

Article

The Role and Significance of Operational Flood Defense Plans on the Waters Second-Order in Republic of Serbia

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Abstract: The aim of this research is to present the role and importance of planning documents for flood defense during the development of the Flood Risk Management Plan (FRMP) in the Republic of Serbia. The scope of the work is the Operational Plans for Flood Defense on Second-Order Waters (OPFDSWs), which are the responsibility of local governments units (LGU). The paper contains an overview analysis of the implementation of the Flood Risk Management Directive (FRMD) in the legal framework of the Republic of Serbia, as well as an analysis of the legislative framework in the field of flood defense. The method of multi-criteria analysis was used for a qualitative assessment of the elements that are part of the OPFDSW. Through the results and discussion of the work, the similarities between the OPFDSW and FRMP were highlighted and explained, which can serve to better understand the importance of quality production of the OPFDSW. In order to harmonize all activities on the territory of LGU, care should be taken that planning documentation for flood protection occupies one of the priority activities in the management of planning acts. The conclusion is that it is necessary to clearly define the rulebook on the methodology for the preparation of the OPFDSW, all in the function of the preparation of the FRMP.

Keywords: flood directive; flood defense plan; flood protection; disaster risk reduction; multi-criteria analysis



Citation: Drobnjak, A.; Ristić, R.; Dragović, N. The Role and Significance of Operational Flood Defense Plans on the Waters Second-Order in Republic of Serbia. *Water* **2024**, *16*, 2255. <https://doi.org/10.3390/w16162255>

Academic Editor: Maria Mimikou

Received: 26 June 2024

Revised: 25 July 2024

Accepted: 2 August 2024

Published: 10 August 2024



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1. Introduction

Floods are the world's most common disaster, and climate change has detectably influenced several water-related variables that increase the hazard risk, jeopardizing the ecosystem, built environment, and human lives [1]. Making decisions on how best to protect life and property from floods is an ongoing challenge [2]. However, due to climate change, the number of flood hazards and communities at risk is expected to increase [3]. The frequency and intensity of extreme flood episodes have been increasing, and their relationship with climate change is undeniable [4–7]. In particular, flood episodes set human lives at risk and have significant social and economic consequences [8–11]. The changing patterns of risk exposure have led to a growing understanding that flood risk cannot be eliminated, and structural flood defenses do not guarantee communities' resilience [12,13]. Understanding flood risk management includes understanding the consequences that come with the risk and developing strategies to minimize or mitigate the risk [14]. Human activities have caused alterations to land use, climate, and precipitation in the past century, with a marked increase in flooding occurrence in recent decades [15,16]. Flooding events in Europe in the period 1998–2009 caused more than 1100 fatalities and the displacement of about one million inhabitants. Total reported economic losses caused by weather and climate-related extremes in the European Economic Area member countries over the period 1980–2015 amounted to over EUR 433 billion, with the largest share of the economic impacts (38%) caused by floods [17,18].

Solid mechanisms to help society recover from flood events are crucial in any flood risk management framework, and financial compensation plays a central role [19]. Flood recovery schemes have already been analyzed in depth from the perspective of solidarity and accessibility [19–22]. Governments in Europe increasingly invest in adaptation to the impacts of climate change, such as more floods and droughts [23]. The Netherlands, for example, has decided to invest approximately EUR 1 billion per year in flood risk management and freshwater supply until the end of 2028 [24], and the European Union has earmarked 20% of its budget for climate-related investments [25].

Poland has had several large, destructive, pluvial, fluvial and flash floods in recent decades, such as flood events in 1997 and 2010. After the floods of 1997, a program was started with help from the World Bank and later also the European Union, which, as a novelty, included creating more room for rivers in order to decrease flood risk [26]. Significant improvements in terms of flood risk management were also made. However, in Poland, it is difficult to create societal support for more far-reaching restrictions on spatial development as they may hamper further economic development that is very much needed in this country with its emerging economy [27]. Spatial planning and flood risk management are mismatched documents due to the division of responsibilities at the national, provincial and municipal levels. Legislation in the field of water management lies at the national level, planning of defenses is taken care of at the provincial level, while spatial planning is mainly a municipal competence. Because the shift of powers in the field of spatial planning to the municipal authorities was not accompanied by the necessary shift in financial resources, local authorities still do not pay enough attention to taking the effects of flood risks into account and they have no formal obligations to do so [26].

Belgium has also suffered major flood damage in the past, so it has changed its approach from traditional flood defense to flood risk management. Legislation is characterized by general principles such as that water constitutes an element to be taken into account in spatial planning, that water should preferably be kept, stored and finally drained and that water should be given as much space as possible [26]. Up to now, a general regime has existed that ensures that no building activities should take place in flood-prone areas without taking mitigation or compensation measures [28]. A new instrument that bridges several strategies is the so-called ‘signal areas’ which are areas where a contradiction may occur between the interests of the water system and the spatial development perspectives [26]. These areas can play an important role in flood risk management, so their use is directly dependent on the level of flood risk assessed.

Floods as extreme weather events are a frequent occurrence in the territory of the Republic of Serbia. In the last few years, and especially after the catastrophic floods of May 2014, the public has accepted the term “flash” flood, which is used when describing a flood on smaller watercourses, with a torrential character [29]. On the territory of the Republic of Serbia, there are more than 11,500 such watercourses, which represent a potential danger for settlements located in downstream areas. Almost all of these watercourses are under the jurisdiction of a local government unit (LGU), given that, according to the Water Law [30], they belong to second-order waters. Extreme weather events—floods—have been declared in the last few years in the territories of LGUs, which are mostly located in hilly and mountainous areas. Consequently, these floods had a torrential character, which means that they occurred in a relatively short period of time and were loaded with a large amount of sediment. These problems are expected to be further intensified due to shifting rainfall patterns related to climate change, aging infrastructures, and the continuous densification of cities, where impervious surfaces are increasingly replacing permeable surfaces and natural drainage [31–35]. In the last few years, the damage caused by these (torrential or flash) floods is far greater than the floods on large rivers in the lowland parts of the territory of the Republic of Serbia. In Serbia, according to data from the Desinventar system database [36], in the period from 1980 to 2017, of all the extreme weather events that occurred, the largest number of deaths were caused by floods, with as many as 30. Also, for the mentioned period, most buildings were destroyed due to floods (50,220). However, lessons learned

from flood experience do not always increase flood resilience [37]. The largest percentage of the land surface within torrential watersheds is under forests, followed by arable land, orchards, and vineyards, so it is necessary to harmonize all planning documents (forest base, agricultural base, spatial plans, etc.) with the requirements of anti-erosion land management. One way of triggering systems' thinking and perspectives is to establish sector-wide actor collaborations early in the planning process, as well as to identify shared goals for common planning [38]. In this context, the lack of informal institutions, such as a culture of cooperation, a lack of trust between different departments, and the great need for social capital (i.e., trust, social networks and norms of reciprocity), can be barriers to systemic change [39]. Political will is also needed to establish an effective system at the early stage of planning. This can be one of the barriers. Nevertheless, a shared understanding between all actors in a collaboration of the nature of a problem addressed is needed for a successful collaboration [40,41].

