



## Impact of wind direction and speed on dusty days

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### Abstract

The direction and speed of winds play an important role in the occurrence of pollutions and dust storms well as location placement for the establishment of industries and the expansion of cities. Yazd is a dry area of Iran, and constantly exposed to the dust particles in the air; and this in terms of human life and health issues are of special importance. In this paper a day when due to the amount of dust particles visual acuity reduces to 5,000 m is considered the dusty day. In this study dusty days and direction and wind speed of 4 synoptic stations were studied in spring 2010. Pearson correlation has been used in the study of relationship between wind direction and speed and the occurrence of dust. The results show a direct correlation between wind direction and speed, the wind direction nearer to 360°, (North) wind speed increases. There is an inverse correlation between the speed and the visibility in dusty days, where in 17 cases this relationship has been significant up to confidence level. Of course, in 5 cases the calculated correlation is negative. So according to the obtained results. there is an inverse relation between speed and visibility in stormy days, so that with increased wind speed visibility is reduced. Although the test does not show a significant correlation between wind speed and Visibility, due to a direct correlation between wind speed and wind direction from one side and the reverse relationship between two components of speed and visibility it can be said that whatever wind direction gets close to the North, in high speed winds visibility reduces.

**Key words:** Wind Direction, Wind Speed, Dusty Day, Yazd Province.

## Introduction

One of the types of natural disasters that result in damages each year in many arid areas of the world and Iran as well is dust and sand storms and severe winds (Omidvar, 2005). Dust and sand storms contain small dust particles sometimes going up to kilometers on the sky (Lashkari, 2006). In general there are four types of dust storms including severe dust storms, dust storms, blowing dust, dust particles floating in the air (Wang et al., 2005). Large storms occur when prolonged drought occurred and the soil surface is completely dry and the wind blows at a considerable speed (Azimzade, et al, 2001, 140). Another important factor in dust generation is the absence of humidity. When there is enough humidity in the air, wind generates precipitation and thunderstorms, while in dry condition wind blow leads to dust storm (Alijani, 1996, 195). Kaviyani (2000, 137) believes that air instability is the cause of dust formation in deserts, and believes that the atmosphere above the surface of the wilderness been highly unstable convective terms and conditions of formation of transient phenomena like the dust have small eddy. High frequency of dust particles in the atmosphere not only depends on Intensity and wind speed, but also soil particles size and diameter are of importance. Moreover, vegetation type may play a role on intensity of the dust formation ( Zolfaghari and Abedzadeh , 2004). Nevertheless the role of human activity along natural conditions geographical environment what comments the management and reduce the impact what in terms of resonance phenomena and it should also be considered (Dayan, 2005). Dayan soil and sand storms vitro model for routing air ... Dayan studied air laboratory model for a 5-day Back Trajectories at the level of 850 hPa during the period of five years in Israel. In the model air currents patterns were evaluated in association with seasonal weather types and a synoptic analysis and classification was done on the dominant weather condition regarding wind blowing patterns and difference significantly a seasonal route, has been shown. Asian Dust Storms (ADS) are known as one of the most important air pollutants (Peijian, 2008). The storms impact on human life and environment from several aspects as disrupting the radiation balance, accelerating ecosystem degradation and desertification in arid regions of Asia, which is usually known to be the origin of the dust storms (Jigjidsuren, 1998), (Sokolik, 1996). The floating particles in the air scatter or absorb sunlight and as a result affect regional balance and atmosphere vertical movement and in a large-scale atmospheric circulation and hydrological cycle (Menon et al., 2002). Although the duststorms cause soil erosion, on the other hand in some areas this suspended particles become sediment in the soil forming. The particles originated from the desert areas are salted and salty soil are also being triggered (Kai et al. 2010). Reduced visibility is one of the main features of the dusty systems, which in addition to the unpleasant effects of respiratory and lung problems can infect the human living environment, as well as tribulation in ground and air transportation (Sun et al., 2006), (Zhuang et al., 1992). Hosseini (1999) believes that Iran on the synoptic scale is of low pressure, high pressure, trough and ridge dominance in the geographical area of Iranian plateau on different seasons of year. Mehrshahi et al (2008) studied Sabzevar dust and showed that duststorms mostly occur in the afternoons. They also indicated that the eastern wind create the phenomenon. Researches show that there has not been a vast research in Iran, but this country is constantly exposed to the dangers of the storm and the hazards of it. In the this research According to the statistics available of dusty days, temporal and spatial variation of dust days should be considered.

