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Assessing the Influence of PET Calculation Method on the Characteristics of UNEP Aridity Index Under Different Climatic Conditions throughout Iran

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Abstract—Accurate assessment of changes in climate conditions and their impacts on different sectors including agriculture, animal husbandry, wildlife, environment, and so forth can affect the appropriate natural disaster management. The aridity index defined by the United Nations Environmental Programme (UNEP) is one of the most widely used indices in the evaluation of climate conditions based on the ratio of precipitation (P) and potential evapotranspiration (PET) parameters. In this study, the impact of changes on PET calculation methods (6 PET calculation methods) in values of UNEP aridity index were compared by analyzing the data series of 28 synoptic stations with various climate conditions on monthly and seasonal time scales in Iran from 1967 to 2017. Therefore, it is determined to apply the FAO Penman–Monteith (FPM) equation as the reference method to measure PET. According to the results, based on the GEE method (Backward Generalized Estimating Equations) within monthly and seasonal time scales, calculated UNEP aridity index based on Hargreaves–Samani (HS), Jensen–Haise (JH), and Blaney–Criddle (BC) equations, respectively had the most similarities with calculated UNEP Aridity Index based on FPM method. The clustering analysis indicated that values of calculated UNEP aridity index within the monthly and seasonal time scales using JH, HS and BC equations are strikingly similar to the values of calculated UNEP aridity index using the FPM method. The average similarity rates of the calculated UNEP aridity index using JH and HS equations and by FPM method were 98.35% and 98.34% within a 1-month time scale and 98.11% and 98.09% within a 3-month time scale, respectively.

Keywords: UNEP, aridity Index, climate variability, PET, GEE method, clustering analysis, Iran.

1. Introduction

Climate variability is one of the main natural driving forces which can adversely affect different sections such as surface water sources, agricultural products, terrestrial and aquatic ecosystems, wildlife, and so on (Mirakhorli & Lashkari, 2014; Zarei & Moghimi, 2019b). To evaluate and monitor the climate conditions of regions in the world, many various important indices, for instance, Köppen–Geiger climate classification system (Köppen & Geiger, 1928; Larson & Lohrengel, 2014), Modified De- Martonne index (De-Martonne, 1926; Aguirre et al., 2018), Camargo method (Camargo, 1991), Thornthwaite climate classification (Thornthwaite, 1948; Srivastava et al., 2013), UNEP aridity index (UNEP, 1992; Zarei & Mahmoudi, 2017) and so forth, have been introduced. Many researchers tried to evaluate and monitor the climate conditions and climate changes in different geographic areas of the world. In the following, some of the studies mentioned on this subject are listed: Şarlak and Mahmood Agha (2017), Hwang et al., (2018), Mahesh and Victor (2018), Peng et al., (2018), Ye et al., (2018), Fraga et al., (2019), Greve et al., (2019), Zarei et al., (2019), Zarei and Mahmoudi (2019) and Zhang and Lu (2019).

The UNEP aridity index, which is developed by the United Nations Environmental Programme (1992) based on the ratio of precipitation (P) and potential evapotranspiration (PET), is one of the widely used indices in the assessment of climate conditions in the different geographic areas of the world (Delgado-Baquerizo et al., 2018; Mahesh & Victor, 2018; Wen et al., 2018; Bahrami et al., 2019; Dave et al., 2019). Ghasemi et al. (2008) examined the agro-climatic zoning (ACZ) by using the UNESCO approach and

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