Journal of Tourism & Hospitality Research
Islamic Azad University, Garmsar Branch
Vol. 2, No. 1, Summer 2012, Pp. 89-100

Evaluation of IRS1D-LISS-III image in Riparian Forest mapping (Case study: Maroon Tourism Riparian Forest, Behbahan)

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Abstract
Ecotourism could be help to conservation of the environment. Riparian forest of Maroon as a virgin area has ecologically importance and ecotourism development. In order to investigation and comparing the capability of LISS-III data in tourism riparian forest mapping, a small window of panchromatic and multispectral images IRS1D -LISSIII satellite data was selected at the Maroon tourism riparian forests in the Khuzestan province. The quality of the data and the radiometric error, orthorectification of LISS-III imagery was implemented using 9 ground control points and with RMS error 0/39 for X axis and 0/49 for Y axis. Some suitable image processing operations were applied on the main bands such as principal component analysis and appropriate vegetation indexes (NDVI) provide the corporation digital analysis in the classification processes. After selecting the training area were done use the classification Maximum likelihood algorithms. Classified was taken to seven and three user classes. Accuracy assessment for three-class classification showed overall accuracy of 98/80 and kappa coefficient of 0/84 that it was the best result. Based on the results LISS-III data have good ability for mapping and classification of Maroon riparian forest.
***Keyword**: Classification supervised, IRS-1D, Riparian forest, Behbahan*

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Received Date: 31 December 2013 *Accepted Date: 10 March 2014*

Introduction

Ecotourism may be defined as voluntary travels to intact natural areas in order to enjoy the natural attractions as well as to get familiar with the culture of local communities (Delavar *et al,* 2010), so ecotourism is one of the fastest and growing tourism segmentation in the world today and Forest areas are important asset for any country. So Ecotourism development is suitable for recreational forest area, due to its' environmental wellbeing.(Anowar *et al*, 2011). As respects Forest and rivers are ecotourism attraction of Iran and the world (Hasani Mehr and Kohi, 2011, Ahmadi Sani *et al*, 2011). So riparian areas are also important for recreation and tourism. Riparian zones possess an unusually diverse array of species and environmental processes. Riparian zones play essential roles in water and landscape planning, in restoration of aquatic systems, and in catalyzing institutional and social cooperation for these efforts (Naiman & Ecamps, 1997) and it is important for ecotourism.

Satellite remote sensing has become an important tool for monitoring and management of natural resources and the environment (Bahadur, 2009). Using satellite data and remote sensing techniques to decrease time consumption reduce field operations and expenses are getting more popular in natural resource mapping (Sivanpillai et al, 2005, Abdi and Ghaderi, 2005). Satellite data improved monitoring resources and forest mapping with acceptable accuracy in most cases (Abdi and Ghaderi, 2005). Satellite data can play a key role in management for land cover maps and forest resources (Knorn et al, 2009). Maanavi *et al* in 2005 used multi spectral data of IRS-1D satellite for vegetation mapping. The results showed the images have good quality for vegetation mapping. Mohammadi and Sadeghian in 1385 examined IRS-1D data to produce visual maps. Dolati in 2007 studied capability of IRS data for classification in forest density of Tamarix. The research presented that IRS data were reliable for mapping Tamarix in Hossein Abad Qom. Shataei *et al* in 2007 evaluated ability of the multi-spectral data and panchromatic fusion of IRS-1D for mapping forest area in Golestan. According to this study, panchromatic fusion from IRS is more appropriate than multi-spectral data. It has suitable spectral and spatial resolution for mapping. Shayeste *et al* in 2008 mapped land cover Using IRS-1D images in

Esfahan. This study illustrated the potential of IRS-1D data. Armenakis and Savopol in 1998 considered potential of panchromatic IRS images in East Ottawa. Ghosh *et al* in 2007 studied land cover mapping using IRS imagery in Barak Valley region of Assam, India. Capabilities of these images were well evaluated for mapping land use management. Furby and Wu in 2007 assessed IRS data for forest mapping in Australia. According to this study, IRS images have enough resolution for mapping. This study also showed capability of LISSIII as a possible alternative for Landsat images. According to high environmental importance of riparian forest of Maroon, research is necessary for better management. It should also be said, ecotourism potential of Maroon Forest River has been distinguished on the Geographic information System and this area is the perfect location for ecotourism, but there is a lack of recreational facilities (Momenzadeh et al, 2011).