## Material and methods

The data in this study was collected from the country's metrological organization which includes synoptic stations across Yazd province and has the most prolonged statistical period from 2008 - 2010, including dusty days as well as wind speeds.

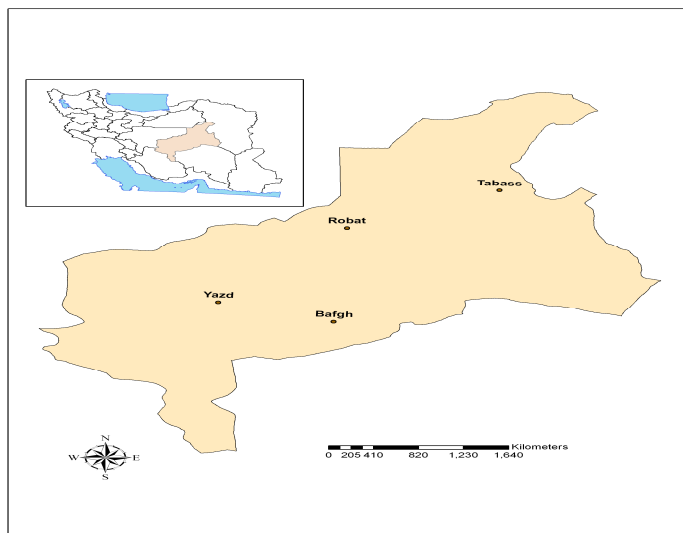


Figure 1 study stations location

Data collected was sorted by Excel software. To study the relationship between direction and speed of wind with dusty days, correlation between the parameters were provided and the results were analyzed.

Correlation relation obtained through the following equation:

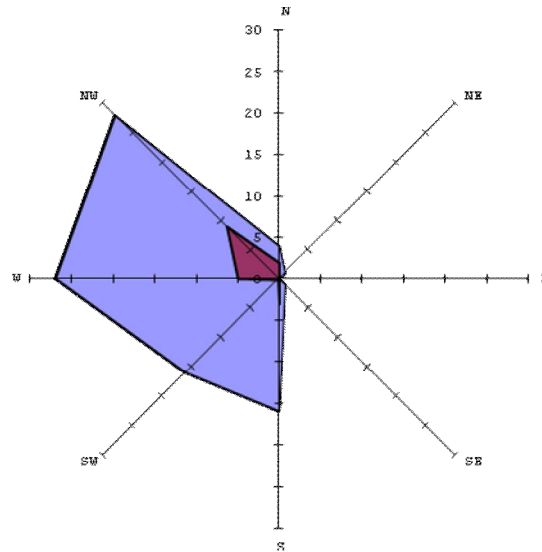
$$r_{xy} = \frac{\sum(x - \bar{x}) * (y - \bar{y})}{\sqrt{\left(\frac{\sum(x - \bar{x})^2}{n - 1}\right) * \left(\frac{\sum(y - \bar{y})^2}{n - 1}\right)}}$$

Where x is for speed and y is one visibility once as an indicator of dust occurrence and once as an indicator of speed direction. The hourly data of visibility, direction and wind speed of 22 duststorms were obtained from Yazd, Tabas, and Aghda meteorological offices. Then using SPSS software, correlation between wind speed and visibility and also correlation between wind direction and wind speed have been calculated.

## Discussion

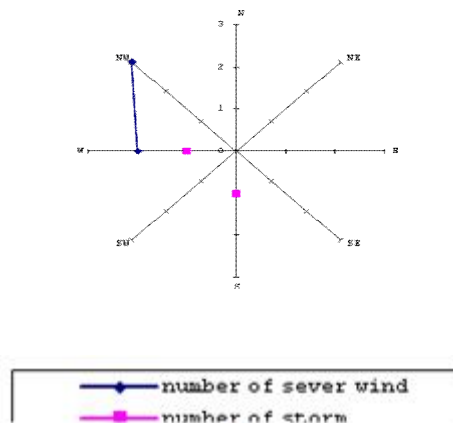
**The relation between wind direction and storm incidence**

According to direction the data and the wind speed were taken correlated with the occurrence days along with dust. Based on the data, wind speed and direction were correlated with occurrence of dusty days. In Robat Posht Badam wind direction is n,t important because each of these storms have formed in different ways .But the northwest and west are in more favorable conditions for the formation of duststorm and severe winds are observed from the west to south sectors, (figure 2).



**figure 2 severe winds and duststorms in Robat Posht Badam**

In Bafgh, studying the directions of severe winds shows that the only winds blown from northwest did not turned in to duststorms and in other directions we observed dust and sand storms, figure 3).



