View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Directory of Open Access Journals

EnvironmentAsia
The international journal published by the Thai Society of Higher Education Institutes on Environment

Available online at www.tshe.org/EA
EnvironmentAsia 5(2) (2012) 76-81

Assessment of Vegetation Variation on Primarily Creation Zones of the Dust Storms Around the Euphrates Using Remote Sensing Images

Jamil Amanollahi [a], Shahram Kboodvandpour [b], Ahmad Makmom Abdullah [a] and Parinaz Rashidi [a]

[a] *Department of Environment Sciences, Faculty of Environmental Studies, Universiti Putra Malaysia, Malaysia.*
[b] *Department of Environment Science, Faculty of Natural Resources, University of Kurdistan, Iran*

Abstract

Recently, period frequency and effect domain of the dust storms that enter Iran from Iraq have increased. In this study, in addition to detecting the creation zones of the dust storms, the effect of vegetation cover variation on their creation was investigated using remote sensing. Moderate resolution image Spectroradiometer (MODIS) and Landsat Thematic Mapper (TM5) have been utilized to identify the primarily creation zones of the dust storms and to assess the vegetation cover variation, respectively. Vegetation cover variation was studied using Normalized Differences Vegetation Index (NDVI) obtained from band 3 and band 4 of the Landsate satellite. The results showed that the surrounding area of the Euphrates in Syria, the desert in the vicinity of this river in Iraq, including the deserts of Alanbar Province, and the north deserts of Saudi Arabia are the primarily creation zones of the dust storms entering west and south west of Iran. The results of NDVI showed that excluding the deserts in the border of Syria and Iraq, the area with very weak vegetation cover have increased between 2.44% and 20.65% from 1991 to 2009. In the meanwhile, the retention pound surface areas in the south deserts of Syria as well as the deserts in its border with Iraq have decreased 6320 and 4397 hectares, respectively. As it can be concluded from the findings, one of the main environmental parameters initiating these dust storms is the decrease in the vegetation cover in their primarily creation zones.

Keywords: Landsat TM5; NDVI; MODIS; 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 that dust storm are wind erosion in Syria desert, Iraq and Saudi Arabia and their movement towards Iran (Amanollahi *et al*., 2011d). 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. Global warming was reported as important factor in decease plant cover (Javanshah, 2010). 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). In last decades, development and advances in remote sensing has opened a new corridor to studding Particulate Matter (PM) during the dust storms (Amanollahi *et al*., 2011a; 2011b; 2011c), and vegetation cover indexes (Yang *et al*., 2011; Huang *et al*., 2011; Eslami *et al*., 2011). 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 (Sheriza *et al*., 2012). 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 vegetation on the surface of the earth as well as the effect of it's on the dust storms in deserts of Syria and Iraq, as areas of the origins of these storms.

2. Materials and Methods

In order to select the study area that is the origin of the dust storm the images from MODIS Satellite, called MODO21KM, were utilized. These images are one

