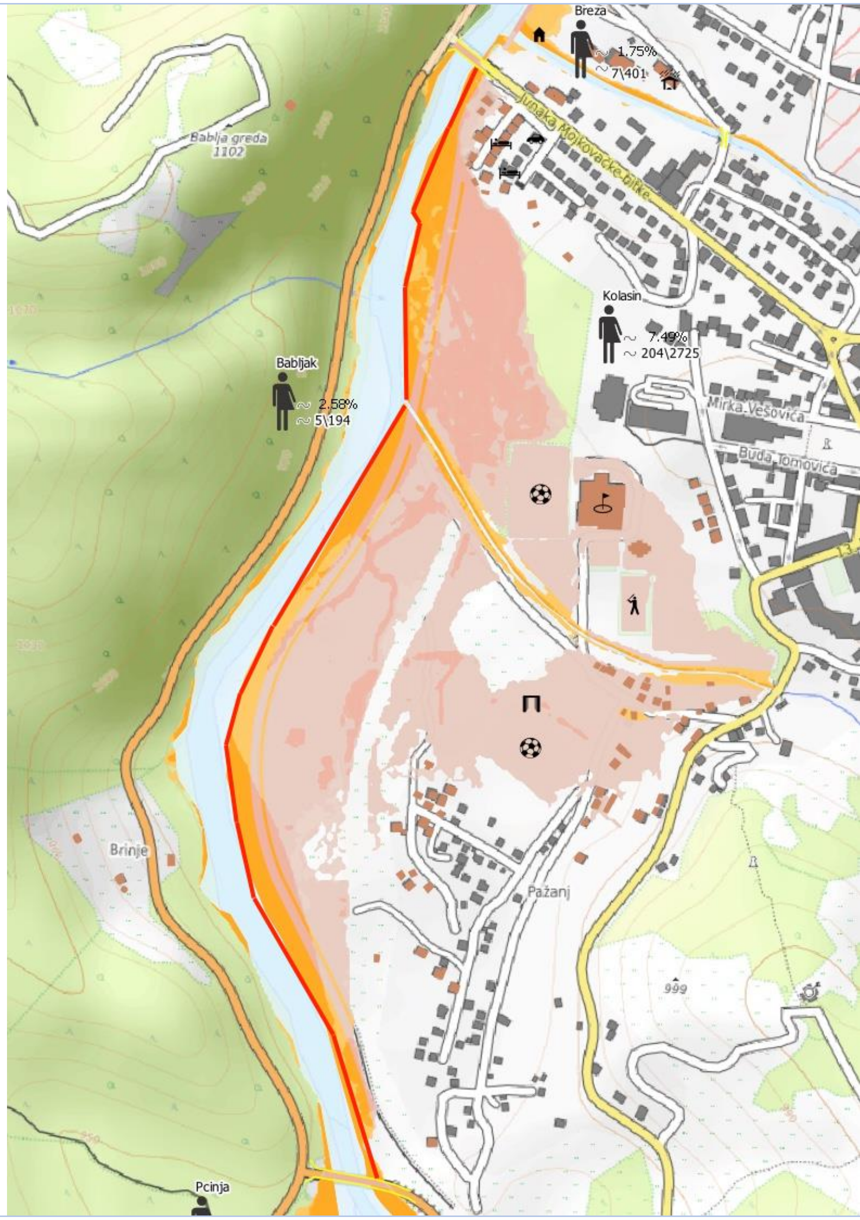


Table 8.17. Measures proposed in APSFR16_DRB_Tara01

Municipality	Kolasin		
Water body	Tara		
Watercourse	Tara		
Surrounding Area	Kolašin – settlement Donji Pažanj		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	62	210	219
Dwellings	10	35	38
Commercial Businesses	0	1	2
Cultural Objects	0	0	0
Inundation (hectares)	27.57	48.37	52.42

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

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eptisa eptisa Southeast Europe d.o.o. suez

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* The regulation of the Tara River through Kolašin was carried out on a section about 100m downstream from the "Babljak" bridge over the Tara River, at the connection of Kolašin with the main road up to above Bećova Bara, in a length of approx. 3000 m. The works were carried out in the period 2012-2014. The proposed measure involves embankment maintenance and watercourse cleaning work, which should be carried out continuously.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Kolašin
Status of Implementation	Implementation underway
Investments Costs	-
Maintenance Costs	Embankment maintenance and clearance of the river bed €50,000/year
Priority (first/second/third)	First

8.2.17 APSFR17_DRB_Tara02

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.19). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.17. The proposed measures for the APSFR are presented in Table 8.18.

Figure 8.17. Identified area of potential flooding in APSFR17_DRB_Tara02

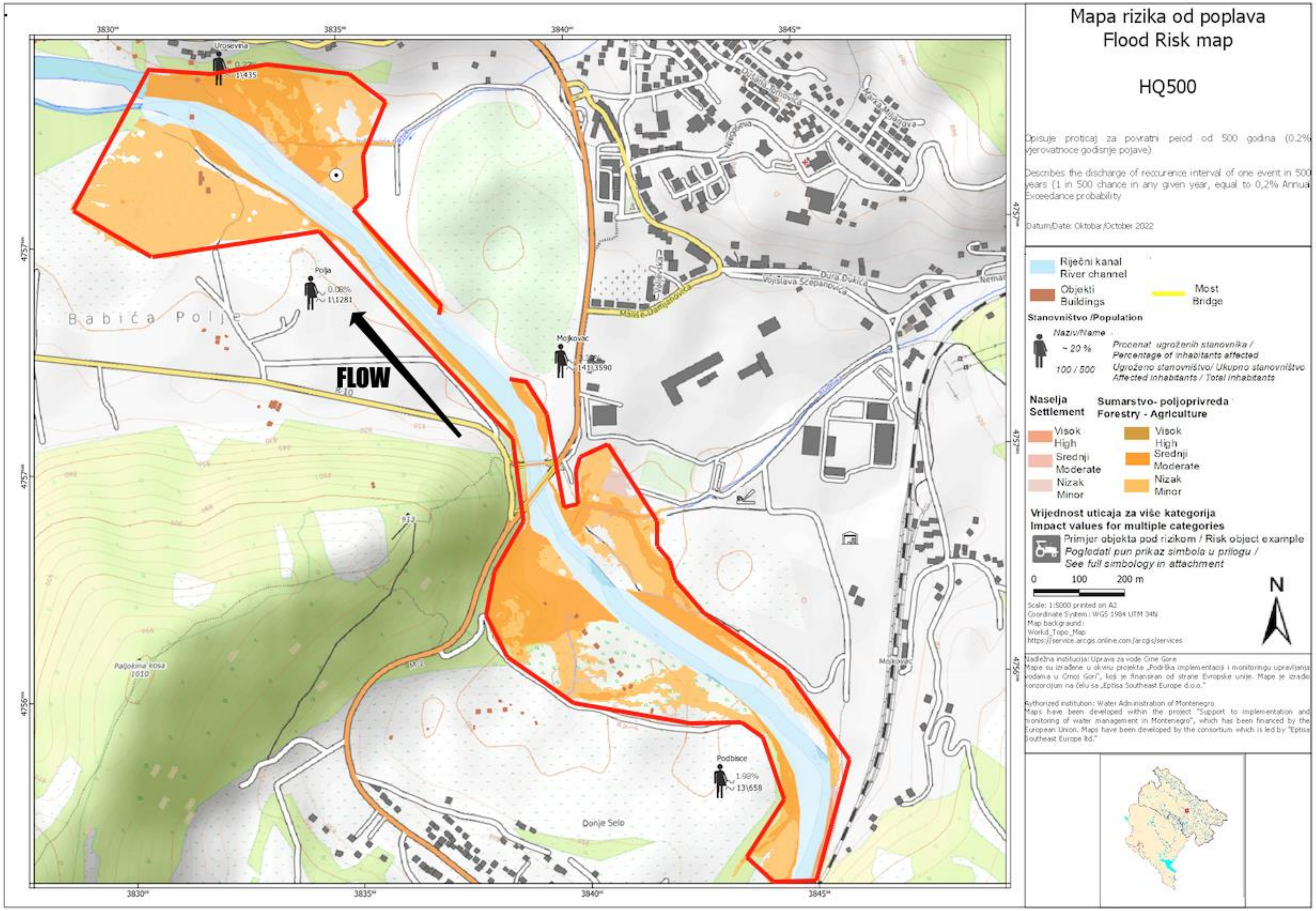

Table 8.18. Measures proposed in APSFR17_DRB_Tara02

Municipality	Mojkovac		
Water body	Tara		
Watercourse	Tara		
Surrounding Area	Settlements Podbišće, Ambarine		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	89	128	156
Dwellings	9	13	16
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	26.38	38.96	46.82

Schematic location of Risk Area (HQ500)

Solid Red lines indicate location of proposed measures

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Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* The Tara River has been regulated in the following sections: • An embankment near Mojkovac in order to protect the right bank downstream from the rehabilitated tailings of the "Brskovo" mine. • Two stone fortifications 100 m long were built on the right bank of the Tara, in the settlement of Ambarine and in the locality of Kneževići • Protection of the Jalovišta embankment - regulation and protection of the Tara shore from the railway bridge to under the sewage treatment plant, as well as protection of the right bank of the Tara and the local road towards Prošćenje, in several locations, 600m long, in the municipality of Mojkovac. Regulation of the Rudnica tributary, which flows into the Tara river immediately upstream of Mojkovac, on a length of 1000 meters, was carried out. The works were carried out in 2013. The proposed measure involves embankment maintenance and watercourse cleaning work, which should be carried out continuously.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Mojkovac
Status of Implementation	Implementation underway
Investments Costs	-
Maintenance Costs	Embankment maintenance and clearance of the river bed €100,000/year
Priority (first/second/third)	First

8.2.18 APSFR18_DRB_Breznica01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.20). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.18. The proposed measures for the APSFR are presented in Table 8.19.

Figure 8.18. Identified area of potential flooding in APSFR18_DRB_Breznica01

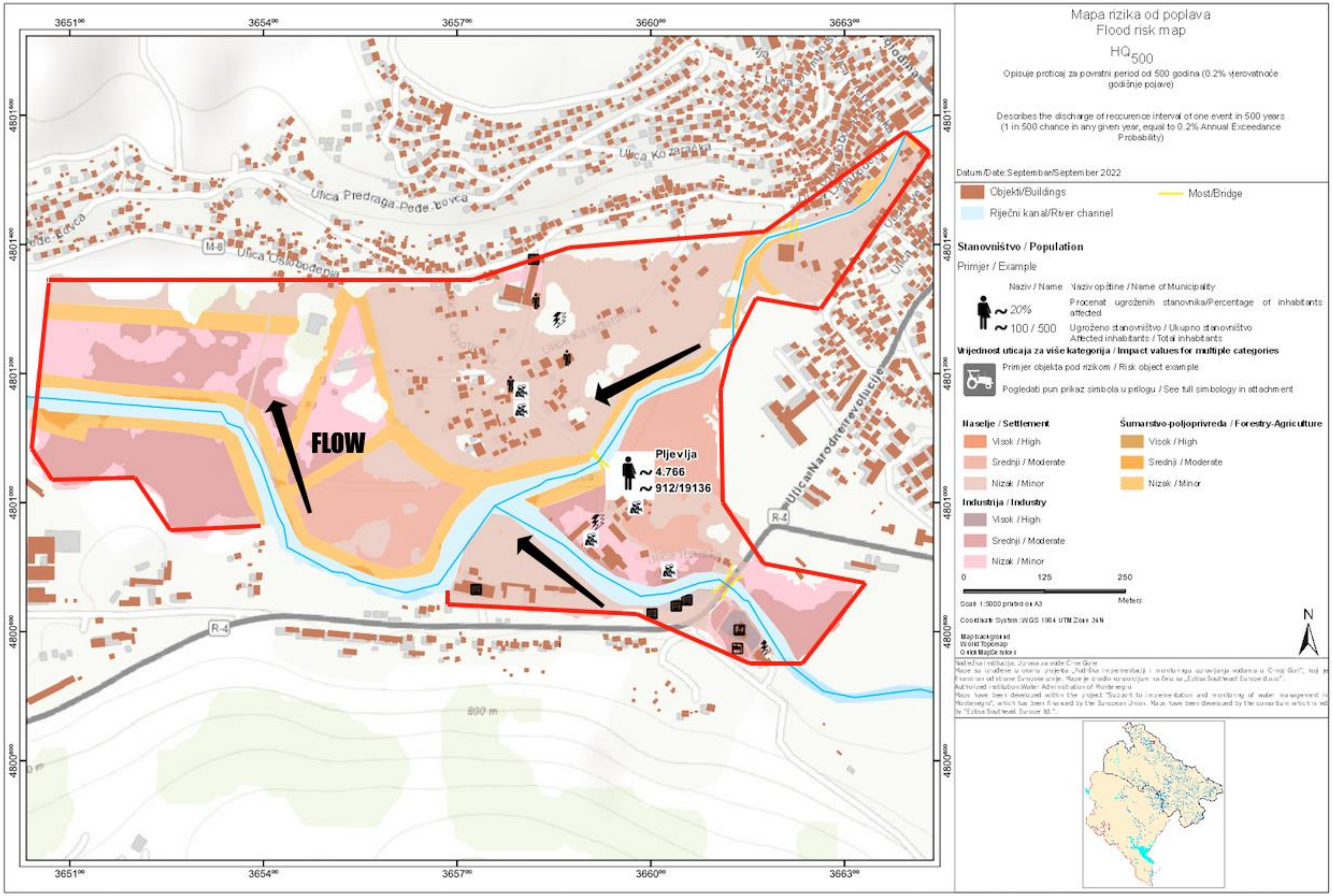
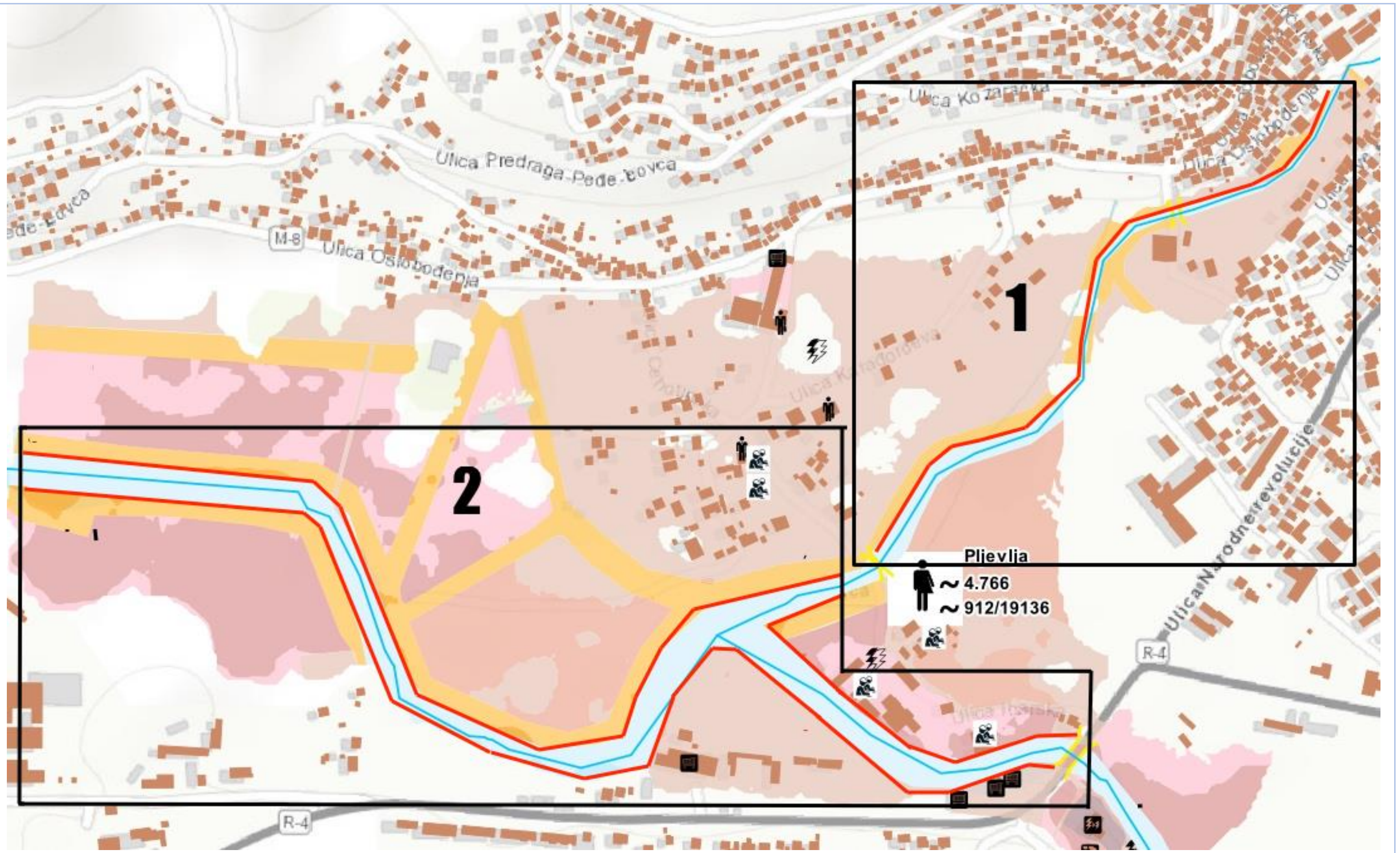


Table 8.19. Measures proposed in APSFR18_DRB_Breznica01

Municipality	Pljevlja		
Water body	Ćehotina		
Watercourse	Breznica		
Surrounding Area	Ševari		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	788	871	912
Dwellings	90	100	102
Commercial Businesses	9	9	10
Cultural Objects	0	0	0
Inundation (hectares)	45.02	48.70	50.37

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* **Section 1** - The bed of the river Breznica is regulated in the city center between the streets Prvi december and Kralj Petar. It is proposed to continue the regulation of the Breznica River in accordance with the already performed works downstream from the bridge on Kralj Petar Street in a length of about 700m. - **Section 2** - Regular maintenance of the flow rate of the river bed of the Breznica river is proposed (cleaning the bottom of the river bed from sediment, mud, waste, low vegetation and trees, cleaning the slopes and banks of the river bed). It is about the section of the Breznica river downstream from the regulated part of the riverbed to the mouth of the Ćehotina river in a length of 600m, as well as downstream from the mouth in a length of 670m (and further up to the WWTP, a total of 2km).
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Pljevlja Capital Projects Administration
Status of Implementation	No status
Investments Costs	Section 1: Construction of embankment €1,500,000 Section 2: Maintenance and clearance of the river bed €300,000
Priority (first/second/third)	First

8.2.19 APSFR19_DRB_Bukovica i Bijela01

The areas at risk of flooding have been identified for the APSFR at a return periods of HQ10, HQ100 and HQ500 (See Section 6.21). The areas prone to flooding where mitigation measures are required are shown at a return period of HQ500 in Figure 8.19. The proposed measures for the APSFR are presented in Table 8.20.

Figure 8.19. Identified area of potential flooding in APSFR19_DRB_Bukovica I Bijela01

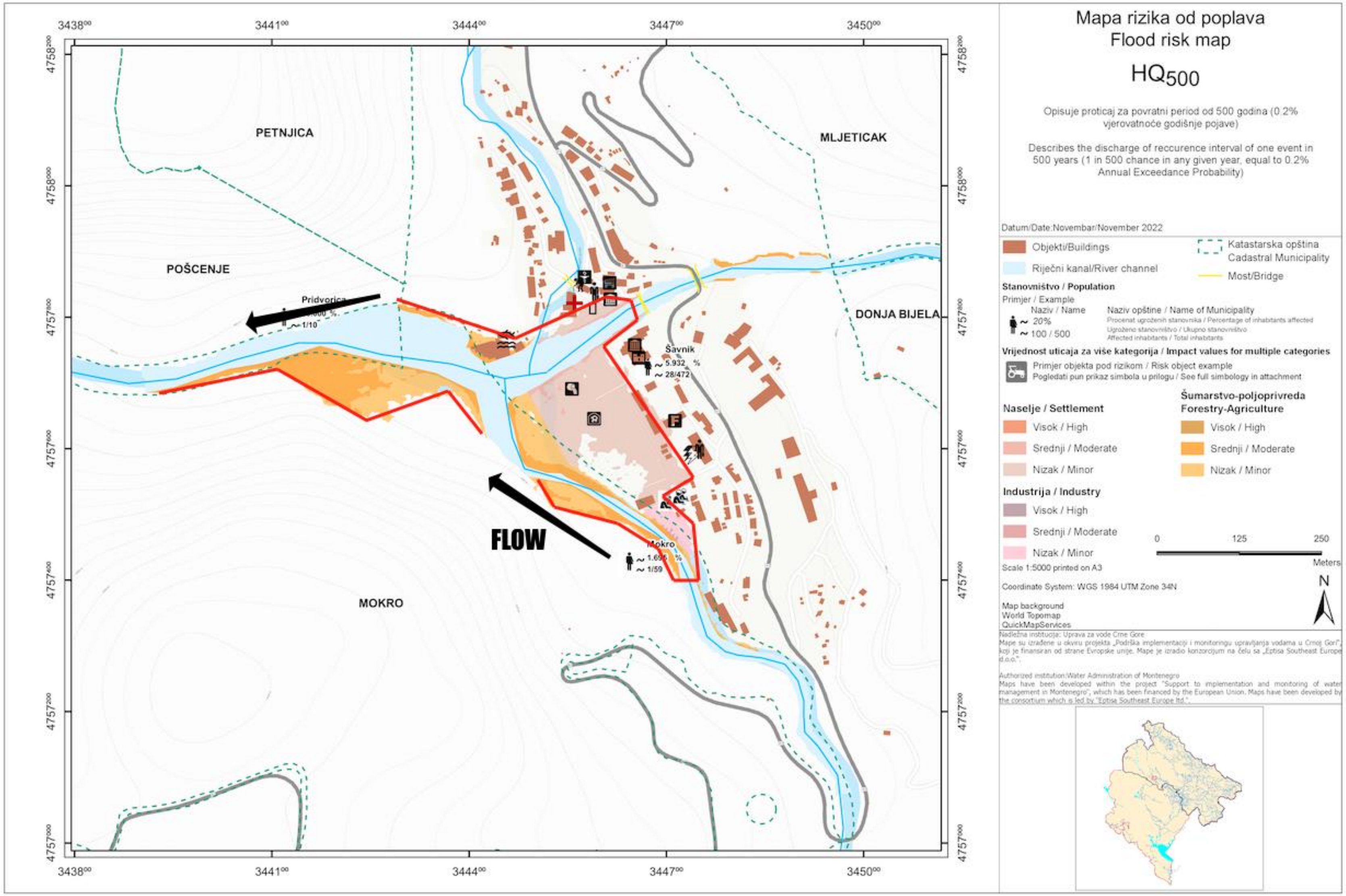
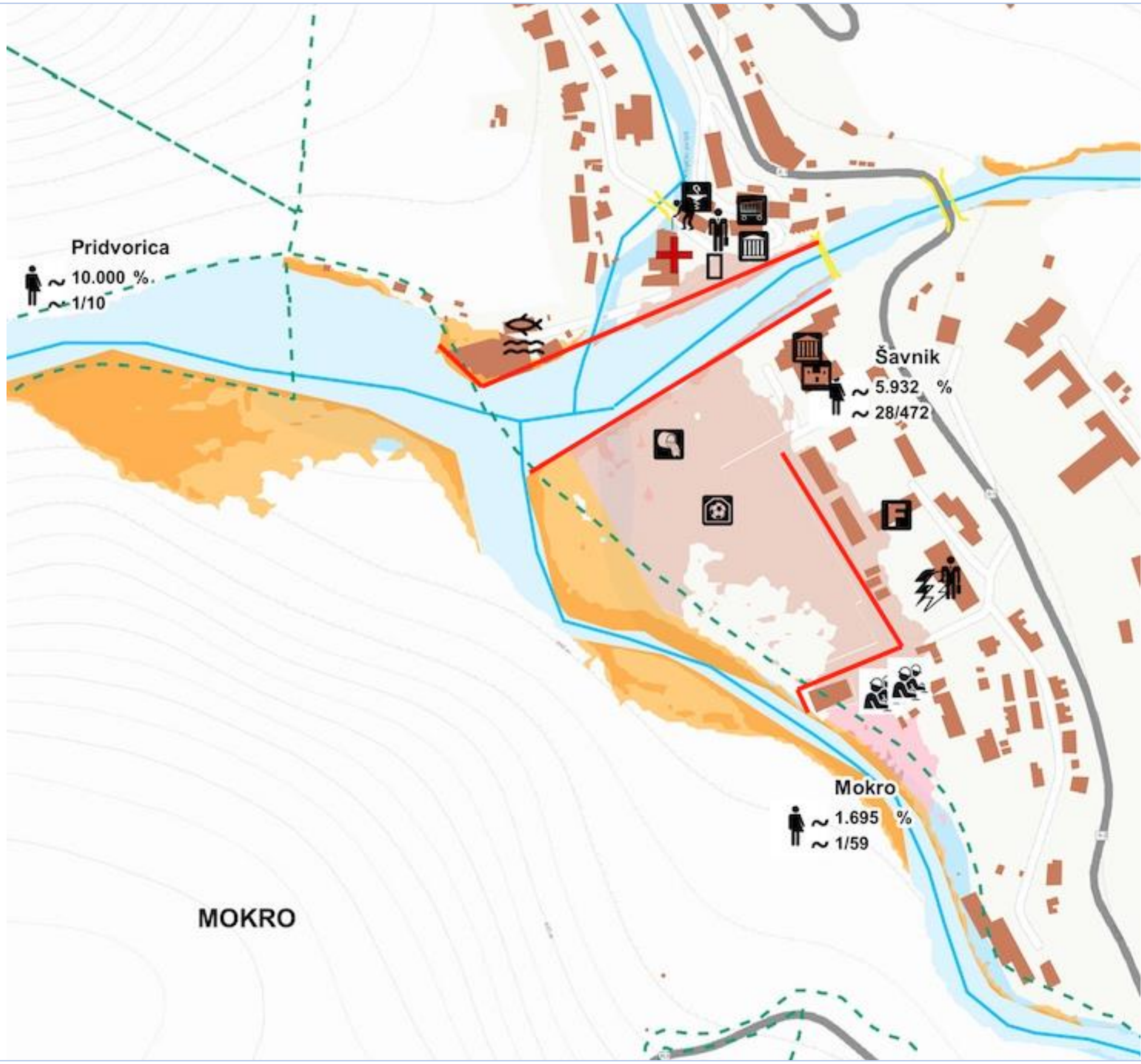