**Figure 3 severe winds and duststorms in Bafgh**

In Tabas, regarding direction there are duststorms in almost all directions of wind blowing. Wind directions are from the north, northeast, northwest and the west; this confirms that dry, loose soil in the area has provided the conditions for the formation of duststorms, figure 4 .

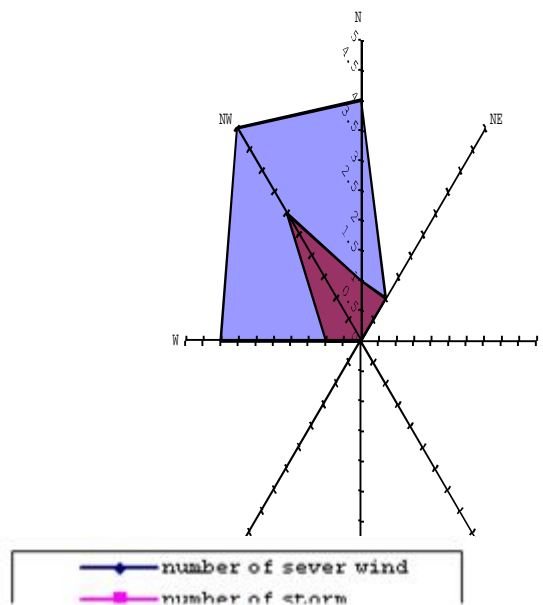


Figure 4 severe winds and duststorms direction in Tabas

In Marvest station, there are severing winds as well as duststorms in all directions. Most storms and winds are blown from south, west and southwest( figure 5).

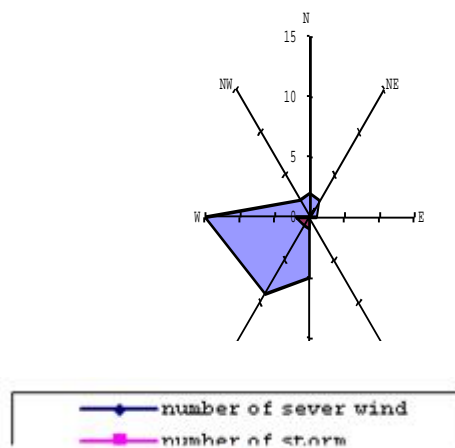


Figure 5severe winds and duststorms direction in Marvest

In Yazd, there are severing winds in all directions. Unlike severing winds from southwest, we don't observe duststorms from this direction. It is because southwest is mountainous and presence of Shirkoh mountains don,t allow for duststorm (figure 6)

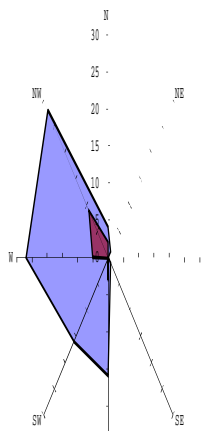


Figure (6) severe winds and duststorms direction in Yazd

The relationship between the wind direction and speed and dusty air

Table 1 correlation between speed, direction and visibility

Correlation confidence level		Correlation between components		date	station	No.
Speed- visibility	Speed- direction	Speed- visibility	Speed- direction			
99%	95%	-0.841	0.501	1/5/2010	Yazd	1
99%	99%	-0.747	0.739	2/5/2010	Yazd	2
99%	.....	-0.682	0.391	3/5/2010	Yazd	3
99%	.....	-0.669	0.223	4/5/2010	Yazd	4
99%	95%	-0.715	0.5	5/5/2010	Yazd	5
99%	.....	-0.768	0.378	6/5/2010	Yazd	6
.....	.....	-0.147	0.161	21/5/2010	Yazd	7
99%	99%	-0.591	0.53	24/5/2010	Yazd	8
99%	95%	-0.747	0.516	29/5/2010	Yazd	9
.....	95%	-0.1	0.616	10/6/2010	Yazd	10
95%	95%	-0.513	0.516	29/4/2010	Yazd	11
95%	.....	-0.775	0.296	24/4/2010	Yazd	12

99%	99%	-0.791	0.639	23/4/2010	Yazd	13
.....	99%	-0.321	0.593	28/4/2010	Yazd	14
99%	.....	-0.866	0.389	22/4/2010	Yazd	15
.....	99%	-0.356	0.605	18/4/2010	Yazd	16
99%	99%	-0.898	0.803	23/4/2010	Aghda	17
.....	99%	-0.35	0.557	30/4/2010	Tabas	18
99%	99%	-0.69	0.904	29/4/2010	Tabas	19
99%	99%	-0.557	0.766	25/4/2010	Tabas	20
99%	99%	-0.632	0.773	24/4/2010	Tabas	21
99%	99%	-0.414	0.671	14/5/2010	Tabas	22
17	16	Accepted correlation				
5	6	Rejected correlation				