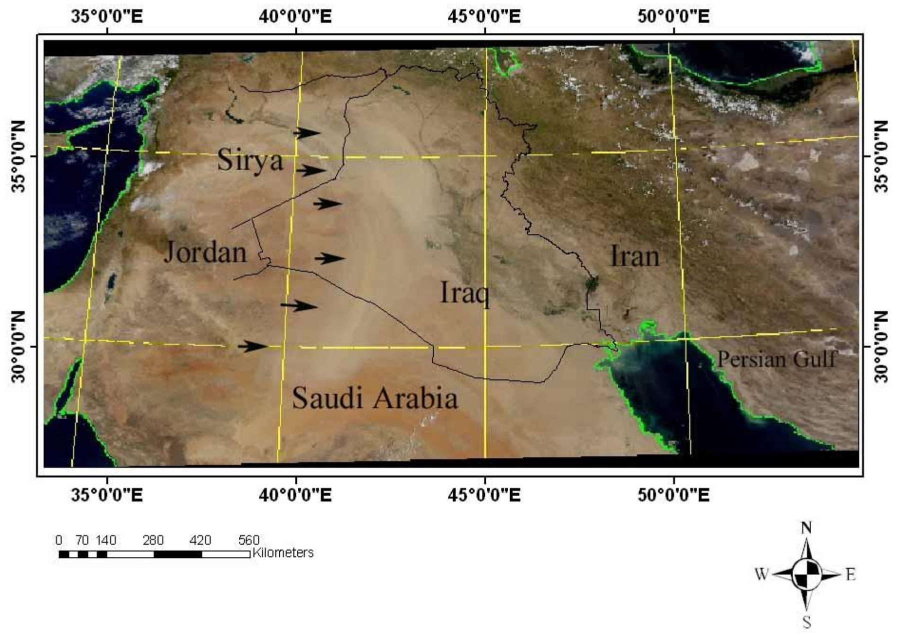

Figure 1. The satellite image by MODIS illustrating the establishment areas of dust storms in Syria, Iraq, and Saudi Arabia (indicated by arrows)

of the various types of graphic products generated by MODIS that are used for identifying the areas affected by dust as well as detecting fire in vast areas (Gupta *et al*., 2007; Amanollahi *et al*., 2011d). This type of image has a spatial resolution of 1KM and is the outcome of the reflection of light in 36 spectral bands on land used by MODIS. The image was produced on June 5th, 2009. In the image, the origins of the dust storms have been indicated by arrows. These areas include the deserts around the Euphrates (Al-Forat River) in Syria and Iraq, the deserts around the Al Anbar Province of Iraq, and the deserts in the north of Saudi Arabia.

The dust storm in Fig. 1 was produced on June 5th, 2009. The dust entered Iran in 24 hours. This resulted in an increase in rates of PM in the air of Sanandaj between 1.00 p.m. and 5.00 p.m. on June 7thh, 2009 to 449 μg/m^3 per cubic meter of air. The rate rose to 511 μg/m^3 at 5 p.m. on June 8th, 2009. Landsat 5TM satellite images were utilized to compare the vegetation cover in Area 1 (Syria), on June 26th, 2003 and June 26th, 2009, in Area 2 (deserts in the Iraq-Syria border) on May 24th, 2007 and June 18th, 1991, and in Area 3 (deserts around the Euphrates in the west of Baghdad, Iraq) on June 2nd, 2003 and June 28th, 2009.

2.1. Image processing

Images were rectified to the UTM projection system (datum WGS84 zones 37, 38) and were geo-referenced based on map (1:250000) that covered the lake near the Euphrates from Syria to Iraq using 50 points ground control points (Chen *et al*., 2006). 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.

3. Results and Discussion

3.1. Area 1

The first area comprises Dayr az Zawr and the deserts in the south west of this region in Syria. These

Table 1. Defined ranges for NDVI indicator for determining the vegetation cover in the establishment areas of the dust in West and south west of Iran.

