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Past and Future Drought Regimes in Turkey

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Climate variability in the 20th century was characterized by apparent precipitation variability at both temporal and spatial scales. In addition to the well-known characteristic seasonal and year-to-year variability, some marked and long-term changes in precipitation occurred in Turkey, particularly after the early 1970s. Drought, originating from a deficiency of precipitation over an extended time period (which is usually a season or more) has become a recurring phenomenon in Turkey in the past few decades. Spatially coherent with the significant drought events since early 1970s, water stress and shortages for all water user sectors have also reached their critical points in Turkey. Analyzing the historical occurrence of drought provides an understanding of the range of climate possibilities for a country, resulting in more informed management decision-making. However, future projections about spatial and temporal changes in drought characteristics such as frequency, intensity and duration can be challenging for developing appropriate mitigation and adaptation strategies. Hence, the objectives of this study are (i) to analyze the spatial and temporal dimensions of historical droughts in Turkey, (2) to predict potential intensity, frequency and duration of droughts in Turkey for the future (2070-2100). The Standardized Precipitation Index (SPI) and the Percent to Normal Index (PNI) have been used to assess the drought characteristics. Rainfall datasets for the reference period, 1960-1990, were acquired from 52 stations (representative of all kinds of regions with different rainfall regimes in the country) of the Turkish State Meteorological Service (TSMS). The future rainfall series for the 2070-2100 period were simulated using a regional climate model (RegCM3) for IPCC's SRESS-A2 scenario conditions. For verification of RegCM3 simulations, the model was performed for the reference period and simulated rainfall data were used for computing two drought indices (SPI and PNI) for the 1960-1990 period. Then, to proof the capturing capacity of the RegCM3, these results for the reference period were compared with SPI and PNI values calculated using observed climatic data. The validated climate model was used for performing climatic data for the future 30-year period, and using the projected climate data, the SPI and PNI values were computed for the future conditions, which indicates the drought events within future 30- year period. Furthermore, to determine the likely changes between reference and future periods, the projected future rainfall series was compared with the average rainfall amount derived from the reference period in SPI and PNI calculations. Finally, the maps were drawn to determine the spatial changes of droughts. RegCM3 model could capture the climatic data and also the drought indices well. The study results showed that drought conditions are diverse in the country, and also increasing trends for intensity, frequency and duration were detected. At regional scale, the Eastern part of Marmara, Black Sea Region and northern and eastern parts of the East Anatolia Regions are characterized by wetter conditions. Particularly severe drought conditions are expected in the Western Mediterranean and Aegean Regions, although other regions of the country will also confront with more frequent, intense and long lasting droughts. Both indices SPI and PNI yielded similar results for the reference as well as future period. Most of the rain-fed and irrigated areas as well as the major share of the surface water resources are located in the drought-vulnerable regions of the country. Other water user sectors including urban, industry and touristic places will also be affected from the worsened conditions. Thus, increasing frequency, severity and prolonged duration of drought events may have significant consequences for food production and socio-economic conditions in Turkey.