Table 8.20. Measures proposed in APSFR19_DRB_Bukovica I Bijela01

Municipality	Šavnik		
Water body	Piva		
Watercourse	Bukovica i Bijela		
Surrounding Area	Šavnik		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
No. at Risk During Flooding	High Probability Event (HQ10)	Medium Probability Event (HQ100)	Low Probability Event (HQ500)
Inhabitants	14	22	30
Dwellings	3	5	13
Commercial Businesses	0	0	0
Cultural Objects	0	0	0
Inundation (hectares)	7.47	11.16	13.56

Schematic location of Risk Area (HQ500) Solid Red lines indicate location of proposed measures	

Key Measures	**M33**: *Measures involving physical intervention in freshwater channels, mountain streams and flood-prone areas, such as the construction, modification or removal of structures or the alteration of channels, sediment dynamics management, dykes, etc.* Mobile flood protection in the centre of Šavnik on the banks of the Bukovica river in a length of about 300m and for individual buildings in the floodable zone is recommended.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Municipality of Šavnik Capital Projects Administration
Status of Implementation	No status
Investments Costs	Mobile protection €120,000
Priority (first/second/third)	Second

8.3 Proposed further non-structural measures for APSFR

Aspect	Code	Measure	Indicative Description of Activities	Indicative priority	Period of Implementation	Financing sources
Prevention	M23	Promotion of best practice for integrated and sustainable flood risk management (use of green infrastructure, construction/relocation of residential and other objects from flood-prone areas, spatial planning, etc.)	Workshop with participation of institution responsible for construction, special planning and infrastructure	medium	not defined	National sources (budget) EU funds
		Preparation of spatial planning documentation, where the flood risk maps should be a mandatory part, in order to reserve space for large water spills.	In areas where the risk of flooding has been identified, urbanization should be limited in order to reduce the risk of flooding to human health and the economy, and to enable rapid drainage of flood waters.	high	6 years	National sources (budget)
		Implementation of Rulebook on the Content of Operational Instructions for Retention Management Intended for Protection Against Floods ("Official Gazette of Montenegro", no. 3/18)	Undertake operational instructions for reservoir management intended for protection against floods and multi-purpose reservoirs defined by the Rulebook.	high	Immediate	EPCG
		Promotion of measures for population self-defence in case of floods	Workshop with participation of institution responsible for emergencies and civil protection	high	not defined	National sources (budget, water fees) EU funds
	M24	Identification of areas of interest for flood protection	Consideration of proposals and adaptation of areas of mutual importance for flood protection	high	6 years	
		Coordination of Areas with Potentially Significant Flood Risk (APSFR) in	Bilateral communication related to relevant data exchange	high	6 years	

Aspect	Code	Measure	Indicative Description of Activities	Indicative priority	Period of Implementation	Financing sources
		international basins / areas of mutual interest				
		Promotion of best practices in emergency flood defence	Workshop on measures for emergency flood defence with dykes, with examples of best practices	medium	3 years	
Protection	M32	Implementation of Rulebook on the Content of Operational Instructions for Retention Management Intended for Protection Against Floods ("Official Gazette of Montenegro", no. 3/18)	Undertake operational instructions for reservoir management intended for protection against floods and multi-purpose reservoirs defined by the Rulebook.	high	Immediate	
Preparedness	M41	Continuous improvement of the system for hydrological and meteorological observations and data transfer systems	Support from Hydrometeorological and Seismological institute	high	long term	
		Improvement of national forecast and early warning system	Permanent activities on data collection and development of models. Upgrades in sense of flexible model management which will be adjusted to current and long term needs of the countries	high	long term	
	M43	Encouraging interested public to take part in implementation of FRMP	Regular communication and reporting	high	Continuous	
		Information exchange and coordination of activities in operational flood defence	Creation of an internet application for information exchange between stakeholders involved in emergency flood defence, as well as for informing the public	high	Continuous	

8.4 Summary of measures

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
APFR01_DRB_ Ibar01	Ibar	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M33: Construction and maintenance of embankments on the section Rožaje - Suho Polje - Zeleni, approx. 3.7 km long on both sides.	First	Section 1 - Completed works Section 2 - Completed works Section 3 - Preliminary project Section 4 - No status	€100,000/yr €50,000/yr €3,500,000 €1,500,000 Total: €5,150,000	- National sources (budget, water fees) EU funds Loans (The World Bank, EIB, EBRD…)
APSFR02_DRB_ Ibarac01	Ibar/Ibarac	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M33: Construction of the embankment approx. 1 km long on both sides of the river Ibarac.	Second	No status	€2,000,000	
APSFR03_DRB_ Lovnička rijeka01	Ibar/Lovnička	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M33: Cleaning of the riverbed, removal of sediment and vegetation and mobile protection is recommended in a length of 1200m.	Second	No status	€50,000/year €300,000	
APSFR04_DRB_ Županica01	Ibar/Županica	M21: Preventing urbanization and construction of any buildings in areas prone to flooding	Second	No status		

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		M31: By forming a green protective belt M33: Individual mobile protection for facilities on the left and right banks of the Županica river where necessary in a length of 2000 m.			€500,000	
APSFR05_DRB_ Grnčar01	Lim/Grnčar	M33: Construction of an embankment with a length of 842 m.	First	Implementation phase in progress	€10,000,000 [107]	
APSFR06_DRB_ Vruja01	Lim/Vruja	M33: Regular maintenance of the built infrastructure (embankment on the left bank upstream and downstream of the Vruja bridge in a length of 400m).	First	Constructed Regular maintenance	€50,000/god	
APSFR07_DRB_ Lim01	Lim	M33: Construction of an embankment in the settlement of Brezojevica with a length of 1,315 m.	First	Implementation phase in progress	€1,800,000[108]	
APSFR08_DRB_ Lim02	Lim	M33: Regular maintenance of the embankment on the river Lim on the stretch from the mouth of the river Zlorečica to Slatina (above the refugee settlement) in a length of 660m.	First	Constructed Regular maintenance	€50,000/god	
APSFR09_DRB_ Lim03	Lim	M33: Regulatory works on the bed, upstream from the mouth of the	Second	No status		

[107] Loan secured by WB
[108] Loan secured by WB

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		river Vinicka in a length of approx. 4 km.			€6,000,000	
APSFR10_DRB_ Lim04	Lim	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M33: Construction of an embankment in the length of 2134 m.	First	Section 1 - Implementation in progress (1234m) Section 2 - No status (900m) Total	€4,14500,000 €2,000,000 €6,14500,000 [109]	
APSFR11_DRB_ Lim05	Lim	M33: Individual mobile protection on the left bank of the river Lim in a length of about 1,200 m in the village of Ribarevina	Third	No status	€300,000	
APSFR12_DRB_ Lim06	Lim	M33: Construction of an embankment on a section about 600 m long in the Rakonje settlement	Second	No status	€600,000	
APSFR13_DRB_ Lim07	LIm	M33: Construction of an embankment on section 1 from the fire station to Limska Street, length 608m. Section 2, with a length of 950 m, is regularly cleaned and maintained by mobile security.	First	Section 1 - Implementation in progress Section 2 – No status	€4,187,000 €600,000 Total: €4,787,000[110]	
APSFR14_DRB_ Lim08	LIm	M33: Construction of embankments on the left and right banks of the river Lim downstream of the pedestrian bridge in a length	Second	No status	€2,000,000	

[109] Obezbijeđen kredit WB za I fazu u iznosu od 3,200,000€
[110] Obezbijeđen kredit WB

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APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		of about 900m.				
APSFR15_DRB_ Lim09	LIm	M33: Construction of embankment on the left bank of the river Lim in a length of 5 km. On the river Bistrica, in the upstream part in a length of 1 km mobile protection for residential buildings	Treći	No status	€6,500,000 €600,000 Total: 7,100,000	
APSFR16_DRB_ Tara01	Tara	M33: Regular maintenance of the embankment of the Tara River through Kolašin on a section about 100m downstream from the "Babljak" bridge over the Tara River, at the junction of Kolašin with the main road up to above Bećova Bara, in a length of approx. 3000 m.	First	Constructed Regular maintenance	€50,000/yr	
APSFR17_DRB_ Tara02	Tara	M33: Maintenance of embankments and cleaning of waterways.	First	Constructed Regular maintenance	€100,000/yr	
APSFR18_DRB_ Breznica01	Ćehotina/ Breznica	M33: regulation of the Breznica River in accordance with the already performed works downstream from the bridge in Kralja Petra Street in a length of about 700m. Maintaining the flow of the Breznica riverbed to the mouth of the Ćehotina river in a length of 600m, as well as downstream from the mouth in a	First	No status	€1,800,000	

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		length of 670m.				
APSFR19_DRB_ Bukovica I Bijela01	Piva/Bukovica I Bijela01	M33: mobile flood protection in the center of Šavnik on the banks of the Bukovica river in a length of about 300m.	Second	No status	€120,000	
TOTAL:					€ 48,452,000	

9 COST BENEFIT ANALYSIS OF PROPOSED MEASURES

9.1 Introduction

The Cost-Benefit Analysis (CBA) aims to support flood risk management planning in the Danube River Basin in Montenegro. The results of the CBA analysis prepared under the project "Support to Implementation and Monitoring of Water Management in Montenegro" need to help the user to evaluate the relationship between benefits and costs for each investment decision (mitigation measure). This comparison helps users identify those flood risk management plans and measures that allow maximising economic returns on investment costs, i.e. social well-being (in other words, which give "the highest value for money"). Flood risk management plans include structural and non-structural alternative measures through the CBA analysis. Structural (engineering – technical) measures reduce the impact of floods. Non-structural measures include flood warning systems, land use planning, flood response, etc.

This document should make it possible to quickly evaluate and rank different flood risk management measures based on their economic effects. A critical dimension of conducting CBA analysis is the time and resources available for this activity. Because of this, it is crucial that:

- There is a focus on those components of the overall benefits that are highest compared to the efforts to be made to assess them (for example, focusing on non-residential objects in areas where there is a combination of residential and non-residential buildings because the damage caused to non-residential buildings is higher than that of residential buildings);
- The data for the benefits assessment is as accurate as possible (or as little as possible imprecise) because they have a decisive impact on the final result of the CBA analysis;
- The different standards of protection provided by different types of interventions should be comparable to each other to see as efficiently as possible which measure is affordable and what kind of protection it provides.

The basic principle of CBA requires that the results of a project reflected in increasing the economic well-being of society (i.e. the benefits generated by the project) be greater than the cost of its implementation. Generally speaking, cost-benefit analysis is based on comparing the benefits and costs of a particular activity. The measure is desirable if the benefits outweigh the costs, as it increases economic well-being. Conversely, the measure is not socially desirable if the benefits are less than the costs. In the framework of flood risk management, the CBA analysis involves comparing the costs incurred by implementing measures to increase safety in the event of floods (for example, by strengthening embankments or introducing a warning system) with the potential reduction of expected flood damage.

The costs considered in the CBA analysis are investment costs, operating costs (fixed and variable), maintenance costs, and management costs (administrative costs). Benefits are the reduction of damage (or costs) caused by floods. The flood damages are often divided into direct costs (costs of repairing buildings and structures), damages due to interruptions in business operations in a flooded area and indirect costs outside the flooded area, such as

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damage due to business interruption (although outside the flooded area of the enterprise can even benefit from flooding). In some cases, if possible, the CBA analysis also covers the benefits of potential economic growth resulting from improvements in flood defence.

The methodology for the CBA analysis presented in this document is based on the following references:

- Guide to Cost-benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, European Commission, Directorate-General for Regional and Urban policy, Brussels 2014[111];
- Guidelines for the implementation of a Cost Benefit Analysis in flood risk management[112];
- Guidelines for Standards for Flood Protection and Safety[113];
- EU JRC Technical Report: Global flood depth-damage functions: Methodology and the database with guidelines.[114]

The presented CBA methodology starts from the elements and indicators that can be easily calculated based on available data in Montenegro published by the national statistical office and other public institutions.

9.2 Theoretical framework for CBA

General assumptions

Flood protection projects are not projects that generate financial income. Therefore, performing economic instead of financial analysis in this area is necessary. The use of methods for economic assessment, especially cost-benefit analysis, to select, create and implement flood management measures is very common in some countries (UK, Netherlands, Germany). In principle, the methodology for CBA analysis can be seen as sufficiently developed and established to provide valuable inputs when formulating policies. However, particular problems limit its application: for example, the availability of data, the difficulty in expressing specific influences in monetary amounts, and limited openness to public participation.

As pointed out, decisions regarding investing in specific measures to increase security in the event of floods are not made in the private sector but represent a "common good" and are part of social preferences. Therefore, the CBA analysis concerning floods consists mainly of economic analysis. It should cover society's economic benefits and costs that must be quantitatively expressed in monetary terms. However, in some cases, this isn't easy regarding the non-monetary influences of certain factors. Because of this, this approach to assessing investment projects in the area of floods is often criticized. In some countries, the economic assessment within the CBA analysis is supplemented with qualitative elements or used instead of a multi-criteria analysis (France, Netherlands). Although these approaches

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[111] http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf
[112] http://www.floodcba.eu/main/wp-content/uploads/Cost-Benefit-Analysis-Guidelines1.pdf
[113] http://www.floodcba2.eu/site/wp-content/uploads/Guidelines-FLOODCBA2-v-3-10.pdf
[114] Huizinga, J., De Moel H., Szewczyk, W. (2017). *Global flood depth-damage functions: Methodology and the database with guidelines.* JRC Technical Report. European Commission. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC105688/global_flood_depth-damage_functions__10042017.pdf

cannot eliminate all those uncertainties present in CBA, multi-criteria analysis manages to cope with the most criticized aspects of CBA analysis, which is integrating the opinion of stakeholders or the problem of expressing certain types of influence in monetary terms.

However, in practice, decisions regarding flood risk management at the strategic level are often the result of a compromise based on technical, economic and political considerations. Although such decisions can be made based on economic considerations, the level of protection is not the result of a pure economic settlement, nor can all the elements considered be expressed in monetary terms. Therefore, despite all the shortcomings mentioned above, CBA analysis still contains crucial information necessary for rational decision-making.

Another critique is that the CBA analysis does not consider a factor that indicates people's attitudes towards risk. When it comes to decision-making regarding the selection of a plan of measures to increase flood safety, an important element is an attitude of people (whether those who are victims of floods or those who make decisions) towards costs and reduction of flood damage. CBA analysis suggests that people are risk neutral. When people are prone to risk, the costs are estimated to be lower, and the avoided damage is greater than the actual one. Conversely, when people have an aversion to risk, costs are judged higher, and the avoided damage is smaller than actual values. In flood management, this would mean that a risk-averse decision-maker would choose a higher and more expensive level of protection over risk-neutral decision-makers. Although CBA analysis is limited in this domain, it still provides significant rational information necessary for decision-makers.

Reasons for the application of the analysis of Costs and benefits

There are several important reasons why flood risk management measures should be accurately assessed from an economic point of view. A systematic comparison of the cost of risk reduction interventions with the benefits they bring should be made as systematically as possible.

First, such assessments facilitate thinking and learning. The requirement that all investment costs be covered is very important because some of the costs may be accidentally neglected or missed if the assessment is not done properly. Also, the benefit assessment request provides information about the gains that society, the community, and the individual have from reducing the risk of flooding. It requires a systematic approach and as much quantification as possible. Both these cost and benefits processes require significant effort and bring tasks that need to be learned and mastered. All this further requires careful consideration of our goals, which is not an irrelevant role for decision-makers.

Second, accurate assessment maximises the efficiency of public investments. Measures for reducing flood risk are often financed from the state budget, mainly consisting of revenues from people who are not at risk of flooding. Therefore, it is necessary to make it clear to taxpayers that risk reduction expenditure is as effective as possible for those at risk. The experience of developed countries has shown that, under other unchanged conditions, the optimal protection standard is one where the difference between benefits and costs is the greatest and, therefore, the return on investment is the highest.

Third, a cost-benefit analysis allows for deciding how much money should be allocated to reduce risks. Many approaches to assessing public sector investments include cost-benefit and multi-criteria analysis. Although multi-criteria analysis is more comprehensive because it includes elements that cannot be quantified, it does not give decision-makers an answer to how much money they should spend investing in the measures they have created. A major contribution of the CBA analysis is that the answer to the previous question is the quantitative amount of money that should be invested to achieve maximum return on the funds of taxpayers and other financiers.

Fourth, the CBA analysis maximises the transparency of the assessment process. During the conducting of the CBA analysis, the consultant must unequivocally determine the quantitative aspects of his assessment. Furthermore, it is desirable to present all the assumptions from which he has proceeded. Therefore, the process is transparent, and a third party can evaluate (i.e. repeat) the processes and calculations that have been made to ensure the contribution of the conclusions that are the result of the analysis.

This does not mean that the CBA analysis is perfect. It has many disadvantages, mostly related to quantifying "intangible" elements on both the benefit and cost sides. If such "intangible" elements are dominant to any potential decision-making, then CBA analysis may be redundant or seen by policymakers as a weak analytical tool. The only way to overcome this situation is to describe and parallelly attach all those elements that cannot or are difficult to quantify with his calculations. Such a narrative explanation should be sufficiently detailed to highlight the significance of the analysed elements. It allows decision-makers to have all relevant quantitative and qualitative information. In this case, they can weigh the unquantified elements according to the quantitative data presented in parallel. Of course, such a process requires value judgment rather than simple mathematics.

Benefits of costs and public policies

In many cases, public policy consideration involves using scenarios, i.e. projection of the selected set of factors to predict the future impact of the proposed policy, taking into consideration different types of variables (demographic changes, economic growth, changes in spatial planning and natural conditions). Different development scenarios can be compared to determine the best option compared to rating criteria (for example, cost-benefit ratio). It is customary that in the area of floods, the term "scenario" implies a certain flood risk management strategy that has been applied in a specific context of a given river basin.

However, based on a literature review, it is noted that using scenarios when creating action plans in floods is not common. This approach was usually used to determine the impact of a predefined set of measures compared to the option in which nothing is done ("do nothing option", "business as usual"); or compared to the option in which minimum basic flood protection measures are implemented (i.e. it would be done anyway without the project under consideration). This approach is also present in the methodology of cost-benefit analysis proposed in this document. On the contrary, the analysis of scenarios in the true sense of the word that involves comparing, for example, scenarios oriented to flood protection and prevention with a scenario in which nothing is done is rarely present in literature and studies.

Stages in the preparation of benefit and cost analysis

This part provides a proposal for the necessary stages (steps) in the economic assessment of any intervention in the field of flood risk management. The phases covered by the benefit and cost analysis are given on the basis of the reference document mentioned above, in which a more detailed description is given.[115]

The CBA, i.e. the economic assessment of the project/intervention in the field of flood risk management, should consist of four phases:

1. Locating flood-related problems and defining the project area (an area that is potentially threatened by floods and where the benefits of the proposed interventions will arise);
2. Collecting relevant information and maps;
3. Calculation of data for the probability curve of loss occurrence due to floods and discounted amount of annual average damage;
4. Interpreting the results.

Locating the problem and defining the problem area

Any economic assessment of interventions in flood risk management should begin by defining the problem that arises from flooding at a particular location. Here it is very useful if there is historical data on previous floods and maps of the degree of flooding in the past. Also, the role of the stakeholder is crucial at this stage because the local population often has a lot of knowledge about the problems arising from floods, which are missing from national databases and studies containing general estimates. Based on such knowledge and data, it is easier to understand the nature of the problem and its potential gravity in the future.

The project area is the area most likely to be flooded and where the property is at risk, but also one that will benefit from reducing the risk of flooding. The area with the highest likelihood of flooding does not necessarily equal the area that was flooded in the past because previous floods may not have exceeded a certain degree of intensity that will have flooding in the future. Also, benefits may occur if the area on the perimeter of the flooded area is defended because the risk can be reduced by improving certain canals or other similar interventions that reduce flooding in a given area.

Collecting relevant information and maps

It is necessary to identify different land use purposes within the project area that will benefit from the proposed measures to reduce the risk of flooding. This should be done because the land of different purposes has different potential damage, which an economic assessment of measures must cover. It is especially important to separate residential and non-residential buildings because for the latter flood damage is usually expressed per square meter of the building area.

Data on potential flood damage can be collected at the site based on historical data on previous floods. Also, for some types of damage, consultants may use data available to developed countries of the European Union or the surrounding countries. The data should be adjusted according to the analysed country's GDP and inflation rate. This is important

[115] Middlesex University Flood Hazard Research Centre (2014). *Guidelines for the implementation of a Cost Benefit Analysis in flood risk management,* A COMMON FRAMEWORK OF FLOOD RISK MANAGEMENT COST BENEFIT ANALYSIS FEATURES, http://www.floodcba.eu/main/wp-content/uploads/Cost-Benefit-Analysis-Guidelines1.pdf

because there is a time difference between the base period and the one in which the data are used. This approach to assessing certain types of flood damage is also proposed in this document.

Hydrological data are essential for any assessment of interventions to reduce flood risk. These data should express the periods of flood return affecting the observed (project) area (the average length of time that elapses between two events of similar magnitude) either based on historical analysis or the basis of modelling. Therefore, it is necessary to show the period return of floods in a specific range. Flood return periods of 5, 10, 25, 50 and 100 years are commonly used, but others can also be used. In certain circumstances, if necessary, longer periods of, for example, 200 or 500 years may be used.

Although all data quality is important, precise data is not available in many situations. The literature suggests that any data available should be used. When the preliminary CBA results are obtained, it should perform the sensitivity analysis to check and substitute/eliminate data whose accuracy is questionable. Some data have minimal effect on the results, especially the potential damage caused by the most extreme floods since they are very rare and their contribution to the annual average damage is minimal. The economic significance of sporadic events is often overlooked in analyses.

In many cases and countries, quality data is lacking for implementing cost-benefit analysis. However, this should not be a reason not to approach some form of economic analysis. One or more of the approaches that could be applied in this case are:

- Use the best available data rather than trying to improve the quality of data;
- The use of interchangeable data (for example, in the case where data on damage to objects cannot be found, a number of objects in a given area can be used);
- Use of data from other regions or countries;
- Use of scientific research results and expert assessments.

