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An Analysis of Recent Drought Conditions in Turkey in Relation to Circulation Patterns

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Drought commonly is perceived to be a prolonged period with a significant reduction in precipitation. Namias (1985) argues that drought is associated with persistent or persistently recurring atmospheric circulation patterns. For example, the North Atlantic Oscillation (NAO) has a major role in controlling European climate and appears to exert a strong influence in modulating North Atlantic ecosystems. During the positive phases of NAO, the North Atlantic westerlies, which provide much of the atmospheric moisture to north Africa and Europe, shift northward. This, in turn, results in drier conditions over southern Europe, the Mediterranean Sea, and northern Africa (Hurrell, 1995; Hurrell and Van Loon, 1997).

Turkey is situated in the Mediterranean macroclimatic region of the subtropical zone. Because of its complex topographic features and its proximity to water, and because it is a transition zone for different pressure systems and air masses originating from polar and tropical zones, several climatic subregions appear to be dominant over the country. The amount and distribution of rainfall in the coastal areas is determined by troughs and frontal-type mid-latitude cyclones that are associated with the prevailing upper-level westerly flows. The Mediterranean Sea acts as a primary source for moist air masses that produce high rainfall over the windward slopes of the coastal mountain ranges. Frontal Mediterranean cyclones associated with the southwesterly air flows create favorable conditions for heavy rainfall and thunderstorms in the southern and western coastal parts of the country in late autumn and early winter. Annual average rainfall in Turkey is around 630 mm, with 67% of it occurring during the winter and spring, when the eastern Mediterranean basin and Balkans are influenced by eastward propagating mid-latitude cyclones and Mediterranean depressions (Türkes, 1996).

Drought has been a recurrent phenomenon in Turkey for the last several decades. A warming trend that began in the early 1990s has continued in recent years, despite some cooling, and annual mean

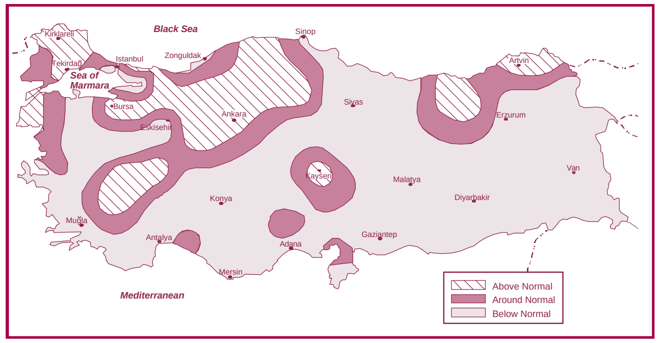

Figure 1. Precipitation conditions in 1999 with respect to climatic normals.

temperatures have remained above average for the last five years. A significant drought was observed during the winter and spring (normally the wettest seasons) of 1999 and 2000. Almost two-thirds of the country, mainly the southeastern and central Anatolia regions, experienced severe drought in 1999, and the drought continued in 2000 with slight differences in areal coverage (Figure 1). Although the central parts recovered slightly from the drought conditions, the effects were felt more dramatically in the eastern and western parts. Moreover, the drought shifted north, extending further into parts of the Black Sea region, normally the wettest in the country.

An analysis of the pressure systems in relation to prolonged dry periods indicates several main changes and shifts in the circulation patterns that affect precipitation conditions in Turkey (Figure 2). These changes can be summarized as (1) weakening of the Siberia anticyclone, especially after the 1980s (winter droughts); (2) penetration of the Azor anticyclone ridge into the eastern Mediterranean; (3) decrease in frequency of frontal systems in the Mediterranean; (4) penetration of the Basra low farther north (summer droughts); and (5) strengthening of Basra low (summer droughts).

