Flash Floods in the Slovak Republic

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The Slovak Republic

Slovakia lies in the heart of Europe and borders on five states: Czech Republic, Austria, Hungary, Ukraine and Poland. The area of Slovakia is 49 036 km² and the number of inhabitants is app. 5.38 million.

In the northern part of country crosses the European watershed divide between Baltic and Black Sea (to the watershed area of Baltic Sea belongs only 4 % of the territory of Slovakia.) From the hydrological point of view Slovakia is divided into 11 main basins (Fig. 1):

Morava, Danube, Váh, Nitra, Hron, Ipeľ, Hornád, Bodrog, Bodva and Poprad with Dunajec.

In the Slovak Republic the 89 % of the land surface are highlands and mountains, rugged (braked) with streams and rivers. The climate is temporary oceanic and continental and is most affected by the height above sea level (supermarine height). The most precipitation falls in the spring - summer period, the most humid month is July.

In the period 1994 - 2001 138 flash floods occurred on the Slovak Republic territory (Tab. 1). The one that appeared on Štrbský Creek on 14 July, 2001 will be discussed later.

Flash floods

A flash flood is a sudden rapid flooding with high peak discharges, produced by intense rainfall associated with thunderstorms that are generally of limited areal extent. They mainly occur on smaller streams in geomorphic low-lying areas (e.g. valleys, canyons). (Flash floods can also occur when ice jams block the normal course of a river, or when a man-made structure, such as a dam, collapses.) Flash flooding occurs when the ground becomes saturated with water that fell so quickly that it could not be absorbed. The runoff collects in low-lying areas and rapidly flows downhill with sudden rising water. Flash floods most often occur in normally dry areas that have recently received precipitation, but may also be seen anywhere downstream from the source of the precipitation (even dozens of kilometers from the source). Flash floods are extremely dangerous because of their sudden nature. They rank as the most destructive process among weather-related hazards in many parts of the world. A moving flood will usually be headed by a debris pile that may have wood branches and/or logs (from Wikipedia, the free encyclopedia).
How we investigate flash floods in Slovakia?

HYDRATE Project

HYDRATE Project is an international framework on flash flood forecasting. The HYDRATE consortium consists of 17 partners and comprises universities and research institutes from: Italy (coordinator), France, Austria, Spain, United Kingdom, Greece, Slovak Republic (The Slovak University of Technology in Bratislava and Slovak Hydrometeorological Institute - SHMI), Romania, United Kingdom, Netherlands, South Africa, United States and Canada.

The HYDRATE objective is to improve the scientific basis of flash flood forecasting by extending the understanding of past flash flood events, advancing and harmonising a European-wide innovative flash flood observation strategy and developing a coherent set of technologies and tools for effective early warning systems. To this end, the project includes actions on the organization of the existing flash flood data patrimony across Europe. The observation strategy proposed in HYDRATE has the objective to collect flash flood data by combining hydrometeorological monitoring and the acquisition of complementary information from post-event surveys.

This will involve a network of existing Hydrometeorological Observatories; all placed in high flash flood potential regions. HYDRATE will develop a freely-accessible European Flash Flood Database to make available the collected hydrometeorological data to the international research community. The final aim of HYDRATE is to enhance the capability of flash flood forecasting in ungauged basins by exploiting the extended availability of flash flood data and the improved process understanding.

HYDRATE consists of a series of "Themes" divided into works packages. The six Themes are:
- compilation of past flash flood data,
- advancing the flash floods observation strategy,
- analysis of flash flood events,
- strategy for creating an European Flash Flood data archive,
- models and procedures for flash flood forecasting in ungauged basins, communication and dissemination of project results,
- project management (HYDRATE, 2005).

Now data collection and analysis is in progress.

Post flash flood investigations

Due to the time-space characteristic scale of flash-flooding, the majority of the upstream catchments affected by these floods are not gauged. If an intensive research activity is to be set up on these hydrological events, it is necessary to develop specific methods to collect and analyse the existing information about the floods when and where they occur and not to limit the analysis to the few events affecting gauged watersheds. Three main types of data will be considered after a major flash-flood event:
Indicators of the peak discharge values: mainly cross-section surveys based on flood marks but also clues of flow velocities (video movies, witness observations, water super-elevations in river bends or in front of obstacles). The report presents and criticizes various indirect post-flood peak discharge estimation methods and puts the emphasis on the cross-validation procedures.

Indicators of the time sequence of the flood: mainly eyewitness accounts where no stream gauge measurements are available. Accounts from eyewitnesses are occasionally cited in flash-flood studies, they have seldom been, to our knowledge, systematically collected and analysed. This report provides a methodology to collect and analyse eyewitness information and discusses the reliability of this source of information.

