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Flood Risk Management Plan for the Adriatic River Basin

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Document Preparation

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CONTENTS

LIST OF ABBREVIATIONS

APSFR	Area of Potential Significant Flood Risk
ARB	Adriatic River Basin
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
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 a 1/10 or 10% chance of being exceeded in any one year.
HQ100	Refers to a 100-year flood which a 1/100 or 1% chance of being exceeded in any one year.
HQ500	Refers to a 500-year flood which a 1/500 or 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

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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
MESPU	Ministry of Ecology, Spatial Planning and Urbanism
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 Preliminary Flood Risk Assessment (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 11 selected existing and historical hydrological stations in the Adriatic 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. A comparison was also made with the results obtained through the German funded and GIZ implemented project, 'Climate Change Adaptation in Transboundary Flood Risk Management for the Western Balkans' and it was concluded that the results matched.

During the assessment, the expected impacts of climate change were considered by applying one extreme flood scenario (extreme flood return 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 Adriatic 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, 6 APSFR in the Adriatic basin area were defined[2] and represented in GIS format. These included areas in the following Sub-Basins:

- Zeta River Sub-Basin
  - APSFR20_ARB_Zeta01
  - APSFR21_ARB_Zeta02
- Morača/Skadar Lake Sub-Basins
  - APSFR23_ARB_Morača and Skadar Lake01
- Skadar Lake Sub-Basin
  - APSFR22_ARB_Cetinje Field Groundwater01
  - APSFR24_ARB_Skadar Lake02
- Bojana River Sub-Basin
  - APSFR25_ARB_Bojana01

A further area that can be considered as an APSFR is the Sutorina River, which is a transboundary watercourse with Croatia identified as an endangered area within the analysis of historical floods. Although this area can be identified as an APSFR, the APSFR is

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

not defined since there are no hydrological data available in this area and therefore the return periods and the extent of flooding cannot be calculated.

Unfortunately, the small and torrential coastal watercourses and canals are not in the network of hydrological monitoring at the state level. Thus, due to the lack of hydrological data, not all of the necessary parameters for defining the potential areas of increased flood risk can be considered. The importance of flood management on the torrents of the Montenegrin coast certainly deserves appropriate attention, and in the future, it must be the subject of consideration of the manner and conditions of formation of hydrological monitoring on selected watercourses. Locations have been identified in the Municipalities of Bar, Budva, Herceg Novi and Kotor where hydrological stations are required to be installed to define the extent of flooding to the coastal regions.

Flood hazard and flood risk maps detail the affected areas in 6 APSFR in the Adriatic River Basin. The maps provide a description of the damage, 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 for low, medium and high-risk flooding events.

Based on the flood hazard and flood risk maps, it is calculated that in the Adriatic River Basin 5362 people are potentially endangered from a medium risk flooding event (HQ100). 1,784 dwellings are also considered at risk. A total of 105 industrial and 1,607 agricultural facilities are also endangered during a medium risk flooding event.

Data calculated on the number of people potentially endangered in each APSFR during high (HQ10) and low (HQ500) probability flooding events indicates the following reductions and increases with respect to a medium risk flooding event:

- APSFR20_ARB_Zeta01: HQ10 (-19%); HQ500 (+10%)[3]
- APSFR21_ARB_Zeta02: HQ10 (-48%); HQ500 (+10%)
- APSFR22_ARB_Cetinje Field Groundwater01: HQ10 (-95%); HQ500 (+27%)
- APSFR23_ARB_Morača and Skadar Lake01: HQ10 (-79%); HQ500 (+30%)
- APSFR24_ARB_Skadar Lake02: HQ10 (-44%); HQ500 (+4%)
- APSFR25_ARB_Bojana01: HQ10 (-83%); HQ500 (+46%)

Increased urbanization in all of the areas of the Adriatic River Basin would be expected to have a negative impact on future floods. Therefore, this information should be taken seriously in future spatial planning.

A total of 29 areas within the Adriatic River Basin have been identified as endangered from medium to high flooding events (HQ100 and HQ500).

A programme of measures, which incorporate flood prevention, flood protection and preparedness has been designed, which includes:

- 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;

[3] Calculate only for the Northern region of the APSFR20_ARB_Zeta01.

- measures that prepare for flooding should it occur (e.g. flood warning, awareness raising, emergency response plans).

Cost Benefit Analysis was conducted to evaluate the relationship between benefits and costs for each investment decision (mitigation measure).

The total estimated investment costs of measures planned for Adriatic River Basin amount to 12,550,000 EUR, while maintenance costs are equal to 214,700 EUR per year. The discounted value of total costs for the project period of 100 years is 17,026,046 EUR.

The benefit/cost ratio is 7.57, which means that the proposed intervention (investment in flood measures) in the Adriatic River Basin is worth the investment in economic terms.

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 and coast lines 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. With this Directive also reinforces the rights of the public to access this information and to have a say 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 document concerns the Adriatic River Basin.

The process by which 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 (Montenegro's Floods Regulation No. 069/15).

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 districts. 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 was adopted in December 2021 and 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 Adriatic River Basin

The format and content of the FRMP Report is prescribed both the 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 Adriatic River Basin includes the general components as detailed in Annex 1 of the Floods Directive, as 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 Adriatic 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 Adriatic River Basin as the following:

- The water area of the Adriatic Basin is a part of the international water area of the Adriatic Sea on the territory of Montenegro, which includes the basins: Zeta, Morača, Skadar Lake, Bojana, Trebisnjica and watercourses of the Montenegrin coast, which flow directly into the Adriatic Sea, with the corresponding ground and surface waters

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 Adriatic 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. 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;
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 VIII 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. 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.

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 ADRIATIC RIVER BASIN IN MONTENEGRO

3.1 Relief and topography

The area of the Adriatic River Basin (ARB) is 6,650 km^2 or 47.8% of the surface area of Montenegro. It includes the central and south part of the country.

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. The coastal plain disappears completely in the north, where Mount Lovcen and other ranges plunge abruptly into the inlet of the Gulf of Kotor. The coastal region is noted for active seismicity. The slope map of the Adriatic River Basin is shown in Figure 3.1.

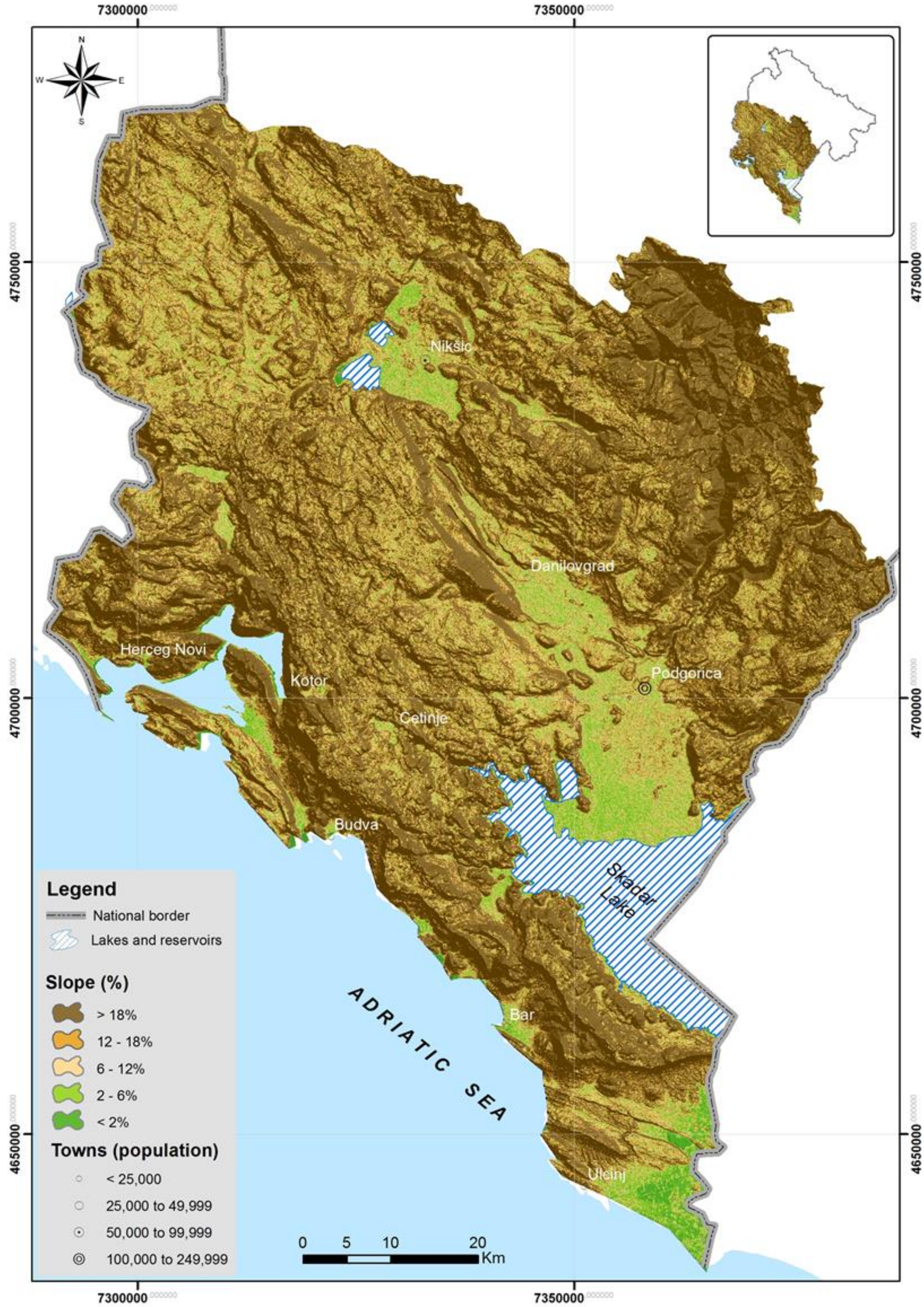
Montenegro's section of the karst lies generally at elevations of 1000 meters above sea level-although some areas rise to more than 2000 meters above sea level. The lowest segment is in the valley of the Zeta River, which flows at an elevation of 1,500 feet. The river occupies the centre of Nikšić Polje, a flat-floored, elongated depression typical of karstic regions. The underlying rock is predominantly limestone, which dissolves to form sinkholes and underground caves.

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]

[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

Figure 3.1. The slope map of the Adriatic River 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 Adriatic 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.

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

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

For the flood 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

[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).

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

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

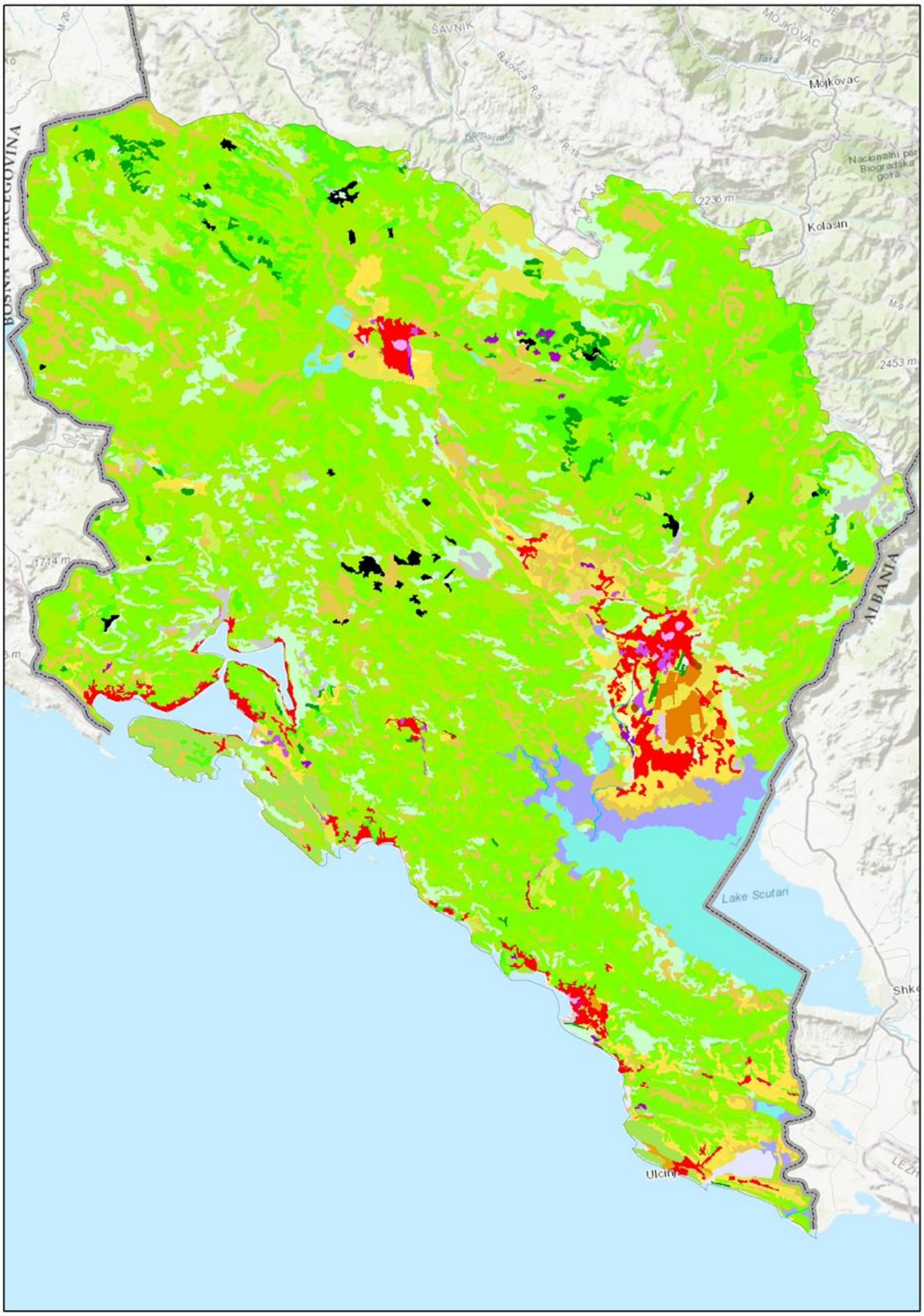


Figure 3.3. Map legend - Corine Land Cover classes

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 area of the Adriatic River Basin (ARB) of 6,650 km^2 with 442,193 inhabitants makes up 71.4% of the total population of Montenegro[8].

The density of population in the Adriatic River Basin is, on average, 64 inhabitants per km^2, which is more than the average value for the whole country but below the value for EU 28 (116 per km^2).

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 Adriatic River Basin. 9 municipalities are located completely in the Adriatic River Basin. Kolašin (47%), Nikšić (96%) and Podgorica (88.2%) are also located in the Adriatic River Basin but with some territory in the Danube River Basin. Similarly, the municipalities of Plužine (4.5%) and Avni (1.1%) also reside in the Adriatic River Basin, albeit to a very small extent. The difference between administrative boundaries and river basin boundaries adds some presently unresolvable complications when it comes to determining the exact density of the population inside of the Adriatic River Basin. The figures shown in Table 3.2. below do not take into account these differences.

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

Municipality	Surface (km^2)	Population	Density (Inhabitants/km^2)
Bar	598	42,048	70
Budva	122	19,218	157
Cetinje	899	16,657	19
Danilovgrad	501	18,472	37
Herceg Novi	235	30,864	131

[8] Data in accordance with census from 2011

Municipality	Surface (km^2)	Population	Density (Inhabitants/km^2)
Kolašin[9]	418	8,380	9
Kotor	335	22,601	67
Nikšić[10]	1,959	72,443	35
Podgorica[11]	1,263	185,937	133
Tivat	46	14,031	305
Tuzi	236	12,096	67
Ulcinj	255	19,921	78
Adriatic River Basin	**6,867[12]**	**442,193[13]**	**64**
Montenegro	**13,910**	**620,030**	**45**

3.4 Hydrographic and hydrologic characteristics

The Adriatic catchment area occupies the central and southern part of Montenegro. The total area of the Adriatic basin of Montenegro is about 6,560 km^2 or 47.5% of the state territory with the main waterbodies including the Bojana, Cijevna, Morača and Zeta Rivers and Skadar Lake (Table 3.3). The Sub-Basins and the river network are shown in Figure 3.4.

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

River/Lake Name	Length (km)	Catchment Area (km^2)
Bojana	41	20,000
Cijevna	32	150[15]
Morača	102	3,260
Zeta	85	1,600
Skadar lake	44	4,460 in MNE (5,490 in total)

[9] 47% of Kolašin Municipality is inside the Adriatic River Basin. The accurate calculation of the population residing in the Adriatic River Basin is not possible. Surface area determined by GIS.

[10] 96% of the Nikšić Municipality is inside the Adriatic River Basin. The accurate calculation of the population residing in the Adriatic River Basin is not possible. Surface area determined by GIS.

[11] 88.2% of the Podgorica Municipality is within the Adriatic River Basin. The accurate calculation of the population residing in the Adriatic River Basin is not possible. Surface area determined by GIS.

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

[13] Population figure are not accurate due to the difference between administrative boundaries and the river basin district boundaries. The figure reflected in Table 3.2 is based on census data collected in 2011.

[14] Rivers over 30km in length.

[15] Catchment area of the Cijevna is estimated because it is difficult in the lower course of the river (Zeta plain) to accurately determine due to the morphology of the terrain.

The Zeta River is formed in the part of the Nikšić field called "Gornje polje" from the watercourse of the Sušice and Rastovca. Zeta generally flows south to the village Zavrh where losing part of the existing water, the water appears in the accumulation Krupac. From there Zeta turns east toward Glibavac, then still turns to the southeast and east of compensations to the pool, where the water tunnel and pipeline lead to HE "Perućica". Before the construction of the hydropower system and the regulation of the riverbed Zeta, this watercourse sinks along the southern rim of Nikšić field (Budoške ponds and Slivlje) to a few kilometers of water appeared on the spring "Glava Zete". The flow of the Zeta River through the Nikšić field is called the Upper Zeta.

Nikšić field is a closed karst field surrounded by mountains, with an average altitude of about 600 to 660 m above sea level. The area of the field is about 66 km^2, and the limestone hills divide the field into smaller units. The catchment area of the Nikšić field is typically karst terrain, very rich in water and is characterized by the presence of about 300 springs, 30 estavels, 30 streams and 890 karstic holes called "ponori". The topographic area of the Nikšić field basin is about 890 km^2, while the real hydrographic basin is estimated at 1000-1100 km^2. The Nikšić field, as a kind of erosion base, drains the surrounding limestone mountains over the Zeta River and other smaller watercourses: Gračanica, Mrkošnica, Grabovik, Bistrica, Glibavac and Moštanica.

Lower Zeta starts from the spring called "Glava Zete" (spring elevation 71 m above sea level) after the sinking of Upper Zeta in Nikšić field and overcoming the height difference of 530 m. The waters of this spring in the immediate vicinity receive the waters of the Perućica spring and then downstream and the waters of the Oboštica spring and thus form the Lower Zeta watercourse. Lower Zeta flows over the "Bjelopavlićka" plain and after 50 km flows into the river Morača in Podgorica, at an elevation of about 30 m above sea level. The total area of the Zeta River basin is about 1600 km^2.

The Morača River originates from a spring above the village of Ljevište in the Pleistocene circus Vragodo. The periodic spring of the river Morača is located at 1,595 m above sea level on the southern edge of the upper valley of the circus Vragodo, at the foot of the northern slopes of the "Štit" , Kapa Moračka. Circus Vragodo is surrounded on the north side by the peaks of Lola Mountain, and on the west and south by the peaks of Kapa Moračka. These are all peaks with elevations around 2000 -2200 m above sea level. The permanent spring of the river Morača is located in the circus Vragodo at about 1,400 m above sea level, at the place where the lower valley of Vragodo begins.

The upper part of the Morača River has a branched river network, which is not a general characteristic of the hydrography of the Adriatic Basin. In this part of the river flows over the sediments of the Upper Cretaceous flysch (sandstones, marls, sandy limestones, etc.), rocks that are not characterized by high permeability as is the case with limestone sediments.

In its middle part, the Morača River has cut the canyon part of the valley known as "Platije". Morača Canyon is the second largest canyon in Montenegro. It is characterized by steep shores up to 1000m deep. The length of the canyon is about 30 kilometres and it ends upstream from Podgorica in the settlement of Zlatica, where the river Morača enters the vast Zeta plain.

In its lower course through the Zeta plain, where the capital Podgorica is located with numerous surrounding settlements and where a third of Montenegro's population lives, the Morača river flows through a porous gravelly-sandy glaciofluvial sediment, all the way to Skadar Lake. The zone of the confluence with Skadar Lake is variable due to large oscillations of the lake level (5-6m maximum). In the first half of its downstream part, through the area of the city of Podgorica, Morača flows through a characteristic canyon formed in glaciofluvial sediments. The height of the canyon sides is between 10 and 20 m.

In the lowest part of its course, the Morača River flows through a significantly devastated, relatively shallow bed, especially around the confluence with the left tributary, the Cijevna River. It is an area densely populated with rural households, and with a significant traffic infrastructure (main roads to Skadar Lake and further to the Adriatic Sea, Belgrade-Bar railway). As it has already been said, the confluence of the Morača and Skadar Lake is changeable and depends on the general hydrological situation. At low waters, Morača flows into the lake in the Vranjina zone, and at extremely high waters upstream from Ponari.

The Morača River is the biggest tributary of Skadar Lake. The area of the Morača River basin to the mouth of Skadar lake is 3260 km^2.

Skadar Lake is one of the most important aquatic waters of Montenegro in hydrological, economic, water management and tourist terms. Therefore, when solving any hydropower and water management activities in its entire basin, it is necessary to consider the implications of these solutions to water balance and Skadar Lake regimes. The Skadar Lake basin, on the territory of Montenegro, belongs to about 70% of the total Adriatic Sea basin.

The length of the lake, along with Crnojevića river, is about 50 km (about 44 km without Crnojevića river), and the largest width is in profile near the state border line, where it is about 14 km. The lake extends in the northwest-southeast direction, in the form of elongated ellipse and it is parallel to the Dinarid mountain system, at the end of which it is formed. It is the southern part of Montenegro, where the following towns are located: Podgorica, Nikšić, Cetinje, Danilovgrad etc. Most of the area considered is represented by typical karstic terrains that are characteristic of the area of the External Dinarides. It is separated from the sea by the mountain ridges of Sutorman and Rumija. Skadar Lake is a cryptodepression, meaning that some of the bottom level is below the sea level.

Skadar lake is a flowing lake. From the Montenegrin side, the waters of the Morača River, the River Crnojevic, the Orahovštica River, as well as the waters of some ten tributaries and underground waters. There are several rivers and streams arriving from Albania in the lake. The waters of Lake swell by river Bojana to the Adriatic Sea.

Skadar Lake covers an area of less than 400 km^2 at minimum water levels, up to 525 km^2 at the highest registered water levels.

The Bojana River is formed by the outflow from Skadar Lake. It flows out of a lake in the city of Shkodra in Albania. This swelling begins over one travertine threshold with an average elevation of about 4.5 m. above sea level. The length of the river Bojana is about 41 km and in the length of about 25 km it represents the border river between Montenegro and Albania. It is characterized by a small overall decline (0.6%) and meandering.

Although it has a relatively short course, the river Bojana is characterized by very complex hydrological conditions, conditioned by natural and anthropogenic factors. The main natural factors are linked to the hydrological regime of the Skadar Lake and its tributaries, particularly the Drim River.

The most important anthropogenic factor that affects the hydrological conditions of the river Bojana, i.e., the conditions of its outflow from the lake are three large reservoirs on the Drim River. Namely, large waters discharged from these reservoirs during extreme rainfall episodes cause large Drim waters to prevent the flow of the Bojana River from the Lake and thus cause large floods in the Skadar Lake zone and in the areas around the Bojana riverbed, on both the Montenegrin and Albanian sides. It should be borne in mind that the basin of the river Drim is about 14,000 km^2 and that in extreme hydrological conditions the flow of the Bojana below their mouth is represented by the waters of the Drim. According to data from the Drim River Hydropower Plants 2006, the extreme peak discharges of the Drim River can reach 9000 m^3/s.

The river Bojana flows into the Adriatic Sea near the town of Ulcinj. The average annual flow at the mouth of the sea is about 670 m^3.

Cetinje field has an area of about 3.8 ha. The length of the field is about 5 kilometres and the average width is about 800 meters. The average altitude of the field is 635 meters, and the highest elevations of the terrain reach 750 m above sea level. The Cetinje field is a closed karst field, so extreme precipitation causes flooding of one part of the field. The waters are evacuated through abysses located in the lowest parts of the field. Having in mind the hydrogeological conditions in the zone of the Cetinje field, floods in the field can be classified as floods caused by meteorological factors (heavy precipitation with melting snow from the basin) and groundwater. The abysses drain the water towards the Crnojević River through karst channels.

The Cetinje field basin is estimated at 46 km^2. If the amount of inflowing water exceeds the capacity of the abyss drainage, the Cetinje field will be flooded. The catastrophic floods that hit Cetinje in February 1986, caused by intense rainfall (February 6-18, 670 mm), sudden melting of snow and occasional karst springs, marked the course of the former Cetinje River.

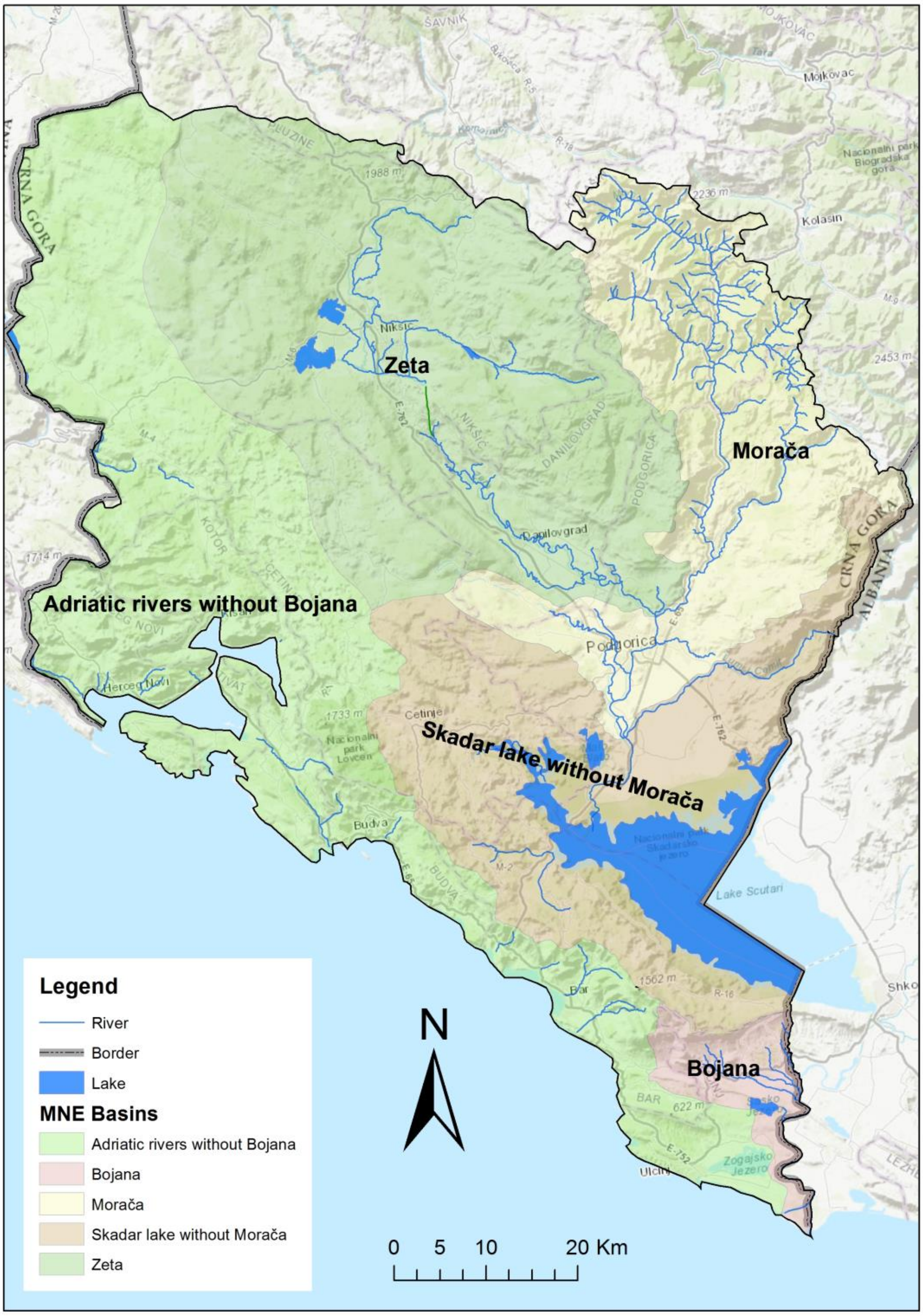
Coastal Watercourses

The specificity of the Adriatic River Basin is represented by small and torrential watercourses and canals. 70 such watercourses are known, of which 40 flow into the sea in urban areas and in the area of bathing areas. The catchment area of these 40 torrents is approximately 450 km^2. The Montenegrin coast with a close hinterland is characterized by high amounts of precipitation causing relatively fast runoff of water in rainy periods, forming fast and short watercourses with large flow oscillations. These torrent watercourses occur along the entire coast.

The riverbeds of these short watercourses are characterized by a large longitudinal fall which causes the destructiveness of torrential water. Extreme rainfall causes water spills from the riverbed and causes floods of a local character. These floods fall into the category of flash floods and are characterized by a short response time of precipitation-flood wave (below 6 hours).

The size of these watercourses does not correspond to their flood potential, especially since the time of accelerated urbanization of the Montenegrin coast. All possible anthropogenic pressures on the natural runoff of large waters are expressed: uncontrolled construction, obstacles in the riverbeds, inadequate interventions in the riverbeds, road, and other infrastructure, etc. Bearing in mind the changes in the runoff regime due to climate change that we are already witnessing, the issue of torrent watercourses on the Montenegrin coast is becoming very topical and a number of these watercourses are objectively classified in the areas of the APSFR because, objectively, they endanger all elements of space (population, material goods, nature, social activities), and thus represent areas of risk.

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



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 3.4. Average temperature in the Adriatic River Basin[16]

Location of measuring station	Temperature (°C)			
	Average (minimum)	Average (maximum)	Average (total)	Measured since (year)
Ulcinj	12.2	20.2	15.8	1949
Bar	11.8	20.6	16.1	1949
Herceg Novi	12.1	20.7	16.1	1948
Cetinje	4.4	17.1	10.3	1946
Podgorica	11.2	21.3	15.9	1947
Nikšić	6.3	16.3	11.1	1949

Table 3.5. Average monthly temperature in the Adriatic River Basin[17]

Measuring Station	Monthly temperature (°C)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Ulcinj												
max	10.9	12.1	14.9	18.4	22.3	26.8	29.7	29.4	26.3	21.7	16.6	12.4

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

Measuring Station	Monthly temperature (°C)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
min	4.1	4.9	7.2	10.3	14.4	18.1	20.4	20.5	17.3	13.4	9.3	5.7
avg.	7.2	8.2	10.7	14.0	18.4	22.3	24.9	24.8	21.2	17.0	12.5	8.7
Bar												
max	12.7	13.3	15.3	18.4	22.6	26.2	28.7	28.9	26.0	22.1	17.8	14.1
min	4.7	5.3	6.9	9.7	13.5	17.1	19.2	19.2	16.4	13.0	9.6	6.3
avg.	8.5	9.1	10.9	14.0	18.3	22.1	24.2	24.0	20.8	17.0	13.4	10.0
Herceg Novi												
max	12.6	13.2	15.3	18.5	22.8	26.7	29.8	30.1	26.2	21.9	17.3	13.9
min	5.2	5.4	7.3	10.1	14.0	17.6	19.8	20.0	17.0	13.4	9.7	6.6
avg.	8.4	8.9	10.9	14.0	18.3	22.2	24.9	24.7	21.0	17.0	13.0	9.8
Cetinje												
max	6.7	7.8	11.1	15.2	20.5	24.8	28.0	28.2	23.2	18.1	12.5	8.2
min	-3.7	-2.8	-0.1	3.7	7.5	10.7	12.4	12.1	8.7	4.7	1.6	-2.0
avg.	1.0	1.9	4.9	9.3	14.1	18.0	20.5	20.0	15.3	10.4	6.2	2.4
Podgorica												
max	10.0	11.7	15.4	19.8	24.9	29.3	32.8	32.9	27.8	22.0	15.9	11.4
min	1.9	3.2	6.1	9.5	14.0	18.0	20.9	21.0	16.9	11.9	7.2	3.3
avg.	5.5	7.0	10.4	14.5	19.4	23.8	26.8	26.6	21.7	16.2	10.9	6.9
Nikšić												
max	5.9	7.2	10.5	14.7	19.8	24.0	27.6	28.0	22.8	17.6	11.7	7.4
min	-1.8	-1.0	1.5	5.2	9.1	12.4	14.6	14.5	11.0	6.9	3.3	-0.2
avg.	1.7	2.6	5.7	9.9	14.5	18.4	21.3	21.0	16.4	11.5	6.9	3.2

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.

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 central region in Montenegro that belongs to the Adriatic Basin also recorded positive changes in the number of summer and tropical days, warm days and nights, and the length of heat waves. The trend is positive, increasing with time, unlike in the northern region where no significant changes in the number of frosty days were observed. There are no significant changes in the length of the growing season, neither for the central region nor for the northern region. Only in Bar there is a significant reduction in the number of frosty days.

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 is projected to be higher (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 without rainfall by the end of the century clearly shows that in the future there will be an intensification of droughts, which will lead to an increased risk of droughts.

3.6 Precipitation and runoff

The following tables show precipitation values taken from the Institute of Hydrometeorology and Seismology, measured over the period of 60-70 years. The distribution of precipitation is uneven, reaching the higher values in Cetinje and lowest in the coastal towns Bar, Ulcinj and Herceg Novi. The snowfall is characteristic for the northern and part of the central region of Montenegro, whereas in the coastal region it is just a rare event with no significant snow cover detected.

Table 3.6. Annual participation in the Adriatic Basin[18]

Measuring Station	Annual precipitation (mm)		
	Average	Maximum	Minimum
Ulcinj	1278.5	2018.8	758.4
Bar	1376.7	1913.1	758.0
Herceg Novi	1873.5	2771.6	1117.0
Cetinje	3341.3	5383.0	1908.9
Podgorica	1660.7	2475.7	869.6
Nikšić	1937.2	3214.3	1096.4

Table 3.7. Average snow cover in the Adriatic Basin[19]

Measuring Station	Snow cover (cm)	
	Average	Measured since (year)
Ulcinj	0	1955
Bar	0	1960
Herceg Novi	0	1948
Cetinje	3	1946

[18] Source: Institute of Hydrometeorology and Seismology
[19] Source: Institute of Hydrometeorology and Seismology

Podgorica	0	1951
Nikšić	1	1951

Measured values of 24-hour precipitation are showing the same the trend as average precipitation, being highest in Cetinje, and lowest at the coastal part of Montenegro, with exception of Herceg Novi where values are higher than in Bar and Ulcinj.

Table 3.8. 24-hour precipitation in the Adriatic Basin[20]

Measuring Station	24-hour precipitation (mm)	
	Average	Measured since (year)
Ulcinj	3.5	1949
Bar	3.7	1949
Herceg Novi	5.1	1948
Cetinje	9.1	1946
Podgorica	4.5	1947
Nikšić	5.3	1949

Table 3.9. Monthly precipitation in the Adriatic Basin[21]

Measuring Station	Monthly precipitation (mm)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Ulcinj	147.5	133.1	11.9	103.0	72.1	56.5	27.4	42.2	100.1	141.1	176.0	161.4
Bar	151.0	141.0	128.0	114.0	85.3	55.5	33.2	47.1	119.2	145.2	182.9	174.5
Herceg Novi	212.9	195.1	181.6	156.9	110.1	68.6	40.6	69.1	149.1	186.3	261.9	241.2
Cetinje	409.5	385.3	336.3	249.8	159.1	103.9	58.6	89.6	200.2	331.5	504.7	512.8
Podgorica	181.2	168.0	152.8	131.6	95.0	61.1	37.5	59.5	127.2	174.0	245.5 5	227.2
Nikšić	202.7	197.7	166.9	153.9	112.9	90.2	52.9	72.6	137.7	200.9	286.7	262.3

The analysis of the annual flow and frequency indicate the long-term changes that occurred at all hydrological stations in the Adriatic basin, significantly affecting the estimation of the mean flows. During the measurement period decrease in flow was recorded at all stations, same as most basins in the Southeast Europe.

[20] Source: Institute of Hydrometeorology and Seismology
[21] Source: Institute of Hydrometeorology and Seismology

Table 3.10. Long term analysis of hydrological stations in the Adriatic Basin

River	Station	Area (km^2)	Period	Flows (m^3/s)				
				Q_{min}	$Q_{min\ avg.}$	$Q_{avg.}$	$Q_{max\ avg.}$	Q_{max}
Moraca	Pernica	440.9	1956-2014	1.4	3.29	29.04	428.7	812
	Zlatica	985.3	1983-2012	0	1.619	59.64	885.6	1.369
	Podgorica	2.628	1948-2014	7.93	15.78	159	1.261	2.073
Zeta	Duklov most	342.2	1955-2014	0.07	0.271	18.9	182.9	286
	Danilovgrad	1215.8	1948-2000	4.68	7.99	77.9	278.2	577
Rijeka Crnojevica	Brodska njiva	79.3	1987-2002	0.458	0.676	6.25	153.9	228

Table 3.11. Water-table for Skadar Lake and Bojana River in the Adriatic Basin

River	Station	Area (km^2)	Period	Flows (m^3/s)				
				H_{min}	$H_{min\ avg.}$	$H_{avg.}$	$H_{max\ avg.}$	H_{max}
Skadar Lake	Plavnica	4.179	1948-2014	4.54	5.107	6.421	8.444	10.4
Bojana	Fraskanjel	16.520	1960-2014	0.019	0.469	1.816	4.764	6.359

4 FLOOD PROTECTION IN THE ADRIATIC RIVER BASIN

4.1 High water and significant floods

The task of hydrological analysis of high waters was 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 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.

The first hydrological analysis was performed for the purpose of producing the PFRA, where 11 hydrological stations (HS) from the Adriatic Basin have been selected. Data from existing and historical hydrological stations were used for the analysis of high-water levels (Figure 4.1 and 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, 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 and calculated 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.

For the needs of this project, the computational processing of the available data series from 11 hydrological stations was performed. Statistical analysis of hydrological extremes yielded models (probability distributions) that describe the X-P relationship well enough in the observed data set. The recorded flows for all 11 hydrological stations were obtained by statistical analysis. The calculated return periods for 7 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 we obtained spatial data 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 Adriatic River Basin

Table 4.1. Hydrological stations in the Adriatic 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

HS[22] Station	Watercourse	River Basin	Longitude	Latitude	m.a.s.l[23]	H(cm)[24]			Q(m^3/s)		
						10%	1%	0,2%	10%	1%	0,2%
Sastavci	Zeta	Morača	42° 49' 12"	18° 55' 6"	617.5	ND[25]	ND	ND	181	267	327
Duklov Most	Zeta	Morača	42° 47' 35"	18° 56' 26"	615.2	224	254	272	244	317	363
Glušje	Gračanica	Zeta	42° 45' 2"	19° 3' 25"	738.33	129	185	222	57.4	101	130
Danilovgrad	Zeta	Morača	42° 33' 16"	19° 06' 44"	33.3	1,148	1,346	1,463	481	593	663
Podgorica	Morača	Skadar Lake	42° 27' 05"	19° 15' 58"	24.6	1,133	1,287	1,366	1,748	2,227	2,506
Podgorica	Ribnica	Morača	42° 26' 12"	19° 16' 11"	32.53	ND	ND	ND	80.8	121	152
Orahovo	Orahovštica	Skadar Lake	41° 14' 48"	19° 04' 06"	12.12	213	247	268	63.5	82	93.8
Plavnica	Skadar Lake	Skadar Lake	42° 16' 17"	19° 11' 45"	4.56	9.27	10.04	10.48	ND	ND	ND
Reč	Bojana	Adriatic Sea	41° 55' 08"	19° 22' 15"	0.09	3.84	4.36	4.63	ND	ND	ND
Fraskanjel	Bojana	Adriatic Sea	41° 58' 15"	19° 23' 17"	-0.07	5.72	6.33	6.69	ND	ND	ND
Bar	Željeznica	Adriatic Sea	42° 06’ 54’’	19° 05’ 27’’	1.82	117	182	224	76.0	132	168

[22] HS: Hydrological station

[23] Height in metres above sea level

[24] For HS Plavnica - Skadar Lake and Rec, Fraskanjel - Bojana River, the water levels (shaded) are shown in meters above sea level (altitude of the water level).

[25] ND: No data available from hydrological stations, i.e., water level or water flow measurements are not recorded.

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

Year	Expected Flooding Mechanism[26]	Calculated Return Period (Years)
Watercourse Location: Zeta, Nikšić, "Duklov most"		
1974	Outflow from the riverbed	10
1979	Large-scale floods	30-40
1984	Outflow from the riverbed	10
1992	Large-scale floods	40
2000	Outflow from the riverbed	10
2008	Outflow from the riverbed	10
2010	Large-scale floods	40
2013	Outflow from the riverbed	10
2014	Outflow from the riverbed	30
2018	Outflow from the riverbed	10
Watercourse Location: Gračanica, Nikšić, "Glušje"		
1968	Outflow from the riverbed	15-20
1991	Outflow from the riverbed	70-80
1992	Outflow from the riverbed	15
1995	Outflow from the riverbed	10
2000	Outflow from the riverbed	70-80
Watercourse Location: Zeta, "Danilovgrad"		
1979	Outflow from the riverbed	10
1986	Outflow from the riverbed	10
1994	Outflow from the riverbed	10
2000	Large-scale floods	90
2002	Outflow from the riverbed	15
2004	Outflow from the riverbed	10
2010	Outflow from the riverbed	25
2019	Outflow from the riverbed	5-10
Watercourse Location: Morača "Podgorica":		
1963	Large-scale floods	15
1974	Outflow from the riverbed	10
1979	Large-scale floods	40
1985	Outflow from the riverbed	10
1992	Outflow from the riverbed	10
1995	Outflow from the riverbed	10
1999	Large-scale floods	25
2000	Large-scale floods	30
2004	Outflow from the riverbed	10
2010	Large-scale floods	20

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

Year	Expected Flooding Mechanism[26]	Calculated Return Period (Years)
Watercourse Location: Ribnica "Podgorica"[27]		
1957	Outflow from the riverbed	10
1968	Outflow from the riverbed	20
1979	Large-scale floods	30
1987	Outflow from the riverbed	10
1995	Outflow from the riverbed	15
1999	Outflow from the riverbed	10
2000	Large-scale floods	25
Watercourse Location: Skadarsko jezero,"Plavnica"		
1952	Outflow from the lake	20
1960	Outflow from the lake	10
1963	Large-scale floods	35
1969	Outflow from the lake	5-10
1970	Outflow from the lake	10
1971	Outflow from the lake	10
1974	Outflow from the lake	5-10
1979	Outflow from the lake	10
1996	Outflow from the lake	5-10
2010	Large-scale floods	100
2018	Outflow from the lake	5-10
Watercourse Location: Bojana, "Fraskanjel"		
1952	Minor outflows from the riverbed	No Data
1963	Minor outflows from the riverbed	5
1966	Minor outflows from the riverbed	20
1970	Minor outflows from the riverbed	5-10
1971	Minor outflows from the riverbed	5-10
1974	Minor outflows from the riverbed	10-15
1976	Minor outflows from the riverbed	10-15
1979	Minor outflows from the riverbed	15-20
1986	Minor outflows from the riverbed	20
1996	Minor outflows from the riverbed	5-10
1999	Minor outflows from the riverbed	5-10
2010	Large-scale floods	60
2013	Minor outflows from the riverbed	5-10
2018	Minor outflows from the riverbed	10-15

In the Adriatic River Basin, the floods are periodically pronounced along the watercourses of Zeta, Morača and Bojana, and in area of Skadar lake. This area contains the largest part of

[27] Refers to river flows (Q) because the data from the water level gauge (H) were not correct.

arable agricultural land in Montenegro. About 50% of the Montenegrin population lives in three cities (Nikšić, Danilovgrad, Podgorica) located in the valleys of the Zeta and Morača rivers.

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 (Table 4.3). Since 1952, four events have been registered with flows of a calculated return period of 100 years. The most common high-water flows in the Adriatic basin are calculated with a 10-year return period, occurring 56 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 Adriatic River Basin

Watercourse, location HS[28]	Return Period[29]		
	≥ 10 < 50 Years	≥50 < 100 Years	≥ 100 Years
Zeta, Nikšić, "Duklov most"	10	-	
Gračanica, Nikšić, "Glušje"	3	2	-
Zeta, "Danilovgrad"	7	1	-
Morača "Podgorica"	9	-	-
Ribnica "Podgorica"	7	-	-
Skadarsko jezero,"Plavnica"	9	-	1
Bojana, "Fraskanjel"	11	1	-
Total	**56**	**4**	**1**

4.1.1 High waters registered in late 2010/early 2011

Despite the hydrological data assessment, which indicates that flooding in the Adriatic basin would have occurred on multiple occasions, the only information available relates to the historical flooding event that occurred in 2010, where major damage was recorded to housing, bridges, and road infrastructure as shown 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 6 municipalities.

[28] HS: Hydrological stations

[29] 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.

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[30]	Flood mechanism/ characteristics[31]	Affected Regions / locations
Zeta	Nikšić	A11, A12, A13	A21/A31	Settlements: Kličevo, Ozrinići, Poljica, Štedim and Straševina.
Zeta	Danilovgrad	A11, A12	A21/A31	Settlements: Pažići, Glavica, Spuž, Podanje, Visko polje, Bogićevići, Livade Bandićke, Gorica, Grlic, Strahinjici, Podkraj.
Morača, Skadar Lake	Podgorica, Tuzi	A11, A12	A21/A31	Zone of Skadar Lake, in the area of the City Municipality of Golubovci, there was a spill of lake water and high levels of groundwater in the settlements of Gostilj, Kurilo, Ponari, Bistrice, Berislavci, and partly in the settlements of Šušunja, Goričani and Mojanovići. In the municipality of Tuzi, the settlements of Podhum, Vranj, Vladne, Kodrabudan, Vuksanlekići, in the local community of Dinoša, the hamlet of Tojeć and the village of Omerbožovići.
Skadar Lake	Cetinje	A12, A13	A21/A31	Zone of Skadar Lake: settlements Rijeka Crnojevića, Lipovik, Dujeva, Poseljani, Prevlaka, Đurovo oko, Karuč, Rogami, Bobija, Dodoši, Filipov krš, Žabljak Crnojevića.

[30] 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 (Annex 2)

[31] 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[30]	Flood mechanism/ characteristics[31]	Affected Regions / locations
Skadar lake	Bar	A11, A12	A21/A31	Settlements along the shore of Skadar Lake: settlements around the railway station Virpazar, Orahovo, Donji Brčeli, Boljevići below the road, Potkraj towards Dupil, Godinje, Donje Seoce, Krnjice, Murići, Bobovište and Ckla; long the torrents (Đurmanski and Suvi potok in Sutomore, the river Željeznica, the torrent Rikavac and the Rhine canal in the narrower urban zone of the town of Bar) settlements Čanj, Šušanj, Sokolana, Polje, Popovići, Ilino, Zaljevo.
Bojana	Ulcinj	A11, A12	A21 and A22/A31	The flooded areas included the settlements: part of Sukobin, Lisna Bori, Fraskanjel, Šas, Štodra, Sv. Đorđe, Reč, Sutjel, Sv. Nikola and the bank of the river Bojana to the mouth, as well as Ada Bojana.

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

Virpazar

Nikšić

Rijeka Crnojevića

Skadar Lake

Herceg Novi

Cijevna river, bridge on the road Podgorica-Tuzi

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 River Basin during 2013, 2014, 2018 and 2019 (Table 4.5). Despite the recorded high waters, data for recorded floods is not available.

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

Year	Calculated Return Period (Years)
Watercourse/HS: Zeta, Nikšić, "Duklov most"	
2013	10
2014	10
2018	10
Watercourse/HS: Zeta, "Danilovgrad"	
2019	10
Watercourse/HS: Lim, Skadarsko jezero, "Plavnica"	
2018	10
Watercourse/HS: Bojana, "Fraskanjel"	
2013	10
2018	10

The catchment area of the Sutorina River, which is a transboundary watercourse with Croatia, is identified as an endangered area within the analysis of historical floods. In particular, the Sutorina River in the Municipality of Herceg Novi recorded a flash flood in 2012 affecting Sutorinsko polje and in particular the town of Igalo. However, although this area can be identified as an APSFR, it is not included in Table 4.5 above since there are no hydrological data available in this area and therefore the return periods cannot be calculated.

Coastal Flooding

Unfortunately, the small and torrential watercourses and canals are watercourses are not in the network of hydrological monitoring at the state level. Thus, due to the lack of hydrological data, not all of the necessary parameters for defining the potential areas of increased flood risk can be considered. The only one exception is the Sutorina River, as a transboundary watercourse with Croatia, which is under the jurisdiction of the relevant state water institutions. Sutorina is proposed[32] as an APSFR on the basis of data on previous floods, their character and scope, despite the missing data on hydrological parameters that define the probability of floods.

[32] The Sutorina River is currently identified as an APSFR. However, due to the lack of hydrological data available the extent of flooding cannot be accurately calculated.

The importance of flood management on the torrents of the Montenegrin coast certainly deserves appropriate attention, and in the future, it must be the subject of consideration of the manner and conditions of formation of hydrological monitoring on selected watercourses. Considering the types and scope of work on hydrometeorological monitoring in Montenegro, performed by the Institute of Hydrometeorology and Seismology of Montenegro (IHMS), which are significantly increased by obligations arising from the WFD and other international conventions, and the objective capacity of the institution, we believe that the future network for hydrological monitoring on small watercourses of the Montenegrin coast should be in the competence of local self-governments. Of course, this does not mean that a special, separate network of stations is formed, but the obligation of the local government to take over operational tasks related to measurement, monitoring and basic maintenance of equipment and facilities at stations, while further specific processing, data storage in the national database, and other necessary actions for the functioning of this network of stations were within the competence of IHMS.

In the study: "Basic characteristics of small watercourses of the Montenegrin coast" (IHMS, 2013) an analysis of 42 watercourses was made in the area of 6 coastal municipalities, which cause damage during heavy rainfall. From those 42 watercourses, the Consultant has identified those which need to be included in hydrological monitoring by the local self-government (Table 4.6), which would significantly contribute to the necessary activities for water protection and water protection on the Montenegrin coast.

Table 4.6. Proposal for hydrological monitoring in coastal municipalities

Municipality	Proposed Location and Size of Catchment Area
Bar	• River Željeznica (bridge on the main road) - catchment area of 35 km^2 • Rikavac (downstream from the main road) - catchment area of 42 km^2
Budva	• Grđevica (bridge on the main road) - catchment area of 14 km^2 • Vještica (bridge on the main road) - the catchment area of 7 km^2 • Bečićka river (bridge on the main road) - catchment area of 9 km^2 • Buljarica stream (in Buljaričko polje) - catchment area of 15 km^2
Herceg Novi	• Sutorina (Igalo, state jurisdiction) - catchment area of 27 km^2 • Ljuti stream (settlement Topla) - catchment area of 17.5 km^2 • Nemila stream (settlement Nemila - Meljine) - catchment area of 3.5 km^2 • Opačica stream (Zelenika) - catchment area of 17 km^2
Kotor	• Gradiošnica (Tivat airport zone) - catchment area of 11.5 km^2 • Kološun (zone Solila) - catchment area of 33 km^2 • Jaška river (upstream from location Jaz) - catchment area of 40 km^2

4.2 Analysis of existing protection infrastructure from floods in the water area of the Adriatic 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.