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

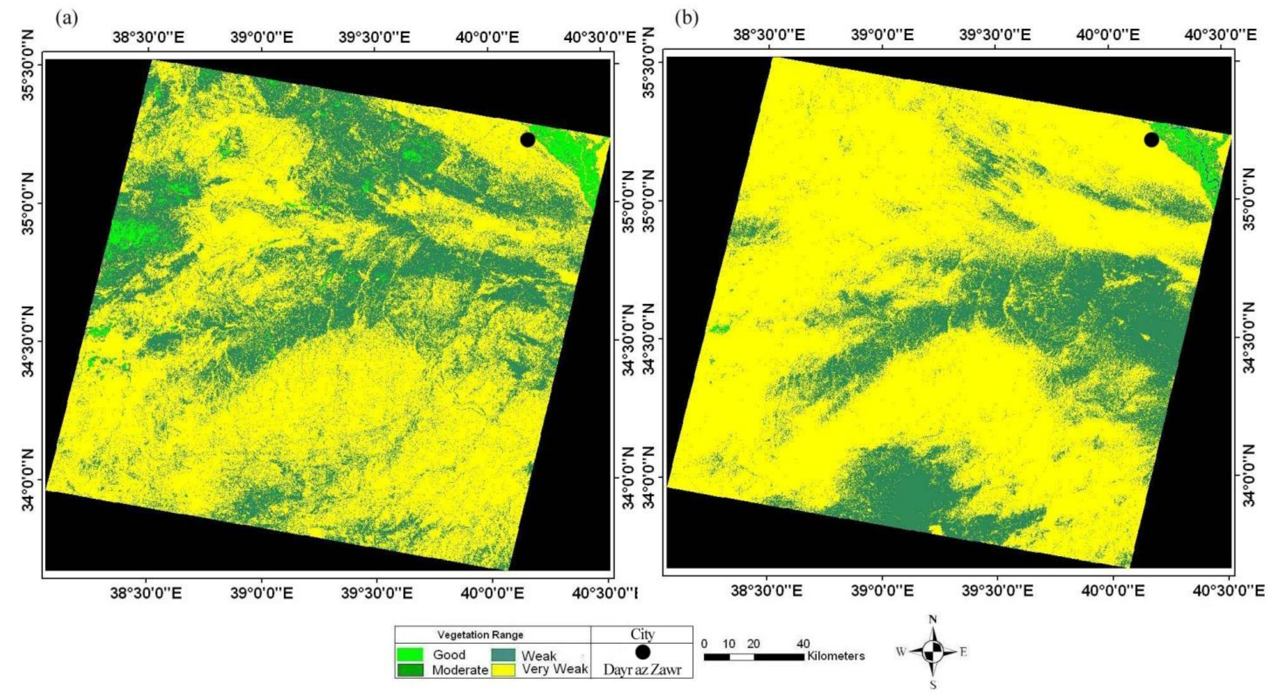

Figure 2. Vegetation cover changes in Dayr az Zawr (Syria) and the adjacent deserts in its south west June, 2003-June, 2009 (images a and b, respectively)

are some of the first areas where the dust storms originate. Fig. 2 shows the change in the vegetation cover of this area during 2003-2009. In Fig. 2, the areas with a very poor vegetation cover (in yellow) have considerably increased by June 26th, 2009 as compared to the same day in 2003. Additionally, the areas with a good vegetation cover on the left top corner of Fig. 2(a) (in light green) have disappeared in Fig. 2(b).

Areas with a poor vegetation cover in Fig. 2(a) are more scattered than in Fig. 2(b). The size and proportion of the changes in the vegetation of the study area from June, 2003 to June, 2009 have been shown in Table 2.

3.2. Area 2

This area includes the northern and southern parts of the Euphrates in the border between Iraq and Syria. The figure 3 encompasses places like Al Mayadin, Hajin, Al-Sha'anta, and Albukamal located in Syria by the Euphrates. It also covers places like the Al Anbar Province and the deserts in the north of the Euphrates near the Syrian borderline in Iraq (Fig. 3).

A comparison between the vegetation cover of the area between June, 1991 [Fig. 3(a)] and May, 2007 [Fig. 3(b)] shows a slight increase in the size of areas with a good or moderate vegetation cover while the size of the areas with a poor or very poor cover indicates no significant change [Fig. 3(b)]. However, the size of rivers, river banks, as well as small and large lakes with a surface area of 6320 hectares is considerable [Fig. 3(b)]. The size and proportion of the vegetation cover in the study area from June, 1991 through May, 2007 have been presented in Table 3.

3.3. Area 3

Area 3 includes the deserts in the north and south of the Euphrates in Iraq, which cover the deserts in the

Table 2. Size and proportion of the changes in the vegetation of Dayr az Zawr (Syria) and the adjacent deserts in it south west June, 2003-June, 2009.

Vegetation cover range	Very Weak	Weak	Moderate	Good
Vegetation cover variation (ha)	462811	-397166	-56017	-10363
percent	20.65	13.66	-70.26	-33.13

Table 3. Size and proportion of vegetation cover changes in the borderline deserts of Iraq and Syria June, 1991- May, 2007 (%).

Vegetation cover range	Very Weak	Weak	Moderate	Good
Vegetation cover variation (ha)	-1313	-19335	1565	1100
percent	-0.03	-0.9	8.7	6.2