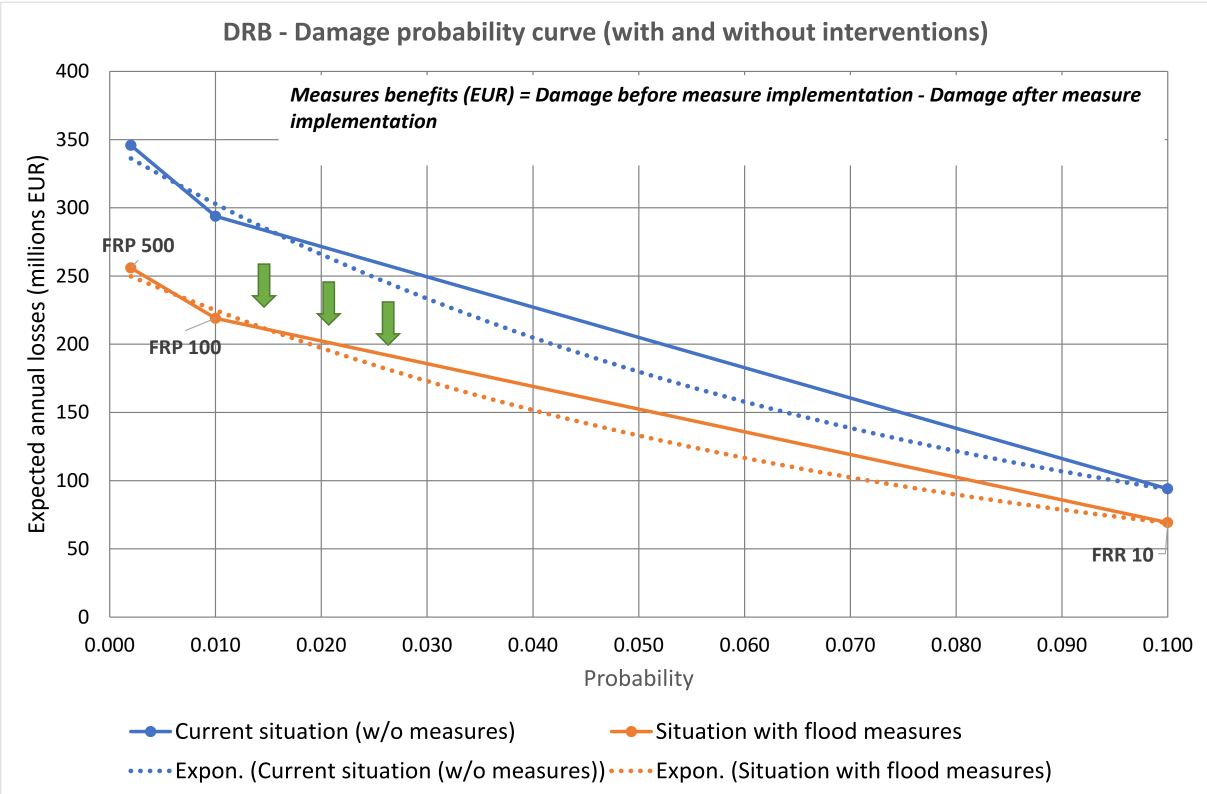
Calculation of probability of losses and discounted monetary amount of annual average damage

A curve that shows the schedule of probabilities of damage (loss) due to floods is essential for the economic assessment of intervention aimed at reducing flood risk. Figure 9.1 below provides a curve depicting the relationship between the probability of a flood and the potential damage that would occur for DRB. The difference between the curve in the case "without intervention" (current situation) and the curve in the case "with the intervention" (i.e. the implementation of the proposed measures) is the average annual benefit of these interventions or the yearly average damage avoided (in monetary amount).

Including a sufficient number of future floods in the analysis is necessary to determine the probability curve of potential damage. It means covering at least five floods in the analysis would be advisable.

The area below the possibility curve represents the annual average damage to a given area. It is necessary to discount this amount of money over the period representing the lifetime of the proposed measures (for example, 50 or 100 years or less for some non-structural measures) to determine the amount of capital worth investing in achieving the benefits of the intervention. The reason for discounting these amounts of money is that general society and individuals value future resources to a lesser extent than current resources. That is, one euro today has more value than the one euro we will receive in the future. This approach stems from the fact that investing a certain amount of money in a project today should bring a return in the future period. Society and individuals expect a reward in the form of yields for sacrificed consumption today.

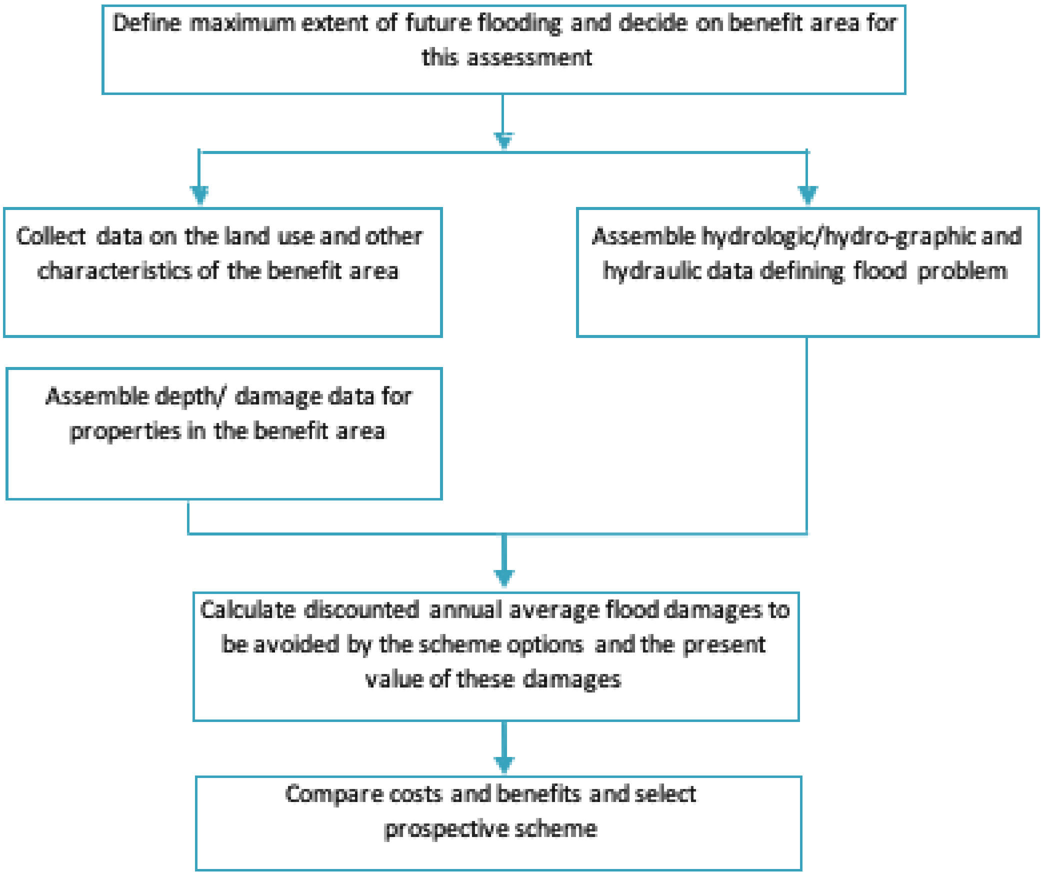
Figure 9.1. The damage probability curve for DRB



The discount rate used to discount the future value to the present value varies from country to country. It is generally associated with the alternative use of capital and the return on that alternative project (opportunity costs of capital). In this document, the proposal is to use the discount rate recommended by the European Union's CBA guide. According to this document, the social discount rate (applied for economic analysis) is 5%.

The following figure shows a simple flowchart, i.e. the stages that need to perform to calculate the benefits of measures aimed at reducing the risk of flooding. In addition, the diagram presents the steps for calculating the present value of flood damages/losses that will occur in the future in the case without the implementation of flood reduction measures.

Figure 9.2. Stages in calculating



Interpreting the results

In the previous step, we calculated the total expected amount of money for investment in the proposed flood risk reduction measures. In other words, the calculated sum represents the maximum amount of capital (equal to the expected benefits) that would be worth investing in the given measures. Further, It should compare the calculated benefits with the proposed measures' discounted costs, including capital, operating and maintenance costs.

Such an approach can calculate the cost-benefit ratio, which shows which measures are more economically valuable and efficient (Benefit/Cost ratio – BCR). However, it is also necessary to calculate the difference between the benefits and costs in absolute terms because it is the result of the return on investments. Usually, it should calculate both indicators, one showing the ratio (ratio) between benefits and costs and the other showing the absolute difference between these values.

If the benefit/cost ratio is less than 1.0, the proposed intervention is not worth the investment, at least in economic terms. On the other hand, it should take with scepticism a benefit/cost ratio higher than 10.0 because such high values often arise due to a calculation error. For example, a high benefit/cost ratio value exists in the case of severe floods that affect large areas over a long period. Over a very long period, it is unlikely that the layout of objects and properties will remain unchanged in a given area, and some surfaces will likely change their purpose or be abandoned.

It should also calculate an additional economic indicator – incremental benefits and costs ratio. This indicator assesses the incremental benefits and costs of the observed intervention in relation to the previously considered (alternative) intervention. The incremental benefits and costs ratio greater than 1.0 shows that the observed intervention is superior to the previously analysed one since its incremental costs do not exceed the incremental benefits that its application would obtain. But, taking into account that only one intervention for DRB is analysed, the incremental BCR is not calculated.

Types of damages and losses from floods

The future flood prevention benefits appear as a result of a set of measures: (1) measures to reduce the floods frequency, (2) measures to reduce the impact of the floods on the property and economic activity, or (3) the combination of the previous two sets of measures.

Flood damages can be classified according to two criteria:

- The type of damaged goods. There are "tangible" damages that can easily be expressed in monetary terms and "intangible" relating to damages to goods and services which are not measurable (or at least not easily measurable) in monetary terms because they are not traded on a market, i.e. valued at market prices (for example, the value of human life or the degree of environmental vulnerability);
- The type of adverse event causing the damage and the nature of the damage itself. The floods cause direct damages (damages to the property due to direct physical contact with the hazard, i.e. the physical destruction of buildings, inventories, stocks, infrastructure or other assets at risk) and indirect damages that represent a secondary effect of the flood (for example, a slowdown in economic activity due to destroyed or damaged facilities and infrastructure).

It can apply this damage classification to all sectors affected by floods: households, economic activity, agriculture, public facilities and infrastructure, environment, and human health.

Direct damage occurs due to physical contact of water with the damaged property and its contents. Many elements of flood damage and loss are a function of the nature and degree of flooding, including its duration, speed and pollution of water by sewage and other pollutants. Several factors affect the amount of damage, but all of them, in the broader sense, can be divided into three categories:

- Physical conditions of floods (water depth, water speed, duration of flooding, season, the amount of sediments brought by flood, etc.);
- Exposed capital (land and real estate value, value and location of personal property and facilities, protection of cables and networks, etc.);
- Human reaction before and after a crisis (warnings, readiness, awareness, behaviour immediately after the warning, i.e., credibility given to the warning, etc.).

Table 9.1 briefly presents an overview of the listed damages and losses from floods.[116]

[116] Meyer, V., Becker, N., Markantonis, V., Schwarze, R., van den Bergh, J. C. J. M., Bouwer, L. M., Bubeck, P., Ciavola, P., Genovese, E., Green, C., Hallegatte, S., Kreibich, H., Lequeux, Q., Logar, I., Papyrakis, E., Pfurtscheller, C., Poussin, J., Przyluski, V., Thieken, A. H., and Viavattene, C.: Review article: Assessing the costs of natural hazards – state of the art and knowledge gaps, Nat. Hazards Earth Syst. Sci., 13, 1351–1373,

Table 9.1. Direct, indirect, tangible and intangible flood losses with examples

		Measurement	
		Tangible	**Intangible**
Form of loss	**Direct**	• Physical damage to facilities and infrastructure • Disruption of operations in companies directly affected by floods	• Loss of human lives • Health effects • Damage to archaeological sites • Disruption in ecosystem services
	Indirect	• Production losses of suppliers and customers of companies directly affected by the hazard	• The inconvenience of post-flood recovery • Increased vulnerability of those who have suffered floods

For the purposes of the CBA analysis, it is very important to ensure that only the economic losses caused by floods at the national level and their indirect consequences are assessed rather than an estimate of financial losses for individuals, households and organisations affected. The financial analysis uses current cash amounts and transfers to evaluate losses and damages. For example, if a 10-year-old refrigerator is damaged in a household by flooding, its value is calculated in the financial analysis according to the current market price of the new refrigerator. Also, the financial calculation of losses includes VAT. On the other hand, economic analysis corrects current market prices in order to calculate real opportunity costs. In the previous example, the value of the ten-year-old refrigerator will be calculated as the value of the damage, i.e. its depreciation will be considered. VAT will not be calculated because it only represents the money transfer within the economy, not profit or loss.

It is also important to ensure that benefits are not double counted, such as counting the loss of trade of a factory that may be flooded as well as counting the consequent loss of business of the factory's retail outlets. For example, a loss in the turnover of a textile factory that may be flooded is, at the same time, a loss of a trade store that sells its products.

Within the CBA analysis, it is necessary to look at two types of costs related to the implementation of measures:

- Direct costs: capital (investment) costs, operating (fixed and variable) and maintenance costs;
- Indirect costs: for example, earnings of people who are in charge of implementing measures.

9.3 Economic benefits assessment

An economic assessment of the proposed measures to reduce the risk of flooding requires calculating the economic benefits of their implementation. Namely, certain structural and non-structural measures aim to reduce damage during and after floods. As explained above, it should express the damages in monetary terms. The economic benefits are equal to the value of damage avoided. They may be calculated as the difference between the value of damage in the case "without measures" and the value of the damage in the case "with measures". As shown in Figure 9.1 the calculation of the total economic benefits could be represented as follows:

Economic benefits (EUR) = *Damage before the implementation of measures (EUR) – Damage after the implementation of measures (EUR)*

According to the EU Floods Directive (FD), floods should include an assessment of the economic benefits for four groups of risk factors that cause flood damage (human health, environment, cultural heritage and economic activity). An assessment of the economic benefits should include, as far as possible, damage to goods for which there is a market price (for example, damage to objects), as well as damage to those goods and services for which there is no market price (for example, human life, ecosystem services). However, for Montenegro, there is not enough data to assess the economic benefits for all these groups of risk elements. Table 9.2 provides an overview of the benefits (avoided damages) for only those groups of threats for which there is data. The following groups will be analysed using the CBA method proposed in this document.

Table 9.2. Benefits of measures to reduce flood risk by area

Groups of risk factors	Benefits of measures to reduce flood risk
Human health	Avoid injuries and deaths of the population
Environment	Avoid damages to the environment
Cultural Heritage	Avoid damages to the environment
Economic activity	Avoided damage to residential, commercial and agricultural facilities
	Avoided damage to public infrastructure (roads)
	Avoided damage to agriculture (land and crops)
	Avoided damage in transport

For each of the above groups of risk elements in which flood damage occurs, the economic benefits of avoided damage in the case of measures to reduce flood risk are calculated using the following general equation:

Expected damage to flooded area at QT = *Dimension × Exposure × Vulnerability × Value*

The expected damage to the flooded area at different periods of flood return QT (for example, Q10, Q20, Q50, Q100) is expressed in monetary units (for example, in euros).

Dimension is the area, number or another type of spatial elements in the selected area (e.g. number of inhabitants, number of buildings, length of road infrastructure).

Exposure is the probability that spatial elements are present in the selected area for a certain period (for example, employees are employed in the workplace 8 out of 24 hours a day).

Vulnerability results from damage to spatial elements in a selected area in the case of events of a certain intensity (for example, damage is expressed as a percentage of the total value).

The value of damage to an element is expressed in monetary units, i.e. EUR/unit (for example, EUR/m of road infrastructure, EUR/m^2 of housing).

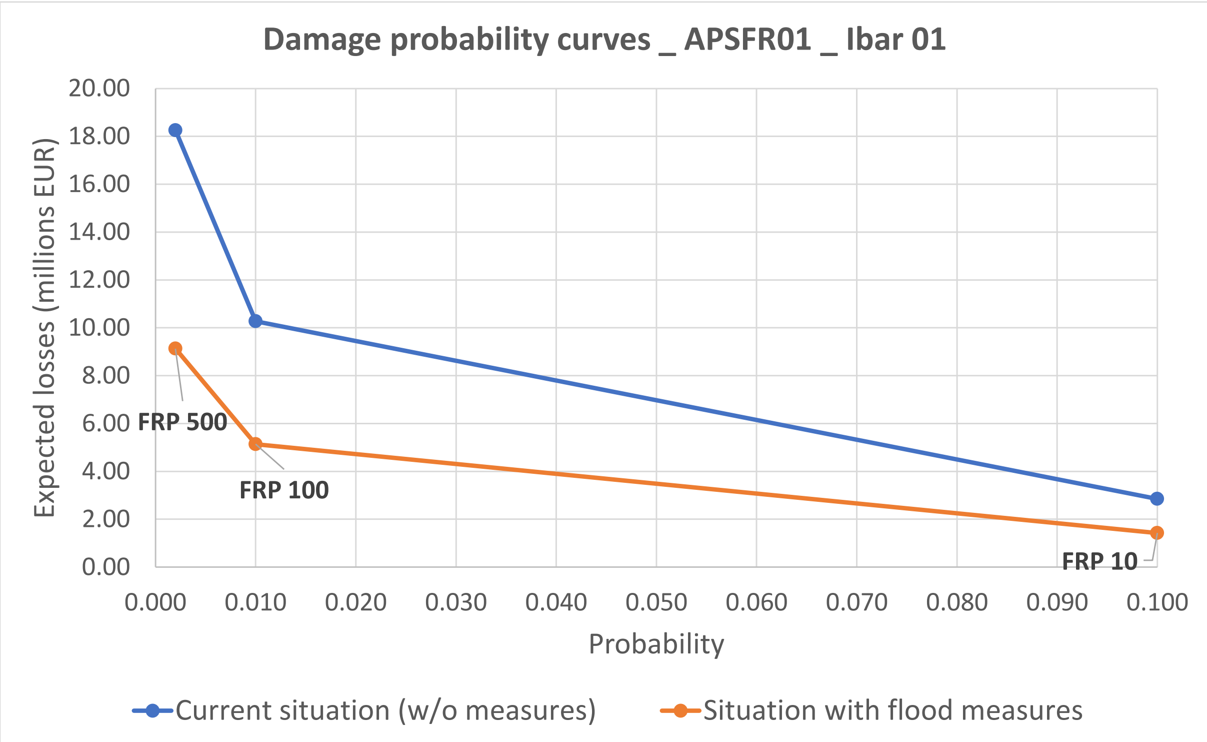
9.4 CBA of proposed measures for APSFR

The following sub-sections provide the cost benefit analysis for the APSFR.

9.4.1 APSFR01_DRB_Ibar01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	5,000,000	150,000	100	8,127,187

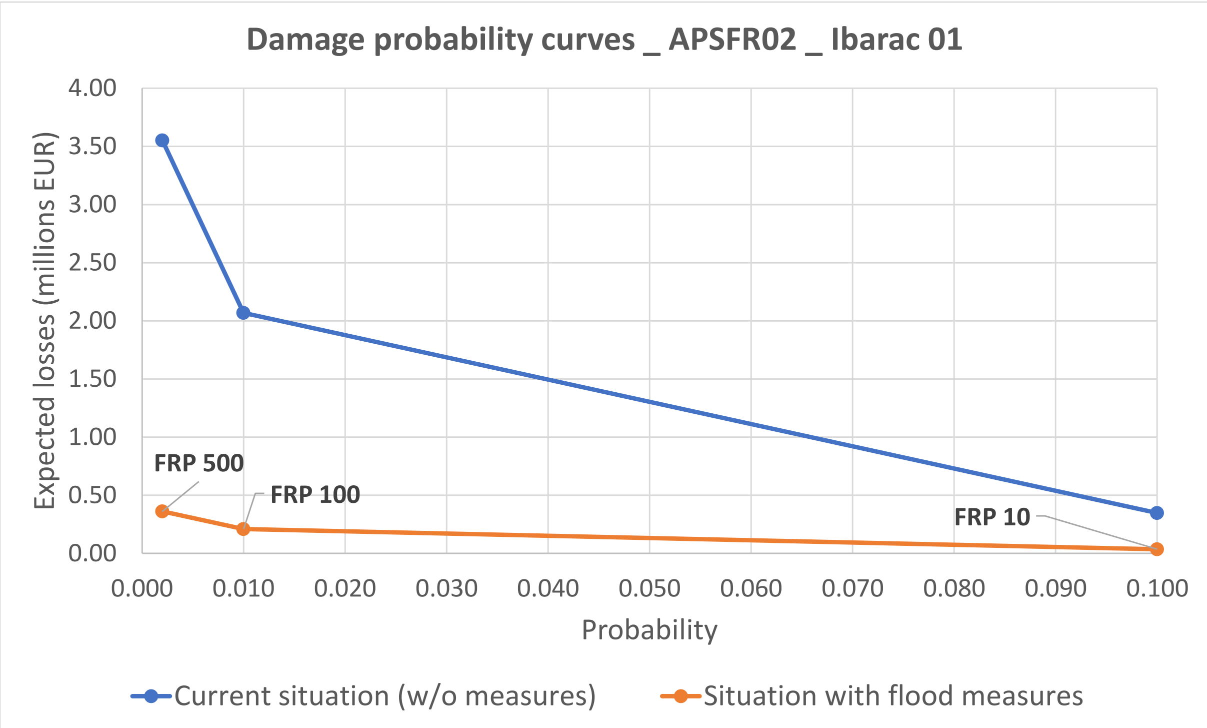
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	14,692,493					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits/ Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	5,886,916	8,805,577	8,127,187	1.08	678,391	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.2 APSFR02_DRB_Ibarac01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	2,000,000	40,000	100	2,833,916

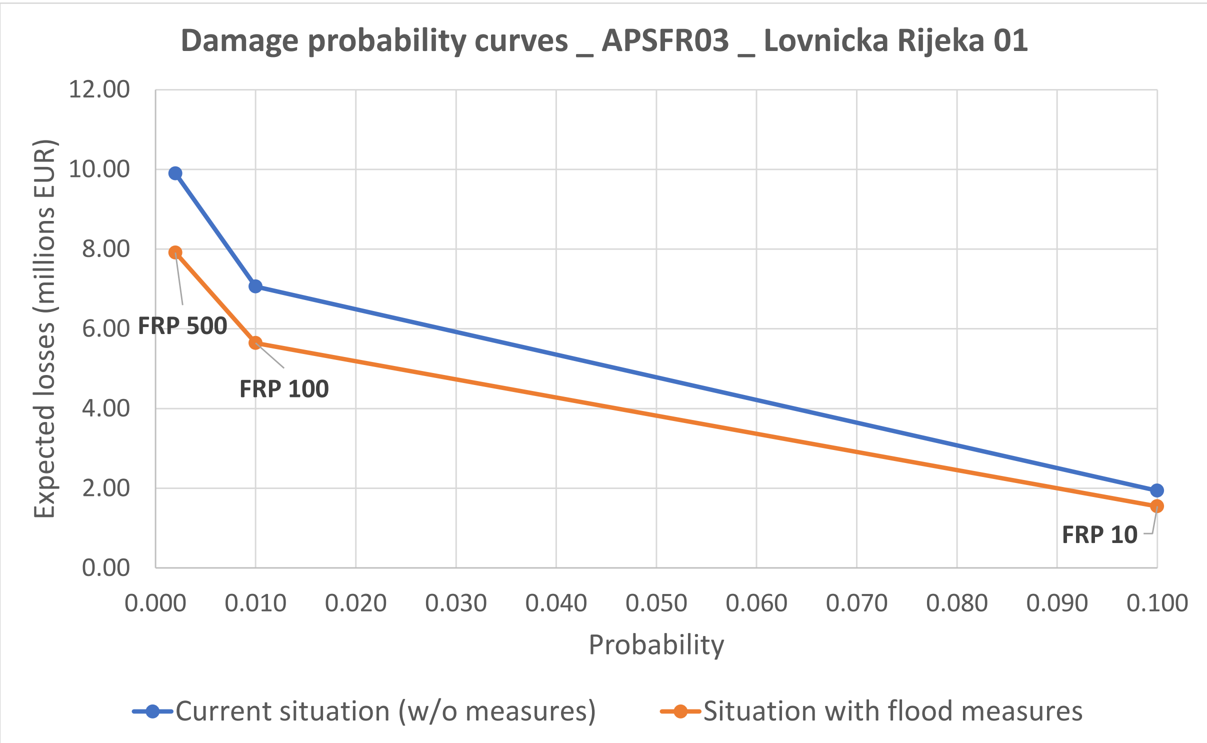
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	2,735,235					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	74,218	2,919,508	2,833,916	1.03	85,592	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.3 APSFR03_DRB_Lovnička Rijeka01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	350,000	50,000	100	1,342,396