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**: These are made for the purpose of protecting the concave curve, but they move the shore and the queen towards the opposite convex shore in relation to the coastal fortification.

- **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 they were mostly performed in the 70s of the last centuries. 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, coastal fortifications and regulated riverbeds are very short - from a few hundred meters to 1-2 kilometres. The weak and irregular maintenance of flood defence facilities has inevitably led to a reduction in the level of protection of coastal areas.

4.2.1 Morača River Flood Defences

For protection against flooding and erosion of the coast along the Morača, several facilities were built during different periods. Unfortunately, flood protection works were not carried out systematically, nor in the full, necessary scope.

The following protective structures were constructed:

- Cijevna-Vranjina Dyke on the left bank of the Morača riverbed. This 16,000-meter-long Dyke was built in 1950. The Dyke was originally planned as an integral part of the reclamation system for the protection of Donja Zeta from the floods of Morača river and Skadar Lake. The railway and the Podgorica-Virpazar road were built along the route of this embankment. The construction of this embankment protects about 1,500 ha on which the frequency of floods has been reduced. The settlement of Bistrice is now in a much more favourable conditions, but the floods have not been completely eliminated.
- Dyke near the village of Vukovci on the right bank of the river Morača, 3,000 meters long, built in 1952.
- Dyke near the village of Ponari on the right bank of the river Morača, 1,500 meters long, built in 1953.
- Embankment near the village of Goricani, 200 meters long. This building was built in 1938.
- Embankment near the village of Grbavci, 200 meters long, built in 1958.
- Parallel structures near the village of Ponari, 200 meters long, built in 1953.
- Nappers in Lekići, 100 meters long, constructed in 1977.

Since the partial regulation of the Morača River, which was carried out in this way, did not eliminate the floods, an integral solution to the problem was approached. For this purpose, in 2010, the main project for the regulation of the Morača River on the stretch from the mouth of the Sitnica River in Botun to Ponar was started.

4.2.2 Sutorina River Flood Defences

For the needs of arranging the Debeli Brijeg border crossing, in 2005 the Main Project for the Regulation of the Sutorina River was made, in part of its flow through the Debeli Brijeg border crossing. The works included the cutting and stabilization of the riverbed, as well as the construction of a 3.5 km long embankment (Figure 4.3).

Figure 4.3. Sutorina section where regulation works were performed

In 2023, the implementation of a project began for the construction of hydro-technical infrastructure, specifically the regulation of a section of the Sutorina riverbed extending approximately 750 meters. Alongside revised project documentation, an Environmental Impact Assessment (EIA) Study was also completed for this initiative. To carry out this project, it will be necessary to apply for funding from EU pre-accession funds.

4.2.3 Bojana River flood defences

To protect Ulcinj's field from water, Dykes were built in 1950, consisting of two parts separated by the hill Sutjel. The first section of Sent Nikola to Reč is 6,300 m long, and the other, Sutjel - Sent George, it is 1,470 m long. These Dykes directly protect the area of about 600 ha between Bojana and the old saltern Dykes, and indirectly the entire Ulcinj's field. The Dyke is placed parallel to the bank of the Bojana river at a distance of 100-200 m.

After construction, the responsibility for maintenance of the Dykes was handed over to the Municipality of Ulcinj. However, today the Municipality does not have documentation on their construction or on the changes that occurred between the 1950s and the present day. The first information about their real condition was obtained by surveying the Dyke after the 1963 flood. At that time, it was stated that the Dykes were not fully completed according to the 1950s project, and that the assessment of the highest possible water level in Bojana proved to be wrong. It was also determined that the Dykes are exposed to systematic destruction in places where rural roads without pavement cross them, which leads to a local lowering of their crown and the creation of a danger of local overflow at high waters.

In 1966, in order to increase flood safety, in the area between Bojana and the old saltern dine, and based on the experience from 1963, the Paratuk Dyke was built. It is 195 m long and connects the old Saltern Dyke and Bojana Dyke Sent Nikola - Rech. In this way, the defended area between the two Dykes was divided into two.

From the time the Dykes were completed in 1950-1951 until 1977, they were not maintained and were overgrown with grass and weeds, and in many places in the body of the embankment large forest trees developed. During 1977, the embankments were partially cleared of trees, shrubs, and other vegetation, after which the grass was mowed. Due to the long-term neglect of the Dykes, it was not possible to achieve a greater effect with these works, especially because not all larger trees were cut down and the roots and stumps of the cut trees were removed and remained in the trunk of the Dykes.

In order to protect Vladimir and Sukobin fields against flooding from Bojana River, two Dykes were built, namely: the Dyke Gropat - Štodra in the length of 960 m, and the section Štodra - Sukobin which is 2,900 m long. These Dykes protect approximately 110 ha in the Vladimir field and about 360 ha in the Sukobin field. The Gropat-Štodra and Štodra-Sukobin Dykes were built in accordance with the 1979 project.

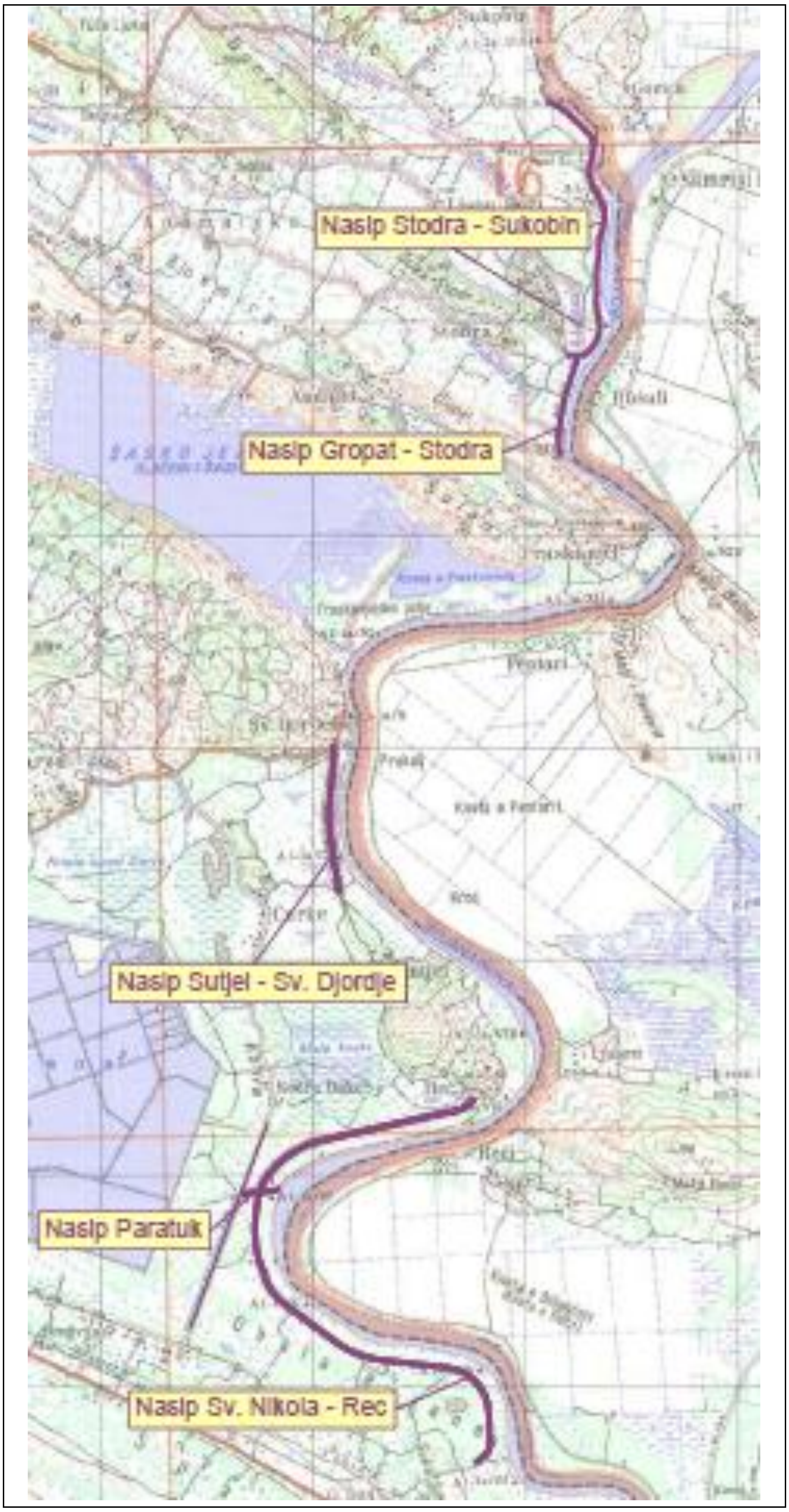
The Ministry of Agriculture, Forestry and Water Management, in cooperation with UNDP, is implementing the first regional project funded by the Adaptation Fund in Europe. The value of the Project is $10,000,000, of which $1,300,000 has been allocated for Montenegro for the development of the Main Projects for the Bojana and Gračanica Rivers as well as for the execution of infrastructural works on the construction of embankments and other measures that the projects will envisage for long-term flood protection. and arrangement of the riverbeds of the mentioned watercourses.

On March 9, 2020, UNDP announced a tender for the development of the Main Project for the Regulation of the Bojana River, within the regional project "Integrated Flood Risk Management in the Drim River Basin".

The expected goal of the Regional Project is to create preconditions for flood protection in the Drim River Basin, with capacity building at the regional, national, and local levels.

In mid-2024, repair work was carried out on a section of the protective embankment along the Gropat-Štodra segment, covering approximately 200 meters.

Figure 4.4. Dykes on the Bojana River



4.2.4 Nikšić Field

Nikšić field is a unique area in Europe and the world where huge amounts of water caused by high rainfall but also large waters that are lost in the porous karst soil. All this caused elements and unforeseen damage to the population. This is the case in almost all karst fields of the Dinarides and the region.

Therefore, people in these areas resorted to various interventions in order to stop the sudden and large waters on their property. In 1960, a unique hydro system of HPP "Peruica" was installed in Nikšić field, which will have a comprehensive purpose - irrigation, tourism, etc. area of water management, but they all had a key goal - utilization for hydropower potential.

Reservoirs in the Nikšić field were formed with the aim of storing water and changing the temporal and spatial distribution of water according to the requirements of the production of HPP "Perućica" and flood regulation. They equalize the flow of watercourses, i.e., make it even in terms of runoff. Due to the high-water permeability of the Vrtac and Slivlje multi-purpose reservoirs , the Gornja Zeta river in this area flows through the Zeta II canal in the Vrtac reservoir, and then through the Zeta canal and downstream from the Vrtca dam in the Slivlje reservoir area. The dams are located on the water-permeable parts of the bottom of the field, so injection curtains have been additionally placed, which will retain water along their axes and the perimeter of the field.

4.2.5 Coastal Areas

The issue of flood defence is additionally burdened by the regulation of torrents in the municipalities of the coastal area of the Adriatic Sea.

There are 41 torrent channels in the Kotor area, some of which are relatively short and flow directly into the sea, flooding relatively narrow valleys and causing significant damage by flooding and collapsing coasts. However, in addition to that, this area is also endangered by groundwater, which, especially under the slow tide, endangers the terrain up to 7 m above sea level.

Sutorina, Repaj and several smaller watercourses in the area of Herceg Novi, torrents in Bar, Budva, Petrovac and Ulcinj, threaten the population with flooding, urban infrastructure, agricultural land, and affect the devastation of the coast and change the sedimentation regime on the beaches.

Tidal waves that cause floods in coastal cities are very common. They are a consequence of heavy rainfall and strong gusts of southeast wind that lead to flooding of public areas - roads, squares, and promenades. They usually do not cause much damage because they last a relatively short time: the faster they appear, the faster they recede.

The negative impact of the sea on floods in the coastal area is evident in the municipality of Kotor. The main problem is the flooding of the Old Town and the Riva during heavy rainfall or strong north wind due to the fact that the sea as a recipient, which is located below the Old Town, is not able to receive so much water. In Herceg Novi, the tidal wave affects the Pet Danica Promenade and can cause damage in the city port if not all preventive measures are taken. The settlements of Igalo and Bijela are also endangered. In Budva, a tidal wave over the beach on Richard's head floods the Old Town and reaches a large square in front of the Avala Hotel.

There are no official data on these phenomena because no special attention has been paid to them so far. Tide gauges recorded the time and intensity of tidal waves but have not been processed so far. Also, there is no infrastructure that would protect the coast from flooding caused by tidal waves, so this issue should be addressed in the future, given the frequency of occurrence and damage they can cause.

4.2.6 Summary of Existing Facilities

Table 4.7 summarizes the existing facilities for passive and active flood defence in Adriatic River Basin. The following maps presented in Figures 4.5 to 4.7 illustrate the existing flood protection facilities in the Adriatic Basin.

Table 4.7. Summary of existing facilities for flood protection in the Adriatic catchment area

	No.[33]	Watercourses	Location	Type of infrastructure	Year of construction
Passive Flood Protection					
1	1.1.	Morača	Cijevna –Vranjina	Dyke 16,000 m	1950
	1.2.	Morača	Selo Vukovci	Dyke 3,000 m	1952
	1.3.	Morača	Selo Ponari	Dyke 5,000 m	1953
	1.4.	Morača	Selo Goričani	Embankment 200 m	1938
	1.5.	Morača	Selo Grbavci	Embankment 200 m	1958
	1.6.	Morača	Selo Bijelo Polje	Parallel structures 170 m	1950
	1.7.	Morača	Selo Ponari	Parallel structures 200 m	1953
	1.8.	Morača	Selo Lekići	Napper 100 m	1977
2	2.1.	Sitnica	Lješkopolje	Regulation 3 km	1987
3	3.1.	Bojana	Sv Nikola-Reč	Dyke 6,337 m	1950-1951
	3.2.	Bojana	Sutjela – Sv. Đorđe	Dyke 1,455 m	
	3.3.	Bojana	Gropad-Štodra	Dyke 960 m	
	3.4.	Bojana	Škodra- Sukobina	Dyke 2,900 m	
	3.5.	Bojana	Paratuk	Dyke 195 m	
4	4.1.	Sutorina	Sutorina	Regulation 3,500 m	2005
Active Flood Protection					

[33] The numbers 1.1 to 4.1 are referenced in Figures 4.5. and 4.6. The numbers in parenthesis in rows 5.1 and 5.2 are referenced in Figure 4.7.

	No.[33]	Watercourses	Location	Type of infrastructure	Year of construction
5	5.1	Zeta	Krupac (1), Slano (2), Vrtac (3), Liverovici (8)	Accumulation	
	5.2	Zeta	Moštanica (4), Opačica (5), Zeta I (6), Zeta II (7)	Canal	

Figure 4.5. Existing flood protection facilities on the Morača River

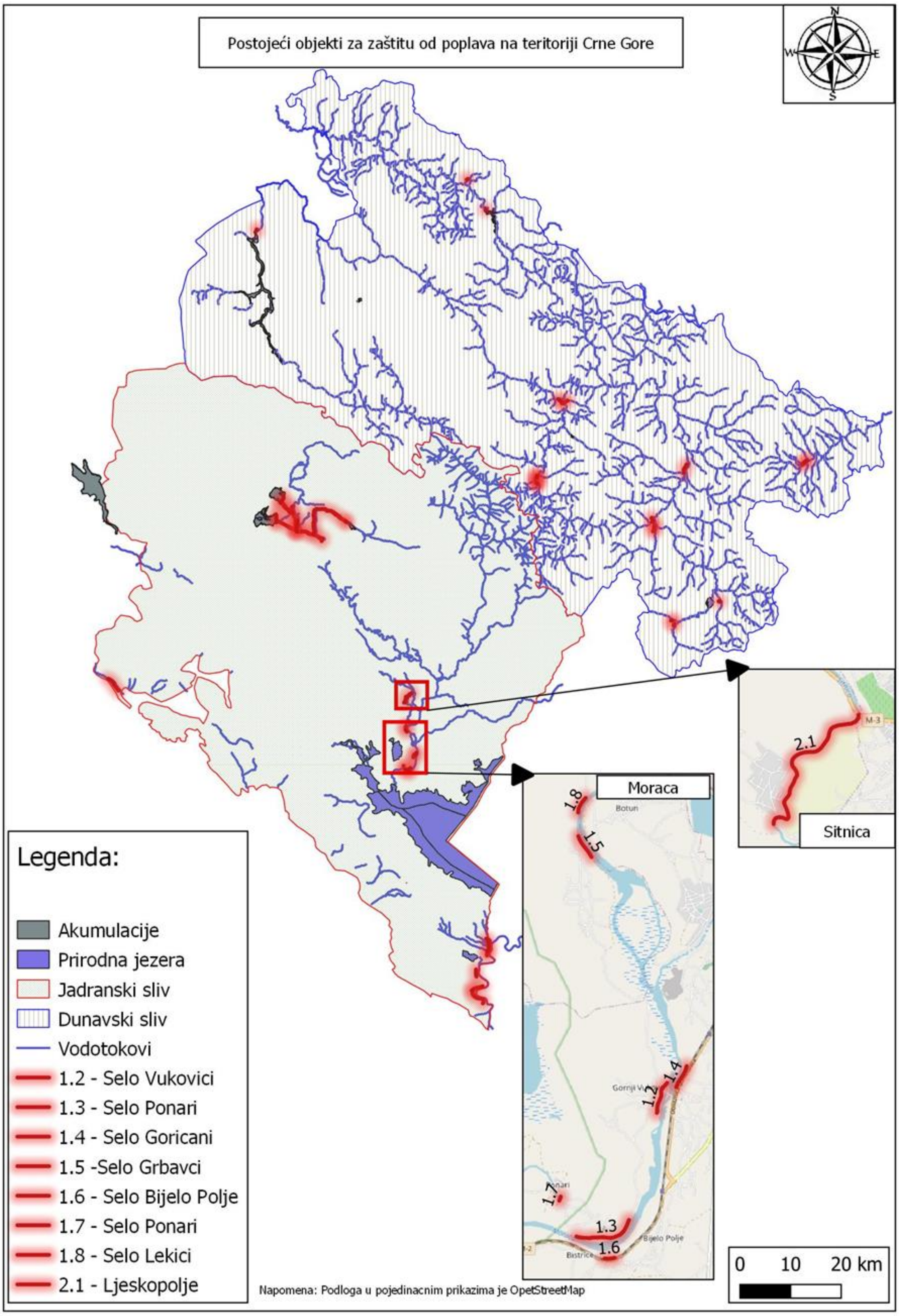


Figure 4.6. Existing flood protection facilities on the Bojana and Sutorina Rivers

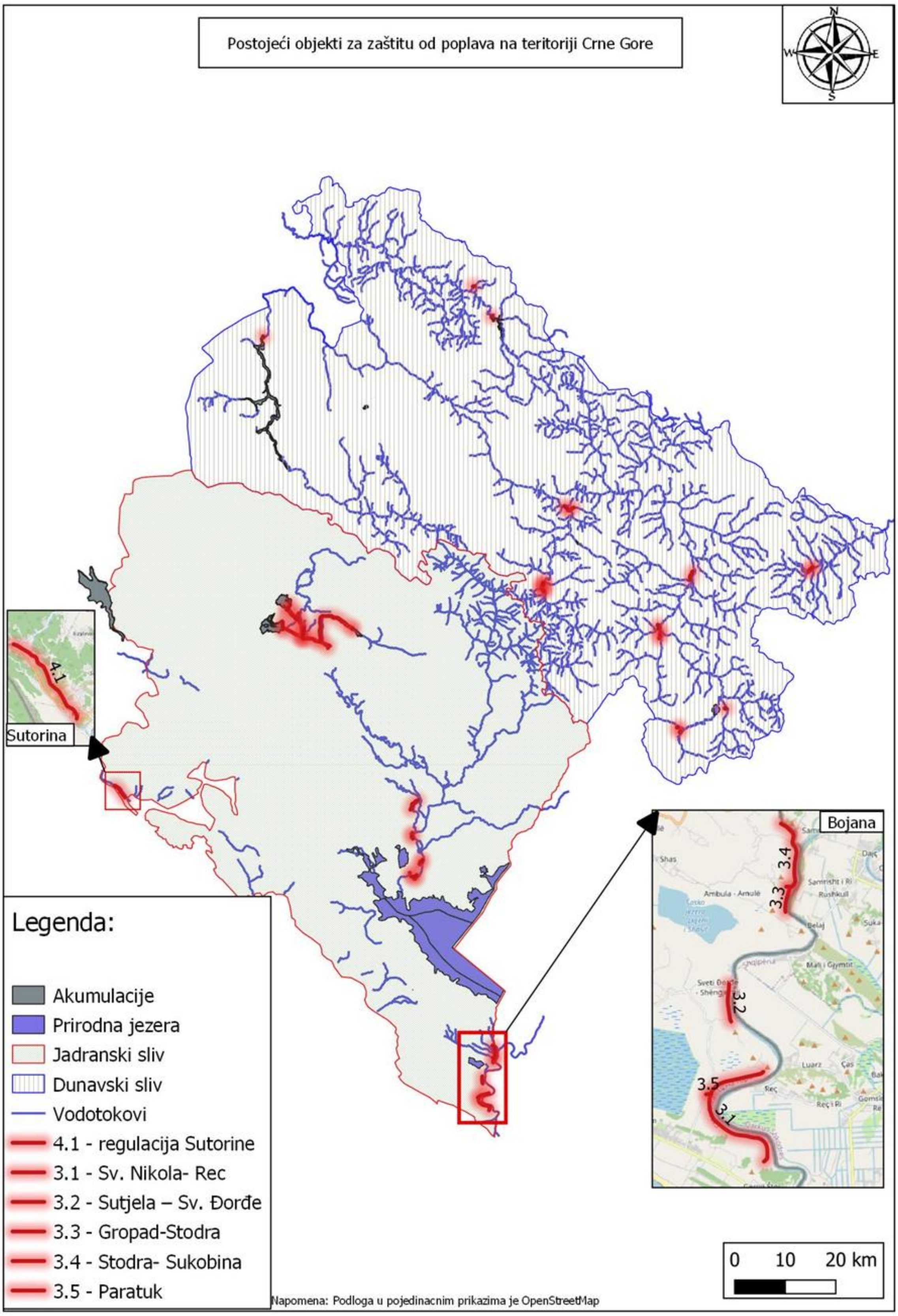
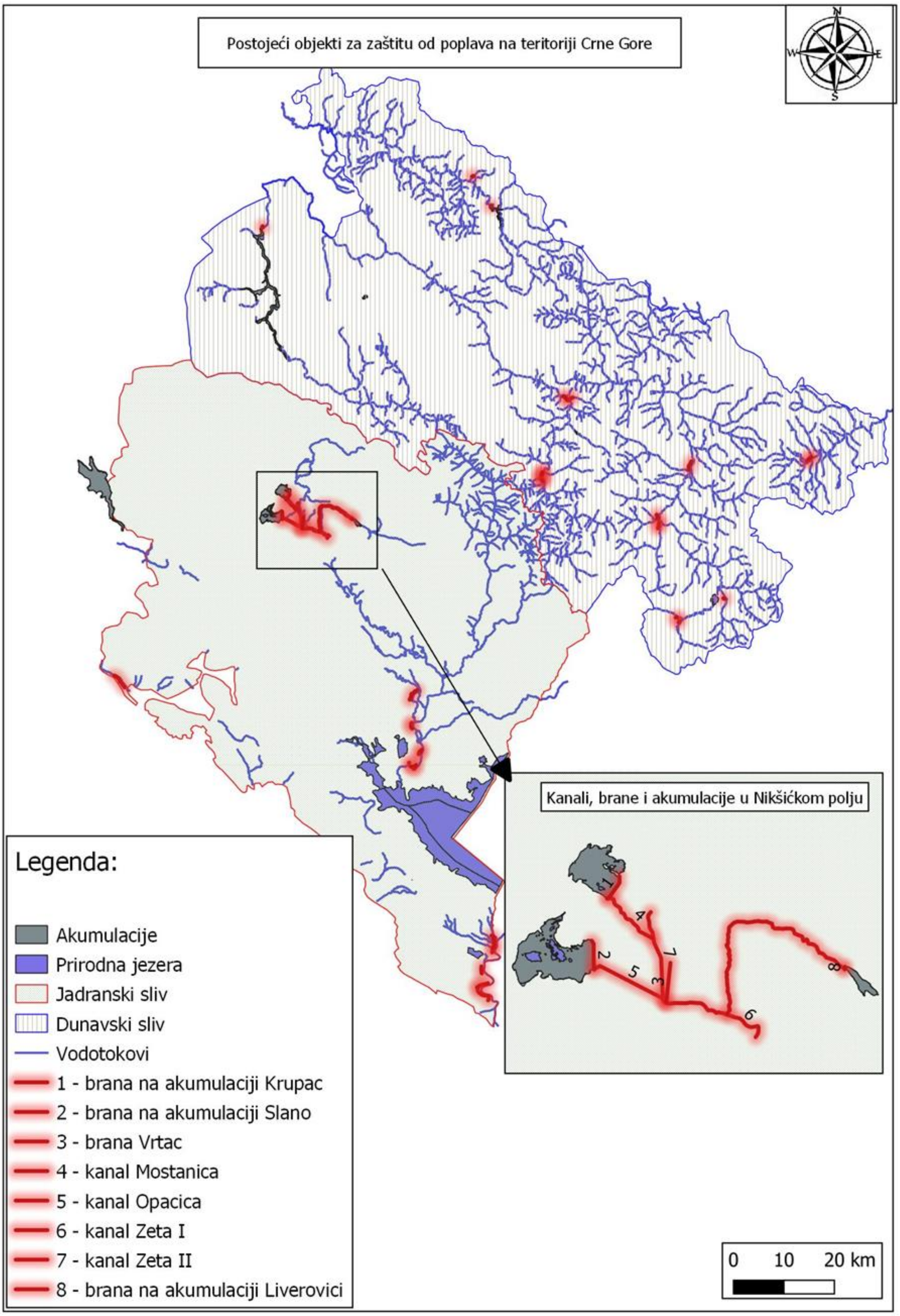


Figure 4.7. Existing flood protection facilities on the Zeta River, Nikšic



5 PRELIMINARY FLOOD RISK ASSESSMENT

5.1 Introduction

This section is focussed on Stage 1, which encompassed the analysis of existing flood infrastructure in the Adriatic 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[34]	Rulebook (Article)	PFRA[35] (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[36]

[34] 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).
[35] Sections of the PFRA document as approved by Governmental Decision in December 2021.
[36] Existing flood protection facilities are included in Section 4.4 of the PFRA.

Content Required[34]	Rulebook (Article)	PFRA[35] (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 Adriatic River Basin when identifying the areas of potential significant flood risk.

The primary focus of the preliminary flood risk assessment 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).

Where the territory of Montenegro is concerned, 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 Adriatic River Basin and therefore an adequate representation of the types of flooding reflecting the natural conditions.

Table 5.2. Source of floods

Type / Source[37]	Description[38]
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.
Sea Water	Flooding of land by water from the sea, estuaries, or coastal lakes. This source could include flooding from the sea (e.g., extreme tidal level and / or storm surges) or arising from wave action or coastal tsunamis.
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 Adriatic River Basin pluvial floods are not modelled and thus systematic risk assessment is not possible based on the existing information. But due to the importance of this type of flood according to the increasing damages from these in the last years at least past flash flood events are documented and considered in the evaluation of potential risk areas. If recurrent past events hit one location or one region this shall be called significant risk in the light of this PFRA.

The determination of flash floods in the context of this study is 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 be defined as 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. [39]

[37] Guidance for reporting under the EU Floods Directive; EU 2013. Technical Report-2013-071.

[38] The possible mechanisms of previous flooding events in the Adriatic River Basin based on hydrological data are shown in Table 4.2 (Section 4.1).

[39] Guidelines for reporting according to the Floods Directive; EU 2013. Techincal Report-2013-071

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 are additionally documented and evaluated according to the significance criteria. In the PFRA for the rivers of the Adriatic River Basin such areas were identified in the Nikšić and Cetinje fields.

5.1.4 Coastal flooding

In the Adriatic River Basin, the mouth of the Bojana, where the Bojana River feeds into the Adriatic Sea, coastal flood risk is relevant. According to local experiences and documentations flooding along the coast is not caused by sea water itself but by the combination of river flood (from the Bojana River) and high sea water levels. The origins of the flood risk are the coastal rivers that cannot discharge into the sea due to high sea water level.

Tidal waves that cause floods in coastal cities are very common (Budva, Kotor, Herceg Novi). They are a consequence of heavy rainfall and strong gusts of southeast wind that lead to flooding of public areas - roads, squares, and promenades. They usually do not cause much structural damage because they last a relatively short time.

5.1.5 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 FRM. However, this has been discussed and it will be pointed out that there is a risk of failure of dams in the Adriatic River Basin in Montenegro (dams Krupa, Slano and Vrtac at the Zeta River). This risk should be regularly assessed (dam failure studies) and considered in maintenance plans and risk management scenarios.

However, it is important to state that in the canals in the Nikšić field, which are Vrtac (Opačica, Moštanica, Zeta II) and the Zeta I canal, any spillage of water from the canal does not affect the flooding. Also, the water that overflows from the Slano and Krupac reservoirs flows into the Vrtac retention, which is formed up to the elevation of 614 m above sea level and is maintained at that elevation by the constitutions. Water from the Vrtac retention is poured into the Slivlje retention.

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):

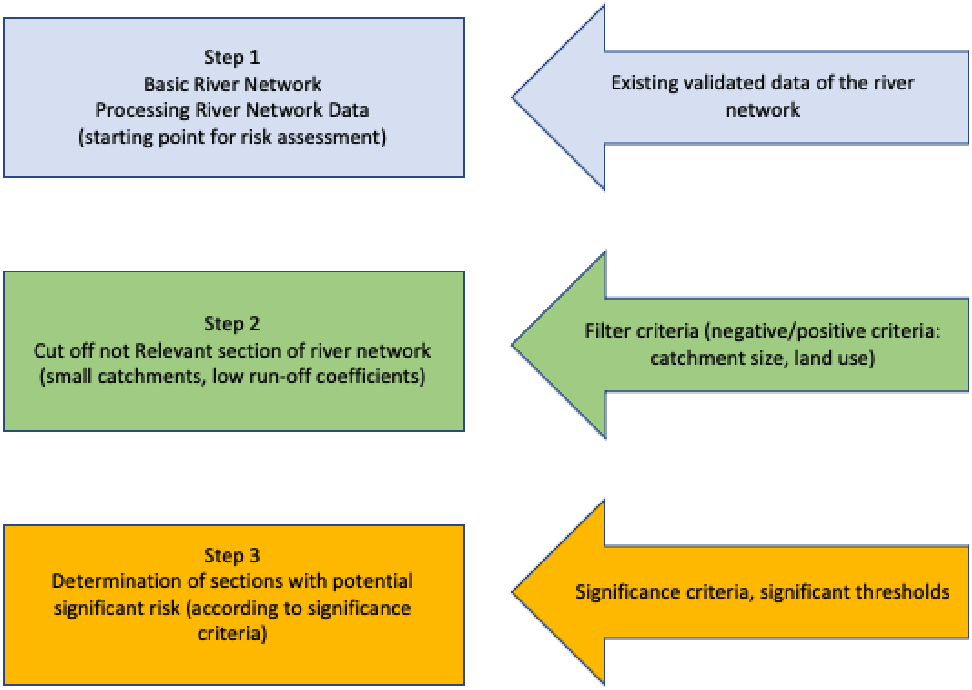
1. Determination of the initial river network: the river network is taken from the Adriatic basin Management Plan. In addition, a validation with Open Street Map (OSM) data and with satellite images ensured the correctness. The whole relevant river network is processed in one GIS project and validated 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).

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

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 areas of potential significant flood risk 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.

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 sheets40.

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

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).

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[40] 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 PFRA as used by the GIZ in the preparation of its document.

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).

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

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 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 done by expert judgement (significant agricultural risk areas or objects).

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	≥ 1

Assets at Risk and Significance Criteria	Receptors				Significance Criteria	Threshold of Significance
	Human Health	Economic Activity	Environment	Cultural Heritage		
Drinking water supply	x		x		scenario)	≥ 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

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 preliminary flood risk assessment, 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 Adriatic River Basin

Based on the analysis described above, six APSFR in the Adriatic 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 Adriatic 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[41]. 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 5.8 indicate the APSFR zones, which incorporate the calculated extent of the 500-year return period[42].

The APSFR are located in each Sub-Basin as follows: Zeta River Sub-Basin (2), Morača/Skadar Lake Sub-Basins (1), Skadar Lake Sub-Basin (2), including one directly from groundwater - Cetinje), and Bojana River Sub-Basin (1).

[41] Technical Support in Relation to the Implementation of the Floods Directive (2007/60/EC) June 2013.

[42] 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 Adriatic River Basin

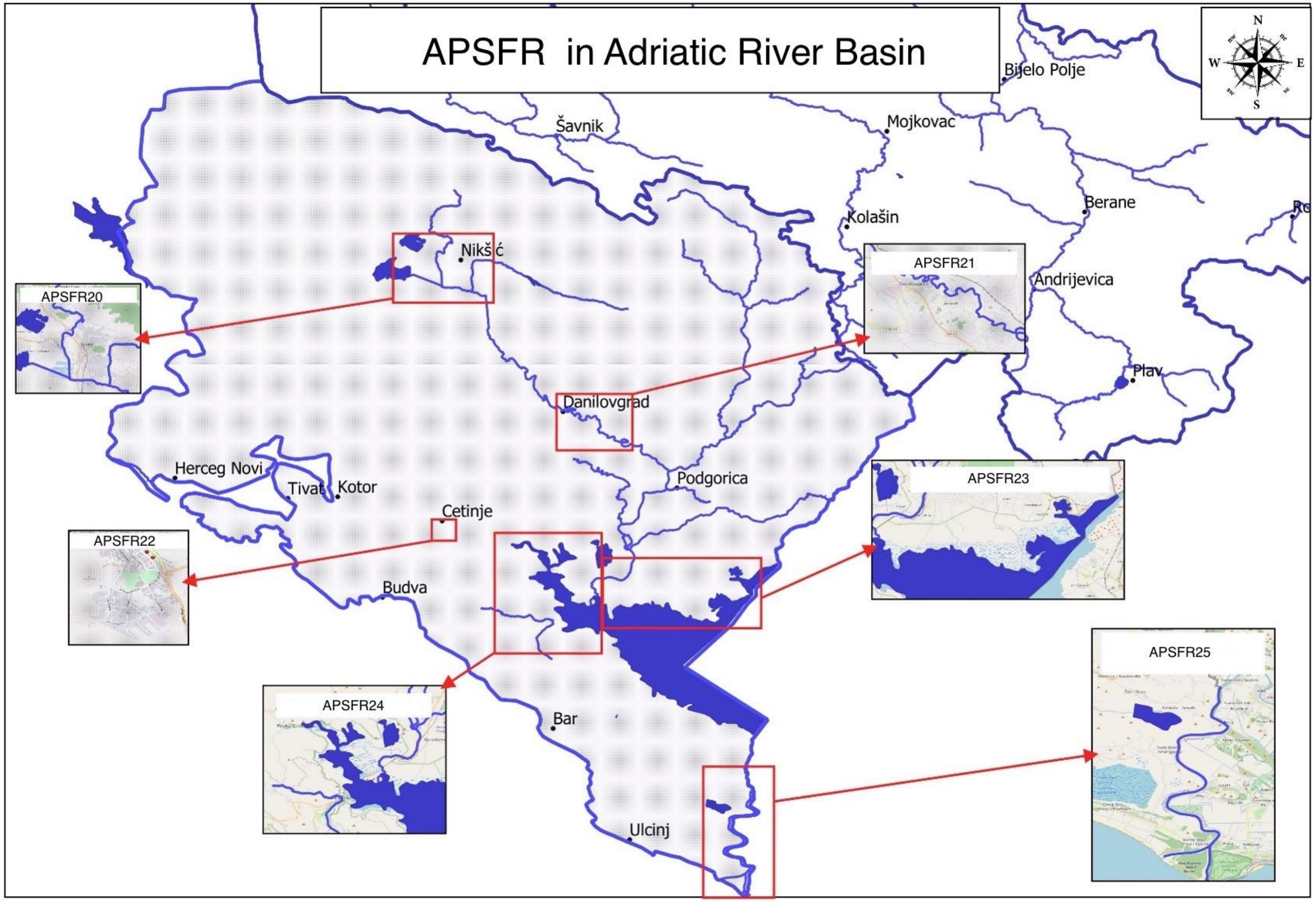


Table 5.5. APSFR for Adriatic River Basin classified according to the EU Schema[43]

APSFR Code	Catchment area	River / Tributary	Year	Period	Flood Sources	Flood Mechanism	Flood Characteristics	Affected Regions / locations	Settlement/ village	Human Health	Environment	Cultural Heritage	Economic Activity
20_ARB_Zeta01	Upper Zeta	Zeta	2010	December	A11 A12 A13	A21	A31	Municipality of Nikšić	Kličevo, Ozrinići, Poljica, Štedim and Straševina	B11 B12	B25	B34	B4, B42 B43 B44
21_ARB2_Zeta02	Lower Zeta	Zeta	2010	December	A11 A12	A21	A31	Municipality of Danilovgrad	Pažići, Glavica, Spuž, Podanje, Visko polje, Bogićevići, Livade Bandićke, Gorica, Grlic, Strahinjici, Podkraj.	B11 B12	B25	B34	B41 B42 B43 B44
22_ARB_Cetinje field	Groundwater	-	1986	December	A12 A13	A21	A31	Municipality of Cetinje	Cetinjsko polje (Donje polje)	B14	B25	B34	B41
23_ARB_Morača and Skadar Lake	Moraca and Skadar lake	Moraca	2010	December	A11 A12	A21	A31	Municipalities of Podgorica and Tuzi	Gostilj, Ponari, Podhum, Tuzi, Vranjina, Bistrice, Kurilo, Bijelo Polje, Berislavci,	B11 B12	B22	B34	B41 B42 B43 B44

[43] Technical Support in Relation to the Implementation of the Floods Directive (2007/60/EC) June 2013.

APSFR Code	Catchment area	River / Tributary	Year	Period	Flood Sources	Flood Mechanism	Flood Characteristics	Affected Regions / locations	Settlement/ village	Human Health	Environment	Cultural Heritage	Economic Activity
24_ARB_West of Skadar Lake	Skadar lake	Orahovštica; Rijeka Crnojević	2010	December	A11 A12	A21	A31	Podgorica, Cetinje and Bar	Boljevici, Dodosi, Dupilo, Karuč, Krnjice, Prevlaka, Rijeka Crnojevica, Virpazar, Žabljak Crnojevića	B11 B12	B22	B34	B41 B42 B43 B44
25_ARB_Bojana	Bojana	Bojana	2010	December	A11, A12	A21, A22	A31	Municipality of Ulcinj	Fraskanjel, Gornji Štoj, Lisna Bori, Sveti Đorđe, Sukobin; Bank of the Bojana River, Ada Bojana	B11 B12	B22	B34	B41 B42 B43 B44

