UTILIZATION OF GIS IN INTERNAL FLOODS

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Abstract: Natural disasters are the result of the interaction between physical impact and vulnerability of people and the environment. Flood risk is a product of the region's exposure to the risk of natural disasters. Climate projections indicate an increased risk of floods in the future and, therefore, an increased risk of internal floods predicted by climate change. This paper presents a methodology and procedure for flood risk assessment using GIS and flood occurrence models.
Keywords: Flood risk, natural disasters, internal floods predicted, GIS and flood occurrence models

1. INTRODUCTION

Natural disaster risk assessment is defined as an assessment of the probability of occurrence of a natural disaster and the degree of danger from natural disasters. It can be said that natural disasters are the result of the interaction between the physical impact and vulnerability of people and the environment. Flood risk for any region is a product of the region's exposure to natural hazards and the vulnerability of facilities to the hazard.
Flood defense means a series of works, facilities, measures and other activities that rationally protect people, natural and material goods from floods. Flood protection is divided into three basic elements:
• Protection against floods that occur when water overflows from the riverbed.
• Protection from all types of water erosion and torrents,
• Protection from all atmospheric and underground water.
Storms that are exacerbated by climate change are spreading all over the world. Such storms can be particularly devastating as they move through inland areas, where soils are already soaked and rivers have increased water level, so they can produce severe flooding if there is not enough time for runoff.
The global threat of flooding has already taken center stage in 2021. Communities in Brazil, Queensland, the US, Canada, Iran and South East Africa experienced extreme flood events, as a result of heavy rains, which had major social and economic impacts to those countries.
These events show that inland flooding remains a very real and serious threat. It is estimated that a quarter of the world's population will be at risk of inland flooding by 2025, with climate projections pointing to an increased risk of future flooding caused by climate change.
These natural disasters also have wide-ranging social impacts, with inland flooding playing a major role. For example, Kerala, India, in 2018, when the state received 255% more rainfall than the monthly average in August (Madaan, 2018). The floods have been described as the worst the country has experienced in a century, with 433 deaths reported and 1.4 million people displaced (Jacob, 2019).
It is very important, especially in large cities, to take measures to avoid a situation in which a large-scale flood leads directly to catastrophic losses, both human and material. In order to deal with the growing vulnerability of cities, especially urban areas, and to avoid or mitigate catastrophic flood risk, it is very important to implement flood risk management in an integrated way, so-called, integrated flood risk management. From this point of view, this paper presents a methodology and procedure for flood risk assessment using GIS and flood occurrence models. Taking the floodplain as the target field instead of the river channel, the concept of micro-zoning should be included where the entire floodplain is divided into numerous areas.

2. CLIMATE CHARACTERISTICS OF THE RESEARCH AREA

The city of Nis is characterized by a predominantly moderate continental climate with moderately cold winters and hot summers. In order to more fully understand the general and hydrological characteristics of the research area, as well as to provide a basis for defining the hydrological flow regime on the key profile, the basic elements of the climate, such as rain precipitation, have been processed and analyzed. Probabilistic analyzes of the probability of occurrence were performed for characteristic annual values using Normal, Log Normal, Gumbelov, Pearson III and Log Pearson III distribution laws.

2.1. Rainfall regime

The precipitation regime was analyzed for the rain station Nis, which can fully represent the precipitation regime in the considered area. Atmospheric precipitation was used in the form of the dependence of "maximum rain height - duration - probability of occurrence" (H-T-P curve) for rains of strong intensity and short duration.

Table 1: The ordinates of the probability distribution of the maximum rain heights H(mm), duration Tk (min) and probability p(%), for rain station Niš T(^{o}C)

Table for H-T-P curve construction - Niš (RHMZ)					
Raun duration - T (min)	H-rain height (mm)				
	P-return period (year)				
	100	50	20	10	2
10	27	24.3	20.7	17.9	10.5
20	37.5	33.6	28.5	24.5	14.0
30	43.3	38.9	32.8	28.2	15.9
60	50.1	44.9	38	32.7	18.8
120	53.6	48.2	41	35.5	21.0
180	55.1	49.7	42.5	37.0	22.5
360	58.8	53.4	46.2	40.7	26.1
720	70.1	64	55.7	49.4	32.8
1440	71.2	65.1	57.1	50.8	34.5

Observing the data obtained from the hydro meteorological institute, a return period of 10 years is accepted as the most optimal. Hydrological analysis of the observed area was conducted, which divided the area into two micro-basins due to topographical characteristics. A rational method was used to determine the hydrological analysis of watersheds.

