

MODEL PROPOSAL FOR INTEGRATION OF DATA OF THE FLOOD RISK MANAGEMENT TO THE DISASTER RISK ASSESSMENT

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Abstract: *For the purposes of preparing the national Disaster Risk Assessment, risk assessments are performed for twelve hazards. One of the hazards contained in the document is flood. For the flood hazard, it is necessary to collect data related to hydrography, historical floods, assumed areas of floods in the future, areas of potential flood risk assessment and others. Also, it is necessary to identify protected values in areas of potential flood risk assessment areas. In the process of flood risk management, data collection is performed in order to make a preliminary assessment of flood risks and flood hazard and flood risk maps. The aim of this paper is to propose a model for integrating data from the flood risk management into the disaster risk assessment, in order to increase the efficiency of flood prevention. The paper analyzes the type of data collected for the purpose of developing a documentation basis for flood risk management, which can be integrated into the national Disaster Risk Assessment in case of flood.*

Key words: *data, flood, risk assessment, disaster, integration*

1. INTRODUCTION

Based on the data collected for the preparation of documents for risk assessment and flood risk assessment, the paper proposes a model of data integration from one document to the another. Two different ministries are responsible for the preparation of national documents that are Preliminary Flood Risk Assessments and Disaster Risk Assessments. Preliminary Flood Risk Assessment for the territory of the Republic of Serbia is under responsibility of the Ministry for water management, i.e. the Republic Directorate for Water. The Ministry responsible for emergency situations, that is, the Department for Emergency Situations, is responsible for preparing the Disaster Risk Assessment for the Republic of Serbia. In this paper, the first chapter is dedicated to the flood that is described as a phenomenon and to the method of data collection for the purposes of creating a Preliminary Flood Risk Assessment. In the second

chapter, the structure of the Disaster Risk Assessment document for floods is described. The third chapter is devoted to the data that is collected for the purposes of creating both documents, the data analysis was performed and a model of data integration from one document to another was proposed.

2. FLOODS IN SERBIA

The territory of the Republic of Serbia is intertwined with rivers. The total length of rivers in Serbia is about 65,980 km (www.premiumsrbija.rs), at least 76 rivers are longer than 50 km. Due to atmospheric precipitation and sudden melting of snow, riverbeds fill up and often overflow, which contributes to the flooding of coasts, arable land, settlements and industrial complexes, etc. The cause of flooding can also be the anthropogenic impact of people on the waters and river banks, which increases the risk of flooding. That is why flood protection measures are taken. Flood protection is implemented by managing flood risks and implementing flood defenses. In accordance with the Water Law (Zakon o vodama, 2018), flood risk management includes: "preparing a preliminary flood risk assessment, creating and implementing flood risk management plans, general and operational flood defense plans, implementing regular and extraordinary flood defense and protection from erosion and floods".

2.1. Preliminary Flood Risk Assessment

A Preliminary Flood Risk Assessment is made at the national level for the entire territory of the Republic of Serbia. The content of the document is defined by the Water Law (Zakon o vodama, 2018) and it includes: maps of water areas with the boundaries of sub-basins entered, topography and land use layers, description of floods that have occurred in the past and the probability of occurrence of similar flooding events in the future, assessment of potential harmful consequences future floods for human health, the environment, cultural heritage and economic activities, etc.

Preparing and the methodology of the Preliminary Flood Risk Assessment is defined by the Rulebook (Pravilnik o utvrDjivanju metodologije za izradu preliminarne procene rizika od poplava, 2012). The result of the Preliminary Flood Risk Assessment is the determination of Areas of Potential Significant Flood Risks. In 2012, the Republic Directorate for Water, which is an integral part of the Ministry of Agriculture, Forestry and Water Management, set up the first Preliminary Flood Risk Assessment (PFRA). The result of the PFRA are 99 designated Areas of Potential Significant Flood Risks. The PFRA was updated in accordance with the regulations, and in 2019, a second one was done, which also contains data from the first. As a result of the updated document, a total of 101 Areas of Potential Significant Flood Risks (APSFR) on the territory of Serbia were determined. For the purposes of updating, data was collected according to the Rulebook annexes (Pravilnik o utvrDjivanju metodologije za izradu preliminarne procene rizika od poplava, 2012)

PFRA and ARSFR were done according the water basins and sub-basins. In the Danube basin, 18 sub-basins were considered, 10 sub-basins were in the Sava basin, a total of 27 in the Morava, Ibar and Lepenac were treated with 4 sub-basins and Beli Drim with 2.