Figure 5.3. APSFR20_ARB_Zeta01

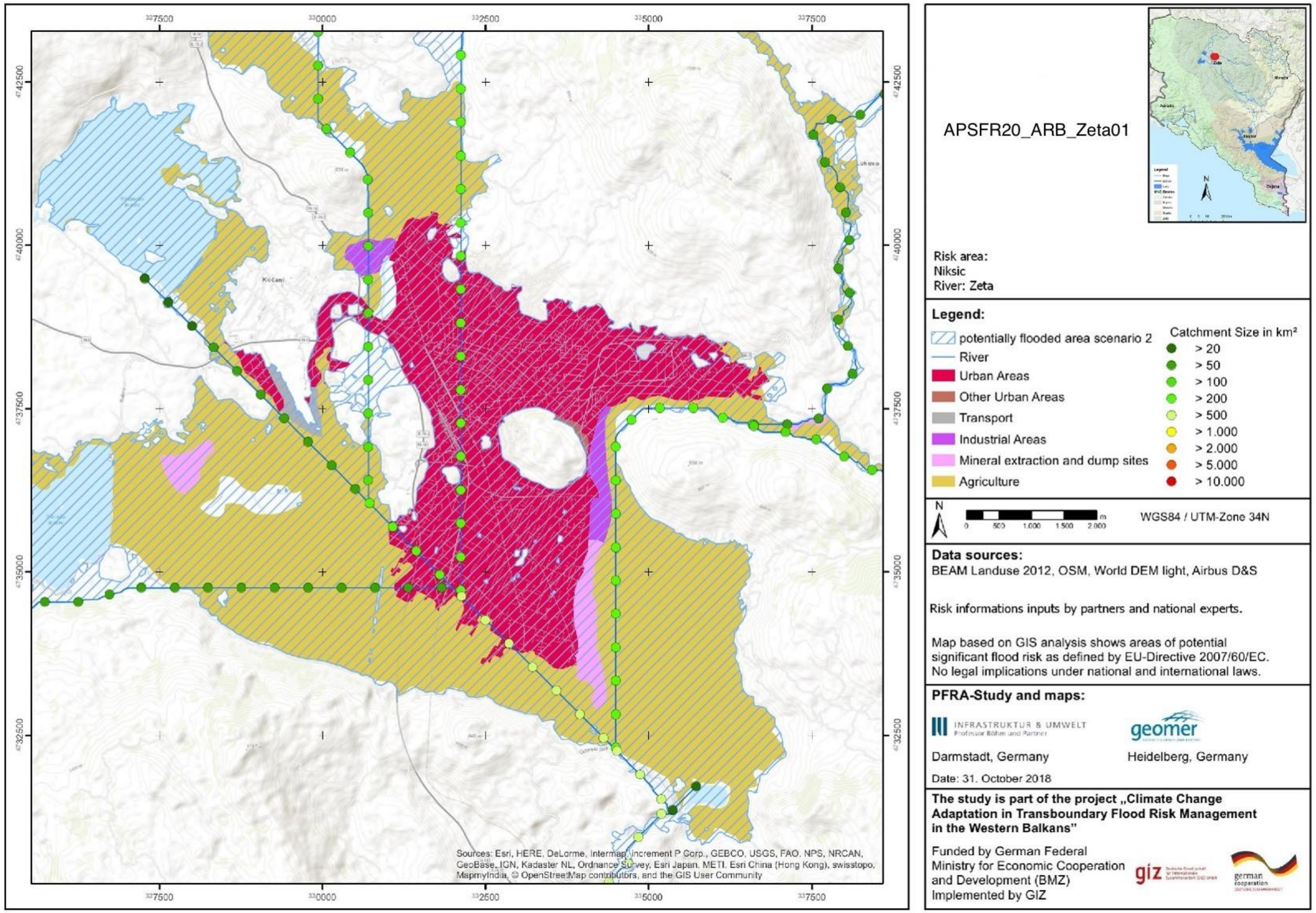


Figure 5.4. APSFR 21_ARB_Zeta02

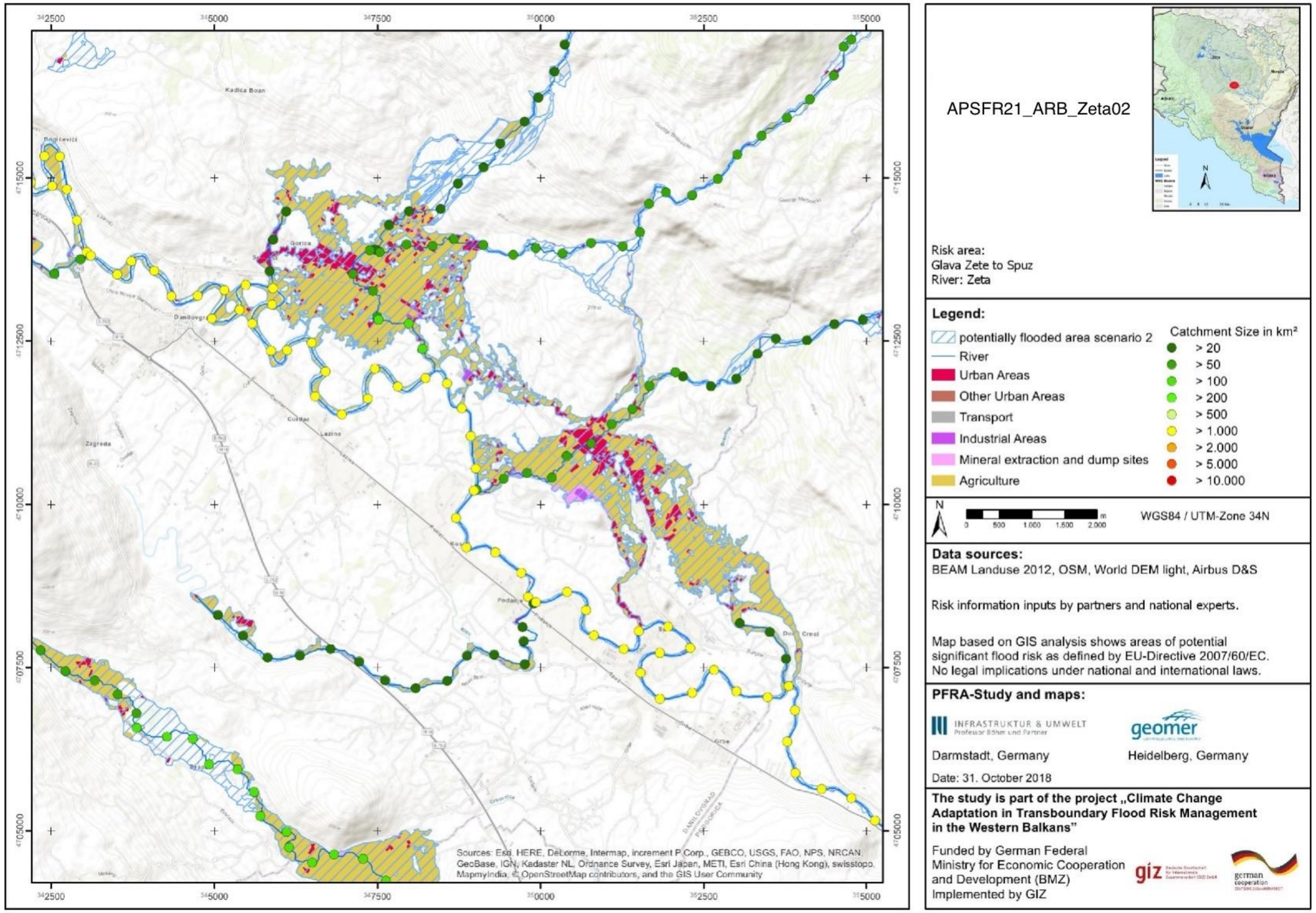


Figure 5.5. APSFR22_ARB_Cetinje field

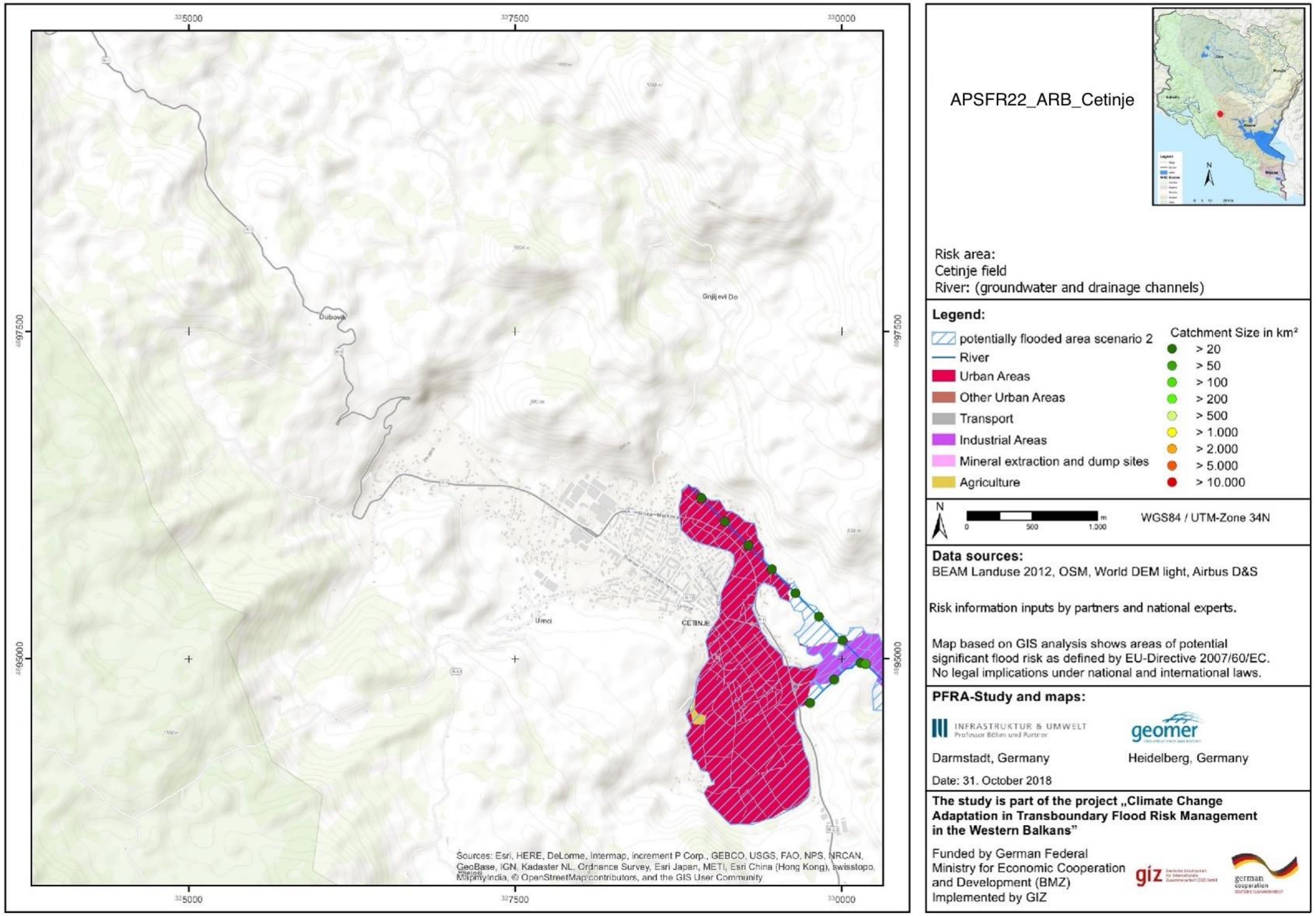


Figure 5.6. APSFR23_ARB_Morača and Skadar Lake

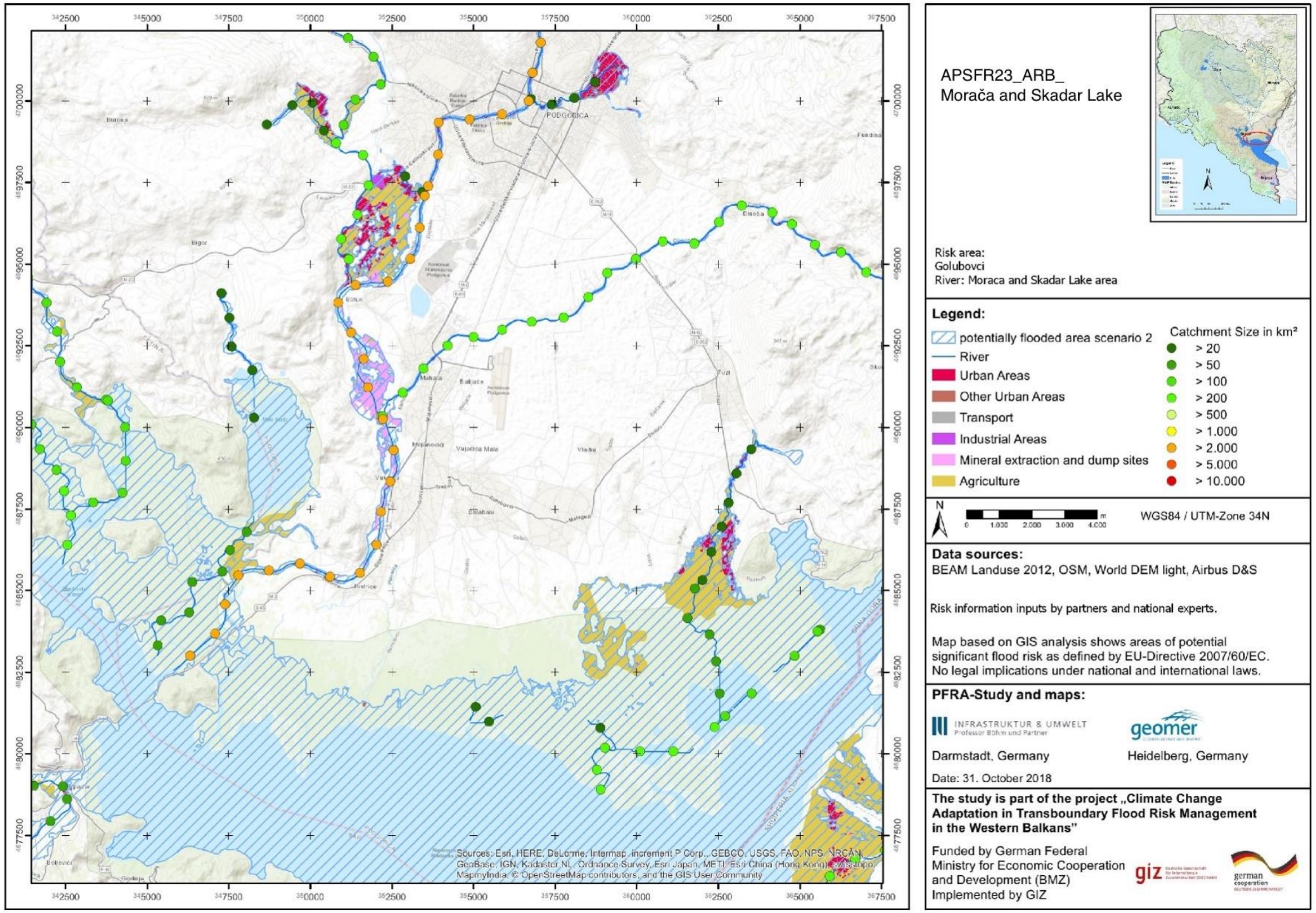


Figure 5.7. APSFR24_ARB_West of Skadar Lake

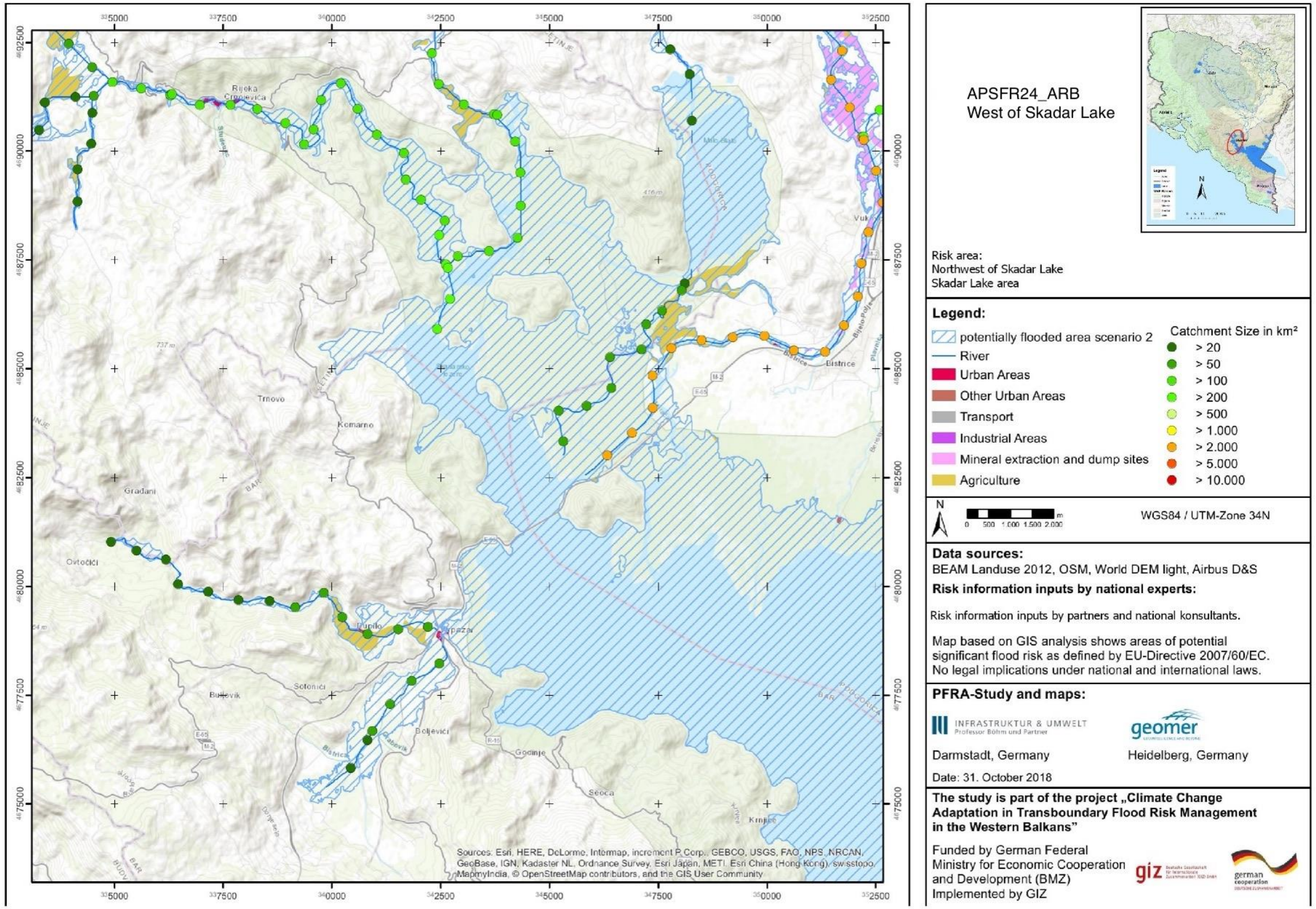
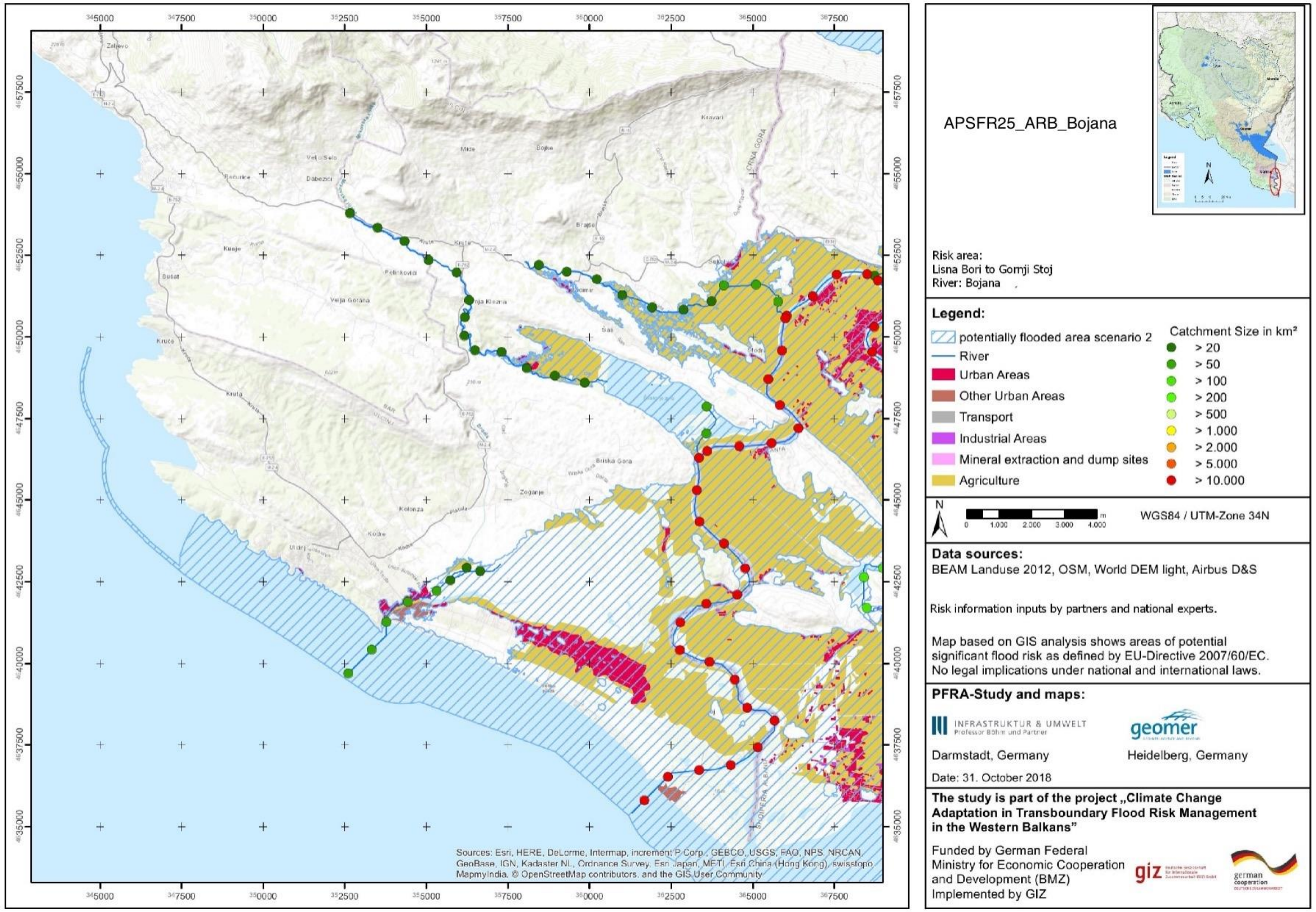


Figure 5.8. APSFR25_ARB_Bojana



5.4 Conclusions from the PFRA

The following conclusion can be drawn from the Preliminary Flood Risk Assessment of the Adriatic 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.

Apart from the strictly legislative framework, with respect to the overall strategy of flood management there is a clear need for streamlining the objectives and recommendations. 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 is required to 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 Adriatic River Basin were analysed from 1952 (when water level measurements began on rivers). Since the early 1950s, five events have been registered with flows of a calculated return period of 100 years. However, the most common high-water flows in the Adriatic basin were calculated with a 10-year return period, occurring 56 times to date.

Despite the fact that the historical hydrological data assessment indicates that flooding in the Adriatic 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 could be used for the PFRA related to the historical flooding event that occurred in late 2010/early 2011 where flood events were recorded within 8 municipalities (Bar, Cetinje, Danilovgrad, Golubovci, Nikšić, Podgorica, Tuzi and Ulcinj).

The recorded data of late 2010/early 2011 included 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 allowed 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 was invaluable for the PFRA.

For the purpose of producing the PFRA, all 11 hydrological stations (HS) the Adriatic 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 results were calibrated based on the 2010 flood data, which are considered to be the largest floods recorded. A comparison was also made with the results obtained through the GIZ funded project, 'Climate Change Adaptation in Transboundary Flood Risk Management for the Western Balkans' and it was concluded that the results matched.

For data analysis, DEMs obtained from Airbus D&S and from the Real Estate Administration in Montenegro. together with available information on the Internet (Open Street Map, 2018) and the Corine Land Cover (2012) map were also considered.

Based on the analysis of all the above data, 6 APSFR in the Adriatic basin area were defined and represented in GIS format[44]. These included areas in the following Sub-Basins: Zeta River Sub-Basin (2), Morača/Skadar Lake Sub-Basins (1), Skadar Lake Sub-Basin (2, including one directly from groundwater) and Bojana River Sub-Basin (1).

A further area that can be considered for the APSFR is the Sutorina River, which is a transboundary watercourse with Croatia identified as an endangered area within the analysis of historical floods. However, although this area can be identified as an APSFR, the APSFR is not defined since there are no hydrological data available in this area and therefore the return periods and the extent of flooding cannot be calculated. The need for hydrological measurements for the Sutorina River catchment is evident.

Unfortunately, the small and torrential watercourses and canals are watercourses are not in the network of hydrological monitoring at the state level. Thus, due to the lack of hydrological data, not all of the necessary parameters for defining the potential areas of increased flood risk can be considered. The importance of flood management on the torrents of the Montenegrin coast certainly deserves attention, and, in the future must be the subject of consideration of the manner and conditions of formation of hydrological monitoring on selected watercourses. The Consultant has identified a total of 13 locations for hydrological stations that are required to be installed and operated in the Municipalities of Bar (2), Budva (4), Herceg Novi (4) and Kotor (3).

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 River Basin is expected, in the future, short heavy rainfall, often combined with snowmelt and soil

[44]GIS maps produced by the GIZ funded project, 'Climate Change Adaptation in Transboundary Flood Risk Management for the Western Balkans' were reproduced in this report with only an adaption for the APSFR nomenclature.

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.

Based on PFRA the Government of Montenegro, in its session on February 24, 2022, adopted the Decision on Determining Areas Significantly Endangered by Floods ("Official Gazette of Montenegro," No. 030/22 of 21.03.2022).

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 Adriatic basin, the following data were available:

- Maximum annual water levels and flows on the profiles of the hydrological measuring stations available to the IHMS of Montenegro.
- Terrain data were taken from the Real Estate Administration of Montenegro - 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[45] 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

[45] 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 for three considered scenarios:

- 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

whereby the green colour codes, used to display these three classes, were taken from the hazard maps that were made in the previous cycle of creating these maps (through the project implemented by GIZ).

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 two of the APSFR[46]. Therefore, for each of the return periods (HQ10, HQ100 and HQ500) a minimum of two maps were created (one with OSM as base

[46] Topographic maps were not prepared under the GIZ project. Only APSFR21_ARB_Zeta02 and APSFR22_ARB_Cetinje Field were prepared as topographic maps.

map and one with OP as base map). Thus, a total (minimum) of six hazard maps are obtained 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. The Guidebook aims to support the flood risk management authorities and organisations involved in the future harmonised development of flood hazard and risk maps (FHRM) in the Drin/Drim – Buna/Bojana River Basin. It is intended to create general understanding, provide guidance for experts and users, and contribute to the harmonisation of maps in the Drin/Drim – Buna/Bojana River Basin.

As determined in Article 2 of the European flood directive - 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 Floods Directive 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

Land Use Class	Vulnerability Value		
	Low	Medium	High
		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		
Intensity		**Low**	**Medium**	**High**
	>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				
		Vulnerability Value		
Intensity		**Low**	**Medium**	**High**
	>5 m or >2 m/s			
	1 m – 5 m			
	0.5 m – 1 m			
	0 – 0.5 m			

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

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

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

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 APSFR20 and APSFR22 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) so that each of the two APSFR areas 9 maps were created. Topographic maps were not created for APSFR identified by the GIZ and thus 6 maps were created for APSFR21, 23, 24 and 25.

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.

6.3 APSFR20_ARB_Zeta01

This APSFR was defined by the historical floods. HPP “Perućica” is the oldest large hydropower plant in Montenegro and was put into operation in 1960. It is named after the well Perućica, which originates in the vicinity of hydroelectric power plant. For electricity production, HPP “Perućica” uses water catchment of river Gornja Zeta, which is water that flows into Nikšić field. HPP "Perućica" consists of the following facilities: accumulations "Krupac" and "Slano" and retention "Vrtac" and the system of channels (Moštanica, Opačića, Zeta I and Zeta II). The management of reservoirs should be such that they can reduce the flood wave that is reflected downstream.

The APSFR for the Zeta01 is distinguished as follows[47]:

Catchment area: Upper Zeta; **River tributary**: Zeta

Flood Hazard	
Flood Source	Fluvial (A11), Pluvial (A12), Groundwater (A13).
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).
Type of Areas Affected	Agricultural > Urban > Industrial > Mineral extraction and dump sites > Transport.
Affected regions	Municipality of Nikšić
Towns/Settlements	Nikšić Town/ Kličevo, Ozrinići, Poljica, Štedim and Straševina.

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).

The APSFR is divided into a northern and a southern part. 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[48,49]. Symbols included on the flood maps are shown in Annex 4.

[47] 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.

[48] Orthophoto and OpenStreet map files are presented in PDF format. Topographic maps are in JPG (picture) format.

[49] 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.

Table 6.5. Flood hazard maps and flood risk maps prepared for APSFR20_ARB_Zeta01

Return Period	Orthophoto	OpenStreet	Topographic
Flood Hazard Maps (Northern Region)			
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 Hazard Maps (Southern Region)			
Flood Extent			
HQ100	Download	Download	Download
Inundation Depth			
HQ10	Not Available	Not Available	Not Available
HQ100	Download	Download	Download
HQ500	Not Available	Not Available	Not Available
Flood Risk Maps (Northern Region)			
HQ10	Download	Download	Download
HQ100	Download	Download	Download
HQ500	Download	Download	Download
Flood Risk Maps (Southern Region)			
HQ10	Not Available	Not Available	Not Available
HQ100	Download	Download	Download
HQ500	Not Available	Not Available	Not Available

For the southern region, modelling of the available hydraulic data did not provide an accurate assessment of the flood extent. It was however possible to calculate the flood extent in this region on the basis of available data collected from the observed boundary line of the flooding event during 2010/2011, which provided the flood extent for HQ100. Corresponding inundation depths for HQ100 were calculated based on the topography of the region. Further data collection is required to be undertaken in the future to determine the flood extents for low and high probability events and inundation depths in this region of the APSFR.

Figures 6.1 to 6.6 below provide examples of the flood hazard and flood risk maps for the northern and southern regions of APSFR20_ARB_Zeta01.

For the northern region, the combined flood extent at HQ10, HQ100 and HQ500 is shown in Figure 6.1 together with inundations based on the HQ500 (Figure 6.2). The flood risk map for the northern region at HQ500 is shown in Figure 6.3.

For the southern region, the flood extent for HQ100 with corresponding inundation depths are shown in Figures 6.4 and 6.5, respectively. The corresponding flood risk map for HQ100 is provided in Figure 6.6.

Figure 6.1. Flood Extent for APSFR20_ARB_Zeta01 (Northern Region)

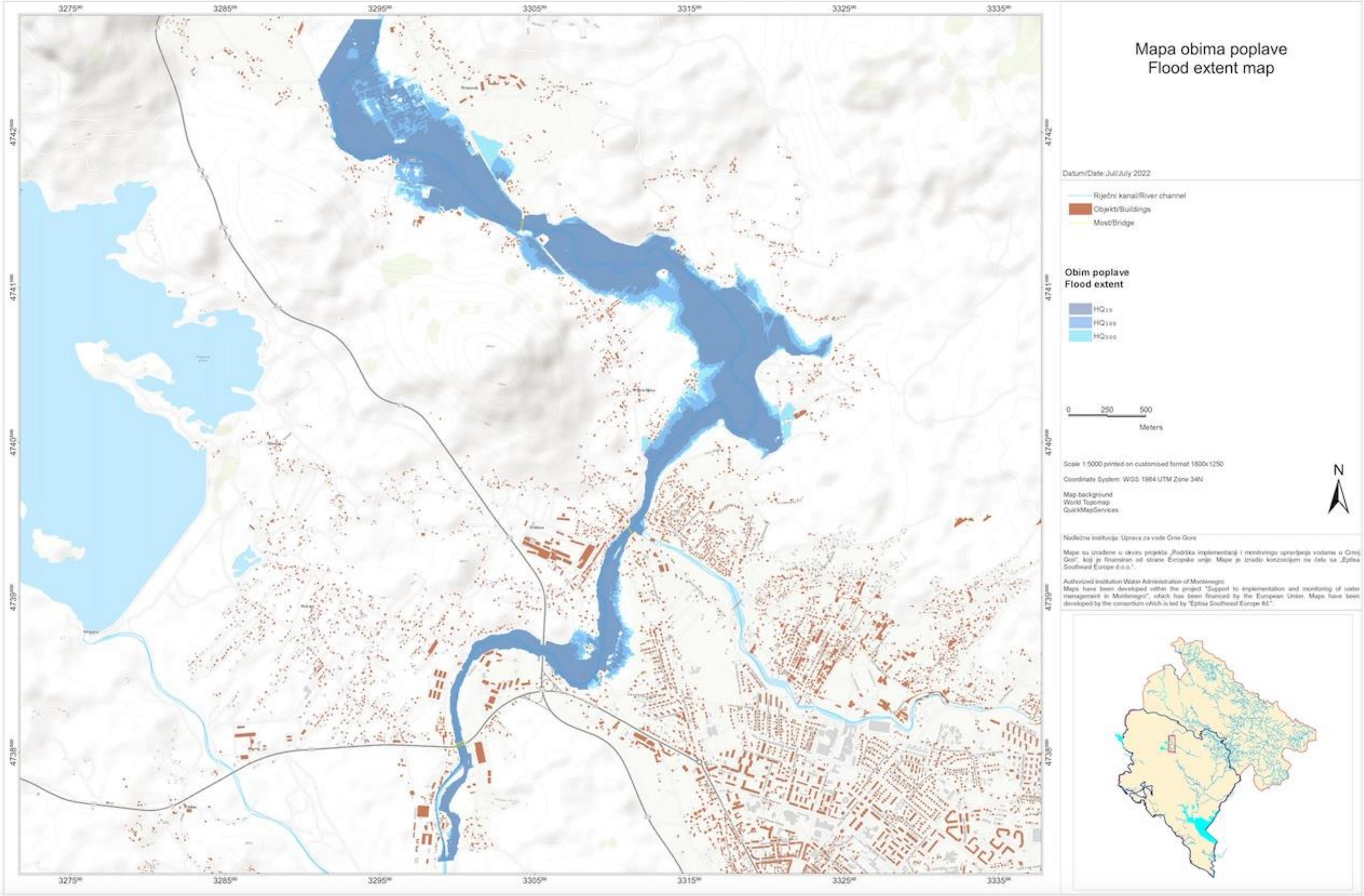


Figure 6.2. Inundation Depth (HQ500) for APSFR20_ARB_Zeta01 (Northern Region)

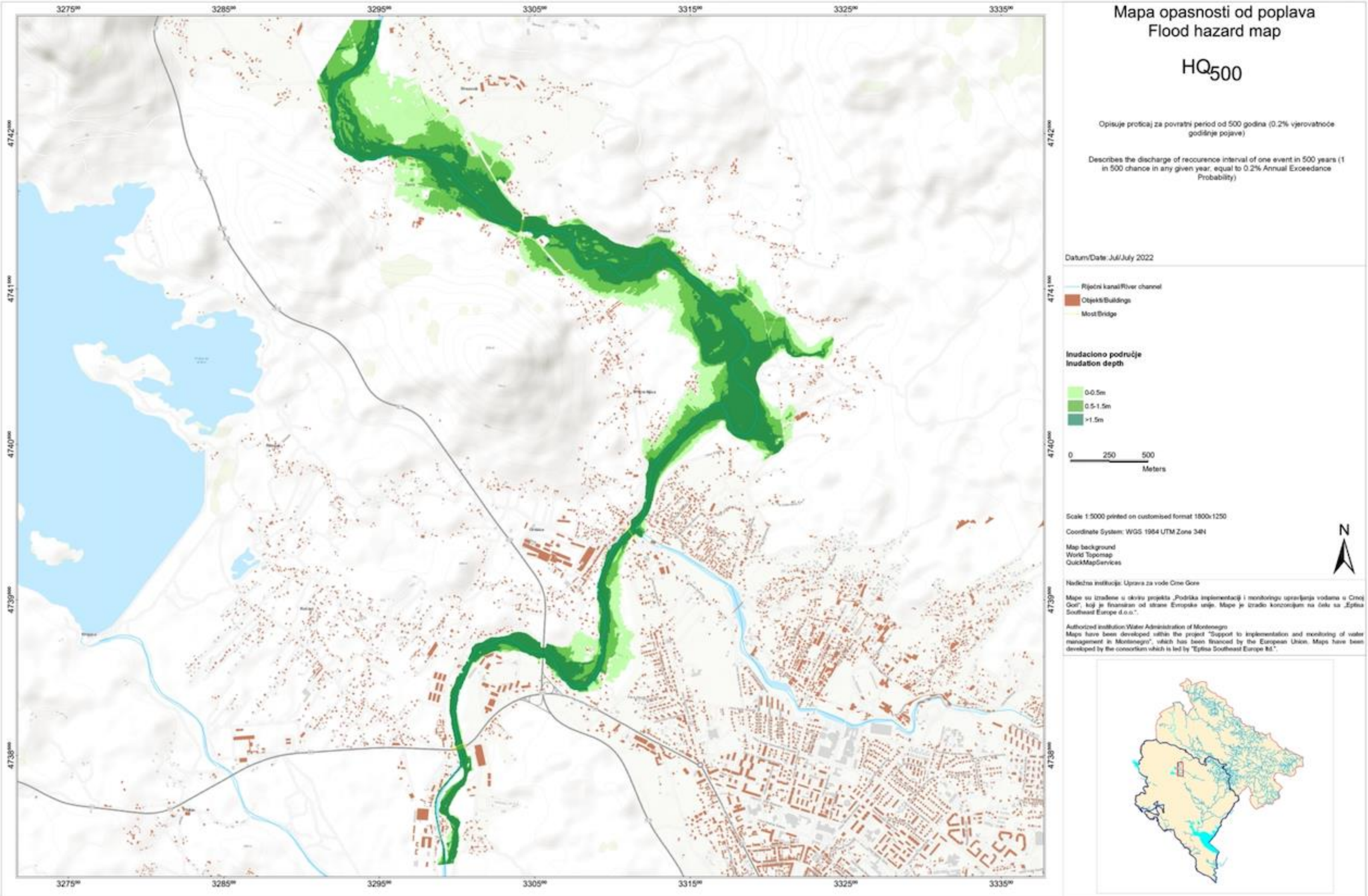


Figure 6.3. Flood Risk (HQ500) for APSFR20_ARB_Zeta01 (Northern Region)

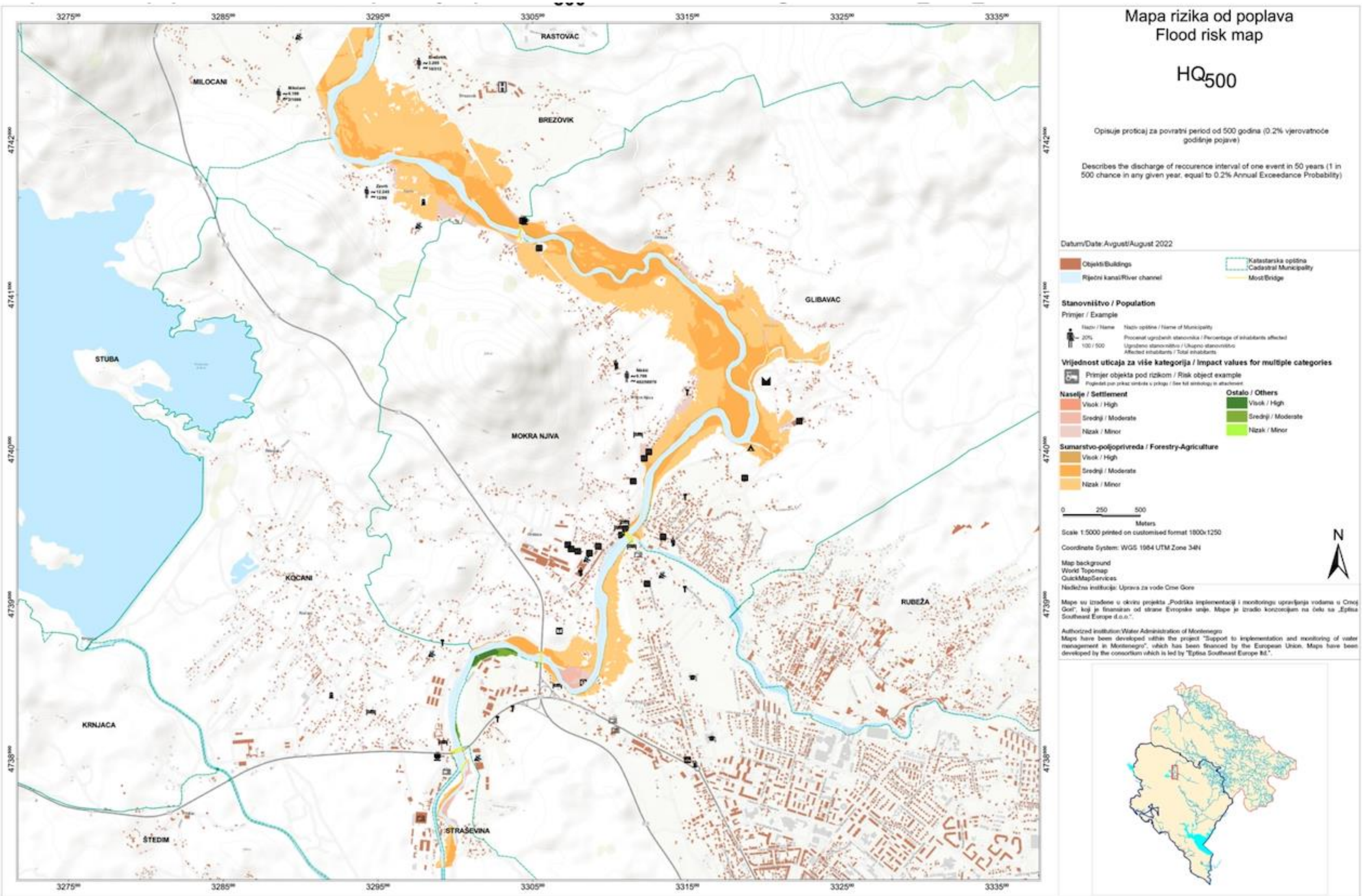


Figure 6.4. Flood Extent for APSFR20_ARB_Zeta01 (Southern Region)

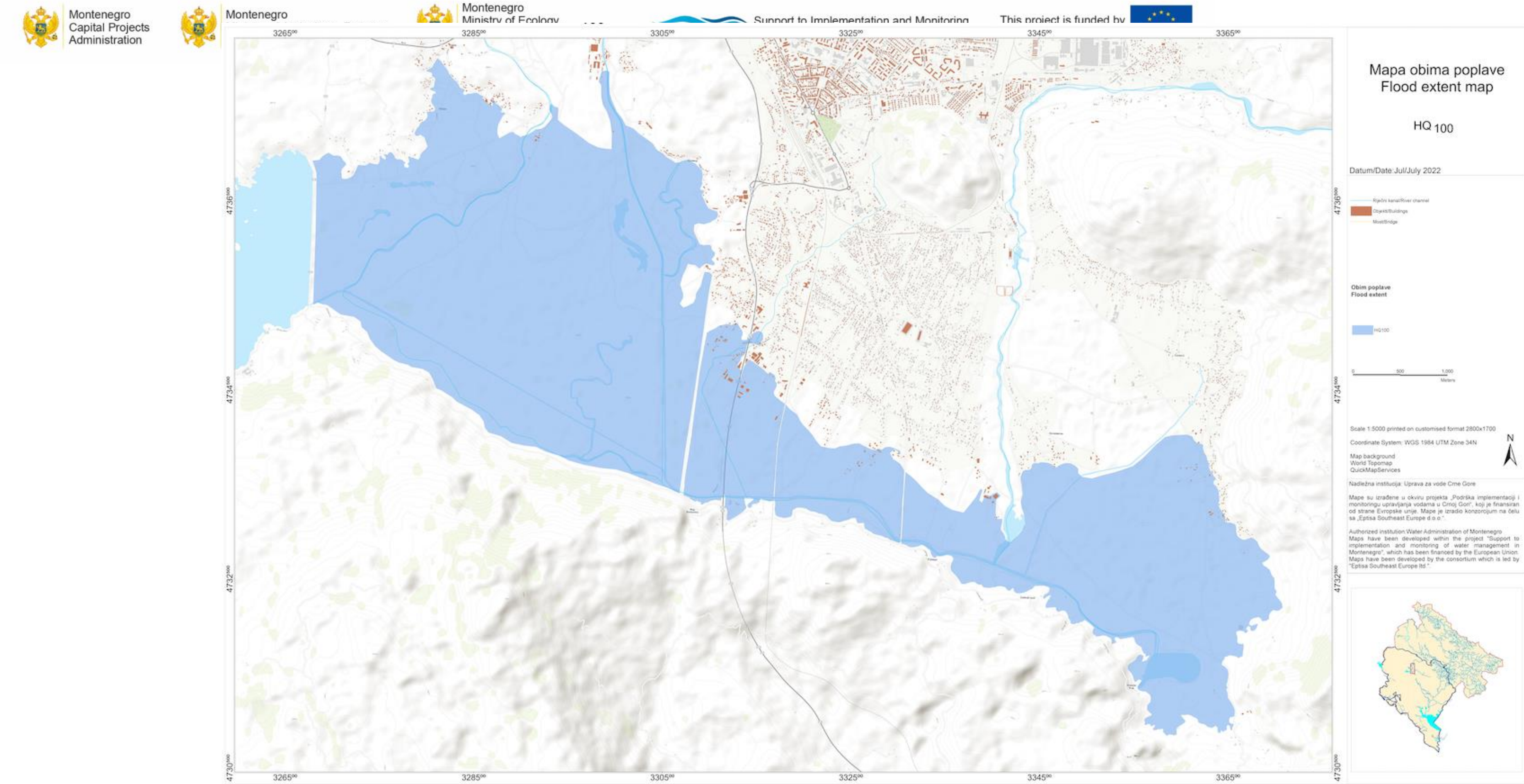


Figure 6.5. Inundation Depth (HQ100) for APSFR20_ARB_Zeta01 (Southern Region)

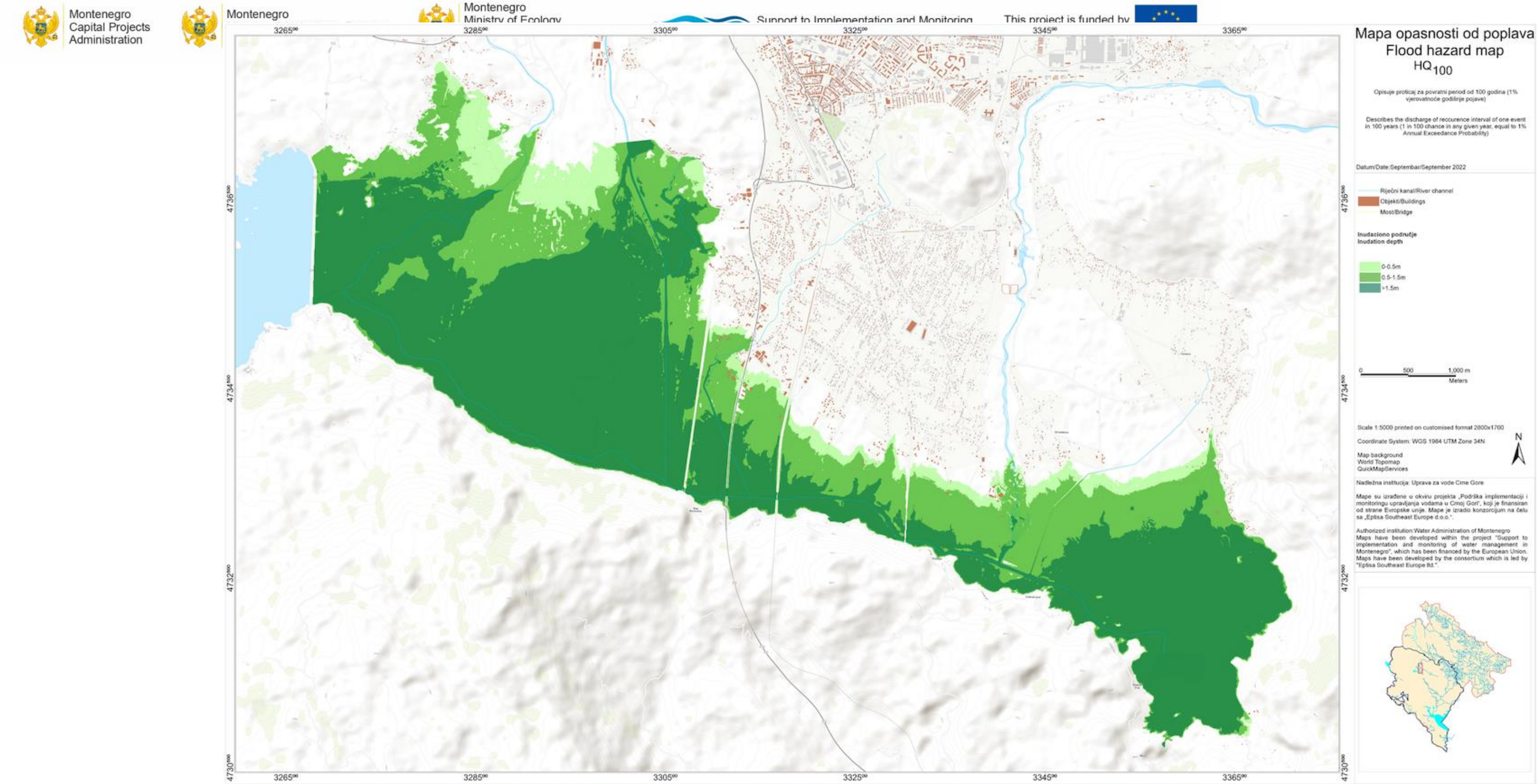
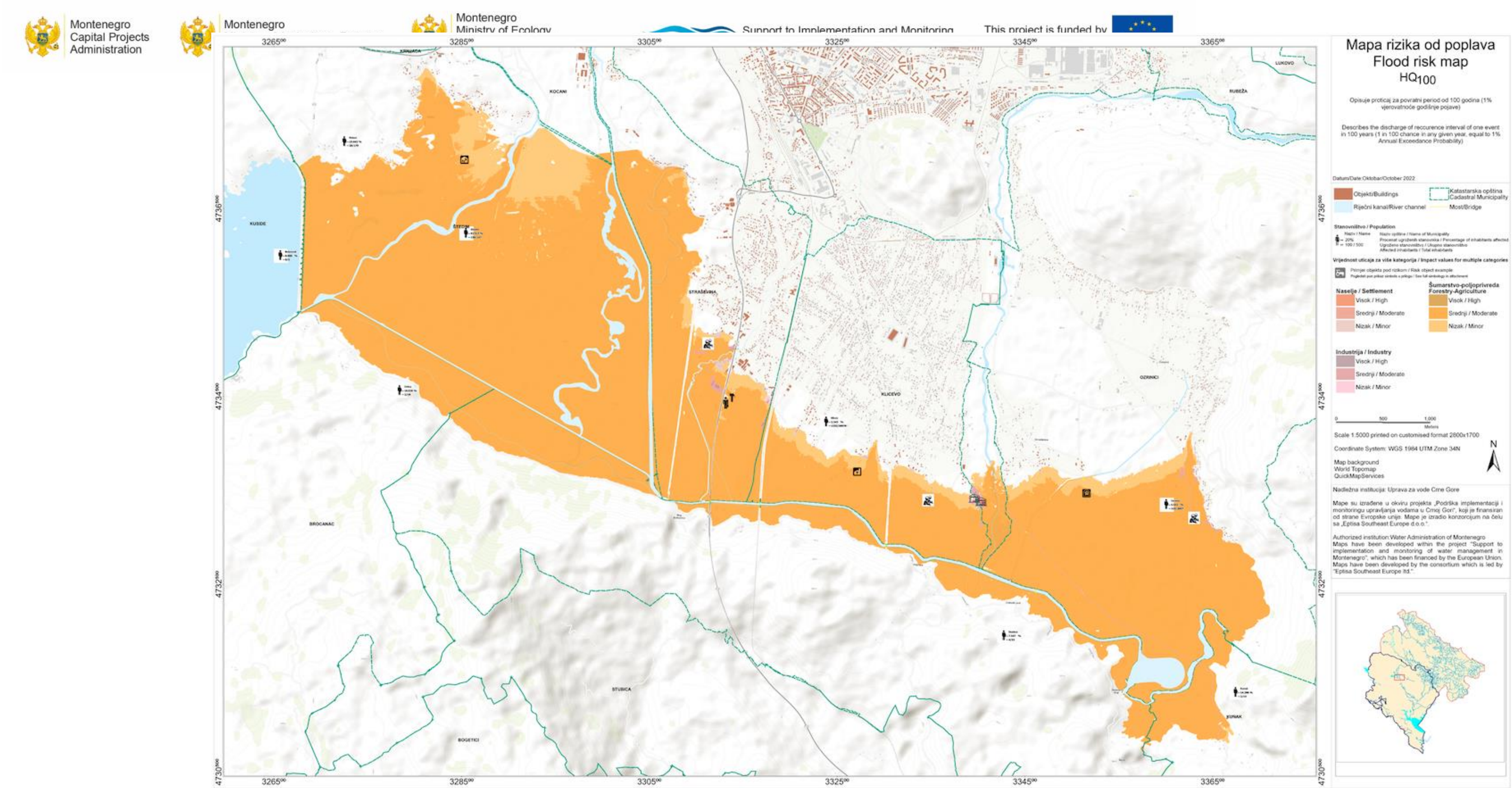


Figure 6.6. Flood Risk (HQ100) for APSFR20_ARB_Zeta01 (Southern Region)


Montenegro
Capital Projects
Administration
Montenegro
Montenegro
Ministry of Ecology
This project is funded by
Mapa rizika od poplava
Flood risk map
HQ100
Opisuje proticaj za povratni period od 100 godina (1% vjerovatnoće godišnje pojave)
Describes the discharge of reccurence interval of one event in 100 years (1 in 100 chance in any given year, equal to 1% Annual Exceedance Probability)
Datum/Date:Oktobar/October 2022
Objekti/Buildings
Katastarska opština
Cadastral Municipality
Rječni kanal/River channel
Most/Bridge
Stanovništvo / Population
Vrijednost uticaja za više kategorija / Impact values for multiple categories
Primjer objekta pod rizikom / Risk object example
Naselje / Settlement
Visok / High
Srednji / Moderate
Nizak / Minor
Šumarstvo-poljoprivreda
Forestry-Agriculture
Visok / High
Srednji / Moderate
Nizak / Minor
Industrija / Industry
Visok / High
Srednji / Moderate
Nizak / Minor
Scale 1:5000 printed on customised format 2800x1700
Coordinate System: WGS 1984 UTM Zone 34N
Map background
World Topomap
QuickMapServices
Nadležna institucija: Uprava za vode Crne Gore
Mape su izrađene u okviru projekta „Podrška implementaciji i monitoringu upravljanja vodama u Crnoj Gori“, koji je finansiran od strane Evropske unije. Mape je izradio konzorcijum na čelu sa „Eptisa Southeast Europe d.o.o.“.
Authorized institution: Water Administration of Montenegro

6.4 APSFR21_ARB_Zeta02

The APSFR for the Zeta02, which was defined by historical floods, is distinguished as follows:

Catchment area: Lower Zeta; **River Tributary**: Zeta

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).
Type of Areas Affected	Agricultural > Urban > Industrial > Mineral extraction and dump sites > Transport.
Affected regions	Municipality of Danilovgrad
Towns/Settlements	Pažići, Bogićevići, Glavica, Gorica, Grlić, Livade Bandićke, Podanje, Podkraj, Spuž, Strahinjici, Viško polje.

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 6.6 below and are available for download (via Google Drive).

Table 6.6. Flood hazard maps and flood risk maps prepared for APSFR21_ARB_Zeta02

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

The APSFR is divided into 5 sections with an overview of the section shown in Figure 6.7.

Figures 6.8 to 6.22 below provide examples of the flood hazard and flood risk maps for APSFR21_ARB_Zeta02. Each section of the APSFR is presented with the combined flood extent at HQ10, HQ100 and HQ500, together with inundations based on the HQ500 and the flood risk map at HQ500.

