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PERCENTAGE OF VEGETATION COVER OF RANGELANDS USING ETM+ IMAGE PROCESSING CASE STUDY: RANGELANDS OF SAFAROUD WATERSHED, MAZANDARAN

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ABSTRACT

The aim of this study was to determine the percentage of vegetation cover of rangelands using digital data of Landsat 8 satellite sensor. For this purpose, satellite images of rangelands of Safaroud watershed in Mazandaran province (Iran) were prepared. Then, visiting the region, field data were taken by random-classified sampling method. In homogeneous regions, rangelands of the sampling units were determined randomly. In each unit, 10 plots of one square meter were placed on the circumference of a circle with a radius of 30 meters, and the percentage of vegetation cover of each plot was estimated. Average vegetation cover of 10 plots was considered as a percentage of the Central plot vegetation cover. For image processing, vegetation index and image fusion techniques were used. The estimation model of the region vegetation cover percentage was developed using stepwise regression statistical analysis on data obtained from field observations as the dependent variable, and analogous pixel value on satellite data obtained by processing the images as independent variable. In this model, images of raw data band 3 (b3), the fusion band 2 (his2) and TVI vegetation index were diagnosed as suitable images. By applying the model on the above images, region vegetation cover percentage was prepared. Using the Regroup technique, the map is divided into different classes, and cover classes map was prepared. Map accuracy was assessed using error matrix technique, and total accuracy and kappa coefficient of the map were calculated 78.2 and 74.5, respectively.

KEY WORDS
vegetation cover percentage, satellite image processing, data fusion, stepwise regression, Safaroud watershed, traditional medicine, Mus musculus, Toxoplasmosis.

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INTRODUCTION

Wide access to information of rangelands and the inability to access some mountainous areas are of the reasons for the use of remote sensing techniques that is able to produce information necessary to assess the vegetation cover and adopt appropriate management practices in all areas (Jabbari et al., 2015). With ground operations in part of the study area, and then determining the relationship between terrestrial information and satellite data, a model can be calculated and extended to the entire region. In order to utilize satellite images, different techniques are used for detection of more information on these images; vegetation indices and satellite data fusion are two examples of it. In other words, the vegetation indices include conducting a kind of arithmetic operation between pixels of a band with analogous pixels in other spectral band(s) for detection of information contained in satellite images (Andress Vina, et al., 2011). In this context, various indicators are designed in the world and different researchers have utilized them.
In a study comparing the use of different vegetation indices for mapping vegetation cover canopy in the Wildlife Refuge of Mote in Isfahan, Rahdari et al. (2009) evaluated different vegetation indices using LISS3 sensor of IRS satellite; and finally, with 78% correlation with cover canopy, SAVI was diagnosed as the best index.
Using digital data from ETM+ sensor and analysis of image fusion, spectral ratios and principal component analysis (PCA), Hosseini et al. (2007) developed the map of rangelands of Chamestan country region in Mazandaran province.

MATERIALS AND METHODS

Study area is rangelands of Safaroud watershed in West Mazandaran (Iran) with an area of 4660 hectares located in geographical area of 50° 25' 00'' to 50° 34' 33'' east longitude, and 36° 48' 35'' to 36° 53' 00'' north latitude. The region vegetation cover consists of one-year and permanent grasses, one-year and permanent shrubs.

Satellite Image Processing

In this study, images of ETM^+sensor of Landsat 8 satellite (4/8/2015) were used which were according to field observations. ETM^+ sensor data have 7 spectral bands with spatial resolution of 30 m (60 m in the thermal band), and also panchromatic band with a resolution of 15 meter; using this band with other bands can lead to detection of a series of information especially the location information of panchromatic band.

In order to implement spatial data from a single-band image with high spatial resolution to multispectral images, various techniques have been developed which are called data fusion. For this purpose, different methods and algorithms have been developed. Color space conversion (HIS) is one of the most common methods. In this method, all multispectral bands are merged with a panchromatic band, and the images obtained contain information of both bands; color space conversion was used in this study.
Hosseini et al. () conducted a study on the application of primary bands and vegetation indices and fusion bands at the same time for mapping vegetation cover percentage, and they used data fusion techniques.

After preparing the image and controlling its geometric match, bands were matched with the panchromatic band using topographic maps of the region so that the spatial resolution of all images were corrected and made equal to 15×15 while maintaining their spectral and radiometric resolution.

