Analysis of significant floods in Bulgarian Danube region till 2010 y

Rositsa Velichkova
Bulgaria, Sofia, 8 Kl. Ohridski Ave, Technical University of Sofia
rvelichkova@tu-sofia.bg

Abstract. Floods in Bulgaria are natural hazards that occur often and make huge damage. In current work the significant floods for Danube region are discussed. An analysis for the period till 2010 is made. The rivers which cause most damages in that region are shown.

1. Introduction
Floods are common natural disasters on the territory of the Republic of Bulgaria. They can cause huge damage as they affect urban territories, productive agricultural lands and woodland. According to the scientific classification for this type of hazards and according to the Water Act, the floods can be natural and technogenic - caused by other influences, such as damage to a hydrotechnical facility, which can lead to an accident as well as to prevent critical situations in hydrotechnical facility.

Floods over recent years have shown that the flood risk reduction activities that have been applied so far are not sufficient and a policy of comprehensive flood risk management should be pursued under the conditions of coexistence with them. Such an integrated approach - flood risk assessment and management is set out in the European Floods Directive, which was adopted in 2007.

Its requirements were introduced into the national legislation through the Water Act in 2010. The reduction of the flood risk is mainly due to the construction of hydrotechnical protection systems and facilities, good spatial planning of the territory and last but not least - increasing the readiness to prevent or reducing the negative effects of floods through preventive measures, training of the population, adequate preparation, planning of rescue activities, etc. Regular cleaning of the riverbeds and their protection in natural conduction conditions is necessary as well.

The aim of the present work is to analyse the significant floods of the rivers in the Danube region by 2010. (Fig. 1)
2. Preliminary risk assessment

According to the recommendations of the Floods Directive, in the framework of the ex-ante flood risk assessment, past floods with significant impacts on the protected categories "Human health", "Environment", "Cultural heritage" and "Economic activities" which are likely to repeat in a similar form in the future (Article 4.2.6). For this purpose, significant floods of the past have to be described as far as significant negative consequences of future similar events can be expected (Article 4.2).

In order to make use of the knowledge of past floods and to identify areas with a significant potential flood risk, pursuant to Article 5 of the Floods Directive, the historical flooding limits need to be redeveloped in addition to the verbal description of past floods. In addition, historical flooding information is of great importance for the development of hazard maps and flood risk maps as they can be used to calibrate hydraulic computational models as well as to control the credibility of the computational results.

Depending on the region, the identification of flood-risk areas, flood risk assessment maps are prepared for different parts of the river network on the territory of the respective municipality or region.

Risk Assessment Cards are developed for the following scenarios:
- floods with low security or with a long period of repetition (extreme floods);
- floods with average collateral (<1%), respectively with an average replication period of 100 years);
- at the discretion and for floods with high security or with a small period of repetition

In accordance with the Directive 60/2007 / EC requirements, flood hazard maps must contain the following information:
- Flooding range / limits;
- Depth of flooding or discretionary water structures;
- at an estimated rate of flow or significant water quantity.
3. Project units in Danube region

The volume of activities in each project unit also depends on the existing flood risk. The determinate project units in our country correspond to the currents basins for the implementation of the Water Framework Directive. The project units determination includes:

- justification of initial territorial river basins for analysis;
- threshold values of the height of the water column;
- analysis of the affected areas and determination of the scale of the flood;
- identifying the importance of flood protection measures for the population and infrastructure.

Project units in the Danube area are listed in Table 1

| Project Unit | Rivers                  |
|--------------|-------------------------|
| 1. 1st       | Timok                   |
|              | Topolovets              |
|              | Voynishika              |
|              | Vidibol                 |
|              | Archar                  |
|              | Skomlya                 |
|              | Lom                     |
|              | Tsibritsa               |
| 2. 2nd       | Ogosta and its influx   |
| 3. 3rd       | Iskar and its influx    |
| 4. 4th       | Vit and its influx      |
| 5. 5th       | Osam and its influx     |
| 6. 6th       | Yantra and its influx   |
| 7. 7th       | Rusenski Lom and its influx |
| 8. 8th       | Tsartsar                |
|              | Senkovets               |
|              | Kanagyl                |
| 9. 9th       | Suha and its influx     |
| 10th         | Vatova                  |
|              | Shablenska              |

European Commission’s guidelines set put in the document "Draft list of flood types and stand consequence" form 16.02.2011 distinguished five types of floods according of their source:

- river – caused by rain and snowmelt;
- slope-caused by rain ;
- lake-caused from rain water inflowing in lakes;
- sea – caused by sea storms;
- infrastructure – caused by insufficient conductivity of sewer and drainage systems due to rainfall and wave transferring seawater over protective embankments in the coastal areas of cities.

The collected information for floods in Bulgaria covers the period 2000-2010 and refers to the 2211 past floods (fig.2).
The predominant mechanism for flood formation is the natural overflow of water over the river banks. Historical flood chronology describes one case of river floods as a result of the blocking of a river with icy blocks (Danube River, 1942), as a result of the rivers (Ogosta, Vit, Osam and Yantra, Rusenski Lom, 2006) from the high level of the Danube River and as a result of reduced conductivity (p. Yantra, 1991). The number of the river floods caused by the reduced possibility of the river beds is very large.

Catastrophic floods are monitored and documented with particular attention. Therefore, such floods have been thoroughly documented and described. These records are an important source of information on the existing flood threat to be used in the framework of the preliminary flood risk assessment, both for describing the flood threat and its consequences and for identifying areas with significant potential flood risks.

4. Analysis of significant floods at Danube region
In this part are made analysis for significant floods by districts in Danube region. It is given the significant floods at each river in this region.
At Danube region have 9 districts: Vidin, Montana, Vratsa, Pleven, Veliko Tarnovo, Rousse, Razgrad, Silistra, Dobirch.
The rivers in this region are given in table 1.

On fig. 3-9 are given the significant floods in Danube region till 2010 year by districts and river is Danube region.
Figure 3. Significant floods in district Vidin

Figure 4. Significant floods in district Montana

Figure 5. Significant floods in district Vratsa

Figure 6. Significant floods in district Pleven

Figure 7. Significant floods in district Veliko Tarnovo

Figure 8. Significant floods in district Ruse
**Figure 9.** Significant floods in district Razgrad

**Figure 10.** Significant floods in district Silistra

**Figure 11.** Significant floods in district Dobrich

In fig. 10 is shown the significant floods by rivers at Danube region

**Figure 12.** Significant floods by rivers at Danube region
5. **Conclusion**

In current paper the significant floods in the Danube plain are analysed. The floods which is happen in past year in the districts are given, as well as the significant floods on the rivers in this area. Based on this, areas with a significant potential flood risk can be identified and validated, focusing efforts on the mapping of the threat and risk of floods and the development of flood risk management plans.

**Acknowledgment**: This work has been carried out in the framework of the National Science Program "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters", approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science (MES) of Bulgaria (Agreement № ДО-230/06-12-2018).

**References**

[1] DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance) Official Journal of the European Union, 6.11.2007

[2] Garo Mardirossian, (Sofia 2009, prof. Marin Drinov Academic Publishing house ), Natural disaster and ecological catastrophes, Study, prevention, protection, Second revised and supplemental edition

[3] Management plan for flood risk for Danube Region basin District

[4] Venelin Makakov, Rositsa Velichkova, Iskra Simova, Detelin Markov, FLOODS RISK ASSESSMENT IN BULGARIA, CBU International Conference on innovation of science and education, March 22-24.2017, Prague, Czech Republic pp 1253-1258

[5] http://www5.moew.government.bg/?page_id=23341