Many watersheds in the southern part of Serbia have been treated with anti-erosion works in the last century. Because of this, the threshold of torrential rain that causes a flood has increased significantly, which shows that these effects and the measures applied in the last century have provided their optimum in flood protection.

Humanitarian aid and rehabilitation after the floods are not enough. Instead of rehabilitation, it is necessary to give priority to prevention, that is, to strengthening resilience in dealing with floods and reducing the risk of floods. Many changes, above all, climate changes, have led the increase in the number of flood events. This indicates that floods cannot be inhibited, but their harmful consequences can be mitigated by preventive measures. According to the United Nations Development Program (UNDP) data [42], on average worldwide, every euro invested in prevention reduces flood damage by seven euros. When it comes to the Republic of Serbia, for every dinar invested in flood prevention, flood damage can be reduced by three to nine dinars [43]. That this is indeed the case is confirmed by the analyses from the study conducted for the Kolubara river basin [44] after the floods in 2014. According to these analyses, in order to achieve the projected flood protection system, it is necessary to invest EUR 204.1 million in the implementation of flood protection measures and works until 2035. In the case that the flood event from May 2014 is repeated in 2035, with previously implemented measures and works, for every euro invested, the potential damage from floods would be EUR 3.44 less, that is, they would be 701.1 million less in total euros.

The traditional way of flood protection in Europe and the world has been replaced by flood risk management. A change in the approach to protection against the harmful effects of water was brought about by the adoption of the Flood Risk Management Directive of the European Parliament and the Council (FRMD) [45]. This Directive was preceded by the EU Water Directive [46], which represents an umbrella document in the field of water for EU members and those aspiring to become part of the EU. As the Flood Directive dictates, there are three stages that must be achieved in flood defense. The final stage is the adoption of the Flood Risk Management Plan (FRMP). The Republic of Serbia submitted the Draft FRMP, which is currently in the process of adoption. States in the region, such as the Federation of Bosnia and Herzegovina, Srpska Republic, Croatia, and Slovenia, have prepared FRMP in the previous period. Flood risk management on torrential watercourses is also covered by the FRMD. In the FRMD, this type of flooding is recognized as flash floods. Guidelines are given for the organization and arrangement of water districts (watersheds and sub-watersheds) for which the FRMP is also issued. The Republic of Serbia has transposed the guidelines from the EU Directives on floods into its Water Law [30], so the division of jurisdiction over waters in the Republic of Serbia has been carried out between republican and local institutions. Torrential watercourses, watercourses of the second order according to the Water Law, are under the jurisdiction of LGUs. The only document in the field of flood protection at the local level, which regulates issues from the FRMD and thus imitates the FRMP at the local level, is the Operational Plan for Flood Defense for Second-Order Waters (OPFDSW). Countries in the region like Montenegro, the Federation of Bosnia and

Herzegovina has also entrusted the management of second-order waters to LGUs, while Croatia and the Srpska Republic have established companies that manage all waters on the territory of these countries. On the basis of the previously mentioned problem, this paper aims to establish the following:

- The potential and importance of the OPFDSW for LGUs,
- The potential and importance of the OPFDSW in the development of the FRMP.

In the course of research for the purpose of preparing the paper, an overview of the relevant legislative framework in the Republic of Serbia, as well as in the countries of the region, was made. A review of and section on the implementation of the Flood Directive in the Republic of Serbia was also written. A detailed analysis of competences was carried out during the preparation of planning documentation for flood defense. The OPFDSW was used as the working material. A multi-criteria analysis was applied to evaluate the production of the OPFDSW. Through the discussion, recommendations for improving the preparation of the subject documentation, as well as for compliance with the FRMP, were also listed. In the conclusion, there are statements about the missing methodology, recommendations, as well as the necessity of the interoperability of data and relevant planning documentation.

2. Background

2.1. Legislative and Institutional Framework for Flood Risk Management in Serbia and the Countries of the Region

The Republic of Serbia, as a country aspiring to become a member of the European Union, is obliged to harmonize its legislation with the Directives of the European Union. The FRMD came into force on 23 October 2007. Its objectives are to identify flood risks, influence the improvement in future flood protection and define flood risk management measures. FRMD stipulates the obligation of EU members, as well as countries that are in the process of joining, to prepare a flood risk management plan through the following activities:

- Preliminary flood risk assessment (PFRA)—represents the first phase and a prerequisite for areas of potential significant flood risk (APSFs);
- Hazard maps (flood-prone areas) and flood risk maps—represent the second phase and are created for vulnerable areas defined by the PFRA;
- Flood risk management plans (FRMPs)—which represent the final, third phase, are based on areas defined by flood and risk maps, and are coordinated at the level of the catchment area and the LGU.

In the middle of 2010, the new Water Law [30] came into force in Serbia, which regulates issues in the field of surface and underground water. This law also contained guidelines from the FRMD. A new approach has been introduced for management and protection against the harmful effects of water, which refers to watersheds, that is, water areas, and not administrative boundaries. According to the data of the post-screening document Environment and Climate Change [47], the provisions of the Water Framework Directive and the FRMD have been partially transposed into the Serbian legal system through the Water Law and secondary legislation [48]. In this area, it is important to mention the regulation on establishing the General Plan for Flood Defense [49], the Water Management Strategy on the territory of the Republic of Serbia until 2034 [50] and the action plan for the implementation of the National Disaster Risk Management Program 2017–2020 [51], as well as the Law on Disaster Risk Reduction and Emergency Management [52]. This law contains guidelines for the establishment of measures and activities aimed at reducing the risk of disasters, including floods as a type of extreme weather events [48]. Most of the FRMD guidelines have been transposed into the Water Law. The same law divided waters according to their size and importance into first- and second-order waters, and the management of waters is the responsibility of republican and local institutions. Under the jurisdiction of the republic's institutions, public water management companies (PWMCs) "Srbijavode" and "Vode Vojvodine" have jurisdiction over 259 waters of the first order [53],

while all other waters are under the jurisdiction of LGUs. Waters of the first order include international watercourses, watercourses that form or cross the state border, watercourses that flow through the territories of two or more LGUs, watercourses on which a high dam with an accumulation has been built, main waterways of the Danube–Tisa–Danube hydrosystem, watercourses that have a catchment area greater than 100 km² or are significant for water use, water protection or water pollution protection [50]. All other waters are waters of the second order.

