

Seasonality river discharge and hydrological seasons of selected Polish rivers

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SUMMARY

The aim of the presented dissertation is to attempt to identify and carry out the multi-faceted analysis of the changes and multiannual variability of the seasonality discharge of the selected Polish rivers. The research of the seasonal river discharge variability was conducted on the basis of the multiannual series for daily discharges. The comprehensive data from 40 water gauges were included. In the analyses, the medium-sized river catchments located in various regions of Poland were taken into account. The length of each collected series of the daily river discharges was between 48 and 60 years and covered the period 1951–2010.

The estimation of the fluctuations and multiannual changes in the outflow seasonality from each river catchment was scrutinized on the basis of the few hydrological parameters: the half-outflow term index (*TPO*), the outflow concentration index (*GMO*), the seasonality index (*IS*) and the time of concentration coefficient (*WPK*). An attempt at a typology of the studied Polish rivers in terms of various aspects of the river discharge seasonality level was made. In connection with this typology the influence of the physiographic catchment properties on the seasonality level of the river discharge can be considered. Furthermore, the linear trends of the multiannual series of the monthly characteristic discharges were investigated. The results of the investigation would seem to suggest that some factors determining the strength and directions of the statistically significant long-term trends can be noted. Moreover, for each studied rivers the hydrological seasons were delimited. On the basis of the research, the significant differences between rivers situated in various regions of Poland were found. The differences between rivers referred to: the attribute and the sequence of delimited seasons, the length of the hydrological seasons and the number of occurrences of the hydrological seasons in particular rivers.

The outcomes of statistical calculations suggest that most of the statistically significant trends of minimum and mean monthly river discharges have been increasing in multiannual period. The biggest number of increasing tendencies of the minimum discharges were indicated in: March, February, May, June and January. While, rising trends of mean discharges dominated in: March, January and February. From the regional perspective, the greatest number of significant increasing tendencies of minimum and mean monthly river

discharges were detected in: the north-west, the south-east and the north-east part of Poland. However, in the long-term series of maximum monthly river discharges a slightly greater number of the decreasing trends than increasing ones was calculated. A major number of the upward trends of the maximum river discharges was noted in March and September. In March the long-term rising tendencies were observed in the rivers in the northern part of Poland (the Pomeranian Lake District). On the contrary, in September the upward trends were noted primarily in the series of maximum river discharges in rivers in the southern Poland (the Carpathian Mountains), respectively. From these facts it can be concluded that the “continental” features of the hydrological regimes of Polish rivers have abating in long-term period (at the expense of the maritime features).

On the basis of the magnitude and the distribution of the calculated measures of the seasonality it was possible to notice that the seasonal structure of river runoff in the studied river catchments was altering in multiannual period. Simultaneously, the regional differentiation in the course of changes and magnitude of the seasonality of Polish river discharges was observed. It can be seen from the calculated hydrological parameters that the relatively early average half-outflow term index (*TPO*) in multiannual period was characteristic of the lowland and lakeland rivers. The data indicates that the majority of the lakeland rivers were characterized by the smallest level of the seasonality discharge (on the basis of the seasonality index *IS* magnitude) and the most equal discharge during a year (with respect to the outflow concentration index *GMO*). Furthermore, the lakeland rivers were characterized by the relatively early time of concentration coefficient (*WPK*). On the contrary, in the mountain rivers, in particular the Carpathian rivers, the half-outflow term index *TPO* occurred relatively late in long-term period. Moreover, most of the mountain rivers were characterized by the most concentrated river discharge (in terms of the outflow concentration index *GMO*). Simultaneously, from the calculated hydrological parameters it was apparent that the majority of the mountain rivers were characterized by the high level of the seasonality of discharges (on the basis of the seasonality index *IS*) and a quite late time of concentration coefficient (*WPK*).

The statistical analyses show that the time convergence between changes of the series of the *IS* and the *GMO* and the *TPO* and between the *WPK* was investigated. From the timing relations of these pairs of the hydrological parameters it could be concluded that the *IS* and the *GMO*, the *TPO* and the *WPK* respectively, documented similar aspect of the river discharge seasonality. Simultaneously, these pairs of the hydrological parameters indicate various features of the seasonal structure of the river runoff.

In the examined group of Polish rivers, 29 hydrological seasons were identified. The hydrological seasons were diversified in terms of level and multiannual variability of the mean daily discharges, as well as autocorrelation. Additionally, the number of the occurrence of the hydrological seasons was various, likewise. On the one hand, one of the hydrological season (season of the high outflows, average variability and random homonymous outflows in multiannual period) was observed in almost half of the studied Polish rivers. On the other hand, the significant number the hydrological seasons was identified in one or two rivers (6 and 7 hydrological seasons, respectively). Furthermore, the considerable number of the hydrological seasons (12) were characterized by the statistically significant autocorrelation of homonymous outflows in multiannual period. From these facts we can conclude that there occurs a certain rhythm (negative autocorrelation) lasting longer than a year in the long-term period or a trend (positive autocorrelation) to the river discharges.

On the basis of the analysis it is possible to infer that the procedure of the delimitation of the hydrological seasons gave satisfactory results. The method of the hydrological seasons delimitation indicated the regional similarity in discharge and its variability between rivers which drained various regions of Poland. However, the application of that method allowed to identify specific and individual features of the dynamic and seasonal structure of studied Polish river discharges.