

## Determining criteria for monitoring torrential rains

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Torrential rains are an intense physical process of short duration, limited in time and space. They are formed from cumulonimbus cloud systems. The monitoring of these kinds of cloud formations is geared toward anti-hail protection and air traffic. After ice turns into water, little significance has been given to the rain itself and its characteristics, despite the fact that these rains cause torrential floods. Due to the large number of rapidly changing observed data, mathematical models are aimed at the specific task of anti-hail protection. On the other hand, mathematical models of intense rains of short duration require more computer time than the phenomenon itself. This results in devastating flash floods being characterized as "unexpected" or "sudden".

Analysis of previously recorded flash floods and their causes has shown that every rain forming cloud formation has been completely recorded. The mathematical model for precipitation prediction lags beyond the time of need for these predictions. The delay in the notification of potential torrent floods is in part due to shortcomings of existing prediction models for integrating hydrological and meteorological processes. Specifically, these prediction models were designed for relatively large catchments where floods are caused by day-long rains and last several days.

Flash floods are caused by heavy rains that last from 1 to 5 hours and are characterized by torrential flow regime and great destructive power, endangering traffic corridors, infrastructure systems and urban areas. These are constructions of high value and high urban density. That is why damages are proportionally high, with the inevitable loss of life.

The construction of passive flash flood protection systems is expensive, slow and significantly lags behind the needs. This is why the protection from flash floods in urban environments and traffic corridors has become a major problem. Due to the nature of the causes and effects, the research is focused on monitoring and mathematical modelling of meteorological and hydrological processes, as is the case with large cloud systems and river basins. Unfortunately, the desired results have not been achieved.

The search for the solution is directed towards defining the lower threshold of the phenomenon that triggers flash floods, i.e. the intensity and duration of heavy precipitation, because this is possible to identify and evaluate during the monitoring of the cloud system.

All observed occurrences of flash floods have been analyzed, as well as the characteristics of rains that caused them. Based on this analysis, sets of intensities and amounts of heavy precipitation have been defined, which are the criteria needed for the monitoring of cloud systems using remote sensing and radar observations.

These criteria are the basis of timely predictions and notifications of flash floods which can operate in real time, and is in operation in Serbia.