Figure 6.7. Overview of the Sections (1-5) of APSFR21_ARB_Zeta02

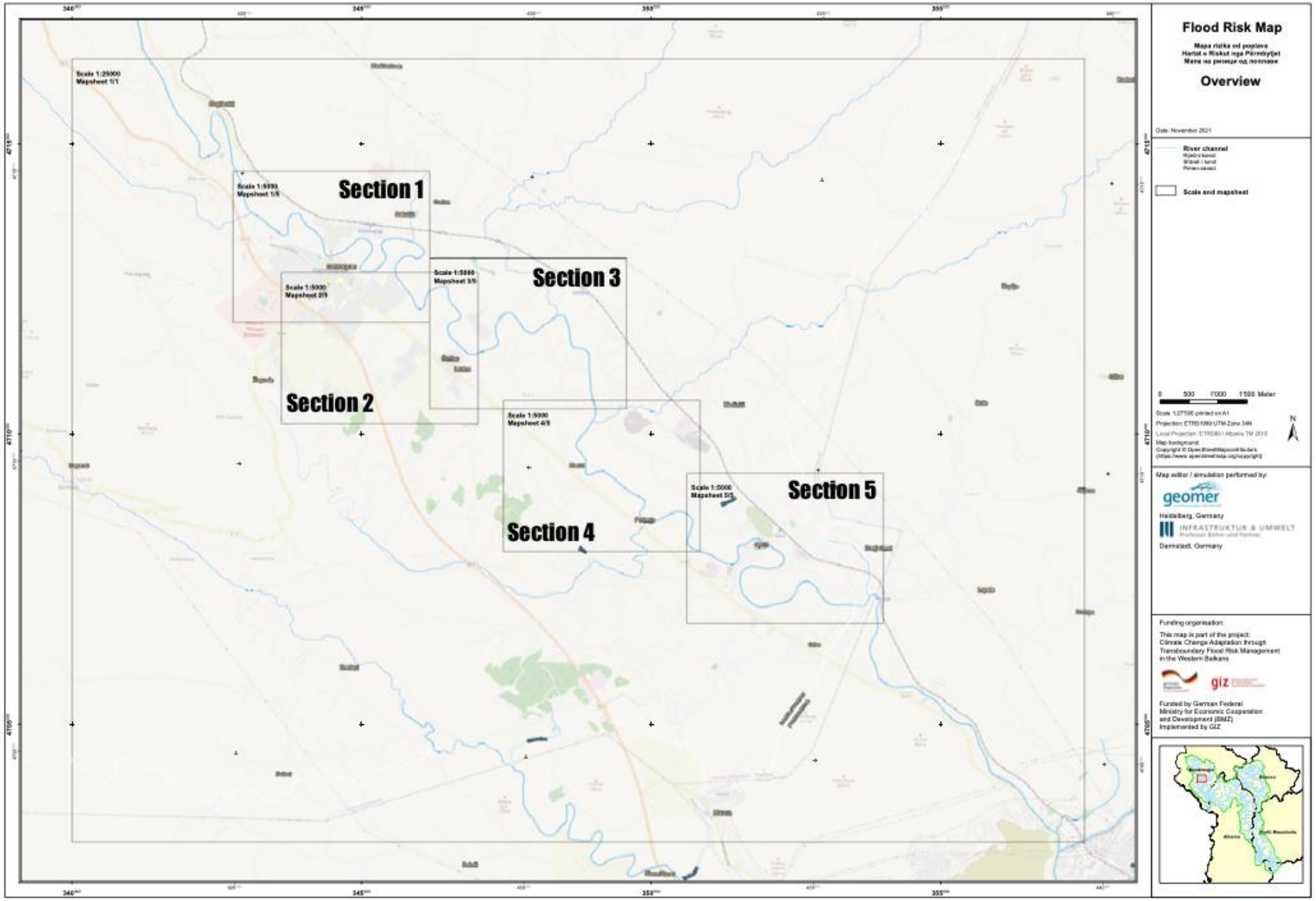


Figure 6.8. Flood Extent for APSFR21_ARB_Zeta02 (Section 1)

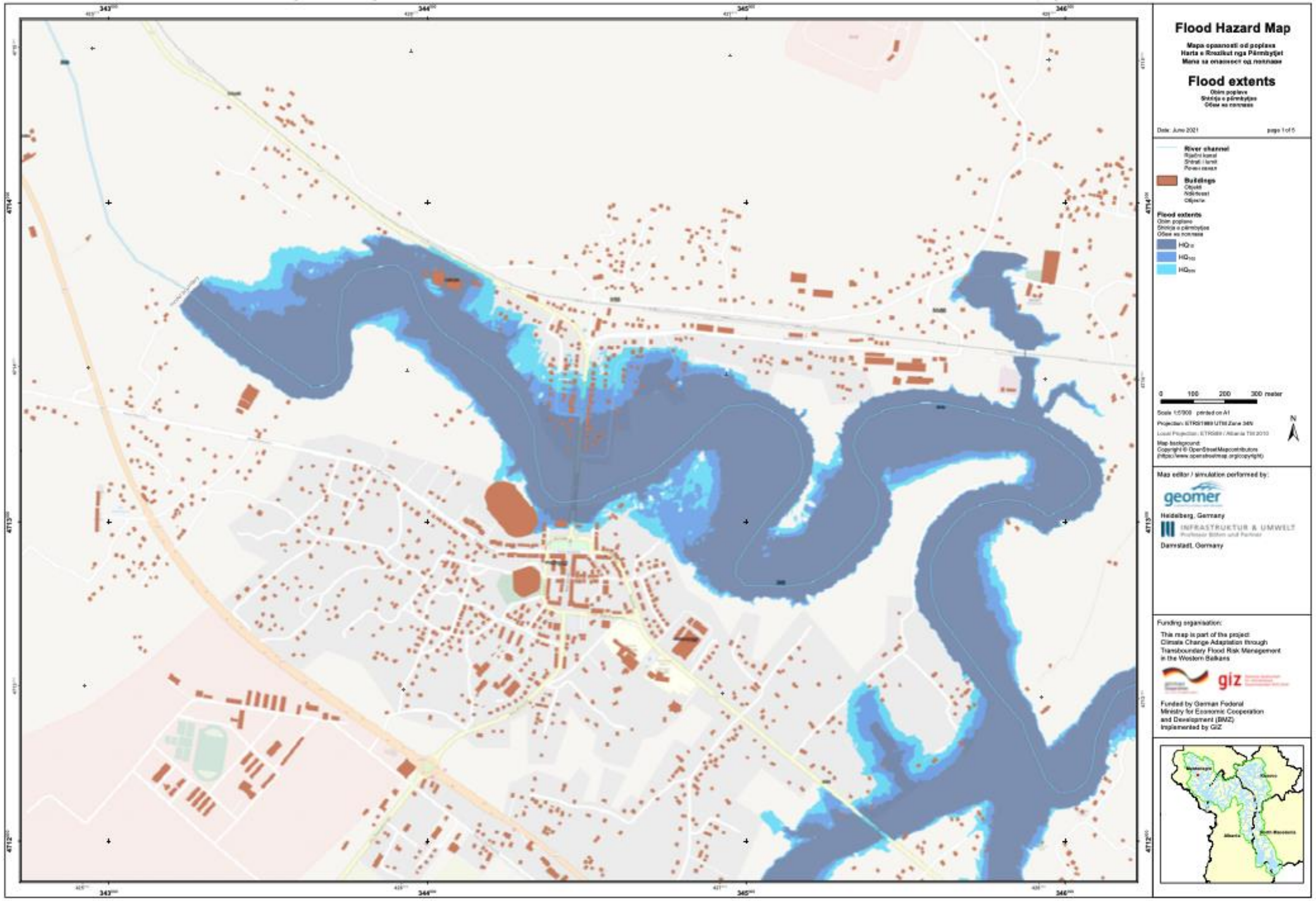


Figure 6.9. Inundation Depth (HQ500) for APSFR21_ARB_Zeta02 (Section 1)

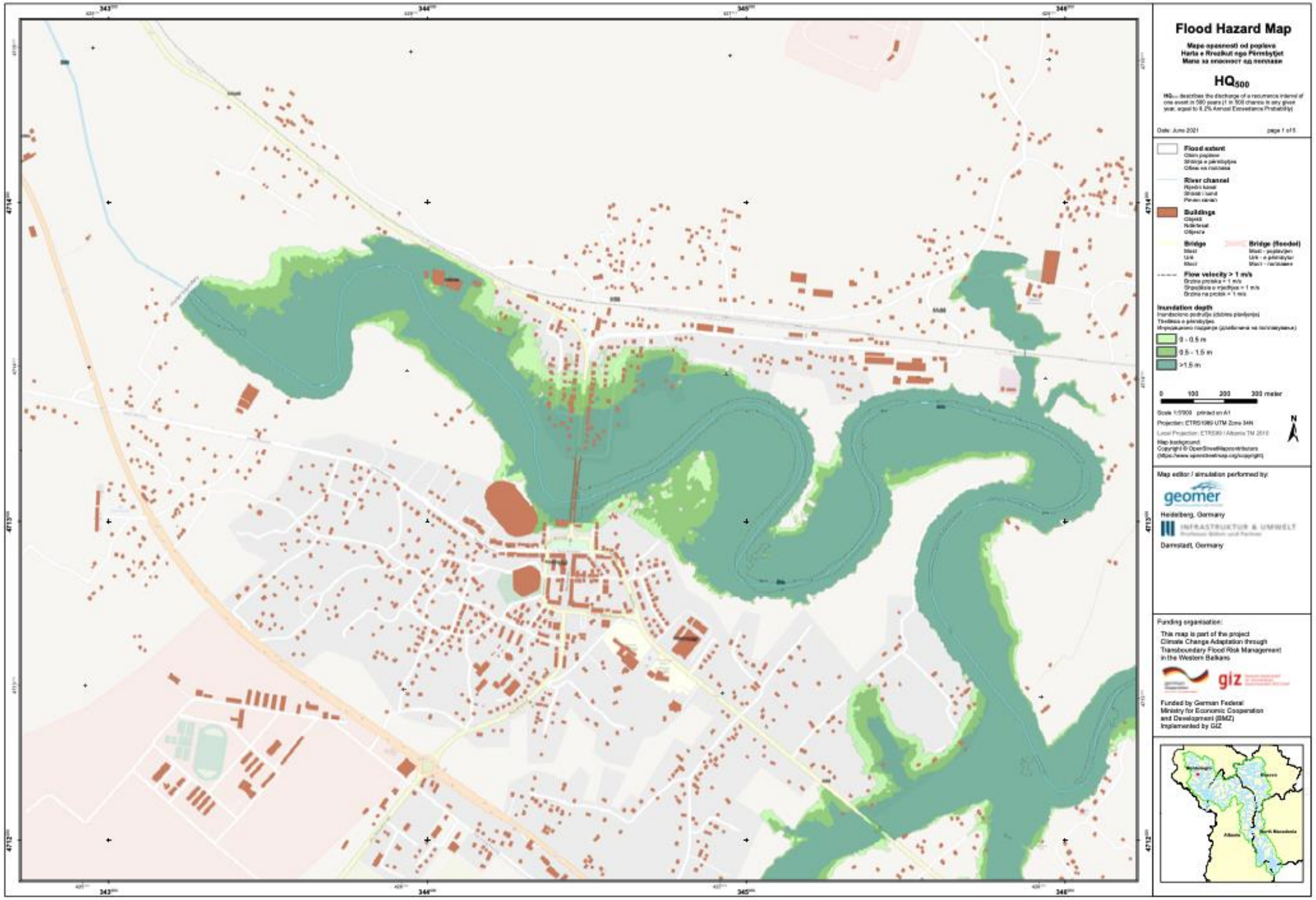


Figure 6.10. Flood Risk (HQ500) for APSFR21_ARB_Zeta02 (Section 1)

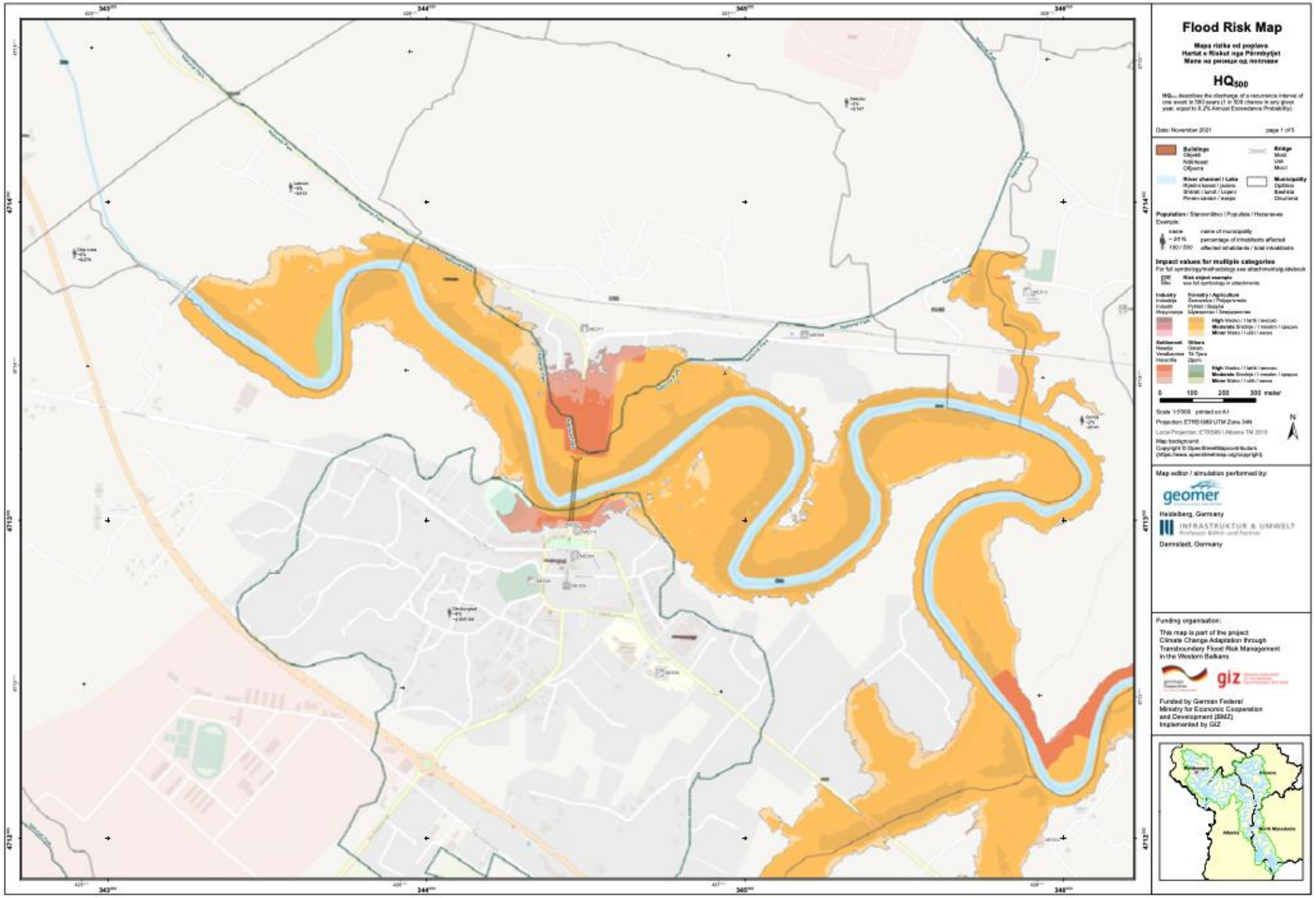


Figure 6.11. Flood Extent for APSFR21_ARB_Zeta02 (Section 2)

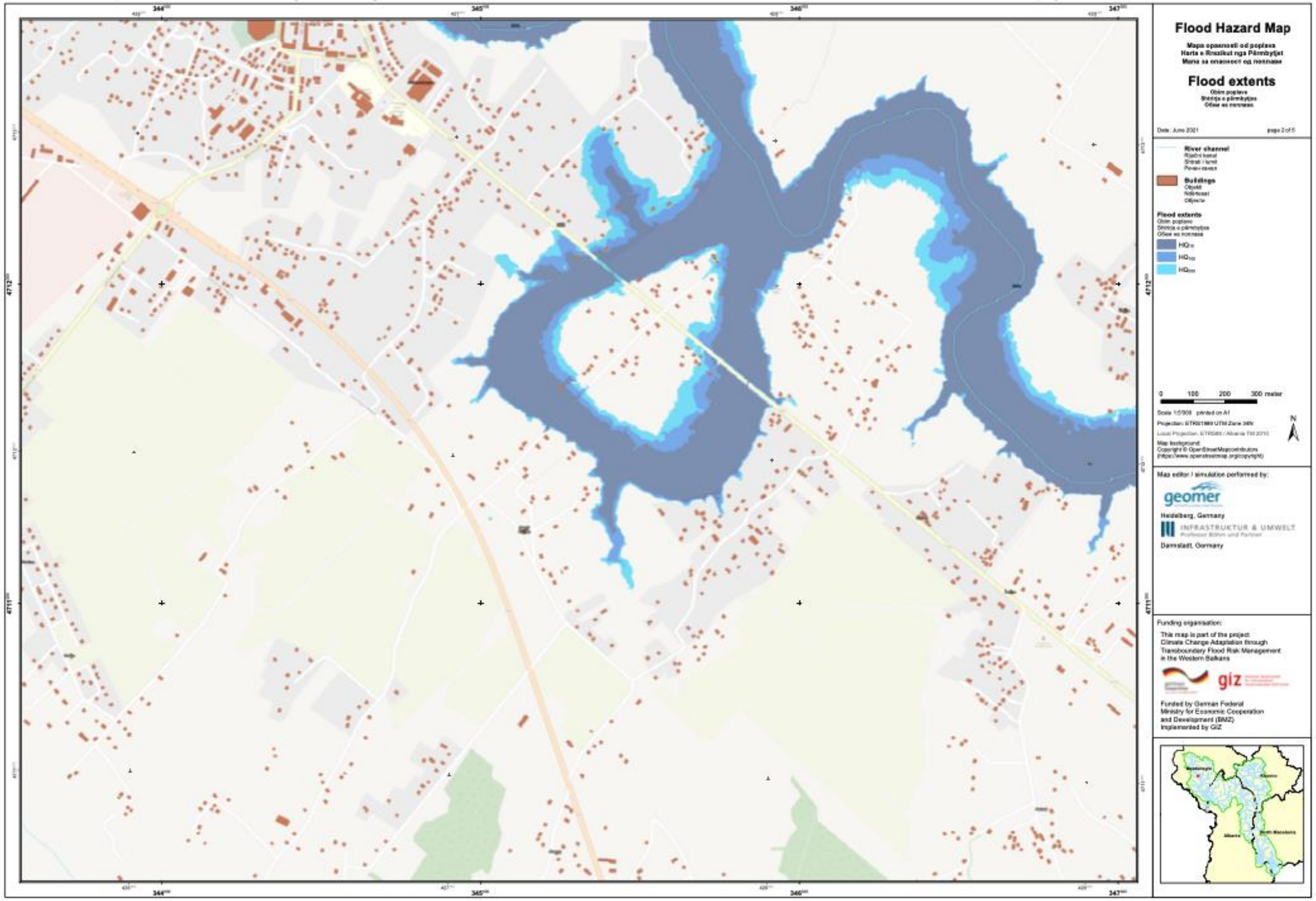


Figure 6.12. Inundation Depth (HQ500) for APSFR21_ARB_Zeta02 (Section 2)

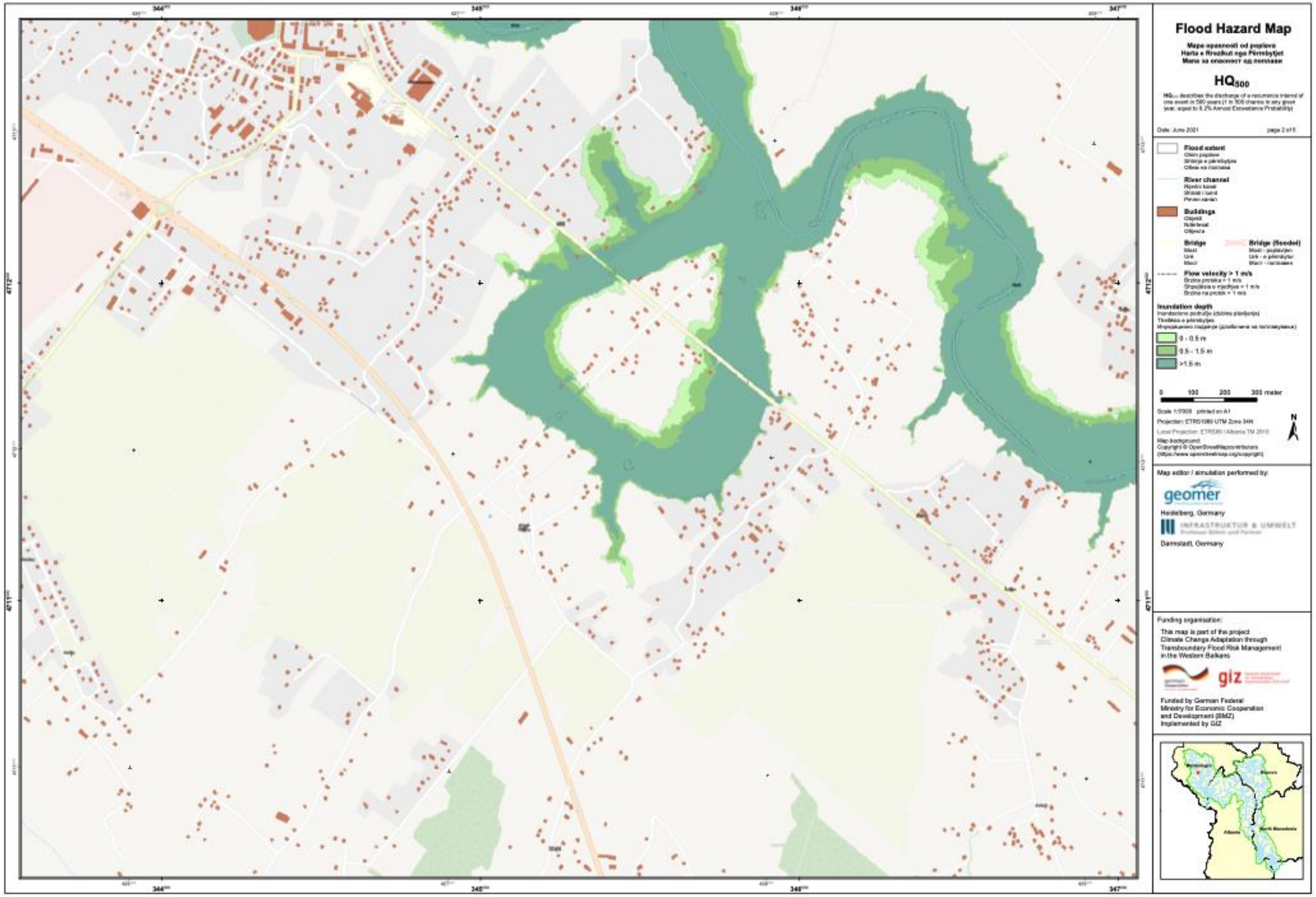


Figure 6.13. Flood Risk (HQ500) for APSFR21_ARB_Zeta02 (Section 2)

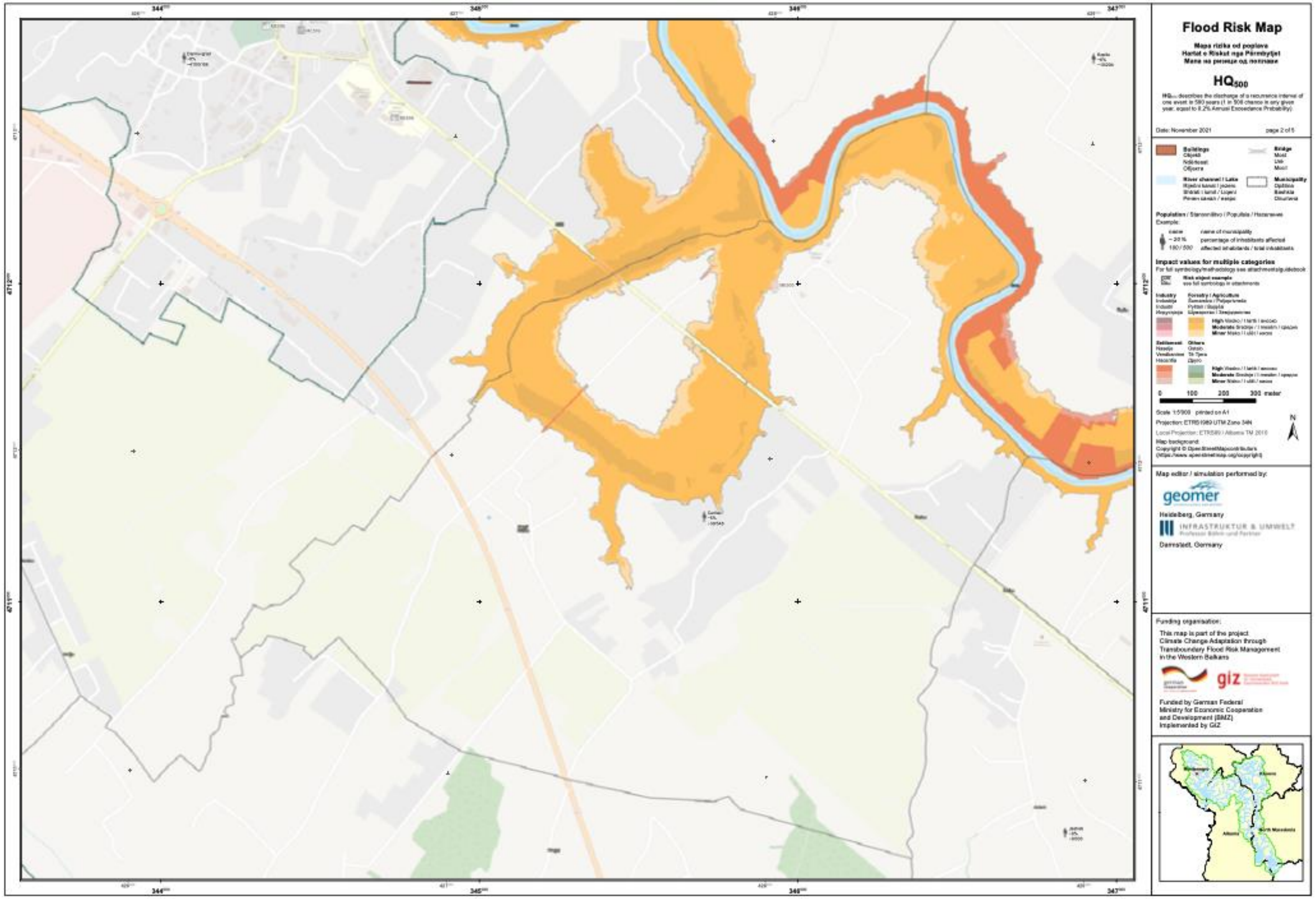


Figure 6.14. Flood Extent for APSFR21_ARB_Zeta02 (Section 3)

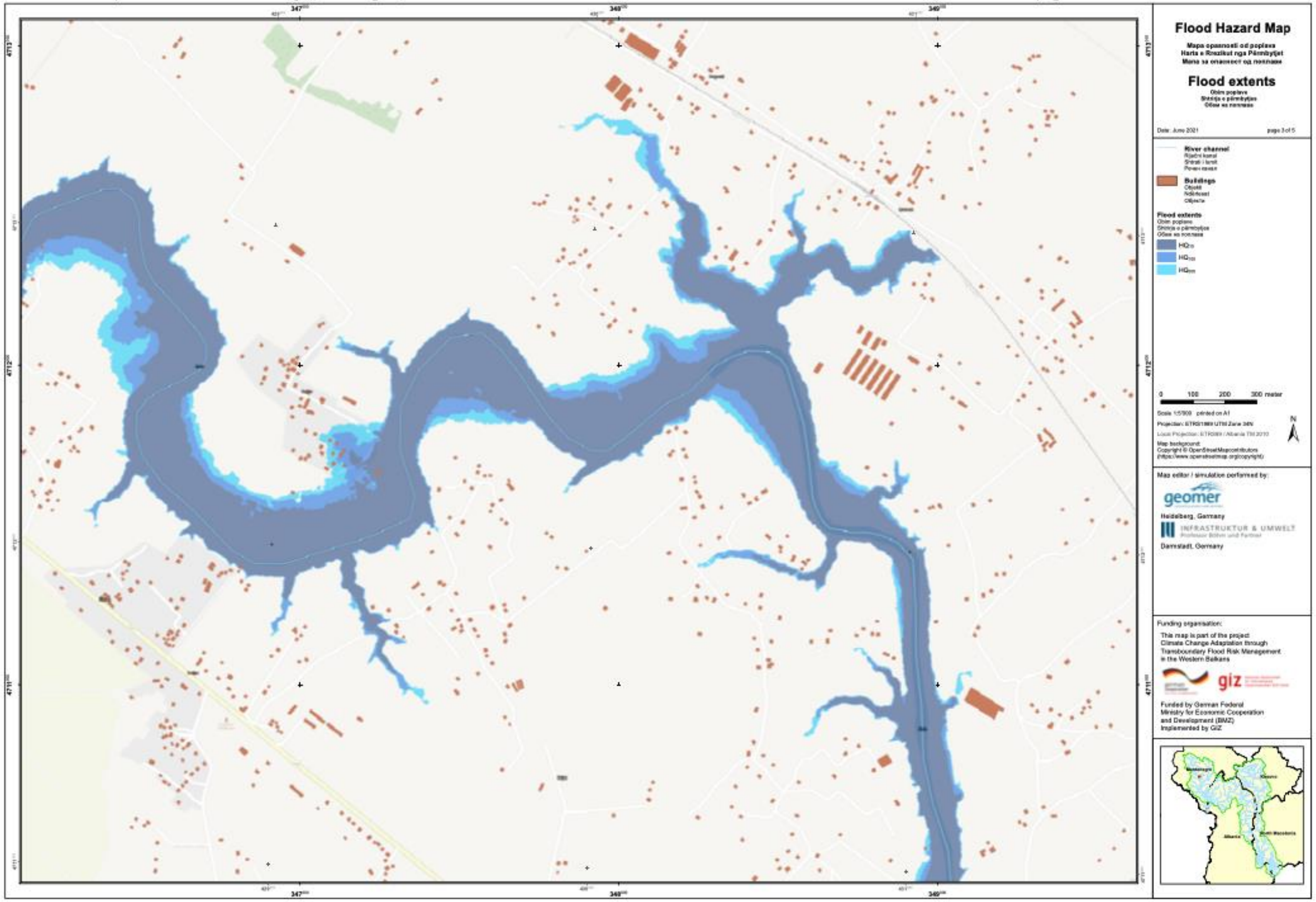


Figure 6.15. Inundation Depth (HQ500) for APSFR21_ARB_Zeta02 (Section 3)

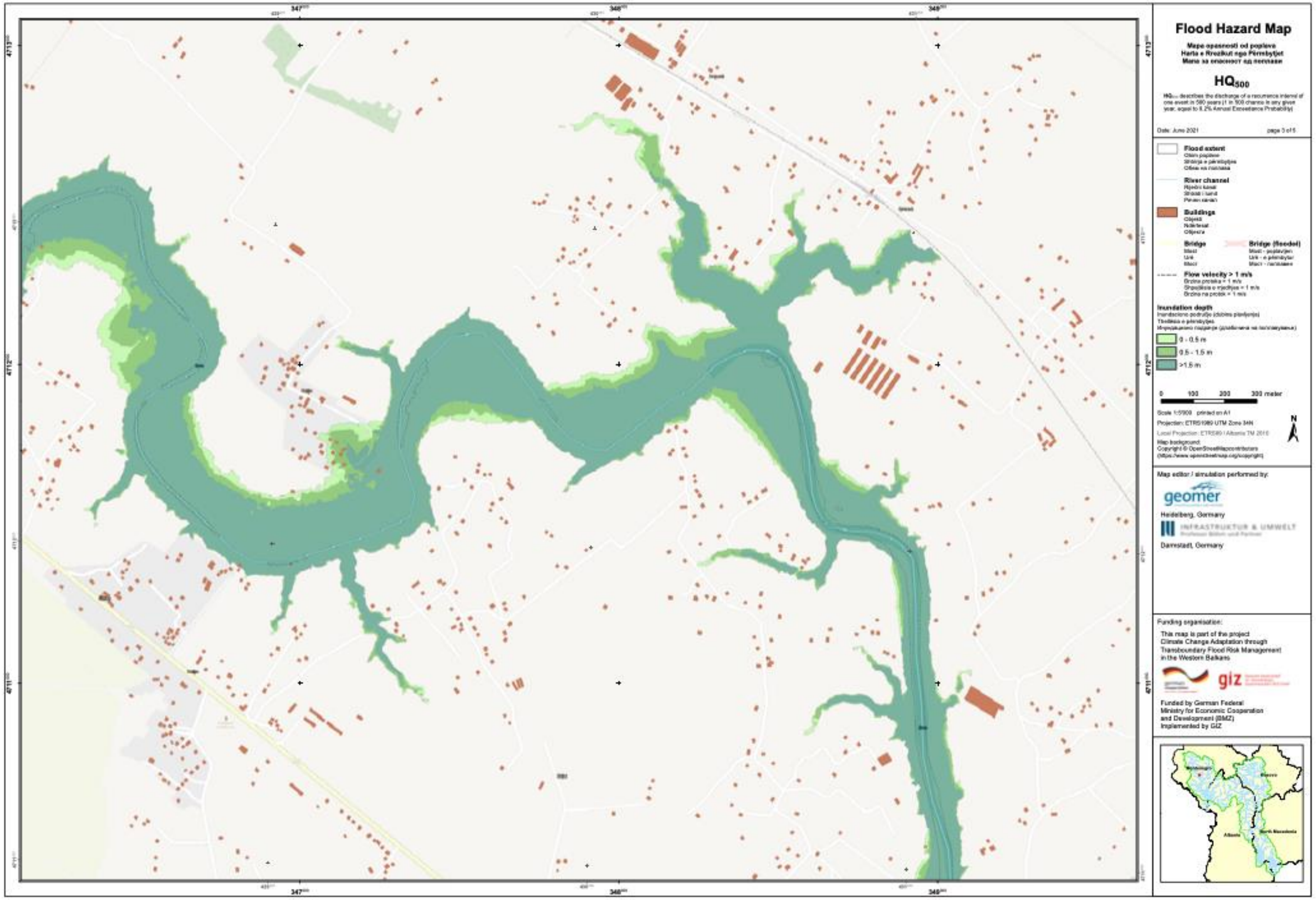


Figure 6.16. Flood Risk (HQ500) for APSFR21_ARB_Zeta02 (Section 3)

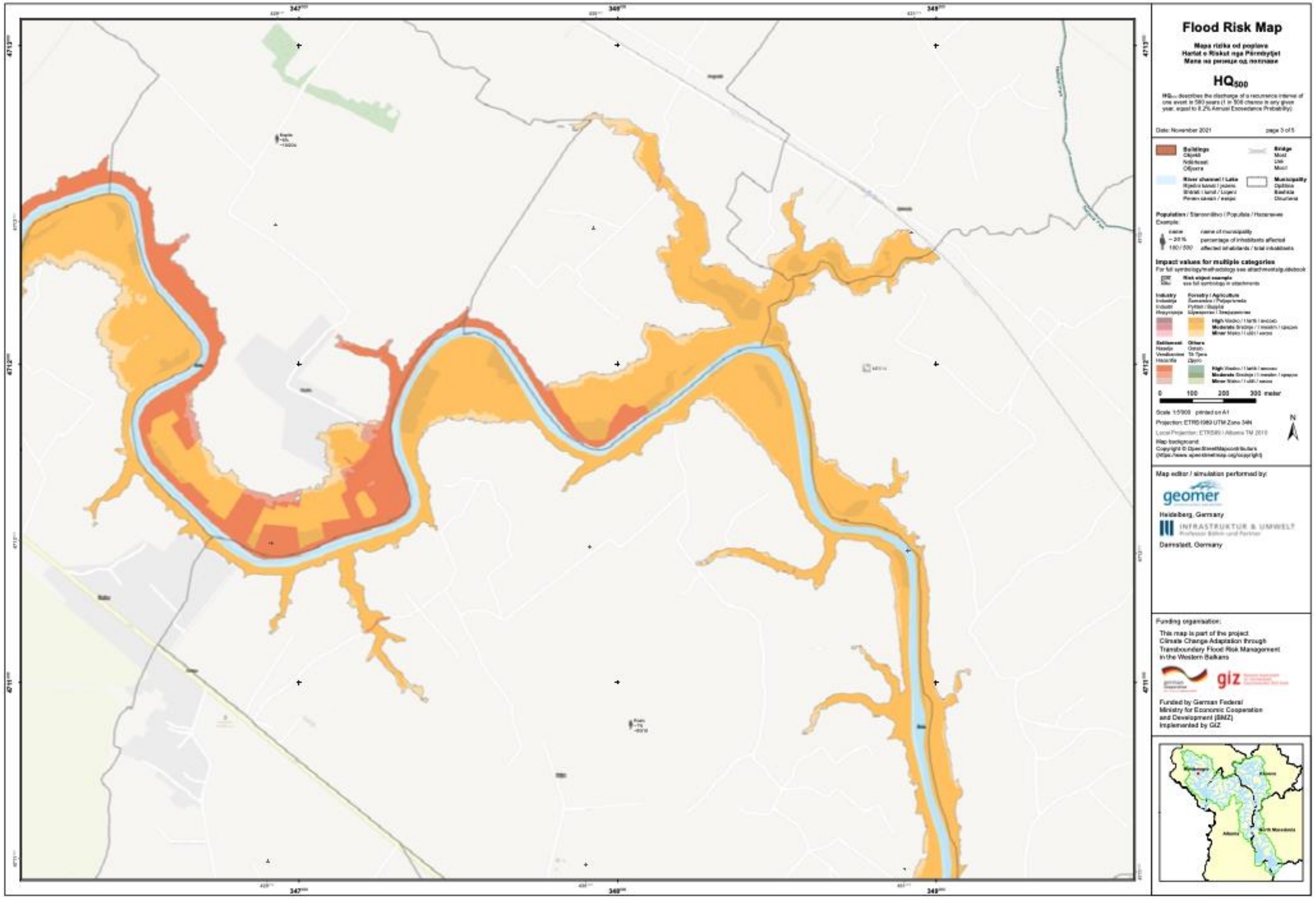


Figure 6.17. Flood Extent for APSFR21_ARB_Zeta02 (Section 4)

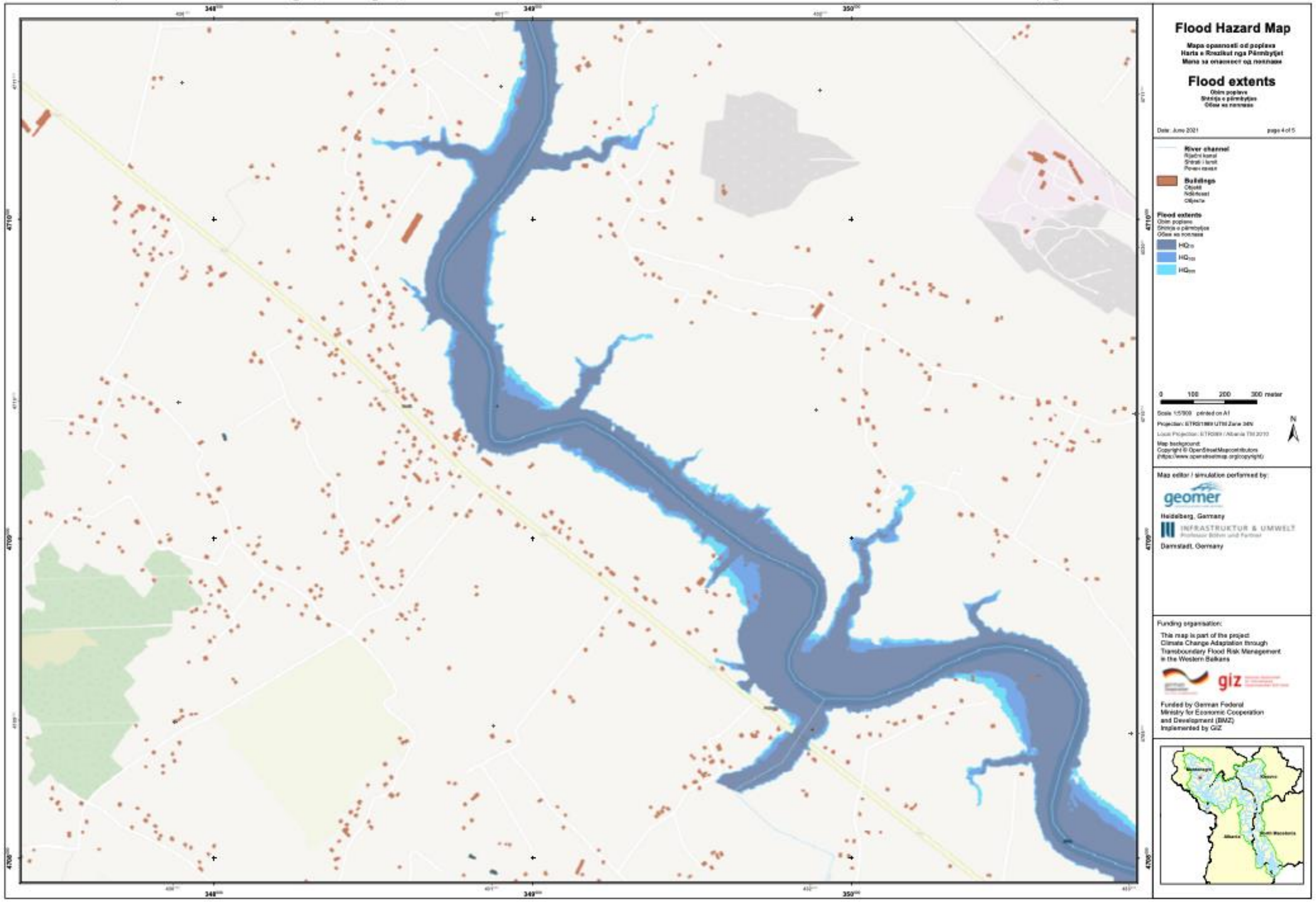


Figure 6.18. Inundation Depth (HQ500) for APSFR21_ARB_Zeta02 (Section 4)

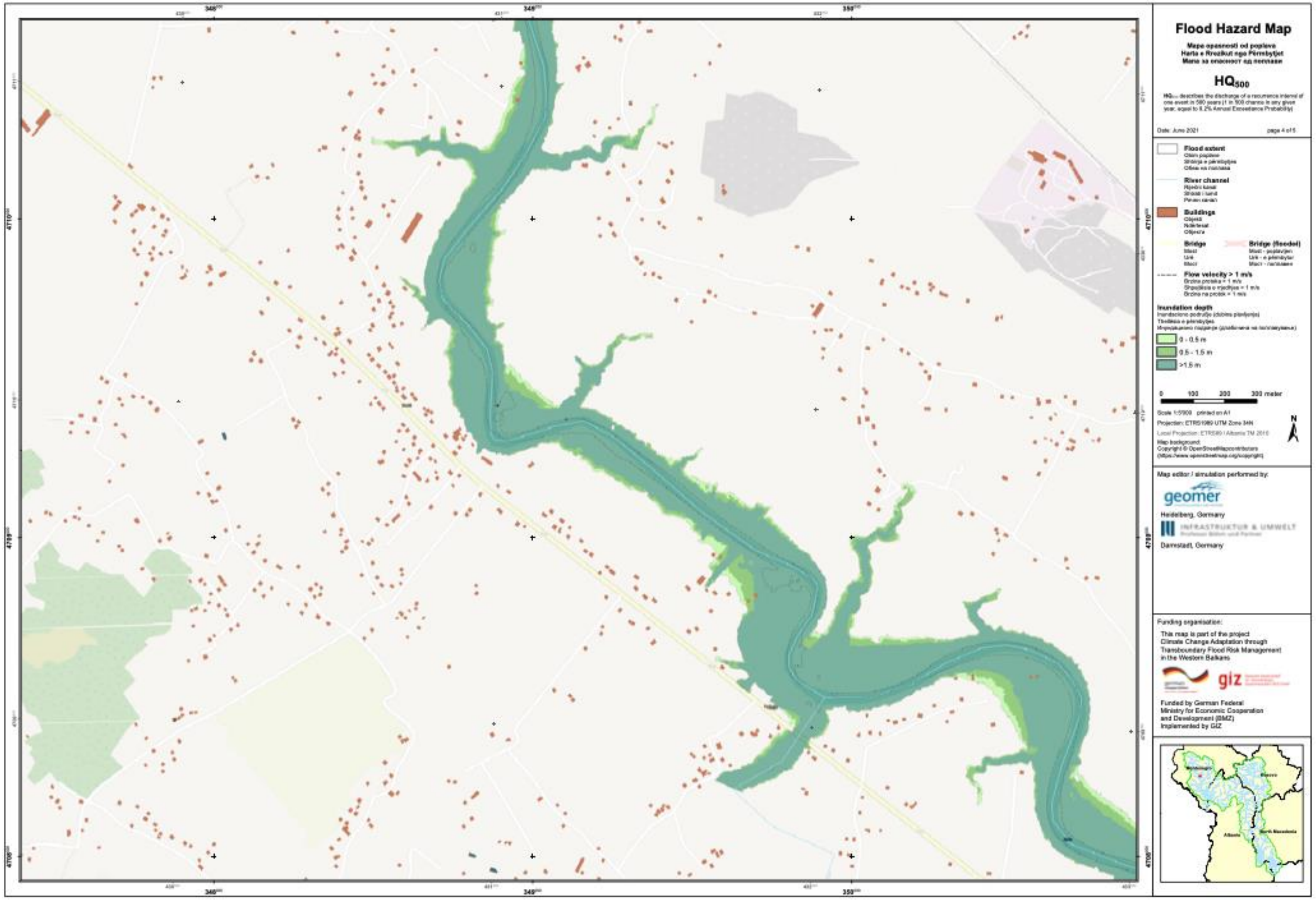


Figure 6.19. Flood Risk (HQ500) for APSFR21_ARB_Zeta02 (Section 4)

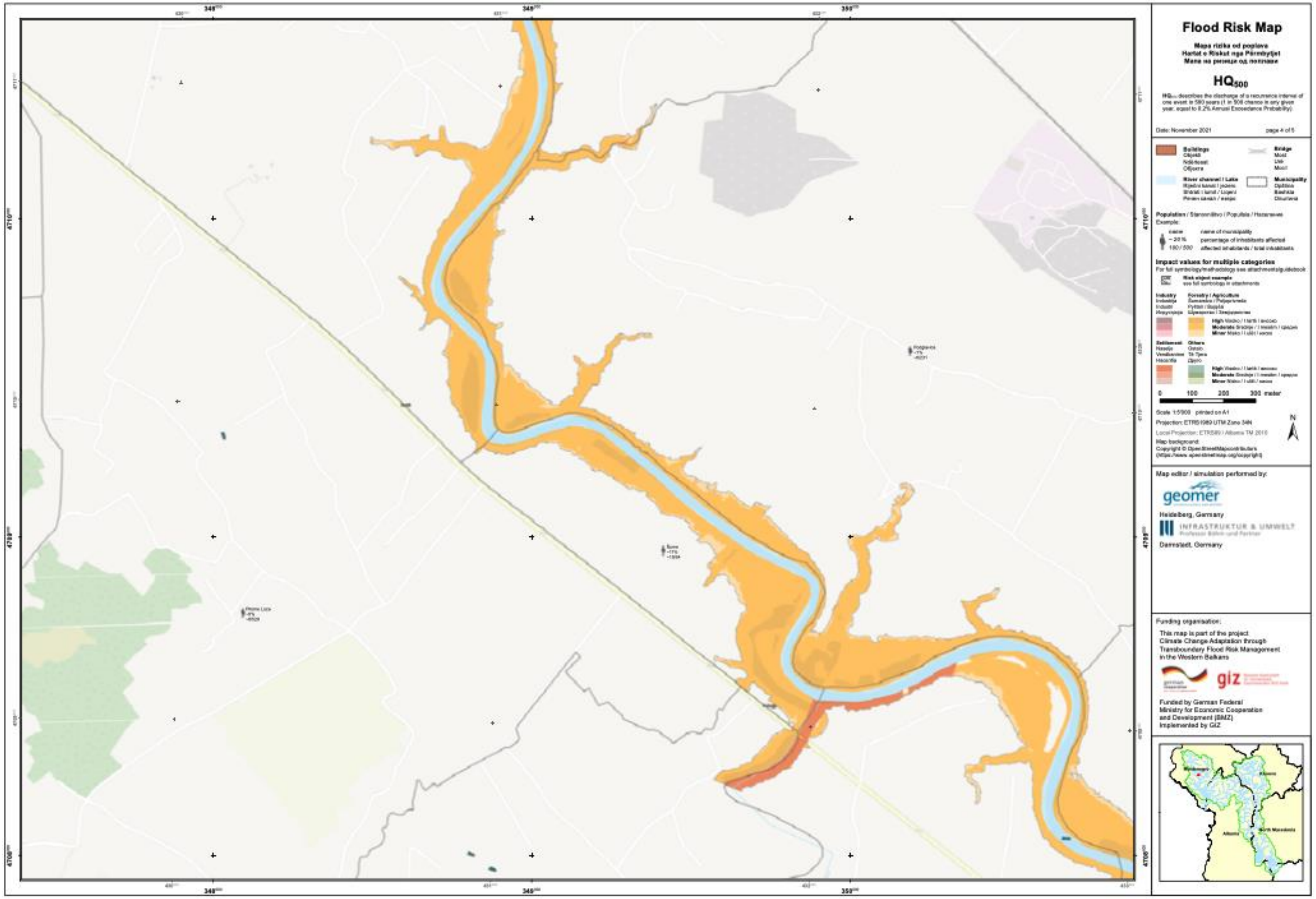


Figure 6.20. Flood Extent for APSFR21_ARB_Zeta02 (Section 5)

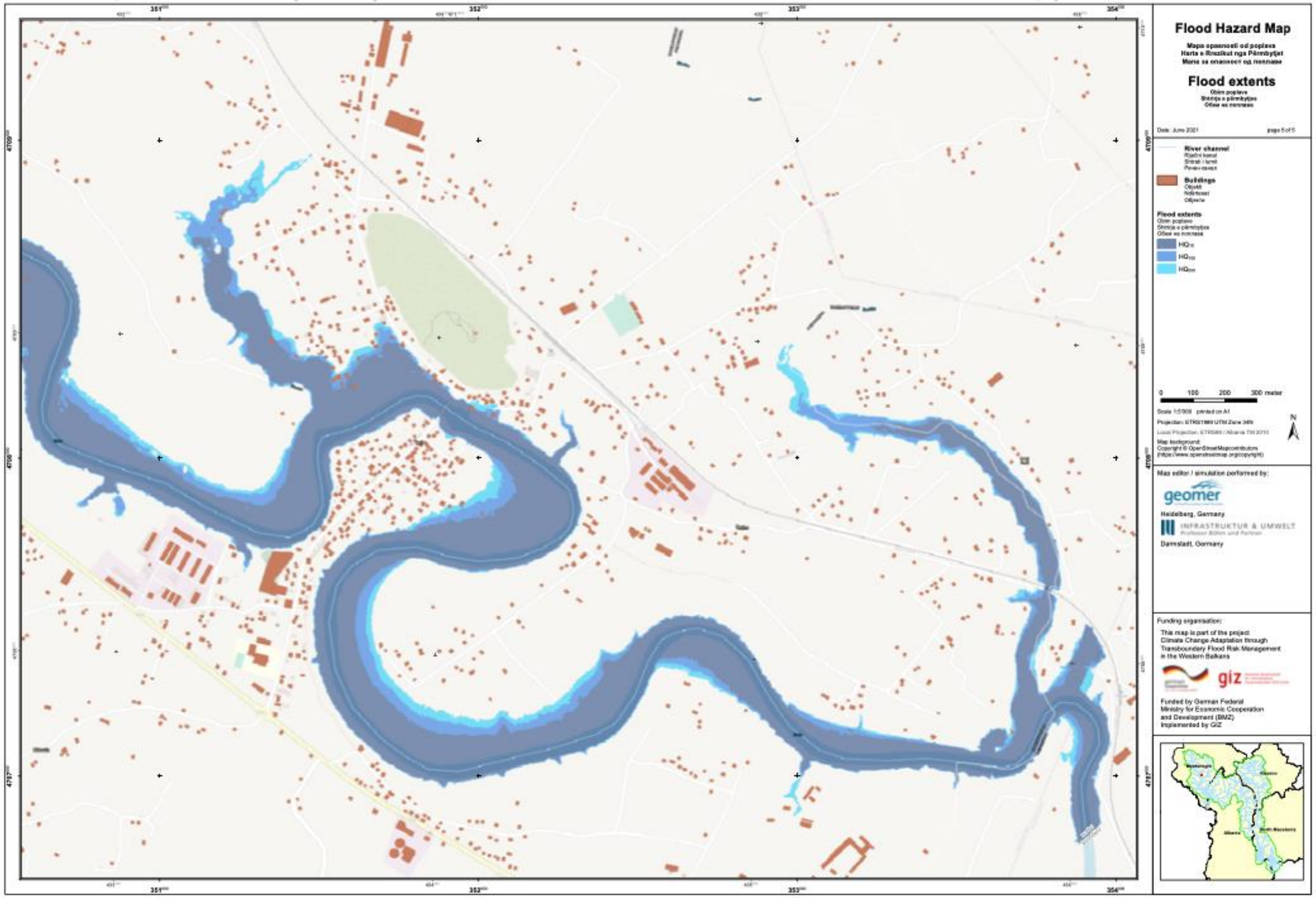


Figure 6.21. Inundation Depth (HQ500) for APSFR21_ARB_Zeta02 (Section 5)

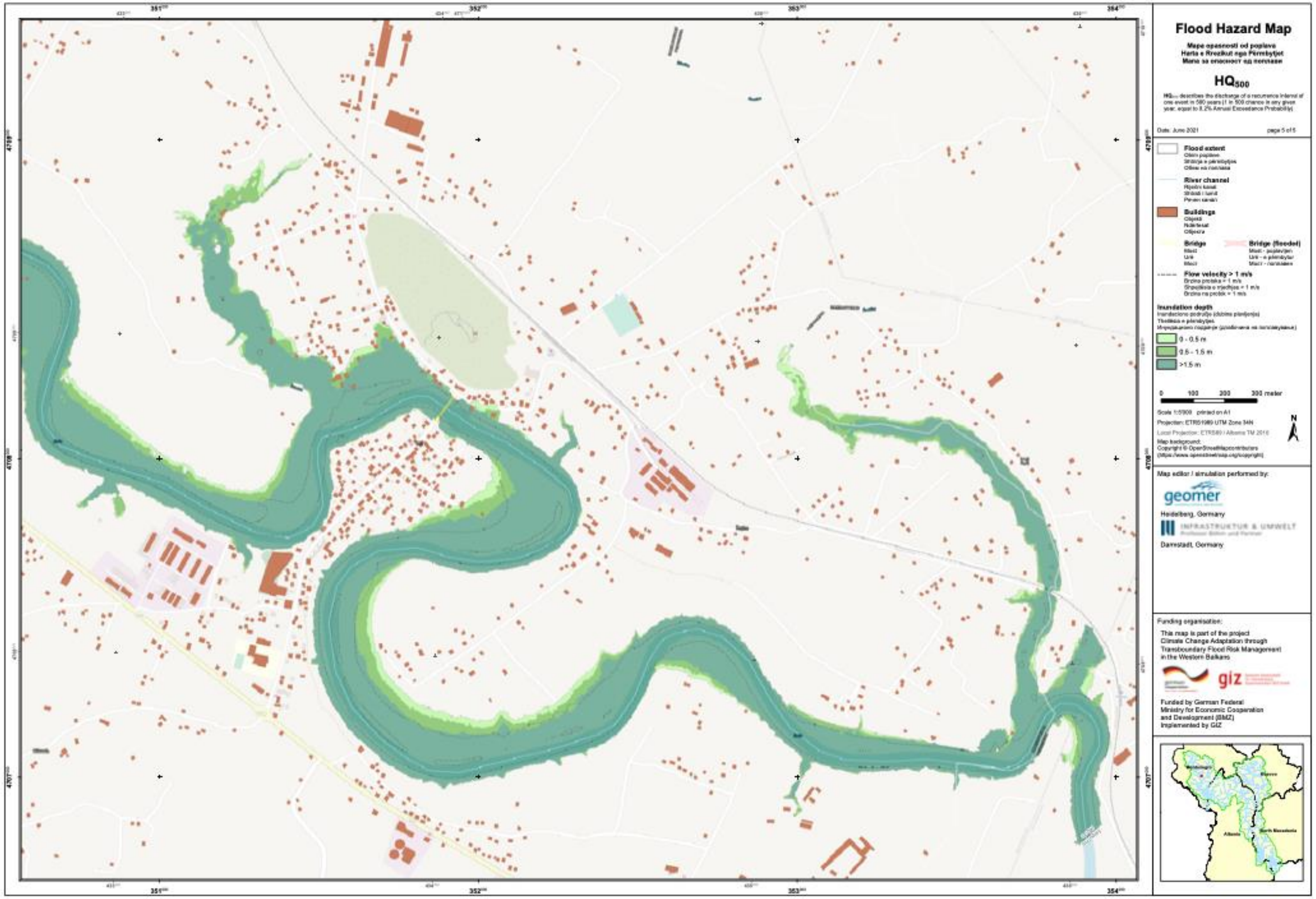
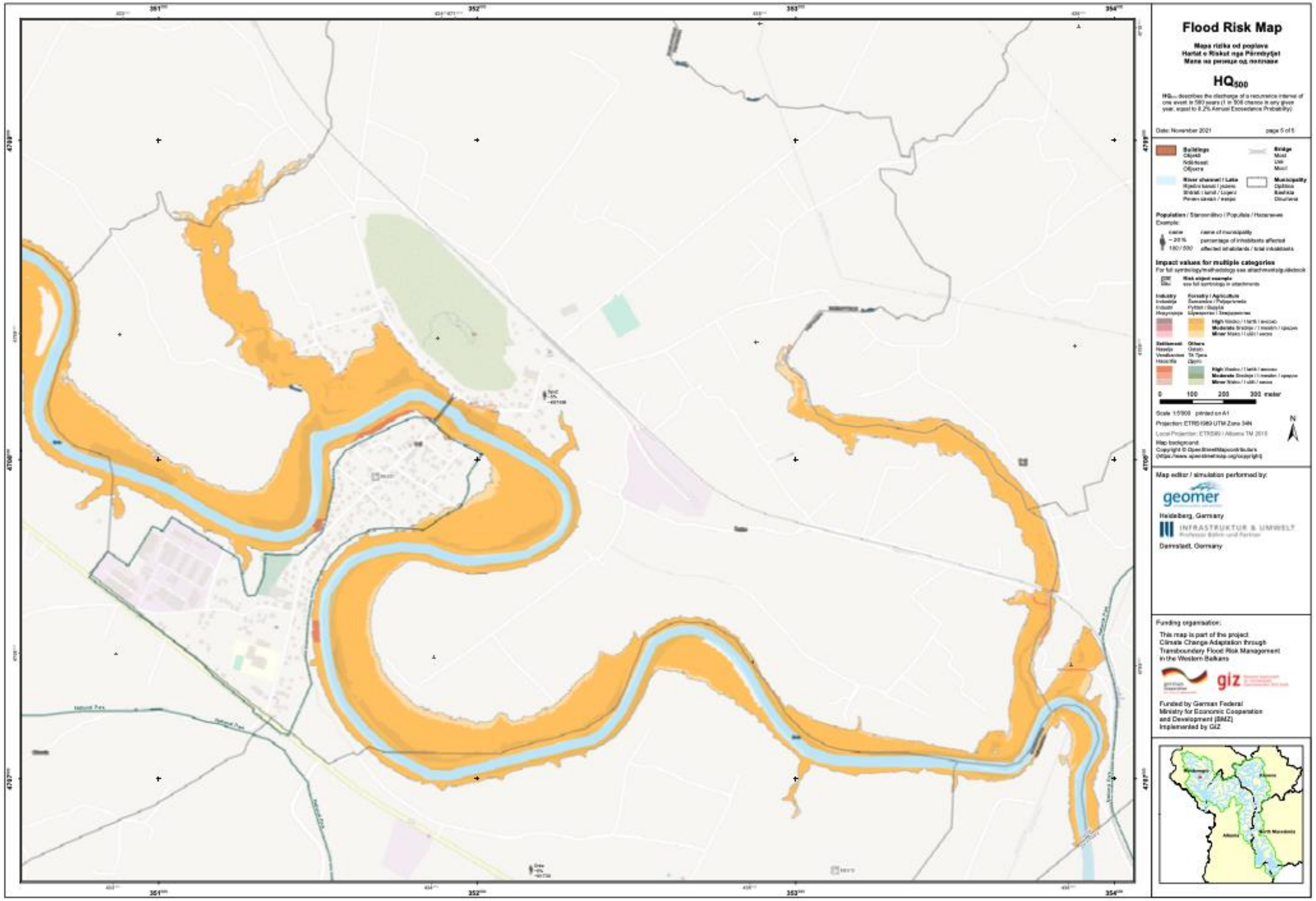


Figure 6.22. Flood Risk (HQ500) for APSFR21_ARB_Zeta02 (Section 5)



6.5 APSFR22_ARB_Cetinje field

The APSFR for the Cetinje field is distinguished as follows:

Catchment area: Groundwater

Flood Hazard	
Flood Source	Pluvial (A12), Groundwater (A13).
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).
Type of Areas Affected	Urban > Industrial > Agricultural
Affected regions	Municipality of Cetinje
Towns/Settlements	Cetinje

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). 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).

