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Assessment of historical and future extreme flood characteristics for Novorossiysk city on the Black Sea coast of the North Caucasus

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Several catastrophic floods have occurred in the North Caucasus region in recent years. One such, the dramatic flood in Krymsk in July, 2012 led to more than 160 deaths. Except for late warning, the main reason for damage and loss of lives is the unpreparedness of urban drainage systems and hydraulic structures to the increased intensity and volume of precipitation which has been observed in the region in recent years.
This study aimed to assess flood characteristics and estimate possible inundation areas for Novorossiysk city, located at the Black Sea coast of the North Caucasus. The Cemes River which flows through the city originates on the north-east slopes of the Gudzev Mountain (425 m) and has a basin area about 83 km2. The study is conducted for the purpose of improving the city drainage system.
The task of flood characteristic estimation is complicated by the lack of both hydrological and meteorological data. The Cemes River is ungauged and there are no operative precipitation gauges on the mountain slopes where most of the precipitation occurs. There is only one station located in the city on the coast.
The assessment was conducted using several approaches. One is that the recommendations which are used in hydrological engineering practice were applied. They include the use of basin-analogous data and the application of regional formulas and maps to estimate maximum discharge of required exceedance probability (1% in this study). In this case where the shortage of observation data is combined with considerable changes in rainfall and land-use, the methods estimating runoff characteristics using the statistical approach of observation data extrapolation may yield incorrect results. As a result, the deterministic-stochastic (DS) modeling approach used herein is suggested as an alternative. Here the deterministic model distinguishes between the processes within catchments, while the stochastic model provides stochastic meteorological input and a framework to link global climate models in a changing environment with land surface components.
The Deterministic-Stochastic Modelling System (DSMS) developed by Prof. Vinogradov in the State Hydrological Institute of Russia was applied to assess current extreme rainfall and runoff characteristics and possible changes to these in the future. The DSMS consists of two elements: a deterministic hydrological model Hydrograph and a Stochastic Model of Weather (SMW).
The stages of the research included:
1.establishing a dataset containing historically observed hydrological and meteorological values and landscapes characteristics for the study region,
2.verification of the Hydrograph model,
3.deriving ensembles of scenarios of future climate using the stochastic weather generator and climate change scenarios
4.assessment of extreme runoff characteristics under historical, recent and future conditions.
Based on the results, a set of inundation maps for Novorossiysk city was developed. The results of standard and deterministic-stochastic approaches will be presented and discussed.