The jurisdiction of waters is in conflict with APSFRs and maps made by PWMCs, so we have cases where APSFRs are defined on waters of the second order by creating PFRA, and maps for APSFRs are made by PWMCs. On the other hand, LGUs were given the maintenance and management of a significantly longer network of waters, mostly unregulated, with a significantly smaller (or no) budget. LGUs are obliged to record all damages and consequences of floods on waters of the second order and through the city headquarters for emergency situations to send the data to competent republican institutions. On the basis of all these data, the PFRA is created. Also, another obligation of LGUs is to prepare the OPFDSW, since the Operational Plan for Flood Defense of First-Order Waters (OPFDFW) is prepared by the republic's institutions.

According to the Water Law [30], the FRMP is adopted for a period of six years, after which it is changed and supplemented every six years. The implementation of the FRMP is the responsibility of the Ministry of Agriculture, Forestry and Water Management—the Republic Directorate for Water (MAFWM-RDW), the PWMCs “Srbijavode” and “Vode Vojvodine”, the Ministry of the Interior—the Emergency Situations Sector (MI-ESS), the Republic Hydro Meteorological Institute of Serbia (RHMI) and other institutions, as well as LGUs. It is mandatory to prepare a strategic assessment of the impact of the FRMP on the environment [30] in accordance with the regulations governing environmental protection. The essence of the FRMP is the setting of goals for reducing the risk of flooding and the selection of structural and non-structural measures to achieve the goals during the period of implementation of the FRMP, which is 6 years. The FRMP must include the widest range of measures that, together with investment measures—the construction of facilities for flood protection—contribute to reducing the risk of floods and strengthening flood resistance.

The role of LGUs in this process and division of responsibilities is not fully defined. LGUs manage the waters of the second order and prepare the OPFDSW for these watercourses. A city typically can be viewed as an arena where the battle between interests is materialized in the urban space [54]. That is, city environments in many ways mirror the preferences of those in a position to influence the urban agenda [54]. Similarly, spatial requirements related to flood control and stormwater management are being constantly, implicitly or explicitly, negotiated [55,56]. Since there is no clearly defined rule book, nor a methodology for the preparation of such plans, the guidelines for the preparation of plans based on the model of the OPFDFW are recognized from the existing legal regulations. Waters that are of the second order, and which have not been declared as APSFRs, remain invisible in the application of the FRMD and are completely left to the management of LGUs. It is precisely on these waters that floods have become more frequent in the last few years. For this reason, it is necessary to integrate the activities of LGUs into the FRMP, which also fulfills the prerequisites for the joint and coordinated implementation of the FRMP by all competent entities.

The FRMD guidelines have been adopted in different ways in the region. Water management in BiH is divided according to the entities. In Bosnia and Herzegovina (Federation), all waters are divided into first- and second-category waters. The waters of the first category include all the larger, more significant waters in the water area of the Sava and the water area of the Adriatic Sea [57–59]. All other waters are waters of the second category. Protection against floods on waters of the first category in the Federation of Bosnia and Herzegovina is defined by the Federal Operational Plan adopted by competent ministers. The cantonal minister adopts an Operational Plan for Flood Defense for waters of the second category for the competent canton.

In the Srpska Republic (BiH), water management is defined at the level of large watershed units [60,61], which is in accordance with the FRMD on water and aims to harmonize all activities on the use, arrangement and protection of water and environmental protection. Public consultation is represented in the process of water management planning [60], which fulfills one of the important requirements from several international documents, which is the creation of a solid connection in planning and decision making in the relationship: state bodies in the water sector–LGUs–users–non-governmental sector–scientific institutions [61]. In the Srpska Republic, this connection should also be achieved through the Council for Regional River Basins, which includes all the aforementioned entities, which is one of the most modern solutions in the practice of water decision making in Europe [61]. The state administrative structure of the water sector was formed in accordance with principles and practice across the world. At the head of the management structure is the Ministry of Agriculture, Forestry and Water Management, in which a special department of water management deals with the policy and organization of operational water management. In accordance with the Water Law, the public institution “Vode Srpske” was formed. In the jurisdiction of “Vode Srpske” are precisely all the tasks provided for in the water directives [61].

In the Republic of Croatia, according to the Water Law [62], surface waters are divided into waters of the first and second order. All waters on the territory of the Republic of Croatia are managed by “Hrvatske vode”. Operational flood defense is carried out in accordance with the National Flood Defense Plan, which includes activities and measures for ice protection on watercourses. Flood Defense is organized by water areas, and within them by county areas, by sectors and by sections of watercourses. Operational flood defense is carried out by organizational units of “Hrvatske vode”.

In Montenegro, all waters on the territory of the state, according to their importance or cross-border influence, are divided into waters of importance for the Republic and waters of local importance [63]. In the territory of Montenegro, a FRMP is prepared for water areas in accordance with the legal framework. The FRMP is submitted by a competent administrative authority to the European Commission within three months from the date of their publication, and a PFRA, hazard maps and flood risk maps within three months from the date of their creation [63]. Protection against harmful effects of water is organized and implemented in accordance with general and operational plans for protection against the harmful effects of water, which are adopted for waters of importance for the Republic and waters of local importance [63].

2.2. The Current State of FRMD Implementation in Serbia

The initial stage in flood risk management according to the FRMD is the preparation of the PFRA. The PFRA in the Republic of Serbia is prepared in accordance with the rulebook on determining the methodology for the preparation of a PFRA [64] in order to determine the APSFR. An APSFR is a flood area where significant flood risks exist or may occur, i.e., where a significant flood has been recorded in the past and/or for which it is estimated that there is a risk of a significant flood occurring in the future [64]. The first PFRA in Serbia was carried out in 2012 and identified 99 APSFRs [65]. Reviewing and, if necessary, amending the PFRA is carried out by a competent ministry after 6 years from its creation. In the second cycle, during 2019, the PFRA was updated (Figure 1), which identified 101 APSFRs [65].

