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# Identification of Dust Centers in Birjand City

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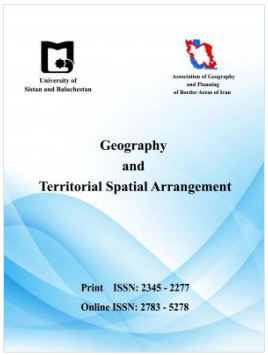


**Keywords:**
Dust, Birjand, Modis Sensor, Remote Sensing, HYSPLIT Model.

## ABSTRACT

Climatic phenomena in different regions of the world are different in relation to the geographical characteristics of each region. Dust is one of the dominant atmospheric phenomena in desert and semi-desert regions of the world. This phenomenon is related to air pollution in most parts of Iran with dry climate, including Birjand in eastern Iran. The origin and direction of dust in this area are varied in the year, and knowing them helps urban risk management, forecasting and desertification. In this study, Landsat satellite images were used to determine the origin of dust in the period of 1955-2017. The dust day was defined based on the classification of Shao and Dong with code 06 and 07 with horizontal visibility of less than 10 km, and revealed with BTD and TDI index. To determine dust atmospheric patterns, grid data from NOAA was used, and dust trajectories were carried out with the HYSPLIT model. The results showed that the most dust days in 1963 and 2008 (45 years), with 148 and 128 days, respectively, which mainly occur in the warm season and July. The 120-day winds of Sistan in the east of Iran plays a major role in transporting dust particles and air pollution in Birjand from the east and northeast from the deserts of Central Asia, Turkmenistan, Afghanistan, Khorasan Razavi plains and interior plains. But in the cold period of the year, Siberian cold masses from the east, cold fronts (migrating anticyclone), occluded fronts and low pressures from the northwest, west and southwest by passing through the central plains of Iran and sometimes the deserts of Syria and Iraq causes dust in the upper levels of the atmosphere. In all these centers, the occurrence of particles and pollution of cities prevails during periods of drought.

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## Extended Abstract

### Introduction

Atmospheric hazards related to the latitude of the regions, altitude above sea level, and distance from seas and deserts are different. The main hazards related to humidity and heat, dry air and temperature fluctuations, temperature drop and freezing are in tropical, subtropical and extra tropical zones respectively. But within 25 to 40 geographical degrees, the boundary between the subtropical and temperate zone, which are known as climatic transition zones (warm to cold climate). Inherently, the atmospheric anomaly is the most. Iran in this climatic zone with the low and high altitudes of the Iranian Plateau (the Mountains of Zagros and Elburz and the lowlands areas of Kavir Desert and Lut Desert) doubles the atmospheric hazards. As out of 41 recorded natural hazards, 31 examples occur in Iran, including frost, heat and cold waves, flood, drought, dust and so on. Dust is a climatic phenomenon on a global, regional and local scale, which causes air pollution in cities and damage to human health. Mainly, deserts, areas with a lack of vegetation, dry wetlands and dry lakes with fine-grained deposits of sand and clay are the origin and source of dust production. including the deserts of Iraq, Syria and Arabia in the Middle East (Givehchi et al., 2013), Khuzestan (Dargahian et al., 2016), Karaj (Bagherabadi et al., 1400: 143), Bushehr (Mahmoudi Kandar and Atai, 2015) and local sources of the Hamoun lake is in Zabul (Rahadari et al., 2017) and Urmia Lake is in Tabriz (Dargahi et al., 2015: 55). These resources can be identified with climatic data and Modis satellite images (Kim, 2008 :). The horizontal and vertical air currents associated with the Eastern Mediterranean trough pattern of Syria and western Iraq (Khorshid Dost et al., 2018: 57), move dust particles far away from the source (Hamidi, 2012). Considering the harmful effects of dust on health and the ecosystem, knowing the origin of dust is essential for risk management. The aim of this research is to identify dust centers by processing Modis satellite imagery in combination with collocation methods and tracking dust using HYSPLIT model during the year.

