Flood Management in Municipalities in the Prešov Region

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Abstract. The paper deals with a questionnaire survey aimed at assessing the preparedness of municipalities in Prešov region in terms of flood protection. The questionnaire contained 27 questions which, in addition to formal information on the municipality were focused on the occurrence and periodicity of floods, the time axis of floods, the current state of preparedness of municipalities in terms of floods, as well as the improvement/worsening of the situation in the case of applied flood protection measures. The answers provided by municipalities have been processed and evaluated by using tables and charts in the paper. The questionnaire survey was intended to help municipalities and self-governments to deepen their knowledge level in the area of flood protection. Many of them have expressed interest in the feedback - the results of the questionnaire survey to be sent to them. Based on the results obtained and their evaluation, the research can make a significant contribution to increasing flood protection, especially in areas affected by this phenomenon. It should be emphasized that reducing the risk of flooding increases the safety of people in the areas under consideration.

1. Introduction
Approach to flood management has changed in recent decades [1–3]. Strategy of application of exclusively technical measures to prevent floods (water treatment flows, construction of water reservoirs, polders and dykes) [4–6] has gradually shifted towards integrated management flood risk of the so-called adaptive flood strategy [7].

One way to get information on experience of flood risk communities is to conduct a questionnaire survey. In the presented paper, a part of the results of the questionnaire survey, which took place in 93 municipalities in the Prešov region have been presented. This region has been extremely exposed to floods mainly in the past decades [8–10]. The questionnaire contained questions about personal experience of the municipalities with the flood, about the last registered flood, the periodicity of floods, development of the flood danger over the 10-year period, environmental damage and the current state of the feasibility of flood control measures in their municipality.
2. Material and Methods

2.1 Study area

The Prešov region is the second largest region with an area of 8,973 km$^2$. It occupies 18.3% of the country's area. In the south, it borders with the Košice region, in the southwest with the Banská Bystrica region and in the west with the Žilina region. The state border with Poland also forms the border of the region as well as Ukraine in the east. It is divided into 13 districts as can be seen from Figure 1 [11]. The largest districts of the Prešov region are the districts of Poprad, Bardějov and Prešov. The Prešov Region consists of 665 municipalities, 23 of which are towns and 642 are villages.

![Figure 1. Prešov region.](image)

There are 816,845 inhabitants registered for permanent residence (dated on 31 December 2017) in Prešov region, which represents 15.03% of the population of the Slovak Republic. The third largest city in Slovakia - Prešov has 173,457 inhabitants. At the same time, the city belongs to the most populated communities in the Prešov region.

From the hydrological point of view, the Prešov region is situated on the main European watershed. A large part of the territory belongs to the Poprad catchment area where water flows into the Black Sea. The Tisza catchment area with the Bodrog and the Slaná system runs into the Danube basin. The small Danube river basin is a tributary of the Vistula River in the territory of Poland. There are over 400 thermal and mineral springs in the Prešov region. [6] Most of them are used by the inhabitants of the villages in the location where they spring. This mineral water is filled into bottles and sold as remedial, mineral and table water, e.g. Sulinka, Cigelka, Balovka. Spa baths and spa towns are situated near the springs. The most famous are Bardejovské Spa, Spa Vyšné Ružbachy, the High Tatras Spa and the modern Aqua City Spa in Poprad [12]. Daily air temperatures in Prešov area range from -5°C in January to +25°C in July. The coldest months include December and January when daily average temperatures drop below zero. The warmest months are July and August. In the winter months, there is an increased number of the days with precipitation. In the November and December, there are on average 7 days with precipitations in Prešov. Most rainfall comes in June, with up to 10 days. During the year, the number of days with precipitations ranges from 5 to 10 [13].
2.2 The questionnaire survey
A questionnaire survey was carried out in the municipalities of Prešov region. The questionnaires were distributed to a municipality representative with a request for their completion and subsequent dispatch in doc. format. The total of 662 questionnaires (100%) were distributed in the Prešov region, 96 questionnaires (14.5%) were filled in (including questionnaires with partial answers) and subsequently evaluated, 30 questionnaires (4.53%) were returned as undeliverable, probably due to a technical error or malfunction of the Internet mailbox and 536 questionnaires (80.97%) were not filled in.

In the months of October 2017 and February 2018 the questionnaires were distributed to all municipalities (more than 1,100 emails in two rounds) to all villages and towns in the Prešov region.

The questionnaire contained more than 27 questions aimed at general information as well as at flood protection measures. Seven of them have been discussed in detail in this paper:

1. Has the flood ever occurred in your municipality?
2. When was the last registered flood according to the month of occurrence?
3. Do you register any environmental damage in your municipality?
4. Do the floods occur periodically?
5. What was the development of flood occurrence situation over the past 10 years?
6. What is the current state of feasibility of the flood control measures in your municipality?