The second phase involves the creation of hazard maps and flood risk maps. Maps are produced for APSFRs. For the territory of the Republic of Serbia, they were carried out sporadically, within several projects, using different methodologies. The rulebook on establishing the methodology for creating hazard maps and flood risk maps came into force at the beginning of 2017 [66]. Hazard maps and flood risk maps were made for 97 out of the 101 APSFR in the period from 2012 to 2021. Considering that more than 6 years have passed since some of the maps were made, those maps have been updated, and therefore, more precise and updated data are used in the analysis (Figure 2). The Water Law stipulates that the boundaries of flood areas, as map products, should be included in spatial and urban

plans [30]. This provision is extremely important because it encourages the connection of spatial planning and flood risk management, creating numerous positive effects [48].

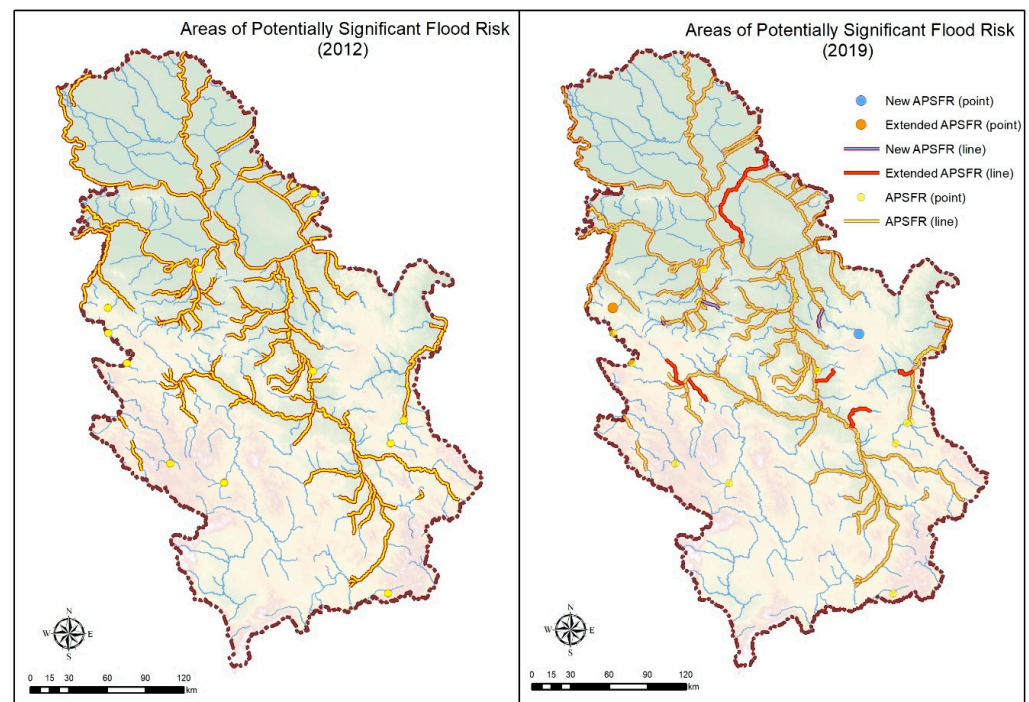


Figure 1. Map showing APSFRs from 2012 to 2019 (author).

The final stage in flood risk management is the creation of the FRMP. The adoption of the FRMP by law was established by 2017. However, the previous phase, which included the creation of hazard and risk maps, which was a requirement for the FRMP, was not implemented. The Republic Directorate for Water (RDW), under the jurisdiction of the Ministry of Agriculture, Forestry and Water Management, initiated the process of drafting the Draft FRMP for the period 2021–2027 for APSFRs defined by the PFRA from 2019. The draft FRMP was prepared and submitted for approval by the government of the Republic of Serbia, and it is the first such plan to be adopted for the territory of the Republic of Serbia.

