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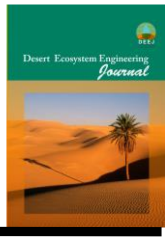

Investigating Spatial and Temporal Trends of Temperature and Precipitation Extremes in Karkheh Watershed

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Extended Abstract

Introduction: Changes in the climate system's components, and in particular the severity and frequency of extreme events, are more effective on society and the natural environment than changes in climate averages. Therefore, it is important to examine the variability of limit indices. To this end, this study used the temperature and precipitation data collected from six meteorological stations in Ahvaz, Khorramabad, Dezful, Kermanshah, Hamedan, and Sanandaj Karkheh synoptic basins to investigate the spatial and temporal trends of temperature and precipitation limit values, which were then measured using R-climdex software. Moreover, the trends of all ten precipitation indices and sixteen temperature indices were determined individually via the Mann-Kendall test. The study's results indicated that the trend of precipitation indices was decreasing in most of the watershed stations, leading to a significant decrease in the trend of precipitation indices on wet, heavy, and very heavy precipitation days, and consecutive wet and/or dry days. The results also suggested that temperature indices such as frost days, ice days, cold days, cold nights, and the range of daytime temperature variations revealed negative trends at most stations at 95% and 99% confidence levels. Furthermore, increasing trends were found for the indices of summer days, hot days, and hot nights at all stations studied at the catchment level.

Materials and Methods: This study used the data collected from six Karkheh watershed's synoptic stations, including Kermanshah, Khoramabad, Sanandaj, Hamedan, Dezful, and Ahvaz to study the spatial and temporal trends of temperature and rainfall in terms of maximum temperature, minimum temperature, and rainfall at a daily scale during a thirty-year period (1980-2010). It should be noted that the data such as quality control and their homogeneity was pre-processed using the RH Test program. Then, the data was converted to the R-climdex model format to identify extreme indices.
The output of the model was used to determine the trend analysis using MATLAB2014 software, the Mann - Kendall test, and Sen's slop. It is worth mentioning that the output included ten precipitation extreme indices, including maximum 1-day precipitation amount, maximum 5-day precipitation amount, simple daily intensity index, the number of heavy precipitation days (over 10 mm), the number of very heavy precipitation days (greater than or equal to 10 mm), the maximum number of consecutive dry days (sum of precipitation less than 1 mm), the maximum number of consecutive wet days (the sum of precipitation rate is greater than or equal to 10 mm), days with a total precipitation rate of more than 95 percentile of rainy days (very wet days), days with precipitation rate greater than the 99th percentile of rainy days (very wet days), the ratio of precipitation to very wet days to the sum of rainfall rate. The output also included sixteen temperature indices including the number of below-freezing days, the number of summer days, the number of ice days, the number of increasing tropical nights, season length, the

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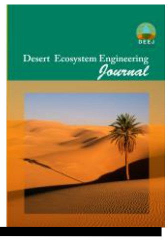

monthly maximum value of daily maximum temperature, the monthly minimum value of daily maximum temperature, the monthly maximum value of daily minimum temperature, the monthly minimum value of daily minimum temperature, cold nights, percentage of cold days, warm nights, warm days, heatwave duration index, cold wave duration index, and diurnal temperature range.

Results: The results suggested a decreasing trend for precipitation indices in most of the studied stations. Accordingly, there found a significant decrease at a 99% confidence level for precipitation indices, including the number of consecutive wet and/or days and heavy and very heavy precipitation days at Kermanshah and Sanandaj stations, respectively. Moreover, the results indicated negative trends for extreme indices such as the number of below-freezing days in Khorramabad, Hamedan, and Sanandaj, cold days, and cold nights at Ahwaz, Sanandaj, and Hamedan, ice days at Hamedan and Kermanshah, and diurnal temperature range at Ahwaz and Sanandaj stations. Also, increasing trends were found for summer days, warm days, and warm nights in all the stations located at the watershed.

Discussion and conclusion: The investigation of the trend of temperature indices in the Karkheh watershed during the period of 1980-2010 indicated an increase in the frequency of warm events, such as warm days and nights and growing season length, and a decrease in the frequency of cold events, such as cold days and nights, and the number of below-freezing and ice days. However, while most of the obtained results were consistent with the results found by the Intergovernmental Panel and other national and international studies, a completely unified pattern cannot be made for changing the indices across the basin. On the other hand, it can explicitly be stated that the minimum quantities of the minimum temperatures changed more than those of the maximum temperature rates. Moreover, the analysis of the precipitation indices revealed a decreasing and negative trend in all the studied stations.

Furthermore, the comparison of the rainiest and the least rainy years showed that the range of precipitation fluctuations varied greatly from year to year and that the precipitation distribution was different at different stations. Therefore, considering large dispersion and low precipitation in most stations, a uniformed regional pattern cannot be offered for precipitation. The results also indicated that the temperature points increased with a positive trend and that the precipitation peaks represented a negative precipitation trend.

Keywords: Climate change, Temperature, Karkheh watershed, Trend, exterm indices.