Stochastic modeling of storm precipitation scenarios

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Abstract The article is dedicated to stochastic modeling of storm precipitation. The presented scientific study tests the main hypothesis about the sufficient adequacy of the main statistical characteristics of the observed and modeled storm precipitation using a special algorithm of the Monte Carlo method.

Keywords: storm precipitation, stochastic modeling, North Caucasus.

Methods

- The purpose of the study is to model on the basis of the observed data the greatest probable storm precipitation within the limits of 1 hour and 24 hours in order to estimate the severity of potential floods in the region.
- The baseline data for the study includes some series of precipitation, registered in Tuapse, North Caucasus.
- The study deals with 69 rains with total daily precipitation greater than 30 mm.
- Each observed rain has its own duration (from 1 to 24 hours, in steps of 1 hour) and its own intensity at each hour.
- On the basis of the collected data 69 rainfall scenarios have been obtained.
- Using the Monte Carlo method 500 random values characterizing the rainfall probability were generated.
- The method considers 500 rainfalls according to the obtained scenarios.

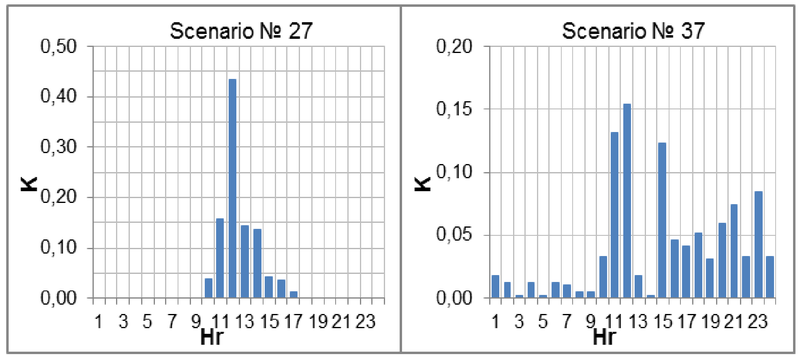

Figure 1: Examples of different rainfall scenarios.

Results

To assess the consistency of the presented modeling method, the statistical characteristics of the observed and modeled series were calculated. These characteristics include mean values and variation coefficient Cv for amount of the rainfall (Xd) at the hour with the maximum precipitation (Xmh), at the previous hour (Xmh – 1 hr) and at the next one (Xmh + 1 hr).

Table 1: Mean values for observed and modeled series

	Observed data, mm	Modeled data, mm	Difference, %	Root mean square error, %
Xd	48,0	47,8	0,410	5,441
Xmh	23,2	22,5	3,317	6,922
Xmh–1hr	4,7	5,3	11,754	14,121
Xmh+1hr	7,1	6,7	6,236	15,349

Table 2: Values for variation coefficient for observed and modeled series

	Observed data	Modeled data	Difference, %	Root mean square error, %
Xd	0,452	0,419	7,876	9,232
Xmh	0,575	0,573	0,349	9,635
Xmh–1hr	1,173	1,214	3,414	12,152
Xmh+1hr	1,275	0,958	33,031	12,606

Conclusions

Analysis of the tables shows that we can use the presented method for modeling scenarios of storm precipitation because the results are quite accurate and an inaccuracy appears just in one case (value for the variation coefficient at the hour following the hour with maximum precipitation).

The presented method for modeling scenarios of storm precipitation on the Tuapse river basin is enough accurate. It can be used in “precipitation – runoff” models for dangerous floods.

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