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Abstract of the PhD thesis “Copulas in studies of relationships of hydro-meteorological variables and flood hazard and risk in the upper Nysa Kłodzka catchment”

In the conditions of progressing climate change and its numerous consequences for the water cycle, the rational use of water resources, their proper recognition and protection are of key importance for maintaining the socio-economic development. However, water is not only a resource, but also a threat - in mountain areas it is most often associated with its periodic excess, i.e. floods. Therefore, research on the relationship between precipitation and floods is also of a practical significance, and their results can be used, for example, during the planning process related to flood protection or the creation of early warning systems.

The research topics included in the dissertation concern both the relationship of precipitation and river runoff in average annual terms, as well as the relationship of precipitation and discharges or water levels in the analysis of extreme events (floods) in the context of flood hazard and risk. Not only hydrological, but also meteorological and economic variables are used in the studies. These include e.g. river discharge and runoff, flood wave parameters, precipitation totals and potential flood losses. The main objective of the dissertation is to determine, in probabilistic terms, the strength of relationships and their differentiation in time and space between hydrological, meteorological and economic variables in the upper Nysa Kłodzka catchment. The doctoral thesis is a collection of four articles published in peer-reviewed scientific journals with Impact Factor. The conducted research concerns both shaping the most important elements of the water balance in that area, formation of its water resources, as well as flood hazard and risk.

The catchment area of the upper Nysa Kłodzka River is a hydrologically interesting area, which, on the one hand, is of great importance in shaping the water resources of the Oder River basin, and on the other hand, exposed to large floods, which are a consequence of the mountainous nature of the watercourses and the concentric river network. The obtained results indicate the complicated nature of the relationship of hydro-meteorological variables in that area. The research results shed new light on both the conditions of water resources formation and the issues related to flood hazard and risk in the upper Nysa Kłodzka catchment. Attention should be paid to the special role of the eastern part of the analysed area both in the formation of the runoff from the entire studied catchment and in the search for the causes of the flood risk of Kłodzko town.

Apart from the research area, methodology based on the copula theory is the element connecting all the analyses. Synchronicity of occurrence of phenomena was used as a measure allowing to study the relations between selected variables and their strength. The developed methodology is universal and can be used to analyse relationships between variables of the same type (e.g. discharge-discharge), but also more complex relationships between different hydro-meteorological and economic variables.