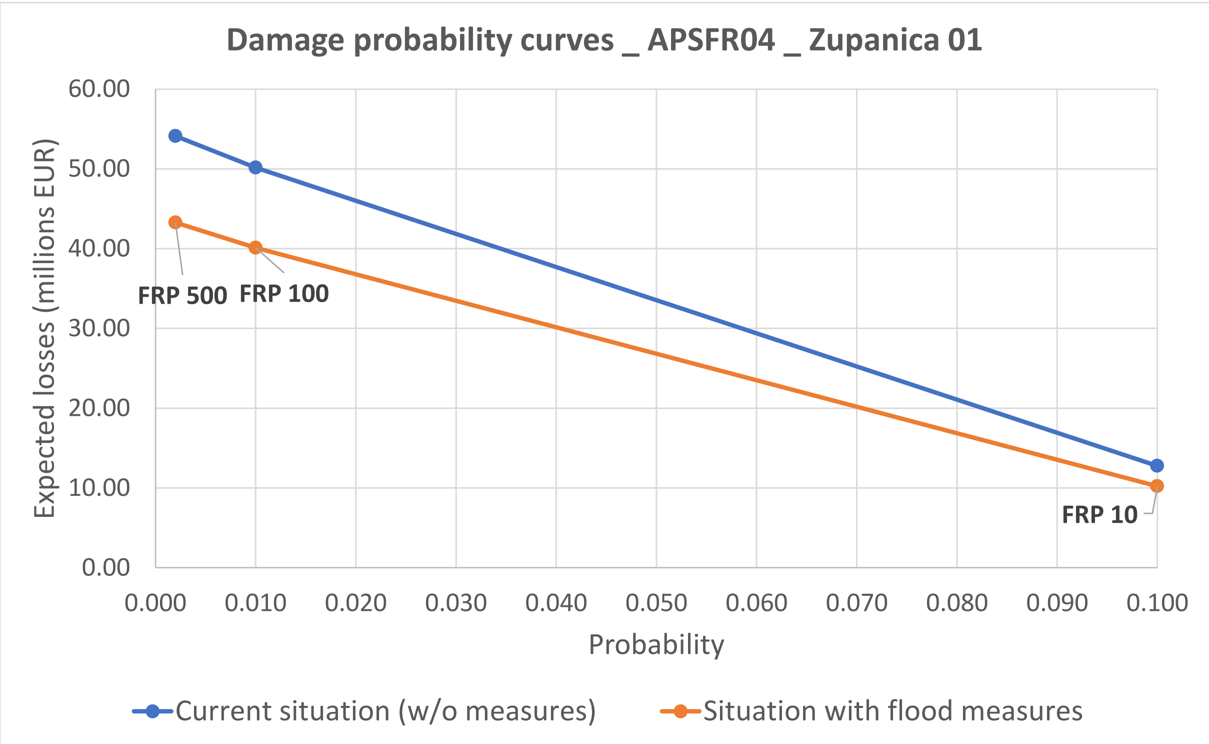
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	9,852,156					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits/Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	7,873,520	1,978,636	1,342,396	1.47	636,241	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.4 APSFR04_DRB_Zupanica01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	500,000	10,000	100	708,479

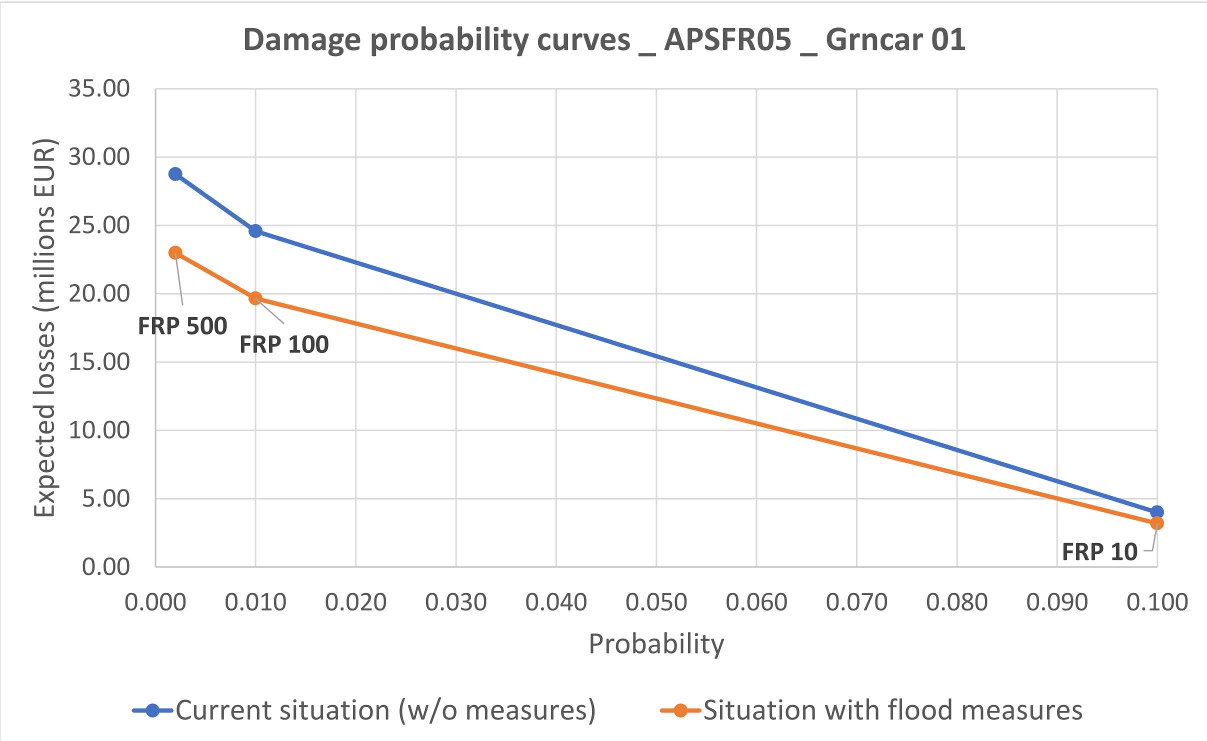
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	67,712,102					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	60,935,700	6,776,402	708,479	9.56	6,067,923	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.5 APSFR05_DRB_Grncar01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	10,000,000	200,000	100	14,169,582

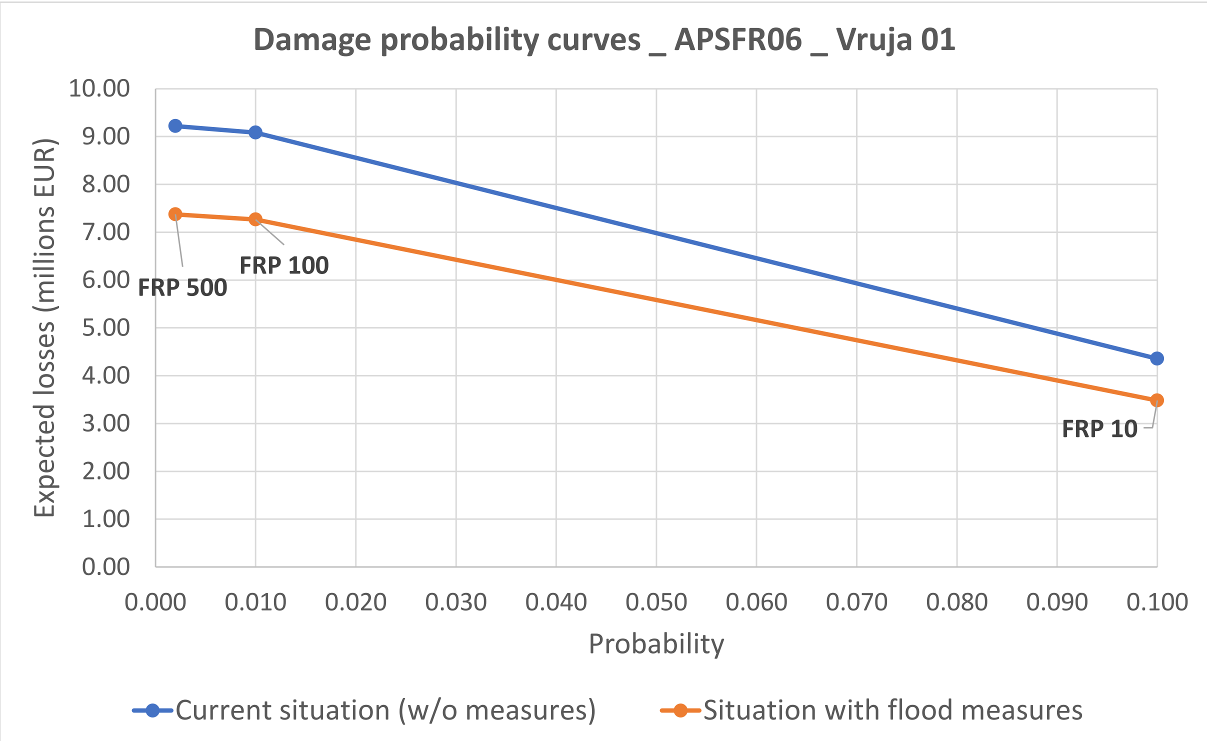
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	31,233,727					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	15,616,864	15,616,864	14,169,582	1.10	1,447,282	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.6 APSFR06_DRB_Vruja01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	0	50,000	100	1,042,396

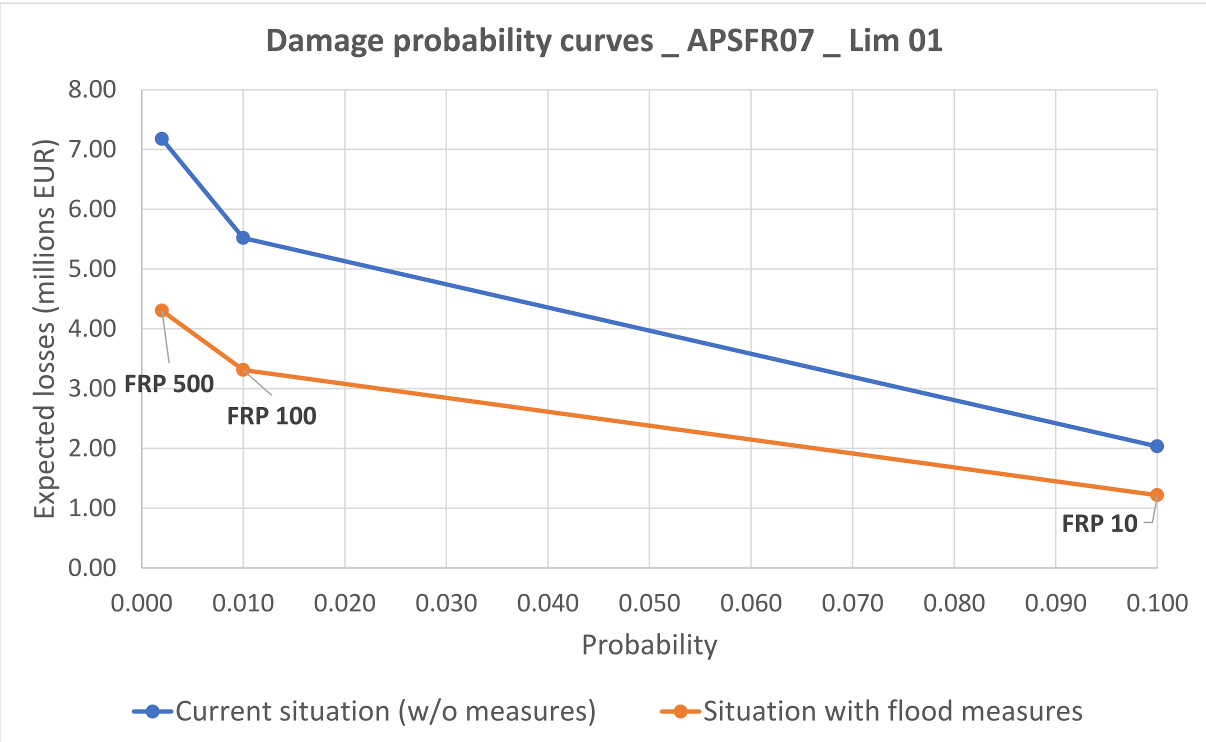
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	14,132,495					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	11,302,005	2,830,489	1,042,396	2,72	1,788,094	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.7 APSFR07_DRB_Lim01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	1,800,000	36,000	100	2,550,525

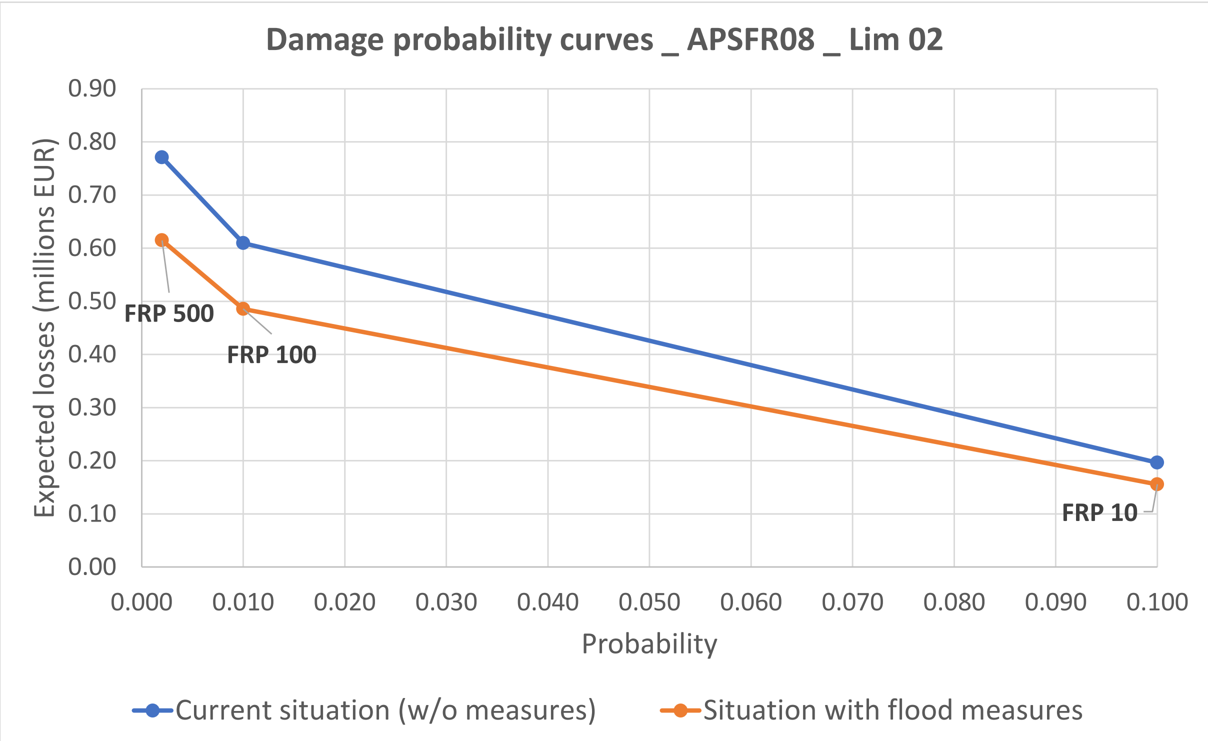
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	8,143,481					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	4,883,329	3,260,151	2,550,525	1.28	709,627	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.8 APSFR08_DRB_Lim02

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	0	50,000	100	1,042,396

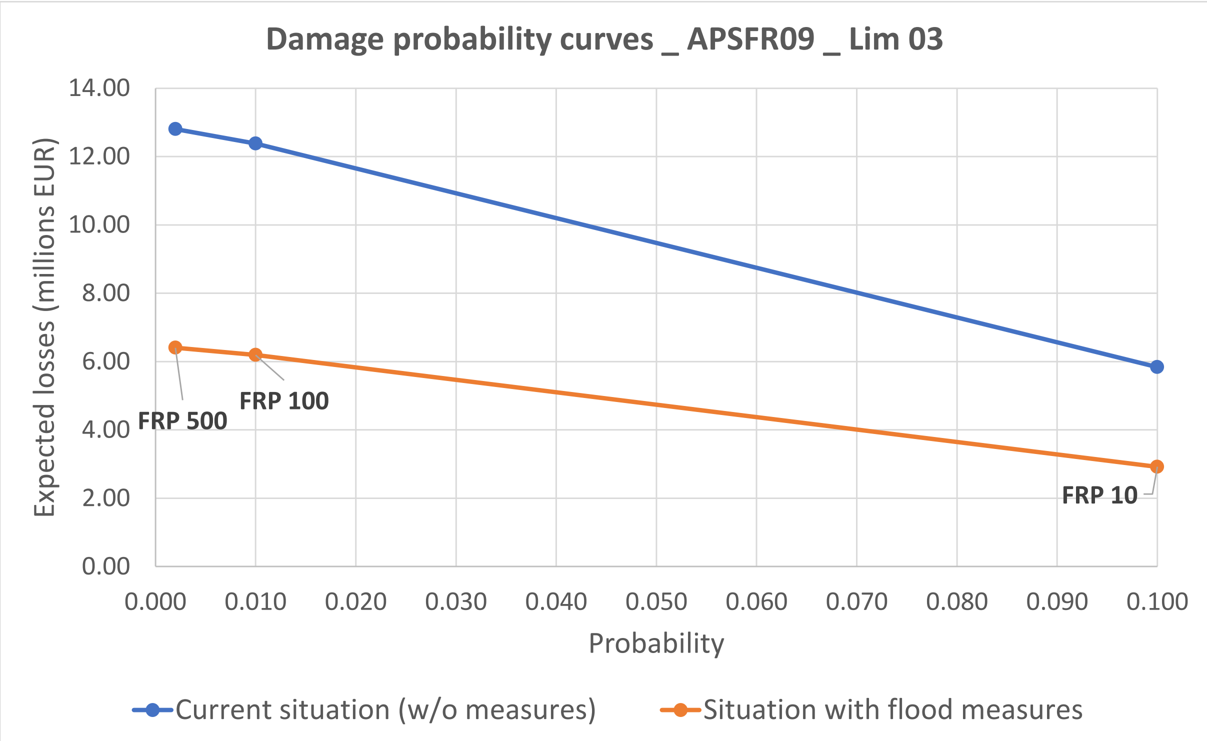
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	1,049,814					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	5,590	1,044,224	1,042,396	1.00	1,829	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.9 APSFR09_DRB_Lim03

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	6,000,000	120,000	100	8,501,749

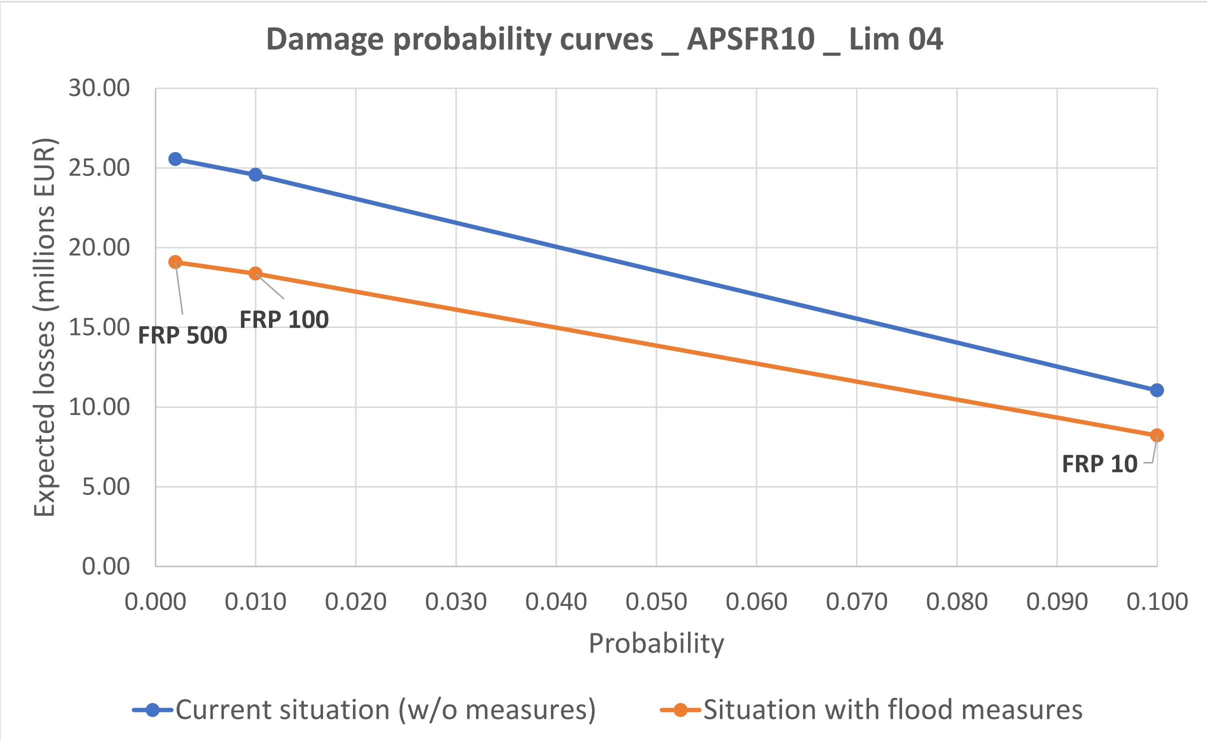
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	19,187,369					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	9,593,685	9,593,685	8,501,749	1.13	1,091,935	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.10 APSFR10_DRB_Lim04

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	6,145,000	122,900	100	8,707,208

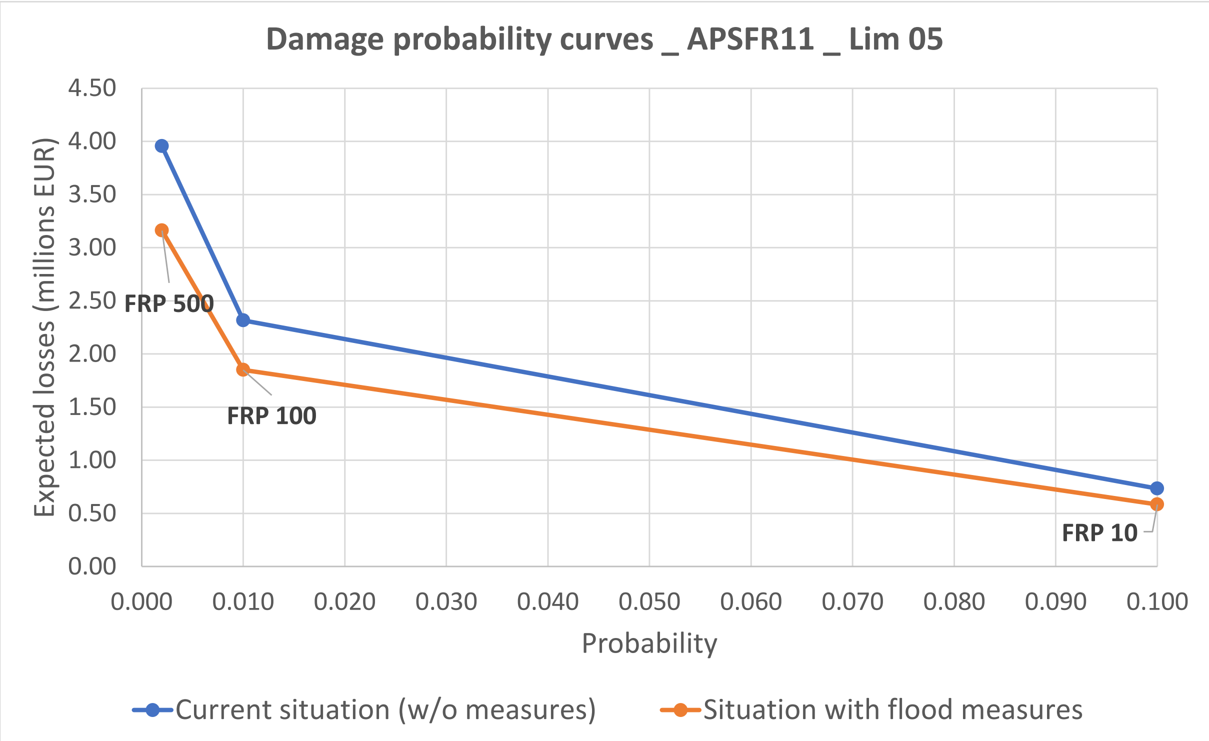
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	37,579,594					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	28,057,725	9,521,868	8,707,208	1.09	814,660	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.11 APSFR11_DRB_Lim05