Mass transfer processes (erosion and deposits on the slopes and in the river bed, hyper-concentrated, mud or debris flow) as the main focus of the post-flood investigation but also as an indication of the local flow energy and velocity.

Information on socio-economical aspects can also be collected like geo- and time-references of accidents, qualitative description of public behaviour, effectiveness of warning broadcasts, nature and extension of the damages caused to bridges, roads and buildings.

All the collected data are filled in a summary sheet. A column of the sheet should be filled for each basin and for each section where a flash flood has been observed.

Beyond the procedure and methods, it is important to keep in mind the general philosophy: the data collected are necessarily inaccurate, no method is perfect and the very first concern must be to verify, crosscheck, verify and crosscheck again. It is the only way to limit the risks of errors on peak discharge estimates. (FloodSite, 2006).

**Flash flood on Štrbský Creek in July 24, 2001, in the afternoon**

The flood reconstruction was made after terrain investigation on August 14, 2001 (21 days after the flood) by SHMI. Figure 2a,b,c,d and 3a,b shows the flood situation in Štrba village.

**Natural characteristics of the catchment area**

Štrbský Creek is a small 5.2 km long stream with catchment area only 12.23 km$^2$. Its watershed occurs on the northern side of main watershed divide of Black and Baltic Sea. Štrbský creek flows in eastern direction through the village Štrba. Under the village discharges to Mlynica Creek the tributary of Poprad River in its upper part. From the hydrogeological point of view, the whole catchment creates the quarter sediments on the foot of High Tatras. Vegetation cover is composed of meadows, pastures and forest. The gradient of slopes in Štrbský Creek area ranges 20-30%; the slope of creek itself is 2.1% in average.

**Meteorological situation**

July in 2001 had interesting precipitation regime. The intensive continuous precipitation was combined torrential rains, connected with thunderstorm activity.
Rain gauge station lying close to the expected rain core were (in the brakes is direction from core): Štrba 1,7 km (E), Štrbské Pleso 7,0 km (N), Važec 6,0 km (W), Čierny Váh 11,0 km (SW), and Liptovská Teplička 11,0 km (SE).

After station observation the occurrence of heavy rain in the Štrba village was from 15,20 till 16,10 (precipitation sum was 73,6 mm).

**Hydrological situation**

The reconstruction of hydrological situation in the locality of Štrba village was based on facts as follows:

- Identification of area of intensive torrential rainfall
- Disposable measurement from rain gauge station in Štrba village
- Information (by interview) about rainfall duration as well as about its time and space distribution
- Information from terrain investigation (marks after heavy rain and flood)
- Video record from flood course (which was made by citizen app. 5 – 10 minutes after culmination)
- Measurement of two cross sections with flood remarks

The estimated value of peak discharge was 120 m³.s⁻¹. It means, that T-year culmination discharge was higher than 1 000 years. The peak specific runoffs were from 10,7 to 26,0 m³.s⁻¹.km⁻².

**Flood prevention measures and flood damages**

There are no technical flood protection objects situated in the streams of the affected areas. Very fast starting up of the flood caused, that it was not possible to make any flood protection measures. Decrease of the damages after occurrence of the flash flood (extreme and intensive phenomenon) is very problematic without long-term prevention measures and existing early warning system.

The flood situation in touched village occurred in afternoon. In spite of sudden occurrence of the flash flood in such a magnitude the behaviour of people was reasonable. No people died, no damage of people health was registered. Immediately after citizens purposefully joined to eliminate issues of the flood. One of local citizen filmed the course of flood suddenly after culmination. He provided with video record the experts of Hydrometeorological service.

With respect to reasonable behaviour during the flood no evacuation of population was needed. To the Central Flood Commission in the Slovak Republic were reported only damages on municipal properties in total high of 1,085 mill. SKK (app. 30 thous. EURO). The damages were generated on local communications, on flooded sewer system and sewage water treatment plan.

**Interaction between flood and natural resources**

In the affected areas there were no pollution sources. The drinking water in water supply system was not contaminated; only some local sources of water (wells) were polluted. Fallen animals were not registered. The health authority tested each local source of drinking water very carefully.
Figure 1: The 11 main basins of Slovakia and the situation of Štrbský catchment (source: www.shmu.sk).

Table 1: Flash floods occurred on the Slovak Republic territory in the period 1994 – 2001.

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Figure 2 a,b,c,d: The flood situation on Štrbský Creek in Štrba village, July 24, 2001.

Figure 3 a,b: Štrbský Creek, a - the water level immediately after culmination, b - the water level cca two weeks after flood.
References


http://referaty.atlas.sk/prirodne-vedy/geografia/17786/?page=1

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www.shmu.sk  - Slovak Hydrometeorological Institut