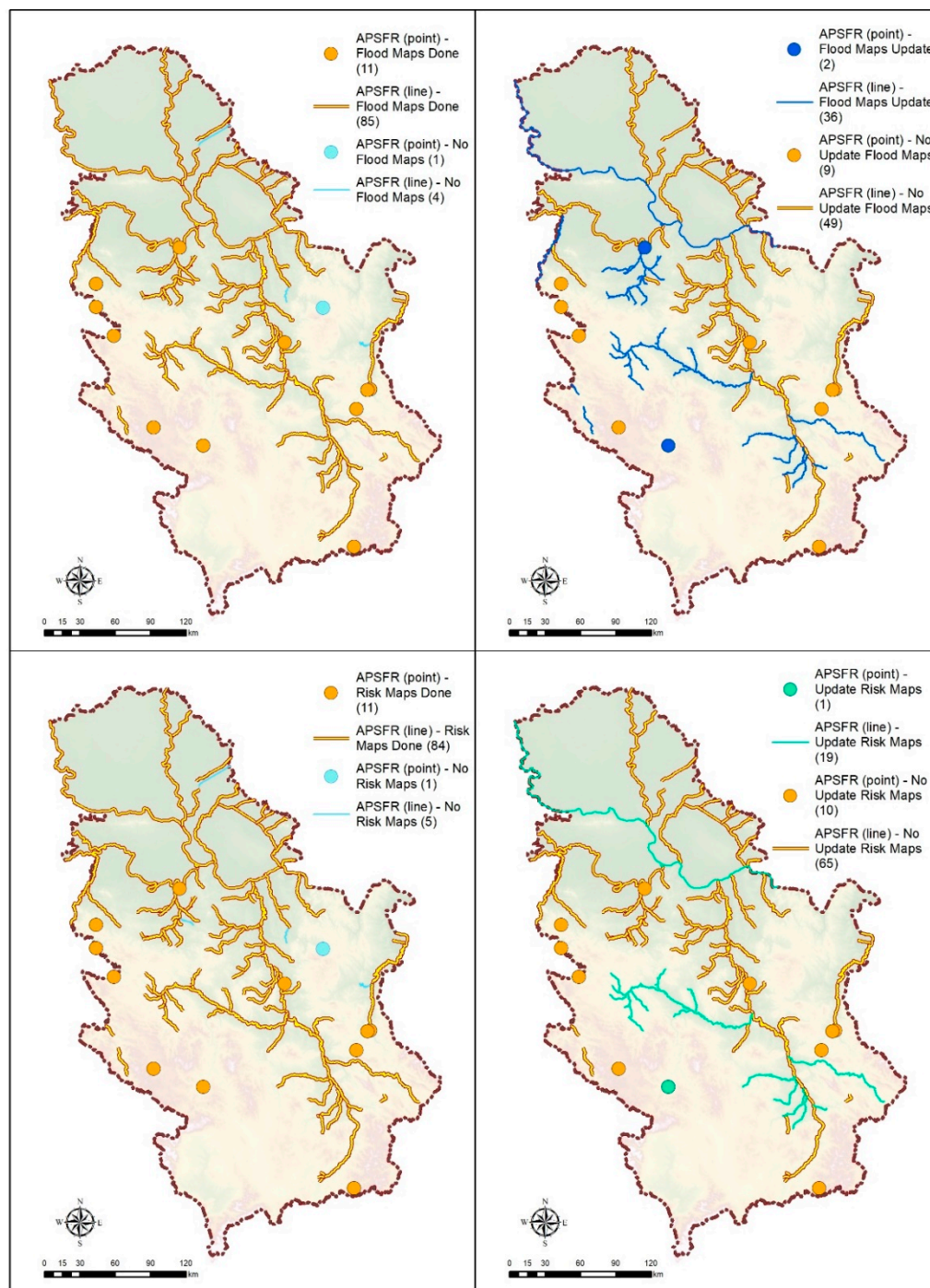


Figure 2. APSFR maps: **upper left**—hazard map, **upper right**—hazard map updated, **down left**—risk map, **down right**—updated risk map (author).

3. Materials and Methods

3.1. Operational Plans for Flood Defense in the Republic of Serbia—Competences and Preparation

Flood defense on the territory of the Republic of Serbia is implemented on the basis of the following documents: Water Law [30] and Law on Emergency Situations [67,68].

According to the Law on Emergency Situations, from preparation to operational defense against all emergency situations, the main role is assigned to emergency headquarters [69]. Headquarters are formed from the level of the Republic to the level of the municipality and have the role of organizing protection and rescue in case of emergency situations. The following authorities are involved in flood protection:

- MI-ESS;
- MAFWM-RDW;
- PWMCs;
- RHMI;
- LGUs.

The General and Operational Plans for Flood Defense define in more detail the activities, before, during and after an emergency situation, of these authorities in flood defense. Table 1 shows an overview of the responsibilities and competences of institutions in flood protection.

Table 1. Presentation of the responsibilities of institutions participating in flood protection.

Institution	Response Level	Description
MI-ESS	National and Local	Implementation of flood defense on waters of the first and second order through the headquarters for emergency situations.
MAFWM-RDW	National	Adoption of the General and OPFDFW.
PWMCs	National and Local	Participating in the preparation and implementation of the General and Operational Plan for Flood Defense for first-order waters. Gives an opinion on the Operational Plan for Flood Defense for second-order waters.
RHMI	National	It regularly submits hydrological and meteorological forecasts to all competent republican bodies that participate in flood defense.
LGU	Local	Participation in the preparation and implementation of the OPFDSW. Collection of data on flood damage.

The MI-ESS through the Republic and Municipal Headquarters plays a significant role in the implementation of flood defense on the territory of the Republic of Serbia, both for first-order and second-order waters.

The RDW has the obligation to adopt a General and Operational Plan for Flood Defense on first-order waters. The General Plan is adopted for a period of 5 years, while the Operational Plan for first-order waters is adopted every year and must be in accordance with the General Plan for Flood Defense. It also coordinates the implementation of the plan during regular and emergency flood defense.

The Operational Plan for Flood Defense includes the following: sectors and sections of watercourses, protective structures, authoritative water meters, criteria for declaring regular/extraordinary flood defense from external waters, and protected flood areas; and for inland waters by melioration areas, drainage systems, the names of legal and other responsible persons implementing flood defenses, and criteria for declaring regular/extraordinary flood defenses from inland waters. The plan is only valid for one year and a new one is issued every year, which includes all of the works and changes that have taken place in the meantime (embankments, canals, dams, etc.).

In the Operational Plan for Flood Defense of the Republic of Serbia for the year 2023, there was a total of over 3500 km of embankments and other protective structures, 58 dams with reservoirs, 413 hydro-melioration systems in public ownership with about 28,000 km of canal network and numerous pumping stations [70].

PWMCs are obliged to participate in the preparation and implementation of the General and Operational Plan for water of the first order. During the duration of the flood defense, the PWMC is obliged to hire territorial and specialized competent companies for the implementation of flood defense, which means the on-call implementation of measures and works to mitigate the consequences of the flood wave, etc.

The RHMI, in accordance with its scope of work, during the duration of the defense against floods and ice, is obliged to regularly deliver hydrological and meteorological forecasts, as well as the current situation at the stations under their jurisdiction, to all competent authorities participating in the defense against floods. Also, it has an obligation

to perform an analysis of the flood wave that predicts a certain regime on the watercourse, on the basis of which regular or extraordinary flood protection is declared.

The competent authority of the LGU is obliged to, no later than 30 days from the date of the adoption of the OPFDFW, with the opinion of the PWMC, adopt the OPFDSW in accordance with the General Plan and the Operational Plan for first-order waters. The OPFDSW is adopted for a period of one year, which is prescribed by Article 55 paragraph 5 of the Water Law [30]. Also, Article 55 paragraph 6 of the Water Law stipulates that the OPFDSW contains the following: data necessary for the effective implementation of flood defense, criteria for declaring flood defense, the names of managers and names of flood defense entities, methods of alerting and notification, and measures to reduce flood risk. The LGU is obliged to participate in the implementation of measures and works during regular and extraordinary flood defense. If it is established that the watercourse regime is such that it threatens to cause great damage, the LGU is obliged to declare a state of emergency situation on its territory, which allows it to direct all available means to prevent major damage from the flood wave.

According to the current legislation, apart from the guidelines in the Water Law [30] and the decision on the General and Operational Plan for first-order waters [49], there is no rulebook for the preparation of the OPFDSW.

In the legal act regulation on establishing the General Plan for flood defense for 2020 [49], the form of the General Plan is defined, which contains the following items:

1. Introductory provisions;
2. Territorial organization of flood defense;
3. Organizing flood defense;
4. Preventive measures, activities, works and reporting on the condition and readiness for flood defense;
5. Coordination and management of flood defense;
6. Phases of flood defense and emergency situations;
7. Powers and duties of persons who coordinate flood defense;
8. Duties, responsibilities and powers of persons managing flood defense and reporting on implemented flood defense;
9. Duties and responsibilities of companies and other subjects participating in the implementation of flood defense, emergency interventions and works.