### Study Area

The city of Birjand is located in the center of Birjand Plain, that surrounded by mountains ranges, with a geographical location of 32°53'N and 59°13'E. It is surrounded from the north by Shukr Ab Mountain, from the east by Moemen Abad Mountain, from the south by Baghran mountain range, and from the west by the desert plain. This city is located at an altitude of 1491 meters in Foothill of Baghran Mountains. The city of Birjand has a cold and dry climate with an average rainfall of 170 mm and an average annual temperature of 16 degrees Celsius with successive dry and wet periods (Bani Waheb and Alijani, 2014: 33).

### Material and Methods

To determine the dusty days, the daily data of horizontal visibility (VV), wind speed (FF), wind direction (DD) and atmospheric phenomenon code (WW) in a period of 63 years (1955 to 2017) from the Iran Meteorological Organization (IRIMO.IR) was used. The temporal distribution of dust in each specific code and the frequency of repeating the code of dust occurrence (repeatability and probability of occurrence), code 06 and 07, were studied. A dusty day was defined as a day when the minimum horizontal visibility is less than 10 km based on the classification of Shayo and Dong (2006) and recorded in two daily sampling sessions. By comparing the dusty days of Birjand synoptic station and air pollution data with air quality index (AQI) of more than 150, 21 days of severe dusty days were selected. In order to reveal the phenomenon of dust, the Modis satellite images of the Terra and Aqua satellites with a resolution of 1 km from the National Aeronautics and Space Administration website of the United States (USGS[1]) were used. Geometrical, radiometric and atmospheric corrections of the images were carried out with the brightness temperature difference (BTD) and thermal infrared dust (TDI) index. The dust days were divided into two groups and origin and how the dust phenomenon enters the sky in Birjand city were analyzed in both groups. Atmospheric patterns of dust were used with daily data of zonal (U) and meridional (V) wind components at 850 HP level from the American Center for Environmental Prediction and Atmospheric Research (NCEP/NCAR) with a resolution of 2.5 degrees (Kalnay et al, 1996). Determining the origin and direction of dust movement from HYSPLIT models with a time step of 6 hours and altitude levels of 50, 500 and 1000 meters were used (Draxler & Hess, 1998, Draxler et al, 2009).

1. https://earthexplorer.usgs.gov

**Result and Discussion**

The dust phenomenon in Birjand from 1955 to 2017 has an increasing and decreasing fluctuation. The highest occurrence frequency with 147, 128, 114 and 104 days occurred in 1963, 2008, 1971 and 1962 respectively. Spring with 607 days and summer with 548 days have the most and autumn with 98 days have the least occurrences. July has the most dust with 303 days and March and June are next with 216 and 214 days, respectively. Also, the month of November with 25 days, is the least event and the cleanest month in Birjand. Therefore, the dust phenomenon is less in winter and autumn than in summer and spring. Most of the dust is in the warm half of the year, and the role of local and regional factors, sunlight and dryness of the environment is important in the occurrence of this phenomenon.