3. Results - assessment of the questionnaire survey
All the districts participated in the questionnaire survey in the Prešov region. Most of the answers were from the Prešov district (13 replies) and the least from the districts of Sabinov and Svidník (4 replies).

Based on the above collected answers, a chart (Figure 2) showing the number of villages, towns and cities in the Prešov region has been elaborated.

![Figure 2. Classification of the municipalities.]

Seventy-five municipalities were classified as towns, remaining 18 as villages. In terms of a number of inhabitants, there are no big cities in the Prešov region.

One of the questions was aimed at finding out if the floods had already occurred, or whether the inhabitants met the floods in their municipality. The answers in the survey were
“yes” or “no”. The question was answered by 93 municipalities, representing 100%. Individual responses are shown in Figure 3.

![Graph showing flood occurrence](image)

**Figure 3.** Has the flood ever occurred in your municipality?

The answer to the question whether flood has occurred in the municipality was answered by 73 municipalities in total. The answer was negative by 18 municipalities. Two municipalities did not answer the question.

Figure 4 shows the answers to the question focusing on the occurrence of the last flood from the time point of view (in which month the event occurred).

![Pie chart showing last flood month](image)

**Figure 4.** Last registered flood according to the month of occurrence.

It can be seen from Figure 4 that the floods occurred mostly in May (15 municipalities) and in July (9 municipalities). The month of the last flood was reported as June in 8 municipalities and as August in 3 of them. The last flood during winter months of November and February was registered in one town/village, the flood in January occurred in 3 villages. The question was not answered by 53 municipalities.
Recorded environmental damage (damage to landscape, animals, plants or crops) in the municipalities after the flood was identified by another question of the questionnaire. The answers were “yes” or “no” (“no answer” was also noticed). 93 municipalities answered this question. Figure 5 shows distribution of the percentage of the answers.

![Figure 5. Registered environmental damage.](image)

The answer "no" which stands for any occurrence of environmental damage, was reported in 46 municipalities while 34 municipalities encountered environmental damage and 13 municipalities did not answer the question.

The frequency of floods is very important in terms of flood protection, so next question addressed this topic. Answers were "yes" or "no". The question: “Do the floods appear periodically?” was answered by 93 municipalities. The percentage of positive and negative responses can be seen in Figure 6.

![Figure 6. Do the floods occur periodically?](image)

Negative responses were expressed by 52 municipalities out of the total of 93 respondents, 31 municipalities on the other hand reported that floods occur repeatedly. Ten municipalities did not answer the question.
Municipalities have been able to compare the flood situation over the last 10 years due to the occurrence of floods. The response options were as follows: the situation has improved, the situation has deteriorated and the situation has remained the same. The municipalities were not able to compare the situation. Figure 7 shows individual responses.

![Figure 7. Development of flood occurrence situation.](image)

Considering the frequency of floods, 50 municipalities (out of 93 questionnaires in total) expressed that the situation in flood protection has improved. The situation remains the same in 29 municipalities and 10 municipalities did not answer the question. Worse situation was in one municipality, 3 municipalities did not know the current situation with the previous comparison.

The state of feasibility of the flood control measures in the municipality was also researched by the questionnaire. The answer was "yes" or "no" where 93 municipalities answered the question. A summary of the answers is shown in Figure 8.

![Figure 8. Current state of the feasibility of the flood control measures.](image)
68 municipalities responded "yes" (flood measures were implemented in their municipality) which correspond to 74.19% of respondents. No flood control measures were implemented in 19 (20.43%) municipalities and 6 municipalities did not answer the question (6.45%).

4. Conclusion
In connection with the floods appearing in particular in 1998, 2004, 2005, 2009, 2010 and 2013, several projects and studies have been carried out in recent years to increase flood protection of villages, towns and municipalities. Their main task was to increase the non-compliant level of flood protection, to protect the built-up areas from damage to property and to protect the health and life of the population.

The questionnaire survey was intended to help municipalities and to deepen knowledge level in the area of flood management in municipalities. Many of them have expressed interest in the feedback - the results of the questionnaire survey to be sent to them. Although the number of the filled questionnaires was quite small – 126 out of 662 distributed questionnaires – the completed ones are important for improving flood management in the given area. Based on the results obtained and the evaluation, they can make a significant contribution to increasing flood protection, especially in areas affected by this phenomenon. It should be emphasized that reducing the risk of floods increases the safety of people in the area under consideration.

It is not possible to stop on the boundary of the cadastral area when designing and subsequently implementing flood control measures, they should also take into account the adaptation they cause in the adjacent river basins.

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