APPLICATION OF ETM+ DATA FOR ESTIMATING RANGELANDS COVER PERCENTAGE
(CASE STUDY: CHAMESTAN AREA, IRAN)

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KEYWORDS: ETM^+, Vegetation indices, Fusion, Percentage vegetation cover, Correlation analysis, Stepwise regression.

ABSTRACT:

The major land cover in Iran is rangeland, so it is not possible to assess the vegetation cover of these vast areas through field work. During the recent years, many researchers have used various satellite data with vegetation indices as a tool to evaluate the rangelands vegetation cover and to estimate the yield and percentage cover. This study was carried out in Chamestan area rangelands (12000ha) in Mazandaran province, Iran. Landsat ETM^+ data with acquisition date of 18th July, 2000 were registered to digital topographic maps with scale of 1:25000. Multi spectral bands were registered to TM8 panchromatic band using data fusion method in two ways: "Spectral Response" and "Hue, Intensity, Saturation (HIS)" techniques. In addition, 26 vegetation indices were applied to Landsat data as well. Field surveys and available vegetation maps confirmed the limited number of vegetation types that were not exceed to four major vegetation forms at the studied areas. Totally on 40 points, 400 quadrates were placed to estimate vegetation cover. To arrange these quadrates, on each randomly selected point, 10 quadrates each 10m*10 m were placed on perimeter of a supposed circle with 20m radius. This supposed circle covers (3*3) =9 pixels of ETM^+ image. Inside of each quadrate the percentage vegetation cover was estimated and the dominant species were recorded. Correlation and stepwise regression analysis were applied to field data and vegetation indices. These indices were the products of the Landsat data bands and the fused bands. The results illustrated that vegetation indices alone did not have enough ability to estimate percentage cover on studied rangelands. But applying of vegetation indices to ETM^+ bands along with fused bands, leads to get reliable results on estimating of rangelands percentage cover.

INTRODUCTION

During the recent years, implication of satellite data on vegetation assessment and land cover mapping has been extended. Field surveying and data collection can be carried out on a part of studied area, then the collected data relation with satellite data can be modeled to assess the vegetation cover on the whole region. According to this point some works have been managed. Among them, Longford and et al. (1997) used TM data to map land cover of Caucau in Colombia. Khajeddin (1995) use Landsat MSS data to assess the vegetation cover of Jazmourian area, Iran. Sepehri (2002), applied TM data and vegetation indices, to assess the percentage vegetation cover of rangelands in Jahannema protected area, Iran. Also Leeuwen and Huete (1996) have employed NDVI and MNDVI on litter determination and vegetation assessments.

MATERIAL AND METHODS

The studied area is located in Mazandaran province, northern part of Iran, between 36° 14´ to 36° 17´E and 52° 0´ to 52° 15´N about 12000ha where the mean annual precipitation is 1200mm. Landsat ETM+ images of 18th July, 2000 were registered to 1:25000 digital topographic maps by nearest neighbor

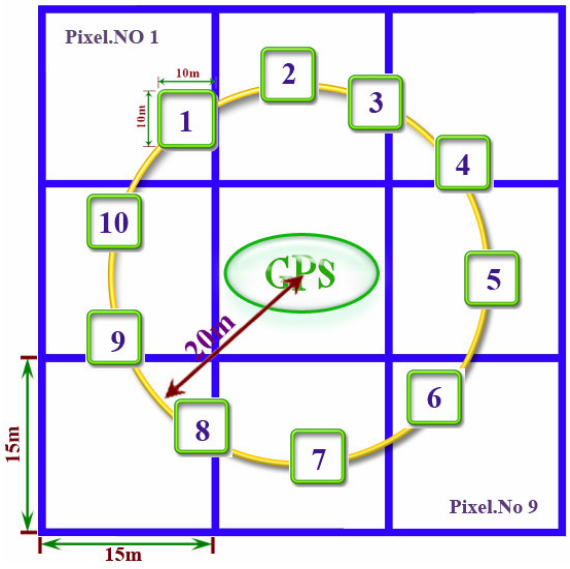
resampling algorithm which the RMSe was less than one pixel. To use the panchromatic band, the multi spectral and thermal bands were registered to the pan band, then data fusion (merging) was done with two methods: "Spectral Response" and "Hue, Intensity Saturation (HIS)". In spectral response method, 2, 3 and 4 bands were merged with pan band. In HIS method all of the bands were merged with pan band. Also pixel size of thermal and multi spectral bands were equaled to pan band. Subsequently a lot of 26 vegetation indices were tested (Table 1).

Field surveys and available vegetation maps confirmed that only four major vegetation types can be found in the studied area. Totally, on 40 randomly selected sample points, 400 quadrates were randomly placed to estimate vegetation cover in a manner that on each sampling sit, 10 quadrates (10*10m) were placed on the perimeter of supposed circles with 20m radius to cover 9 ETM+ pixels (Figure 1). Inside of each quadrates the percentage vegetation cover was estimated and the dominant species were recorded.

(Table 1) The tested vegetation indices.

