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HYSPLIT algorithm in dust source Identifying and modeling

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Abstract

Dust storms are one of the most important natural disasters and can strike due to different reasons, the phenomenon of dust is one of the most important sources of pollution in the world. This paper was used to identify dust hotspots in southwestern of Iran using Modis satellite images with appropriate temporal and spatial resolution. Modis images of MOD021KM were taken on dates corresponding to dust days and a true color combination and index (BTD) were used to identify dust. After dust detection, the main source and modeling of dust was performed by HYSPLIT algorithm at three heights and 48-hour return path. By tracking and identifying the source of dust storms, investigation of vegetation changes was carried out as this research was being done and the correlation between dust index and vegetation was also investigated. The results demonstrated that the dust source originates from neighboring countries such as Iraq, Syria, Jordan and Libya, and the increase in the occurrence of dust storms has had negative impacts on vegetation changes and plant loss.

1. Introduction

Dust is considered one of the biggest environmental issues in arid and semi-arid regions of the world today that every year it causes a lot of damage to sectors such as industry, transportation, agriculture, tourism and human health. (Baagghideh and Ahmadi, 2014).

Furthermore, it has disturbed the environment and reduced the growth of plants, this phenomenon has a strong negative impact on natural resources and vegetation (Baagghideh et al. 2014; Hao et al. 2007).

Previous research has shown that dust has become widespread, thus it has turned into an uncontrollable phenomenon (Taghavi et al., 2013).

Remote measuring and spatial information system have the ability to identify the center and source of the dust storm as well as tracking and predicting the direction of dust movement.

2. Method

Khuzestan province is a vast plain which is one of the richest provinces in Iran in terms of fertility.

The latitude and longitude of the study area is, 47°, 50° E and 30° 33° N respectively. It is the fifth most populous province of Iran with an area of 640057 square kilometers, it is located in the southwest of Iran on the shores of the Persian Gulf and the Arvand River. Due to the proximity to the Persian Gulf and the dry and burning winds of the Arabian Peninsula, it is a dry region and has a desert climate.

This study aims at monitoring and tracking the dust source related to the years 2010 and 2017. By examining the recorded data of dust in 20 synoptic stations and matching the time of recording the occurrence of dust phenomenon in the station with the imaging time of Modis sensor (MODIS), suitable data were obtained for this study.

Two methods of true color combination (TCC) and dust index (BTD) were used to monitor dust storms. In the color combination method, (3-4-1) dust is seen as a cloud mass in the image (Karimi et al. 2012; Ghaderi et al. 2019; Ghaderi et al 2020). In the BTD index method, dust has a higher temperature in bands 31 and 32 than other phenomena and the difference in radiance temperature between these two bands in the detection of dust phenomenon is the BTD index (Ghaderi et al. 2019 and samadi, 2019). Finally, using the Hysplit method, the

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sources of dust in the study area (Khuzestan) were tracked. Then, correlation and vegetation analysis with dust in the area was performed.

2.1. Meteorological Model HYSPLIT

HYSPLIT is one of the most commonly used atmospheric models to specify the backward trajectories to determine the origin of air masses. One of the tools used in this research is the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) meteorological model.

Modeling by tracking and reversing method, in 48 hours before the occurrence of dust phenomenon in Khuzestan province, at three altitudes of 100, 500 and 1000 meters to determine the path of dust particles was done.

2.2. Vegetation changes and its correlation with dust phenomenon

In this section, by analyzing and evaluating two vegetation maps in 2010 and 2017, the impact and role of dust storm in vegetation changes and plant loss were investigated.

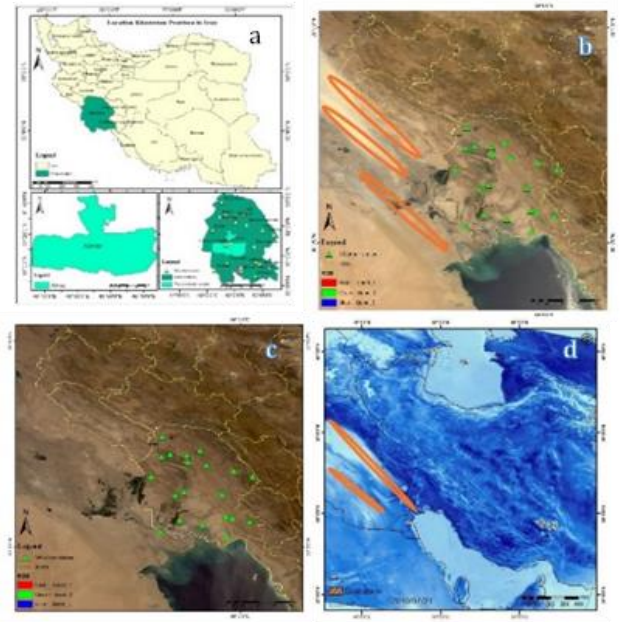


Figure 1. Study area, b, c) TCC image July/07/2010 and June/22/2017 d) BTD index.

Based on the NDVI index, the origin of dust was identified and the relationship between vegetation and dust in the study area was determined.

3. Results

The BTD dust index was used to identify the dust storm and the true color composition (TCC) was interpreted visually. Therefore, dust was identified in the west and north of Khuzestan province.

In order to modeling from meteorological model, the HYSPLIT was performed backwards from the starting point in Khuzestan province with three altitude trajectories.

