Influences of the heat and vegetation cover changes of Iraq deserts on dust storms using Satellite images processing

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Abstract

In recent years, dust storms in Iraq and their movement towards Iran have caused severe to community health and potential environmental concerns. In this study the effect of vegetation cover and Land Surface Temperature (LST) variation in western desert of Iraq which is one of the creation zones of these storms has been investigate using remote sensing. Normalized Differences Vegetation Index (NDVI) was utilized to determine the vegetation cover variation and LST variation was showed using thermal band of Landsat TM5 images of the 18/06/1991 and 20/06/2007. The result of NDVI index indicated that the areas with the very weak and week vegetation covers did not change but the area with moderate vegetation cover increased up to1565 hectares. The LST changes in the areas with ranges of temperature, included 40.5°C – 43°C, 43.5°C – 46°C, 46.5°C – 49°C, and 49.5°C–50°C respectively increased, 111215, 1730310, 508028 and 5338 hectares. Results of this study concluded that remote sensing is a useful tool to study disaster phenomena in international areas especially in the areas that ground measurements are not available.

Key words: Landsat TM5, NDVI, Land surface temperature, Dust storm, Iran

1. Introduction

In last decade, dust storms have caused severe to community health and Potential environmental concerns in west and south west of Iran. The responsible of those dust storm are wind erosion in Syria desert, Iraq and Saudi Arabia and their movement towards Iran (Amanollahi et al. 2010). Iran Meteorological Organization reported that (IMO, 2010), construction of dams, inefficient farming and the decrease in the plantation in Beinolnahrien in Iraq, outbreak of drought in the recent years, erosion of soil during the war ever since 1990, are five main reasons for the dust storms in the west and southwest of Iran. Any decreases in the plantation directly or indirectly can cause these storms (Ye et al, 2002; Fan et al, 2002). plants by covering the surface of the soil and reduce the speed of the wind (Vanden Van, 1989) play the role of a natural retention wall that protects the soil against the wind which directly decreases the potential of create dust storms (Hupy, 2004; Miri et al., 2010). On the other hand, changes in the plantations of deserts can lead to changes in soil humidity rate and indirectly increases the potential of create dust storms in soil. Li et al, (2006) showed that the water presents in the soil can moderate storms. The soil moisture rate has a reverse relationship with the Land Surface Temperature (LST). Land surface temperature (LST) is a key factor of the land surface condition and can provide information on surface temperature and mass fluxes, vegetation water stress, and soil moisture (Pinhero et al. 2004). Huang et al., (2008) measured air temperature on four types of land cover consisting of the urban woods or the shade of trees, urban bare concrete cover, urban water areas and urban lawn, in Nanjing, China. They acquired that during the daytime the air temperature of different land covers were as bare concrete cover > lawn > water areas > woods or the shade of trees. The temperature can be measured using traditional methods such as a thermometer in ground station (Zeng et al. 2009), car traverse measurements (Saaroni et al., 2000) which can prove costly and time-consuming for vast study areas. In last decade, development and advances in remote sensing has opened a new corridor to studding LST. Remote sensing is offer a new, cost-effective, efficient and accurate method to measure LST. One of the important sensors which used in study LST by many researchers is MODIS which is able to provide the LST with a power resolution of 1 km (Wang & Liang, 2009; Vancutsem et al., 2010; Imhoff et al., 2010). Landsate satellite is another satellite which has been utilized to study LST. However, in comparison with MODIS, Landsat Satellite has a higher resolution and a high image accuracy of in estimating LST. It has been shown that this satellite is very appropriate for such investigations (Vancutsem et al., 2010). Therefore, researchers today prefer to use Landsat TM5 Satellite imaging which has a high resolution (120m) for studying LST variation (Amiri et al., 2009; Lie et al; 2009). Indeed, other bands (bands 4 and 3) of Landsat TM5 with a resolution of 30 m has been utilized for studying vegetation cover by many researchers (Li et al. ,2009; Amiri et al., 2009; Zhang et al., 2009). Normalized Differences Vegetation Index (NDVI) is indexes that were used to study the vegetation cover. Third band (red) and the fourth band (near infrared) of Landsat satellite are utilized to obtain the NDVI index. The NDVI ranges between +1 to -1. A positive value indicates vegetation and a negative value signifies a lack of vegetation in a region. A value of +1 show highly concentrated vegetation but -1 means a complete absence of vegetation. The objective of this study was to investigate the changes in temperatures and vegetation on the surface of the earth as well as the effect of the two factors on the dust storms in eastern and western desert of Syria and Iraq respectively, as one of the origins of these storms.

