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**The effect of urbanization of rural catchment on the formation of rain floods on the example of the upper Mławka river**

SUMMARY OF DOCTORAL DISSERTATION

The main purpose of the dissertation was to determine the effect of urbanization of the rural catchment on the increase of flood risk. An analysis has been conducted on the impact of this phenomenon on the formation of rain floods in a lowland catchment area of the upper Mławka (area of 66 km<sup>2</sup>), which is the left tributary of Wkra. The subject of the analysis was not only the total outflow but also its components - surface runoff, subsurface and ground drainage.

The literature review focuses on issues related to the description of the river outflow and its components, including Horton infiltration theory and the Variable Source Areas (VSA) theory, as well as the issues related to urbanization and its impact on the above processes. The subject of literature studies was also a review of the mathematical models used in hydrology and the methodology of simulation-based research.

The physico-geographic and hydrological characteristics of the research facility have been presented, in which systematic measurements and hydrological and meteorological observations have been carried out since 1976. The characteristic feature of the surveyed catchment is a very high infiltration capacity of the area.

The research method consisted in conducting simulation studies using specially developed conceptual models for natural catchment and partially urbanized areas. Identification of model parameters by optimization were based on hourly precipitation and evapotranspiration input data and corresponding total outflow hydrographs. Verification of the natural catchment model carried out on the dependent and independent data showed very good compatibility of simulation results with measurement data.

An additional element of the research was the development of a method for determining the range of Variable Source Areas and the determination of this range for the catchment area using the Topographic Wetness Index (TWI) and Digital Terrain Model (DTM), the ground

water level digital model and the hydraulic conductivity of the soils. Spatial analyzes were carried out in GIS software. The results of this work are relevant thematic maps.

In the section on modeling the work contains descriptions of the structures of developed hydrological models. For the purposes of the study, urban areas were classified based on their location in the catchment area and the way of discharge of rain water. For different types of impervious areas there have been constructed complementary modules of the previously developed hydrological model for the natural catchment.

The research carried out was multifaceted, as evidenced by 90 variants of calculations. Simulations of natural catchment areas were made to identify factors influencing the shape and parameters of outflow hydrographs in pre-urbanized conditions. These studies have taken into account the different levels of probability of precipitation and initial wetness of the catchment and the role of the channel flow routing.

The variants for the urban catchment were differentiated by the location of the impervious areas, the degree of urbanization of the catchment, the state of the catchment's wetness and the assumed precipitation. They provided the basis for assessing the impact of urbanization on the catchment area on the formation of rain floods, taking into account natural characteristics such as the presence of Variable Source Areas. An analysis of the impact of urbanization on both total outflow and its components has been presented.

The work includes a tabular and graphical presentation of simulation results. The description and analysis of the results is focused on the shape and parameters of the outflow hydrographs.

The objectives have been achieved and the conclusions and recommendations for the planning of urban development of rural areas that minimises flood risks have been formulated.