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	300,000	6,000	100	425,087

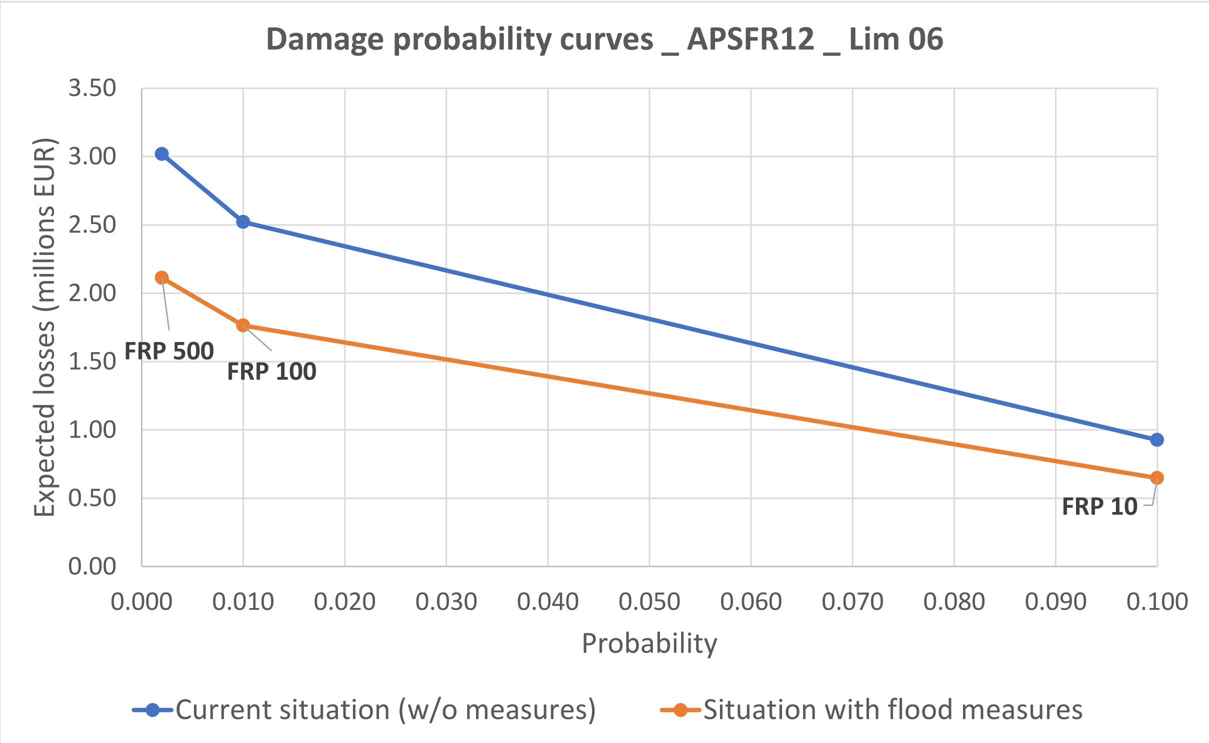
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	3,382,110					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	2,700,343	681,767	425,087	1.60	256,680	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.12 APSFR12_DRB_Lim06

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	600,000	12,000	100	850,175

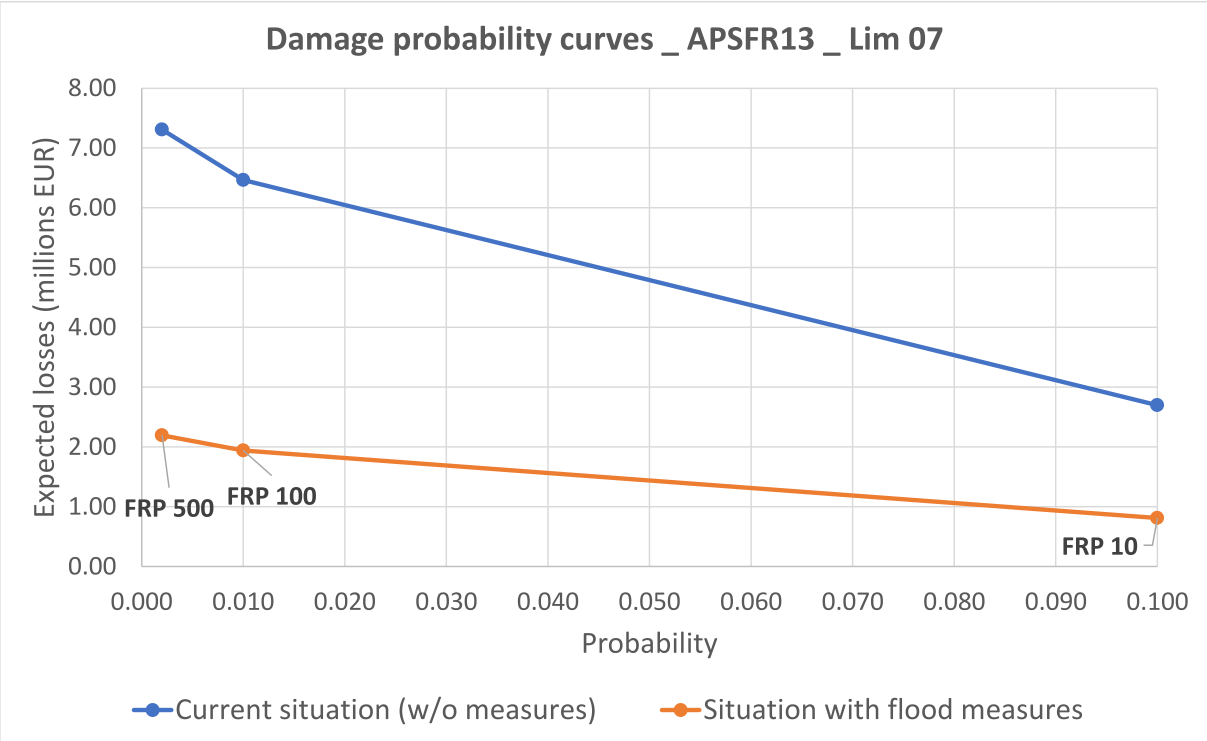
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	3,695,759					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	2,584,478	1,111,281	850,175	1.31	261,106	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.13 APSFR13_DRB_Lim07

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	4,787,000	95,740	100	6,782,979

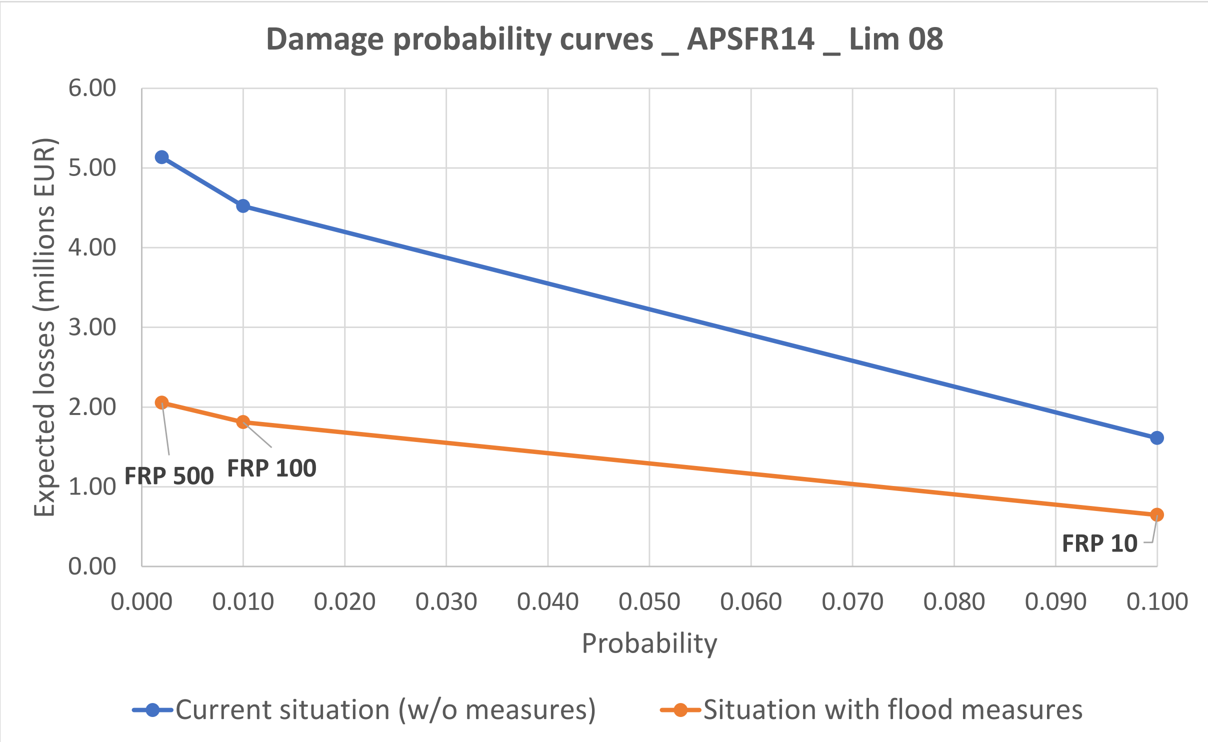
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	9,744,115					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	1,955,376	7,788,739	6,782,979	1.15	1,005,760	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.14 APSFR14_DRB_Lim08

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	2,000,000	40,000	100	2,833,916

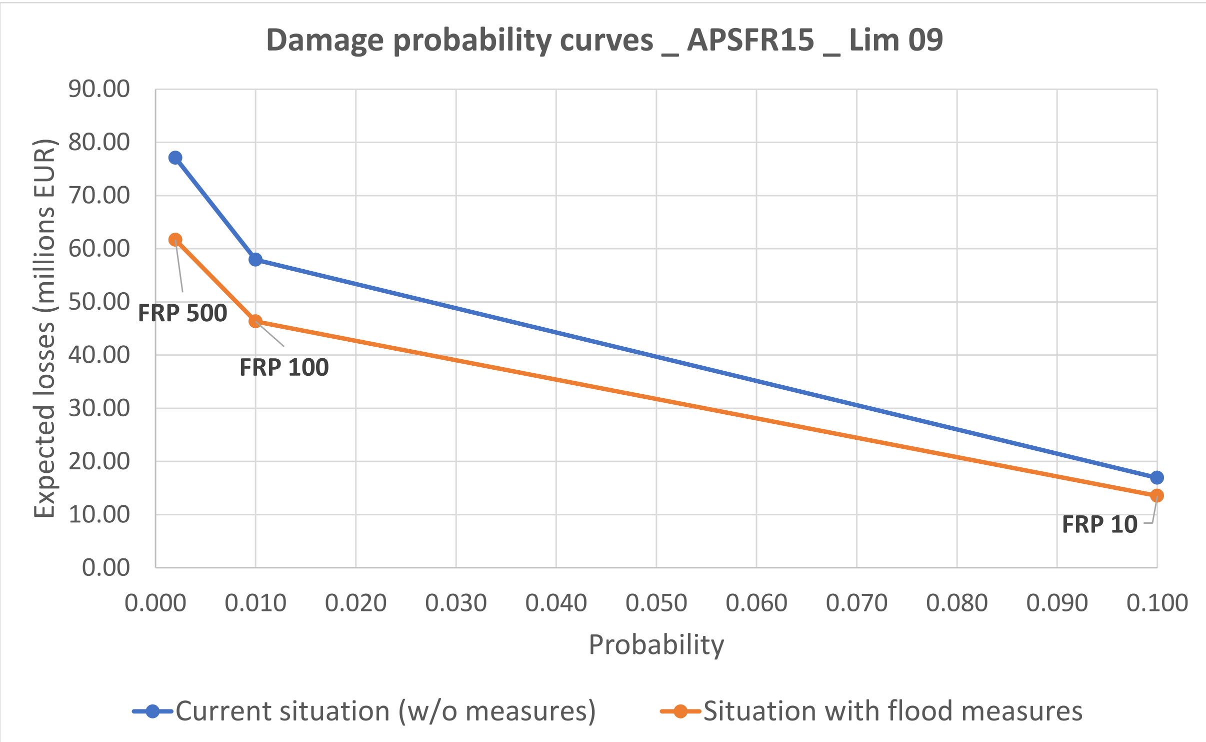
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	6,557,897					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	2,624,369	3,933,528	2,833,916	1.39	1,099,612	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.15 APSFR15_DRB_Lim09

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	7,100,000	142,000	100	10,060,403

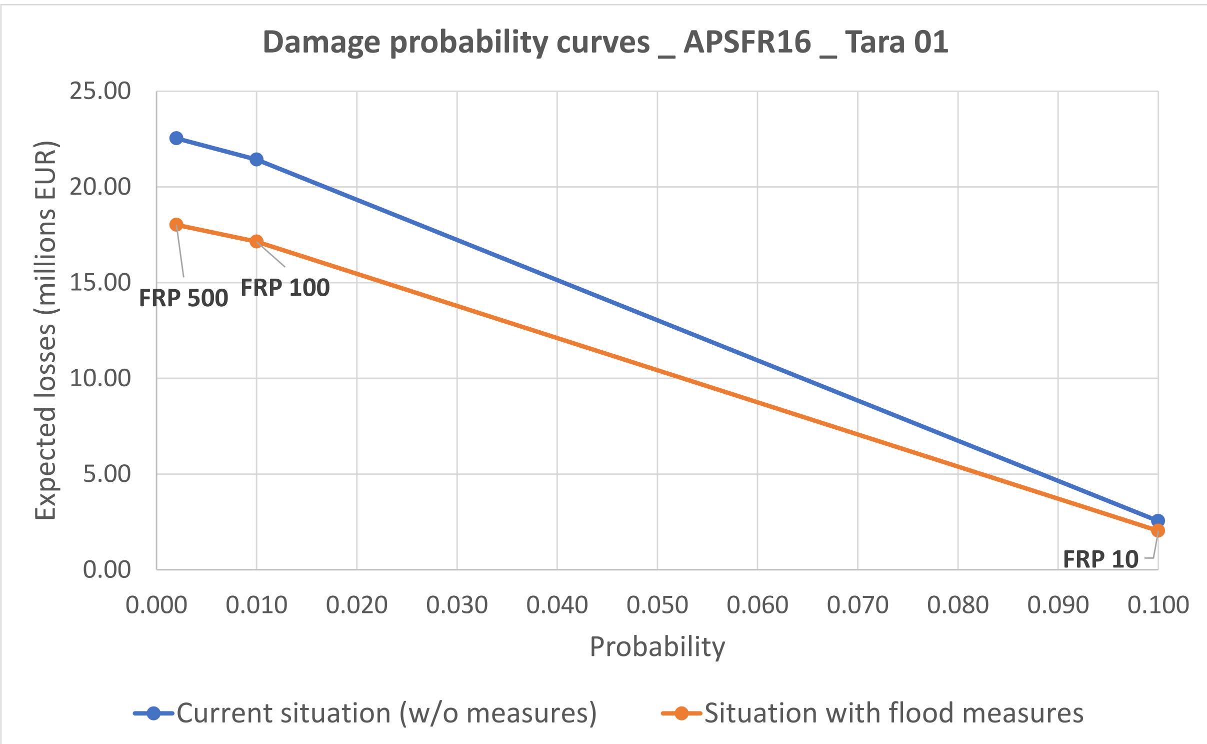
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	81,437,215					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	65,135,048	16,302,167	10,060,403	1.62	6,241,764	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.16 APSFR16_DRB_Tara01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	0	50,000	100	1,042,396

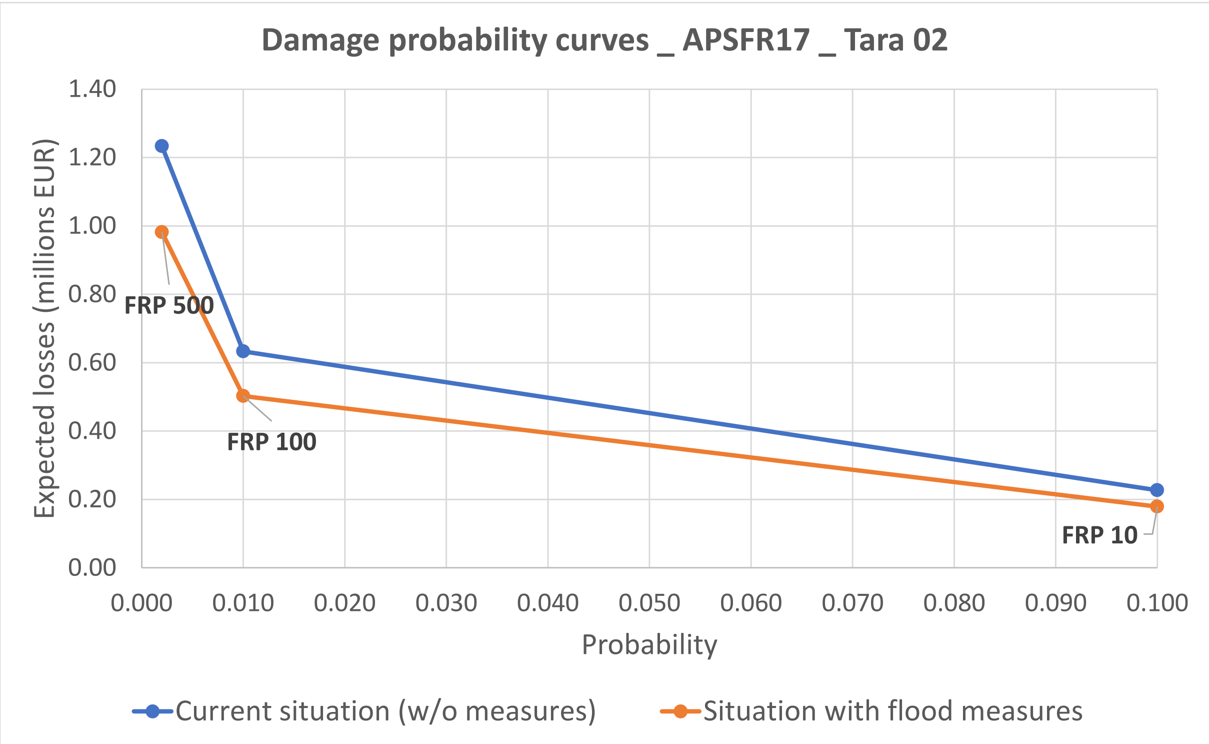
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	26,149,515					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	23,522,957	2,626,558	1,042,396	2,52	1,584,163	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.17 APSFR17_DRB_Tara02

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	0	100,000	100	2,084,791

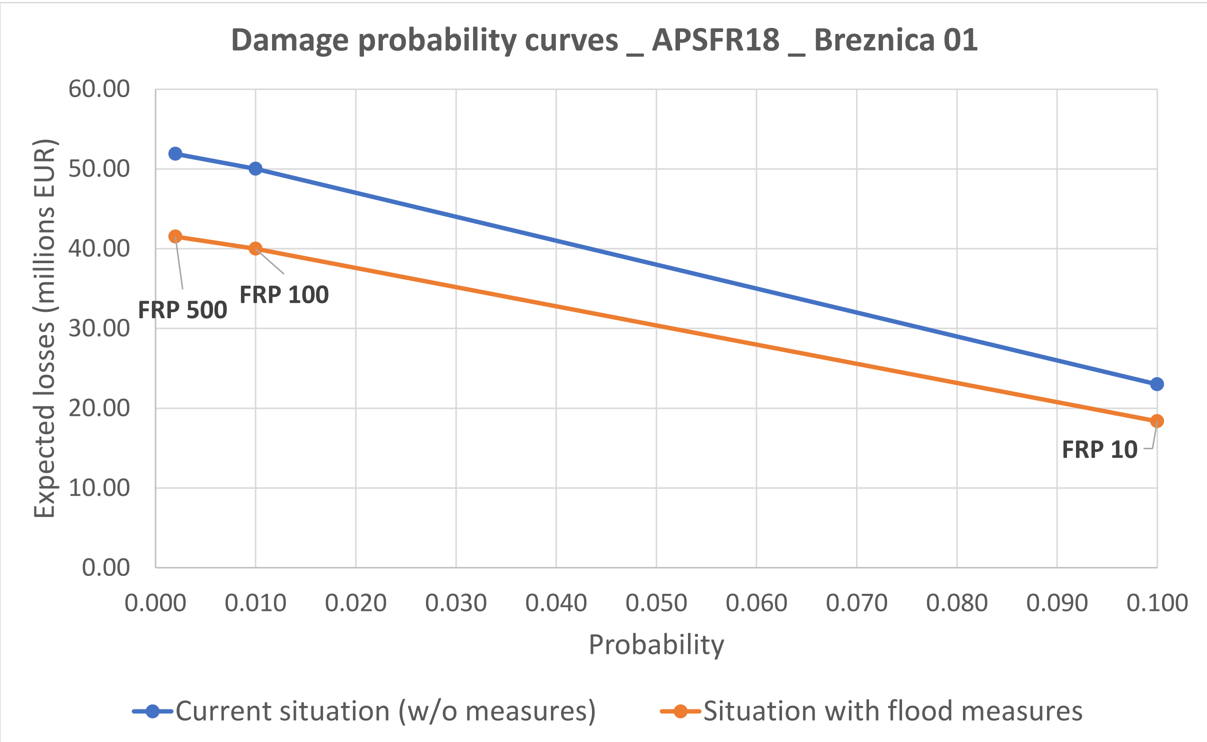
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	2,193,692					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	105,292	2,088,400	2,084,791	1.00	3,609	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.18 APSFR18_DRB_Breznica01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	1,800,000	36,000	100	2,550,525

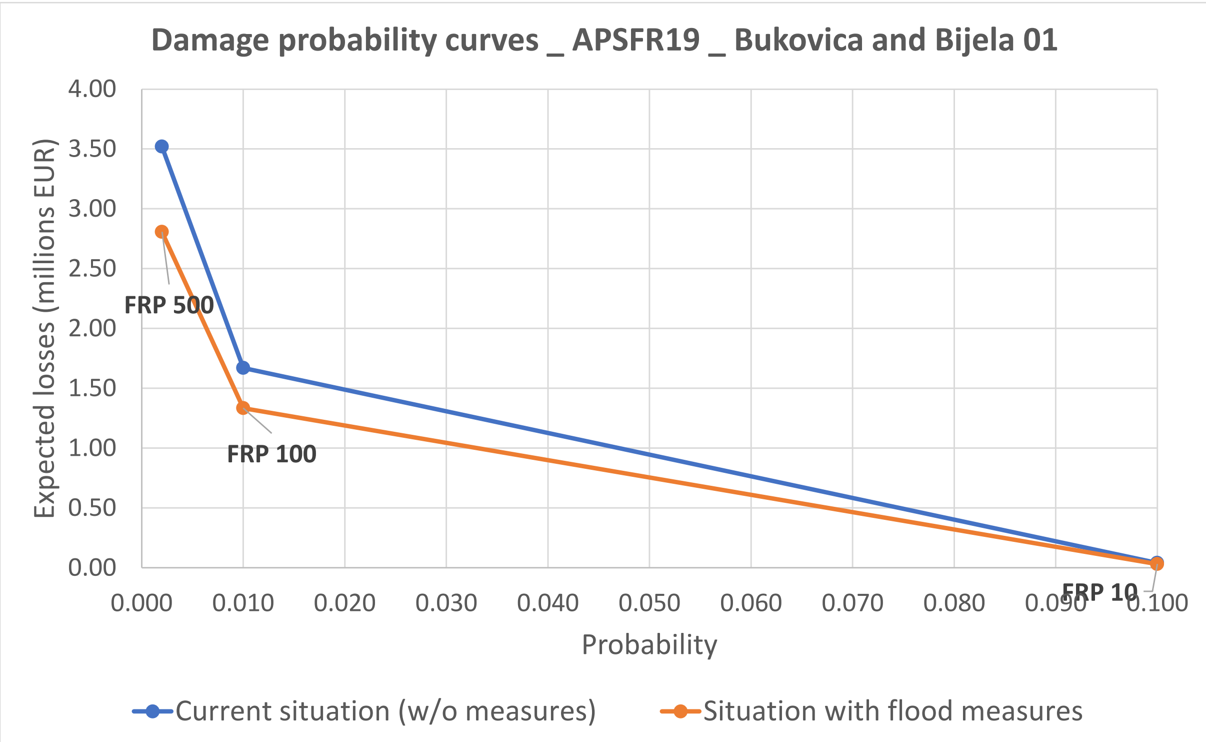
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	76,989,259					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	69,224,063	7,765,196	2,550,525	3.04	5,214,672	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.19 APSFR19_DRB_ Bukovica i Bijela01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	0
Intervention 1	120,000	2,400	100	170,035

CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	2,035,163					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	1,626,411	408,751	170,035	2.40	238,716	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.5 Economic benefits for the Danube River Basin

9.5.1 Human health

The calculation of the economic benefits related to human health is based on determining the number and place of residents under threat during floods. The value of economic benefits in monetary terms is defined as the benefit of the proposed measures resulting from avoided injuries and deaths of the population in floods. The methodology covers the number of residents present in a certain period in their homes, workplaces, educational institutions (schools, colleges) and hospitals. It is also necessary, if possible, to include the population that can be present on the roads during floods and is therefore at risk. However, it is difficult to estimate the number of people who can be present on a particular part of the road during floods. Because of that, assessing the benefits of avoided accidents on the roads in flooded areas includes the length of the roads and the probability that an accident will occur on them.