## Conclusions

Yazd is one of arid areas in Iran and constantly prone to floating dust particles in the air. This is important regarding environmental issues and human health. In this paper a day when due to the amount of dust particles visibility reduces to 5,000 m is considered the dusty day. In this research dusty days and wind speed of 4 synoptic stations were studied during 2008-2010. wind speed and directions were correlated with dust occurrence. Table (1) indicates that 16 days of 22 selected days of study have experienced dust storms. This shows a significant correlation between wind speed and direction. Almost in all cases this significance is up to 99% confidence level. It means that there is a direct relation between wind speed and wind direction, getting more nearer to 360° (north), wind speed increases, so severe winds blow from north.

## References

- Andreae, M.A., (1996); Raising dust in the greenhouse. *Nature* 380, 389-390.
- Dehghanpour A., 2005, Statistical Analysis and synoptic days with dust in the central plateau of Iran between 2000-1990, Ph.D thesis. Tarbiat Moallem University of Tehran.
- Goudie, A.S., Middleton, N.J., (2001). Saharan dust storms : nature and consequences , *Earth – Science Reviews* 56: 179-204.
- Hemmati, N., 1995, Frequency of dust storms in Central and South West regions of the country, *Geophysics*, Tehran University, MA thesis.
- Hosseini, Bagher, 2000, Study of synoptic extreme storms Tehran, Tehran University,.
- Idso, S., and Brazel, A., (1977); Planetary radiation balance as a function of atmospheric dust: climatological consequences. *Science* 198, 731-733.
- Idso, S.B. (1976); Dust storms. *Scientific American* 235(4): 108-111, 113-14.

- Khosravi, Abbas, wind analysis of Kashan and applying it to stabilize sand dunes, *Sepehr*, period VII, No. 27.
- Koch, J., Dayan, U., (1992). A synoptic analysis of the meteorological conditions affecting dispersion of pollutants emitted from tall stacks in the coastal plain of Israel. *Atmos. Environ.*, 26A:2537-2543.
- Li, X., Maring, H., Savoie, D., Voss, K., Prospero, J.M., (1996); Dominance of mineral dust in aerosol light scattering in the north Atlantic trade winds. *Nature* 380, 416-419.
- Littmann, T., (1991); Dust storm frequency in Asia: climatic control and variability. *International Journal of Climatology* 11, 393-412.
- Marjani, Sydsdraldyn investigate synoptic winds in excess of 15 meters per second, Khorasan, Marjani, S., 1993, Synoptic Study of Severe Winds More than 15 m/s (Storm) in Khorasan Thesis of Meteorology (Synoptic) for the Degree of M.A, Tehran University.
- Mershahi, Darius and Nekoonam brocade, 2009, *Geography*, No. 22.
- Nekoonam, Z., 2008, Analysis of Dust Storms in Sabzevar City, Thesis of Physical Geography (Climatology) for the Degree of M.A, Yazd University.
- Omidvar, K., 2005, The Study and Synoptic Analysis of Sand Storms in Ardakan-Yazd Plain, Geographical Research of Yazd University, pp. 215-225.
- Saaroni, H., Ziv, B., Bitan, A., & Alpert, P., (1998). Easterly Wind Storms over Israel, *Theor. Appl. Climatol.* 59:61-77.
- Shigong Wang, Jinyan Wang, Zijiang Zhou, Kezhengshang, (2005). Regional characteristic of three kinds of dust storm event in China. *Atmospheric Environment* 39:509-520.
- Ta-Hsiung, L., (2001). Long-range transport of yellow sand to Taiwan in Spring 2000: observed evidence and simulation, *Atmospheric Environment* 35:5873-5882.
- Tegen, L., fung, L., (1995); Contribution to the atmospheric mineral aerosol load from land surface modification. *Journal of Geographical Research* 100, 18,707-18,726.
- Tegen, L., fung, L., (1994); Modeling of mineral dust in atmosphere: source transport and optical thickness. *Journal of Geographical Research* 99, 22,897-22,914.
- Tegen, L., Lacis, A.A., Fung, L., (1996); The influence on climate forcing of mineral aerosol from disturbed soil. *Nature* 380, 419-422.