2. Data and material

2.1. Study area

The eastern deserts of Syria, western and shout western desert of Iraq, and northern deserts of Saudi Arabia are responsible to created dust storms which interred to Iran (Amanollahi et al., 2011). The primarily area which caused suspend of dust is eastern deserts of Syria (Amanollahi et al., 2010). In this study the boundary deserts of Syria and Iraq which are one of the primarily of origins of these storms were analyzed (Figure 1) using satellite imagery. Figure (1b) was prepared on June 20, 2007. This image fully shows that except the small fertilizer land around Eubiforat River, other area is desert with weak vegetation. These areas are the northern deserts of Alanbr province and Eubiforat River in Iraq and deserts of near the Eubiforat River in Syria including Almyadyn, Hajyn, Alshnth, and Albvkmal. Satellite images of Landsat TM5 on June 18, 1991 and June 20, 2007 were used to compare the changes in land surface temperatures and the vegetation in the study area.

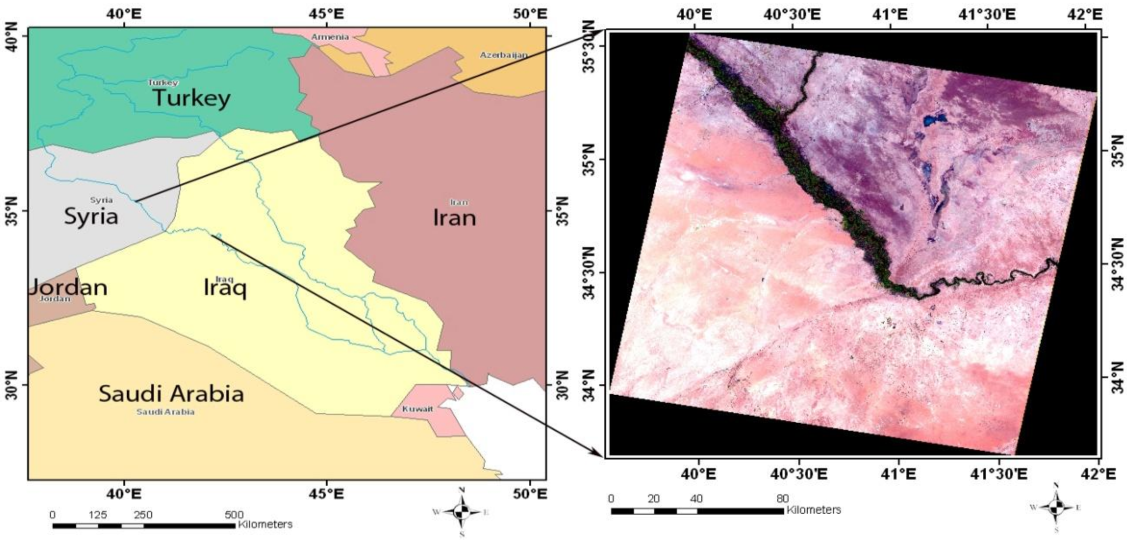


Figure 1. (1a) shows the geographical position of Eubiforat River inTurkry, Syria and Iraq, and (1b) shows the desert's boundary of Syria and Iraq.

3. Research Methodology

images were rectified to the UTM projection system (datum WGS84 zone 37) and were geo-referenced based on map (1:250000) that covered the lake near the Eubiforat River from Syria to Iraq (Chen et al., 2006) using 50 points ground control points. RMSE were less than one pixel for all bands. Nearest Neighbor resampling algorithm were utilized to preserve the brightness values of the pixels the (Li et al., 2009). NDVI was calculated from the bands 4 and 3 of images using the follow equation:

$$NDVI= p(\text{band } 4) - p(\text{band } 3) / p(\text{band } 4) + p(\text{band } 3) \quad (1)$$

Where, p is reflectance of band 4 and 3. NDVI was classified to several specific domains according to Table1. The supervised classification method with a Minimum Distance algorithm was also applied on NDVI images to classify the vegetation cover.

