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Spatiotemporal trend analysis of runoff and actual evapotranspiration in Northern Algeria between 1901 and 2020

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Abstract

In water resources management, the estimation of the water balance component is mainly used to control dams, agriculture, and irrigation developments and also to provide water supply for drinking and industry. The spatial trend analysis applied to the Northern Algerian region to determine the significant changes in rainfall–runoff (IARR) and actual evapotranspiration (IAEa) required a sufficient period. In this study, we carried out this analysis in four periods between 1901 and 2020, according to the data availability of climate variables (IAR, and IAT), since the hydrological measurement posed a big problem during this period. In this regard, a set of nonparametric and empiric water balance models were applied and compared on five bioclimatic floors of Northern Algeria between 1991 and 2020 to estimate IARR and IAEa between 1901 and 1990. The results obtained from several tests, such as regression analysis, scattergram graphs, R2 , R2 Adj, MSE, RMSE, and DW, proved that Yang's model gives the best performance and good results in very humid regions when replacing n by 2. On the other hand, Schreiber and Pike's models are more efficient in the humid and semi-humid regions, respectively. Furthermore, the model proposed by Sharif is well performed in the Mediterranean and semi-dry areas. The variability analysis given by the t test and the regression curves is applied on IAEa and IARR in each bioclimatic floor during intervals measurement of [1901, 1930], [1931, 1960], [1961, 1990], and [1991, 2020]. It showed a significant change in both components between 1961 and 1990 in very humid, semi-humid, and Mediterranean regions when compared with observations done between 1931 and 1960. Moreover, a large variation and significant trend in IARR were also observed in humid and semi-humid areas between 1991 and 2020 compared to the previous periods.

Keywords Rainfall–Runoff · Actual evapotranspiration · Spatiotemporal · Trend analysis · Bioclimatic floor · Watershed

Introduction The quantification of water balance components such as actual evapotranspiration, surface runoff, groundwater discharge, and change in soil storage is essential for hydrology, ecology, forestry sciences (Ghandhari and Moghaddam 2011; Quinn et al. 2019), and water supply (Lei et al. 2018). Actual evapotranspiration is the principal component required for estimating water and energy balance equations (Fathi et al. 2019; Xu and Singh 2005). Furthermore, in water resources management, the estimation of water balance components is mostly used to control dams, agriculture, and irrigation developments and to provide water supply for consumption and industry uses. As reported about African water for 2025, the continent will have many water problems, not only about the scarcity of natural resources but also their poor management and the high spatial variability of rainfall distribution (LA Banque Africaine and Bankgroup 2000). In the countries of North Africa, the populations complain about a decrease in precipitation, although it is in the Mediterranean part. In Algeria, several studies have shown that the country has reduced precipitation since 1970 (Baahmed et al. 2015). However, the country's hydrological services use poorly confident water management strategies, especially in areas that have a small stock of groundwater, and almost entirely depend on surface.

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