In the same regulation, guidelines are given for the preparation of some of the mentioned items related to the OPFDSW.

In the legal act order on establishing the Operational Plan for flood defense for the year 2023 [70], it is stated that in addition to the above data for the efficient implementation of flood defense, data on legal entities that implement flood defense from external and internal waters and ice congestion are also necessary. The OPFDSW is not specified here; however, the entire organizational structure of the first-order water plan is applied in the preparation of the OPFDSW.

As far as the legal part is concerned, all the mentioned acts do not prescribe a more detailed preparation of the OPFDSW. Most of the plans, according to the mentioned guidelines, are made on the model of the water plan of the first order.

3.2. Analysis of the Creation of the OPFDSW

The OPFDSW, according to the Water Law, is required to be made by LGUs whose territory contains second-order waters. The total number of plans analyzed in this work is 107, of which 100 are in Central Serbia, while 7 are in the territory of AP "Vojvodina" (Figure 3). In the territory of AP "Kosovo and Metohija", no plan was analyzed, due to the unavailability of data.

The duration of these plans is one year, after which the same plans are updated in accordance with the changes that occurred in the year in the territory of the local self-government in terms of protection from water of the second order.

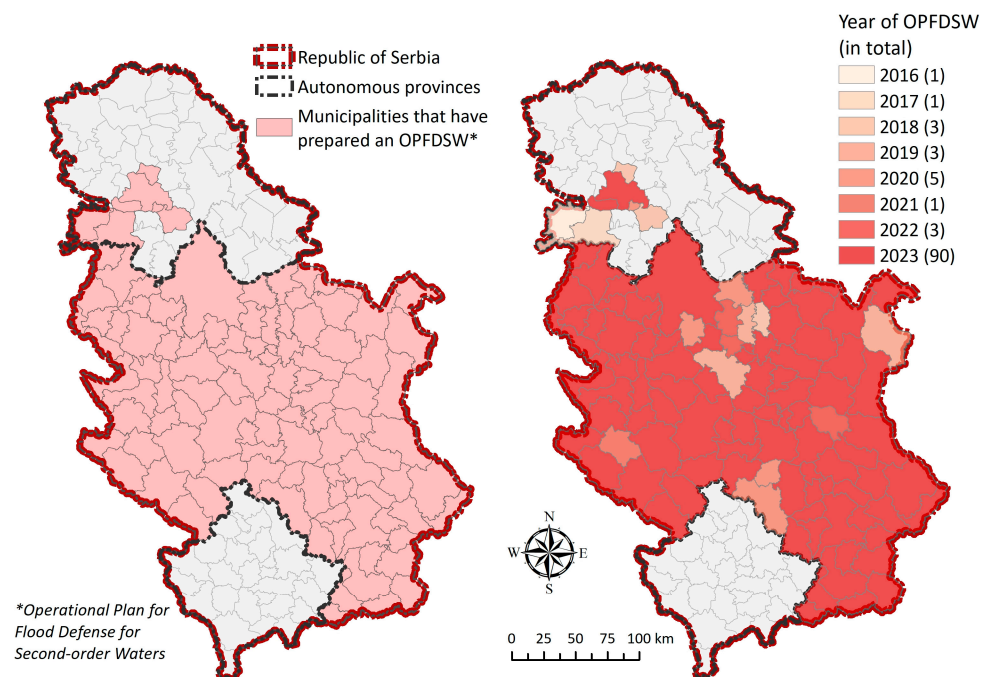


Figure 3. Left—view of local self-governments created by OPFDSW, right—view of OPFDSW by year of preparation (author).

For the purposes of the research in this paper, plans for 2023 (90) and plans from previous years (17) were used so that the results of the research would be more extensive, and the results of the analysis of the quality of making plans more credible.

The OPFDSWs were taken from the database of PWMCs, as well as from the database of LGUs.

4. Results and Analysis

According to the provisions of the Water Law [30], the OPFDSW is issued by the competent authority of a local self-government unit in accordance with the general and operational plan for first-order waters, for a period of one year, no later than 30 days from the date of the adoption of the Operational Plan for first-order waters, based on the previously obtained opinion of the PPMC.

The opinion is issued on the basis of a series of criteria that determine whether the OPFDSW contains all the necessary activities that would give a complete picture of flood defense on second-order waters. After the opinion issued by the PPMC, the OPFDSW is passed or adopted for each municipality.

The analysis of the content and quality of the creation of the OPFDSW was carried out using 20 criteria, on the basis of which the PPMC opinion document was issued. The opinion document of the PPMC was used as additional expert information.

The criteria are as follows:

1. Compliance with the Operational Plan for first-order waters;
2. Compliance of the submitted OPFDSW with the prescribed content;
3. Presentation and description of protected areas;
4. Presentation and description of the state of protective facilities on waters of the second order;
5. Presentation and description of unprotected flood areas;
6. Presentation and description of the state of watercourses without constructed protective facilities under the jurisdiction of the local self-government (waters of the second order);
7. Presentation and description of the criteria for declaring and canceling flood defenses;
8. Assessment of the vulnerability of protected areas;

9. Assessment of the vulnerability of unprotected flood areas;
10. Presentation and description of planned activities, measures and works;
11. Display and description of data on appointed authorized management persons in flood defense;
12. Determine and display the data of the authorized person for recording flood events in the area of local self-government;
13. Presentation and description of the communication plan of flood defense participants;
14. Presentation of the division of duties and responsibilities of companies and other entities participating in the organization and implementation of flood defense;
15. Description of the obligations of competent entities in all phases of flood defense;
16. Description of the entities available for the needs of flood defense, which have the necessary manpower, machinery, equipment and material, as well as a communication system: radio, telephone and/or mobile network;
17. Display of storage locations of available materials, equipment, machinery and other resources, as well as procedures for efficient delivery and use during flood defense;
18. Presentation of the procurement specification of the required amount of equipment and materials for flood defense;
19. Plan for providing financial resources for the implementation of the OPFDSW;
20. Graphic documentation.

Each of the OPFDSWs is analyzed in detail according to the specified criteria. The evaluation criterion had a positive and negative evaluation (for example, contained, did not contain; displayed, did not display; listed all participants correctly with all data, etc.). If an item is not fully satisfied (it does not contain all the details, for example, a presentation of the division of duties and responsibilities of companies and other entities participating in the organization and implementation of flood defense), it is evaluated with a negative grade. The opinions of the PWMCs were used to supplement the data in order to make a more reliable evaluation according to the criteria.