Dimension

For determining the dimension, the analysis includes the number of inhabitants with a permanent or temporary place of residence in the observed area for a given period of flood reversal. These data can most often be found in the reports of national statistical institutes, official ministries (education, sports, health...) or registers of companies.

Exposure

Exposure refers to the probability that certain elements of a dimension are located in an area threatened by floods. For example, employees, children, pupils and students will be at work, kindergarten, school or college during one part of the day, while the rest of the day will be at their place of residence. It is assumed that residents are present on one of the roads potentially threatened by flooding for 1 hour a day.

The value used in the model that residents with permanent or temporary residence will find themselves in their homes at the time of flooding is 0.84.

Vulnerability

Vulnerability is the likelihood of death or injury for residents due to flooding in a particular area.

The estimated risk of death for the population due to flooding is 0.00007, while the probability of injuries requiring hospital treatment is 0.00056.

Value

The assessment of the economic benefits of avoiding deaths or injuries from floods is based on a study that provides data on their avoided damage due to decreased fatalities or injuries in floods in the Netherlands.[117] The values from this analysis are converted/adjusted for Montenegro according to the ratio of its GDP to the number of inhabitants relative to the same size in the Netherlands. The publications of the Statistical Office of Montenegro (MONSTAT) include data for GDP, GDP per capita and inflation rates.

[117] Bockarjova, Rietveld, Verhoef, 2012: „Composite Valuation of Immaterial Damage and flooding: Value of Statistical Life Value of Statistical evacuation and Value of Statistical Injury“

Result

As a result of the economic analysis (economic benefits in the field of human health), the following values are expressed in monetary terms:

- economic benefits arising from damage avoided in the event of a fatal outcome,
- the economic benefits of damage avoided in the event of injury.

Table 9.3. Potential damages – Human health (Danube River Basin) without and with intervention

CURRENT SITUATION (without interventions)

HEALTH

Total potential damage calculation in the case of death

Flood return period (years)	Residents				
	Total population (#)	Exposure	Vulnerability	Damage because of death case (EUR/cap)	Total potential damage (EUR)
10	4738	0.84	0.00007	1,535,384	427,749
100	5885	0.84	0.00007	1,535,384	531,301
500	5929	0.84	0.00007	1,535,384	535,274

Total potential damage calculation in the case of injury

Flood return period (years)	Residents				
	Total population (#)	Exposure	Vulnerability	Damage because of injury (EUR/cap)	Total potential damage (EUR)
10	4738	0.84	0.00056	20,773	46,298
100	5885	0.84	0.00056	20,773	57,506
500	5929	0.84	0.00056	20,773	57,935

Intervention 1

HEALTH

Total potential damage calculation in the case of death

Flood return period (years)	Residents				
	Total population (#)	Exposure	Vulnerability	Damage because of death case (EUR/cap)	Total potential damage (EUR)
10	2369	0.84	0.00007	1,535,384	213,875
100	2943	0.84	0.00007	1,535,384	265,651
500	2965	0.84	0.00007	1,535,384	267,637

Total potential damage calculation in the case of injury

Flood return period (years)	Residents				
	Total population (#)	Exposure	Vulnerability	Damage because of injury (EUR/cap)	Total potential damage (EUR)
10	2369	0.84	0.00056	20,773	23,149
100	2943	0.84	0.00056	20,773	28,753
500	2965	0.84	0.00056	20,773	28,968

9.5.2 Environment

Floods affect the environment and ecosystem services. In the case of flooding, there is a disruption in the supply of clean drinking water to the population. Also, there is the pollution of soil and water. Potential sources of pollution are damaged factories or warehouses from which leakage of chemical substances is hazardous to the environment. Possible sources of pollution are also damaged landfills, septic tanks or liquid fuel warehouses used for heating households and other buildings. The economic benefits in this segment are avoided damages/costs arising in the event of floods and with the period of return (QT) due to the need to supply clean water to the population or decontaminate land and water.

Dimension

The economic benefits in the environment domain are calculated based on avoided damages/costs in the case of (for different flood return periods) violation of the aesthetic value and the environment and services that depend on biodiversity.

Ecosystems provide aesthetic value to the environment and services depending on biodiversity. The CBA model, as input data, takes into consideration the area of land that may potentially be threatened due to flooding with a period of QT return.

The publications of the national statistical office include data on the first two elements.

Exposure

Exposure is the probability of the presence of a spatial component in a particular threatened area over a specific period. For example, the probability of elements such as drinking water sources, areas from which drinking water is taken, the environment and possible sources of pollution is equal to 1 because these elements are fixed at a particular location and cannot be moved to another location before and during floods.

Vulnerability

Vulnerability is the likelihood that the observed elements in a given space will suffer damage. The assumption is that in the environmental domain, this probability is 0.5. The CBA analysis starts from the assumption that, for example, drinking water sources in the affected area will certainly be polluted and that they cannot supply water to the population for a certain period. It has also been assumed that the probability of soil and water pollution due to leakage of certain toxic substances from plants and warehouses is equal to 0.5, although in reality, data on this probability should be sought in IPPC permits issued following the EU IED directive.

Value

The CBA model assumes certain input parameters for unit values used to calculate the total economic benefits.

The calculation of the value of damages that may occur when it comes to the aesthetic value of the natural environment is based on the assumption that the value of biodiversity-dependent services is equal to 0.3% of GDP, while the aesthetic value is equal to 0.18% of GDP. It means that the unit value of damage avoided on this basis is equal to the value obtained as 0.48% of GDP divided by the area of land (for example, arable land and gardens) threatened in the event of flooding.

Result

The result of this part of the CBA (economic benefits in the environment) is economic benefits based on avoided damages reducing the aesthetic value of the environment and degrading the quality of services that depend on biodiversity.

Table 9.4. Potential damages – Environment (Danube River Basin) without and with intervention

CURRENT SITUATION (without interventions)

ENVIRONMENT

Aesthetic value to the environment and services depending on biodiversity

Flood return period (years)	Surface area (ha)	Exposure	Vulnerability	Value of flood impact on environment (EUR/ha)	Total potential damage (EUR)
10	467	1	1	59.774	27943.42125
100	682	1	1	59.774	40777.12628
500	757	1	1	59.774	45262.05549

Intervention 1

ENVIRONMENT

Aesthetic value to the environment and services depending on biodiversity

Flood return period (years)	Surface area (ha)	Exposure	Vulnerability	Value of flood impact on environment (EUR/ha)	Total potential damage (EUR)
10	348	1	1	59.774	20,803
100	518	1	1	59.774	30,939
500	575	1	1	59.774	34,387

9.5.3 Economic activity

The calculation of economic benefits in terms of avoided damages in the domain of economic activity includes the following elements:

- residential, commercial (factories, offices) and agricultural facilities,
- public infrastructure (national and local roads),
- agricultural land (arable land, pastures and forests) and crops,
- economic activity (basic and working capital of business entities).

Dimension

The calculation of economic benefits in terms of avoided damages in the domain of economic activity includes the following elements:

- endangered area on which residential buildings are located,
- endangered area on which there are commercial (factories, offices, shops) and agricultural facilities and land,
- endangered area where the public infrastructure is located (national and local roads) and performs transport activities.

Each element located in the endangered area is represented by the surface of the area (land area in m^2) for each of the analysed periods of flood return (QT).

Exposure

The CBA analysis assumed that the probability of given elements in this domain in the flooded area equals 1. Commercial facilities and public infrastructure have a fixed location and, therefore cannot be relocated before and during floods.

Vulnerability

CBA analysis assumes that the probability that certain elements in this group will be damaged in the event of floods on all surfaces equals 0.5.

Value

The value of damage in economic activity is given in euros per m^2 based on the reference values for Montenegro estimated by the Joint Research Centre of the European Union.118 The 2010 constant price benchmarks are presented Table 9.5. In the CBA analysis, 2010 prices are converted into current prices, i.e., prices from the year in which the flood protection measures are implemented. This conversion is based on the cumulative inflation rate in the euro area in the period under review.

Table 9.5. Unit values of maximum damage in the economy in Montenegro (2022 prices)

Residential buildings (EUR/m^2)	Commercial facilities (EUR/m^2)	Industrial facilities (EUR/m^2)	Agriculture (EUR/ha)	Infrastructure (EUR/m^2)	Transport (EUR/m^2)
98.91	186.25	217.08	638.40	4.95	148.54

Result

As a result of this part of the CBA analysis (economic benefits in the domain of economic activity), the following values are obtained in the monetary expression:

- economic benefits based on avoiding damage to residential, commercial and agricultural facilities,
- economic benefits arising from avoided damage to public infrastructure (national and local roads) and transport activities;
- economic benefits arising from the avoided damage to agriculture (crops);
- economic benefits due to avoided damages to the company's gross and working assets.

[118] Huizinga, J., De Moel H., Szewczyk, W. (2017). *Global flood depth-damage functions: Methodology and the database with guidelines.* JRC Technical Report. European Commission. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC105688/global_flood_depth-damage_functions__10042017.pdf

Table 9.6. Potential damages – Economic activity (Danube River Basin) without intervention

CURRENT SITUATION (without interventions)

ECONOMIC ACTIVITY

Potential damage on the residential buildings

Flood return period (years)	Damage on the residential buildings				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	1375728	1	0.5	98.91	68,034,208
100	2380111	1	0.5	98.91	235,408,416
500	2853490	1	0.5	98.91	282,228,748

Potential damage on the industrial facilities

Flood return period (years)	Damage on the industrial facilities				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	208346	1	0.5	217.08	22,613,973
100	231456	1	0.5	217.08	50,244,528
500	250520	1	0.5	217.08	54,383,057

Potential damage on the commercial facilities

Flood return period (years)	Damage on the commercial facilities				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	0	1	0.5	186.25	0
100	0	1	0.5	186.25	0
500	0	1	0.5	186.25	0

Potential damage on the agricultural facilities

Flood return period (years)	Damage on the agricultural facilities				
	Surface area (ha)	Exposure	Vulnerability	Potential damage (EUR/ha)	Total potential damage (EUR)
10	305	1	0.5	638.40	97,510
100	427	1	0.5	638.40	272,367
500	459	1	0.5	638.40	293,197

Potential damage on the road infrastructure

Flood return period (years)	Damage on the road infrastructure				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	35925	1	0.5	4.95	88,829
100	46817	1	0.5	4.95	231,523
500	53288	1	0.5	4.95	263,526

Potential damage on the transport activity

Flood return period (years)	Damage on the transport activity				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	35925	1	0.5	148.54	2,668,111
100	46817	1	0.5	148.54	6,954,124
500	53288	1	0.5	148.54	7,915,363

Table 9.7 Potential damages – Economic activity (Danube River Basin) with intervention

Intervention 1

ECONOMIC ACTIVITY

Potential damage on the residential buildings

Flood return period (years)	Damage on the residential buildings				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	1048771	1	0.5	98.91	51,865,131
100	1821512	1	0.5	98.91	180,159,406
500	2163433	1	0.5	98.91	213,977,569

Potential damage on the industrial facilities

Flood return period (years)	Damage on the industrial facilities				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	147783	1	0.5	217.08	16,040,373
100	164686	1	0.5	217.08	35,750,096
500	177400	1	0.5	217.08	38,510,135

Potential damage on the commercial facilities

Flood return period (years)	Damage on the commercial facilities				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	0	1	0.5	186.25	0
100	0	1	0.5	186.25	0
500	0	1	0.5	186.25	0

Potential damage on the agricultural facilities

Flood return period (years)	Damage on the agricultural facilities				
	Surface area (ha)	Exposure	Vulnerability	Potential damage (EUR/ha)	Total potential damage (EUR)
10	227	1	0.5	638.40	72,491
100	322	1	0.5	638.40	205,857
500	348	1	0.5	638.40	222,290

Potential damage on the road infrastructure

Flood return period (years)	Damage on the road infrastructure				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	12619	1	0.5	4.95	31,204
100	16639	1	0.5	4.95	82,284
500	18881	1	0.5	4.95	93,372

Potential damage on the transport activity

Flood return period (years)	Damage on the transport activity				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	12619	1	0.5	148.54	937,242
100	16639	1	0.5	148.54	2,471,513
500	18881	1	0.5	148.54	2,804,562

9.5.4 Economic efficiency

Two economic indicators may be used to assess the economic efficiency of the proposed structural/non-structural measures in DRB.

The difference between benefits and costs in absolute terms shows the return on investments. Therefore, the intervention providing the highest return on investment is, from the point of view of economic efficiency, the best option.

However, the decision on the option should not be made solely based on this indicator. **The ratio of benefits and costs** that shows which measures are more economically valuable is also an important indicator. The first condition an intervention should meet is that the benefit-cost ratio is higher than 1.0. For example, suppose we are in doubt about two interventions, each of which has an absolute positive difference between benefit and cost. In that case, it is necessary to choose the one where the ratio between benefits and costs is higher.

The total estimated investment costs of measures planned for Danube River Basin amount to 48,452,000 EUR, while maintenance costs are equal to 1,313,040 EUR per year. The discounted value of total costs for the project period of 100 years is 75,826,140 EUR.

The benefit/cost ratio is 1.36. That means the proposed intervention (investment in flood measures) in the Danube River Basin is worth the investment in economic terms.

Table 9.8 Potential damages – Economic activity (Danube River Basin) with intervention

CURRENT SITUATION W/O MEASURES	
Future potential damage discounted	417,091,296

INTERVENTIONS

Options	Future potential damage without intervention (discounted EUR)	Future potential damage with intervention (discounted EUR)	Benefits (Potential future damage w/o intervention minus Potential future damage with intervention) (discounted EUR)	Total costs (discounted EUR)	Benefits/Costs	Benefits - Costs (discounted EUR)	Incremental benefits/ Incremental costs
Intervention 1	417,091,296	313,707,889	103,383,407	75,826,140	1.36	27,557,267	N/A

10 INTERNATIONAL COORDINATION

10.1 International cooperation and coordination in the Flood Risk Management

Montenegro's cooperation with neighbouring countries and the wider international environment in water management is regulated by interstate agreements and signed conventions and agreements in the field of water, which are part of the legal framework for water management in Montenegro. In the Danube River Basin, the Lim River Basin covers the territories of Montenegro, Bosnia and Herzegovina, Albania, and Serbia, and is partly the border river between Montenegro and Serbia. The Tara and Ćehotina Rivers are part of the border river between Montenegro and Bosnia and Herzegovina. The Ibar River covers the territories of Montenegro and Serbia.

Montenegro became a candidate for membership in the European Union in December 2010, and the negotiation process between Montenegro and the European Union officially began in June 2012.

On Montenegro's path to the European Union, the negotiating Chapter 27 - Environmental Protection and Climate Change, within which the sub-area - Water quality, is one of the most demanding. The Ministry responsible for ecology is coordinating the negotiation process in Chapter 27.

International cooperation related to the Danube basin is related to the cooperation of Montenegro in the Danube. Namely, Montenegro has been a member of the International Commission for the Protection of the Danube River (ICPDR) since 2008.

Cooperation at the level of the Sava River Basin in Sava Commission, is realized in accordance with the Memorandum of Cooperation between the International Commission for the Sava River Basin and Montenegro. Namely, the Memorandum of Understanding on Cooperation Concerning Regular Functioning and Maintenance of the Flood Forecasting and Warning System in the Sava River Basin was signed of July 1, 2020. Whereas the Protocol on Flood Protection to the Framework Agreement on the Sava River Basin was signed on June 1, 2010. The obligation of Bosnia and Herzegovina, the Republic of Croatia, the Republic of Serbia, and the Republic of Slovenia to establish a coordinated or joint system for forecasting, warning, and alerting from floods in the Sava River Basin in coordination with the International Sava River Basin Commission has been established. Montenegro, being non-party to the Protocol, took part in the establishment on the basis of the Memorandum of Understanding on cooperation between the International Sava River Basin Commission and Montenegro, signed in Belgrade on 9 December 2013, and as a beneficiary of the Project. The signing of the said memorandum is only a continuation of these activities.

An agreement on the Condition of use of the Flood Forecasting and Warning System in the Sava River Basin was also signed by Ministry of Agriculture, Forestry and Water Management and the Institute of Hydrometeorology and Seismology. The Flood Forecasting and Warning System in the Sava River Basin is established within the implementation of the Protocol on Flood Protection to the Framework Agreement on the Sava River Basin. The effective joint operational structure and procedures of regular maintenance and performance control of the system are regulated by the provision of the Memorandum of Understanding.

In addition to international cooperation for Montenegro, due to the transboundary nature of most watercourses, cooperation with neighbouring countries in the field of transboundary water resources management is of great importance.

In the forthcoming period, it is necessary to further develop bilateral and multilateral cooperation with neighbouring countries in the field of water management, and especially in the field of flood management.

10.2 Regional Projects

The Ministry of Agriculture, Forestry and Water Management, in cooperation with the World Bank, is implementing the regional project "Management of the Drina River Basin in the Western Balkans". The project is funded by a grant from the Global Environment Facility (GEF) and the Special Climate Change Fund (SCCF).

Part of this project is the preparation of project documentation for the regulation of the Lim River (with Grnčar) in order to combat climate change and integrated management of natural resources. The municipalities covered by the project are: Gusinje, Plav, Andrijevica, Berane and Bijelo Polje. This project will create conditions for the realization of capital infrastructure works on the construction of multi-purpose fortifications on Lim and Grnčar.

11 COORDINATION WITH THE WATER FRAMEWORK DIRECTIVE (2000/60/EC)

Chapter 5 of the Directive, consisting of Article 9 and 10, deals with Public Information and Consultation process.

Art 9 of the FD requires Member States shall take appropriate steps to coordinate the application of this Directive and that of Directive 2000/60/EC focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of Directive 2000/60/EC. In particular:

1. The development of the first flood hazard maps and flood risk maps and their subsequent reviews as referred to in Articles 6 and 14 of this Directive shall be carried out in such a way that the information they contain is consistent with relevant information presented according to Directive 2000/60/EC. They shall be coordinated with, and may be integrated into, the reviews provided for in Article 5(2) of Directive 2000/60/EC;
2. The development of the first flood risk management plans and their subsequent reviews as referred to in Articles 7 and 14 of this Directive shall be carried out in coordination with, and may be integrated into, the reviews of the river basin management plans provided for in Article 13(7) of Directive 2000/60/EC;
3. The active involvement of all interested parties under Article 10 of this Directive shall be coordinated, as appropriate, with the active involvement of interested parties under Article 14 of Directive 2000/60/EC.

The full transposition of this article of the directive is contained in Articles 95a and 95e of the Law on Waters and in Article 8 paragraph 1 item 4 of the Rulebook.

Articles 95a of the Law on Waters determines that the Flood risk reduction measures shall be compliant with water and environmental protection measures referred to in Article 73 of this Law.

Articles 95e determines that, for areas under significant flood risk, a FRMP shall be drafted at the level of a river basin district, in accordance with water management plan referred to in Article 24 of this Law.

According to the Article 8 paragraph 1 item 4 of the Rulebook on Detailed Content of the Preliminary Flood Risk Assessment and Flood Risk Management Plan shall contain the measures that will be implemented according to priorities with the aim of managing flood risks, measures that will be implemented in order to achieve compliance between the Plan and the Water Basin Management Plan referred to in Article 24 of the Law on Waters, and measures that will be implemented based on regulations on environmental impact assessment, strategic environmental impact assessment, industrial accidents and water management, provided those measures do not increase flood risks upstream or downstream in other countries at the same river basin or sub-basin, except in cases when countries have concorded such measures.

Art 10 FD, in accordance with applicable Community legislation, Member States shall make available to the public the preliminary flood risk assessment, the flood hazard maps, the flood risk maps and the flood risk management plans. Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans referred to in Chapter IV.

The full transposition of this article of the directive is contained in Articles 95f of the Law on Waters which determines, in the process of drafting the flood risk management plans and updating them, the involvement of all stakeholders and public participation shall be ensured in order to enable provision of comments, proposals and suggestions.

Preliminary flood risk assessment, areas of potential significant flood risk, flood hazard maps, flood risk maps and flood risk management plan shall be published on the website of the Ministry and of the competent administrative authority.

Compliance of flood risk management measures in the Danube basin and the measures given in the River Basin Management Plan for the Danube basin in relation to environmental protection goals

The River Basin Management Plan for the Danube basin provides a program of measures aimed at preserving or improving the status of water bodies, as well as environmental protection goals that must be achieved. The program of measures of the Flood Risk Management Plan for the Danube basin is harmonized with the measures to preserve and improve the status of water bodies, i.e. the application of flood protection measures will not lead to deterioration of the status of water bodies. We especially emphasize the importance of non-structural measures in order to manage flood risks, which foresee improvements related to spatial planning in flood zones, as well as encouraging the preservation of wetlands and green areas in the areas around watercourses, which increase natural retention properties and affect the reduction of flood waves.

Table 11.1 Environmental protection objectives provided for in the River Basin Management Plan for the Danube basin, related to flood protection

Environmental/Activity Objective	Measurable Units	Goals		
		2021*	2027	2033
Reducing the harmful effects of floods on human health, the environment, cultural heritage and the economy				
Removal/reduction of the amount of hazardous substances and nitrates entering groundwater bodies	% reduction of contamination	30	50	80
Increasing the efficiency of wastewater treatment as groundwater pollution from urban and industrial sources of pollution is avoided	% reduction of untreated wastewater discharges from cities with >2000 population equivalents (concentrated sources)	10	50	95
Reducing the harmful effects of floods on human health, the environment, cultural heritage and the economy **				
Reduction in the number of inhabitants affected by floods	% of affected population	<10	<5	<1

*2021 is the base year of the river basin management cycle

**Water management strategy, 2015

The measures provided for in the Flood Risk Management Plan for the Danube Basin will contribute to the achievement of the environmental protection goals set out in the River Basin Management Plan for the Danube Basin.

12 PUBLIC INFORMATION AND CONSULTATION

In accordance with Article 95f of the Water Law and Directive 2007/60/EC on the assessment and management of flood risks, the Water Administration, in cooperation with the Ministry of Agriculture, Forestry and Water Management, ensured public participation and information during the preparation of the Flood Risk Management Plan (FRMP) for the Danube River Basin District, as well as the accompanying Strategic Environmental Assessment (SEA). In line with applicable legislation, the Water Administration was obliged to enable active participation of the public and interested parties in the procedure of preparation and adoption of the Flood Risk Management Plan and to make available all documentation relevant to its development. The preparation of the plans (for both river basin districts) and the accompanying assessments was carried out within the IPA project "Support for the Implementation and Monitoring of Water Management in Montenegro," as one of the final steps in the implementation of Directive 2007/60/EC on flood risk management.

The public consultation lasted from 21. august to 21. september 2024, during which all interested stakeholders were able to submit comments, suggestions, and proposals to the Water Administration or by mail to the institution's official address. The public was timely informed of the consultation through the official websites of the Ministry and the Water Administration, as well as through the media.

The central event of the public consultation was the conference held on 17. september 2024 in Bijelo Polje, attended by representatives of the Ministry of Agriculture, Forestry and Water Management, the Water Administration, and the Municipality of Mojkovac. Also participating were consultants engaged in the preparation of the Flood Risk Management Plan from the company EPTISA, as well as consultants from EcoEnergy Consulting responsible for preparing the Strategic Environmental Assessment. During the presentations, technical and methodological aspects of the plan's development were discussed, including criteria for determining priorities and financing measures, as well as possibilities for integrating proposed activities into local development plans and improving cross-border cooperation.

A significant number of comments and suggestions (ANNEX 3) were received during the public consultation from the Ministry of Agriculture, Forestry and Water Management, the Water Administration, the Ministry of Interior, and other institutions. Most comments related to aligning and correcting investment and operational costs across tables, ensuring consistency between the Montenegrin and English versions (names, codes, and tables), and updating information on the status of projects and planned investments, including activities under the Sava and Drina Integrated Development Program (SDIP). Additional needs were noted regarding the clarification of cartographic representations, coding of Areas of Potential Significant Flood Risk (APSFR), and improvements related to maintenance, methodological explanations, and clearer presentation of data in tables and graphics. Cooperation between institutions and plan developers was highly constructive, and most comments were accepted and incorporated into the final version of the Plan, improving and fully harmonizing the document with applicable regulations and EU standards.

After the public consultation, the draft Flood Risk Management Plan for the Danube River Basin District was submitted to neighboring countries for review via the Ministry of Foreign Affairs on 31. march 2025, in accordance with cross-border cooperation obligations and the principles of integrated water resources management established by the Water Framework Directive and the Floods Directive. The deadline for submitting opinions was 31. may 2025. The Republic of Serbia issued a positive opinion on the draft Plan.

