FORMATION OF THE RAIN PEAK FLOOD DISCHARGES IN SMALL RIVERS AND THEIR COMPUTATION

N.G. Vasilenko, S.A. Zhuravin

State Hydrological Institute, St.Petersburg, Russia
zhuravin@hotmail.ru

Introduction

Despite the presence of numerous theories, methods and equations for the rain peak flood discharges computation (Floodflow Computation, 1976) many aspects of rain floods formation processes are still unclear. As a result methods for the computation of this important hydrological characteristic are complex in use and are not quite corresponds to a requirements of practice for the unstudied rivers especially. Therefore, further efforts for the studies of flood formation processes and development of computation methods based on the most significant physical factors are still of actual. The methods for independent definition of these factors are important as well.

The study included rain flood formation experimental studies in small research basins in Eastern Siberia and further interpretation of the obtained results for the development of the small rivers peak flood discharges method computation.

Purposes and study objects

The experimental studies of flow formation processes at the experimental area Mogot were carried out by the State Hydrological Institute for 1976-1985 in the southern mountainous taiga zone of Eastern Siberia. The general goals of observation were to study features of hydrological regimes, find proportion of the water balance components and assess the main regional hydrological characteristics.

The nested research watersheds consist of the Nelka River (30.8 km^2) and its tributaries: Filiper (4.7 km^2), Zakharenok (5.8 km^2) and Oniks (3.0 km^2). According to the landscape and climatic evaluation the Mogot experimental area is a representative for the area at approximately 100000 km^2.

The work program at the site included observations on meteorogical characteristics, water and heat balance components. Special experimental studies of the rain flood formation included artificial raining of small plots and assessment of drainage density during natural events. The obtained results were tested for the conditions of the Kolyma Water Balance Station (KWBS) and different regions in Siberia and Northern Caucasus.

Results and discussion

The results of small plots artificial raining and observations at small watersheds shown that short precipitation of high intensity was forming peak flood discharges in very small watersheds, while influence of maximum rain intensity was decreasing for larger basin area. The beginning of peak flood maximum discharge was draw near to the time of the end of the rain effective part for the cases of significant average rain intensity (more than 40 mm·h^{-1}). Thus it is impossible to separate prevailing influence of intensity or depth of rain storm on the maximum peak flood discharge formation. Therefore it was proposed to use parameter taking into account both rain characteristics forming peak flood in small rivers, i.e. depth (H) and average intensity (a) of the effective rain part. This parameter $N=H{\cdot}a$ was called "meteorological rain power". According to the observations at the Mogot experimental area correlation coefficient between N and maximum peak flood discharges was 0.79-0.92, and it was 0.78-0.82 for the small watercourses of KWBS.

Besides precipitation depth and intensity maximum peak flood discharges depends on the landscape conditions of watershed. The most important basin information indicators determining transformation rain storm into the flow are drainage density (j), watershed slope (i) and runoff coefficient (α).

According to the observations there were not found surface flow from slopes at watersheds in the research area. Quick ground flow along subsurface drains and network of temporal slope channels were formed for the rain events. The length of temporal drainage network depends on the basin surface properties, basin moistening before event and depth and intensity of the effective part of the rain storm. Observed total length of the temporal basin network during rain storm may be from 30% till 100% of the basin permanent channel network length (Vasilenko, Khersonsky, 1986). According to computations in case of precipitation depth more than 50 mm·day total drainage density at the basin increasing into 1.2-1.5 times and in case of 100 mm per day – up to 1.8-2.2 times.

Precipitation losses for flood formation at watersheds were evaluated using runoff coefficients. It was found that values of runoff coefficients had stable trend to change from 0.9 in May to 0.1 in August for the considered region. Runoff coefficients depend on the moistening of basin during the warm period for the real year and vary widely. It is expedient to use observed extreme runoff coefficients trends to change during warm period for the computation of possible maximum rain peak flood discharges.

So, analysis of obtained experimental and observed data allows propose equation for the computation of maximum rain flood peak discharges based on the following principles:

– Equation should not pretend to take into account all indicators determining rain flood formation, but the main indicators, which may be found from data of observations;
– Equation have to allow computing real maximum rain peak flood discharges using observed precipitation and maximum rain flood peak discharges for the needed return period using precipitation of given exceedance probability;
– Precipitation losses at the basin determines using extreme runoff coefficients, its trends for the warm period and dependence from the basin conditions;
2 Transformation precipitation into the flow taking into account using basin structural indicators reflecting its hydraulic properties – permanent and temporal drainage density and basin slope.

The proposed equation is as follows:

$$Q = Kj\ J\ \alpha\ N^{i}A$$

where N – meteorological rain power, mm^{2}·s^{-1}; α – runoff coefficient; J – permanent drainage density (determine using maps); Kj – coefficient, increasing basin drainage density by temporal drainage network during the rain storm event; A – basin area, km^{2}; I – coefficient, numerically equal to basin mean slope, in parts of 1.

Comparison of maximum rain peak flood discharges computed by this method and observed at the rivers of KWBS and standard observational network in Eastern Siberia (southern mountainous taiga zone), Jamal peninsula and mountainous small rivers of the Kuban River (Northern Caucasus) (Vasilenko, Banshchikova, 2008) shown mean square deviation between them not more than 26% in 80% cases. Difference of computed by this method maximum rain peak flood discharges of 1% exceedance probability and discharges computed using frequency curves was 20% on average from 4% to 45%).

Conclusion

Experimental studies of the rain peak flood formation using artificial raining and field observations on the drainage density as well as other detailed observations at small research basins allowed to transform obtained results into approaches for the maximum rain peak flood discharges computation. It was obtained quite satisfactory results for several regions. Further assessment of parameters taking into account specific features of different regions may give a possibility to use proposed method for computation of peak floods for the engineering practice.

References

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