The cyclical nature of hydrological regime of a mountain and upland river in the upper Vistula catchment in the multi-year period of 1984–2012: A potential tool for paleohydrology analysis

Andrzej Wałęga a, Natalia Malik b, Artur Radecki-Pawlik c, *, Karol Plesiński a

a University of Agriculture in Krakow, Faculty of Environment Engineering and Land Survey, Mickiewicza 24/28, 30-058 Krakow, Poland
b MGGP S.A. Krakow, Lea St. 112, 30-133 Krakow, Poland
c Cracow University of Technology, Institute of Structural Mechanics, Faculty of Civil Engineering, Warszawska 24, 31-155, Krakow, Poland

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ABSTRACT

The study assesses the cyclical nature of occurrences of wet and dry years in the catchment of the Dunajec – to the Nowy Targ-Kowniec section and the Rudawa – section Balice. The analysis was based on the data of mean daily flows from the multi-year period of 1984–2012. Student’s t-test was used in order to demonstrate the differences between the values of flows in dry and wet years. The relationship between the Mean Annual Flow (MAF) flows was determined in subsequent years by using the test of series. The cyclical nature of mean annual flows was examined by using a Fourier series. The probability of occurrence of wet and dry years was estimated by the conditional probability. The analysis showed that the mean annual flows in both catchments varied between dry and wet years. The greatest periodicity of MAF flows occurs in the Rudawa catchment; this can be the result of changing weather conditions determined by the predominant types of atmospheric circulation, as well as by the greater retention capacity of the catchment. The conditional probabilities of the occurrence of dry and wet years varied from 54% to 88%. The highest probabilities occur in the Rudawa catchment, where there is the greatest cyclicality of flows. Another study goal was to conduct an example study for paleohydrologists in analyzing long period times for flood observations of different tributaries, which are feeding the same river treating a time series analysis of flow regimes as a simple paleohydrological tool. As postulated by Gregory and Walling (1973), any study of water and sediment dynamics in the past introduces a promise for future investigations. In that sense, if have a similar case and data used here might be possible to analyze hydrological trends for catchments in the future.

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1. Introduction

River runoff has been identified as key variable for the economy. Also, runoff variability and change have attracted attention because of their impacts on water resources management, use, and consequent redistribution of economic and environmental benefits (Li et al., 2017). Climatic and hydrological phenomena cause cyclic variability and renewability of water resources (Chowdhury and Eslamian, 2014; Hong et al., 2014; Mujere and Eslamian, 2014). The hydrological cycle regulates the conversion of rainfall into the runoff from the catchment; it is responsible for particular elements of water balance and their proportionality in relation to one another (Wałęga et al., 2016). Rivers in Poland, particularly mountainous and submontane ones are characterized by small retention, therefore the water resources of rivers are associated with precipitation, which is the source of their supply and natural renewability with time. Fluctuations in time, both in the sequentiality of dry and wet years, can cause economic problems. The issue of repeatability of both hydrological and meteorological phenomena, and their regularity in particular, i.e. cyclicity or periodicity, has long been a subject of research (Eichner et al., 2006; Schumer, 2014). Regardless of the existence of temporal periodicity patterns of hydrometeorological processes, the problem of spatial similarities in the periodicity, not necessarily a very distinct one, is also very interesting. The actual periodicity can be expected to have not only the local range, but also, e.g., comparability of flow values in nearby gauge sections. Such similarity may refer to the periodicity at different

* Corresponding author.
E-mail address: rradecki@cyf-kr.edu.pl (A. Radecki-Pawlik).

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