The risk area has been assessed based on local knowledge and local experiences to determine where the groundwater potentially causes problems. Thus this area should be determined as APSFR to be further investigated.

Table 6.7. Flood hazard maps and flood risk maps prepared for APSFR22_ARB_Cetinje field

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 6.23 to 6.25 below provide examples of the flood hazard and flood risk maps for APSFR22_ARB_Cetinje field, which includes the combined flood extent at HQ10, HQ100 and HQ500 is shown in Figure 6.23 together with inundations based on the HQ500 (Figure 6.24). The flood risk map for HQ500 is shown in Figure 6.25.

Figure 6.23. Flood Extent for APSFR22_ARB_Cetinje field

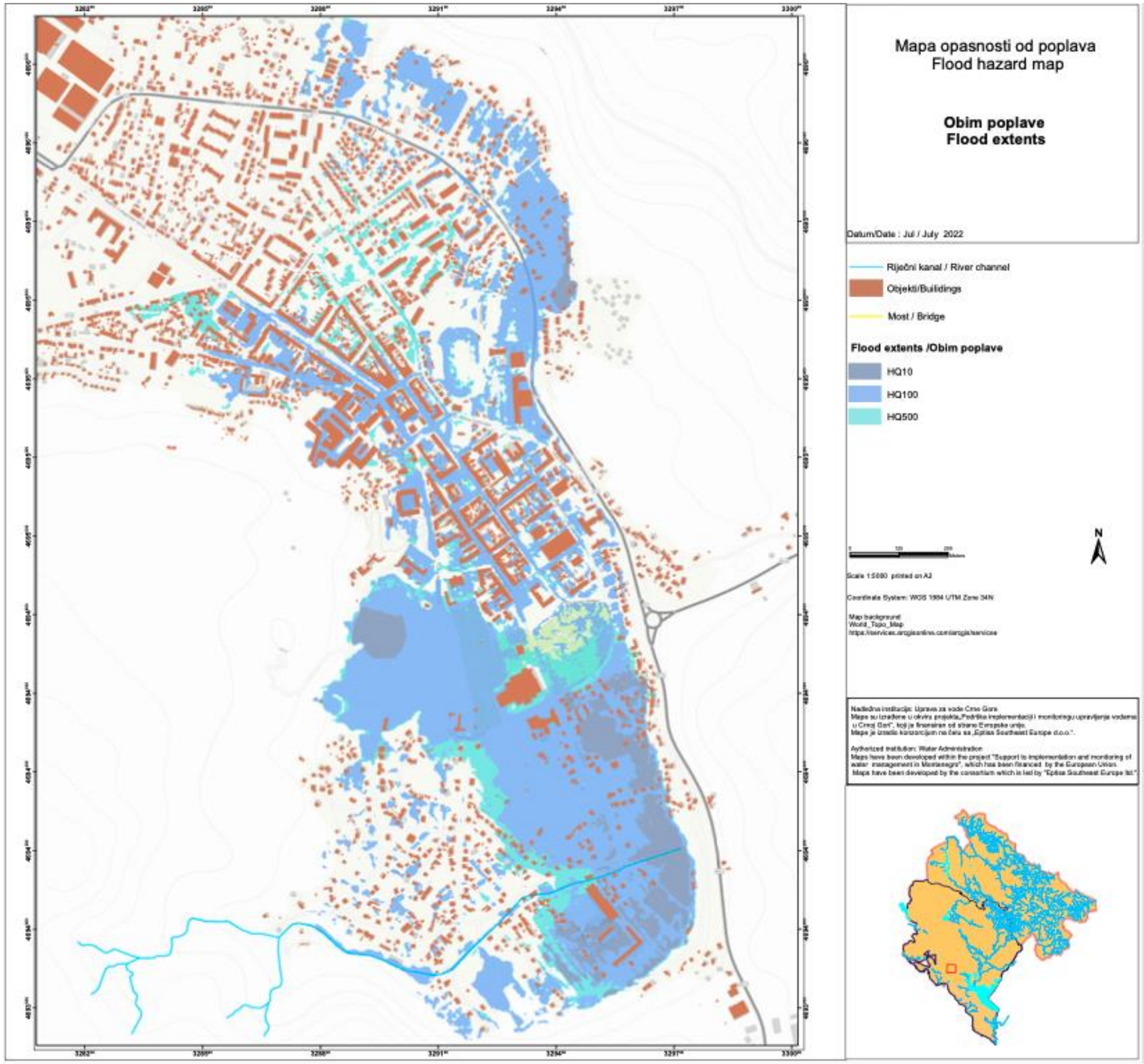


Figure 6.24. Inundation Depth (HQ500) for APSFR22_ARB_Cetinje field

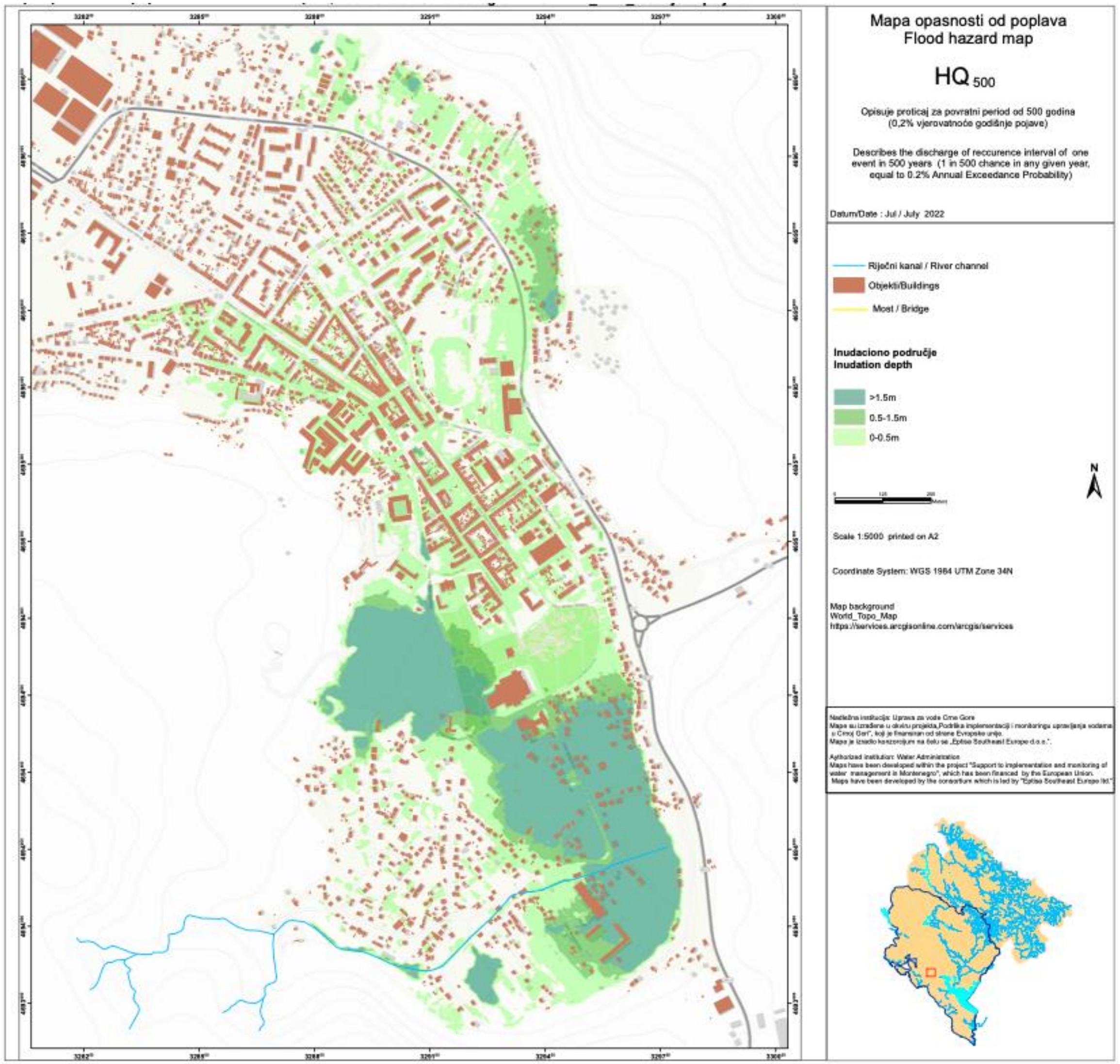
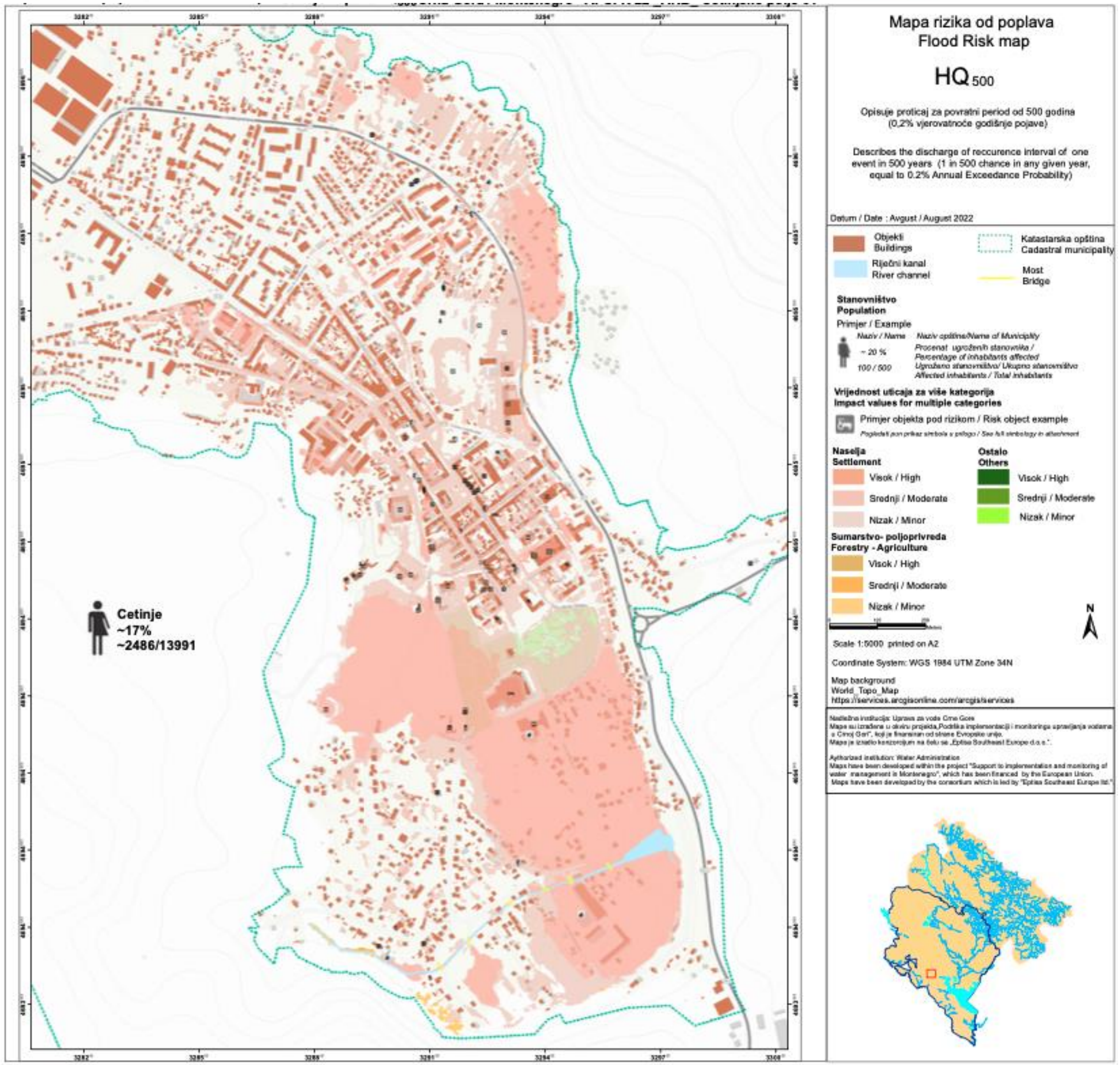


Figure 6.25. Flood Risk (HQ500) for APSFR22_ARB_Cetinje field


Cetinje
~17%
~2486/13991
Mapa rizika od poplava
Flood Risk map
HQ 500
Opisuje proticaj za povratni period od 500 godina (0,2% vjerovatnoće godišnje pojave)
Describes the discharge of reccurence interval of one event in 500 years (1 in 500 chance in any given year, equal to 0.2% Annual Exceedance Probability)
Datum / Date : Avgust / August 2022
Objekti Buildings
Katastarska opština Cadastral municipality
Riječni kanal River channel
Most Bridge
Stanovništvo Population
Primjer / Example
Naziv / Name
Naziv opštine/Name of Municipality
~ 20 %
Procenat ugroženih stanovnika / Percentage of inhabitants affected
100 / 500
Ugroženo stanovništvo/ Ukupno stanovništvo Affected inhabitants / Total inhabitants
Vrijednost uticaja za više kategorija
Impact values for multiple categories
Primjer objekta pod rizikom / Risk object example
Naselja Settlement
Visok / High
Srednji / Moderate
Nizak / Minor
Ostalo Others
Visok / High
Srednji / Moderate
Nizak / Minor
Sumarstvo- poljoprivreda Forestry - Agriculture
Visok / High
Srednji / Moderate
Nizak / Minor
N
Scale 1:5000 printed on A2
Coordinate System: WGS 1984 UTM Zone 34N
Map background
World_Topo_Map
https://services.arcgisonline.com/arcgis/services

6.6 APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_ Skadar Lake02

Data provided by GIZ for the northern shore and the west area of Skadar Lake is distinguished as an individual APSFR. However, based the analysis carried out in the PFRA[50], the northern shore and the west area of Skadar Lake were proposed as two individual areas primarily based on the influence of the input of rivers. These include i) the region influenced by Morača together with the northern shore of Skadar lake (APSFR23_ARB_ Morača and Skadar Lake01), and ii) the west region of Skadar Lake, which is affected by the Rijeka Crnojević (APSFR24_ARB_ Skadar Lake02).

APSFR23_ARB_Morača and Skadar Lake01

The APSFR has been defined by the historical floods. Floods in the municipalities of Golubovci and Tuzi are mostly endangered by large areas of land along the periphery of the Skadar Lake and in the lower flow zone of the Morača River. The flood zone is part of the National Park "Skadar Lake".

The APSFR23_ARB_Morača and Skadar Lake01 is distinguished as follows:

Catchment area: Morača and Skadar Lake; **River Tributary**: Morača

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).
Type of Areas Affected	Urban > Industrial > Agricultural
Affected regions	Municipality of Podgorica
Towns/Settlements	Gostilj, Kurilo, Ponari, Podhum, Tuzi, Bistrice, Kurilo, Bijelo Polje, Berislavci, Balabani, Zabljak

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	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 (B22).
Cultural Heritage	N/A
Economic Activity	Property: Adverse consequences to property, which could include homes (B41).

[50] Preliminary Flood Risk Assessment prepared in June 2021 and approved by Governmental Decision in December 2021.

	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).

APSFR24_ARB_ Skadar Lake02

The APSFR was defined by the historical floods. Major damage was on orchards and vineyards, boats and fishing material and a part of livestock and food for livestock also disappeared. Infrastructure facilities were endangered by the Old Bridge on Rijeka Crnojević and three bridges on the road of Rijeka Crnojevića - Virpazar. Also, the pumping station of the Cetinje Water Supply in Podgora was endangered, from where Cetinje is supplied with water. The flood zone is part of the National Park "Skadar Lake".

The APSFR for the West of Skadar Lake is distinguished as follows:

Catchment area: Skadar Lake; **River Tributary**: Rijeka Crnojević

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).
Type of Areas Affected	Mineral extraction and dump sites > Agricultural
Affected regions	Municipalities of Cetinje, Bar and Podgorica.
Towns/Settlements	Boljevici, Dodosi, Dupilo, Karuc, Krnjice, Prevlaka, Rijeka Crnojevica, Rogame Bobija, Virpazar, Zabljak Crnojevica.

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	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 (B22).
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 6.8 below and are available for download (via Google Drive).

Table 6.8. Flood hazard maps and flood risk maps prepared for APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02[51]

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

Figures 6.26 to 6.28 below provide examples of the flood hazard and flood risk maps for APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02, which includes the combined flood extent at HQ10, HQ100 and HQ500 is shown in Figure 6.26 together with inundations based on the HQ500 (Figure 6.27). The flood risk map for HQ500 is shown in Figure 6.28.

[51] Flood hazard and flood risk maps for APSFR25_ARB_Bojana (Section 6.7) are also included in the downloads in Table 6.8.

Figure 6.26. Flood Extent for APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02

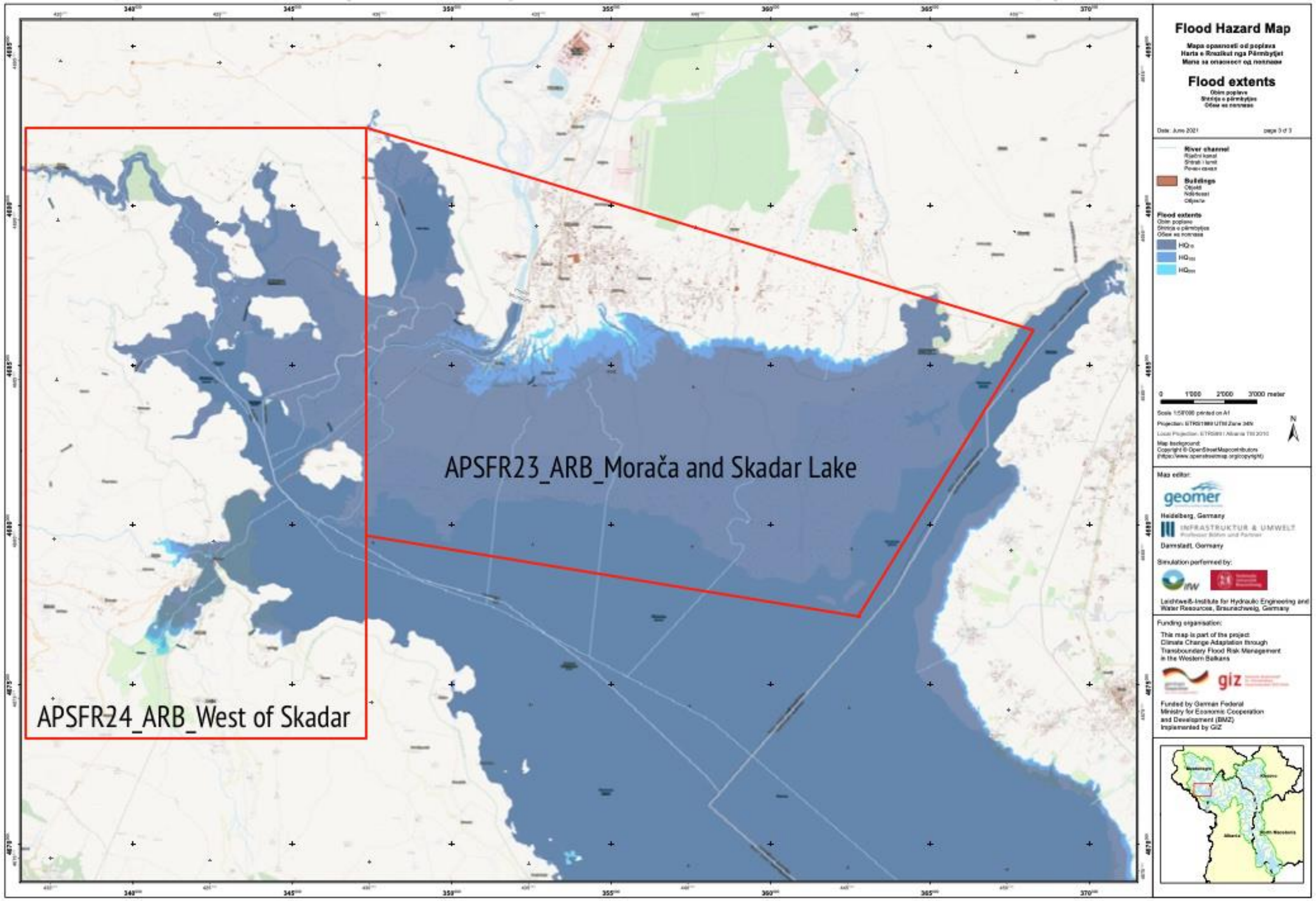


Figure 6.27. Inundation Depth (HQ500) for APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02

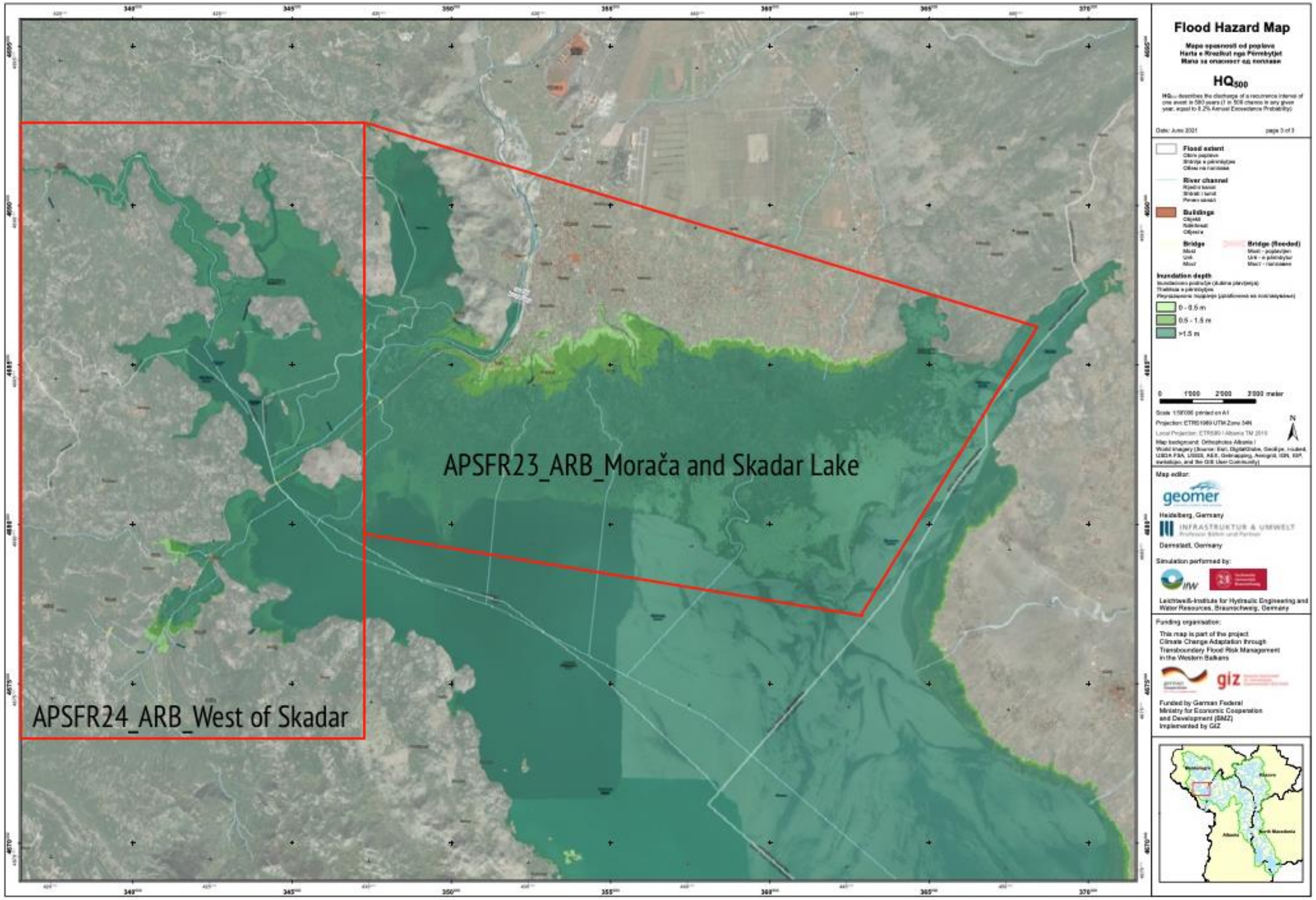
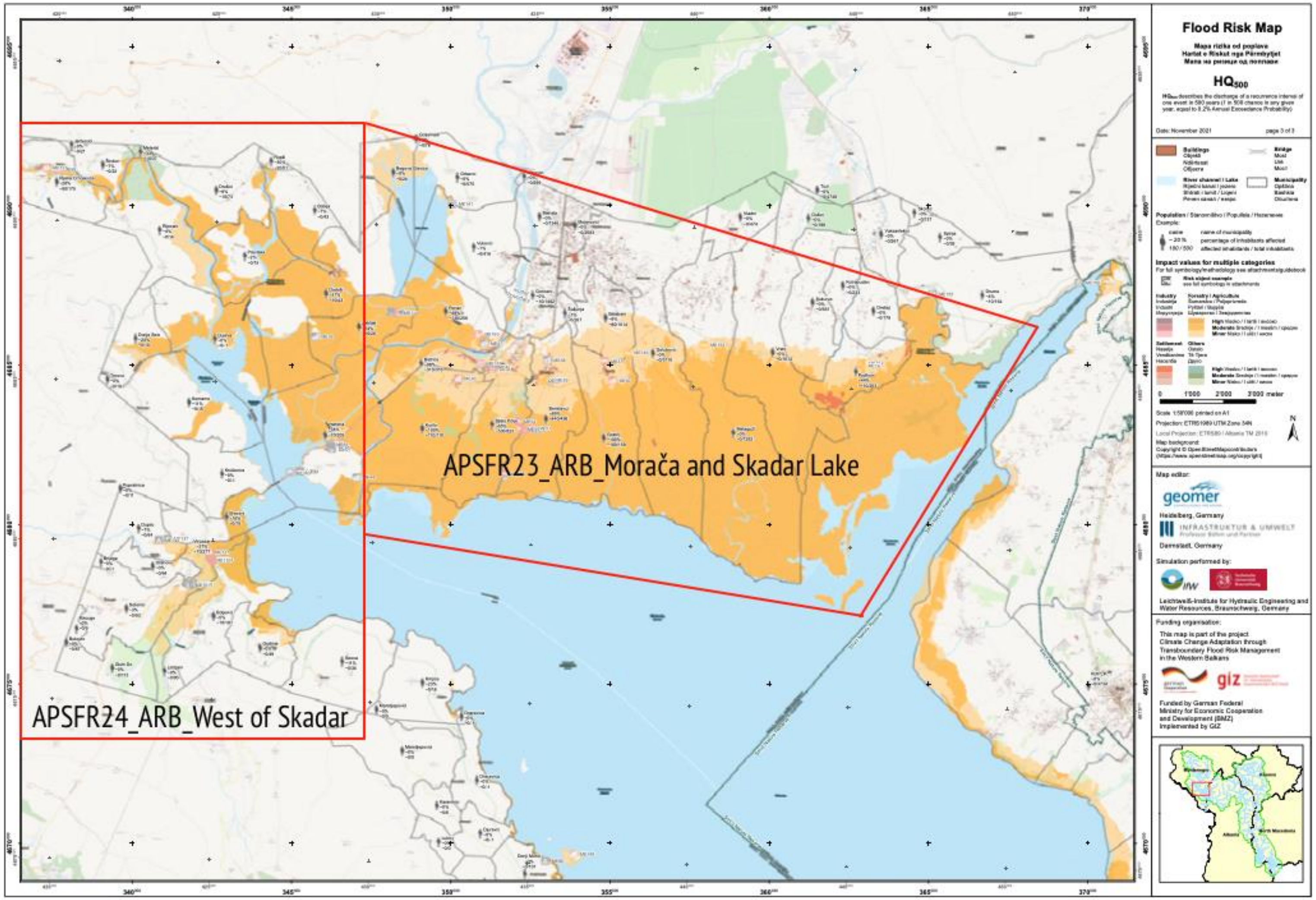


Figure 6.28. Flood Risk (HQ500) for APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02



6.7 APSFR25_ARB_Bojana01

This APSFR was defined by the historical floods. The biggest areas of land and private facilities near the river Bojana are endangered. It is primarily about ground-level houses and houses with a maximum of one to two floors, as well as large plantations of fruits and vegetables.

APSFR25_ARB_Bojana01 is distinguished as follows:
Catchment area: Skadar Lake

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). Defence Exceedance: Flooding of land due to floodwaters overtopping flood defences (A22).
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).
Type of Areas Affected	Agricultural > Urban
Affected regions	Municipality of Ulcinj.
Towns/Settlements	Fraskanjel, Gornji Štoj, Lisna Bori, Sukobin, Sveti Đorđe; Bank of the Bojana River, Ada Bojana

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	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 (B22).
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 6.8 (Section 6.6) and are available for download (via Google Drive).

Figures 6.29 to 6.31 below provide examples of the flood hazard and flood risk maps for APSFR25_ARB_Bojana01, which includes the combined flood extent at HQ10, HQ100 and HQ500 is shown in Figure 6.29 together with inundations based on the HQ500 (Figure 6.30). The flood risk map for HQ500 is shown in Figure 6.31.

Figure 6.29. Flood Extent for APSFR25_ARB_Bojana01

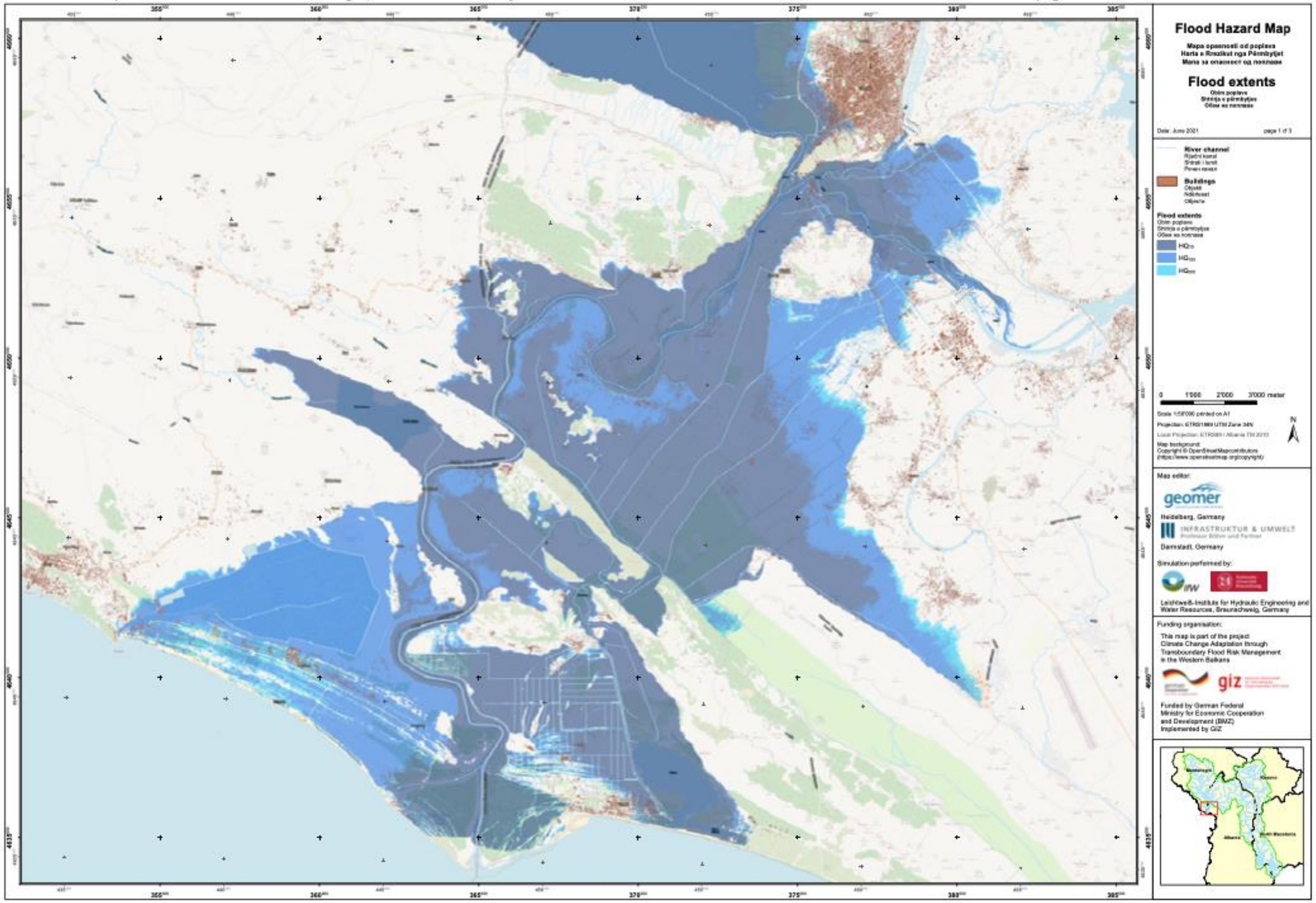


Figure 6.30. Inundation Depth (HQ500) for APSFR25_ARB_Bojana01

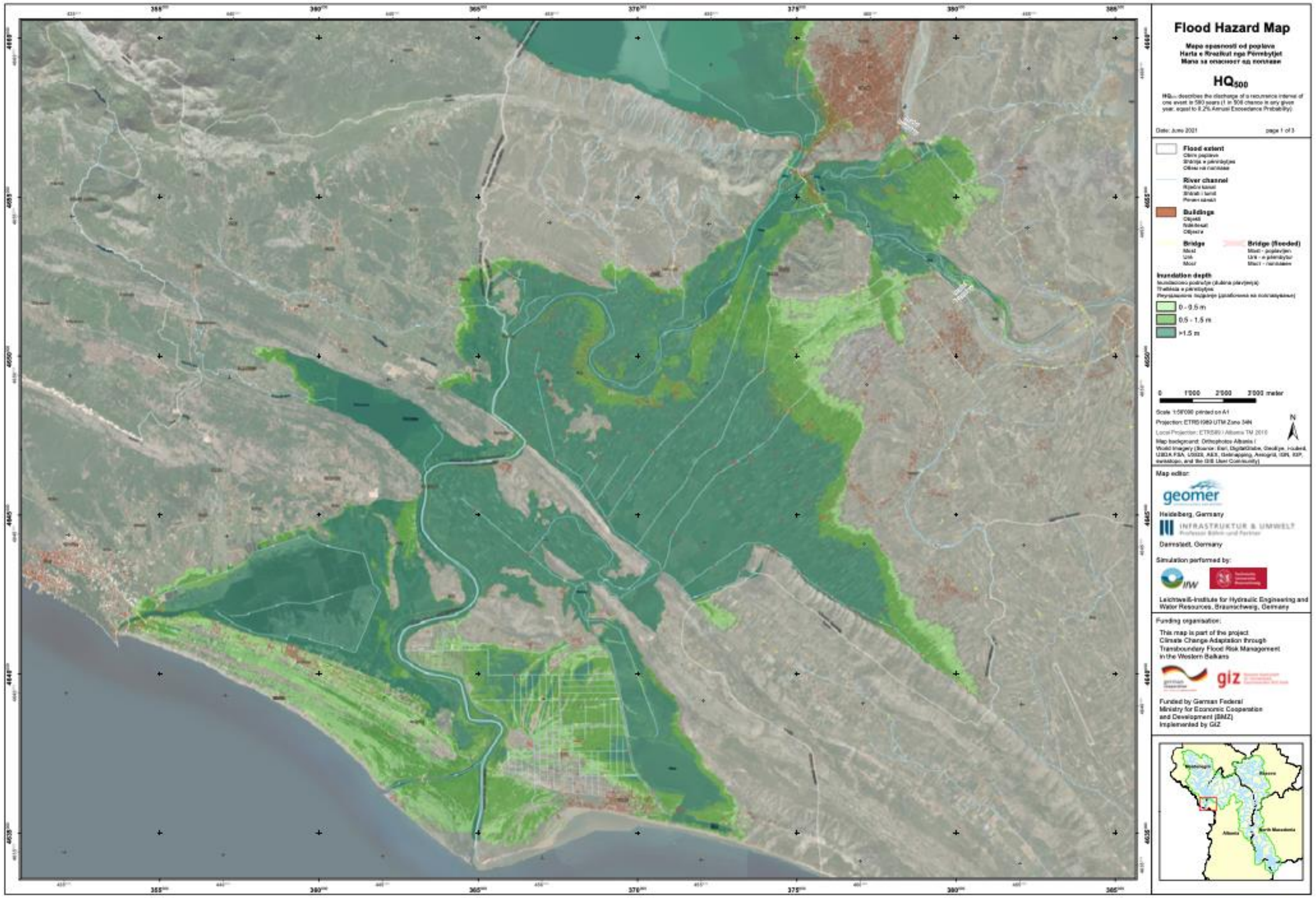
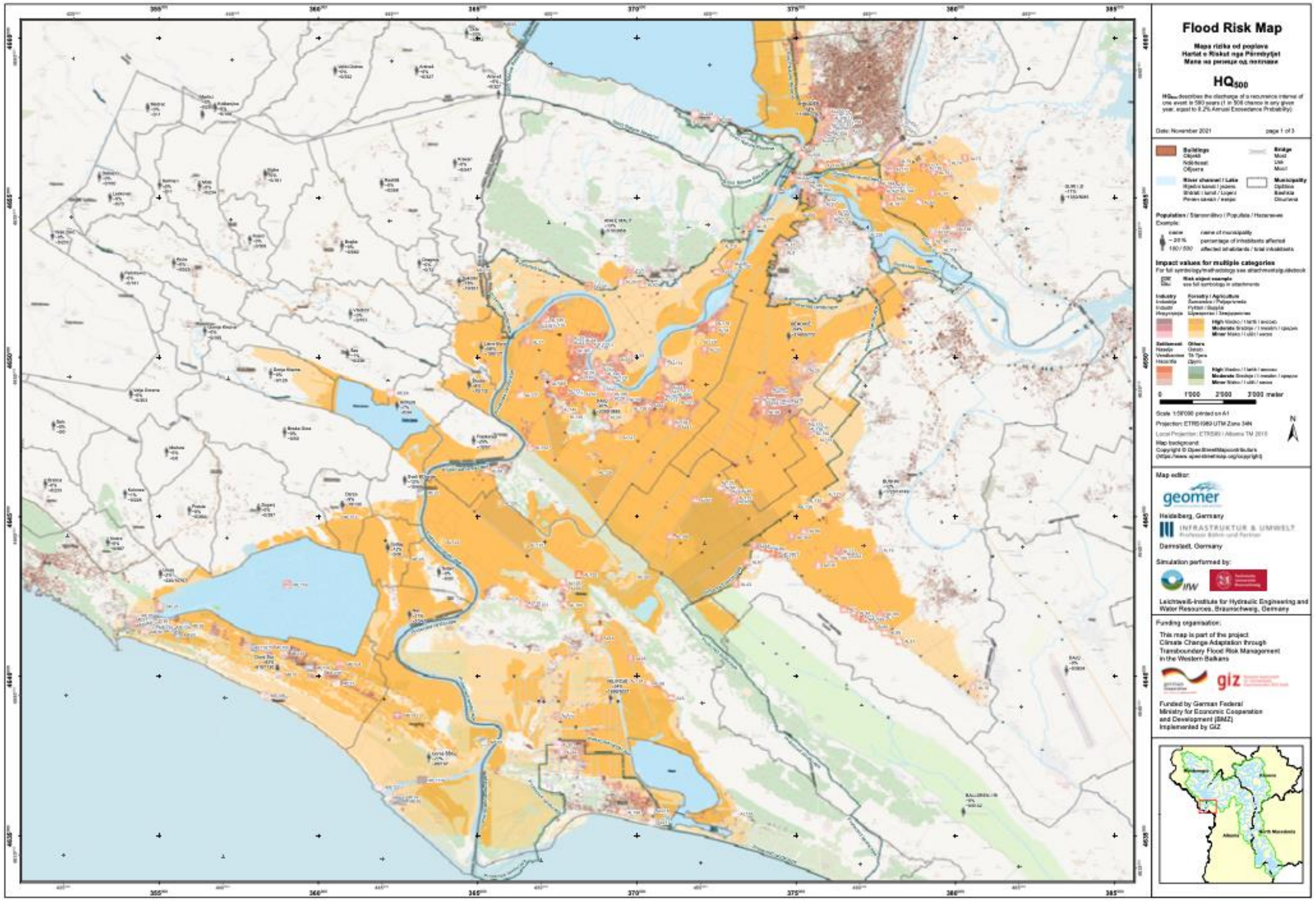


Figure 6.31. Flood Risk (HQ500) for APSFR25_ARB_Bojana01



6.8 Conclusions drawn from the maps

The flood hazard and flood risk maps detail the affected areas in 6 APSFR in the Adriatic River Basin. A description of the damage, 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 in Tables 6.9 to 6.14 for a medium risk flooding event (HQ100).

Based on the flood hazard and flood risk maps, it is calculated that in the Adriatic River Basin 5362 people are potentially endangered by a medium risk flooding event (HQ100). 1784 dwellings are also at risk.

A total of 105 industrial facilities and 1607 agricultural facilities are also endangered during a medium risk flooding event. The data for both industrial and agricultural facilities can be regarded to be an underestimate since data on both types of facilities for APSFR22 and APSFR 24 has not been recorded.

Data calculated on the number of people potentially endangered in each APSFR during high (HQ10) and low (HQ500) probability flooding events indicates the following reductions and increases, respectively:

- APSFR20_ARB_Zeta01: HQ10 (-19%); HQ500 (+10%)[52]
- APSFR21_ARB_Zeta02: HQ10 (-48%); HQ500 (+10%)
- APSFR22_ARB_Cetinje Field: HQ10 (-95%); HQ500 (+27%)
- APSFR23_ARB_ Morača and Skadar Lake01: HQ10 (-79%); HQ500 (+30%)
- APSFR24_ARB_Skadar Lake02: HQ10 (-44%); HQ500 (+4%)
- APSFR25_ARB_Bojana01: HQ10 (-83%); HQ500 (+46%)

Increased urbanization in all of the areas of the Adriatic River Basin would be expected to have a negative impact on future floods. Therefore, this information should be taken seriously in future spatial planning.

[52] Calculate only for the Northern region of the APSFR20_ARB_Zeta01.

Table 6.9. Medium flood risk in the APSFR20_ARB_Zeta01 (HQ100)[53]

No.	Sub-Basin	River/Tributary	Affected Regions / Municipalities	Affected Settlements/ Villages	Affected Area (km²)	No. of Persons At Risk	No of Dwellings At Risk	No. of Affected Industrial Facilities At Risk	No. of Affected Agricultural Facilities At Risk
1.	Zeta	Zeta	Nikšić	Kličevo, Ozrinići, Poljica, Štedim and Straševina	22	186	42	42	11

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines[54]: S - A11, A12, A13; M - A21; C - A31

Description of Potential Damage: Endangered residential settlements, roads, industrial facilities (warehouses, bakery, and craft plants) agricultural land and agricultural facilities (livestock farms).

Risk Assessment / Significance of Potential Risks[55,56]:

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 (in ha)		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		PRTR-location		Bathing waters			
Industrial area (in ha)							

Possibility for significant damage in the future[57]	Urbanization[58]: Yes	Other Reasons: No

[53] industrial and agricultural facilities reported after flooding events during November 2010 to January 2011, which represent a flood return period of HQ100.
[54] Based on guidance for reporting under the EU Floods Directive; EU 2013. Technical Report-2013-071
[55] According to threshold of significance criteria detailed in Section 5. 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).
[56] The extent of the flood stating the settlements that are endangered, which was later confirmed by maps showing the boundaries of floodplains for ten-year, hundred-year and five-hundred-year waters. It should also be noted that the runoff of flood waters is carried out over the riverbed and inundation land.
[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.

Table 6.10. Medium flood risk in the APSFR21_ARB_Zeta02 (HQ100)

No.	Sub-Basin	River/Tributary	Affected Municipalities	Affected Settlements/ Villages	Affected Area (km²)	No. of persons Affected	No of Affected Dwellings	No. of Affected Industrial Facilities	No. of Affected Agricultural Facilities
2.	Zeta	Zeta	Danilovgrad	Pažići, Glavica, Spuž, Podanje, Viško polje, Bogićevići, Livade Bandićke, Gorica, Grlic, Strahinjici, Podkraj.	6	169	43	1	18

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

Description of Potential Damage: Settlements, roads, one industrial facility and 165 ha agricultural land.

Risk Assessment / Significance of Potential Risks (see footnotes 55 and 56 above)

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 (in ha)		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		PRTR-location		Bathing waters			
Industrial area (in ha)							

Possibility for significant damage in the future	Urbanization: Yes	Other Reasons: No

Table 6.11. Medium flood risk in the APSFR22_ARB_Cetinje Field01 (HQ100)

No.	Sub-Basin	River/Tributary	Affected Municipalities	Affected Settlements/ Villages	Affected Area (km²)	No. of persons Affected	No of Affected Dwellings	No. of Affected Industrial Facilities	No. of Affected Agricultural Facilities
1.			Cetinje	Cetinjsko polje (Donje polje)	NR[59]	1,965	490	NR	NR

Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A12, A13; M - A21; C - A31	
Description of Potential Damage: Settlements, roads from groundwaters and torrential flooding events	
Risk Assessment / Significance of Potential Risks (see footnotes 55 and 56 above)	

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 (in ha)		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		PRTR-location		Bathing waters			
Industrial area (in ha)							
Possibility for significant damage in the future		**Urbanization:** Yes		**Other Reasons**: No			

[59] NR: Not recorded

Table 6.12. Medium flood risk in the APSFR23_ARB_Morača and Skadar Lake01 (HQ100)

No.	Sub-Basin	River/Tributary	Affected Municipalities	Affected Settlements/ Villages	Affected Area (km²)	No. of persons Affected	No of Affected Dwellings	No. of Affected Industrial Facilities	No. of Affected Agricultural Facilities
1.	Skadar Lake	Morača	Podgorica, Tuzi	Gostilj, Ponari, Podhum, Tuzi, Vranjina, Bistrice, Kurilo, Bijelo Polje, Berislavci	NR[60]	2083	317	30	1,367

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

Description of Potential Damage: Floods in the settlements along the periphery of the Morača and northern Skadar Lake. The flood zone is part of the National Park "Skadar Lake". Industrial facilities endangered. Large agricultural area and many agricultural facilities endangered.

Risk Assessment / Significance of Potential Risks (see footnotes 55 and 56 above)

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 (in ha)		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		PRTR-location		Bathing waters			
Industrial area (in ha)							

Possibility for significant damage in the future	Urbanization: Yes	Other Reasons: No

[60] NR: Not recorded

Table 6.13. Medium flood risk in the APSFR24_ARB_Skadar Lake02

No.	Sub-Basin	River/Tributary	Affected Municipalities	Affected Settlements/ Villages	Affected Area (km²)	No. of persons Affected	No of Affected Dwellings	No. of Affected Industrial Facilities	No. of Affected Agricultural Facilities
1.	Skadar Lake	Orahovštica; Rijeka Crnojević	Cetinje, Bar	Boljevici, Dodoši, Dupilo, Karuč, Krnjice, Prevlaka, Rijeka Crnojevica, Virpazar, Žabljak Crnojevića	NR[61]	775	190	29	181
	Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A12, A13; M - A21; C - A31								
	Description of Damage: Major damage potential to orchards and vineyards, livestock and food for livestock, boats and fishing material. Infrastructure facilities endangered by the Old Bridge on Rijeka Crnojević and three bridges on the road of Rijeka Crnojevića - Virpazar. Also, the pumping station of the Cetinje Water Supply in Podgora is endangered, from where Cetinje is supplied with water.								
	Risk Assessment / Significance of Potential Risks (see footnotes 55 and 56 above)								

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 (in ha)		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		PRTR-location		Bathing waters			
Industrial area (in ha)							

Possibility for significant damage in the future	Urbanization: Yes	Other Reasons: No

[61] NR: Not recorded

Table 6.14. Medium flood risk in the APSFR25_ARB_Bojana01

No.	Sub-Basin	River/Tributary	Affected Municipalities	Affected Settlements/ Villages/ Areas	Affected Area (km²)	No. of persons Affected	No of Affected Dwellings	No. of Affected Industrial Facilities	No. of Affected Agricultural Facilities
1.	Bojana	Bojana	Ulcinj	Fraskanjel, Gornji Štoj, Lisna Bori, Sveti Đorđe, Sukobin; Bank of the Bojana River, Ada Bojana	NR	184	36 housing unitis and 666 weekend houses	3	30
	Source (S), Mechanism (M) and Characterization (C) of flood according to EU guidelines: S - A11, A12; M - A21, A22; C - A31								
	Description of Damage: The biggest areas of land and private facilities near the river Bojana are endangered. It is primarily about ground-level houses and houses with a maximum of one to two floors, as well as large plantations of fruits and vegetables. At the mouth of the Bojana river, there is a huge complex with 390 facilities (fishing houses, cottages, and restaurants) and the famous tourist centre Ada (440 ha). Ulcinj is also endangered due to flooding from Bojana.								
	Risk Assessment / Significance of Potential Risks (see footnotes 55 and 56 above)								

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 (in ha)		Locations of substances		Drinking Water supply areas		Other cultural heritage sites	
Industrial objects		PRTR-location		Bathing waters			
Industrial area (in ha)							

Possibility for significant damage in the future	**Urbanization:** Yes	**Other Reasons**: No

7 OBJECTIVES OF THE FLOOD RISK MANAGEMENT IN THE ADRIATIC RIVER

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 Adriatic 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 local levels. Areas of Potential Significant Flood Risk

(APSFR) identified during the Preliminary Flood Risk assessment should be 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 Adriatic 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

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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 Adriatic River basin should be coordinated between responsible authorities in the country, but also bilaterally with Albania 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 Adriatic 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.

