

Investigating the influence of the Gusty of 120-day Winds on the Occurrence of Fine Dust Phenomenon: A Case Study of Zabul & Herat Regions

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Extended Abstract

Introduction: Emanating from non-whirlwind-based storms, gusty winds are regarded as the most destructive natural threats, causing extensive damage to infrastructure, agriculture sections, trees, power lines, and structures. 120-day winds occur during the warm season of the year, typically starting from mid-May in eastern Iran and western Afghanistan and continuing until mid-September. Normally, the velocity of the winds varies sharply, sometimes greatly increasing the intensity of the gusty winds blows. However, the influence of the gusty of 120-day winds on the number of dusty days and the regions where the winds increase or decrease the creation of fine dust has remained unaddressed in the studies conducted on such winds. Therefore, in addition to examining the current status of the gusty winds, this study sought to investigate the role of the gusty winds (as an important element in 120-day winds) in creating dusty phenomena and days in the Zabul region, Iran, and Herat in Afghanistan using satellite images and statistical tests. In other words, this study attempted to answer the following questions:

-What is the status of the gusty of 120-day winds in Herat and Zabul stations?

-What is the relationship between the characteristics of the gusty of 120-day winds and the occurrence of dust phenomena in Herat and Zabul stations?

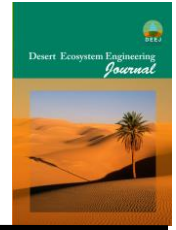
Materials and Methods: This study used the data collected from Herat International Meteorological Station (with the international code OADR awarded by the International Aviation Organization (ICAO)) located at 34 degrees and 13 minutes' north latitude and 62 degrees and 13 degrees' east longitude, and Zabol station in Iran. The METAR reports received from the databases of the University of Iowa in the USA and the Oigimet website concerning the Zabol International Meteorological Stations in Iran and Herat in Afghanistan (from 01/01/2012 to 12/26/2019) were decoded using the latest instructions, codes, and methods for Weather Monitoring, mentioned in Annex 3 of the Convention on International Civil Aviation, approved by the World Meteorological Organization. The reports provide some information regarding the area's weather, including wind direction and velocity, wind direction, horizontal visibility, current weather, cloudy weather, air temperature, dew point temperature, past air pressure, and the weather status for aviation applications at the airport and non-airport stations.

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Having identified the period range of the occurrence of 120-day winds, the information concerning the gusty winds was extracted from the database. Then, to investigate the influence of the gusty winds on the occurrence of fine dust phenomena and evaluate the gusty winds' intensity in each Zabul and Herat station individually, the station-extracted quantitative data of the parameter were classified, compared, and measured based on the intensity and quantity of the parameter's frequency in both stations.

Results: According to the study's results, 8059 cases of gusty winds were reported to have occurred in Zabol station, whose velocity ranged from 9 to 32 meters per second. Within such a range, the highest frequency belonged to 17 meters per second with 1232 frequencies, and the lowest frequency belonged to 32 meters per second with merely one frequency. The frequency of the gusty winds' direction in Zabol station was 8059 cases, the highest frequencies of which were found at 330 and 340 degrees with 5629 repetitions. The frequency of the winds' direction in Zabol was exactly in line with the direction of the prevailing wind, i.e., the northwest. Moreover, the lowest frequencies of the gusty winds' direction belonged to 120, 150, 170, and 190 degrees with merely one repetition. The frequency of the gusty winds was reported to be in 5700 cases in Herat station, whose velocity ranged from 5 to 32 meters per second, where the highest frequencies were reported as 13, 14, and 15 meters per second with 2342 repetitions, and the lowest frequencies were identified as 5 and 31 meters per second with merely one repetition. Moreover, 5700 cases were identified in Herat station in terms of gusty winds' direction, whose highest frequencies were found in 10 to 30 degrees' directions with 2685 repetitions, and the lowest frequencies belonged to zero and 120 degrees with three repetitions. On the other hand, the frequency of the winds' direction in Herat was exactly consistent with the station's prevailing wind direction, i.e., the northeast, just as the case was for Zabol station. Furthermore, a significant correlation was found between gusty of 120-day winds and the occurrence of dust phenomena in Herat and Zabol stations. To test this hypothesis, first, the frequency distribution of the gusty winds and the characteristics of soil phenomena throughout the period when the 120-day winds blew in the stations located in the study area were identified based on the results obtained from the mean test (which was also used for identifying the period when the winds blew). Then, a correlation test was applied to evaluate the association between the gusty of the winds and the dust phenomenon.

Discussion and Conclusion: As one of the most important characteristics of wind, a gust may cause lots of damage to various infrastructures due to its strong fluctuations in a short moment. These strong blows can intensify the rise of dust in deserts and dry wetlands and expand the range of the dust phenomena to hundreds of kilometers away from the sources of the dust. It can be concluded that the difference in the frequency and intensity of the occurrence of dust phenomena cannot merely be attributed to the existence of a climatic feature such as wind and its gusts, and environmental and geomorphological factors are also involved in this regard. The environmental factor referred to is the dryness of the Hamon wetland and the desert nature of the north of Sistan and Baluchistan, preparing the ground for the occurrence or intensification of the dust phenomena by the wind's blows. In Herat, the frequency of not-wind-induced soil erosion phenomena inside the station was 391.5% (almost four times) more than that of the wind-induced one. Therefore, it could be argued that due to the mountainous nature of the Herat region and the predominance of transitional soil phenomena, there is no source of dust production in the area. However, the dust transferred to the station from Northern Herat areas (that is, the areas within the range of 120-day wind activity with potential sources of dust production such as the southwest deserts of Turkmenistan) penetrates into Herat, referred to by the DU and HZ codes.

Keywords: Gusty Winds, Wind Velocity, Horizontal Visibility, Correlation, Dust.