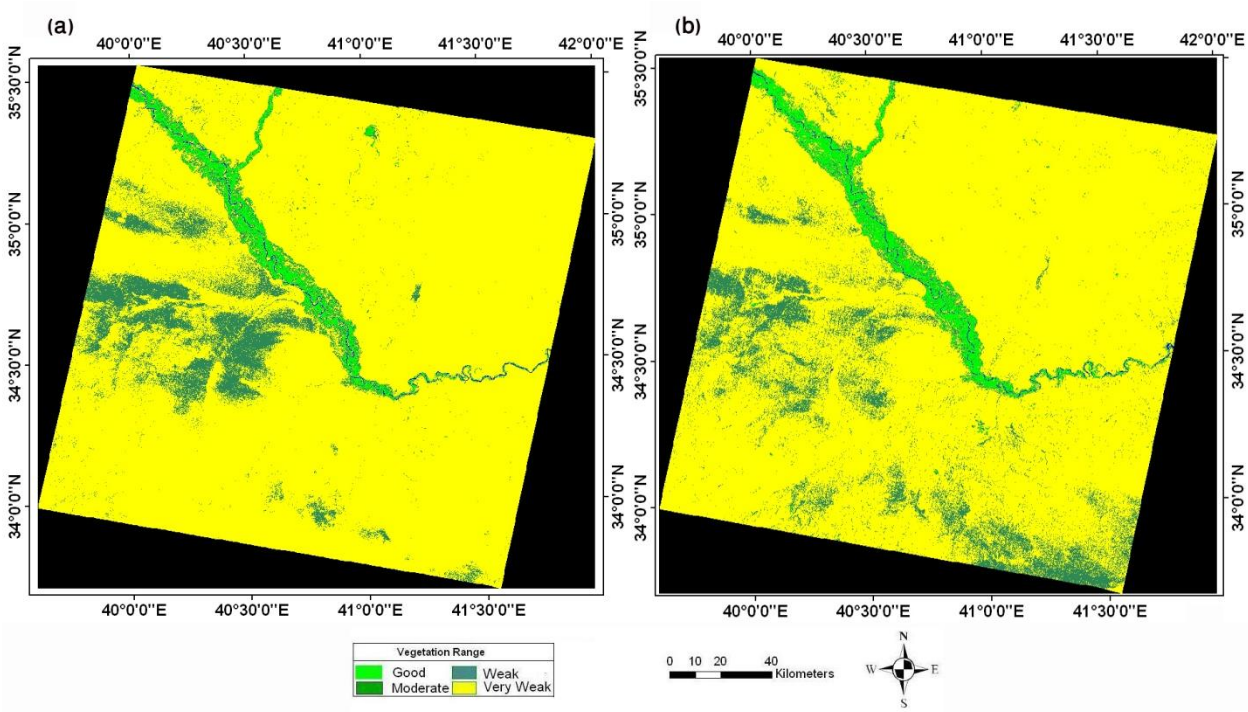

Figure 3. Vegetation cover changes in deserts between Iraq and Syria in June, 1991- May, 2007.

west of Baghdad, south of the Province of Neinava, and regions like Ennana and Al-Naur in the banks of the Euphrates. The deserts in this area are, in fact, the extension of those in Area 2 and are among the origins of the dust storms that influence the west and south-west of Iran. As we move from this area towards the west of Iraq, we reach Baghdad and the farm lands adjacent to it. Considering the farm lands in addition to other vegetation covers created by the dams on the Euphrates as well as the lakes around this river, this area cannot be regarded as one of the primary establishment areas of the dust storms. Fig. 4 illustrates the vegetation cover in the area from June, 2003 to June, 2009. As it can be observed from this figure, the main part of lands in this area, excluding the farm lands around the Euphrates, are covered with very poor vegetation.