For each of the sub-basins, information has been prepared on the characteristics of the basin and watercourses, hydro meteorological characteristics of the basin, land use, protection and flood risks.

In the part related to flood protection and risks, special attention is paid to:

- flood protection system,
- floods occurred in the past,

- measures and works undertaken to reduce the risk of floods,
- possible harmful consequences of future floods,
- possible measures and works that could reduce the risk of flooding and
- certain APSFR in the basin.

2.2. Example for the Kolubara River

Based on the collected data on occurred floods in the past, the map was created showing the scope of floods (Figure 1). The data was collected by the Public Water Management Company and the local self-government units, according to the Annexes which are an integral part of the Rulebook (Pravilnik o utvrđivanju metodologije za izradu preliminarne procene rizika od poplava, 2012). Based on data from the past, floods that may occur in the future at the same location were assumed, which is shown in Figure 2 for the Kolubara River.



Figure 1. Location of the flood occurred in the past in the sub-basin of the Kolubara river

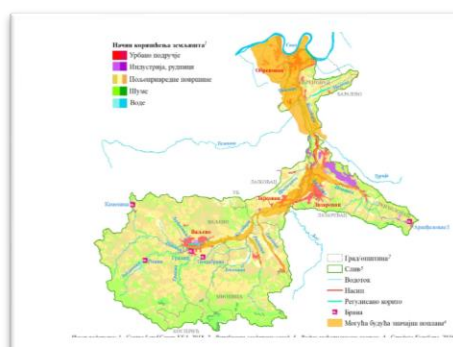


Figure 2. Location of possible future floods in the sub-basin of the Kolubara river

Source: (Preliminary Flood Risk assessment for the territory of Republic of Serbia, 2019)

During the preparation of the Preliminary Flood Risk Assessment, a review was made of the physical characteristics of the observed basin and watercourse, hydro meteorological data, land use, water facilities and flood protection systems were identified, an analysis of past floods and measures and works carried out for risk reduction, assumption of possible future floods and finally the areas of potential significant flood risks are deracinated. Thus, the Kolubara River was designated as an area of potential significant flood risk along its entire course, and it is listed in the table under serial number 31(Preliminary Flood Risk Assesment, 2019).

3. RISK ASSESSMENT OF NATURAL DISASTERS IN THE REPUBLIC OF SERBIA

In 2019, a national Disaster Risk Assessment in the Republic of Serbia (Procena rizika od katastrofa u Republici Srbiji, 2019) was set up for the territory of the Republic of Serbia, in which the risk of floods was described in a separate chapter. The document discusses the risk of "flooding" for the following rivers: Sava, Bjelica in the municipality of Lucani and on the river Kolubara in the municipality of Obrenovac. Respecting the provisions defined by the Instruction on the preparation methodology and content of the disaster risk assessment and the protection and rescue plan (Uputstvo o metodologiji izrade i sadržaju procene rizika od katastrofa i plana zaštite i spasavanja, 2019), the flood risk assessment was developed for two scenarios:

1. The most likely adverse event and
2. The scenario with the most severe possible consequences.

On the Sava River, the most likely unwanted event is created for the case of flooding on the right bank of the river when the Drenovac pumping station fails due to insufficient capacity, in the Drenovac settlement that is situated in the back of the right embankment. The scenario with the most severe possible consequences was considered for the left bank of the Sava River, in the territory of Sid and Sremska Mitrovica due to the increased water level and the demolition of the quay wall in the Bosut settlement.