7.6 Implementing the solidarity principle

The Memorandum of Understanding signed by respective countries - Montenegro, Albania, Kosovo and North-Macedonia, in November 2011 under the Drin Dialogue Process, has set goals for climate change risk reduction, especially the co-operation on flood prevention. The "Integrated Climate-Resilient Transboundary Flood Risk Management in the Drin River Basin in the Western Balkans" Project (Drin FRM Project) was signed by UNDP on 22 October 2019. The aim of this project is to improve the transboundary cooperation in the field of flood protection and flood risk management.

Under the international cooperation, it is recommended to introduce the solidarity and the no-harm principle. To implement the solidarity principle in the event of an emergency flood defence, the affected Party or Parties may seek assistance from other Parties under the international agreement, stating the extent and type of assistance they need. Parties from which the assistance is sought are required to consider such a request in the shortest possible time, and the requesting Party should be informed of the possibilities for providing the requested assistance, as well as its scope and conditions.

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[62], 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-M52).

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.)

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

Aspect of flood risk management	Type	Measure Group	Description
Protection	M31	Natural flood management / runoff and catchment management	Measures to reduce the flow into natural or artificial drainage systems, such as overland flow interceptors 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 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

Aspect of flood risk management	Type	Measure Group	Description
			assistance, disaster unemployment assistance; Temporary or permanent relocation; Other
	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 Adriatic 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:

- the Preliminary Flood Risk Assessment;
- the conclusions that can be drawn from the Flood Hazard Maps and Flood Risk Maps;
- the environmental objectives of the Water Framework Directive;
- the 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 APSFR20_ARB_Zeta01

The areas at risk of flooding have been identified for the northern region of the APSFR at a return period of HQ500 (Figure 8.1) and for the southern region at HQ100[63] (Figure 8.2).

The individual identified areas and proposed measures for the northern and southern APSFR are presented in Tables 8.2 and 8.3, respectively.

[63] Due the inability to determine the accurate representation of flood hazard and flood risk at HQ10 and HQ500, as previously discussed in Section 6.

Figure 8.1. Identified areas of potential flooding in APSFR20_ARB_Zeta01 northern region (HQ500)

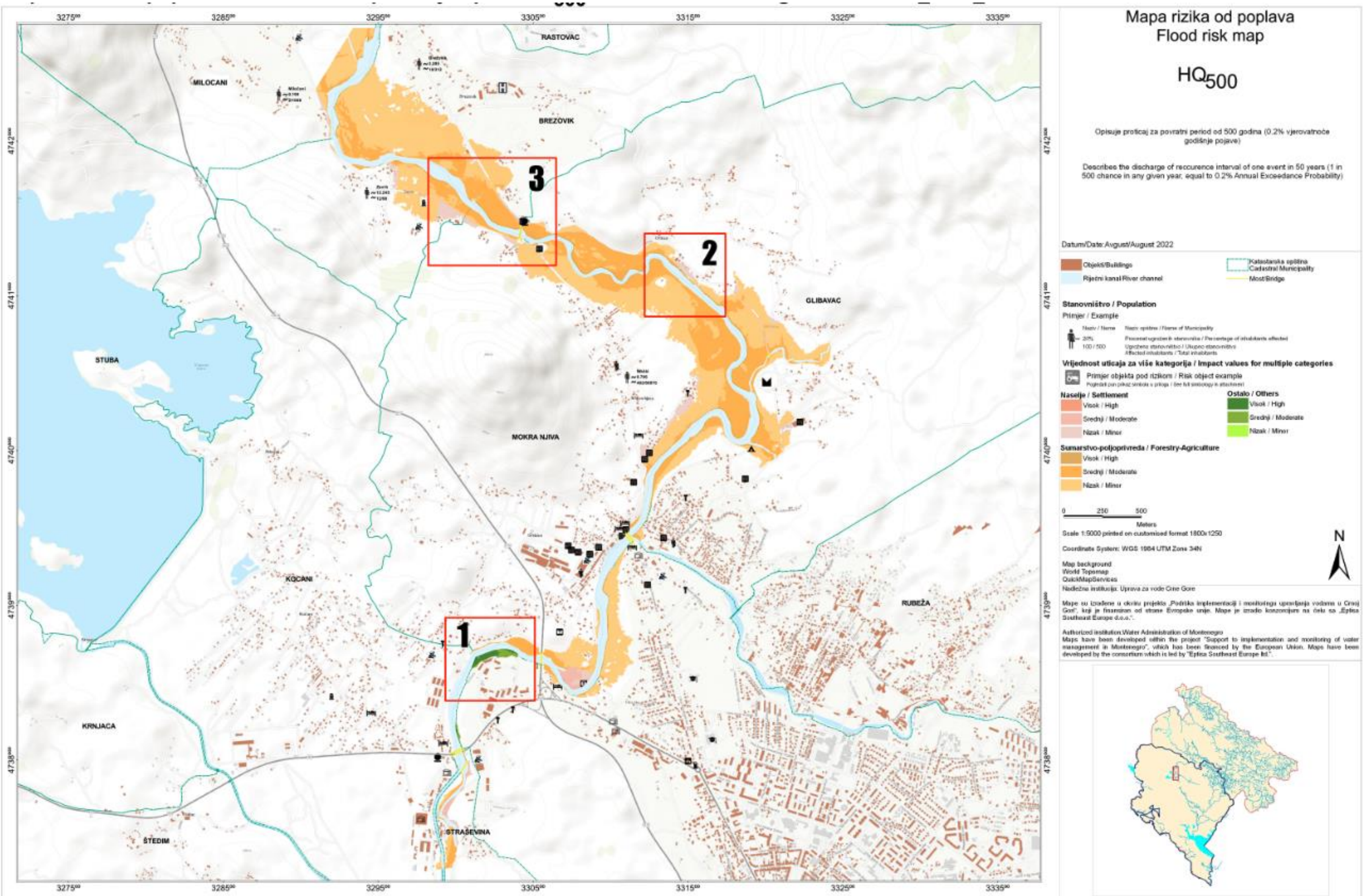

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Figure 8.2. Identified areas of potential flooding in APSFR20_ARB_Zeta01 southern region (HQ100)

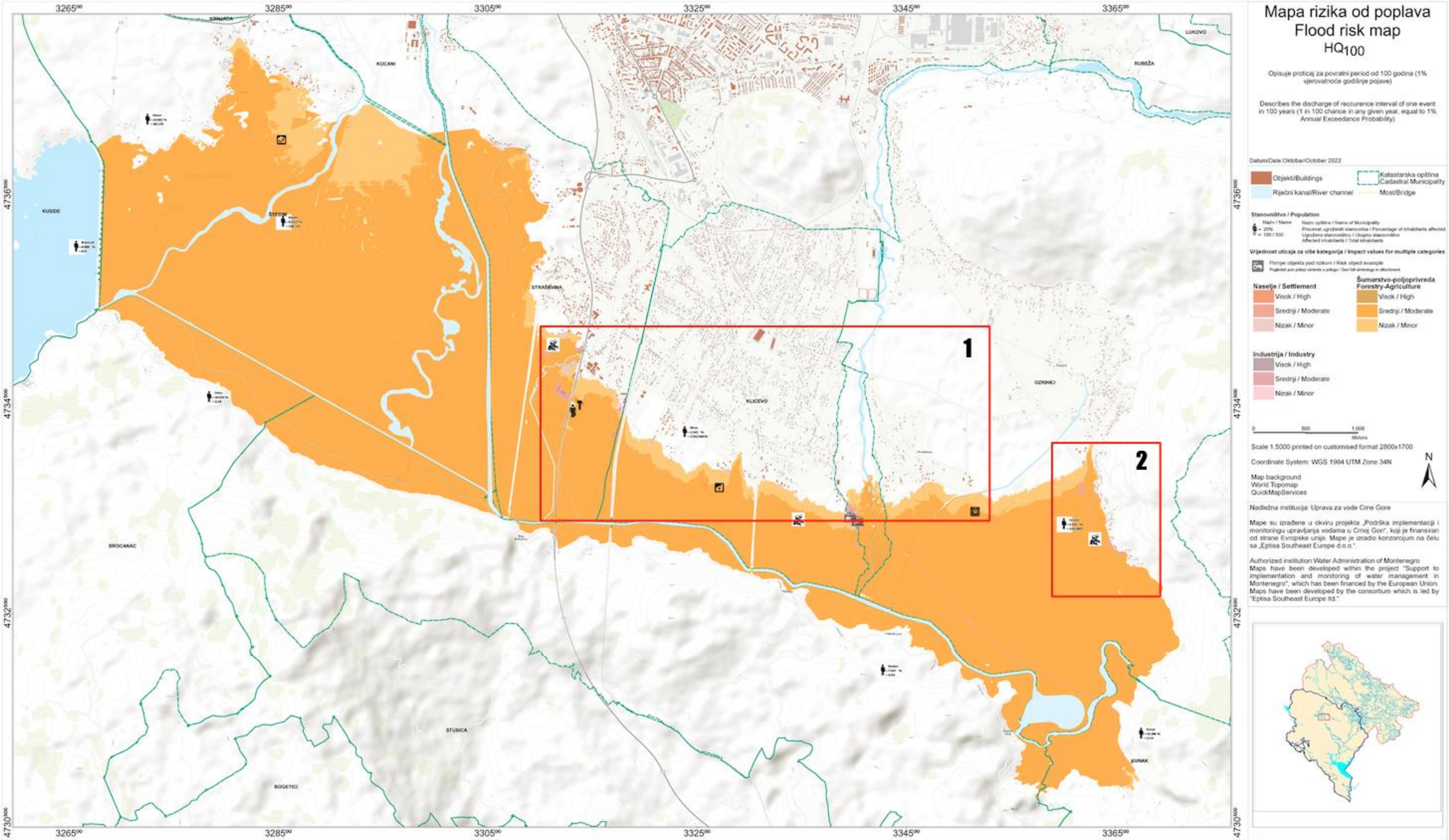
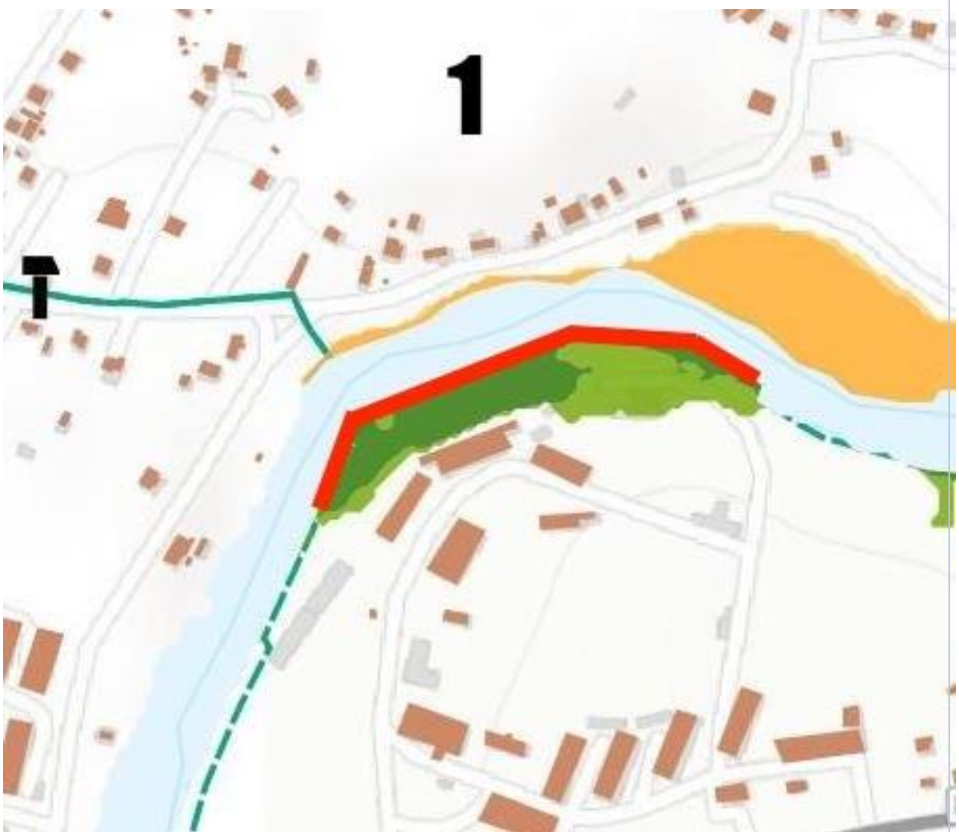
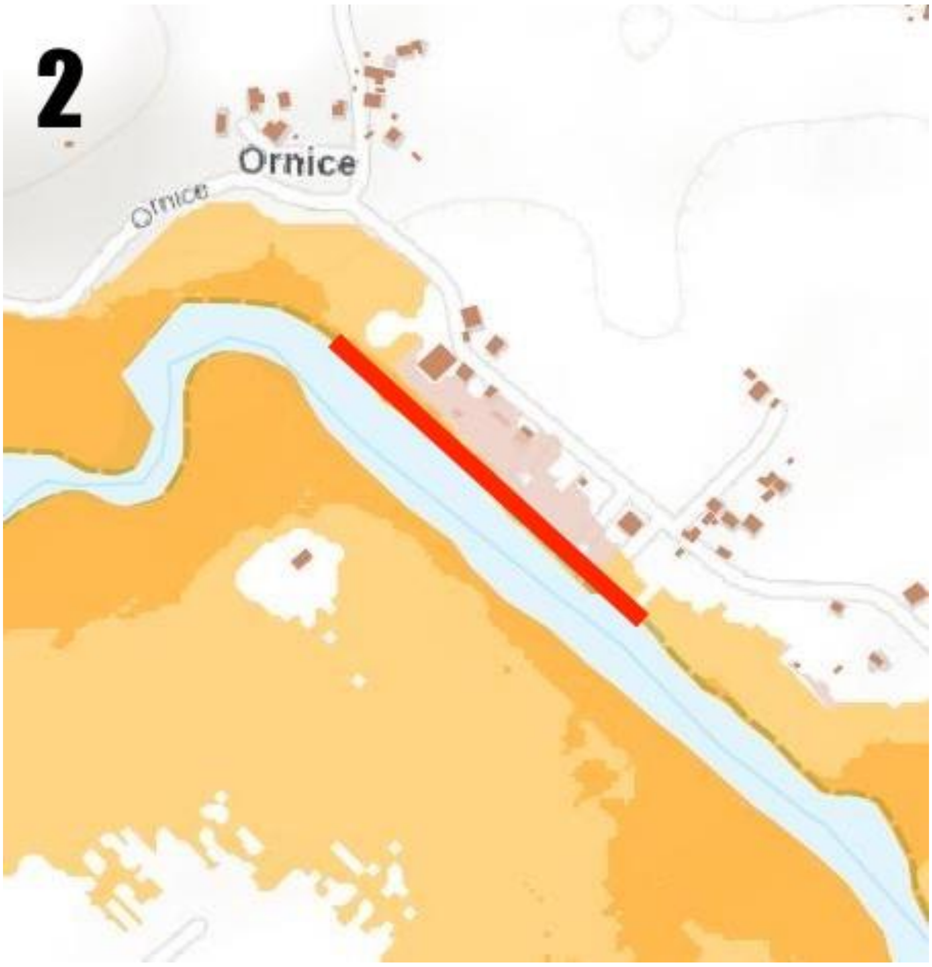
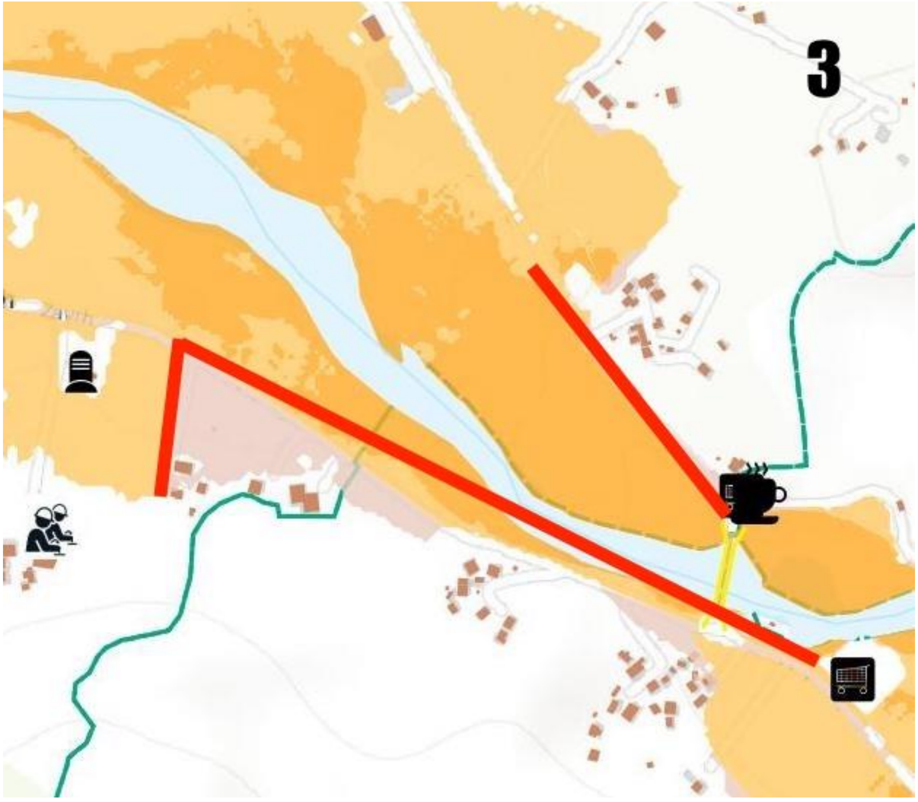


Table 8.2. Measures proposed in APSFR20_ARB_Zeta01 northern region

Municipality	Niksic		
Water body	Zeta		
Watercourse	Zeta		
Surrounding Area	City of Niksic and settlements Kočani and Mokra Njiva.		
Key Type of Measure	M21, M24, M32, M33, M41		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
Description of Damage in APSFR	Endangered residential settlements, roads, industrial facilities (warehouses, bakery, and craft plants) agricultural land and agricultural facilities (livestock farms).		
Northern Area (1)			

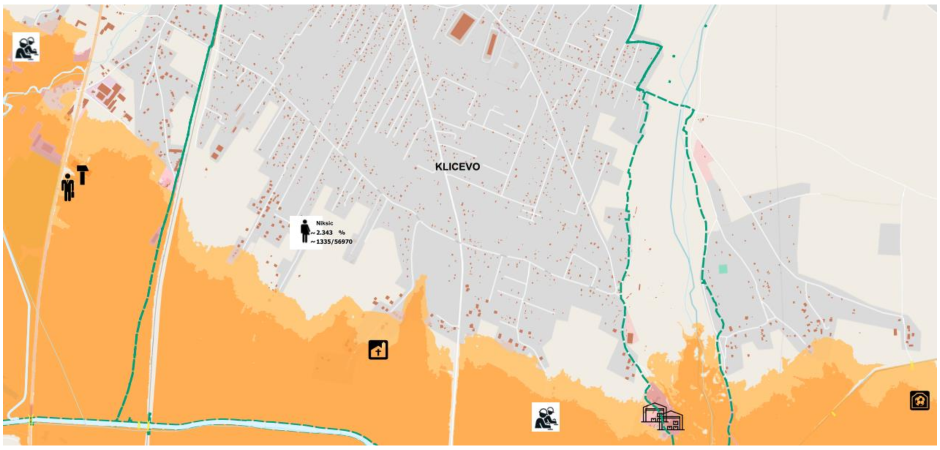
<table>
<tr><td>Proposed Measure for northern area (1)</td><td>M33: Mobile protection on the left bank of the river Zeta in a length of 400 m.

Location 1 is in the Kocani settlement on the left bank of the Zeta River. The critical section that is flooded is about 400m long. There are no residential buildings in the flooded area, but there are military facilities and barracks "13th July" in the immediate proximity. Given that this is an area of high risk of floods that can reach a height of over 1.5m, and the importance of military facilities, mobile protection is recommended for the length of 400m</td></tr>
<tr><td>Northern Area (2)</td><td>
</td></tr>
<tr><td>Proposed Measure for northern area (2)</td><td>M33: Mobile individual protection.
Location 2 is in the area called Mokre njive on the left bank of the Zeta River. The critical section that is flooded is about 300m long. 6 residential and auxiliary buildings were built on the floodplain. Given that this is an area of low risk of floods that can reach a height of up to 0.5 m, mobile individual protection of endangered buildings is recommended.</td></tr>
</table>

Northern Area (3)	
Proposed Measure for northern area (3)	**M33**: Mobile protection. Location 3 is in the settlement called **Mokre njive** on the left and right bank of the Zeta river. The local road Niksic - Brezovik is at risk. The critical section that is flooded is the bridge and the road about 250 m before and 300 m after the bridge on the Zeta River. Also, on the right bank of the Zeta River, the local road that leads from the bridge to the cemetery in Mokre Njive in the length of 600m, and two private buildings are at risk. In order to protect this area from floods with structural measures, it is considered necessary to build an embankment on both sides of the Zeta river in a length of approx. 2 km, which is an investment of around 4 million Euros. The area is at medium risk of floods that can reach a height of 0.5 m. Considering that it is an agricultural land with the local road, threatened by floods in a length of about 0.5 km, the installation of mobile metal protection is proposed as a more rational and cheaper solution.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Ministry responsible for energy sector Municipality of Niksic
Status of Implementation	No status

Investments Costs	Location 1 - €100,000.00, mobile protection, Location 2 - €20,000.00, individual mobile protection, Location 3 – €300,000.00, mobile protection.
Other Remarks	In order for these measures (M33) for mobile protections on 3 locations to be implemented it is necessary to develop plans for the use of mobile protection. The exact type of length of mobile protection, and the conditions for its installation should be defined based on geodetic survey and other relevant data. The Plan shall also include the scope of preparatory works on cleaning and setting up the corridors for the mobile protection temporary installation. Further measures: **M21** - Spatial plans shell includes information presented on the hazard and risk maps regarding the flood spatial distribution, in order to prevent the construction of any buildings and urbanization in areas that are at risk of flooding. It applies to all levels of spatial planning documents, starting from the Spatial Plan of Montenegro (currently in the drafting phase). **M24**: Water flow regulation (EPCG/MAFWM) – see Table 8.3 for further information. **M41** - Continuous improvement of the system for hydrological and meteorological observations and data transfer systems resulting in setting up the early warning system.
Priority (first / second / third)	Second

Table 8.3. Measures proposed in APSFR20_ARB_Zeta01 southern region

Municipality	Niksic		
Water body	Zeta		
Watercourse	Zeta		
Surrounding Area	City of Niksic and settlements Kličevo, Ozrinići, Straševina.		
Key Type of Measure	M21, M24, M41		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☐ Yes	☒ No
Description of Damage in APSFR	Endangered residential settlements, roads, industrial facilities, agricultural land and agricultural facilities (livestock farms).		
Southern Area (1)			
Proposed Measure for southern area (1)	**M21 – Measure to prevent the installation of new or additional receptors in areas prone to flooding** Spatial plans shell includes information presented on the hazard and risk maps regarding the flood spatial distribution, in order to prevent the construction of any buildings and urbanization in areas that are at risk of flooding. It applies to all levels of spatial planning documents, starting from the Spatial Plan of Montenegro (currently in the drafting phase). **M24 - measures to improve flood prevention**		

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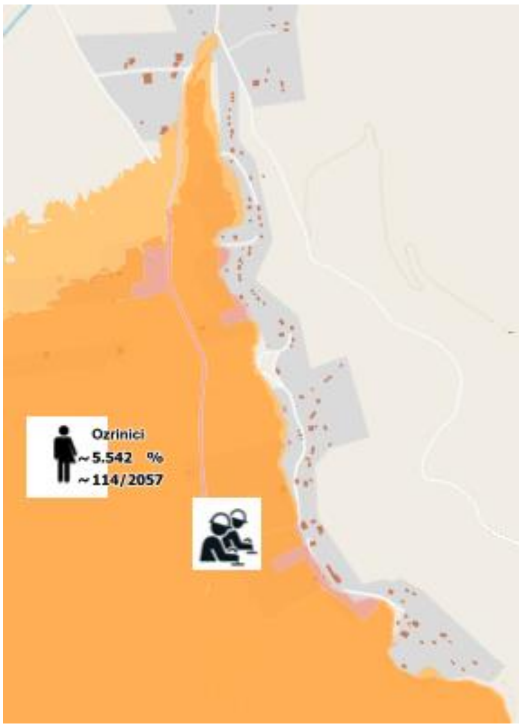
	Pursuant to Article 101, paragraph 3 of the Law on Waters (Official Gazette of RMNE, no. 27/07 and Official Gazette of MNE, no. 32/11, 48/15 and 52/16), the of Ministry of Agriculture and Rural Development has adopted the Rulebook on the Content of Operational Instructions for Retention Management Intended for Protection Against Floods (Official Gazette of Montenegro, no. 3/18 dated 19 January 2018). Article 3 of the Rulebook provides operation instructions for reservoir management which will influence the degree of potential flooding in this region. In accordance with the above-mentioned rulebook, in 2019, EPCG adopted the Operational Instruction for the management of the Piva HPP accumulation for the purpose of flood protection. This Instruction defines the "safe elevations" of reservoirs for the purpose of flood prevention, namely: - The characteristics of the valley directly behind the Krupac dam to the Vrtac retention are such that the mitigation of the flood wave is great and that the flood wave quickly dissipates into the Vrtac retention. The maximum wave height at the Vrtac dam compared to the initial state is 5m and in front of the Vrtac dam 1.9m. The width of the flooding zone ranges from 1800m to 900m. The "safe elevation" for the Krupac reservoir is any elevation lower than the elevation of the normal stoppage of the Krupac reservoir (620 masl.), with the condition that the elevation of the depression in the Vrtac retention pond is lower than the elevation of the normal depression. - Downstream from the Slano dam, i.e. in retention Vrtac, the flood wave is transmitted in a fan-like manner. The "safe level" of the Slano reservoir is any level of the water level at which a part of the volume of the Slano reservoir fills the Vrtac retention, with the condition that the maximum water level does not exceed the level of normal stoppage 615.08m above sea level. - Given that the spread of the flood wave along the Slivlje retention is limited by topographical conditions, a safe elevation in the Vrtac retention can be considered any elevation for which the Slivlje retention has elevations lower than the elevation of the maximum stoppage of water of 614.00 masl. **M41** – **Flood forecast and warnings** Continuous improvement of the system for hydrological and meteorological observations and data transfer systems resulting in setting up the early warning system.

Southern Area (2)	
Proposed Measure for Southern area (2)	As measure for southern area (1) above.
Competent Water Authority	Ministry responsible Water Management Water Administration (WA)
Other Relevant Authorities	Elektroprivreda Crne Gore, Ministry responsible for energy sector, Municipality of Nikšić
Status of Implementation	M 21 - Flood hazard maps will be an integral part of spatial planning documentation M24 - The management of reservoirs should be in accordance with the Operational instructions for the management of reservoirs and retentions of HPP Perućica HPP for flood defense. M 41 – In the implementation phase
Investments Costs	NA -.
Other remarks	
Priority (first /	First

second / third)	

8.2.2 APSFR21_ARB_Zeta02

The areas at risk of flooding have been identified for the APSFR at a return period of HQ500 (Figure 8.3).

The individual identified areas and proposed measures for the APSFR are presented in Table 8.4.

Figure 8.3. Identified areas of potential flooding in APSFR21_ARB_Zeta02 (HQ500)

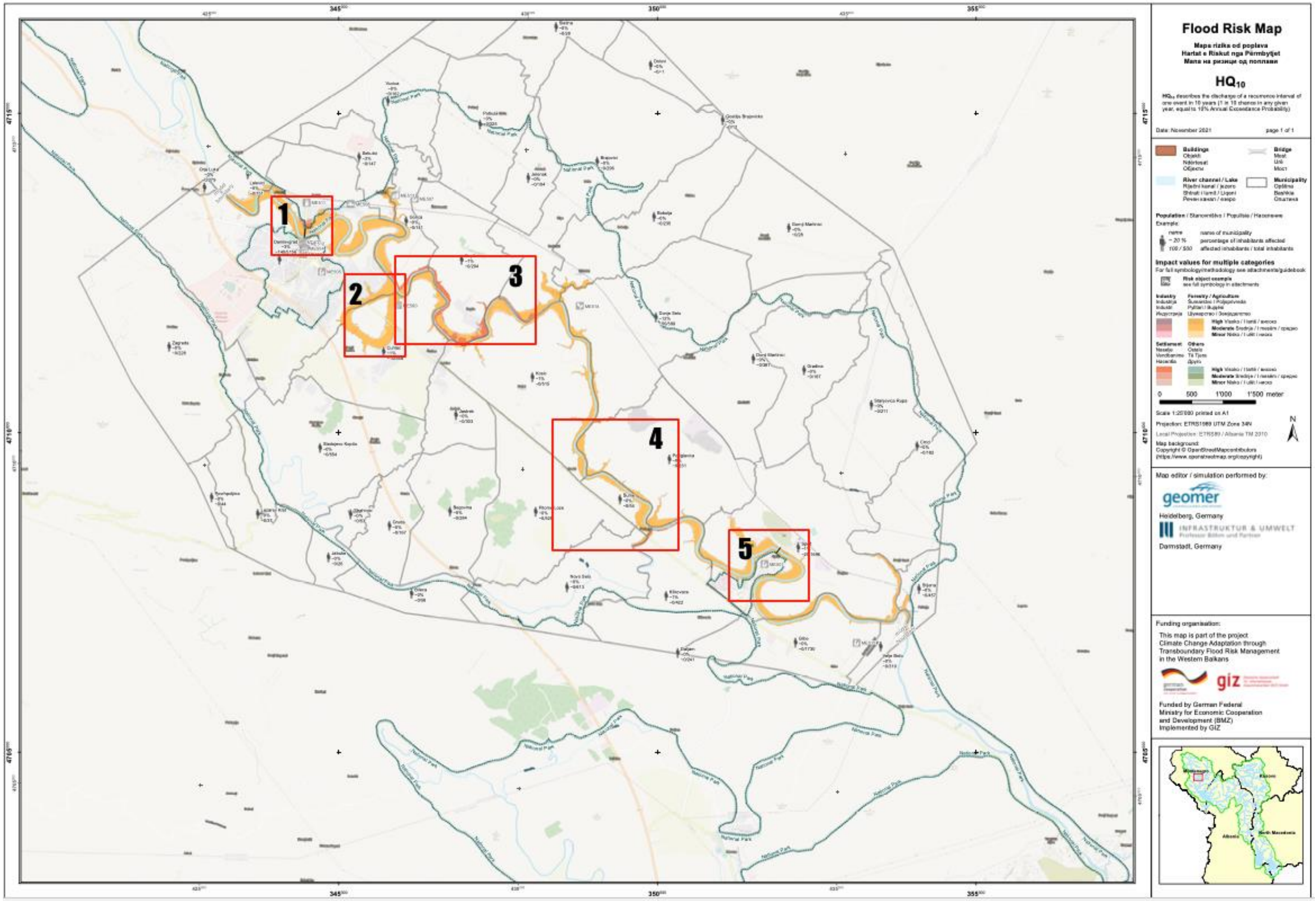
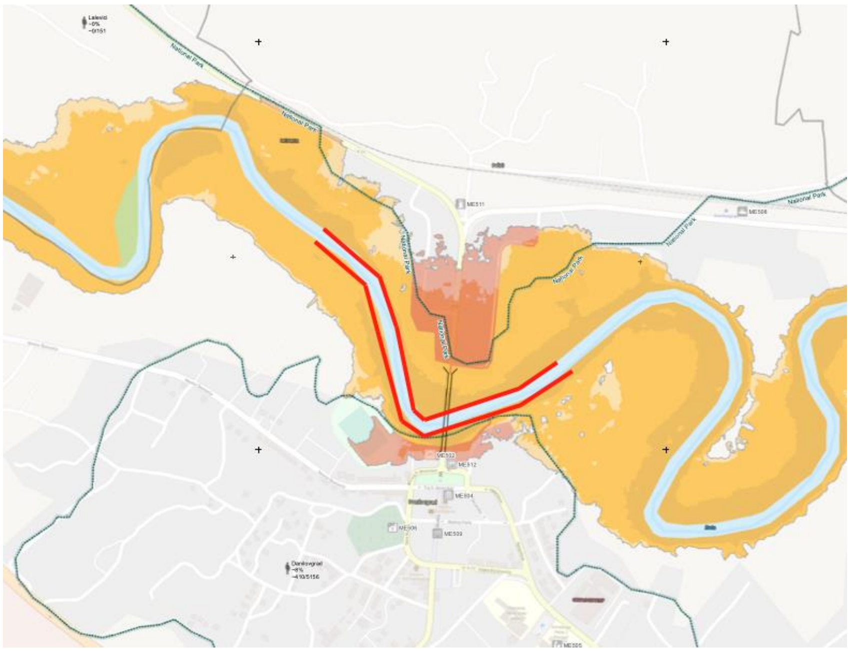
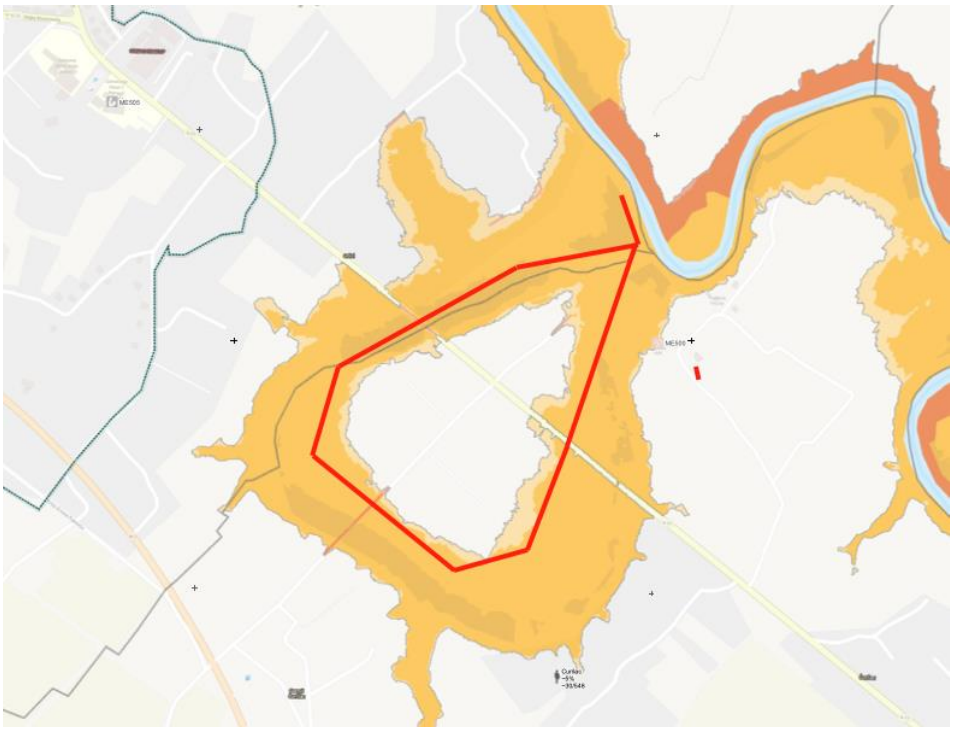
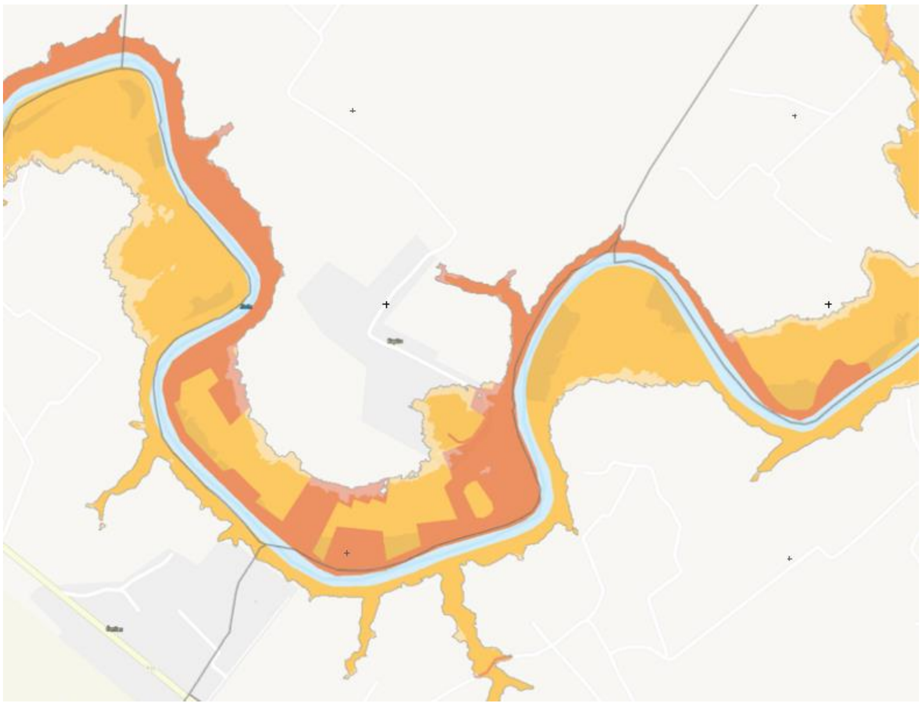
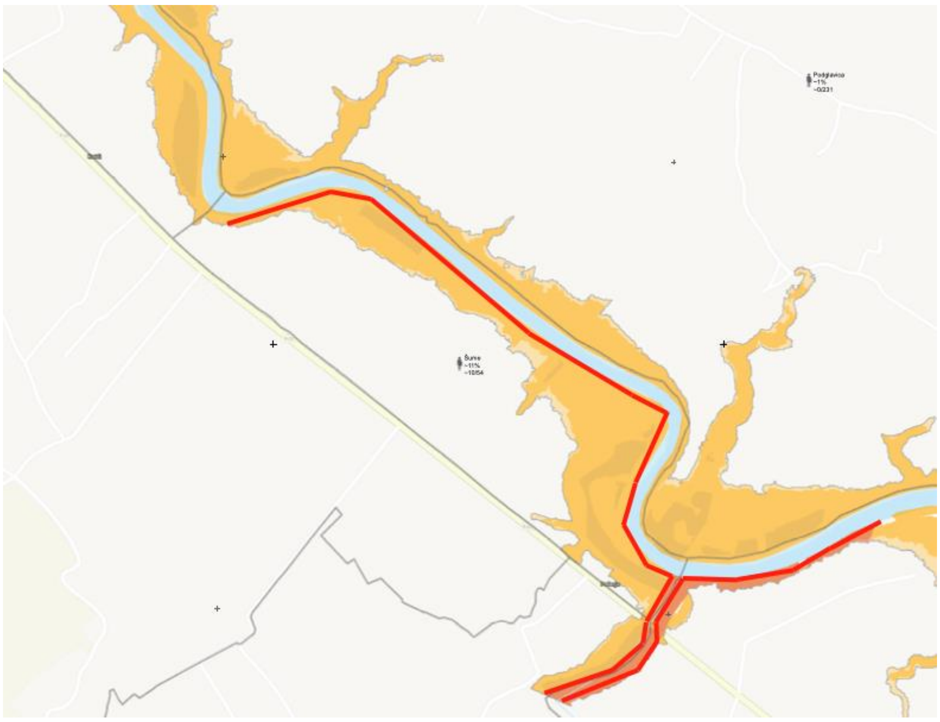
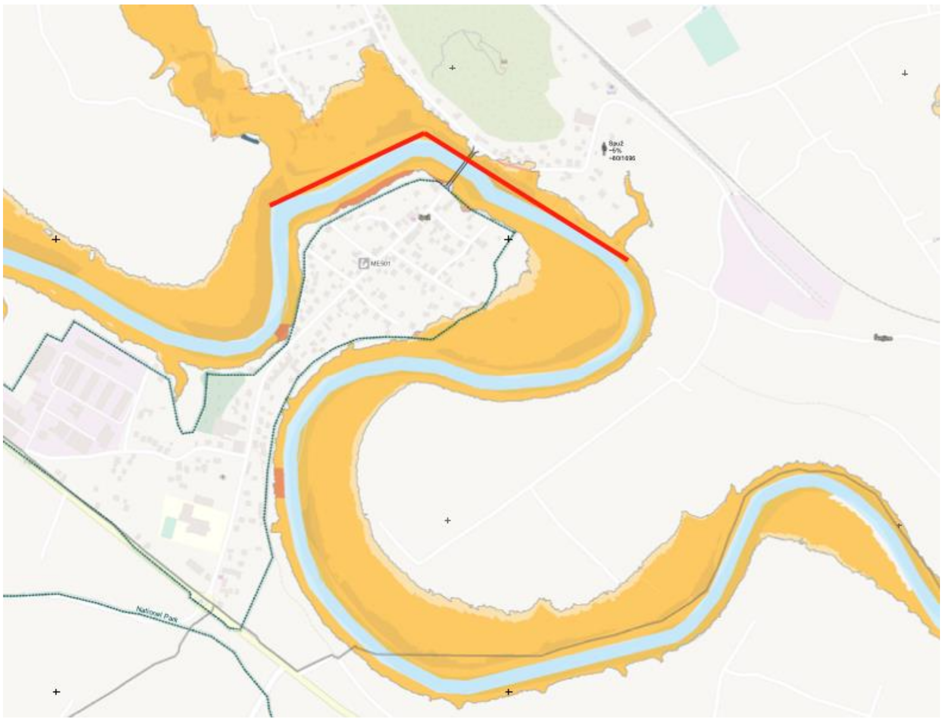


Table 8.4. Measures proposed in APSFR21_ARB_Zeta02

Municipality	Danilovgrad		
Water body	Zeta		
Watercourse	Zeta		
Surrounding Area	City of Danilovgrad and settlements Pažići, Glavica, Spuž, Podanje, Viško polje, Bogićevići, Livade Bandićke, Gorica, Grlic, Strahinjići, Podkraj.		
Key Type of Measure	M33		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☒ Yes	☐ No
Description of Damage in APSFR	Affected area includes left and right banks of the lower course of the Zeta River, about 15 km long. Flooding threatening settlements, roads, one industrial facility and agricultural land.		
Area (1)			

Proposed Measure for area (1)	**M33** - Construction of an embankment in the center of Danilovgrad on both sides of the Zeta River in the length of 1100 m (650 m upstream of the bridge and 450 m downstream). The overflow of the Zeta River threatens is Pažići settlement near the bridge on the left bank of the Zeta River in Danilovgrad. About 30 residential buildings and about 80 residents are at risk. During the occurrence of high water for the HQ500, the flooding depth is more than 1.5m. In those situations, the bridge over the Zeta River is endangered since the bridge openings cannot let the high water through. On the right bank of the Zeta River, which is at a slightly higher altitude, 2 business, 2 residential buildings and the Cultural Centre are at risk. In total, about 410 inhabitants, or 8% of Danilovgrad's population, are at risk of flooding in this section.
Area (2)	
Proposed Measure for area (2)	**M33** - Cleaning the ducts - deepening and clearing of vegetation. The settlement of Ćurilac is threatened by floods caused by blocked draining channel that surrounds the area. High waters during the flood waves cannot be evacuated. The flooding depth is more than 1.5m. The length of the channel is about 2.7 km. About 30 inhabitants (about 5%) of this settlement are at risk.

Area (3)	
Proposed Measure for area (3)	**M33** – Individual mobile protection. In the settlement of Kopito, the left bank of the Zeta river is threatened in a length of 4.7 km. It is about agricultural land and three residential buildings with about 10 inhabitants are at risk, so individual mobile protection for homes are proposed.
Area (4)	
Proposed Measure for area (4)	**M33** – construction of an embankment on right side of the Zeta River in a length of 2 km and bought sides of river Sušica, in the length of 450m. In the settlements of Šuma and Klikovače, floods are the result of the overflowing of the Zeta River and its tributary Sušica. The right bank of the Zeta

	and both banks of the SuŠice river are damaged. Although these are mostly agricultural areas, several households with about 20 inhabitants are also threatened. Given that the flow velocity is greater than 1.5 m/s and the depth of water can be greater than 1.5 m, the construction of an embankment is recommended.
Area (5)	
Proposed Measure for area (5)	**M33** - construction of an embankment on left side of the Zeta River in a length of 950 m. On the left bank of the Zeta River, downstream and upstream from the bridge in Spuž, there are 20 buildings with about 80 inhabitants threatened by floods. In the part of the Spuž settlement located on the right bank, there are no buildings threatened by floods. Given that the flow velocity is greater than 1.5 m/s and the depth of water can be greater than 1.5 m, the construction of an embankment is recommended.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Ministry responsible for energy sector Municipality of Danilovgrad
Status of Implementation	No status
Investments Costs	▪ Location 1: 2,500,000.00€, construction of an embankment. ▪ Location 2: 50,000.00€ cleaning of the channels; ▪ Location 3: 20,000.00€ individual mobile protection; ▪ Location 4: 2,000,000.00€, construction of an embankment. ▪ Location 5: 1,200,000.00€, construction of an embankment.
Priority (first /	First

second / third)	

8.2.3 APSFR22_ARB_Cetinje field Groundwater01

The areas at risk of flooding have been identified for the northern region of the APSFR at a return period of HQ500. The identified areas and proposed measures for the APSFR are presented in Table 8.5.

Table 8.5. Measures proposed in APSFR22_ARB_Cetinje Field Groundwater01

Municipality	Cetinje
Water body	Skadar Lake (SWB); Orahovštica – Rijeka Crnojevića (GWB)
Watercourse	Groundwater
Surrounding Area	Cetinje – Donje Polje
Key Type of Measure	M24, M33, M41
Location of Proposed Measures	

Type of area	Urban	☒ Yes	☐ No
	Rural	☐ Yes	☒ No
	Protected Area	☐ Yes	☒ No
Description of Damage			
The affected area includes urban and industrial areas.			
Description of the Measures			

Overview

Cetinje field is a closed karst depression that covers an area of about 3.8 ha. The length of the field is about 5 km and the average width is about 800 meters. The valley is closed from all sides, so extreme precipitation causes flooding of one part of the field. The waters are evacuated through abysses and the short artificial semi-tunnel located in the lowest parts of the polje (around 631 m asl). Having in mind the hydrogeological conditions in the zone of the Cetinjsko field, the floods can be classified as floods caused by meteorological factors (heavy precipitation with melting snow from the basin) and groundwater. The abysses drain the water towards the Crnojević River through a well-branched network of karst channels and caves (Figure A). The average discharge of the Crnojevića spring is 6.15 m^3/s (Figure B).

The Cetinje field basin is estimated at 46 km^2 ([64]). When the amount of inflowing water exceeds the sinking capacity of the abysses, then the Cetinje polje floods.

The main sinking zone is located in the south-eastern part. It is distributed along the Cetinje fault that bounds the polje from the eastern side. There is also a significant abyss in the Vladičina Bašta (the southwestern part).

The depth of the groundwater level is about 80-100 m in the dry period of the year, but in the zone of the Cetinje fault, it is over 200 m ([65]). The fluctuation of groundwater level was about 25 m for the observation period 1969-1973[66]. However, the fluctuations can be significantly higher in years with extreme precipitation when the water table exceeds the ground level of the polje. Even a piezometric level exceeded the ceiling elevation of the access tunnel for Cetinje Cave (649 m asl) during the floods in 1986[67].

[64] Mijatović B (1986): Funkcionisanje hidrogeološkog sistema u Cetinjskom polju. Vodoprivreda 18, Beograd
[65] Radulović M (2000): Hidrogeologija karsta Crne Gore. Posebna izdanja Geološkog glasnika, knjiga XVIII, Podgorica.
[66] Mijatović B (1986): Funkcionisanje hidrogeološkog sistema u Cetinjskom polju. Vodoprivreda 18, Beograd
[67] Bošković M, Živaljević R. (1986): Hidrološki osvrt na poplavu Cetinja od 18 – 20.02.1986. Vodoprivreda 18, Beograd

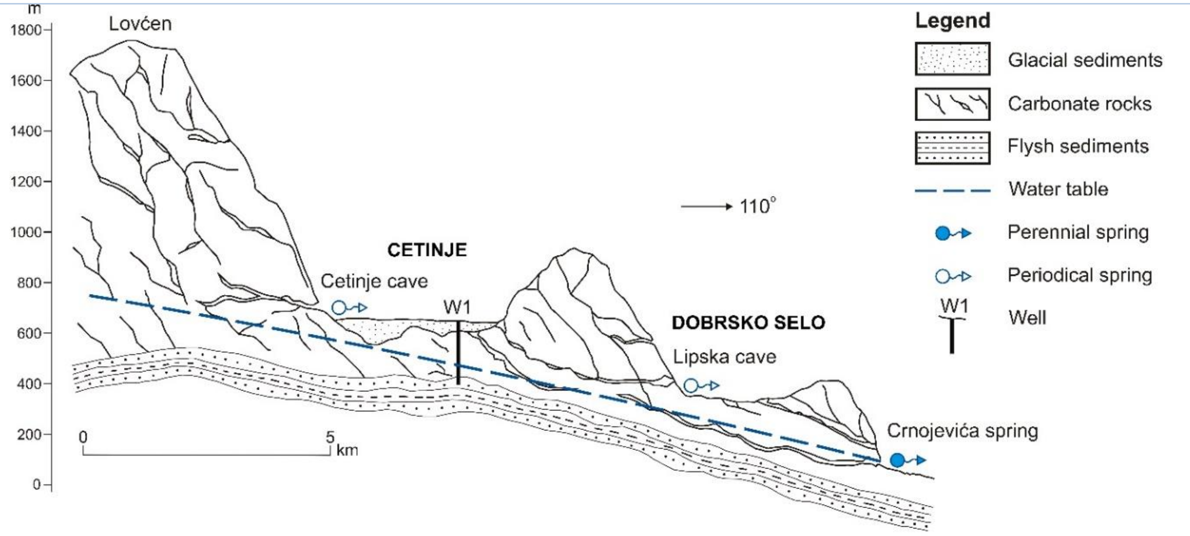


Figure A. Hydrogeological section of Lovćen–Crnojevića spring[68]

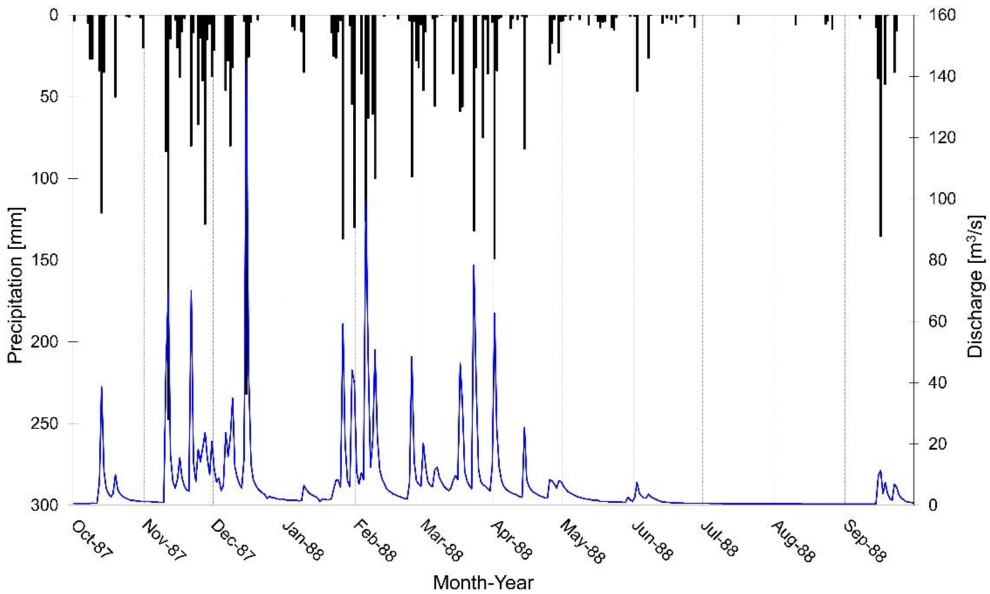


Figure B. Hydrograph of Rijeka Crnojevića spring discharge (hydrometric station "Brodska Njiva") with precipitation bar graph (climatological station "Cetinje")[69]

Data from the large flood in 1986

During the last large flood of the Cetinje field (16-20. February 1986), around 670 mm of rainfall was recorded in five days, and at the same time, there was a high daily temperature (10 °C) that caused the snowmelt in the catchment area (the snow depth was 0.7-1 m before the flood)[70]. The total inflow of water (from the cave's tunnel and Bogdanov Kraj to Donje Polje) was around 55 m^3/s and the sinking capacity of the lowest abysses was 27.1 m^3/s[71]. So the water excess of about 28

[68] Radulović MM et al. (2015) Hydrogeology of the Skadar Lake ba-sin (Southeast Dinarides) with an assessment of considerable subterranean inflow. Environ Earth Sci 74:71–82. doi: 10.1007/s12665-015-4090-7
[69] Radulović MM et al. (2015) after Živaljević R. (1992): Hidrogeološka analiza kretanja kraških voda na primjeru sliva rijeke Crnojevića. Doktorska disertacija, Univerzitet „Veljko Vlahović". Građevinski fakultet, Titograd.
[70] Mijatović B (1986): Funkcionisanje hidrogeološkog sistema u Cetinjskom polju. Vodoprivreda 18, Beograd
[71] Bošković M, Živaljević R. (1986): Hidrološki osvrt na poplavu Cetinja od 18 – 20.02.1986. Vodoprivreda 18,

m^3/s created the flood which covered 45 ha of the settlement (Figure C). The maximal flood level in Donje Polje was 640.8 m asl and the maximal volume of the ponded water was 771,720 m^3.