Terrestrial data collection

Field data collection was done with the deployment of 340 plots on 34 sampling units in homogeneous areas in different randomly classified vegetation types. Out of these, 16 and 18 units were used for mapping and assessing the accuracy of the final map, respectively. In each sampling unit, according to the spatial resolution of satellite data (30×30 meters), 10 one square-meter plots were placed on the circumstance of a circle with a radius of 30 meters. A total of 160 and 180 plots were placed for mapping and assessing the maps, respectively; and the plots' vegetation cover percentage was measured. The mean percentage of vegetation cover per sampling unit was considered as the corresponding number in the same unit. [Fig. 1]

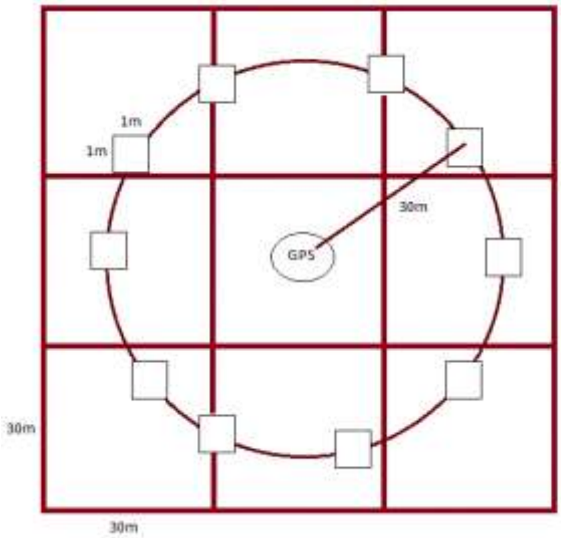

Fig. 1: Sampling method and plot deployment.

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Statistical analysis and mapping of vegetation cover percentage

For statistical analysis, sampling units' locations were determined on the satellite images first. Then, average Digital Number (DN) for the nine pixels of each sampling unit from the primary bands, bands from image processing techniques (fusion) as well as vegetation indices provided in the software ERDAS IMAGINE 2014 were extracted. Numbers extracted from satellite images and field data were inserted into SPSS. Implementing the stepwise regression analysis among field data as the dependent variable (Y) and data derived from satellite images as the independent variable (X), different statistical models were evaluated. [Table 1]

Table 1: Variables used in this study

Dependent variable	Independent variables		
Field observation	Raw bands	Fusion bands	Vegetation indices
	B4 - B3 - B2 - B1 B7 - B6 - B5	His1 - His2- His3	MIRV2 - VNIR2 - VNIR1 - NIR - NDVI SAVI - IRI - MINI - TVI - PD322 - MIRV1

Finally, a model at the level of 5% error was introduced and implemented as an appropriate model. The output of running the model is the vegetation cover map of the region. In the next step, the map is divided into different classes using the Regroup technique, and at the end, the accuracy of the map was evaluated based on the field data (18 plots).

RESULTS

The results of the statistical analysis among terrestrial information and satellite images are presented in the tables below. In [Table 2], the results of stepwise regression analysis on indexes, primary bands and the bands from data fusion are presented.

Table 2: Results of stepwise regression analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	2787.208	3	929.069	30.731	.000 a
	Residual	362.792	12	30.233		
	Total	3150.000	15			

a. Predictors: (Constant), B3, HIS2, TVI

In the final mode introduced, among the independent variables used, three variables of B3, HIS2, TVI were determined appropriate. In the [Table 2] above, total and mean squares are listed for regression and error sources. Given that sig value is less than 0.01, at 99% confidence, we can say that regression equation is approved. The regression coefficients are given in [Table 3].

Table 3: Regression coefficients used in this study

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
3	(Constant)	219.632	23.518		9.339	.000
	b3	-.021	.003	-1.846	-6.531	.000
	his2	-.005	.001	-1.198	-3.768	.003
	TVI	240.599	95.283	.339	2.525	.027

According to the coefficient in the table above, the final relation can be written as follows:

$$Y = 219.632 - 0.021 B3 - 0.005 HIS3 + 240.6 TVI$$

Applying the above regression model on the images of B3, HIS and TVI, vegetation cover map was prepared. The map was divided into eight categories based on the Regroup technique. [Fig. 2]