Based on the conducted multi-criteria analysis, the results are presented in Table 2. None of the analyzed plans satisfied the set criteria. In some OPFDSWs, there is only a transcribed form from the general flood defense plan (the so-called extract from the General Plan), while in some, it is shown in detail. The quality of making the OPFDSW themselves varies a lot, from those who elaborated all the activities in great detail to those who just listed them.

Table 2. OPFDSW containing the activities listed as criteria.

Criteria for Evaluation of OPFDSW	No. of OPFDSWs that Met the Specified Criteria	Percentage of the Total Number of OPFDSWs (%)
1. Compliance with the Operational Plan for first-order waters;	96	90%
2. Compliance of the submitted OPFDSW with the prescribed content;	90	84%
3. Presentation and description of protected areas;	74	69%
4. Presentation and description of the state of protective facilities on waters of the second order;	10	9%
5. Presentation and description of unprotected flood areas;	73	68%
6. Presentation and description of the state of watercourses without constructed protective facilities under the jurisdiction of the local self-government (waters of the second order);	6	6%

Table 2. Cont.

Criteria for Evaluation of OPFDSW	No. of OPFDSWs that Met the Specified Criteria	Percentage of the Total Number of OPFDSWs (%)
7. Presentation and description of the criteria for declaring and canceling flood defenses;	62	58%
8. Assessment of the vulnerability of protected areas;	54	50%
9. Assessment of the vulnerability of unprotected flood areas;	54	50%
10. Presentation and description of planned activities, measures and works;	95	89%
11. Display and description of data on appointed authorized management persons in flood defense;	104	97%
12. Determine and display the data of the authorized person for recording flood events in the area of local self-government;	98	92%
13. Presentation and description of the communication plan of flood defense participants;	101	94%
14. Presentation of the division of duties and responsibilities of companies and other entities participating in the organization and implementation of flood defense;	98	92%
15. Description of the obligations of competent entities in all phases of flood defense;	93	87%
16. Description of the entities available for the needs of flood defense, which have the necessary manpower, machinery, equipment and material, as well as a communication system: radio, telephone and/or mobile network;	85	79%
17. Display of storage locations of available materials, equipment, machinery and other resources, as well as procedures for efficient delivery and use during flood defense;	76	71%
18. Presentation of the procurement specification of the required amount of equipment and materials for flood defense;	66	62%
19. Plan for providing financial resources for the implementation of OPFDSW;	85	79%
20. Graphic documentation.	11	10%
All of the listed activities	0	0%

The conducted analysis shows that the majority of OPFDSWs do not contain a sufficient amount of information that is important for flood defense on second-order waters. The OPFDSWs carried out in this way do nothing else but satisfying the form in order to fulfill the obligation. The OPFDSWs are not used in cases where flood defense occurs, they do not contain GIS data to obtain a clear picture of the coverage and overview of all useful layers, and they do not contain clearly defined elements about critical locations, criteria for declaring flood defense, as well as defined communication links in case of flooding.

5. Discussion and Recommendations

Directive 60/2007/EC [45] on the assessment and management of flood risk constituted a considerable change in the planning and management of flood risk in the European space, promoting preventive measures based on mapping and territorial planning as basic elements of risk reduction [71]. Maps are a principal tool for the Directive in identifying, accrediting, and preventing flood risk. In order to elaborate the flood hazard and risk maps, Directive 60/2007/EC indicates the need to conduct a preliminary assessment of a flood risk using the available information, such as recorded data and long-term evolution studies [72].

Although the FRMD guidelines [45] have been partially transposed into the Water Law [30], the FRMP has not yet been adopted in Serbia. One of the reasons is the availability of resources and data. The absence of quality bases for the creation of hazard maps and flood risk maps are a significant item in terms of the accuracy of the created mentioned maps for different probabilities of occurrence. Some of these foundations are under the jurisdiction of LGUs. In addition to the digital model of the terrain, data on infrastructural and other important objects are important sources for flood risk management. When submitting documents, LGUs mostly submitted data in a written form, and a small percentage of LGUs submitted GIS (geo-referenced spatial) data. The field of flood risk management requires data that contain geospatial information so that the basic products, hazard maps and flood risk maps, gain credibility and quality. Therefore, it is necessary to foresee the recording of river valleys with LiDAR technology in order to obtain high-quality data on the terrain. The resolution of the field survey (the number of points per square meter) should be in accordance with the desired resolution of the final product. Also, it would be desirable, in managing all risks, that all infrastructure facilities are digitized with GIS technology to create a standard that would be used by all LGUs who would be obliged to deliver data for the FRMP in the same way and to use the same data when creating their OPFDSWs.

The General and Operational Plans for first-order waters refer strictly to the area of flood defense. In the OPFDSW, several elements can be observed that exclude this plan from the framework of flood defense and bring it closer to planning documentation for flood risk management. Changing the name of the OPFDSW should be considered and adjusted to the actual situation, which means that the OPFDSW contains a part related to operational flood defense, while the remaining part is closely related to the FRMP and its elements, so the name of this document should be changed accordingly.

Analyzing the OPFDSW on the one hand and FRMP on the other, a number of similarities can be observed that help us to better understand the connection and importance of making these plans.

The recording of **flood events** as an activity is recognized in both plans. When elaborating risk maps and defining flood management measures, studies that include a historical analysis of extreme natural phenomena, in this case floods, have constituted a fundamental tool for identifying the risk existing in a territory and influencing human behavior, with the aim of informing about floodable areas and preventing their occupation. Internationally, there are multiple studies using historical data analysis to analyze past climate characteristics and their behavior in relation to extreme events (droughts, glaciations, and floods) [73], reconstructing and estimating historical flood frequency based on existing historical records, using an analysis to calculate flood trends in different climatic regions of the world, and even using historical flood marks [72]. Kjeldsen et al. (2014) point out that the analysis of historical flood events from academic application to practice has been limited but that it serves to estimate the frequency of past floods and to understand future trends [71,73]. They also highlight the great heterogeneity of methodologies applied when carrying out historical analyses, which generally depend on the data series (short or long) available [71,73]. The conclusions drawn by the authors indicate that there is considerable potential to improve the reliability of current flood risk assessments by collecting valuable information on past extreme events contained in historical datasets [72,74].

LGUs record flood events for the purposes of creating two documents:

- The OPFDSW;
- Damage assessments after extreme weather events [75].