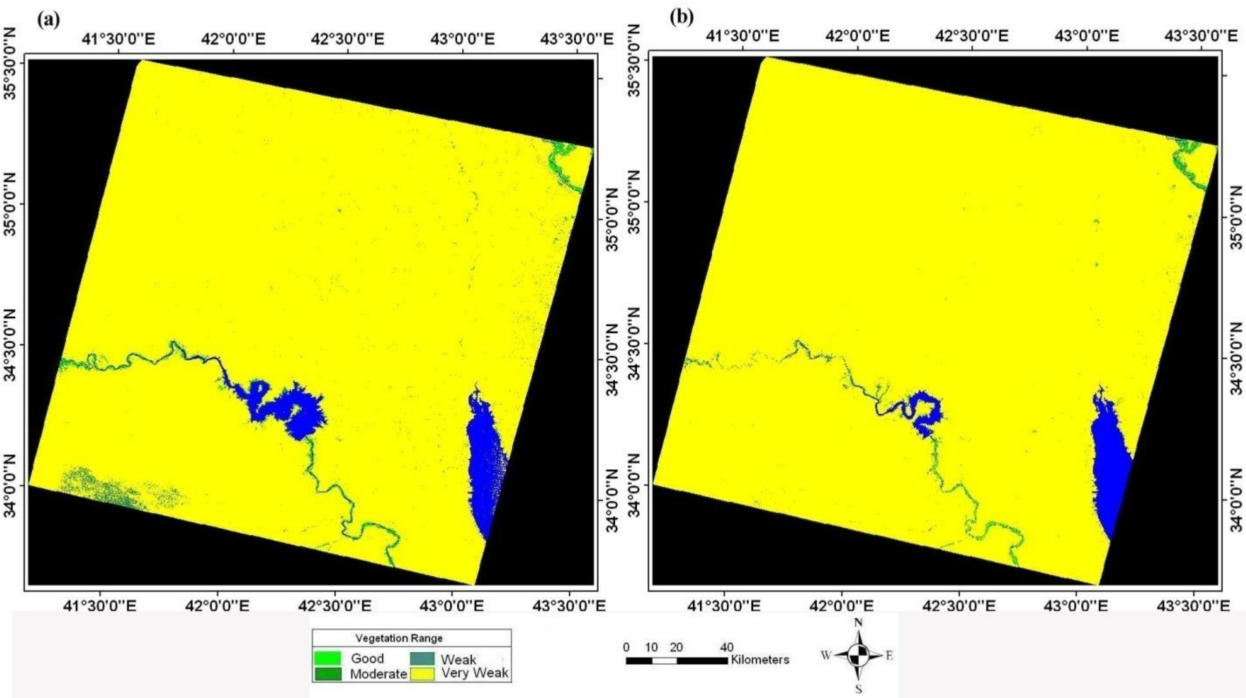

Figure 4. Vegetation cover changes in the northern and southern deserts of the Euphrates in west of Baghdad, Iraq in June, 2003-June, 2009.

Table 4. Size and proportion of vegetation cover changes in the borderline deserts of Iraq and Syria from June, 2003 to June, 2009.

Vegetation cover range	Very Weak	Weak	Moderate	Good
Vegetation cover variation (ha)	-81763	-72799	-4941	373
percent	2.44	3.85	-30.6	2

A comparison between the two figures indicates that the lands with a moderate vegetation cover have decreased during the period between 2003 and 2009, and the size of the lands with a very poor vegetation cover has relatively increased. Table 4 depicts the size and proportion of vegetation cover changes in the study area from 2003 to 2009. Overall, Area 3 has a poorer vegetation cover in comparison to the two preceding areas during the period of study. Like the two previous areas, the size of lakes has decreased by 4397 hectares.

The study of vegetation cover changes using bands 3 and 4 by Landsat 5 TM satellite indicator showed remarkable changes in the area in the period of study. A decrease in the size of lands with a good vegetation cover and an increase in the size of lands with a poor vegetation cover have paved the way for dust storms in the area. Among the three study areas in this research, Area 1 is of a crucial role since the soil or sand particle matter carried to the other two areas by the wind lead to the erosion of the surface soil making the soil weak in the face of wind erosion (Torabi Mirzaei *et al*., 2012; Kidron *et al*., 2000).

4. Conclusion

Detection of primarily places which creates dust storms is essential in air pollution study. MODIS image showed Syria and Iraq deserts are responsible for creating dust storms in west of Iran. The result of vegetation cover variation indicated by NDVI showed that the areas with the very weak and weak increased in study area. Our research concludes that the main reasons of creation dust storms in these areas are decreases vegetation cover and water content in soil. It showed dust storms are powerfully connected with the annual cycle of rainfall. This study showed that remote sensing is useful tools to study vegetation cover variation in international areas.

References

Amanollahi J, Abdullah AM, Farzanmanesh R, Ramli MF, Pirasteh S. PM_{10} distribution using remotely sensed data and GIS techniques; Klang Valley, Malaysia. Environment Asia 2011a; 4: 47-52.

Amanollahi J, Abdullah AM, Pirasteh S, Ramli MF, Parinaz R. PM_{10} monitoring using MODIS AOT and GIS, Kuala Lumpur, Malaysia. An International Research Journal of Chemical Sciences and Environmental Sciences 2011b; 15: 982-85.