Figure C. Flood in Cetinje (February 1986)

Drainage projects

The conceptual design for diverting overflow water from Donje Polje was made in 1975[72]. According to this solution, the designers predicted the hydro-technical tunnel (1300-1425 m long) towards Dobrsko Selo. They took into account the 65-year flood with an inflow of 40 m^3/s, so the tunnel with 2.5-4 m in diameter and a slope of 2.4-3.8% was chosen.

The main design for the evacuation of high water was finished in 1982[73]. It also predicted the hydro-technical tunnel, 1300-1400 m long. Unfortunately, the project was abandoned.[74]

After the flood in 1986, a new Preliminary design was created[75], but again there were not enough financial resources for its realization.

As a transitional and economical solution, the short semi-tunnel (150 m long) was constructed only in 2003 (Figure D). It cut the fault and natural cave channels (96 m from the entrance) so that the drainage conditions have been significantly improved[76]. Since this semi-tunnel was constructed, there have not been any significant floods in the Donje Polje (Cetinje).

Beograd
[72] ZETA (1975) Idejno rješenje za odvođenje prelivnih voda sa ponora u Donjem polju. RO za uređenje i iskorišćenje voda SRCG Zeta, Titograd
[73] Geoinženjering (1982) Idejni i Glavni projekat odvodnje otpadnih i atmosferskih voda Cetinja, Geinženjering, Sarajevo
[74] Bošković M, Živaljević R. (1986): Hidrološki osvrt na poplavu Cetinja od 18 – 20.02.1986. Vodoprivreda 18, Beograd
[75] Centroprojekt (1987) Idejni projekat hidrotehnikog rješenja osnovnog sistema zaštite Cetinja od poplava. Centroprojekt, Beograd
[76] Radulović M., Mrdak R., Žarković Ž., Sekulić G. (2008): Hidrogeološki uslovi terena i rješenje problema periodičnog plavljenja Cetinjskog polja. Zbornik radova stručnog skupa Građevinarstvo - nauka i praksa“, Žabljak

According to the hydro-technical study from 2016[77], the wastewater and flood water would be drained towards the Dobrsko Selo through the same hydro-technical tunnel with a length of 1280 m.

Flood measures

In the user guide of the European Commission[78], the 18 possible flood measures have been distinguished. Below is the list of flood measures that could be implemented in Cetinje. The measures are separated by type according to the EC's user guide, but each of the listed measures does not fully correspond to the description in the guide due to the specific hydrological conditions of karst depressions.

M24:

1. Hydrogeological investigations in order to define the dimensions and spatial position of the revealed karst channels and their hydrological function[79].

2. Analysis of previous studies and, if necessary, updating the hydro-technical study from 2016 (reviewing the dimensioning of the hydro-technical system).

M33:

1. Checking the condition of the abysses and semi-tunnel, and performing site clearance (removal of garbage, branches, deposit, etc.).

2. Development and implementation of the design for diverting overflow water from Donje Polje.

M41:

Forecasting and early warning system. An observation borehole should be drilled (250 m deep) in the south-eastern part of the polje for the purposes of such a system. Since the groundwater level rise is the cause of flooding in Cetinje, the measurements of groundwater level (simultaneously with meteorological parameters) and an early warning system are highly recommended.

[77] ING - INVEST (2016) Hidrotehnička studija, knjiga 2/4 (dio tehničke dokumentacije Projekta kanalisanja, tretmana i odvođenja otpadnih i atmosferskih voda iz Cetinjskog polja). Ministarstvo održivog razvoja i turizma - Direkcija javnih radova, Podgorica

[78] EC (2013) Technical support in relation to the implementation of the floods directive (2007/60/EC), A user guide to the floods reporting schemas (report ref: v5.0 June 2013). European Commission, Brussels

[79] Radulović M., Mrdak R., Žarković Ž., Sekulić G. (2008): Hidrogeološki uslovi terena i rješenje problema periodičnog plavljenja Cetinjskog polja. Zbornik radova stručnog skupa Građevinarstvo - nauka i praksa“, Žabljak

Figure D. The semi-tunnel in the south-eastern part of the Cetinje polje[80]

Competent Water Authority	Ministry responsible for Water Management, Water Administration (WA)
Other Relevant Authorities	Ministry reposnsible for ecology
Status of Implementation	No status.
Investments Costs	M24 – 200,000.00€ M33 –100,000.00€ M41 – N/A
Priority (first / second / third)	Second

[80] Dć MM (2012) Multi-parameter analysis of groundwater recharge in karstic aquifers–case examples from Skadar Lake basin (in Serbian). Dissertation, University of Belgrade

8.2.4 APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02

APSFR23_ARB_Morača and Skadar Lake01

The areas at risk of flooding have been identified for the northern region of the APSFR at a return period of HQ500 (Figure 8.4).

The proposed measures for the individual identified areas in the APSFR are presented in Table 8.6.

APSFR24_ARB_Skadar Lake02

The areas at risk of flooding have been identified for the APSFR at a return period of HQ500 (Figure 8.4).

The proposed measures for the individual identified areas in the APSFR are presented in Table 8.7.

Figure 8.4. Identified areas of potential flooding in APSFR23_ARB_Morača and Skadar Lake01 and APSFR24_ARB_Skadar Lake02 (HQ500)

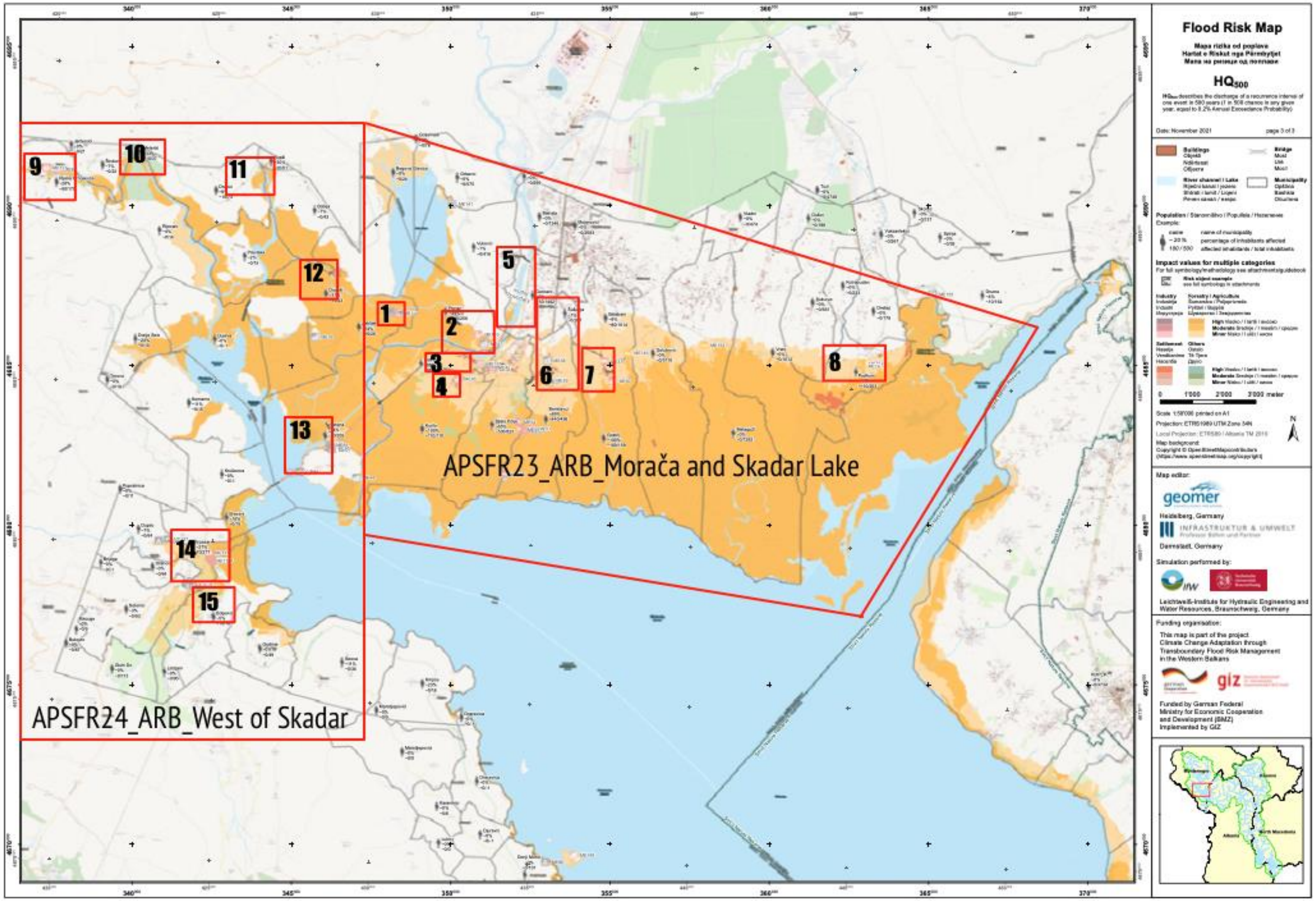


Table 8.6. Measures proposed in APSFR23_ARB_Morača and Skadar Lake01

Municipality	Podgorica, Zeta, Tuzi		
Water body	Morača River and Skadar Lake		
Watercourse	Skadar Lake		
Surrounding Area	Settlements (as shown in Figure 8.4): Vranjina (1), Ponari (2), Bistrice (3), Kurilo (4), Bijelo Polje (5) , Berislavci (6), Gostilj (7), Podhum (8), Tuzi (9).		
Key Type of Measure	M21, M24, M33, M41		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☒ Yes	☐ No
Description of Damage in APSFR	The affected area includes urban, industrial and agricultural land. Floods mostly endangered the settlements in the lower course of the river Morača and large areas of land along the northern periphery of the Skadar Lake. The flooded zone is part of the National Park "Skadar Lake". Industrial facilities, large agricultural areas and many agricultural facilities, are threatened.		
Proposed Measure for areas (1-9)	The following flood protection measures are proposed: **M21** – – Measure to prevent the installation of new or additional receptors in areas prone to flooding Spatial plans shell includes information presented on the hazard and risk maps regarding the flood spatial distribution, in order to prevent the construction of any buildings and urbanization in areas that are at risk of flooding. It applies to all levels of spatial planning documents, starting from the Spatial Plan of Montenegro (currently in the drafting phase). **M24** - Development of hydromorphological studies In the northern part of Lake Skadar, in a length of about 20 km, large agricultural areas are threatened by flood waters, as well as the settlements Vranjina, Ponari, Bistrice, Kurilo, Bijelo Polje, Berislavci, Gostil, Podhum) and Tuzi). The depth of flooding is 0.5-1 m. In order to reduce the negative impact of floods caused by heavy rainfall and raising the water level of Lake Skadar, regular maintenance of drainage channels is necessary. Due to the existing configuration of the terrain and fluctuations in the level of		

	Lake Skadar, it is hard to suggest a structural measure that would prevent floods in such a large area. For the assessment of the possible measures like drainage system, further hydromorphologcial studies need to be developed, covering the area of Skadar Lake and Bojana River. **M33** - Use of individual mobile protection and deepening and clearing of vegetation: All settlements **M33 – Ponari (2):** Channel cleaning and construction of an embankment on right side of the channel in a length of about 750 m. The settlement of is located on the bank of the channel that drains the coastal part of Lake Skadar. The insufficient capacity of this channel is one of the reasons why there the floods occur. Cleaning, deepening and regular maintenance of channel flow is important to prevent floods. Almost half of the population, a large number of residential and auxiliary buildings are threatened by floods. The depth of flooding is 1-2m. For that reason, it is recommended to build an embankment on the bank of the channel in a length of about 750 m. Mobile protection of individual buildings is recommended for those buildings that are outside of the proposed embankment and are at risk of floods. **M41** - Continuous improvement of the system for hydrological and meteorological observations and data transfer systems resulting in setting up the early warning system. Supporting development of joint protection and rescue plans in flood events between municipalities. Supporting joint simulation exercises of response in flood events among various stakeholders
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Ministry of responsible for ecology Ministry responsible for energy sector Municipalities of Podgorica, Zeta and Tuzi
Status of Implementation	M 21 - Flood hazard maps will be an integral part of spatial planning documentation M24 – No status. M33- No status. M 41 – In the implementation phase
Investments Costs	M 24- €200,000 for a hydro morphological study M33 - Location Ponari (2) - €750,000 construction of embankment M33- €100,000 canal cleaning

Priority (first / second / third)	First

Table 8.7. Measures proposed in APSFR24_ARB_Skadar Lake02

Municipality	Podgorica, Cetinje and Bar		
Water body	Skadar Lake		
Watercourse	Skadar Lake / Rijeka Crnojevića		
Surrounding Area	Settlements (as shown in Figure 8.4): Rijeka Crnojevića (10), Dodoši (11), Žabljak Crnojevića (12), Virpazar (13), Boljevići (14), Dupilo (15), Karuč (16), Krnjice (17), Prevlaka (18)		
Key Type of Measure	M21, M24, M33, M41		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☒ Yes	☐ No
Description of Damage in APSFR	The affected area includes urban, industrial and agricultural areas (orchards and vineyards, boats and fishing equipment), infrastructure facilities (the Old Bridge on Rijeka Crnojevića and three bridges on the Rijeka Crnojevića - Virpazar road, the Cetinje drainage pumping station in Podgora, from where Cetinje is supplied with water.		
Proposed Measure for areas (10-18)	The following flood protection measures are proposed: **M21** – Measure to prevent the installation of new or additional receptors in areas prone to flooding Spatial plans shell includes information presented on the hazard and risk maps regarding the flood spatial distribution, in order to prevent the construction of any buildings and urbanization in areas that are at risk of flooding. It applies to all levels of spatial planning documents, starting from the Spatial Plan of Montenegro (currently in the drafting phase). **M24** - Development of hydromorphological studies In the western part of Lake Skadar large agricultural areas are threatened by flood waters, as well as the settlements Dupilo, Karuč, Krnjice and Prevlaka.		

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

	The depth of flooding is 0.5-1 m. **M33 Rijeka Crnojevića (10**) – Mobile protection on left side of the Crnojevića river in a length of 1 km. In the city Riječki grad, it is proposed to build drainage channels and divert flood waters away from buildings. In the Rijeka Crnojevića settlement, the lower part of the town - the market, residential and auxiliary buildings, several restaurants, and the Old Bridge over Rijeka Crnojevića is threatened by floods. About 50 inhabitants (28% of the total population of Rijeka Crnojevića) are at risk. The depth of flooding is 1-2m. The use of mobile protection on the left bank of the Crnojevića River is recommended. *In order for this measure to be implemented it is necessary to develop plans for the use of mobile protection. The type of mobile protection, the exact length and the conditions for its installation should be defined based on geodetic survey and other relevant data. The Plan shall also include the scope of preparatory works on cleaning and setting up the corridors for the mobile protection temporary installation. City Riječki grad, which is located in the karst field on the right bank of the Crnojevića River, is outside of the flooded area obtained by the hydrological modelling, has also been flooded. The cause of the flooding of residential buildings and an old church is the influx of large amounts of water from the surrounding hills during heavy rainfall and the impossibility of its drainage. It is recommended to build drainage systems to take flood waters away from buildings and into the field. **M33 Dodoši (11)** - Channel cleaning and mobile protection installation. The village of Dodoši is surrounded by floodplains. Most of the buildings are on the high ground, but 16 residential and auxiliary facilities, and several restaurants are at risk. About 20 inhabitants (about 30%) of this settlement are at risk. The depth of flooding is 1-2m. Due to the configuration of the terrain and the position of the settlement, it is recommended to set up a mobile protection in a length of 1 km, which would almost surround all buildings in the Dodoši settlement. **M33 – Žabljak Crnojevića (12)** The village Zabljak Crnojevića is located on the bank of the canal on high ground and most buildings are not threatened by floods. On the hill there is an old church and a cemetery, as well as the ruins of historical buildings. However, several residential and auxiliary buildings located at lower elevations were submerged by flood waters. About 10 inhabitants are settled. The depth of flooding is 1-2m. Due to the configuration of the terrain and the position of the settlement, it is recommended to set up a mobile protection against pollutant individually for endangered objects. In order to reduce the negative impact of floods caused by heavy rainfall and raising the water level of Lake Skadar, regular maintenance of drainage channels is necessary. One such channel passes in the immediate vicinity of the settlement and needs to be deepened and cleaned. **M33 Virpazar (13**) – Channel cleaning and individual mobile protection. Due to the rise in the level of Lake Skadar, almost all private, tourist and business facilities in Virpazar and its surroundings and the railway station are

	threatened. About 21% of population are at risk. The depth of flooding is 1-2m. In order to reduce the negative impact of floods caused by heavy rainfall and raising the water level of Lake Skadar, regular maintenance of drainage channels is necessary. One such channel passes in the immediate vicinity of the settlement and needs to be deepened and cleaned. Mobile protection is recommended for the protection of buildings. **M 41** - Continuous improvement of the system for hydrological and meteorological observations and data transfer systems resulting in setting up the early warning system Supporting development of joint protection and rescue plans in flood events between municipalities. Supporting joint simulation exercises of response in flood events among various stakeholders
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Ministry responsible for ecology Ministry responsible for energy sector Municipalities of Podgorica, Cetinje and Bar
Status of Implementation	M 21 - Flood hazard maps will be an integral part of spatial planning documentation M24 – No status. M33 - No status. M 41 – In the implementation phase
Investments Costs	M33 Location Rjjeka Crnojevića (10) – 250,000.00€ Location Dodoši (11) – 250,000.00€ Location Žabljak Crnojevića (12) – 10,000.00€ Location Virpazar (13) – 100.000.00€
Priority (first / second / third)	First

8.2.5 APSFR25_ARB_Bojana01

The areas at risk of flooding have been identified for the APSFR at a return period of HQ500 (Figure 8.5).

The proposed measures for the individual identified areas in the APSFR are presented in Table 8.8.

Figure 8.4. Identified areas of potential flooding in APSFR25_ARB_Bojana01

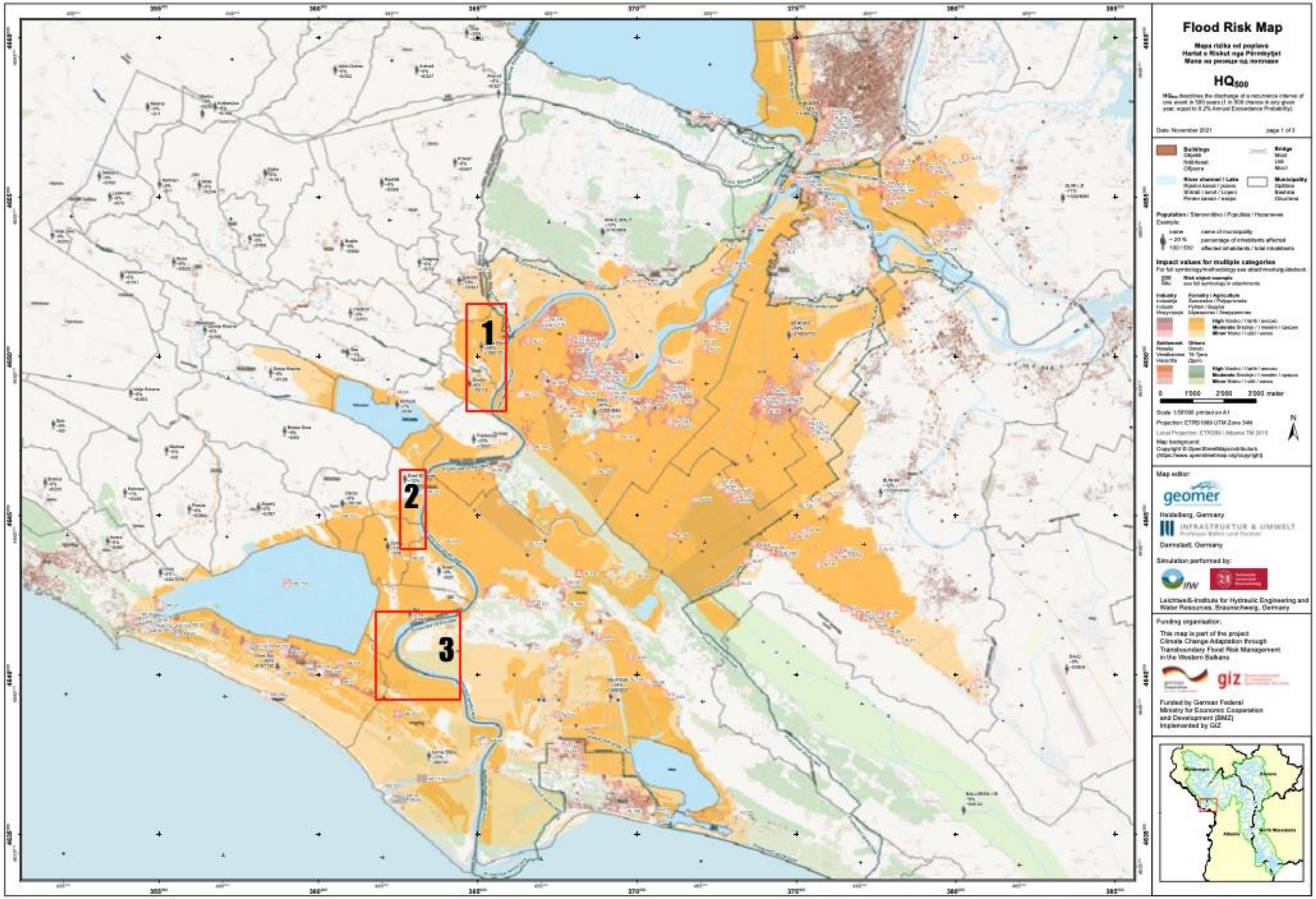


Table 8.8. Measures proposed in APSFR25_ARB_Bojana01

Municipality	Ulcinj		
Water body	Bojana		
Watercourse	Bojana		
Surrounding Area	Settlements Fraskanjel, Gornji Štoj, Lisna Bori, Sveti Đorđe, Sukobin; Reč, Darza, Doni Štoj, Ulcinj, Bank of the Bojana River, Ada Bojana		
Key Type of Measure	M33		
Type of Area	Urban	☒ Yes	☐ No
	Rural	☒ Yes	☐ No
	Protected Area	☒ Yes	☐ No
Description of Damage in APSFR	Affected area is near the River Bojana and it includes urban and agricultural land. There are mostly ground-level houses and houses with maximum two floors, whereas agricultural land is covered by large plantations of fruits and vegetables. Flood protection structures have been built in this area. However, the current condition of these structures is unsatisfactory and therefore there is no protection in the event of high waters.		

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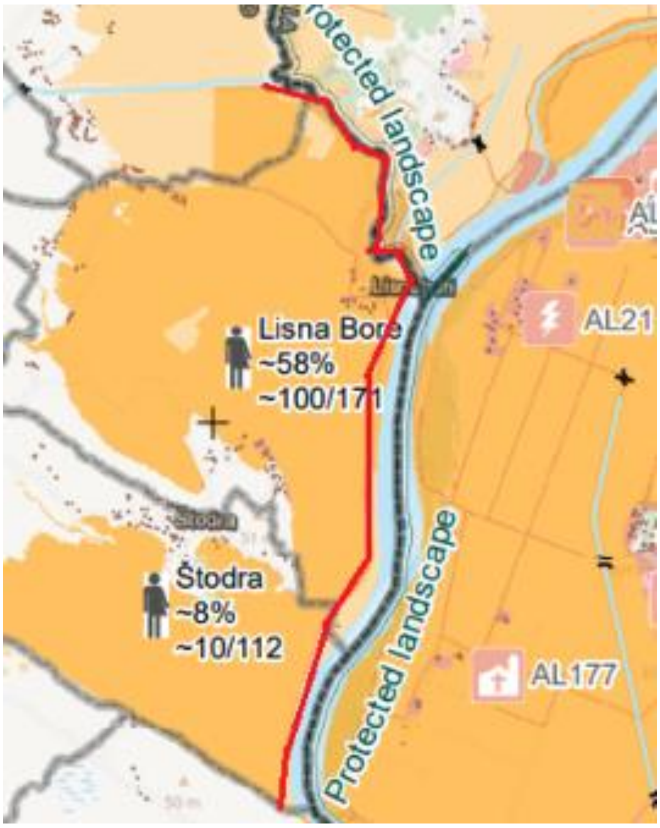
<tr><td>Area 1</td><td>
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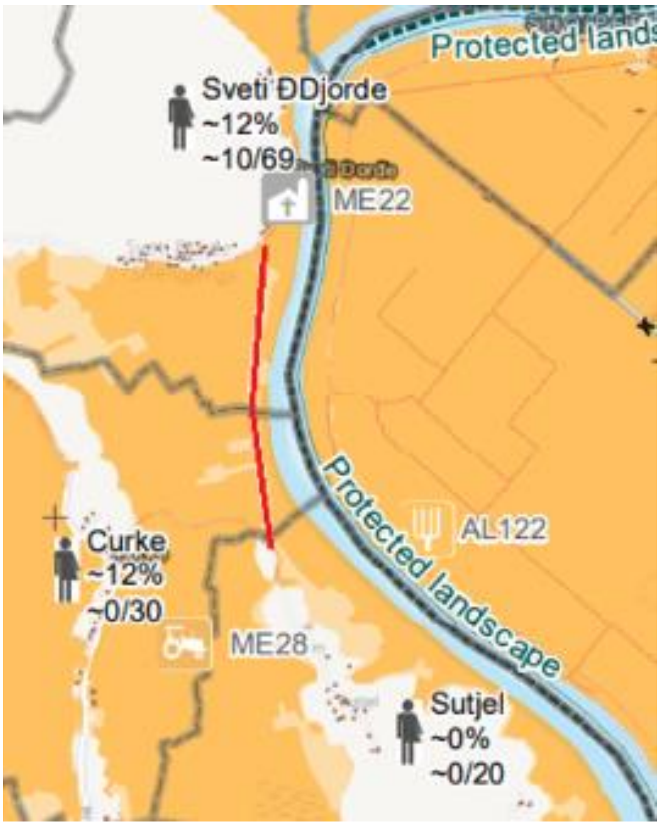
<tr><td>Area 2</td><td>
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</table>

Area 3	
Proposed Measure for areas 1 - 3	The Bojana River flows from Skadar lake, and downstream (at a distance of 1.2 to 2.0 km) on the left it receives the Drin River. After 18 km of flow through Albania, the Bojana River represents the approximately 25 km long border between Montenegro and Albania. At the exit of the lake, the regime of the Bojana River is relatively normal. However, with the high-water level of the Drin River, the water level and flow of the Bojana River increases too. This phenomenon, on the one hand, causes flooding along the Bojana River, and on the other hand slows the discharge of water from the lake, causing flooding on the north side of Skadar Lake. The hydrological characteristics of the Bojana River are extremely complex asthey actually depend on the hydrological characteristics of Lake Skadar and its tributaries, and especially on the hydrological characteristics of the Drini River. In order to properly manage this complex hydrological system, it is necessary to implement the integrated water management approach coordinated between two countries. High water threatens: Vladimir and Sukobin fields , Šasko Lake zone and Ulcinj field. To protect Ulcinj field from high water, Dykes were built in 1950, consisting of two parts separated by the hill Sutjel. The first section of Sveti Nikola to Reč is 6,300 m long, and the other, Sutjel – Sveti Đorđe, it is 1,470 m long. These Dykes directly protect the area of about 600 ha between Bojana and the old saltern Dykes, and indirectly the entire Ulcinj field. The Dyke is placed parallel to the bank of the Bojana river at a distance of 100-200 m. In 1966, in order to increase flood safety in 1966 the Paratuk dyke was built. It is 195 m long and connects the old Bojana Dyke and Dyke Bojana- Sveti

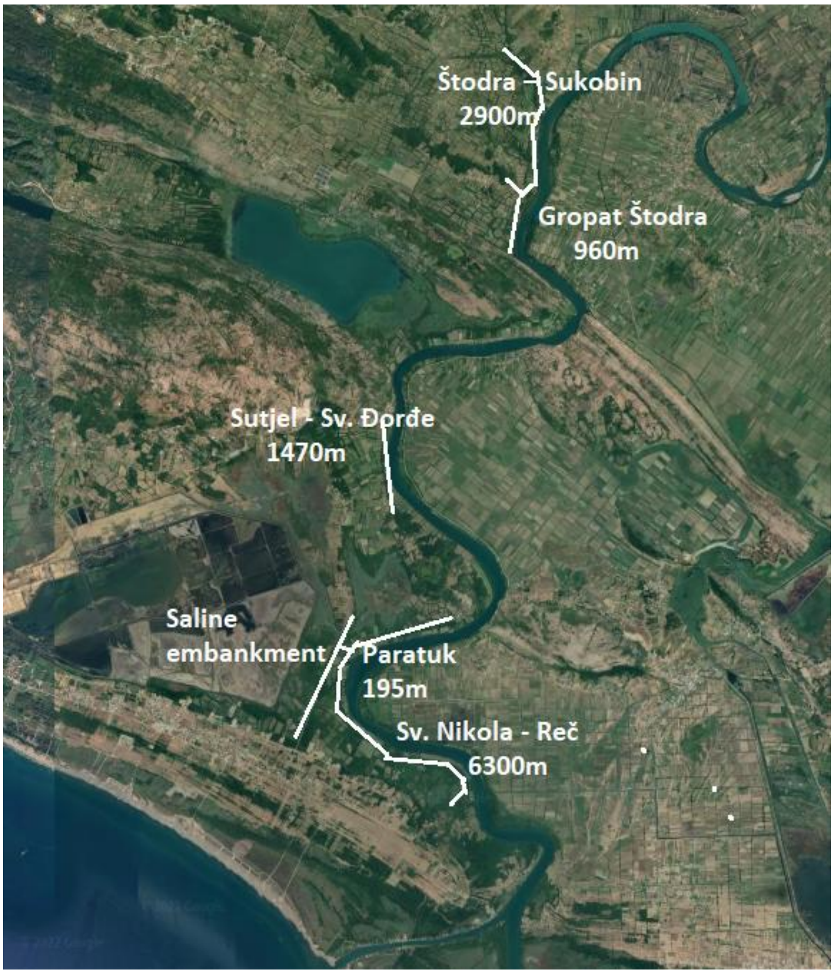
Nikola - Reč. In this way, the defended area between the two dykes was divided into two.

From the time the dykes were completed in 1950-1951 until 1977, they were not maintained and were overgrown with grass and weeds, and in many places in the body of the embankment large forest trees developed. During 1977, the embankments were partially cleared of trees, shrubs, and other vegetation. Due to the long-term neglect of the Dykes, it was not possible to achieve a greater effect with these works, especially because not all larger trees were cut down and the roots and stumps of the cut trees were not removed and remained in the trunk of the Dykes.

In order to protect Vladimir and Sukobin fields against flooding from Bojana River, two Dykes were built-the Dyke Gropat - Štodra in the length of 960 m, and the section Štodra - Sukobin which is 2,900 m long. These Dykes protect approximately 110 ha in the Vladimir field and about 360 ha in the Sukobin field. The Gropat-Štodra and Štodra-Sukobin Dykes were built in accordance with the 1979 project.

The embankments built along Bojana largely prevent large waters from entering deep into the land, but spills still occur in the downstream areas because sufficient width of the inundation area was not left, the required height of the embankment was not met, and no special attention was paid to the maintenance of the embankment.

Figure A. Dykes on the Bojana River



	According to guidelines of the EC, the proposed common measures are classified into 18 groups within 6 aspects: no action (M11), flood prevention (measures M21-M24), flood protection (M31-M35), preparedness (M41-M44), restoration and review (M51-M52) and other (M61). Considering the above, the following flood protection measures are proposed: **M33** – Rehabilitation of old and construction of new embankments. The Ministry of Agriculture, Forestry and Water Management, in cooperation with UNDP, is implementing the first regional project funded by the Adaptation Fund in Europe. This project contains development of the Main design for the Bojana River as well as for the execution of infrastructural works on the construction of embankments and other measures that the projects will envisage for long-term flood protection and regulation of the riverbeds of the mentioned watercourses. On March 9, 2020, UNDP announced a tender for the development of the Main Project for the Regulation of the Bojana River, within the regional project "Integrated Flood Risk Management in the Drim River Basin". The reconstruction of the Štodra - Sukobin and Gropat - Štodra embankment will protect the settlements of Skobin (70 inhabitants endangered - 18%), Lisna Bore (100 inhabitants endangered - 58%), Stodra (10 inhabitants endangered -8%). The reconstruction of the Sutjel - Sveti Đorđe embankment will protect the settlement Sveti Đorđe, several residential buildings and a church, where about 10 residents are at risk. Due to the breaching of the embankment Sveti Nikola - Reč, numerous buildings in the densely populated area of Gornji and Donji Štoj and further towards Ulcinj were threatened. The reconstruction of the Sveti Nikola - Reč embankment. By reconstructing and raising the embankment, this area will be protected from floods.
Competent Water Authority	Ministry responsible for Water Management Water Administration (WA)
Other Relevant Authorities	Ministry responsible for ecology Ministry responsible for energy sector Municipality of Ulcinj;
Status of Implementation	The main project for the reconstruction of the embankment on the right bank of the Bojana River was completed and revised. According to the GP, about €5,000,000 is needed for the reconstruction of the embankment system on the Bojana River for infrastructure works on five critical sections. Activities are currently underway to start infrastructure works on one of the critical sections of Štodr - Sukobin. The Adaptation Fund has allocated €600,000 for

	this section, and the total value of the necessary infrastructure works is €1,100,000, so the provided amount covers only the first phase of infrastructure works, while funds need to be provided for the II phase, as well as for the remaining 4 sections.
Investments Costs	€4.400.000,000 works on the reconstruction of the dykes on the right bank of the Bojana river
Priority (first / second / third)	First

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	Bilateral communication related	high	6 years	

Aspect	Code	Measure	Indicative Description of Activities	Indicative priority	Period of Implementation	Financing sources
		Significant Flood Risk (APSFR) in international basins / areas of mutual interest	to relevant data exchange			
		Create hydromorphological studies for the northern part of Lake Skadar.	Due to the existing configuration of the terrain and fluctuations in the level of Lake Skadar, it is impossible to recommend any infrastructure facility that will protect such a large area from flooding. It is possible to solve the problem after making a hydromorphological study for the entire area of Lake Skadar, including Bojana (it may include modelling and flood risk assessment, flood vulnerability assessment, etc.). This study should give an answer about the need to build a system for draining flood waters or for protection against them	high	3 years	
		Reduction of the risk of floods through the active role of reservoirs, including the activation of natural floodplains.	The role of the existing reservoirs, the existing way of functioning and operational management in the conditions of the occurrence of high water were considered. Management of reservoirs should be in accordance with Operational instructions for the management	high	long-term	

Aspect	Code	Measure	Indicative Description of Activities	Indicative priority	Period of Implementation	Financing sources
			of accumulations and retentions of HPP Perućica HPP for flood protection, which was adopted in 2019, in accordance with Rulebook on the content of operational instructions for the management of reservoirs for flood protection, (Official Gazette of Montenegro, No 3/18).			
		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 for 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	Regular communication and	high	Continuous	

Aspect	Code	Measure	Indicative Description of Activities	Indicative priority	Period of Implementation	Financing sources
		in implementation of FRMP	reporting			
		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 proposed structural measures

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
APSFR20_ ARB_Zeta01-northern region	Zeta	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M24: Regulation of water flow - The management of reservoirs should be in accordance with the Operational Instructions for the management of reservoirs and retentions of HPP Perućica HPP for flood defense. M33: Mobile protection on the left bank of the Zeta River in the Kočani settlement (400m) and on the left and right banks in the Mokre njive settlement (500m). M41: Continuous improvement of the system for hydrological and meteorological observation and the data transmission system resulted in the establishment of an early warning system	Second	No status	Location 1 - 100,000.00€, mobile protection, Location2 - 20,000.00€, individual mobile protection , Location 3 – 300,000.00€, mobile protection TOTAL: 420,000.00€	- National sources (budget, water fees) - EU funds - Loans (The World Bank, EIB, EBRD…)
APSFR20_ ARB_Zeta01-southern region	Zeta	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M24: Regulation of water flow - The management of reservoirs should be in accordance with the Operational Instructions for the management of reservoirs and retentions of HPP	First	Implement ation phase	N/A	

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		Perućica HPP for flood defense. M41: Continuous improvement of the system for hydrological and meteorological observation and the data transmission system resulted in the establishment of an early warning system				
APSFR21_ ARB_Zeta02	Zeta	M33: Construction of an embankment in the center of Danilovgrad on both sides of the Zeta River in a length of 1100m (650m upstream from the bridge and 450m downstream). Canal cleaning - deepening and clearing of vegetation in the Ćurilac settlement. Individual mobile protection in the Kurilo settlement Construction of an embankment on the right side of the Zeta river in the settlements of Šuma and Klikovače in a length of 2 km and on both sides of the river Sušice, in a length of 450 m. Construction of an embankment on the left side of the Zeta river downstream and upstream of the bridge in Spuž in a length of 950m.	First	No status	Location 1: 2,500,000.00€, Construction of an embankment. Location 2: 50,000.00€ Canal cleaning; Location 3: 20,000.00€ individual mobile protection ; Location 4: 2,000,000.00€, Construction of an embankment. Location 5: 1,200,000.00€, Construction of an embankment TOTAL: 5,770,000.00€	
APSFR22_ ARB_ ground waters of Cetinjsko polje01		M24: Hydrogeological investigations in order to define the dimensions and spatial position of the revealed karst channels and their hydrological function. M33: Checking the condition of the	Second	No status	M24 – 200,000.00€ M33 –100,000.00€ M41 – N/A TOTAL: 300,000.00€	

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		sinkhole and half-tunnel and cleaning the ground. M41: Continuous improvement of the system for hydrological and meteorological observation and the data transmission system resulted in the establishment of an early warning system				
APSFR23_ARB _ Morača and Skadar Lake01	Moraca and Skadar Lake	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M24: Preparation of hydromorphological studies M33: Canal cleaning and building an embankment on the right side of the canal in a length of about 750 mu in Ponarima. M41: Continuous improvement of the system for hydrological and meteorological observation and the data transmission system resulted in the establishment of an early warning system	First	No status	M 24- 200.000€ for a hydromorphological study M33- Location Ponari(2) - 750.000€ Construction of an embankment M33- 100.000€ Canal cleaning TOTAL: 1,050,000.00€	
APSFR24_ARB _ Skadar Lake02	Skadar Lake	M21: Preventing urbanization and construction of any buildings in areas prone to flooding M24: Preparation of hydromorphological studies. M33:Mobile protection on the left side of Rijeka Crnojevića in a length of 1 km. Cleaning the canal in Žabljak	First	No status	Location Rjjeka Crnojevića (10) – 250,000.00€ Location Dodoši (11) – 250,000.00€ Location Žabljak Crnojevića (12) – 10,000.00€ Location Virpazar (13) – 100,000.00€	

APSFR	River	Type of measure	Priority	Status	Indikative costs	Indicative Financing Sources
		Crnojevića. Installation of mobile protection and cleaning of canals in the village of Dodoši. Mobile protective installation in the settlement of Vranjina in a length of 350m. Mobile protection of buildings and canal cleaning in Virpazar. M41: Continuous improvement of the system for hydrological and meteorological observation and the data transmission system resulted in the establishment of an early warning system			TOTAL: 610,000.00€	
APSFR25_ARB _Bojana01	Bojana	M33: Rehabilitation of old and construction of new embankments Deepening and widening of the right arm of the Bojana river delta	First	Implement ation phase	4,400,000.00€	
TOTAL:					12,550,00€	-

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

9 COST BENEFIT ANALYSIS OF PROPOSED MEASURES

9.1 Introduction

The Cost-Benefit Analysis (CBA) aims to support flood risk management planning in the Adriatic 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 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[81];
- Guidelines for the implementation of a Cost Benefit Analysis in flood risk management[82];
- Guidelines for Standards for Flood Protection and Safety[83];
- EU JRC Technical Report: Global flood depth-damage functions: Methodology and the database with guidelines.[84]

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

[81] http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

[82] http://www.floodcba.eu/main/wp-content/uploads/Cost-Benefit-Analysis-Guidelines1.pdf

[83] http://www.floodcba2.eu/site/wp-content/uploads/Guidelines-FLOODCBA2-v-3-10.pdf

[84] 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.[85]

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

[85] 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.

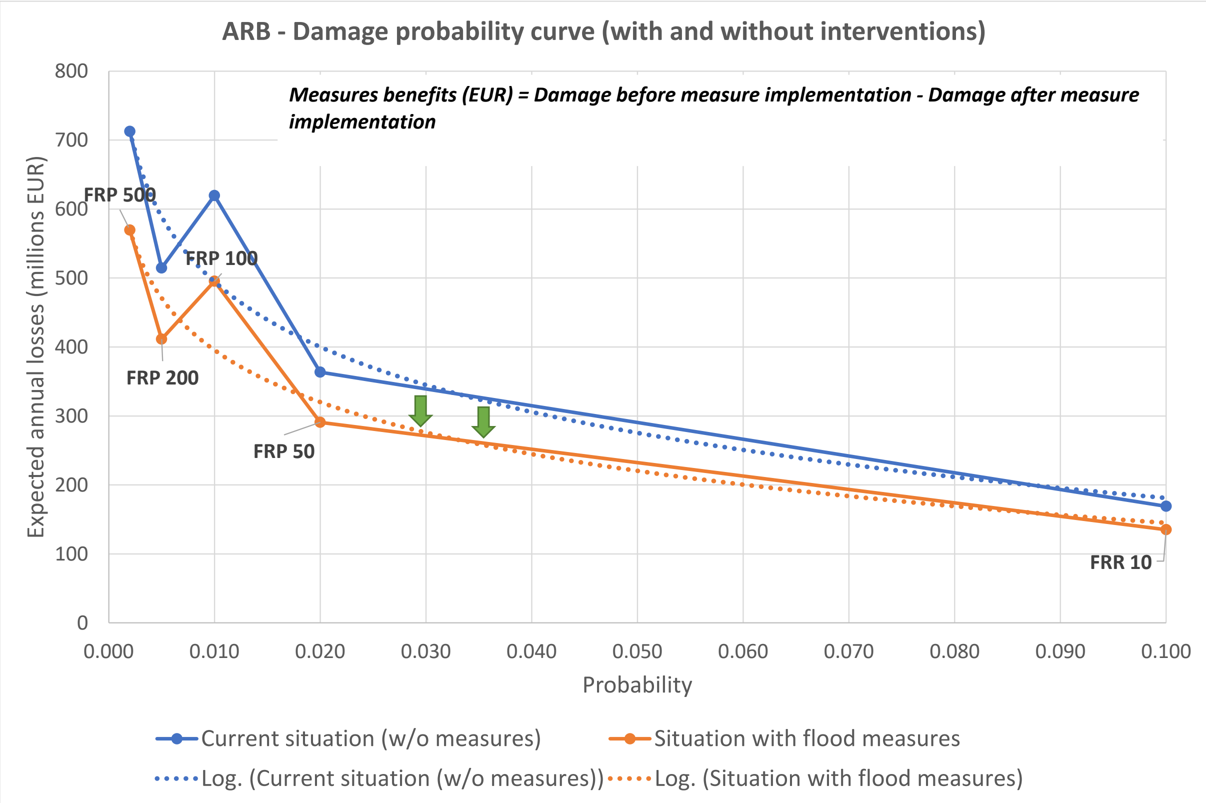
Calculation of probability of losses and discounted monetary amount of annual average damage

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 ARB. 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.

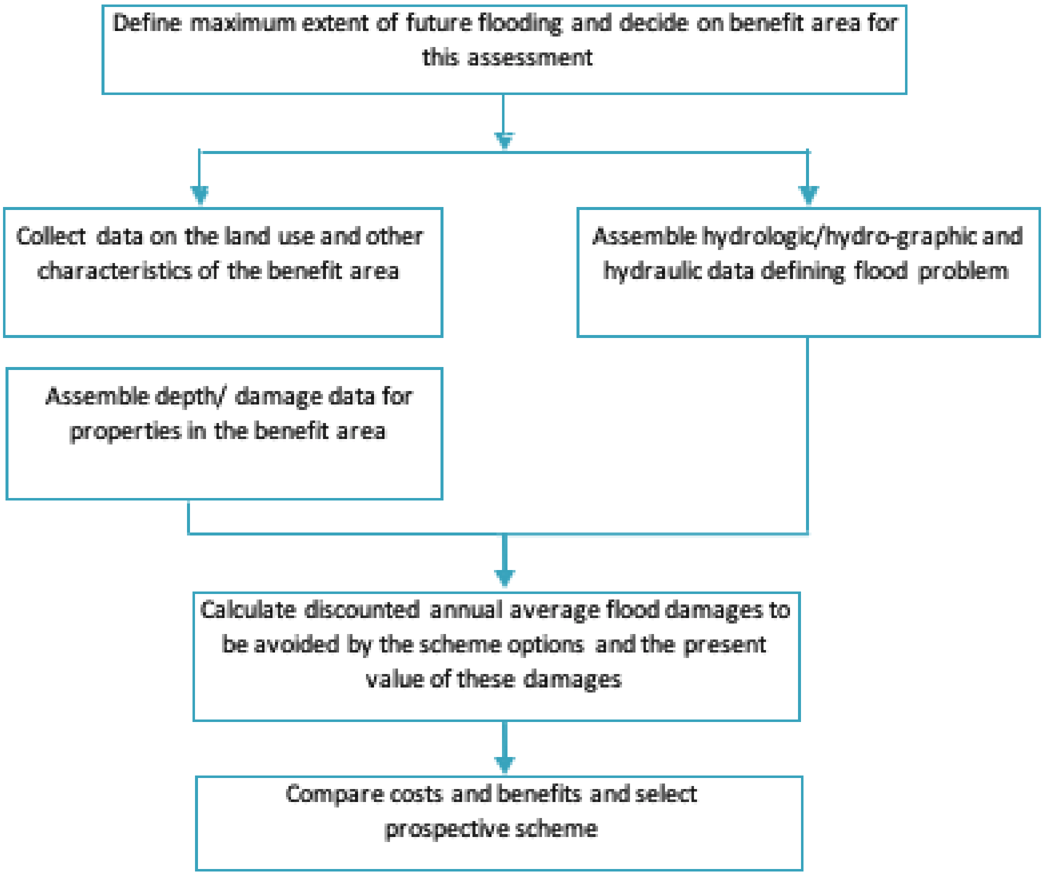
Figure 9.1. The damage probability curve for ARB



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 ARB 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.[86]

[86] 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
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).

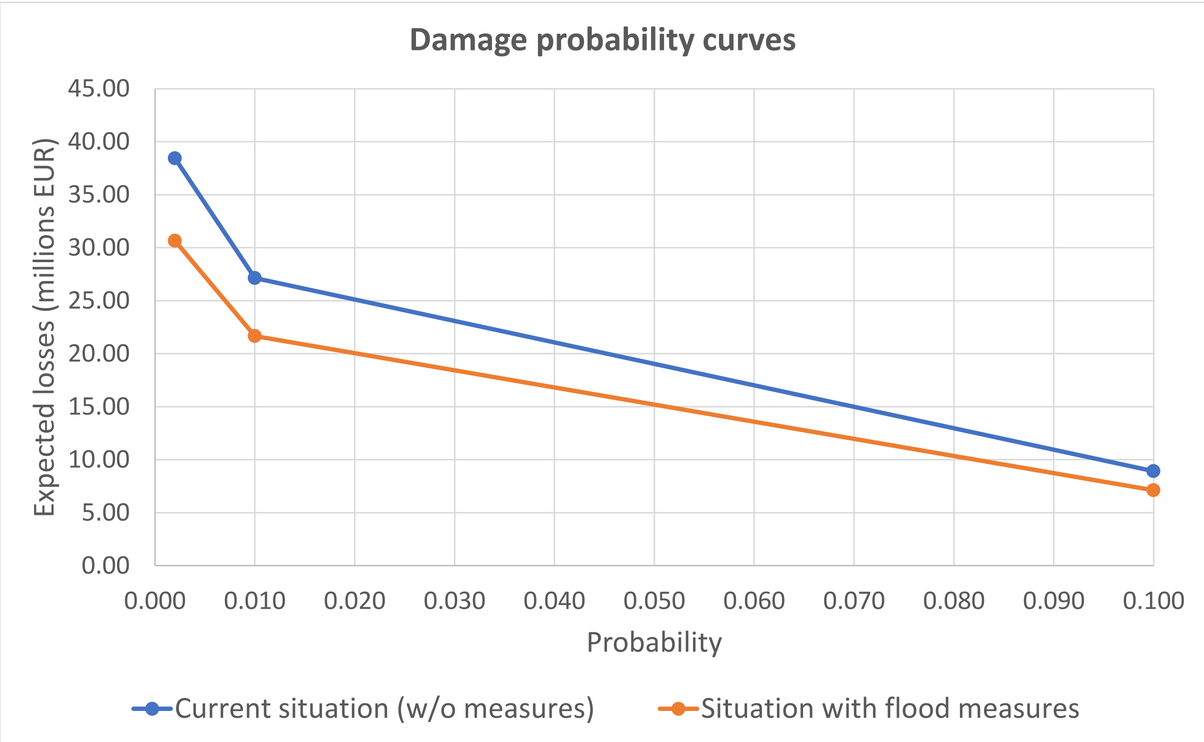
9.4 CBA of proposed measures for APSFR

The following sub-sections provide the cost benefit analysis for the APSFR. It is noted however that cost benefit analysis does not distinguish between APSFR23, 24 and 25. This is due to the fact that the individual areas of these APSFR are not yet been agreed, and, as such, the cost benefit analysis has been carried out as one single area.