**Atmospheric patterns of dust:** The atmospheric pattern of dust is the establishment of a strong cyclone from the Caucasus, the Caspian Sea to Turkmenistan and a strong thermal cyclone from Pakistan to the southeast of Iran and the Oman Sea in warm period. The arrangement of pressure centers has caused the formation of the 120-day currents of Sistan in eastern Iran, which have different speeds due to the influence of the high and low altitudes of eastern Iran. Mainly, speed of the currents in the low-lying areas and by approaching the low pressure of Pakistan intensifies and turns into a sandstorm. The 120-day wind of Sistan in the warm period from late spring (June) to early autumn (October), with the movement of the winds in the form of low level jet, brings dust. The dust track is from the desert of Turkmenistan, the western plain of Afghanistan and Khorasan, which causes the movement of dust from dry plains with poor vegetation. The internal centers of dust in this pattern are the plains of Shahrekht, Dagh Ptergan, Esfadan, Gazik, Darmian, Tabas Mesina, Sedeh, Birjand, Dasht Khaf and Dasht Zozan, and the external centers are the Herat plain of Afghanistan. In cold period, the atmospheric pattern in the cold period is the establishment of two circulation centers in Europe and Central Asia in Middle latitudes and circulation centers in the subtropical region in Egypt, Arabian Peninsula and the Oman Sea. Iran is located in the boundary between these two large-scale atmospheric systems. Therefore, the strong air flow from west to east mainly brings humidity and precipitation in the east, but sometimes due to the lack of moisture in the air masses, dust particles are transferred from the deserts of Syria, northern Arabia, Iraq, and the interior plains of Iran, including the plains of Khuzestan, Tabas, Beshravieh, Se Ghale, and Chahak Mousavieh. Dusts from these centers reach the region with cold air currents caused by migratory anticyclones, weak cyclones and low pressures. Another pattern in winter, the high-pressure Siberian current from Central Asia causes instability and movement of soil particles at the beginning of autumn from the warm deserts. So in general, the outside centers of dust in the warm period are the deserts of Central Asia (Turkmenistan, North and South-West Afghanistan), Herat Plains of Afghanistan (Gochink Plain, Baran Abad, Gazan, Asiyab Abad, South East, North West and West Herat and the Eastern River basin), But in the cold period are the deserts of Syria, Arabia, Iraq. But the inner centers in the warm period are the deserts of Razavi Khorasan (Dasht Sarkhas, Dashte Taibad, Namakzar Khaf, Dashte Zozen), and the central deserts of Iran (Dasht Lut and Kavir) in the cold period. The local centers of dust are Shahrekht, Degh Patergan, Qain, Darmian, Gazik, Esfadan, and Sarbisheh plains in the warm season, and the Ferdous, Sarayan, Beshroieh, Dihuk, Se Qale and Khosuf plains in the cold season.

**Conclusion**

Dust is the main characteristic of arid and semi-arid climates in the subtropical regions of the world including Iran. Eastern Iran is one of the dry regions with the highest dust phenomenon. Most of the dust in Birjand is related to the role of local and regional factors. Atmospheric systems and sources of dust are different in cold and warm periods, as mainly the 120-day winds of Sistan from mid-spring to late September transport dust from the deserts of Central Asia, Turkmenistan, Afghanistan, Khorasan-Razavi plains and local plains. The Siberian cold front from the deserts of Central Asia, Afghanistan and eastern Iran, especially in late summer and early autumn, causes dust. Also, large-scale atmospheri systems, westerly winds, cyclones, anticyclones and thermal low pressures are the most important factors of atmospheric instability in the cold period in Iran, Sometimes these atmospheric patterns by passing through plains of Iraq, Syria, Saudi Arabia, Khuzestan plains, and central desert, dust reaches to Birjand city. Also, the local factors, lack of vegetation, land dryness, heights and the low and high lands of eastern Iran are effective in intensifying the regional winds of 120 days and local winds in the warm period. As these currents pass through the heights and enter to low areas, becomes to the bottom jet with strong winds and cause dust storms in the low plains of Torbet Jam, Khaf, Gonabad, Birjand, Nahbandan and Sistan. Wind flow in dry areas with poor vegetation cover in South Khorasan, Western plains of Afghanistan and dry plains (Petergan) is associated with the movement of dust. Dust occurs to passing fronts of cold through warm and dry lands in the cold period. As, only the cold front or the cyclones subside and cold air reaches to the region. Sometimes these atmospheric currents bring with dust in the upper atmosphere, in the

dry plains of Iraq, Syria, or in the interior plains of Lut desert and the Se Qala desert. Climate change, decrease of precipitation, increase of temperature, makes more climatic anomalies in Iran, including dust storms in similar climates of eastern Iran occur with local or non-local origin. Adaptation and management plan based on climatic anomalies and local knowledge to reduce dust and risk management is necessary.
**Key words:** Dust, Atmospheric Pattern, HYSPLIT Model, Remote Sensing, Birjand.

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