Changes in the NAO also affect rainfall variability in Turkey. During the positive phases of NAO, the North Atlantic westerlies, which provide much of the atmospheric moisture to north Africa and Europe, shift northward. This, in turn, results in drier conditions over southern Europe, the Medi-

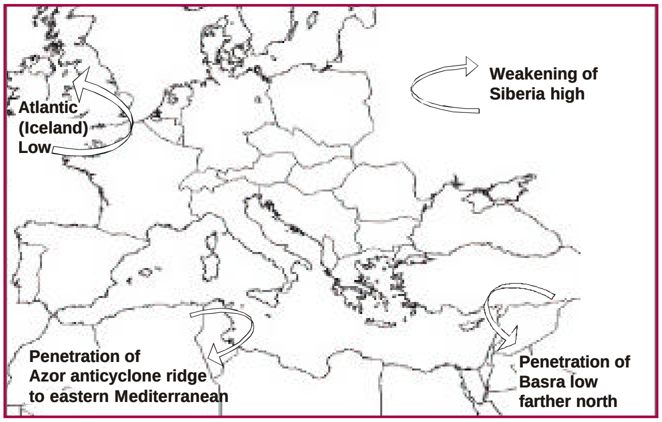

Figure 2. Changes in circulation patterns and pressure systems in relation to drought conditions in Turkey.

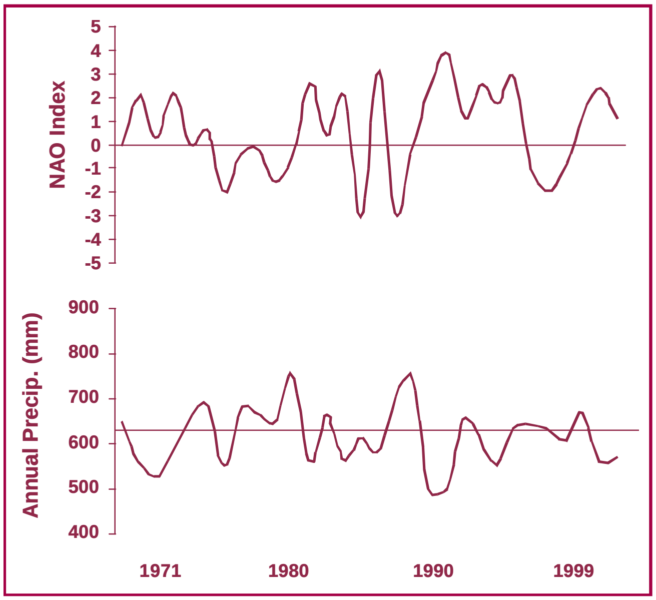

Figure 3. Relationship between NAO and annual rainfall changes in Turkey (1970–2000).

terranean Sea, and northern Africa (Hurrell, 1995). Jansa (1992) argues that the heaviest rainfall in the Mediterranean region is observed from the end of autumn to the beginning of spring, when significant cyclogenetic activity fundamentally determines the maximum rainfall. Since these winter cyclones are the dominant source of Middle Eastern rainfall and river runoff, NAO-related changes in Atlantic westerly heat/moisture transport and Atlantic/Mediterranean SSTs influence Middle Eastern climate.

It has been observed that during positive NAO years, Turkey becomes significantly cooler and drier (Cullen and deMenocal, 1999). Figure 3 shows a correlation between annual rainfall and NAO indices over the last three decades. It has been shown that the dry periods correspond well with the positive phases of the NAO, and, similarly, humid conditions prevail during the negative phases of the NAO. Considering that the country receives most of its rainfall in winter and spring, winter droughts in Turkey can be attributed to positive NAO anomalies. On the other hand, summer droughts experienced in eastern and southeastern parts of the country are usually associated with strengthening and penetration of the Basra low pressure farther north.

In conclusion, drought conditions that prevailed over the last 2–3 decades in Turkey are related to changes in the weather patterns in the Atlantic region, specifically variations in North Atlantic Oscillation. Furthermore, penetration of the Basra low farther north and weakening of the Siberia anticyclone contributed to the summer and winter droughts to a great extent.

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