About one case of predicting losses of floods based on monitoring data

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Floods challenge people globally and are considered one of the key natural risk factors for human life and activity. In terms of the number of catastrophic events that occurred during 1998-2017, floods outweigh any other natural disasters. The number of people affected per floods in 1998-2017 was near 2.0 billion (45% of all injured through natural disasters); the number of worldwide deaths due to them exceeded 142,000 (11% of all-natural catastrophes) [1]. Overall worldwide losses caused by 1980-2019 flood events reached US$ 1,092bn [2].

Ukraine also suffers from floods harmfully. The area of lands affected by floods in the country is almost 165,000 km^2 (more than 27 per cent of its territory), and about a third of Ukraine's population lives in flood-prone areas. Especially often disastrous floods occur in the western regions of the country, on the Carpathian rivers [3, 4].

Admittedly, comprehensive flood monitoring with assessing of flood losses could be an important component of modern flood management strategies to minimise flood risks [5]. To emphasize the importance of targeted flood monitoring in the country, there was performed a retrospective prediction of the confirmed monetary losses due to destructive floods that occurred in the Tisza River basin in the Transcarpathian region in 1980, 1986, and 1998 using available monitoring data on the floods in the region from 1955 to 1998. The main aim of the research was to reveal whether the losses of the 1980, 1986, and 1998 floods could have been predicted in advance.

While solving the problem, there was revealed and modelled the dependence of risks of flood losses in the

Transcarpathian region on the maximum water discharges of the Tisza River gauged at the hydrological station (HS) "Vylok". Input data comprised the time series on maxima water discharges gauged at the HS from 1954 to 1999 and confirmed losses due to floods in the Transcarpathian region from 1955 to 1998. Predicting was based on the hypothesis of the stationary random process for maximum water discharges. It allowed using an empirical distribution function of a random variable regarding observed flood water discharges for numerical computing of the risks of flood losses.

Predicting was carried out by means of the combined situational-inductive predictive modelling method (CSIPMM) of the original author's development [6]. The method is based on the use of extrapolation-regression type models. According to this method, the prediction task was performed in two stages. The first stage realised the retrospective situational modelling task aiming to obtain a set of simple regressions (situational models) built on data of sample time series. Those situational models were assumed to be adequate ones within certain periods of time determined as situations. In the second stage, based on the generalization (on ensemble) of the obtained retrospective situational models, inductive "levels" models were built to reflect the behaviour of risks of losses as a resulting variable at fixed values of the predictor in time. Next, the inductive models were used in extrapolative predicting a situational model belonging to a future period (situation).

In total, three prediction options were made: (1) taking into account the annual maximum flood discharges from 1954 to 1979 (before the flood of 1980); (2) the same from 1954 to 1985 (before the flood of 1986); (3) the same from 1954 to 1997 (before the flood of 1998). In order to assess the predictive skill of developed predictive models the Nash-Sutcliffe model efficiency coefficient (NSE) and its application in regression procedures (NSE_R) were used. The check

revealed that the NSE coefficient value for all three prediction options was over 0.93, and the NSE_R coefficient value was 0.94. It confirmed the good predictive skill of the used predictive models and the CSIPMM as a predictive modelling method. The study found that there had been a realistic possibility to predict the confirmed monetary losses caused by the flood of 1986 and 1998 (relative predicting errors of 7.2-8.7% and 6.0-12.8% depending on the prediction options).

References

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