On the river Bjelica, the case of exceeding the capacity of the pumping station "Lucani" in the area of the "MB-Namenska" factory was considered for the scenario of the most likely adverse event, and the case of failure of the flood defense line with a mobile system in the area of the bridge was considered for the scenario with the most severe possible consequences on the road to Guca in combination with the penetration of water into the embankment which is rooted in the body of the railway line.

For the scenario of the most likely adverse event, the case of intrusion of waters on the Kolubara at the site of the intersection of the E-736 highway and the Kolubara embankment was adopted. The scenario with the most severe possible consequences is set so that Obrenovac is flooded with water of the once in a hundred years return period due to overflowing of the left Tamnava embankment, overflowing of the Kolubara embankment upstream of the Cikovac stream with water intrusion at the intersection of the E-763 highway with the left Kolubara embankment during a flood wave on the Sava that was hundred-year return period.

3.1. Flood risk assessment case for the Kolubara river

For the case of flooding from Kolubara in Obrenovac within the boundaries of the municipality, on the basis of the collected data, a hydraulic model of flooding was made for the case of the most likely adverse event (Figure 3). According to the adopted probability of the flood event, the consequences for people's life and health, economy and social stability were estimated obtained overall risk in the high rank (Figure 4).

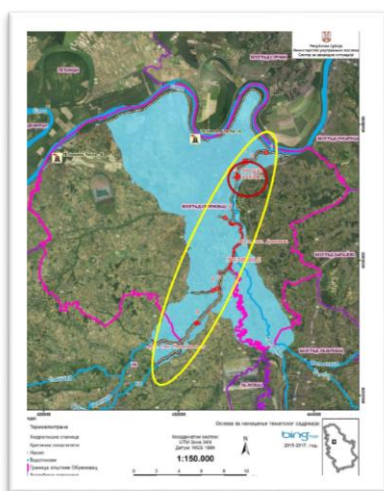


Figure 3. Kolubara river – hydraulic model
Source: *Disaster risk assessment in the Republic of Serbia*

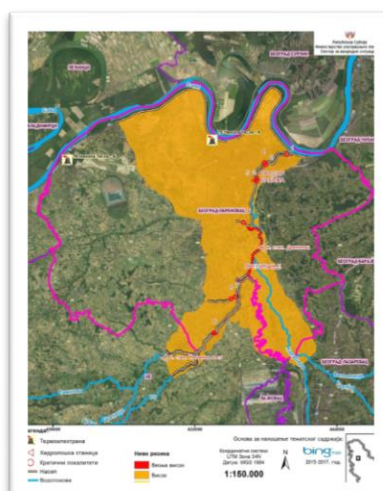


Figure 4. Kolubara river – Flood risk
Source: *Disaster risk assessment in the Republic of Serbia*

Figure 2 shows a possible flood in the future in Kolubara, and Figure 3 shows the level of the determined risk of flooding. Based on the figures, it can be concluded that the Kolubara River has been identified as a flooding river with a high risk. It is also concluded that there is a risk of flooding along the entire course of the river.

4. DATA COLLECTION AND PROPOSAL FOR INTEGRATION MODEL

For the purposes of preparing the Preliminary Flood Risk Assessment for the territory of the Republic of Serbia and the preparation of the Disaster Risk Assessment in the Republic of Serbia in case of a flood risk, it is necessary to collect data. The basic data that has been collected is first of all the data on the recorded flood events that happened in the past.

For the purposes of preparing the Preliminary Flood Risk Assessment for the territory of the Republic of Serbia, data were collected in accordance with the Rulebook (Pravilnik o utvrDjivanju metodologije za izradu preliminarne procene rizika od poplava, 2012). Annex 1 of the Rulebook prescribes the type of flood data that is particularly requested:

- location and date of the event described with the following information: municipality, cadastral municipality, water district or melioration area, watercourse, section of watercourse with a code and description from the current operational flood defense plan, flood reach,
- characteristics of the flood described through the date of occurrence, duration in days, flooded area, length of the threatened section, probability of flood occurrence, maximum registered water level, registered precipitation and etc,
- the cause of flooding (rainfall, melting snow, overflowing of embankments or dams, etc.),
- mechanism of flooding (exceeding the capacity of the basic riverbed without a protective system, overflowing of the embankment, failure of the function of the protective facilities, narrowing of the riverbed, congestion of the bridge, etc.),
- character of floods (slow onset, fast onset, torrential, with great depths, with great speeds, large amount of floating embankment, etc.).

