Spatial and temporal assessment and forecasting vulnerability to meteorological drought

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Abstract

Meteorological drought and its adverse effects can occur anywhere with each climate conditions, topography state, and vegetation cover. It seems the degree of effect of drought on different regions is mainly dependent on the sensitivity and vulnerability of the area to drought. So, in this study, by using autoregressive fractionally integrated moving average (ARFIMA) and Fuzzy-analytic hierarchy process or Fuzzy-AHP (Fu-A) methods, the vulnerability of Iran to meteorological drought was evaluated and predicted. For this purpose, the climatic data of 34 stations in Iran from 1967 to 2021 was used. First, seven effective criteria for vulnerability to meteorological drought were selected. In the next stage, for each indicator, the vulnerability map was prepared in ArcGIS software (into four classes from mild (M) to very severe (V-Sev)). Then, the weight of each criterion was determined using the Fu-A. Finally, to prepare the final vulnerability map for each year, the prepared vulnerability maps for all chosen indicators were superposed. This was done for 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, and 2021. Finally, using the ARFIMA model, the Spatio-temporal vulnerability to meteorological drought was predicted in Iran in the years 2023, 2025, 2027, 2029, and 2031 at the pixels level (412,000 pixels with pixel size equal to 2000 × 2000 m). The results of Fu-A showed that the mean annual precipitation had the highest (0.3617), and the average spring potential evapotranspiration had the lowest weight (0.0348). Also, in the investigated years, the study area was classified into 3 or 4 vulnerability classes. Generally, the most vulnerable regions were located in the eastern and southeastern parts, and the less vulnerable regions were located in the northern regions of Iran. From 1999 to 2021, the area of the regions with M and moderate (Mod) vulnerability classes had decreased, and classes severe (Sev) and V-Sev had increased. The ARFIMA validation test showed this model had an accuracy of 94.02%. Vulnerability prediction revealed that from 2023 to 2031, Iran could be classified into four classes (mainly Mod and Sev). Also, the most vulnerable areas are primarily located in the eastern and southeastern regions of Iran.

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