In the OPFDSWs, the person responsible for recording flood events is specified, and this information exists in as many as 90% of the analyzed plans. However, none of the OPFDSWs provide data on floods from previous years, as well as data on damage caused by floods. There is no article in the Water Law that defines that the record of flood events is the obligation of LGUs when preparing the OPFDSW. A damage assessment after extreme weather events is an obligation of LGUs defined in the Law on Reconstruction after Natural and Other Disasters [75].

Flood events are the basic set of data from which the APSFR is derived during the development of the FRMP. According to the Law on Reconstruction after Natural and Other Disasters [75], as well as according to the Sendai Framework from 2017 [76], municipalities are obliged to keep “Desinventar” forms that are part of the system for managing information about accidents as a result of certain hazards in which floods are also counted. This should be a unified legal regulation that includes guidelines for recording flood events, as well as identification of damage caused as a result of floods, which is not the case in municipalities, as well as in the related laws mentioned.

APSFRs are the basic foundation for all subsequent activities in the flood risk management cycle. An PFRA from 2012 [65] identified as many as 5 out of 99 APSFRs in the area of second-order waters, while an PFRA from 2019 [65] identified as many as 10 in the area of second-order waters. Bearing in mind the differences between the first and second PFRA, this initial step represents a clearly defined approach to flood risk management and confirms the need to amend the APSFR in a period of 6 years.

When preparing the OPFDSW, LGUs select a list, a list of endangered areas, protected and unprotected. About 70% of municipalities contain some kind of information about flood areas based on experience from previous years. In the OPFDSW, it is not clearly defined how an endangered area is determined and what the criteria are for defining it. Not a single OPFDSW was noted to mention APSFRs, nor any analysis related to the FRMD. Therefore, it is evident that there is no methodological approach when creating elements of the OPFDSW, and the similarity of the endangered areas defined in the OPFDSW and the APSFR is also evident.

The creation of the **flood hazard maps** according to the FRMD implies different scenarios of high water, and for each scenario, it gives a zone of flood spread—a flood zone. In the OPFDSW, flood zones are not defined but are described textually for each listed threatened area. Also, the vulnerability assessment defines different scenarios, and the vulnerability is described based on them. There is an obvious similarity in the definition of these two bases, but there is a lack of a methodological approach for defining the areas threatened by flooding, as defined in the FRMD, i.e., the rulebook on establishing the methodology for the creation of hazard maps and flood risk maps [66].

The creation of **flood risk maps** according to the FRMD implies the inclusion of all threatened objects within the defined flood zone, flood hazard maps. The flood risk map is determined based on risk receptors for the population, infrastructure, economic activities, protected assets and potential pollutants. The data must have geospatial information. In the OPFDSW, the risks are defined through a list of endangered objects, mostly tabulated, defined by assessment, without any detailed analysis. As with hazard maps, a methodology for defining risk receptors on the territory of the LGU is necessary here, as well as a method of processing and displaying such data.

The FRMP implies a complex analysis of all previous products, on the basis of which a **catalog of measures** for protection against the harmful effects of water and flood risk management is proposed, taking into account another aspect, which is the cost estimate of all the measures foreseen, i.e., that the facility that protects the endangered area against risks should not be more expensive to run than all the buildings to be protected. On the other hand, the OPFDSW emphasizes the need for LGUs to declare a program of preventive measures and works for the current year, which represents a catalog of flood risk

management measures for the next year but carried out without any detailed analysis. Also, there is an obligation to report on the works carried out in the past period on protection against the harmful effects of water, which is shown by a small number of LGUs. The main difference between these two documents is that in the FRMP, everything is defined and supported by a methodological approach, while in the OPFDSW, most activities are carried out intuitively and without any prior analysis.

Taking into account the similarities of these two plans according to the elements shown, it is necessary to define certain regulations by which the specified elements, which are part of the OPFDSW, would be developed in accordance with the development of elements for the FRMP. The period of preparation and updating of these data would have to follow the preparation of the FRMP, as well as other significant related planning documents.

6. Conclusions

There are critical gaps in flood risk management systems in every country, especially in developing countries such as Serbia, where the transposition of European Directives into legislation is challenging. The main gaps (shortcomings) are the insufficient capacity of lower institutional levels, low compliance with laws and regulations, unrelated policies of certain departments, problems in communication and coordination, and inadequate resources.

The existing legislation did not clearly define nor did it provide guidelines for the exchange of data that are the final products of the analyzed plans between republican and local institutions, which indicates the need for data interoperability between institutions.

The conducted research points to the need to improve the development of the OPFDSW. The aim of the improvement would be to establish a functional system of water management, both of the first and second order in the territory of LGUs. The improvement should be based on the existing legal procedures, with the definition of additional legal regulations, especially with regards to defining the endangered area on second-order waters. It is necessary to define the risks to clearly define the tasks of individuals and business entities and emphasize the improvement in procedures that will enable more efficient communication of all institutions, organizations and individuals of importance for the water management system in the territories of local governments. In relation to the factual situation on the ground, it is important to set up an efficient system, which, in the coming period, would contribute to a faster and better reaction but also give an account of all the shortcomings that can then be managed as tasks and obligations to different actors.

It is necessary to clearly define the rulebook on the methodology for the development of the OPFDSW and for the function of the development of the FRMP. Bearing in mind the fact that the initial data come from LGUs in the form of damage from disasters, as well as that the implementation of the foreseen measures ends with the participation of LGUs, these activities related to data from the OPFDSW should be approached very pragmatically and in detail. As stated in the Water Law [30], vulnerability maps and flood risk maps should be included in the spatial plans of local governments and influence the control of the construction of infrastructure projects in flooded areas.

In order to harmonize all activities on the territory of LGUs, care should be taken that planning documentation in the field of water protection occupies one of the prioritized activities in the management of planning acts, especially if the data on damage caused as a result of floods are taken into account.

Author Contributions: Conceptualization, A.D. and N.D.; methodology, A.D.; validation, A.D., N.D. and R.R.; formal analysis, A.D.; investigation, A.D.; resources, A.D.; data curation, A.D.; writing—original draft preparation, A.D.; writing—review and editing, A.D. and R.R.; visualization, A.D.; supervision, R.R. and N.D. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was funded by Public Water Management Company “Srbijavode”.

Data Availability Statement: The original data analysed in the study are openly available on the request [Public Water Management Companies, Local Government Units].

Conflicts of Interest: Author Aleksandar Drobnjak was employed by the company Public Water Management Company “Srbijavode”. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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