In addition to the above data, data on the consequences of the flood on people's life and health, the environment, cultural heritage and economic activities are also collected. Among the other data, the applied flood protection measures, the rehabilitation works performed and the planned works aimed at reducing the risk of floods are mentioned.

For the purposes of creating a disaster risk assessment for the danger of flooding in the territory of the Republic of Serbia, data was also collected on historical floods that had significant harmful consequences on human health, the environment, cultural heritage and economic activity, then the characteristics of the flood, the reach of the flood wave, the direction of the flow and assessment of the adverse impact on protected values, the construction of the flood protection system, the efficiency of the constructed facilities, weak points in the system and others. Table 1 shows the data that was used to create the document

Table 1: data that was used to create the document:

Preliminary Flood risk Assessment	Disaster Risk Assessment (in case of floods)
Maps:	Maps:
Water basins with the boundaris of sub basins	Water basins in the needed scale with the boundaries of sub basins
Topografy	Topografy
Corrina land use	Corina land use
Hydrographic surfaces	
Pedological foundations	
Characteristics of floods	Characteristics of floods

Preliminary Flood risk Assessment	Disaster Risk Assessment (in case of floods)
Flooded area and flood wave	Flood wave
Flood protection system	Construction of the flood protection system
Implemented flood defense measures	
Consequences to the protected values	
Determination of the Area of Potential Significant Flood Risks	Level of flood risks
others	others

Table 1 shows that for both documents it is necessary to obtain data related to the same set of data. Based on this, the following model of data collection can be proposed for the purposes of creating a Preliminary Flood Risk Assessment, which can be completely assigned and integrated for the purposes of creating a Disaster Risk Assessment for floods.

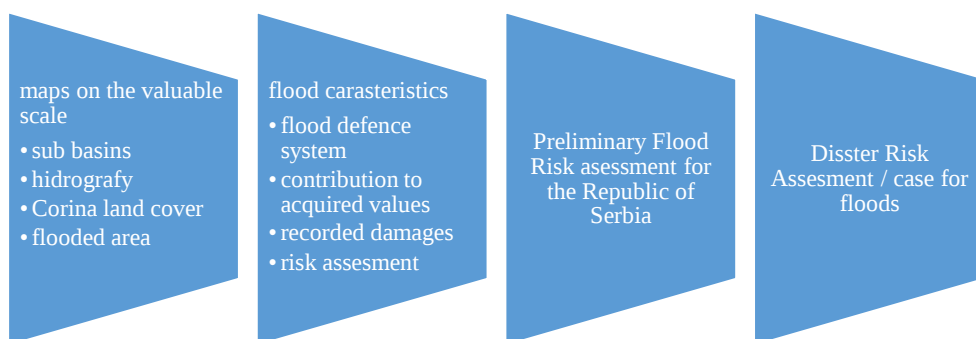


Figure 5. Proposed data integration model

On the basis of Figure 5, which proposed a model for the integration of data collected for the purposes of creating a Preliminary Flood Risk Assessment, it is concluded that the same data can be integrated and used for the purposes of creating a Disaster Risk Assessment for floods. In this way, the process of making a Disaster Risk Assessment in case of floods is simplified in terms of saving human and material resources.

5. CONCLUSION

In this paper, a model of data integration that is used to translate one document into another is proposed. The analysis determined that for the purposes of preparing the Preliminary Flood Risk Assessment for the territory of the Republic of Serbia, the same data is used as for the preparation of the Disaster Risk Assessment for the Republic of Serbia (in case of flood risk). In order to rationalize work, save human and material resources, the data used can be handed over to the competent institution for further use. Since the Preliminary Flood Risk Assessment is under responsibility of the water sector authority and the Disaster Risk Assessment is under responsibility of the emergency sector, the proposed model shows that the work on the Disaster Risk Assessment in case of floods can be simplified by using already collected data and results.

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