Amanollahi J, Abdullah AM, Ramli MF, Pirasteh S. Real time assessment of haze and PM_{10} aided by MODIS AOT over Klang Valley, Malaysia. World Applied Science Journal Special Issue 2011c; 14: 8-13.

Amanollahi J, Kaboodvandpour Sh, Abdullah AM, Ramli MF. Accuracy assessment of moderate resolution image spectroradiometer products before and during dust storms. International Journal of Environmental Science and Technology 2011d; 8: 373-80.

Amiri R, Weng Q, Alimohammadi A, Alavipanah SK. Spatial-temporal dynamics of land surface temperature in relation to fractional vegetation cover and land use/ cover in the in the Tabriz urban area, Iran. Remote Sensing of Environment 2009; 113: 2606-17.

Eslami A, Zahedi SS. Providing poplar plantation map by Indian remote sensing (IRS) satellite imagery in Northern Iran. African Journal of Agricultural Research 2011; 6: 4769-74.

Fan YD, Shi PJ, Wang XS, Pan YZ. The analysis of typical dust storms in northern China by remote sensing. Advance in Earth Sciences 2002; 17: 289-94.

Gupta P, Christopher SA, Box MA, Box GP. Multiyear satellite remote sensing of particulate matter air quality over Sydney, Australia. International Journal of Remote Sensing 2007; 20: 4483-98.

Huang Y, Jiang D, Zhuang D, Ren H, Yao Z. Filling gaps in vegetation index measurements for crop growth monitoring. African Journal of Agricultural Research 2011; 6: 2920-30.

Hupy JP. Influence of vegetation cover and crust type on wind-blown sediment in a semi-arid climate. Journal of Arid Environments. 2004; 58: 167-79.

IMO. Iran metrological organization, 2010; Available online at: http://www.irimet.net

Javanshah A. Global warming has been affecting some morphological characters of Pistachio trees (*Pistacia vera* L.). African Journal of Agricultural Research. 2010; 5: 3394-401.

Kidron GJ, Barzilay E, Sachs E. Microclimate control upon sand microbiotic crusts, western Negev Desert, Israel. Geomorphology. 2000; 36: 1-18.

Li JJ, Wang XR, Wang XJ, Ma WC, Zhang H. Remote sensing evaluation of urban heat island and its spatial pattern of the Shanghai metropolitan area, China. Ecological Complexity 2009; 6: 413-20.

Miri A, Moghaddamnia A, Pahlavanravi A, Panjehkeh N. Dust Storm Frequency after 1999 Drought in the Sistan Region, Iran. Cliamat Research 2010; 41: 83-90.

Sheriza MR, Ainuddin N A, Hazandy AH, Helmi Zulhaidi MS, Ismail AM. Assessment of NDVI data for land cover classification using gamma methods. International Geoinformatics Research and Development Journal 2012; 3: 33-40.

Torabi Mirzaei F, Tajamolian M, Sarkargar Ardakani A, Azimzadeh H. Study of the vegetation effect on dust reduction using satellite images (case study: Yazd city). International Geoinformatics Research and Development Journal 2012; 2: 11-16.

Vanden VTAM, Fryrear DW, Spaan WS. Vegetation characteristics and soil loss by wind. Journal of Soil Water Conservation 1989; 44: 347-49.

Yang ZZ, Ming MX, GuoShun L, Fang FJ, Hong BQ, Ying WZ, Lin S, Feng SW. A study on hyperspectral estimating models of tobacco leaf area index. African Journal of Agricultural Research 2011; 6: 289-95.

Ye DZ, Chou JF, Liu JY, Zhang ZX, Wang YM, Ju HB, Huang Q. Causes of sand-stormy weather in northern China and control measures. Acta Geographica Sinica. 2000; 55: 513-21.

Zhang Y, Odeh IOA, Han Ch. Bi-temporal characterization of land surface temperature in relation to impervious surface area, NDVI and NDBI, using a sub-pixel image analysis. International Journal of Applied Earth Observation and Geoinformation 2009;11: 256-64.

Received 14 January 2012
Accepted 30 April 2012

Correspondence to
Jamil Amanollahi
Department of Environment Sciences,
Faculty of Environmental Studies,
Universiti Putra Malaysia,
Malaysia.
E-mail: RS.Environment@gmail.com