LIST OF PARTICIPANTS:

17. september 2024, Bijelo Polje

Name	Institution
Željko Furtula	Ministry of Agriculture, Forestry and Water Management
Zorica Đuranović	Ministry of Agriculture, Forestry and Water Management
Dragana Đukić	Ministry of Agriculture, Forestry and Water Management
Milo Radović	Water Administration
Janko Burzanović	Water Administration
Tamara Kuč	Water Administration
Ivan Ašanin	Municipality of Mojkovac
Danilo Barjaktarović	EcoEnergy Consulting
Milena Ostojić	EPTISA
Zdenka Ivanović	EPTISA
Maja Krivokapić	EPTISA
Biljana Medenica	EPTISA
Ana Medojević Pejović	EPTISA

Figures 12.1. Public Hearing Bijelo Polje

ANNEX 1: TABLE OF TRANSPOSITION FD 2007/60/EC WITH THE PROVISIONS OF MONTENEGRIN REGULATIONS

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
CHAPTER I: GENERAL PROVISIONS		
Art 1 The purpose of this Directive is to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community.	Art 95a par 1 Law on Waters (OG MNE No 27/07, OG MNE No. 32/11, 47/11, 48/15, 52/16 i 84/18): Flood risks shall be managed with the aim of reducing adverse consequences for human health, environment, cultural heritage and economy.	Full transposition
Art 2 For the purpose of this Directive, in addition to the definitions of 'river', 'river basin', 'sub-basin' and 'river basin district' as set out in Article 2 of Directive 2000/60/EC, the following definitions shall apply:	Art 5 par 1 point 58, 60, 61 and 80 Law on Waters: 58) river is a terrestrial water body, which for the most part flows over the surface of the earth and which can flow part of its course below the surface of the earth; 60) river sub-basin is the area of land from which all surface waters through a series of watercourses, rivers, i.e. through a lake and underground, flow to a certain point of a watercourse (usually a lake or the mouth of another river); 61) river basin is the surface of the land from which all surface waters through one or more watercourses, rivers, i.e. through the lake and underground, flow directly into the sea through a single estuary, tributary or delta; 80) water area is the area of land and sea, which consists of one or more neighbouring river basins, or sub-basins, on the territory of Montenegro, with associated groundwater and coastal sea waters, in accordance with Article 21 of this Law, which is determined as the basic unit for water management;	Full transposition
'flood' means the temporary covering by water of land not normally covered by water. This shall include floods from	Art 5 par 1 point. 49 and 50 Law on Waters: 49)means the temporary covering by water of land not normally covered by	Full transposition

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Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems; 'flood risk' means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event.	water. This shall include floods from rivers, torrents, temporary water courses, lakes, marine waters in coastal zones and ground waters, except for floods from sewerage systems; 50) flood risk is a combination of the probability of a flood event and of the potential adverse consequences thereof for human health, environment, cultural heritage and economic activities;;	
Art 3 1. For the purposes of this Directive Member States shall make use of the arrangements made under Article 3(1), (2), (3), (5) and (6) of Directive 2000/60/EC.	Art. 8, 21, 151 and 157 Law on Waters	Full transposition
2. However, for the implementation of this Directive, Member States may: (a) appoint competent authorities different from those identified pursuant to Article 3(2) of Directive 2000/60/EC; (b)identify certain coastal areas or individual river basins and assign them to a unit of management different from those assigned pursuant to Article 3(1) of Directive 2000/60/EC. 3. In these cases, Member States shall, by 26 May 2010, communicate to the Commission the information referred to in Annex I to Directive 2000/60/EC. For this purpose, any reference to competent authorities and river basin districts shall be taken as references to the competent authorities and unit of management referred to in this Article. Member States shall inform the Commission of any changes in the information provided pursuant to this paragraph within three months of the change coming into effect.	There is no corresponding provision	The option is not binding and has not been used, the implementing bodies and management units of both Directives (WFD and FD) are the same
CHAPTER II: PRELIMINARY FLOOD RISK ASSESSMENT		
Art 4 1. Member States shall, for each river basin district, or unit of management referred to in Article 3(2)(b), or the portion of an international river basin district lying within their territory,	Art 95b par 1 Law on Waters: Preliminary Flood Risk Assessment shall be drafted for every river basin by competent administrative body.	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
undertake a preliminary flood risk assessment in accordance with paragraph 2 of this Article.		
2. Based on available or readily derivable information, such as records and studies on long term developments, in particular impacts of climate change on the occurrence of floods, a preliminary flood risk assessment shall be undertaken to provide an assessment of potential risks. The assessment shall include at least the following: (a) maps of the river basin district at the appropriate scale including the borders of the river basins, sub-basins and, where existing, coastal areas, showing topography and land use; (b) a description of the floods which have occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed; (c) a description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged; and, depending on the specific needs of Member States, it shall include: (d) an assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity, taking into account as far as possible issues such as the topography, the position of watercourses and their general hydrological and geo-morphological characteristics, including floodplains as natural retention areas, the effectiveness of existing man-made flood defence infrastructures, the position of populated areas, areas of economic activity and long-term developments including	Art 3 par 1 Rulebook on detailed contents of preliminary flood risk assessment and flood risk management plan, OG MNE No. 69/15): A Preliminary Flood Risk Assessment contains: 1)river basin maps in appropriate proportion with sub-basin boundaries, and marine coastal maps with topography and land use details; 2)description of past flood events which had significant adverse impacts on human health, the environment, cultural heritage and economic activity, for which it is probable to occur again in the future, taking into account the severity of flood events, runoff directions and assessment of adverse impacts caused by such events; 3)description of floods that occurred in the past in areas where significant adverse impacts can occur in the future due to changed conditions (urban development, proclamation of protected areas); 4)impact of climate change on occurrence of floods; 5)assessment of potential harmful impacts of future floods on human health, environment, cultural heritage and economic activities, considering topography, position of water courses and their hydrological and geo-morphological characteristics, flood plains as natural retentions, efficiency of the existing flood protection facilities, position of settlements, areas of economic activities and long-term development plans, as necessary; 6)used data (records, long-term development studies); 7)conclusions on flood risks.	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
impacts of climate change on the occurrence of floods.		
3. In the case of international river basin districts, or units of management referred to in Article 3(2)(b) which are shared with other Member States, Member States shall ensure that exchange of relevant information takes place between the competent authorities concerned.	Art 95b par 2 Law on Waters: Preliminary Flood Risk Assessment for a river basin which is a part of an international river basin shall require exchange of information with the countries in territories of which portions of that river basin are located.	Full transposition
4. Member States shall complete the preliminary flood risk assessment by 22 December 2011.	There is no corresponding provision	Not applicable.[119]
Art 5 1. On the basis of a preliminary flood risk assessment as referred to in Article 4, Member States shall, for each river basin district, or unit of management referred to in Article 3(2)(b), or portion of an international river basin district lying within their territory, identify those areas for which they conclude that potential significant flood risks exist or might be considered likely to occur. 2. The identification under paragraph 1 of areas belonging to an international river basin district, or to a unit of management referred to in Article 3(2)(b) shared with another Member State, shall be coordinated between the Member States concerned.	Art 95c Law on Waters: On the grounds of PFRA, the Government shall identify the areas of potential significant flood risk, or of probable occurrence of floods (hereinafter referred to as: area of potential significant flood risk – APSFR). Identification of an APSFR for a river basin which makes part of an international river basin shall be coordinated with the countries in territories of which portions of that river basin are located.	Ful transposition
CHAPTER III: FLOOD HAZARD MAPS AND FLOOD RISK MAPS		
Art 6 1. Member States shall, at the level of the river basin district, or unit of management referred to in Article 3(2)(b), prepare flood hazard maps and flood risk maps, at the most appropriate scale for the areas identified under Article 5(1).	Art 95d par 1 Law on Waters: For the areas under significant flood risk, competent administrative body shall draft flood hazard maps and flood risk maps, for each river basin separately.	Full transposition

[119]Montenegro has no obligation to follow the deadlines set in the Directive. The Law on Waters prescribes the drafting of the PFRA by the end of 2019, and it was done in 2021.

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
2. The preparation of flood hazard maps and flood risk maps for areas identified under Article 5 which are shared with other Member States shall be subject to prior exchange of information between the Member States concerned.	Art 95d par 3 Law on Waters: Drafting the flood hazard maps and flood risk maps for areas under significant flood risk that include territories of neighbouring countries shall be done based on information exchange with those countries.	Full transposition
3. Flood hazard maps shall cover the geographical areas which could be flooded according to the following scenarios: (a) floods with a low probability, or extreme event scenarios; (b) floods with a medium probability (likely return period ≥ 100 years); (c) floods with a high probability, where appropriate.	Art 95d par 2 Law on Waters: Flood hazard maps and flood risk maps shall be drafted for: -low probability floods; -medium probability floods (return period 100 years); -high probability floods, as necessary. <u>Remark</u>: Repeated in Article 5, paragraph 1 and Article 7, paragraph 1 of the Rulebook, and in Article 2, paragraph 1, items 2, 3 and 4 are defined: 2. low-probability floods are floods caused by running waters with return period of at least 500 years, or floods caused by still waters with water levels with return period of at least 500 years; 3. medium-probability floods are floods caused by running waters with return period of 100 years, or floods caused by still waters with water levels with return period of 100 years; 4. high-probability floods are floods caused by running waters with return period of ten years, or floods caused by still waters with water levels with return period of ten years.	Full transposition
4.For each scenario referred to in paragraph 3 the following elements shall be shown: (a) (a)the flood extent; (b) water depths or water level, as appropriate; (c) where appropriate, the flow velocity or the relevant water flow.	Art 4 par 1 Rulebook: Flood hazard maps for floods of low, medium and high probability shall contain data on: -size of the event; -water depth and/or water level; -water course speed and/or water flow speed, as necessary.	Full transposition
5.Flood risk maps shall show the potential adverse consequences associated with flood scenarios referred to in paragraph 3 and expressed in terms of the following: (a) the indicative number of inhabitants potentially affected (b) type of economic activity of the area potentially affected;	Art 6 par 1 Rulebook: Flood risk maps for low, medium and high probability floods shall contain data on: -number of potentially affected population; -types of economic activities in potentially affected area;	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
(c) installations as referred to in Annex I to Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (9) which might cause accidental pollution in case of flooding and potentially affected protected areas identified in Annex IV(1)(i), (iii) and (v) to Directive 2000/60/EC; (d) other information which the Member State considers useful such as the indication of areas where floods with a high content of transported sediments and debris floods can occur and information on other significant sources of pollution.	-potential sources of pollution, activities and installations that could cause sudden pollution in case of floods; -potential hazard for protected areas referred to in Articles 74a paragraph 2, items 1, 3 and 5 of the Law on Waters; -areas where floods can occur with high content of transported sediments and other sources of pollution.	
6. Member States may decide that, for coastal areas where an adequate level of protection is in place, the preparation of flood hazard maps shall be limited to the scenario referred to in paragraph 3(a). 7. Member States may decide that, for areas where flooding is from groundwater sources, the preparation of flood hazard maps shall be limited to the scenario referred to in paragraph 3(a).	Art 5 par 2 Rulebook: For the floods caused by marine waters in coastal zones, where there is a certain level of protection against floods, as well as for areas where floods occur due to elevation of ground waters, flood hazard maps are made only for low probability flood events.	
8. Member States shall ensure that the flood hazard maps and flood risk maps are completed by 22 December 2013.	There is no corresponding provision	Not applicable.[120]
CHAPTER IV: FLOOD RISK MANAGEMENT PLANS		
Art 7 1. On the basis of the maps referred to in Article 6, Member States shall establish flood risk management plans coordinated at the level of the river basin district, or unit of management referred to in Article 3(2)(b), for the areas identified under Article 5(1) and the areas covered by Article 13(1)(b) in accordance with paragraphs 2 and 3 of this Article.	Art 95e par 1 Law on Waters: For areas under significant flood risk, a FRMP shall be drafted at the level of a river basin district.	Full transposition

[120] Montenegro has no obligation to follow the deadlines set in the Directive. Law on water prescribes the development of FHM and FRM by the end of 2020 (NEAS - same deadline)

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	**Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)**	**Compatibility**
2. Member States shall establish appropriate objectives for the management of flood risks for the areas identified under Article 5(1) and the areas covered by Article 13(1)(b), focusing on the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity, and, if considered appropriate, on non-structural initiatives and/or on the reduction of the likelihood of flooding.	Art 8 par 1 point 3 Rulebook: A Flood Risk Management Plan shall contain: 3) flood risk management goals for the areas significantly threatened by floods, aimed at reducing adverse impacts of floods to human health, environment, cultural heritage and economic activities;	Full transposition
3. Flood risk management plans shall include measures for achieving the objectives established in accordance with paragraph 2 and shall include the components set out in Part A of the Annex. Flood risk management plans shall take into account relevant aspects such as costs and benefits, flood extent and flood conveyance routes and areas which have the potential to retain flood water, such as natural floodplains, the environmental objectives of Article 4 of Directive 2000/60/EC, soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure. Flood risk management plans shall address all aspects of flood risk management focusing on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin. Flood risk management plans may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event.	Art 8 par 1 point 4, 5, 6 i 7 Rulebook: A Flood Risk Management Plan shall contain: 4) measures that will be implemented according to priorities with the aim of managing flood risks, measures that will be implemented in order to achieve compliance between the Plan and the Water Basin Management Plan referred to in Article 24 of the Law on Waters, and measures that will be implemented based on regulations on environmental impact assessment, strategic environmental impact assessment, industrial accidents and water management, provided those measures do not increase flood risks upstream or downstream in other countries at the same river basin or sub-basin, except in cases when countries have concorded such measures; 5)financial means for implementation of measures with cost-benefit analysis (CBA), depending on the size of flood event, run-off ways for flood waters, areas that can retain flood waters, environmental and land and water management goals, in compliance with spatial-planning documents; 6) manner of flood risk management, focused on prevention and protection, including flood forecasting and early warning systems, depending on river basin or sub-basin characteristics; 7) manner of promoting sustainable land use, better water retention and controlled flooding of certain areas in case of floods;	Full transposition
4. In the interests of solidarity, flood risk management plans established in one Member State shall not include measures which, by their extent and impact, significantly increase flood risks upstream or downstream of other countries in the same	Art 8 par 1 point 4 Rulebook: A Flood Risk Management Plan shall contain: 4) measures that will be implemented according to priorities with the aim of managing flood risks, measures that will be implemented in order to achieve	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
river basin or sub-basin, unless these measures have been coordinated and an agreed solution has been found among the Member States concerned in the framework of Article 8.	compliance between the Plan and the Water Basin Management Plan referred to in Article 24 of the Law on Waters, and measures that will be implemented based on regulations on environmental impact assessment, strategic environmental impact assessment, industrial accidents and water management, provided those measures do not increase flood risks upstream or downstream in other countries at the same river basin or sub-basin, except in cases when countries have concorded such measures;	
5. Member States shall ensure that flood risk management plans are completed and published by 22 December 2015.	There is no corresponding provision	Not applicable. (see footnote 2)
Art 8 1. For river basin districts, or units of management referred to in Article 3(2)(b), which fall entirely within their territory, Member States shall ensure that one single flood risk management plan, or a set of flood risk management plans coordinated at the level of the river basin district, is produced. 2. Where an international river basin district, or unit of management referred to in Article 3(2)(b), falls entirely within the Community, Member States shall ensure coordination with the aim of producing one single international flood risk management plan, or a set of flood risk management plans coordinated at the level of the international river basin district. Where such plans are not produced, Member States shall produce flood risk management plans covering at least the parts of the international river basin district falling within their territory, as far as possible coordinated at the level of the international river basin district. 3. Where an international river basin district, or unit of management referred to in Article 3(2)(b), extends beyond the boundaries of the Community, Member States shall endeavour to produce one single international flood risk management plan or a set of flood risk management plans coordinated at the level of the international river basin district; where this is	Art 95e par 4 i 5 Law on Waters: The Plan referred to in paragraph 1 of this Article for a river basin district that makes part of an international river basin shall be drafted as a joint flood risk management plan for the countries in territories of which portions of that river basin are located. Unless the Plan referred to in paragraph 4 of this Article has been drafted, a FRMP shall be drafted for a part of the international river basin located in the territory of Montenegro in cooperation with the countries in territories of which portions of that river basin are located.	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
not possible, paragraph 2 shall apply for the parts of the international river basin falling within their territory.		
4. The flood risk management plans referred to in paragraphs 2 and 3 shall be supplemented, where considered appropriate by countries sharing a sub-basin, by more detailed flood risk management plans coordinated at the level of the international sub-basins.	There is no corresponding provision	The provision is not binding and depends on the relations and agreements of the countries that share a certain basin (sub-basin).
5. Where a Member State identifies an issue which has an impact on the management of flood risks of its water and that issue cannot be resolved by that Member State, it may report the issue to the Commission and any other Member State concerned and may make recommendations as to how the issue should be resolved. The Commission shall respond to any report or recommendations from Member States within a period of six months.	There is no corresponding provision	Not applicable.
CHAPTER V: COORDINATION WITH DIRECTIVE 2000/60/EC, PUBLIC INFORMATION AND CONSULTATION		
Art 9 Member States shall take appropriate steps to coordinate the application of this Directive and that of Directive 2000/60/EC focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of Directive 2000/60/EC. In particular: 1. the development of the first flood hazard maps and flood risk maps and their subsequent reviews as referred to in Articles 6 and 14 of this Directive shall be carried out in such a way that the information they contain is consistent with relevant information presented according to	Art 95a par 3 Law on Waters: Flood risk reduction measures shall be compliant with water and environmental protection measures referred to in Article 73 of this Law. Art 95e par 1 Law on Waters: For areas under significant flood risk, a FRMP shall be drafted at the level of a river basin district, in accordance with water management plan referred to in Article 24 of this Law. Art 8 par 1 point 4 Rulebook: A Flood Risk Management Plan shall contain: 4) measures that will be implemented according to priorities with the aim of	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
Directive 2000/60/EC. They shall be coordinated with, and may be integrated into, the reviews provided for in Article 5(2) of Directive 2000/60/EC; 2. the development of the first flood risk management plans and their subsequent reviews as referred to in Articles 7 and 14 of this Directive shall be carried out in coordination with, and may be integrated into, the reviews of the river basin management plans provided for in Article 13(7) of Directive 2000/60/EC; 3. the active involvement of all interested parties under Article 10 of this Directive shall be coordinated, as appropriate, with the active involvement of interested parties under Article 14 of Directive 2000/60/EC.	managing flood risks, measures that will be implemented in order to achieve compliance between the Plan and the Water Basin Management Plan referred to in Article 24 of the Law on Waters, and measures that will be implemented based on regulations on environmental impact assessment, strategic environmental impact assessment, industrial accidents and water management, provided those measures do not increase flood risks upstream or downstream in other countries at the same river basin or sub-basin, except in cases when countries have concorded such measures;	
Art 10 1. In accordance with applicable Community legislation, Member States shall make available to the public the preliminary flood risk assessment, the flood hazard maps, the flood risk maps and the flood risk management plans. 2. Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans referred to in Chapter IV.	Art 95f Law on Waters: In the process of drafting the flood risk management plans and updating them, the involvement of all stakeholders and public participation shall be ensured in order to enable provision of comments, proposals and suggestions. Preliminary flood risk assessment, areas of potential significant flood risk, flood hazard maps, flood risk maps and flood risk management plan shall be published on the website of the Ministry and of the competent administrative authority.	Full transposition
- CHAPTER VI: IMPLEMENTING MEASURES AND AMENDMENTS Art 11, Art 12 - CHAPTER VII: TRANSITIONAL MEASURES Art 13	There is no corresponding provision	Not applicable.
CHAPTER VIII: REVIEWS, REPORTS AND FINAL PROVISIONS		
Art 14 1. The preliminary flood risk assessment, or the assessment and decisions referred to in Article 13(1), shall be reviewed, and if necessary updated, by 22 December 2018 and every six	Art 95b par 3 Law on Waters: Preliminary Flood Risk Assessment shall be revised upon the expiry of six years from its drafting, i.e. revision, taking into account impact of climate change to the occurrence of floods.	Full transposition

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
years thereafter. 2. The flood hazard maps and the flood risk maps shall be reviewed, and if necessary updated, by 22 December 2019 and every six years thereafter. 3. The flood risk management plan(s) shall be reviewed, and if necessary updated, including the components set out in part B of the Annex, by 22 December 2021 and every six years thereafter.	Art 95d par 4 Law on Waters: Flood hazard maps and flood risk maps shall be revised upon the expiry of six years following their drafting, i.e. revision. Art 95e par 6 Law on Waters: Flood Risk Management Plans shall be revised upon the expiry of six years from the date of their drafting or revision, considering the impact of climate change on the occurrence of floods.	
4. The likely impact of climate change on the occurrence of floods shall be taken into account in the reviews referred to in paragraphs 1 and 3.	Art 3 par 1 point 3 Rulebook: A Preliminary Flood Risk Assessment contains: 4) impact of climate change on occurrence of floods; Art 9 par 1 Rulebook: The Plan shall be updated if there are changes in data defined by the Plan, taking into account impact of climate change on occurrence of floods.	Full transposition
Art 15 1. Member countries must make the preliminary flood risk assessment, flood risk maps, flood risk maps and flood risk management plans referred to in Articles 4, 6 and 7, as well as their review, or their updated versions, available to the Commission in within three months after the dates specified in Articles 4(4), 6(8), 7(5), respectively, 14. 2. Member States must notify the Commission of the decisions taken in accordance with Article 13(1), (2) and (3) and make available the relevant information about them by the dates specified in Articles 4(4), 6(8), respectively , 7(5).	Art 95e par 7 Law on Waters: Flood Risk Management Plans shall be submitted by the competent administrative authority to the European Commission within three months from the date of the publication thereof, and PFRA, flood hazard maps and flood risk maps within three months from the date of drafting thereof.	Full transposition
Art 16, Art 17, Art 18 and Art 19	There is no corresponding provision	Not applicable.
ANNEX A. Flood risk management plans	Article 8, paragraph 1, item 1, 2, 3, 4 and 8 of the Rulebook: The flood risk management plan (hereinafter: the plan) contains:	Fully compliant

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)	Compatibility
I. Components of the first flood risk management plans: 1. the conclusions of the preliminary flood risk assessment as required in Chapter II in the form of a summary map of the river basin district, or the unit of management referred to in Article 3(2)(b), delineating the areas identified under Article 5(1) which are the subject of this flood risk management plan; 2. flood hazard maps and flood risk maps as prepared under Chapter III, or already in place in accordance with Article 13, and the conclusions that can be drawn from those maps; 3. a description of the appropriate objectives of flood risk management, established in accordance with Article 7(2); 4. a summary of the measures and their prioritisation aiming to achieve the appropriate objectives of flood risk management, including the measures taken in accordance with Article 7, and flood related measures taken under other Community acts, including Council Directives 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment and 96/82/EC of 9 December 1996 on the control of major accident hazards involving dangerous substances , Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment and Directive 2000/60/EC; 5. when available, for shared river basins or sub-basins, a description of the methodology, defined by the Member States concerned, of cost-benefit analysis used to assess measures with transnational effects.	1) map of the water area, showing the areas significantly threatened by floods determined in accordance with the conclusions from the preliminary flood risk assessment; 2) flood hazard maps and flood risk maps with conclusions; 3) goals of flood risk management for areas significantly threatened by floods, in order to reduce the harmful effects of floods on human health, the environment, cultural heritage and economic activities; 4) measures that will be implemented according to priorities in order to manage flood risks, ban or restrict construction in areas significantly threatened by floods, measures that will be implemented in order to harmonize the plan with the Water Management Plan from Article 24 of the Law on Water and measures that will be implemented on the basis of regulations on environmental impact assessment, strategic environmental impact assessment, industrial accidents and water management, provided that these measures do not increase flood risks upstream or downstream in other countries on the same river basin or sub-basin, unless have the states harmonized those measures; 8) description of the methodology used for cost-benefit analysis and assessment of measures with international effects for river basins and sub-basins shared with other countries, if necessary.	