9.4.1 APSFR20_ARB_Zeta01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	**0**
Intervention 1	420,000	8,400	100	**595,122**

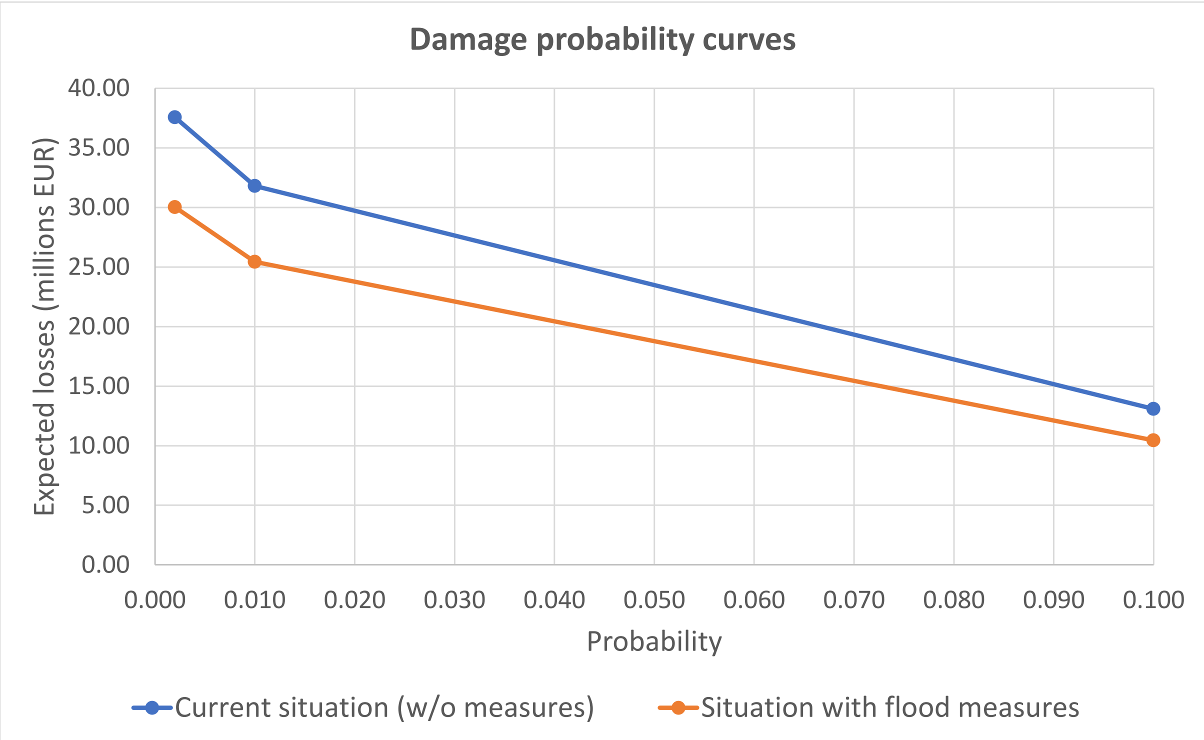
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	39,287,126					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits/ Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	31,351,933	7,935,193	595,122	13.33	7,340,070	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.2 APSFR21_ARB_Zeta02

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	**0**
Intervention 1	5,770,000	115,400	100	**8,175,849**

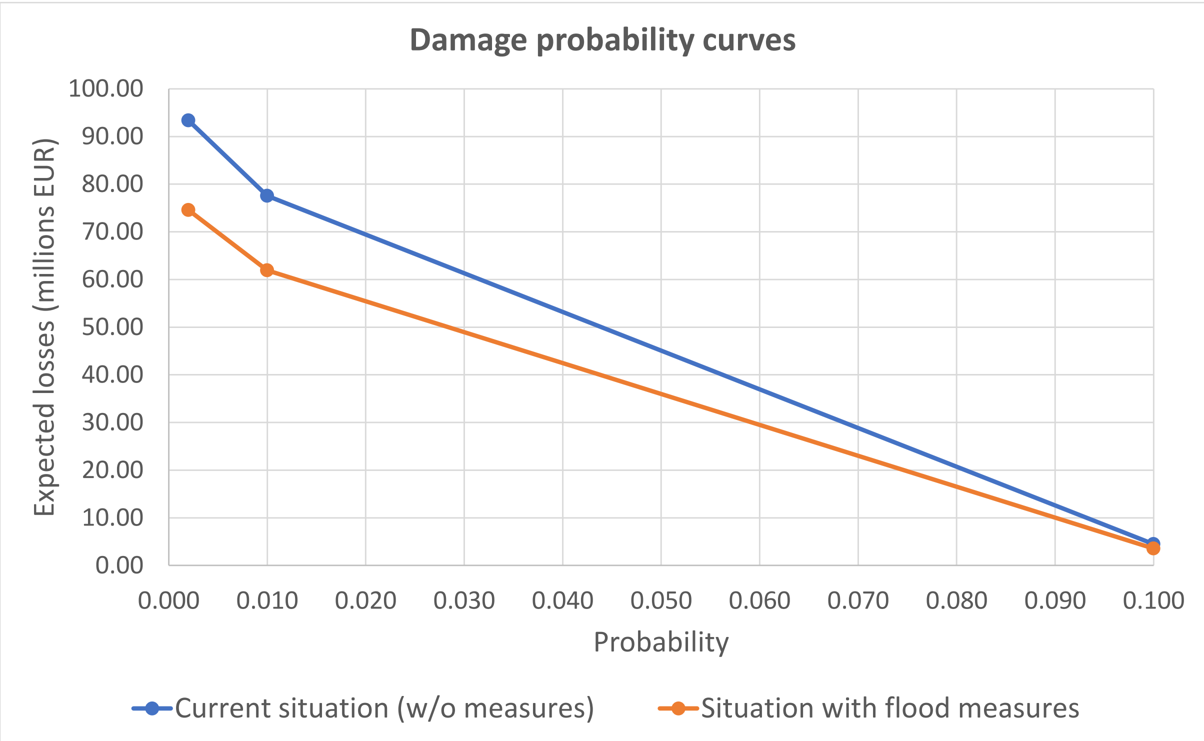
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	47,898,321					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefit s/Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	38,294,196	9,604,125	8,175,849	1.17	1,428,276	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.3 APSFR22_ARB_Cetinje Field Groundwater01

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	0	100	**300,000**

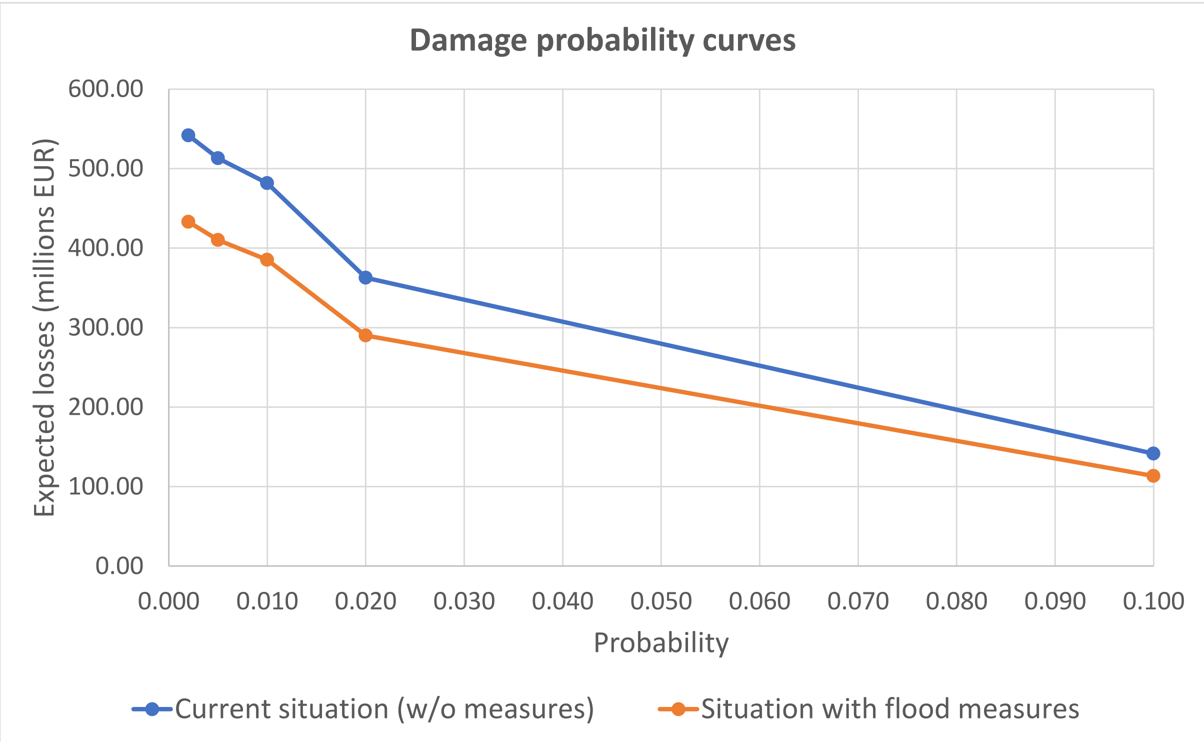
CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	91,189,643					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefit s/Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	72,812,402	18,377,241	300,000	61.26	18,077,241	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



9.4.4 APSFR23_ARB_Morača and Skadar Lake01, APSFR24_ARB_Skadar Lake02, APSFR25_ARB_Bojana01

Description	Investment costs (EUR)	Maintenance costs per year (EUR)	Life time	Average total discounted costs (EUR)
Current situation	0	0	100	**0**
Intervention 1	6.060.000	90.900	100	**7.955.075**

CURRENT SITUATION W/O MEASURES						
Future potential damage discounted (EUR)	593,342,524					
INTERVENTIONS						
Options	**Future potential damage - discounted value (EUR)**	**Benefits(*) (EUR)**	**Total costs (EUR)**	**Benefits /Costs**	**Benefits - Costs (EUR)**	**Incremental benefits/ Incremental costs**
Intervention 1	474,643,360	118,699,164	7,955,075	14.92	110.744.908	N/A
(*) Discounted value of potential future damage w/o intervention minus Discounted value of potential future damage with intervention						



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

9.5 Economic benefits for the Adriatic 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.[87] The values from this analysis are converted/adjusted for

[87] Bockarjova, Rietveld, Verhoef, 2012: „Composite Valuation of Immaterial Damage and flooding: Value of Statistical Life Value of Statistical evacuation and Value of Statistical Injury"

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.

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 (Adriatic 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	927	0.84	0.00007	1,535,384	83,694
50	790	0.84	0.00007	1,535,384	71,286
100	4,527	0.84	0.00007	1,535,384	408,684
200	2,382	0.84	0.00007	1,535,384	215,051
500	7,659	0.84	0.00007	1,535,384	691,436

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	927	0.84	0.00056	20,773	9,059
50	790	0.84	0.00056	20,773	7,716
100	4,527	0.84	0.00056	20,773	44,234
200	2,382	0.84	0.00056	20,773	23,276
500	7,659	0.84	0.00056	20,773	74,838

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	433	0.84	0.00007	1,535,384	39,085
50	480	0.84	0.00007	1,535,384	43,354
100	1,322	0.84	0.00007	1,535,384	119,357
200	874	0.84	0.00007	1,535,384	78,918
500	1,822	0.84	0.00007	1,535,384	164,466

Izračunavanje ukupne potencijalne štete u slučaju povreda

Flood return period (years)	Residents				
	Total population (#)	Exposure	Vulnerability	Damage because of injury (EUR/cap)	Total potential damage (EUR)
10	433	0.84	0.00056	20,773	4,230
50	480	0.84	0.00056	20,773	4,692
100	1,322	0.84	0.00056	20,773	12,919
200	874	0.84	0.00056	20,773	8,542
500	1,822	0.84	0.00056	20,773	17,801

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 (Adriatic 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	23,334	1	0.5	72.924	850,793
50	24,076	1	0.5	72.924	877,864
100	40,260	1	0.5	72.924	1,467,953
200	40,105	1	0.5	72.924	1,462,323
500	40,276	1	0.5	72.924	1,468,539

Intervention 1

ENVIRONMENT

Aesthetic value to the environment and services depending on biodiversity

Flood return period (years)	Flooded surface (ha)	Exposure	Vulnerability	Value of flood impact on environment (EUR/ha)	Total potential damage (EUR)
10	18,667	1	0.5	72.92	680,635
50	19,261	1	0.5	72.92	702,291
100	32,208	1	0.5	72.92	1,174,363
200	32,084	1	0.5	72.92	1,169,858
500	32,221	1	0.5	72.92	1,174,831

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.88 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.

[88] 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 (Adriatic 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	1,129,180	1	0.5	98.91	55,841,609
50	1,154,091	1	0.5	98.91	114,147,147
100	2,878,239	1	0.5	98.91	284,676,559
200	2,100,813	1	0.5	98.91	207,784,031
500	3,692,133	1	0.5	98.91	365,175,993

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	28,091	1	0.5	217.08	3,048,957
50	0	1	0.5	217.08	0
100	44,342	1	0.5	217.08	9,625,806
200	0	1	0.5	217.08	0
500	64,293	1	0.5	217.08	13,956,807

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	819,094	1	0.5	186.25	76,279,156
50	802,489	1	0.5	186.25	149,465,620
100	926,343	1	0.5	186.25	172,533,781
200	888,555	1	0.5	186.25	165,495,630
500	957,806	1	0.5	186.25	178,393,745

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	15,637	1	0.5	638.40	4,991,448
50	17,687	1	0.5	638.40	11,291,356
100	19,651	1	0.5	638.40	12,544,932
200	18,920	1	0.5	638.40	12,078,154
500	19,704	1	0.5	638.40	12,578,796

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	361,997	1	0.5	4.95	895,096
50	570,890	1	0.5	4.95	2,823,238
100	899,857	1	0.5	4.95	4,450,085
200	829,406	1	0.5	4.95	4,101,681
500	913,195	1	0.5	4.95	4,516,046

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	361,997	1	0.5	148.54	26,885,425
50	570,890	1	0.5	148.54	84,799,799
100	899,857	1	0.5	148.54	133,664,358
200	829,406	1	0.5	148.54	123,199,594
500	913,195	1	0.5	148.54	135,645,611

Table 9.7 Potential damages – Economic activity (Adriatic River Basin) with intervention

Intervention 1

ECONOMIC ACTIVITY

Potential damage on the residential buildings

Period povratka poplave (godine)	Damage on the residential buildings				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	903,344	1	0.5	98.91	44,673,287
50	923,273	1	0.5	98.91	91,317,717
100	2,302,591	1	0.5	98.91	227,741,247
200	1,680,650	1	0.5	98.91	166,227,224
500	2,953,707	1	0.5	98.91	292,140,794

Potential damage on the industrial facilities

Period povratka poplave (godine)	Damage on the industrial facilities				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	22,472	1	0.5	217.08	2,439,166
50	0	1	0.5	217.08	0
100	35,474	1	0.5	217.08	7,700,645
200	0	1	0.5	217.08	0
500	51,435	1	0.5	217.08	11,165,446

Potential damage on the commercial facilities

Period povratka poplave (godine)	Damage on the commercial facilities				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	655,275	1	0.5	186.25	61,023,325
50	641,991	1	0.5	186.25	119,572,496
100	741,075	1	0.5	186.25	138,027,025
200	710,844	1	0.5	186.25	132,396,504
500	766,245	1	0.5	186.25	142,714,996

Potential damage on the agricultural facilities

Period povratka poplave (godine)	Damage on the agricultural facilities				
	Surface area (ha)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	12,510	1	0.5	638.40	3,993,159
50	14,150	1	0.5	638.40	9,033,085
100	15,721	1	0.5	638.40	10,035,946
200	15,136	1	0.5	638.40	9,662,523
500	15,763	1	0.5	638.40	10,063,037

Potential damage on the road infrastructure

Period povratka poplave (godine)	Damage on the road infrastructure				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	289,597	1	0.5	4.95	716,077
50	456,712	1	0.5	4.95	2,258,590
100	719,885	1	0.5	4.95	3,560,068
200	663,525	1	0.5	4.95	3,281,345
500	730,556	1	0.5	4.95	3,612,837

Potential damage on the transport activity

Period povratka poplave (godine)	Damage on the transport activity				
	Surface area (m2)	Exposure	Vulnerability	Potential damage (EUR/m2)	Total potential damage (EUR)
10	289,597	1	0.5	148.54	21,508,340
50	456,712	1	0.5	148.54	67,839,839
100	719,885	1	0.5	148.54	106,931,486
200	663,525	1	0.5	148.54	98,559,675
500	730,556	1	0.5	148.54	108,516,489

9.5.4 Economic efficiency

Two economic indicators may be used to assess the economic efficiency of the proposed structural/non-structural measures in ARB.

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 Adriatic River Basin amount to 12.550.000,00 EUR, while maintenance costs are equal to 214.700,00 EUR per year. The discounted value of total costs for the project period of 100 years is 17.026.046,00 EUR.

The benefit/cost ratio is 7.57. That means the proposed intervention (investment in flood measures) in the Adriatic River Basin is worth the investment in economic terms.

Table 9.8 Potential damages – Economic activity (Adriatic River Basin) with intervention

CURRENT SITUATION W/O MEASURES	
Future potential damage discounted (EUR)	643,866,969

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)
Intervention 1	643,866,969	514,995,552	128,871,417	12,632,414	10.20	116,239,003

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.

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 of Ecology, Spatial Planning and Urbanism, is responsible for coordinating the negotiation process in Chapter 27.

Montenegro's interstate relations with respect to the Adriatic River Basin in the field of water with neighbouring countries Albania and Croatia are regulated by Agreements concluded between the states:

- Agreement between the Government of Montenegro and the Government of the Republic of Croatia on mutual relations in the field of water management, made and signed on September 4, 2007, in Zagreb, and
- Framework Agreement between the Government of Montenegro and the Council of Ministers of the Republic of Albania on mutual relations in the field of transboundary water management, in Shkodra on July 3, 2018.

The signed agreements lay the foundations for integral, continuous, and long-term regulation of issues of importance for water management of common interest or transboundary impact, on the principles of cooperation, equality and mutual respect in exercising and satisfying both individual and common rights and interests. The implementation of the contract implies the obligation to consider each open issue in detail in order to reach acceptable solutions.

In the catchment area of Adriatic River Basin is Skadar Lake, the largest lake in the Balkans. Two-thirds belong to Montenegro and one-third to Albania. The Bojana River is for the most part of its course a border river between Montenegro and Albania, and the Cijevna basin includes the territories of Montenegro and Albania. Works and facilities with a possible transboundary impact on which states must harmonize their positions are the construction of capital hydro-accumulation facilities, water transfer from one basin to another, construction of water treatment plants, especially large pollutants, regulation of rivers and other waters, etc.

Montenegro signed its first agreement with the Republic of Albania in 2001. This agreement is not fully in line with the Water Framework Directive and the two sides on the road to the European Union are expected to harmonize it.

In addition to the Agreement between the two countries in the field of water management, the following were also signed:

- Agreement between the Academies of Sciences and Arts of Montenegro and Albania in 2005.
- Memorandum of Understanding between the Council of Ministers of the Republic of Albania and Montenegro for “Cross-border Development of Skadar Lake” on 26 May 2006.
- Memorandum of Understanding between the Ministry of Agriculture and Rural Development of Montenegro and the Ministry of Environment, Forestry and Water Management of Albania on 14 December 2010.
- Memorandum for cooperation between 4 Hydrometeorological institutes (Montenegro, Albania, North Macedonia, and the Republic of Kosovo) Cooperation and Data Exchange for Flood warning in the Drim\Drin - Buna\Bojana River Basin (2011).

These Memoranda established the following:

- The unfavourable hydrological regime of Skadar Lake and Bojana River is an increasing cause of frequent floods.
- It is necessary to ensure a greater degree of protection of the shores of Skadar Lake and the Bojana River.
- Regulation of the water regime of Skadar Lake and the riverbeds of the Bojana and Drim rivers is of great importance for the general development of the border area between Montenegro and the Republic of Albania.

These documents also show the full readiness of both sides for joint action on the accelerated implementation of projects for the regulation of Skadar Lake, Bojana and Drim. The need for the adoption of an Action Plan for sustainable flood prevention in the Skadar Lake and Bojana river basins was pointed out, and short-term and long-term measures were defined. Short-term measures included the preparation of project documentation for the arrangement of the Bojana riverbed, which determined the priorities in the execution of works, agreed by both parties. Long-term measures include the development of management plans for the Skadar Lake, Bojana and Drim basins, the development of complete project documentation for the regulation of Skadar Lake, Bojana and Drim, as well as the implementation of measures defined by the projects. In order to coordinate and harmonize activities on the implementation of both short-term and long-term measures, both countries have formed Commissions, which have developed an action plan and detailed defined urgent measures that need to be taken. The exchange of data has proved very good during flood management in the last few years and thus the negative impact of floods has been reduced.

The agreement between the Government of Montenegro and the Government of the Republic of Croatia was signed in order to develop direct long-term cooperation in the field of waters of common interest, which contributes to the improvement of overall mutual relations, as well as relations in the region.

Based on the Agreement, a Standing Montenegrin-Croatian Commission for Water Management of Common Interest was formed, as well as a subcommittee:

- Subcommittee for Pipeline Plat Herceg Novi.
- Sub-commission for regulation of mutual relations related to the issue of using the potential of the Trebišnjica river basin, and
- Subcommittee on Mutual Relations in the Field of Protection of the Adriatic Sea.

So far, intensive work has been done at the level of state commissions, as well as subcommittees for the Plat Herceg Novi pipeline. Current issues that are important for mutual relations in the field of water management are:

- Signing a trilateral agreement between Montenegro, Croatia and Bosnia and Herzegovina regarding the use and protection of waters of common interest, especially the waters of the Trebišnjica River Basin.
- Water supply of Herceg Novi from the Republic of Croatia from the Plat reservoir until the final solution of water supply from the Regional Waterworks.
- Resolving the issue of mutual relations in the field of protection of the Adriatic Sea.
- Joint activities in the work of the Danube and Sava Commission.

From the point of view of the interests of Montenegro and its water resources in the Adriatic River Basin, bilateral cooperation should be achieved with Bosnia and Herzegovina. For now, cooperation with Bosnia and Herzegovina is being realized through the Sava Commission.

10.2 Regional Projects

The Ministry of Agriculture, Forestry and Water Management, in cooperation with UNDP, is implementing regional project Integrated climate-resilient transboundary flood risk management in the Drin River basin in the Western Balkans (Albania, the Former Yugoslav Republic of Macedonia, Montenegro). The objective of the project is to assist the riparian countries in the implementation of an integrated climate-resilient river basin flood risk management approach in order to improve their existing capacity to manage flood risk at regional, national and local levels and to enhance resilience of vulnerable communities in the DRB to climate-induced floods. The countries will benefit from a basin-wide transboundary flood risk management (FRM) framework based on: improved climate risk knowledge and information; improved transboundary cooperation arrangements and policy framework for FRM and; concrete FRM interventions.

Within this project, $2.3 million will be spent on the regulation of the river Bojana, the river Gracanica in the area of the municipality of Nikšić, as well as on the strengthening of institutions and measures to eliminate the negative anthropogenic impact on the watercourses of the Drim basin.

In March 2020, the United Nations Development Program (UNDP) announced a tender for the development of the main project for the regulation of the Bojana River. The deadline for drafting the project is the end of 2021. After the tender procedure was carried out, the most favorable contractor was selected. In mid-2024, works were carried out on the part of the repair of the protective embankment in the length of about 200m on the Gropat-Stodra section. The value of this investment is around €700,000. The deadline for the completion of the works is the end of October 2024. Also, a contractor was selected to develop a project for the regulation of the river Gracanica in the municipality of Nikšić. The deadline for drafting this project is July 2021. In order to continue the implementation of this project, it is necessary to apply for funds from EU pre-accession funds.

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 Adriatic basin and the measures given in the River Basin Management Plan for the Adriatic basin in relation to environmental protection goals

The River Basin Management Plan for the Adriatic 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 Adriatic 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 Adriatic 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	% reduction of contamination	30	50	80

entering groundwater bodies				
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

The measures provided for in the Flood Risk Management Plan for the Adriatic Basin will contribute to the achievement of the environmental protection goals set out in the River Basin Management Plan for the Adriatic Basin.

12 PUBLIC INFORMATION AND CONSULTATION

In accordance with Article 95f of the Water Act 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 development of the Flood Risk Management Plan (FRMP) for the Adriatic River Basin District, as well as the accompanying Strategic Environmental Assessment (SEA). The Water Administration, in line with the applicable legal framework, was obliged to provide active participation of the public and interested parties in the procedure of preparing and adopting the Flood Risk Management Plan, and to make all relevant documents available. The preparation of the plans (for both river basin districts) and accompanying assessments was conducted 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 was held from 21 august to 21 september 2024, during which all interested parties were able to submit comments, suggestions and proposals to the Water Administration by email or by post to the official institutional address. The public was informed of the consultation in a timely manner through the official websites of the Ministry and of the Water Administration, as well as through media outlets. The central event of the consultation was the Conference held on 18 september 2024 in Podgorica, attended by representatives of the Ministry of Agriculture, Forestry and Water Management, the Water Administration, the Environmental Protection Agency, the Capital of Cetinje, the Electric Power Company of Montenegro, and representatives of the Sava and Drina Integrated Development Program (SDIP). Consultants involved in preparing the Flood Risk Management Plan from the company EPTISA also took part, as well as consultants from EcoEnergy Consulting, responsible for the Strategic Environmental Assessment. Presentations focused on the technical and methodological aspects of the plan preparation, criteria for prioritization and financing of measures, and possibilities for integrating proposed activities into local development plans and improving cross-border cooperation.

A significant number of comments and suggestions (ANNEX 3) were submitted during the public consultation by the Ministry of Agriculture, Forestry and Water Management, the Water Administration, the Ministry of the Interior, and other institutions. Most comments related to harmonization of technical and financial data between the Montenegrin and English versions of the document, updating project status information, investments and relevant regulations, and clarifying geographical, demographic and terminological data. Remarks related to chapter consistency, updating decisions and legislative references, and ensuring unified presentation of data across all chapters and annexes were particularly emphasised. Cooperation between institutions and plan developers was highly constructive, and most comments were accepted and incorporated into the final version of the Plan, thereby improving the document, technically aligning it and fully harmonising it with the current legislation and EU standards.

Following the consultation, the draft Flood Risk Management Plan for the Adriatic River Basin District was forwarded to neighbouring countries for opinion through the Ministry of Foreign Affairs on 31 March 2025, in line with cross-border cooperation obligations and principles of integrated water resources management prescribed by the Water Framework Directive and the Floods Directive. The deadline for submitting opinions was 31 May 2025. No opinions were received within the prescribed period.

LIST OF PARTICIPANTS:

18 September 2024, Podgorica

Name	Institution
Željko Furtula	Ministry of Agriculture, Forestry and Water Management
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Figures 12.1. Public Hearing in Podgorica

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 RMNE 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, ie 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, ie 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 neighboring 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

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

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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
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.	Atr 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.[89]
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

[89]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, item 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.[90]
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

[90] 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	Fullytransposition

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 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	Article 8, paragraph 1, item 1, 2, 3, 4 and 8 of the Rulebook: The flood risk management plan (hereinafter: the plan) contains: 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;	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
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.	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.	
II. Description of the implementation of the plan: 1. a description of the prioritisation and the way in	Article 10 paragraph 1 of the Rules: The implementation of the plan is carried out in accordance with the Action	

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
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.	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.	
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.	

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.	2.3.4	- Art. 219 - Align the last paragraph with the current activities on the project.	page 222
2.	2.3.4	- Show the total costs of the proposed structural measures in Table 8.4 and reconcile them with the costs presented in Tables 9.4.1 to 9.4.4.	Modified
3.	2.3.4	For example, the total indicative costs from Table 8.4 amount to €12,570,000, while from Tables 9.4.1 to 9.4.4 they amount to €12,930,000.	Modified

WATER ADMINISTRATION

No.	Chapter	COMMENT	RESPONSE
1.	2.4	“The law defines a water area in Article 5 (for the Adriatic basin water area) as a land area, which consists of one or more adjacent river basins...”. After the word land, the term seas should also be added, in accordance with Article 5, paragraph 1, item 80.	Included
2.	2.5 ENG	In the English version, instead of for the Danube catchment area, it should be for the Adriatic.	Modified
3.	6.2.1 ENG	In the ENG version, the sentence '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 basin, the following data were available' should be renamed to the actual water area (Adriatic)	Modified

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		and the correct number of APFSR areas (6)	
4.	2.6 ENG	In the ENG version, chapter 2.6 begins with the sentence 'Chapter VII of the Directive, consisting of Article 14 and 15', whereas in the MNE version it begins with 'Chapter VIII of the Directive, in Articles 14 and 15'. Since the EU directive recognizes Articles 14 and 15 in Chapter VIII, the English version of the document needs to be corrected.	Modified
5.	2.9	"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 Regulations.
6.	3.3	The Demographics chapter refers to data from the 2011 Census. The comment pertains to the fact that in the meantime the municipality of Zeta has been formed, that the number of municipalities has increased, and that a new population census has also been conducted in Montenegro.	Partially, detailed data from the new census, which would allow us to present new calculations, are not available. Some of the text has been supplemented with data from the new census that are available.
7.	3.4 ENG	The English version of the	Modified in the MNE

		document recognizes about 300 springs in the Nikšić field, as well as 30 estavelles, 30 watercourses, and 890 sinkholes, while the MNE version does not note the same. Align the MNE and ENG versions.	version
8.	3.4 ENG	"Morača in the village of Vukovci just before the confluence with Skadar Lake (low and high waters)" – the sentence is incomplete and has been removed in the MNE version	Modified in the English version
9.	4.1	In Chapter 4.1, it is indicated that historical hydrological data related to recorded major (potential) flood waters at the network of hydrological stations in Montenegro have been analyzed since 1952, when water level measurements on rivers began (Table 4.3), while Chapter 3.6 notes that 'at all stations, decreases in flow were recorded for the period from 1948 to 2014.' Also, Table 3.10 recognizes 1948 as the starting year. Which of these statements is correct, i.e., since when has the water level been monitored?	Amended in chapter 3.6
10.	4.1.2	The Sutorina River basin, although it could be identified as an APSFR area, is not considered one because there is no hydrological data available in this area, so return periods cannot be calculated. It is also suggested to improve monitoring, with the note that Chapter 8.3, which relates to the proposed non-structural measures for APSFR, should specifically recognize the improvement of monitoring, among other things, particularly for this watercourse.	Statement. Given through measure 41 in chapter 8.3.
11.	4.2.1	In the section on Flood Protection	Deleted that the works

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		on the Morača River, it is noted that the execution of works according to the 2010 project is still ongoing. After 2010, the project was supplemented, but regulatory works are not being carried out, and this needs to be corrected in both the MNE and ENG versions.	are in progress
12.	4.2.2	In the section on Flood Defense on the Sutorina River, only the project from 2005 is mentioned, but not activities related to the Project for the construction of hydraulic infrastructure – regulation of part of the Sutorina River bed over a length of approximately 750m, for which, in addition to the revised project documentation, an Environmental Impact Assessment Report was also prepared. If this project does not need to be recognized in the Chapter related to existing infrastructure, it should have been at least mentioned in some other FRMP chapter.	It is adopted.
13.	4.2.3	In the section on Flood Defense on the Bojana River, it is necessary to update the data on activities in the project 'Integrated Flood Risk Management in the Drin River Basin,' both in terms of activities on the Bojana River and concerning the Gračanica River. The originally planned activities in this project, which, as stated in the text, are carried out by the Ministry of Agriculture, Forestry and Water Management in cooperation with UNDP and funded by the Adaptation Fund, underwent various phases, with the implementation of measures at one location beginning in 2024.	It is adopted, added to the text

14.	5.1.2	The text states that if the 'catchment area from which water flows to that location is < 20 km², and there is no permanent river or stream, and there is a rapid response (less than 6-8 hours of runoff) to rainfall in the basin, it is defined as a heavy rain or flash flood. If the catchment area is > 20 km² and there is a permanent river or stream, it is defined as a river flood.' For this statement, it would be desirable to provide the source of information and the context of the catchment area sizes in Montenegro in relation to catchment area sizes in other countries.	Partially YES
15.	5.3	Chapter 5.3 refers to Identified APSFR areas in the Adriatic Basin. Not only this chapter, but the entire planning document, does not recognize the Decision on the designation of areas significantly at risk of floods ("Official Gazette of Montenegro", no. 030/22 of 21.03.2022). The decision was adopted by the Government at the session on February 24, 2022, based on Article 95c, paragraph 1 of the Water Law, and it must be acknowledged both in this chapter and in all other chapters, especially considering that this current subordinate regulation contains, among other things, the designations (codes) of areas significantly at risk of floods.	Included
16.	5.4	FRMP in chapter 5.4 provides conclusions from the Preliminary Flood Risk Assessment, and immediately after that, it moves on to hazard maps and flood risk maps. We believe that the document should also include conclusions for APSFR areas, along with a statement on the adopted	Partially adopted

		Decision on the designation of areas significantly at risk of flooding.	
17.	6.3	Opačića or Opačica	Added
18.	6.3	Footnote 47 states that after the review and approval of all maps by the Flood Working Group, the files will be removed from Google Drive and delivered to the Client as a single annex (Map Atlas) to the FRMP. The maps are an integral part of the plans and, in accordance with the law, are submitted to the European Commission, so it would be beneficial for them to be available to the general public during the public consultation process, regardless of the role of the Flood Working Group, as they can be commented on during the public consultation process.	Statement, adopted
19.	6.5	In the section on flood risk related to economic activities, the MNE version has, among other things, code B43, while the English version does not have it. However, table 5.5 for APSFR22_ARB_groundwater of the Cetinje field01 recognizes B41 as the only code for economic activities.	It will be corrected in the EN version
20.	6.7.	In the flood risk section related to the flood mechanism in the MNE version, code A22 is missing (it exists in the ENG version). Since table 5.5 recognizes both code A21 and code A22, it is necessary to correct the MNE version.	Included in the MNE version
21.	6.8	The conclusions drawn from the maps indicate that, based on hazard maps and flood risk maps, it has been calculated that 6,969 people in the Adriatic basin are	Adopted, corrected

		potentially at risk from medium-risk floods (HQ100), and 1,687 residential buildings are at risk. A total of 76 industrial and 1,607 agricultural facilities are also at risk during medium-risk floods. The conclusions drawn from the maps indicate that, based on hazard maps and flood risk maps, it has been calculated that 6,969 people in the Adriatic basin are potentially at risk from medium-risk floods (HQ100), and 1,687 residential buildings are at risk. A total of 76 industrial and 1,607 agricultural facilities are also at risk during medium-risk floods. Below are Tables 6.9-6.14, and by summing them, the following data is obtained: - Summing the number of people at risk from Tables 6.9-6.14 results in a figure of 5,362, while the conclusions cite a figure of 6,969 people at risk. - Summing the number of residential buildings at risk from Tables 6.9-6.14 results in 1,118 residential buildings and 666 weekend houses, while the conclusions cite a figure of 1,687 residential buildings at risk. - Summing the number of industrial facilities at risk from Tables 6.9-6.14 results in 105 industrial facilities at risk, while the conclusions cite a figure of 76 industrial facilities at risk, while in the ENG version, adding up leads to the figure of 76 endangered industrial facilities; - The number of endangered agricultural facilities matches the figure from the conclusions (in	

		both the MNE and ENG versions).	
22.	6.8	- The number of endangered agricultural facilities matches the figure from the conclusions (in both the MNE and ENG versions).	Repeats from the previous row
23.	6.8	In tables 6.9 – 6.14, in the section on risk assessment / significance of potential risks, check which footnote numbers each table refers to (e.g., see footnotes 47 and 48 / 53 and 54 / 29 and 30).	The footnote numbers in the comment are incorrect.
24.	6.8	The decision on designating areas significantly endangered by floods recognizes the settlement of Vranjina, while Table 6.12 does not recognize Vranjina.	Included
25.	6.8	UNESCO cultural heritage for APSFR23_ARB_Morača and Lake Skadar01 is recognized in the MNE version as a value below the threshold criteria (colored green), while in the ENG version it is colored red. Check and correct.	Modified
26.	6.8	In Table 6.13 in MNE for APSFR24_ARB_Skadarsko jezero02, the number of endangered industrial facilities (29) is shown, while in the ENG version the designation NR (Not recorded) is given. Verify and correct.	Accepted
27.	6.8	Table 6.14 shows the average flood risk for APSFR25_ARB_Bojana01, where the number of endangered residential buildings is listed as - 36 residential buildings and 666 holiday homes, while in the description of possible damage, the following statement is made: "At the mouth of the Bojana River, there is a huge complex with 390 buildings (fishermen's houses, holiday homes, and restaurants)."	Both. Not all houses and cottages are at risk.

		The question is which of this is correct.	
28.	7.2	In this chapter, as well as in all other chapters, it would be desirable to use designations from the regulations (e.g., the ministry responsible for water affairs) instead of the names of ministries (e.g., Ministry of Agriculture, Forestry and Water Management). This is all because, for example, in this chapter the Ministry of Ecology, Spatial Planning and Urbanism is mentioned, which no longer exists.	Modified
29.	8.2.1.	Table 8.2. The proposed measures in APSFR20_ARB_Zeta01 northern region in the MNE version detect the key types of measures M21, M24, M33, M41, while the ENG version detects measures M21, M32, M33, M41. Check which version is correct and adjust accordingly.	The English version will be aligned with the MNE version.
30.	8.2.1.	On page 155, 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 in the Measures Program entail. Whether the explanation will be given at the beginning of Chapter 8 or for each measure individually is a question for the plan's authors, but we believe that clarifying this measure is of crucial 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 this protection as well as its storage (in practice: who has the capacity, equipment, and space for this type	This issue should be defined in the Strategy for Disaster Risk Reduction and in the action plan.

		of protection).	
31.	8.2.1.	For each of the APSFR areas, the competent authorities are listed. As we have indicated with 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 (8.2-8.8), the Ministry of Capital Investments is mentioned, which also no longer exists. Therefore, we once again propose introducing the term – ministry or administrative body competent for the matters of .... Also, the general comment also applies to the competent authority according to the division of waters, to waters of importance for Montenegro and waters of local significance. In this regard, the competence will not be the same for the rivers Zeta, Morača, Bojana, and Lake Skadar, as it is for the cleaning of canals and streams of local significance.	Adopted, corrected
32.	8.2.1.	In Table 8.3. Proposed measures in APSFR20_ARB_Zeta01, the southern region has no image for the southern area (2). This is a technical error that can easily be corrected, considering that the image exists in the ENG version.	It had already been corrected
33.	8.2.2.	Table 8.4. Proposed measures in APSFR21_ARB_Zeta02 in the MNE version detect only M33 as a key measure type, while the ENG version shows both M33 and M34. Also, in the MNE version, the proposed measure for area (2) is shown as M33 - Channel cleaning - deepening and vegetation clearing, whereas for the same item in the ENG version, measure M34 is prescribed (M34 - Cleaning	The English version will be aligned with the MNE version.

		the ducts - deepening and clearing of vegetation). Check which version is correct and adjust accordingly. In summary, in chapter 8.4, only measure M33 is noted in both the MNE and ENG versions of the documents.	
34.	8.2.2.	The phrase 'High waters during flood waves cannot be evacuated' should be rephrased	The English version will be aligned with the MNE version.
35.	8.2.3	Figure B. Hydrograph of the spring flow of the Crnojević River – check if the translation is correct	Modified
36.	8.2.4	In Table 8.6. Proposed measures in APSFR23_ARB_Morača and Skadar Lake01 for the part concerning the area, the question is whether areas (1) Vranjina and (9) Tuzi are missing. They are included in the ENG version, and these areas are also defined by the Decision on the determination of areas significantly threatened by floods specifically for this APSFR area.	Modified in the MNE version
37.	8.2.4.	Table 8.7. The proposed measures in APSFR24_ARB_Skadarsko Lake02 include the following areas: “Settlements (as shown in Figure 8.4): Rijeka Crnojevića (10), Dodoši (11), Žabljak Crnojevića (12), Virpazar (13), Boljevići (14), Dupilo (15), Karuč (16), Krnjice (17), Prevlaka (18). In the section of proposed measures for areas (10-18), the settlement Vranjina is shown - M33 Vranjina (13) - mobile protection 350m long, but the problem is that according to the Decision, the settlement Vranjina does not belong to this APSFR area (Vranjina is, according to the Decision, part of APSFR23_ARB_Morača and Skadarsko Lake01). Even the nomenclature in Chapter 8.2.4 is	Adopted, corrected

		not consistent (Vranjina (13), Virpazar (13), Virpazar (14)).	
38.	8.2.5	Align the program of measures with the current and planned future implementation dynamics of the project 'Integrated Flood Risk Management in the Drim River Basin.' Align the implementation status in documents in both languages, as they differ almost completely, as well as part of the investment costs (in the ENG version, the investment costs are €650,000, while in the MNE version the value is around €5,000,000).	The English version will be aligned with the MNE version.
39.	8.3	In the section of the proposed non-structural measures for APSFR, it is stated that workshops with the participation of the institution responsible for construction, particularly planning and infrastructure, could be financed, among other things, by water fees. Is this statement in accordance with the Law on Financing Water Management, i.e., can workshops be financed from water fees?	Adopted, corrected
40.	8.3	Is the term 'reservoir' appropriate, or should it be corrected in certain places in the document?	It's okay with me for this term to remain in the table in chapter 8.3.
41.	8.4	Chapter 8.4 provides a summary of the proposed structural measures. Indicative costs are given in accordance with those provided in the Measures Program. In the summary, as well as in the cost-benefit analysis (CBA), it is stated that the total estimated investment costs for the planned measures in the Adriatic River Basin amount to 12,930,000 euros, while chapter 8 gives a total figure of 12,570,000 euros. This	Corrected and reconciled. The total is 12,550,000 euros.

		important section must be interpreted in a valid manner, and it must also be aligned with the adjustments related to measures on the Bojana River.	
42.	9.4.4.	The Montenegrin and English versions of the document in chapter 9.4.4. differ completely. Investment costs, annual maintenance costs, and average total discounted costs are more than twice as high in the Montenegrin version as in the English version.	The English version will be aligned with the MNE version.
43.	9.5.1.	Table 9.3. Potential damages – Human health for the Adriatic basin provides data with return periods of 10, 50, 100, 200, and 500 years, while the same table for the Danube basin provides return periods of 10, 100, and 500 years. We believe that the document must include an explanation or a correction must be made.	Data relating to return periods of 50 and 200 years were taken from a previous analysis conducted by GIZ. A similar analysis for these return periods has not been conducted for the Danube River Basin.
44.	9.5.2	Table 9.4. Potential damages – Environment for the Adriatic basin provides data with return periods of 10, 50, 100, 200, and 500 years, whereas the same table for the Danube basin provides return periods of 10, 100, and 500 years. We believe that the document must include an explanation or a correction must be made.	Accepted. Corrected.
45.	9.5.3	Table 9.6. Potential damages – Economic activity without intervention for the Adriatic basin provides data with return periods of 10, 50, 100, 200, and 500 years, while the same table for the Danube basin gives return periods of 10, 100, and 500 years. We believe that the document must include an explanation or a	Adopted. Corrected

		correction must be made.	
46.	9.5.3	Table 9.7. Potential damages – Economic activity with intervention for the Adriatic basin provides data with return periods of 10, 50, 100, 200, and 500 years, while the same table for the Danube basin provides return periods of 10, 100, and 500 years. We believe that the document must include an explanation or a correction must be made.	
47.	9.5.4.	Chapter 9.5.4 - Economic efficiency must be identical in the Montenegrin and English versions of the document. The figures are different, so by correcting the previous tables, they should be identical and in accordance with the changes.	The English version will be aligned with the MNE version.
48.	9.5.4.	The total estimated investment costs of the planned measures for the Adriatic Basin in the MNE version amount to €12,930,000. This figure matches the numbers given in the CBA chapters 9.4.1-9.4.4. However, the Measures Program provides a total indicative figure of €12,570,000. The English-language document in chapter 9.5.4 gives a figure of €9,180,000, while in the summary, the total for the measures program also provides a figure of €12,570,000.	Corrected and reconciled. The total is 12,550,000 euros.
49.	9.5.4	In chapter 9.5.4 of the MNE version, as well as in the summary, it is stated that the maintenance costs are 218,900 euros per year (which matches the tables in the CBA chapter, but not the indicative costs in the Measures Program), while in the English	The English version will be aligned with the MNE version.

		version it is noted that the annual maintenance costs are 165,600 euros.	
50.	9.5.4	The discounted value of total costs for the 100-year period in the MNE version amounts to €17,493,608, while in the English version it amounts to €12,632,424.	The English version will be aligned with the MNE version.
51.	9.5.4	The benefit-to-cost ratio in the MNE version is 7.37, while in the ENG version the benefit-to-cost ratio is 10.2.	The English version will be aligned with the MNE version.
52.	9.5.4	Table 9.8 Potential damages – Economic activity (Adriatic basin) with intervention is not the same in the MNE and ENG versions.	The English version will be aligned with the MNE version.
53.	10.1	In the area of international cooperation for the Adriatic Basin, it would be appropriate to note the cooperation of the Ministry of Internal Affairs (Directorate for Protection and Rescue) with international partners in the field of flood protection.	It is about international cooperation.
54.	10.2	Chapter 10.2 needs to be updated, especially regarding the implementation of the project on the Bojana River, but also in Gračanica (2.3 million dollars, the deadline for the preparation of this project is July 2021). There is also a question of whether to note activities related to small hydropower plants on the Cijevna River and activities on Bileća Lake, because even though these are areas not recognized as APSFR areas, they are correlated with the chapter concerning international cooperation.	The works on the rivers Bojana and Gračanica have been acknowledged and the text has been supplemented.

55.	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 88, 89, and 90, 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.	
56.	ANNEX 4	Annex 4 differs in the MNE and ENG versions.	Modified
57.	ANNEX 5	While the MNE version has ANNEX 5, it is not included in the ENG version of the document.	The English version will be aligned with the MNE version.

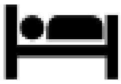
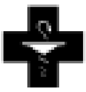
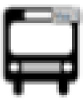
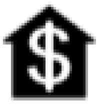
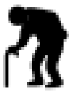
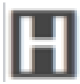
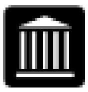
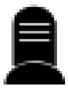
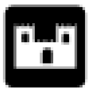
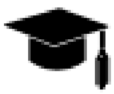
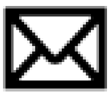
MINISTRY OF INTERNAL AFFAIRS

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 including the new strategy, which will replace the previous one for the period 2018–2023.	Added strategy (old)

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 2017 Water Management Strategy. 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 the implementation of 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 plans.	Modified

3.	3.3	The state territory is administratively divided into 25 municipalities, not 24 as stated in the text. This needs to be corrected in both plans. Figure 9.2. Phases in calculation, page 341 (Flood Risk Management Plan for the Danube River Basin District) and page 301 (Flood Risk Management Plan for the Adriatic River Basin District) Proposal to translate this table from English into Montenegrin.	Modified
4.		In both plans, replace the term 'emergency response' with the term 'response in case of natural disasters, major and other accidents'.	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

ANNEX 5: APSFR20_ARB_ZETA01 COMBINED MAPS OF THE NORTH AND THE SOUTH REGIONS

Figure A4.1 Floods extent in APSFR20_ARB_Zeta01 (HQ100) – North and South Regions together

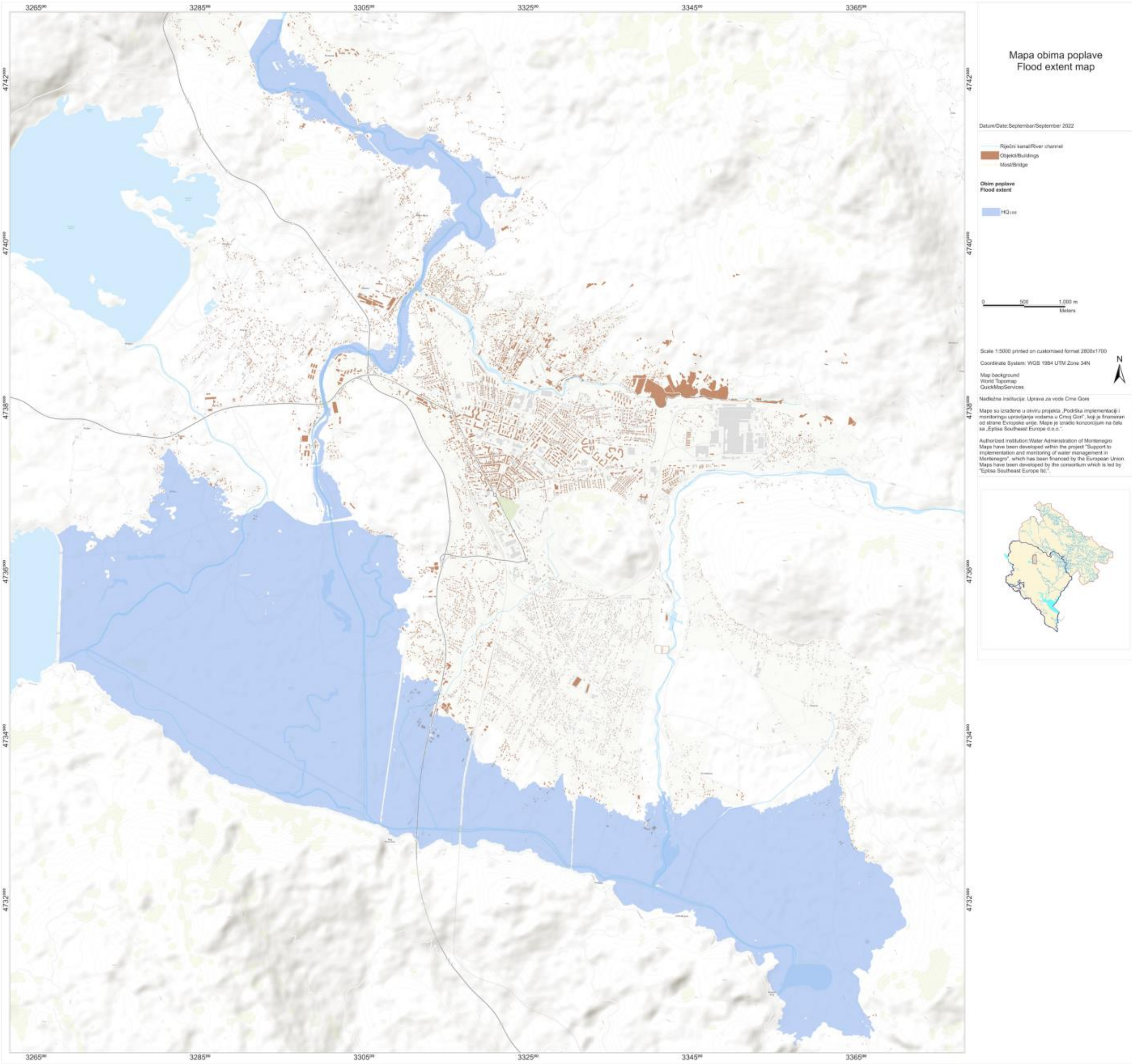


Figure A4.2 Floods depth in APSFR20_ARB_Zeta01 (HQ100) – North and South Regions together