Overviewing General Regulation Plan of the municipality of Medijana, we have retained information that in our project boundary greenery represents 5%, and the rest surfaces are impermeable. With further elaboration, the hydraulic calculation for given micro-watersheds was processed based on the data obtained from the hydrological analysis and the data obtained from JP "Naissus" and the following results were obtained:

Picture 1: Micro-basins

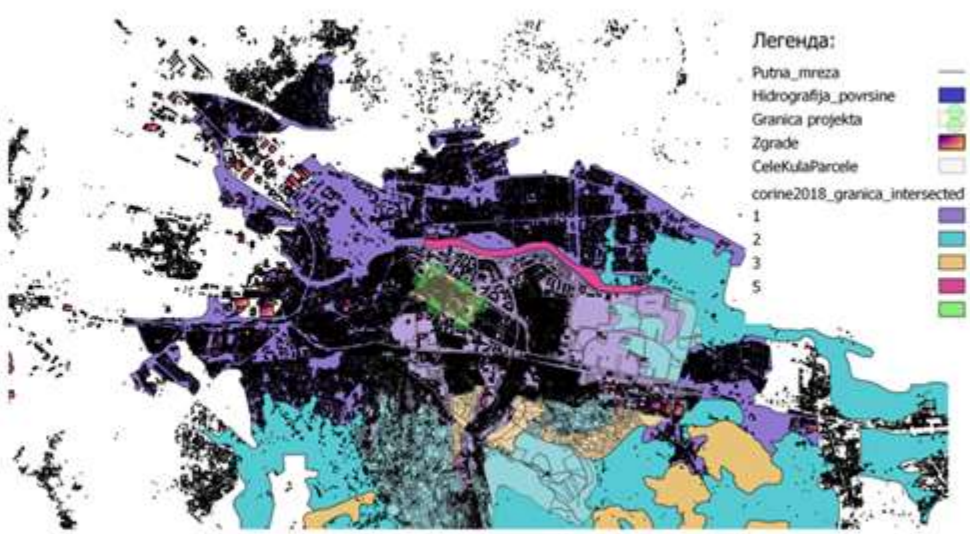
Catchment areas:
F1= 202718.29 = 20.27 ha
F2= 295065.32 = 29.51 ha
Average smoothed catchment drop:
lsl1 = 1150 m
lsl2= 1067 m
Based on the hydrological calculation, the official rain in 15 minutes is implemented.
Collecting sewage system for catchment 1 is DN 800 and for catchment 2 is DN 1200. After the calculation, data is obtained that a pipe DN 800 with 100% capacity can accept Q = 0.711m3/s, and DN 1200 can accept Q = 2.05m3 /s.

3. RESULTS

The observed area of township Mediana in Nis is limited to Vojvode Mišića, Sremska, Bulevar Nemanjića and Bulevar dr Zoran Đinđića. In this paper, a more detailed elaboration of the location with hydrological analysis of the catchment area will be presented using the GIS software package.
Using the GIS software package, the subject location was highlighted on an orthophoto.

Picture 2: Observed area with ortophoto map

Picture 3: Land classification



Based on the previous analysis, the following data were obtained for the observed area and the wider area of GO Median for the purpose of comparing data on the risk of internal flooding, because the observed area is the most congested due to large urbanization and relatively flat terrain and slope towards the river bed. The program obtained the following data through analysis:

1. Moderately threatened area
2. Weak threatened area
3. Non-endangered area
4. Intensively endangered area
5. The floodplain of the Nišava River

4. DISCUSSIONS

The observed area of GO Medijana in Niš, bounded by the streets of Vojvoda Mišić, Sremska, Bulevar Nemanjić and Bulevar Dr. Zoran Đinđić, is divided into two microlocations in the GIS software package due to the topographical structure of the terrain in order to determine the risk of internal flooding. Through a comprehensive analysis of hydrological and hydraulic parameters, and activation of the model, the program generated a high risk of internal flooding in the observed area.

5. CONCLUSIONS

The high prevalence of impermeable surfaces, which amounts to 95% of the observed area, leads to a large surface runoff of rain, and at the same time, due to the configuration of the terrain, water is retained in micro-catchments and thus endangers the objects in the observed area. Also, due to the proximity of the Nišava river, the groundwater level is high, and due to the greater amount of rain, there are additional problems of water infiltration into the underground. Therefore, the GIS software package generated the vulnerability of the observed area as very high, which can be seen on the area classification map.

Analyzing the data obtained by using GIS, we can make a proposal to reduce the possibility of internal flooding by combining several alternative methods:

- By building a separate type of sewage network that could accept a larger amount of water.
- Increasing green areas in the form of rain gardens or green roofs.
- Construction of retention ponds that would retain flood waters and enable their later application.

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