Provision and text of the provision of the source of European Union law (article, paragraph, clause)	**Provision and text of the provision of the regulations of Montenegro (article, paragraph, point)**	**Compatibility**
II. Description of the implementation of the plan: 1. a description of the prioritisation and the way in which progress in implementing the plan will be monitored; 2. a summary of the public information and consultation measures/actions taken; 3. a list of competent authorities and, as appropriate, a description of the coordination process within any international river basin district and of the coordination process with Directive 2000/60/EC.	Article 10 paragraph 1 of the Rules: The implementation of the plan is carried out in accordance with the Action Program, which is an integral part of the plan and contains priorities for the implementation of the plan with deadlines, actions that will be taken to inform and consult the public and the competent authorities for the implementation of the plan.	Fully compliant
B. Components of the subsequent update of flood risk management plans: 1. any changes or updates since the publication of the previous version of the flood risk management plan, including a summary of the reviews carried out in compliance with Article 14; 2. an assessment of the progress made towards the achievement of the objectives referred to in Article 7(2); 3. a description of, and an explanation for, any measures foreseen in the earlier version of the flood risk management plan which were planned to be undertaken and have not been taken forward; 4. a description of any additional measures since the publication of the previous version of the flood risk management plan.	Article 9 paragraph 2 of the Rules: The updated plan contains information on: 1) made changes; 2) assessment of the achieved progress in achieving the goals from Article 8 paragraph 1 point 3 of this rulebook; 3) planned measures with reasons for non-implementation of those measures; and 4) additional measures with reasons for their implementation.	Fully compliant

ANNEX 2: DEFINITION OF EU CODES FOR APSFR

Flood Sources	• A11 - Fluvial • A12 - Pluvial • A13 - Groundwater • A14 - Sea water • A15 - Artificial Water
Flood Mechanism	• A21 - Natural Exceedance: Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands. • A22 - Defence Exceedance: Flooding of land due to floodwaters overtopping flood defences. • A23 - Defence or Infrastructural Failure: Flooding of land due to the failure of natural or artificial defences or infrastructure. This mechanism of flooding could include the breaching or collapse of a flood defence or retention structure, or the failure in operation of pumping equipment or gates. • A24 - Blockage / Restriction: Flooding of land due to a natural or artificial blockage or restriction of a conveyance channel or system. This mechanism of flooding could include the blockage of sewerage systems or due to restrictive channel structures such as bridges or culverts or arising from ice jams or landslides. • A25 - Other: Flooding of land by water due to other mechanisms, for instance wind setup floods. • A26 - No data available on the mechanism of flooding.
Flood Characteristics	• A31 - Torrential flood: A flood that appears and disappears fairly quickly, with little or no warning, usually as a result of intense rainfall over a relatively small area. • A32 - Spring flood due to melting snow: Flooding due to rapid melting of snow, possible in combination with precipitation or ice plug. • A33 - Second flash flood: A flood that occurs rapidly and does not fall into the category of torrential floods. • A34 - Medium-Rapid Flood: The onset of flooding that occurs more slowly than a sudden flood. • A35 - Slow-on Flood: A flood that takes a long time to form • A36 - Sediment flow: A flood that transports large amounts of sediment. • A37 - Rapid flow: A flood in which flood waters flow at high speed. • A38 - Deep flood: A flood in which flood waters are of significant depth. • A39 - Other characteristics. • A40 - Flood characteristics data not available.
Human Health	• B11 - Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment and would include fatalities.

	• B12 - Community: Adverse consequences to the community, such as detrimental impacts on local governance and public administration, emergency response, education, health, and social work facilities (such as hospitals). • B13 - Other • B14 - Not applicable
Environment	• B21- Waterbody Status: Adverse consequences ecological or chemical status of surface water bodies or chemical status of ground water bodies affected, as of concern under the WFD. Such consequences may arise from pollution from various sources (point and diffuse) or due to hydromorphological impacts of flooding. • B22 - Protected Areas: Adverse consequences to protected areas or waterbodies such as those designated under the Birds and Habitats Directives, bathing waters, or drinking water abstraction points. • B23 - Pollution Sources: Sources of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources. • B24 - Other potential adverse environmental impacts, such as those on soil, biodiversity, flora, and fauna, etc. • B25 - Not applicable
Cultural Heritage	• B31 - Cultural Assets: Adverse consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites, and buildings. • B32 - Landscape: Adverse permanent or long-term consequences on cultural landscapes, that is cultural properties which represents the combined works of nature and man, such as relics of traditional landscapes, anchor locations or zones. • B33- Other • B34 - Not applicable
Economic Activity	• B41 - Property: Adverse consequences to property, which could include homes. • B42 - Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage, and communication. • B43 - Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction, and fishing. • B44 - Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services, and other sources of employment. • B45 - Other • B46 - Not applicable

ANNEX 3 COMMENTS

MINISTRY OF AGRICULTURE, FORESTRY AND WATER MANAGEMENT

No.	Chapter	COMMENT	RESPONSE
1.		Present the total costs of the proposed structural measures in Table 8.4 (Tables 8.3 and 8.4 appear twice in the document) and reconcile them with the costs shown in Tables 9.4.1 to 9.4.19. For example: Indicative costs for APSFR03_DRB_Lovnička Rijeka01 according to Table 8.4 amount to €5,630,000, while according to Table 9.4.3 - €3,500,000; The total indicative costs from Table 8.4 amount to €41,400,000 + €400,000/year for maintenance, while from Tables 9.4.1 to 9.4.19 they amount to €39,670,000 (Is it usual to sum investment costs for infrastructure works and preparation of technical documentation with annual maintenance costs, as for APSFR01_DRB_Ibar01?); The total maintenance costs from Tables 9.4.1 to 9.4.19 amount to €759,400, not €2,719,400 as stated on p. 371.	Accepted. Corrected and aligned. Investment and operating costs are presented and treated separately in the cost-benefit analysis, but in the end, it is necessary to provide the total present value (discounted) for all cash outflows as a single figure.

WATER ADMINISTRATION

No.	Chapter	COMMENTS	RESPONSE
1.	3.3	The Demography chapter recognizes data from the 2011 Census. The applicable Regulation on the boundaries of sub-basin areas and small basin areas ("Official Gazette of Montenegro", No. 018/21 of 22.02.2021) identifies the area of the small Bojana basin in the far northeast of Montenegro (covering parts of the Rožaje,	It is not accepted. The text is clearly quoted from the Regulations.

		Plav, and even Andrijevica municipalities). Accordingly, the question is whether the available data from the new census has been considered, and whether the cited Regulation has been taken into account when the percentage distribution of watercourses by municipality is shown, particularly whether Figure 3.4 - Sub-basins and small basins in the river network of the Danube watershed corresponds to the applicable subordinate legislation from 2021.	
2.	3.6	In chapter 3.6, it is noted that at all stations for the period from 1946 to 2012, declining flow trends were recorded, while Table 3.11 provides a long-term analysis of hydrological stations in the Danube Basin, with 1948 shown as the starting year. However, in chapter 4.1, it is stated that historical hydrological data, related to recorded high (potential) flood waters at the network of hydrological stations in Montenegro, are analyzed "from 1952, when water level measurements on rivers began." Which of these statements is correct, i.e., since when has the water level been monitored (1946, 1948, or 1952)? We note that for the Adriatic Basin, it is stated that "at all stations for the period from 1948 to 2014, declines in flow were recorded."	"Tekst je izmijenjen u poglavlju 3.6."
3.	4.2	U poglavlju 4.2 koja prikazuje analizu postojeće infrastrukture za zaštitu od poplava na vodnom području Dunavskog sliva, kao jedan vid zaštite od poplava prepozanate su i paralelne građevine, dok u ENG verziji iste ne postoje. Uskladiti MNE dokument sa ENG verzijom dokumenta.	Engleska verzija je poboljšana
4.	5.2	Page 65 is blank	Deleting an empty page
5.	5.3	Chapter 5.3 refers to the	Added in chapter 5.3

		identified APSFR areas in the Danube basin. Not only this chapter, but the entire planning document (for both the Adriatic basin water area and the Danube basin water area) fails to acknowledge the Decision on Determining Areas Significantly Endangered by Floods ("Official Gazette of Montenegro", no. 030/22 of 21.03.2022). The Decision was adopted by the Government at the session of 24 February 2022, based on Article 95c, paragraph 1 of the Water Act, and therefore it must be recognized in this chapter as well as in all other chapters, especially considering that this valid subordinate regulation contains, among other things, the designations (codes) of the areas significantly endangered by floods, as well as settlements.	
6.	5.3	Table 5.5 lists the approved APSFR codes with a footnote stating that the codes for each APSFR were approved by the Ministry of Sustainable Development and Tourism and the Water Administration. This must again be harmonized with the Decision on defining areas significantly threatened by floods, as it is a valid by-law published in the Official Gazette of Montenegro. In this regard, all codes must be exactly as recognized by the Decision (e.g., instead of APSFR DRB1_Ibar in table 5.5, it should be APSFR01_DRB_Ibar01, and the same applies to all others, both in the MNE and ENG versions).	Amended in Chapter 5.3 for DRB
7.	5.3 ENG	Not only in Table 5.5., but in most places in the ENG version of the document, the names of settlements potentially at risk of flooding need to be corrected (e.g., Donji Ražanj should be corrected to Donji Pažanj, Prljnije to Prljanije, Oljue, Gubaac...)	Modified

8.	6.5	After Figure 6.9, a technical error was made and APSFR is listed for Ibarac01 (written in red). Correct the same in both the MNE and ENG versions of the document, as it concerns the Lovnica River and not the Ibarac.	Modified
9.	6.5	Table 6.10 shows a certain number of industrial facilities that are at risk (for HQ100, 2 endangered industrial facilities are shown, as well as for HQ500), while the flood risk assessment of industrial facilities does not detect them as endangered (colored in green).	Adopted. Corrected
10.	6.7	Table 6.14 shows a certain number of industrial facilities that are at risk (one industrial facility is shown as endangered for HQ100, as well as for HQ500), while the flood risk assessment for industrial facilities does not detect them as endangered (colored in green).	Adopted. Corrected
11.	6.11	In Table 6.22, the MNE version recognized that other cultural heritage is not endangered, as shown by the data in the table, while in the ENG version, other cultural heritage (eng. Other cultural heritage sites) is marked in red. Align Table 6.22 to be identical in the MNE and ENG versions.	Modified in the English version
12.	6.12	In the MNE version, table 6.24, in the urbanization section it says Yes, while in the ENG version in the same place it says No.	Modified in the English version
13.	6.12	Table 6.24 shows a certain number of industrial facilities that are at risk (for HQ10, HQ100, and HQ500, two endangered industrial facilities are shown), while the flood risk assessment of industrial facilities does not identify them as endangered (colored in green).	Adopted. Corrected
14.	6.13	Table 6.26 shows a certain number of industrial facilities that are at risk (for HQ100 one	Adopted. Corrected

		industrial facility is shown as at risk, as well as for HQ500), while the flood risk assessment of industrial facilities does not identify them as at risk (colored green).	
15.	6.13	In Table 6.26, the MNE version recognized that other cultural heritage is not endangered, as shown by the data in the table, while in the ENG version, other cultural heritage sites are colored red. Align Table 6.26 to be identical in the MNE and ENG versions.	Modified in the English version
16.	6.15	Table 6.30 shows a certain number of industrial facilities that are at risk (for HQ100 one industrial facility is shown as at risk, as well as for HQ500), while the flood risk assessment of industrial facilities does not identify them as at risk (colored green).	Adopted. Corrected
17.	6.18	Table 6.36 shows a certain number of industrial facilities that are at risk (one for HQ100 and two industrial facilities for HQ500), while the flood risk assessment of industrial facilities does not identify them as at risk (colored in green).	Adopted. Corrected
18.	6.2	Table 6.40 shows a certain number of industrial facilities that are at risk (for HQ10 and HQ100, 9 endangered industrial facilities are shown, as well as 10 for HQ500), while the flood risk assessment of industrial facilities does not detect them as endangered (colored in green).	Adopted. Corrected
19.	6	Table 6.44 differs in the MNE and ENG versions. In accordance with the comments and corrections given above in the tables from Chapter 6, correct Table 6.44 in both versions of the documents.	Adopted. Corrected
20.	7.2	In this chapter, as well as in all other chapters, it would be preferable to use the designations from the regulations (e.g., the	Modified

		ministry responsible for water affairs) instead of the names of ministries (e.g., Ministry of Agriculture, Forestry and Water Management). This is because, for example, in this chapter the Ministry of Ecology, Spatial Planning and Urbanism is mentioned, which no longer exists.	
21.	8	"The implementation of the Flood Risk Management Plan is carried out in accordance with the Action Program, which is an integral part of the plan and contains priorities for the implementation of the plan with deadlines, actions to be taken to inform and consult the public, as well as the competent authorities responsible for implementing the plan." In this particular case, the integral part of the plan provides the Measures Program, not the Action Program. Whether the Measures Program will remain or an Action Program or DSIP (Directive Specific Implementation Plan) will be prepared should be clarified in the text of the FRMP.	It is not accepted. The text is clearly quoted from the Rulebook.
22.	8.2	For each of the APSFR areas, the competent authorities are listed. As we mentioned in the example of the Ministry of Ecology, Spatial Planning, and Urbanism, which no longer exists, similarly in Table 8.2, as well as in all other tables in the chapter related to the Program of Measures (8.2.1-8.2.19), the Ministry of Capital Investments is mentioned, which also no longer exists. Therefore, we once again suggest introducing the term – ministry or administrative body competent for the tasks... Additionally, the general comment also applies to the competent authority according to the division of waters, regarding waters of national importance for Montenegro and waters of local	Partially modified

		importance. In this regard, the competence will not be the same for the rivers Lim, Ibar, and Tara (as watercourses of national importance for Montenegro) as for cleaning canals and streams of local importance.	
23.	8.2	In chapter 8.2, the terms mobile protection and individual mobile protection are mentioned for the first time. It is very important to explain what these terms and measures entail in the Measures Program. Whether the explanation will be provided at the beginning of chapter 8 or for each measure individually is a matter for the plan developers, but we believe that explaining this measure is of utmost importance for the proper future implementation of flood protection measures (as well as for project proposals). A very important aspect of these measures is also the issue of future management of such protection, as well as its storage (in practice: who has the capacity, equipment, and space for this type of protection).	This issue should be defined in the Strategy for Disaster Risk Reduction and in the action plan
24.	8.2.5	Table 8.6 shows the Proposed Measures for APSFR05_DRB_Grnčar01. The key measures in this chapter should be explained with reference to both the planned and existing situation within the Integrated Development Program of the Sava and Drina River Corridors (SDIP). The English version of the document should be corrected using proper English. Are the statements correct that the expected project completion is in 2024 and that the investment value is €5,630,000 (in accordance with the project documentation from 2019)?	Adopted. Corrected
25.	8.2.6	The key measures in Table 8.7. recognize as one of the measures	50,000€ is the cost for the maintenance of the

		the cleaning of the smaller Vrujica stream. Do the investment costs, which show a figure of €50,000 per year for routine maintenance of the built infrastructure, also include the cleaning of this stream? Additionally, the text states that the total investment for regulating the riverbed and constructing an embankment on the left bank upstream and downstream of the bridge over Vruja, over a length of 400m, amounted to €140,000, so are the annual maintenance investments of €50,000 too high (especially considering that this concerns a watercourse of local significance)?	Vruja River and also includes the Vrujica stream. Development works on the Vruja, amounting to 140,000€, were carried out between 2010-2014 over a length of 400m.
26.	8.2.7	In the measures for APSFR07_DRB_Lim01, the Integrated Development Program project for the Sava and Drina river corridors (SDIP) is recognized, and it is noted that activities are underway and that the expected completion of the project is in 2024. This part needs to be updated with more recent project data, and the value of the works should be verified.	Adopted. Corrected
27.	8.2.10	Considering that work has begun in part of the APSFR10_DRB_Lim04 area in Berane as part of the SDIP project, the text of the program of measures should be adjusted to the existing and planned activities	Adopted. Corrected
28.	8.2.11	In Table 8.12 for APSFR11_DRB_Lim05 in the settlement of Ribarevina in Bijelo Polje, a highway (English version of the document – highway) is mentioned, even though there is no highway in this area. Also, the Municipality of Berane is recognized as the second competent authority instead of the Municipality of Bijelo Polje, and the Water Administration is	Adopted. Corrected

		mentioned twice.	
29.	8.2.12	In Table 8.13, for APSFR12_DRB_Lim06 in the settlement of Rakonje in Bijelo Polje, the Municipality of Berane is listed as the second competent authority, which should be corrected since it concerns an area within the territory of the Municipality of Bijelo Polje.	Adopted. Corrected
30.	8.2.13	Considering that the works within the SDIP project have already started in Bijelo Polje, the text of the program of measures should be adjusted to existing and planned activities, including the value of the works and the deadlines	Adopted. Corrected
31.	8.2.14	Although the Decision on Designating Areas Significantly Endangered by Floods for APSFR14_DRB_Lim08 identifies the settlement of Lipnica as a flood-prone area, Table 8.15 does not recognize this settlement.	Adopted. Corrected
32.	8.2.15	Key measures in Table 8.16 foresee the construction of embankments on the left bank for a length of 5 km (Section 1) and on the right bank in Section 2 for a length of 300 m and in Section 3 for a length of 1,200 m on the rivers Ibar and Lim, while on the river Bistrica, in the upstream part for a length of 1 km, the use of mobile protection for residential buildings is recommended. In terms of investment costs, only the construction of embankments is noted, valued at €6,500,000, and not the costs for the recommended mobile protection.	Adopted. Corrected
33.	8.3	In the section of the proposed non-structural measures for APSFR, it is noted that for workshops with the participation of the institution responsible for construction, particularly planning and infrastructure, one of the sources of funding could include, among other things, water fees. Is	Adopted. Corrected

		this statement in accordance with the Law on Financing Water Management, that is, can workshops be funded from water fees?	
34.	8.4	Chapter 8.4 provides a summary of the measures. Any corrections in the tables above need to be reflected both in the summary and in the CBA chapter.	Adopted. Corrected
35.	9.4.1	For APSFR01_DRB_Ibar01, in Chapter 9.4.1, the investment costs are given at a value of €5,150,000, while the annual maintenance costs are shown at a value of €70,000. The program of measures for this area provides estimated investment costs as follows: for section 1 – Maintenance costs: €100,000/year, for section 2 – Maintenance costs: €50,000/year, for section 3 – Main project and construction works for embankment construction: €3,500,000, and for section 4 – Preparation of project documentation and construction works for embankment construction: €1,500,000. In total, this amounts to €5,150,000, but it is not noted that for sections 1 and 2, the figures of €100,000 and €50,000 are given on an annual basis.	Adopted. Corrected
36.	9.4.5.	The investment costs in chapter 9.4.5 are projected at €3,500,000, while the Action Program for the area APSFR05_DRB_Grnčar01 recognizes investment costs amounting to €5,630,000	Adopted. Corrected
37.	9.4.6	Chapter 9.4.6 shows investment costs amounting to €50,000, while the annual maintenance costs are given as €1,000. The program of measures for APSFR06_DRB_Vruja01 for the regular maintenance of the constructed infrastructure provides a figure of €50,000/year (not considering the cleaning of	Accepted. Corrected.

		the Vrujica stream).	
38.	9.4.8	Chapter 9.4.8 shows investment costs of €50,000, while annual maintenance costs are given as €1,000, and the program of measures for APSFR08_DRB_Lim02 for levee maintenance and watercourse cleaning provides a figure of €50,000 per year.	Accepted. Corrected.
39.	9.4.16	Chapter 9.4.16 shows investment costs amounting to €50,000, while the annual maintenance costs are given as €1,000, and the Action Program for APSFR16_DRB_Tara01 for embankment maintenance and watercourse cleaning provides a figure of €50,000 per year.	Accepted. Corrected.
40.	9.4.17	Chapter 9.4.17 shows investment costs amounting to €100,000, while the annual maintenance costs are given as €2,000, and the Action Program for APSFR17_DRB_Tara02 for embankment maintenance and watercourse cleaning provides a figure of €100,000 per year.	Accepted. Corrected.
41.	9.5.4	The CBA chapter states that the total estimated investment costs of the planned measures for the Danube basin amount to €39,670,000. Considering the figures from tables 9.4.1-9.4.19, the sum comes to the amount indicated in chapter 9.5.4 (€39,670,000). However, the Measures Program as a whole gives a figure of €41,800,000. In addition to the above comments regarding annual maintenance costs (for APSFR01, APSFR06, APSFR08, APSFR16, and APSFR17), a difference is noted regarding the investment costs for APSFR05_DRB_Grnčar01.	Accepted. Corrected.
42.	9.5.4	In chapter 9.5.4, the discounted value of total costs over a 100-year period amounts to 96,363,807 euros, while the average total discounted costs	Accepted. Corrected.

		from tables 9.4.1 – 9.4.19 add up to 55,501,903€.	
43.	9.5.4	In chapter 9.5.4, maintenance costs are 2,719,400 euros per year, while summing up the annual maintenance costs from tables 9.4.1 – 9.4.19 gives a total of 759,400€.	Accepted. Corrected.
44.	10.2	Chapter 10.2 presents regional projects. This chapter should be updated in accordance with the new circumstances of the Integrated Development Program of the Sava and Drina River Corridors (SDIP) project.	Accepted. Corrected.
45.	ANNEX 1	In Annex 1, in the section concerning the provisions and the text of the provision on the source of European Union law (article, paragraph, clause) for Annex A, point 4, instead of numbers 120, 121, and 122, there should be footnotes (in the ENG version they are numbered 1, 2, and 3 in the buildings). Correct both versions in accordance with what the EU directive prescribes.	Adopted. Corrected

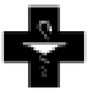
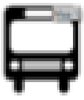
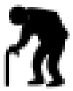
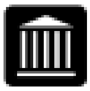
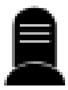
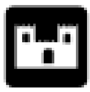
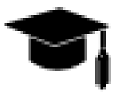
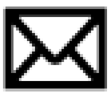
MINISTRY OF INTERNAL AFFAIRS

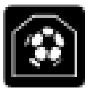
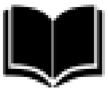
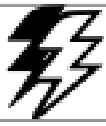
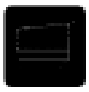
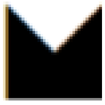
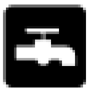
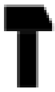
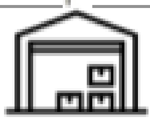
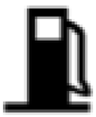
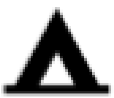
No.	Chapter	COMMENT	RESPONSE
1.	2.2	Add the Strategy for Disaster Risk Reduction with a Dynamic Action Plan for the implementation of the Strategy for the period 2018–2023. This suggestion applies to both plans. Note: In December 2024, the adoption of the Disaster Risk Reduction Strategy for the period 2025–2030 with an Action Plan for 2025–2026 is planned, so depending on when these plans are scheduled to be adopted, it is necessary to consider	Added strategy (old)

		including the new strategy, which will replace the previous one for the period 2018–2023.	
2.	2.8	The National Flood Protection and Rescue Plan is not a strategy, but a planning document, so the following text needs to be corrected and adapted accordingly: 'Measures for flood risk management and strategic guidelines are primarily established by the National Flood Protection and Rescue Plan from December 2019 and the Water Management Strategy from 2017. However, even the recommendations from these two most prominent strategic documents lack mutual synchronization. In addition to these two strategies, objectives related to or associated with flood risk management are defined in several other strategic documents, such as the Disaster Risk Reduction Strategy with a dynamic action plan for implementing the Strategy for the period 2018 - 2023, and the National Sustainable Development Strategy until 2030.' The following two documents should also be listed here: Montenegro's Disaster Risk Assessment (2021) and Montenegro's Disaster Risk Management Capacity Assessment (2023). This suggestion applies to both	Modified

		plans.	
2 3.	3 3.3	4 The state territory is administratively divided into 25 municipalities, not 24 as stated in the text. This needs to be corrected in both plans.	5 Modified
6 4.	7	8 Figure 9.2. Phases in calculation, page 341 (Flood Risk Management Plan for the Danube River Basin) and page 301 (Flood Risk Management Plan for the Adriatic Sea Basin)	9 Modified

ANNEX 4: SYMBOLS SHOWN IN FLOOD MAPS

1		Hotel	Hotel
2		Apoteka	Pharmacy
3		Autobuska stanica	Bus station
4		Bankarska djelatnost	Banking activity
5		Dom penzionera	Retirement home
6		Dom zdravlja	Community Health centre
7		Državne institucije	Government institutions
8		Groblje	Cemetery
9		Objekti kulture	Cultural objects
10		Obrazovne institucije	Educational institutions
11		Poslovne djelatnosti	Business activities
12		Poštanska I mobilna djelatnost	Postal and mobile service
13		Proizvodnja	Production activity

14		Radio televizija	Radio television
15		Restoran	Restaurant
16		Sportski objekat	Sports facility
17		Štamparska djelatnost	Printing activity
18		Trafostanica	Substation
19		Trgovina i usluzne djelatnosti	Trade and service activities
20		Vjerski objekat	Religious building
21		Vodovod	Water pipe
22		Zanatska djelatnost	Craft activity
23		Meteoroloska stanica	Meteorological station
24		Građevinarstvo i stovarišta	Construction and warehouse
25		Kafić	Coffee shop
26		Benzinska pumpa	Gas station
27		Kamp	Camp