Table1, Defined ranges of NDVI index to determine the status of vegetation cover in the initial areas of the dust storms in western and southwestern regions of Iran

Vegetation Index	Good	Moderate	Weak	Very weak
NDVI	NDVI > 0.1	0.01<NDVI ≤ 0.1	0<NDVI ≤ 0.01	NDVI ≤ 0

First, the digital number of each pixel was converted into radiant temperature and second correction of spectral emissivity (ε) was used in more detail considering the different types of land cover (Caselles et al., 1995). In this study, (ε) of thick vegetation (Agriculture area), weak vegetation, bare land, and water were assigned the values of 0.940, 0.925, 0920, and 0.992, respectively (Nichol, 1994; Masuda et al., 1988; Venkateswarlu et al., 2003). In order to doing correction of spectral emissivity (ε) on thermal band, NDVI and thermal band of images were linked. Then, vegetation cover of thermal band pixel was obtained. For classification of heat in pixels the supervised classification method with a Minimum Distance algorithm on the band 6 of the images was used. Bands 3 and 4 images were used to obtain NDVI that indicates the status of vegetation cover (Zhang et al., 2009).

4. Results and discussion

Natural phenomena like LST changes and cover changes are usually measured in ground stations. But,

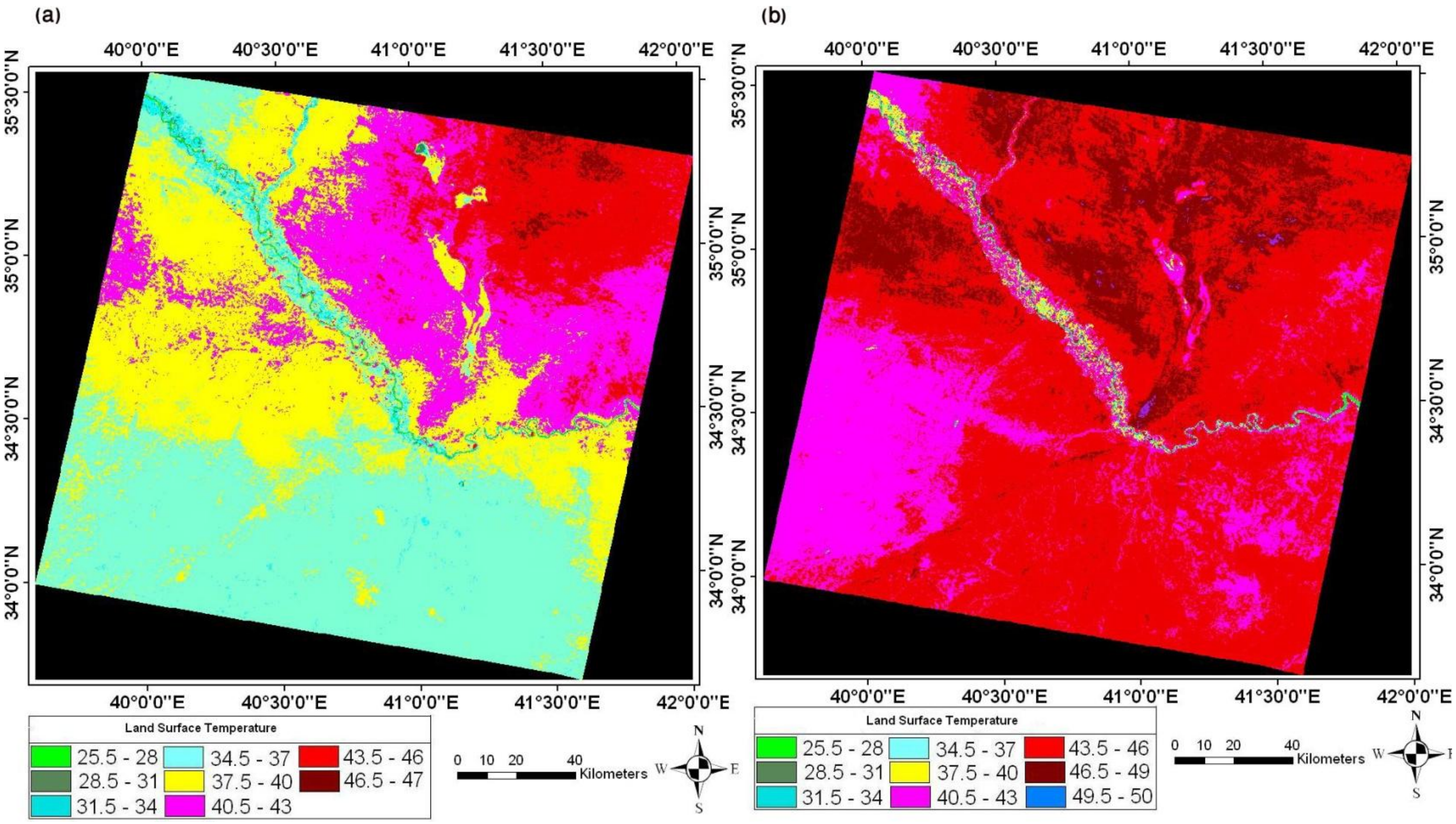


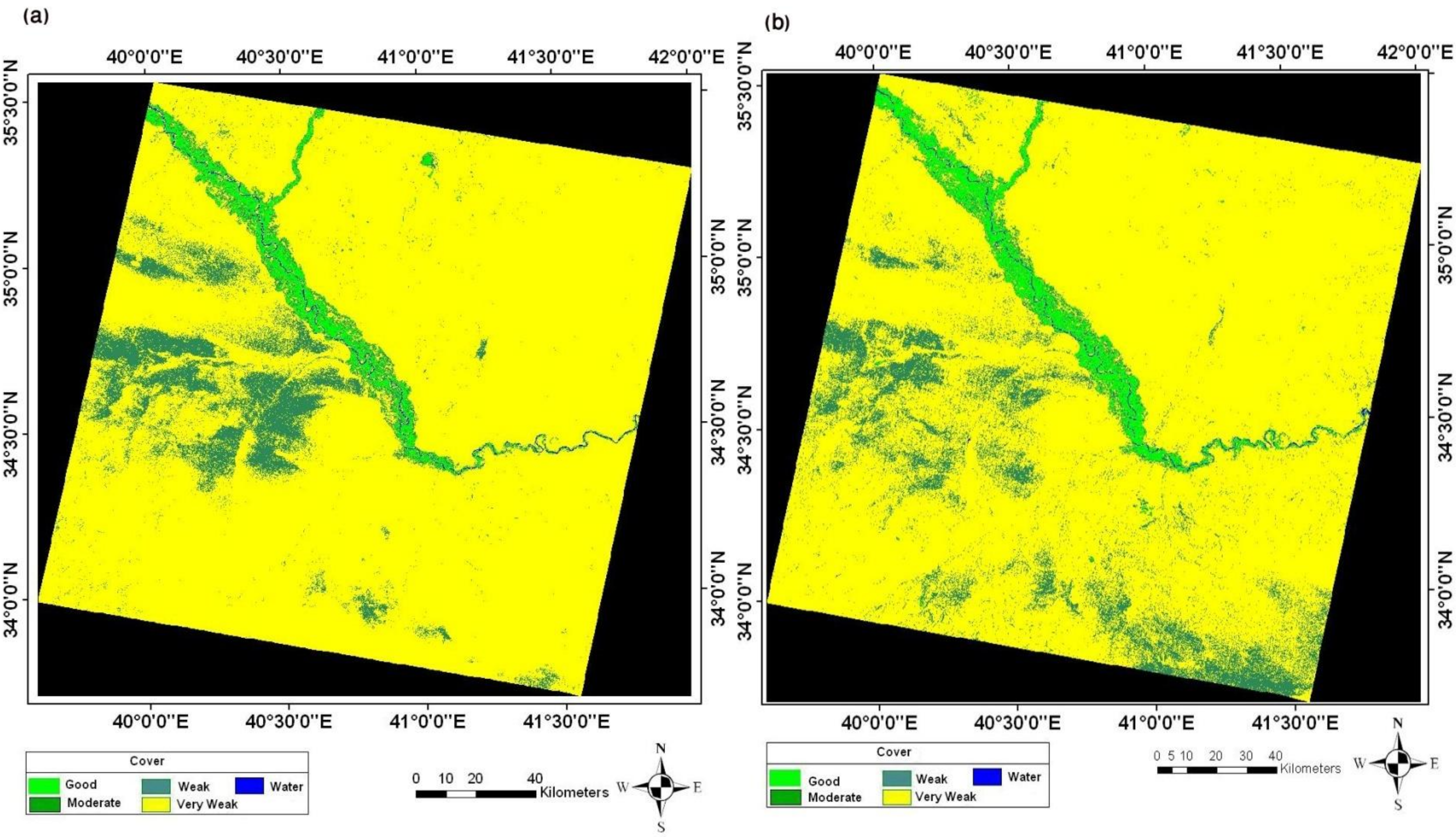
Figure 2. (a) and (b) respectively show the LST variation from June 18, 1991 to June 20, 2007 in desert's boundary in Syria and Iraq.

advancement in remote sensing technology created a new way of LST and canopy cover monitoring. Remote sensing methods are relatively inexpensive, and provide global coverage compared to ground stations. Figure (2) shows desert's boundary in Syria and Iraq around the Eubiforat River. As indicated in figure (1) this area is one of the first origins of the dust storms. Figure (2) indicates the amount of heat variations in the area between June 18, 1991 and June 20, 2007. As Figure (2) showed, the LST on June 20, 2007 indicate a higher ranger compared with those on June 18, 1991. The areas with thermal zones ranging between 25.5and 40° C in figure (2a) were missing in figure (2b), just they observed around the Eubiforat River in figure (2a).