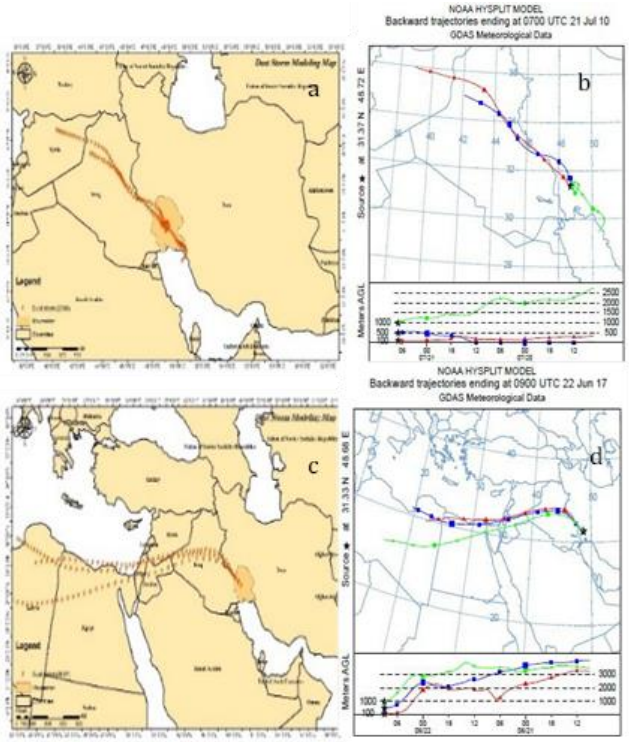


Figure 2. a, c) Hysplit model b, d) Hysplit model results to show dust cloud at three altitudes and validation.

The results of the meteorological model showed that the source of dust is from the west and northwest of Khuzestan province and the main source of foreign dust is from Iraq, Syria, Jordan and Libya.

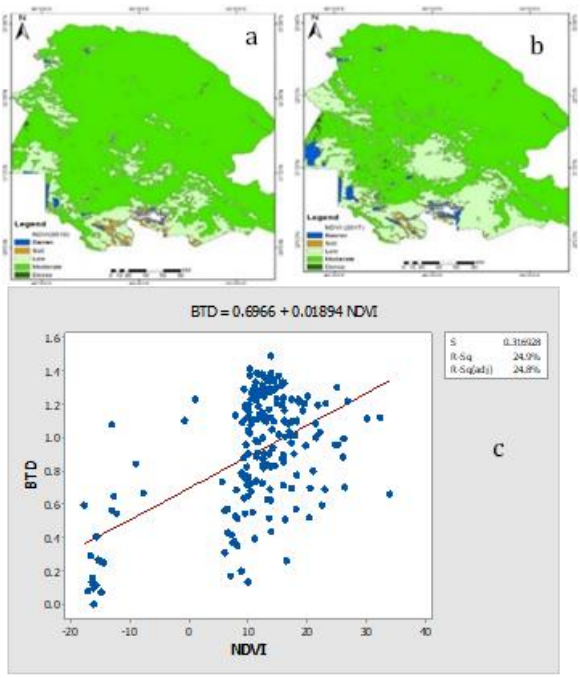
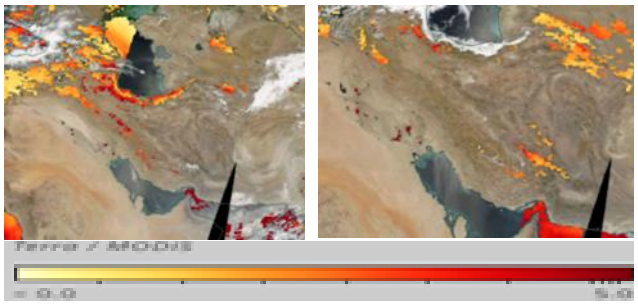


Figure 3. a, b) Map NDVI 2010&2017 c) Correlation of btd variable with ndvi.

Vegetation in 2010, according to the map of the southern regions of Khuzestan province is low. During the 8-year period of research, the vegetation of the areas with the most dust is reduced by vegetation. By analyzing the correlation between vegetation index and dust, it is stated that dust has a negative relationship with

vegetation. That is, with increasing dust, the vegetation decreases. Therefore, dust causes vegetation to disappear. Optical depth of aerosols (AOD) shows the density and depth of dust particles in the Earth's atmosphere and shows the aerosols in the atmosphere. (b).



(a) (b)

Figure 4. a) Aerosol optical depth (AOD) in 2010, b) Aerosol optical depth (AOD) in 2017

4. Discussion

Dust storms usually occur in arid and semi-arid regions of the world, and in recent years have created many problems for people living in arid regions. Therefore, many studies have been carried out with different methods to monitor, prevent and predict the occurrence of storms. Remote measuring and GIS are widely used in identifying and analyzing changes and monitoring meteorological phenomena.

5. Conclusion

This paper applies remote sensing and spatial information systems, data and the images of Terra/Modis were acquired on 21 July 2010, 22 June 2017, at 07.30 hrs. Then the necessary corrections were made in the images, and by using BTD index method the difference in dust brightness temperature was identified. With the HYSPLIT ventilation model, the return route to 48 hours before and three altitude trajectories of dust source and its accuracy were performed. Finally, the vegetation in southern Khuzestan was correlated with dust. As a result, with the increase of dust storm, vegetation was decreasing from 2010 to 2017.

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