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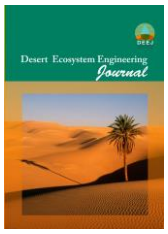

Trend analysis of dusty days frequency in Eastern parts of Iran associated with Climate Fluctuations

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Extended abstract

Introduction: The occurrence of dust storms in deserts or arid regions increases the suspended dust particles to more than the allowed threshold, and this has negative effects on atmospheric conditions, human health and agricultural production. Positioning of Iran in the world arid and semi-arid belt is exposed to various types of dust storm systems. Occurrence of severe dust storms in most parts of the world, especially in areas of east and southeast of Iran has disrupted people's lives and caused human and financial losses. As a result, increasing information on the dust storm variation and trend with using long-term observational data and evaluation of its relationship with other climatic parameters in the eastern part of Iran may help identify areas of crisis in terms of the occurrence of this phenomenon in the future, therefore it is useful for taking environmental management decisions and preparing to deal with dust storms.

Materials and Methods: In order to carry out this research, data of number of dusty days, temperature, precipitation, and wind speed of 31 weather stations in eastern Iran with a statistical period of 66 years (1951 to 2016) have been used. According to the World Meteorological Organization, dusty day is defined as the day in which, at least one code related to dust (including codes 06, 07, 30 to 35 and 98) has been reported in the present weather group (WW) among dust 8 SYNOPs reported from weather stations. Considering the above instructions, first data of number of days with dust in annual scale was provided. Then, the processes related to the averaging, spatial distribution and temporal variation of frequency of dusty days were performed. In order to study the decadal variation of dust storms, both regional averages and data of reference stations are divided into six decades and analyzed with averaging and charting processes. In the next step, to evaluate existence of trend in dusty day frequencies in eastern Iran, two non-parametric statistics of Mann-Kendall and Sen's Estimator Slop tests were used. Finally, to investigate the relationship between climate parameters and dusty days frequency in the region, Spearman correlation coefficient test was used.

Results: The highest and lowest activity of dust storms in study area was in 1971 and 1954 years with average of 58 and 7 days respectively during 1951 to 2016. Despite the relatively large regional differences the annual

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variation of the average dusty days in eastern Iran has not been significant particularly since 1960, and often remains about 40±8 days per year. Decadal variation of dusty days indicates an increase in the number of storms in current decade, but geographic extent of storm activity is limited to the south east. The results of Mann-Kendall trend test indicate a significant increase in dusty days of Zahedan, Iranshahr, Tabas, Garmsar, Chabahar, Gorgan, Tabas and Sarakhs stations at 0.01 or 0.05 confidence levels, so that highest increasing rate was calculated in Iranshahr, Tabas, Zahedan, Gorgan and Sarakhs stations with 1.35, 0.96, 0.78 and 0.52 days per decade, respectively. Although Zabul, Zahak, Bojnourd and Gonabad stations have the most frequency of dusty days but they showed nonsignifican increasing trend. Investigating the relationship between dust storm frequencies with precipitation, temperature and wind speed results showed that dust storm in the eastern Iran show negative correlation coefficient on annual precipitation fluctuations. In contrast a direct significant relationship between dusty days with annual temperature and wind speed at most stations were revealed.

Discussion and Conclusion: The results of this study suggested that the Eastern Iran has no homogeneity in terms of frequency of dust and its process, so that it increases from north to south and from west to east. Based on the results obtained by combining two methods of Sen's Estimator Median and Mann-Kendall, there is an increasing trend in most regions, but its focus is more in South, Southeast and Central regions. Dust storms activity increase is a symbol of the dominance of desert ecosystem and implies the spread of desertification in these areas. These regions have dry climate and flat topography, low altitude and sparse vegetation. Also, stations with a significant downward trend, are mainly located in Northeast Iran, where have less dust storms. Distance from the dust resources and being located in mountainous areas, as well as the expansion of cities (meteorological stations are located on their margins) can be a factor in the reduction of dust days in the northern regions. Of course, in a number of Southern stations, which have a lot of dusty storms, the trend was also downward. Finding the cause of such a downward trend requires further investigation. The worrisome issue is that in some areas (such as Kashmar, Damghan and Garmsar), where dust storm isn't dominant climatic phenomenon, it's likely that in future years, with increasing storm events, dusty storms be added to their climatic landscape. Also, in areas where dust storms occur with a relatively high frequency (including Chabahar, Zahedan and Tabas) increasing number of dusty days may create additional environmental problems. Correlation coefficients of climatic parameters with number of dusty days showed highest relationship with speed wind. With this interpretation, the most effective climatic controller of dust storms frequencies in East Iran is wind speed, which is a function of synoptic systems and regional pressure and temperature gradients. Given that the 120-day winds are the main cause of dust storm in the study area in warm period of year, and also the temperature gradient in this time is more than cold period, as a result, with warming of air and end of rainy season in warm period, climatic conditions is suitable for severe wind flows. These conditions, along with soil dryness and lack of vegetation provide favorable conditions for wind erosion and dust storm. It should be noted that the most effective environmental factor in Eastern Iran dust storms activity, is intensifying of speed and expanding spatial range as well as increasing activity duration of Sistan regional winds from 120 to 165 days.

Keywords: Mann-Kendall Test, Climate Parameters, Dusty days, Eastern part of Iran, Spearman Correlation.

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