Table 2. Changes in thermal ranges in the areas around the Eubiforat River in desert's boundary in Syria and Iraq between June 18, 1991 and June 20, 2007.

LST (°C)	25.5-28	28.5-31	31.5-34	34.5-37	37.5-40	40.5-43	43.5-46	46.5-49	49.5-50
Area (ha)	-9548	-3791	-36250	-1267512	-983809	111215	1730310	508028	5338
percent	-50.21	-41.21	-87.79	-99.15	-95.92	16.67	438.60	1402.86	100

Table 2 shows that increased levels ranging between 43.5-46° C and 46.5-49° C can be observed for high percentages in the figure of figure (2b). The temperature ranges of 47- 49 and 49.5- 50 cannot be observed in figure of (2a) as a result of a rise in temperatures on June 20, 2007. Additionally, areas with low temperature ranges have decreased in the table 2, but the highest reduction rate is related to the temperature ranges between 31.5 and 40° C. This shows an increase in the temperatures of the area between 1991 and 2007. A vegetation cover change in this area shows in figure (3). Areas with very poor vegetation cover (the yellow parts) were obtained higher on June 20, 2007 compared with the same date in 1991.



Figurer 3. (a) and (b) vegetation cover changes in June 1991 and June 2007 in deserts of around Eubiforat River in Syria and Iraq.

However, the areas with a good and moderate cover increased and area with weak and very weak decreed but as table 3 shows the range of changes is not high. Total of good covers were closed around the river and this situation shows that the agriculture land increases in 2007 compared to 1991.

Table 3. Vegetation cover changes in the areas around the Eubiforat River in desert's boundary in Syria and Iraq between June 18, 1991 and June 20, 2007.

Vegetation cover range	**Good**	**Moderate**	**Weak**	**Very Weak**

Vegetation cover variation (ha)	1100	1565	-19335	-1313
percent	6.2	8.7	-0.9	-0.03

In last decade remote sensing widely has been utilized for identifying different phenomena occurring on the earth surface like dust storms (Amanollahi et al., 2011) and identifying the smoke of fir forest (Gupta et al., 2007).

Most important capability of remote sensing is that it allows the researcher to determine the different phenomena values in any places especially when ground measurements are not available and large areas. The deserts around the Euphrates River in Syria and Iraq play a significant role in the emergence of dust storms affecting western parts of Iran. However, vegetation cover studies using NDVI index did not show great changes in this area between 1991 and 2007, and good and moderate ranges of cover increased. Good and moderate ranges cover the areas which are closed to agriculture lands around the Euphrates River and cannot stop the dust movement. A significant increase of high temperature ranges were obtained in these regions compared to cover range. This situation emphasizes the upward trend of land surface temperature and the changes in climatic conditions in this region. The earth surface temperature by affect on the soil moisture (Gu et al., 2002; Liu et al., 2003) has a indirect effect on the creation of dust storms. Rate of plant transpiration, plant need for water, and intensity of evaporation from soil surface are affected by changes of temperature. As the soil moisture decreases the adhesion properties of soil particles are reduced as a result weakening the resistance of surface soil against wind erosion which is the first stage of the formation of any dust storm (Hai et al., 2002). The study area and eastern deserts of Syria requires more attention as compared with other areas because soil or sand particles that the wind transfers from this region to center part of Iraq can weaken the soil surface and reduce soil resistance against wind erosion (Belanap and Gardner 1993; Kidron et al., 2000).

5. Conclusion

In last decade, remote sensing has been increasingly used natural phenomena like LST and vegetation cover variation . In this study the Landsat TM5 images of the 18/06/1991 and 20/06/2007 were used to study LST and vegetation variation in desert's boundary in Syria and Iraq that are one of the primarily place which creates dust storms. The NDVI index was utilized to show vegetation cover variation and indicated no high differences in 18/06/1991 compared to those in 20/06/2007. The LST ranges, included 40.5°C– 43°C, 43.5°C – 46°C, 46.5°C – 49°C and 46.5°C – 50°C in the areas in 18/06/1991 were obtained larger than those in 20/06/2007. Result showed that main reason of creation dust storms is increase LST in study area. Our research concludes that satellite data are useful tool for studying LST and vegetation cover variation in international areas especially when ground measurements are not available.

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