Vegetation Index	Formula
IR2	(TM4-TM7)/(TM4+TM7)
MIR	TM5/TM7
MND	(TM4-(1.2*TM3)/(TM4+TM3)
MSI	TM5/TM4

NDVI	(TM4-TM3)/(TM4+TM3)
NIR	TM4/TM3
RA	TM4/(TM3+TM5)
SAVI	(TM4-TM3)/(TM4+TM3+0.5)*1.5
TVI	(TM4-TM3)/(TM4+TM3)+0.5
IR1	(TM4-TM5)/(TM4+TM5)
VNIR1	(TM4-TM1)/(TM4+TM1)
VNIR2	(TM4-TM2)/(TM4+TM2)
PD311	TM3-TM1
PD312	(TM3-TM1)/(TM3+TM1)
PD321	TM3-TM2
MIRV1	(TM7-TM3)/(TM7+TM3)
MIRV2	(TM5-TM3)/(TM5+TM3)
PD322	(TM3-TM2)/(TM3+TM2)
MINI	(TM7-TM4)/(TM7+TM4)
VI1	TM6H*TM7/TM3
VI2	TM4*TM6H/TM7
VI3	TM2*TM6H/TM7
VI4	TM3*TM6H/TM7
VI5	TM6H-(TM3+TM5)/TM6H+(TM3+TM5)
VI6	TM2-(TM7+TM6H)/TM2+(TM7+TM6H)
VI7	TM6/(TM3+TM5)



(Fig 1) the 9 pixels and the 10 randomly placed quadrates.

Correlation and stepwise regression analysis were examined between field data and relevant 9 pixels values of the vegetation indices calculated using the original ETM$^+$ data and the fused bands data. At least one very well adjusted model was obtained to predict the percentage vegetation cover on the whole region.

RESULTS AND DISCUSSION

Table (2) demonstrates the percentage vegetation cover on each sampling points.

(Table 2) Collected field data on sampling points with described quadrates

Sampling point	Percentage Cover	Sampling point	Percentage Cover
1	48.5	*21*	35
2	42.5	*22*	47.5
3	55	*23*	22
4	37.5	*24*	20
5	30.5	*25*	20
6	48.3	*26*	42
7	75	*27*	32.5
8	59	*28*	33
9	33.75	*29*	42
10	42.5	*30*	50
11	37.5	31	60
12	52	32	60
13	75	33	54
14	22	34	45
15	43.5	35	60
16	53.75	36	48
17	54	37	35
18	33	38	50
19	27	39	50
20	26	40	50

The resulted correlation coefficients of the percentage vegetation cover and vegetation indices of the ETM$^+$ and fused bands data are recorded in Table (4). According to this table VI3, VI4 and Hyb4 (merged by means of spectral response method) have the best correlation with vegetation cover (P=1%)

(Table 4) The resulted correlation coefficients of the field data with image data

Vegetation Index or Band	Correlation coefficient	Vegetation Index or Band	Correlation coefficient
IR2	0.19	B3FU	-0.087
MIR	0.184	B4	0.147
MND	0.329*	B4FU	0.018
MSI	0.111	B5	0.154
NDVI	0.329*	B5FU	-0.053
NIR	0.322*	B6L	-0.044
RA	0.127	B6LFU	-0.006
SAVI	0.329*	B6H	-0.200
TVI	0.329*	B6HFU	0.003
IR1	-0.092	B7	0.112
VNIR1	0.302	B7FU	-0.242
VNIR2	0.335*	B8	-0.038
PD311	-0.135	HYB2	-0.214
PD312	-0.130	HYB3	-0.234
PD321	-0.80	HYB4	0.381**
PD322	-0.034	VI1	0.150
MIRV1	0.309*	VI2	-0.148
MIRV2	0.352*	VI3	-0.392**
MINI	0.019	VI4	-0.270**
B1	-0.114	VI5	-0.027
B1FU	0.184	VI6	-0.055
B2	-0.147	VI7	-0.069
B2FU	-0.012		
B3	-0.132		

* Significantly at P=5% and ** significantly at P=1%
FU= fused band using HIS method
HYB= fused band using spectral response method

The results of stepwise regression analysis are shown in Table (4). On the basis of this table contents, it is possible to create a model to predict the percentage cover over the whole studied area.

Table -4- Results of step wise regression analysis

R^2	Mean of Squares	Degree of freedom	Source of Variation	Variable
0.64	1256.03	4	Regression	VI3 B7FU HYB4 B5FU B6H
	80.71	35	Error	

The suggested model is:

Y=-0.28B6H+2.45B5FU-3.15B7FU+1.46HYB4+27.74

Where

Y= percentage cover,
B6H= band 6 high gain,
B5FU= fused band 5 using HIS method ,
B7FU= fused band 7 using HIS method
HYB4= fused band 4 using spectral response method

Sepehri (2000) applied the mentioned vegetation indices in Jahannema area, Gorgan, Iran and also Boyd et al (1996) and Sepehri et al (1998) used these indices as well. They expressed since there are high variations among cover data, so the vegetation indices are not much applicable to asses the vegetation cover. Among the examined indices, VI3 has highest correlation coefficient with vegetation cover (r=39.2%). Also the Sepehri et al (1998) and Boyd et al (1996), researches have reched the similar results. And the same results have been discussed for the VI6 vegetation index. NDVI has positive correlation with vegetation cover because of the high spectral reflectance of vegetation cover in band 4. Khajeddin in 1995 has proved that NDVI is one of the indices that have correlation with vegetation cover at Jazmourian area. The low correlation coefficient between NDVI and vegetation cover is due to soil back ground (Apan et al 19997). MIRV2 has a high correlation with vegetation cover (r=35%). It seems that, the high vegetation reflectance on near infrared region is responsible to this point. Hyb4, created from merging panchromatic band with band 4, 3 and 2 data, has correlation with vegetation cover (P=1%). Considering the fusion algorithm in spectral responses, the spectral reflectance of Hyb4 is very similar to band 4. In addition, the latter spectral region of the vegetation reflectance is considerable; therefore this band could be used frequently to estimate vegetation cover.

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