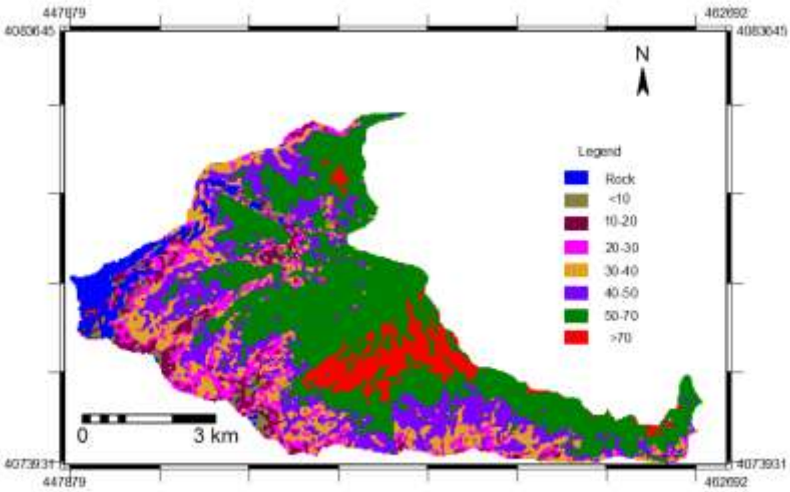

Fig. 2: Map of the vegetation cover classes in the study area.

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The accuracy of the map prepared was examined with the help of 18 sample units; total accuracy and kappa coefficient for the map were 78.2 and 74.5, respectively.

DISCUSSION AND CONCLUSION

The method of collecting field data in this study is in such way that the field data can be matched with information on satellite images with high accuracy. Sepehri (2002) has used a similar method. Khajeddin (1996) has provided a method for field observation which is somewhat different with this method. Basically, all methods are statistically correct. The difference is in how they record the geographic coordinates of the sampling units.

The results show that the raw bands (except b3) have no strong correlation with vegetation cover. This proved the necessity of the use of satellite image processing techniques. Moreover, since the ingredients of rangeland ecosystems such as green cover and cover, soil, rocks and pebbles status have different spectral reflectance status, the necessity of application of image processing techniques is evident.

NDVI vegetation index, which is often used to evaluate vegetation, did not find significant correlation with vegetation cover in this study. Pickup et al. (1993) also reported poor performance of this index in vegetation cover. Among eleven indices studied, TVI vegetation index was introduced as the appropriate index in the regression model. Piro et al. (2004) reported the TVI index as an appropriate index to show the vegetation cover growth.

Of the total data fusion in regression equations, Band 3 (his3) showed the highest correlation. Using data from data fusion is offered by various investigators. Karimi Ashtiani (1999) emphasizes that although fusion by HIS method leads to heterogeneous and spectral changes in original and combined color images, on the other hand, it allows creating separation between the types of vegetation that are not divisible in the normal image.

The results of this study suggest that the use of satellite image and data fusion techniques, which improve images' spatial and spectral data, can enhance the results in the vegetation studies along with statistical analysis.

CONFLICT OF INTEREST

There is no conflict of interest.

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None

REFERENCES

[1] Jabbari S, Khajeddin SJ, Jafari R, Soltani S.[2015] Remote sensing technology for mapping and monitoring vegetation cover (Case study: Semirom-Isfahan, Iran), Pollution, 1(2): 165-174, Spring 165.

[2] Andrés, V, Anatoly AG, Anthony L Nguy, R Yi P.[2011] Comparison of different vegetation indices for the remote assessment of green leaf area index of crops, Remote Sensing of Environment 115 :3468–3478.

[3] Rahdari V, Soffianian A, Khwaja al-Din SJ, Maleki Najaf-Abadi S.[winter 2013] To assess the ability of satellite data in providing maps arid and semi-arid vegetation canopy (Case Study Mouteh Wildlife), Sciences and technology environmental, 15(4).

[4] Hosseini SZ, Khwaja al-Din SJ, Azarnivand H, Farahpour M, Khalilpour SA.[2007] Estimates cover and vegetation cover percentage mapping using satellite images ETM +, Journal of pasture, First year / issue 1 /.

[5] Hosseini SZ, Khwaja al-Din SJ, Azarnivand H, Panchromatic band and fusion techniques capabilities (integration of satellite data) in the assessments Vegetation (Case Study: Chamestan), Proceedings of the Conference's pasture and rangeland of Iran.

[6] Sepehri A, Mottaghi MR. [2002]using vegetation indices of T.M sensor in estimate the percentage of vegetation in pastures protected of Jahannama-Gorgan, Iran Natural Resources Journal, 55(2)

[7] Khwaja al-Din SJ. methods of collection of field data to interpret satellite data, Second National Conference of desertification and different methods of desertification.

[8] Pickup G, VH Chewings, DJ Nelson. [1993] Estimating changes in vegetation cover over time in arid rangelands using landsat MSS data, Remote Sensing Environment, 43: 243-263.

[9] Karimi Ashtiani, Mohsen. [1999] Integration of TM and SPOT images using wavelet transform (Region Tehran), MSc thesis of remote sensing and geographic information systems, Tarbiat Modarres University in Tehran.