The study mainly focused on the evaluation of the present status of riparian forest mapping in Maroon river in Behbahan, using digital satellite data of IRS-1D, topographic maps and field observations data. The study also tried to evaluate the potential of the IRS-1D, LISS-III data for mapping riparian forest of Maroon river in Behbahan.

Materials and methodes

Study Area

The research was carried out in the Riparian forest of Behbahan of Iran. The study area is located between latitude 32° to 35 N and longitude 41° to 44° E, which covers about 16998 hectares (Fig 1). The climate in the study area is classified as semi dry and dries (Riazi, 2012). This forest included species of *Tamarix arceuthoides, Populus euphratica and Lycium Shawii*. The area due to ecological features and biodiversity of flora and fauna is the perfect location for ecotourism (Momenzadeh *et al*, 2011).

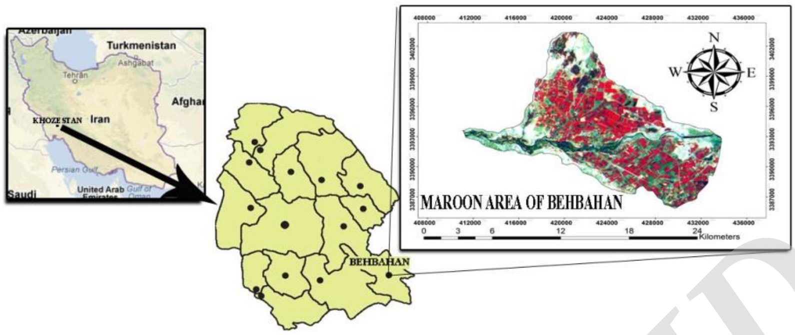


Fig1. The location of study area in Khozestan province of Iran

Data Sources

Data in this study are composed of digital topographic maps at the scale of 1:25000 and IRS-1D satellite data to pathe 68 and row 49 from 11th Octobre 2005(from Iranian Space Agency) were used to generate land cover map.

Spatial resolution of LISSIII bands are 23/5 meter and a panchromatic band is 5/8 meter (Oladi, 2008, Mobasheri, 2010).

Geometric Correction

The images were geometrically corrected via a Polynomial Model using ETM+ images which were geometrically corrected by an image-to-image method. To do this, 9 points were selected on the IRS-1D image with their corresponding points determined on ETM+ image. Root Mean Square Error (RMSE) of control points was equal to 0/39 pixel along X axis and 0/49 pixel along Y axis.

Ground Control Points

To evaluate the classification accuracy, 40 ground control points in the study area were identified as check points collected using a Global Positioning System (GPS).

Satellite image processing

Processes such as principal component analysis (PCA), and data integration were performed on the original image bands. the synthetic bands was performed using classification(Parma *et al*.2009, Alavi panah,2003.2009). First components resulted from PCA had the highest variance of spectral information; therefore, they were added to dataset. In order to obtain a high spectral and spatial resolution image, LISSIII image and panchormatic image were merged using an Pansharp(Gram-Schmidt Spectral Sharpen)(Latifi *et al*,2007) and HSV method. Then all bands of color image fused with IRS-ID panchromatic image, and their pixel size changed to 5.8 m×5.8m.

Vegetation Index

Normalized difference vegetation index (NDVI) were measured for better vegetation cover detection. Due to sparse stand tree coverage in the study area, there is interference between the spectral reflectance of soil and plant cover. This index to enhance reflectivity of vegetation spectral reflectance and reduced the soil effects on vegetation (Mobasheri, 2010).This research for mapping NDVI were used multi-spectral bands 1 and 2.

Separability of Classes

In this study, for class separation (three and seven classes) used Jeffreys–Matusita distance (JM). The JM distance increasing class separation like transformed divergence. This method improves classification accuracies. Characteristic of JM method allow for easier comparison of class separability between images (Laliberte *et al*, 2012, Gong *et al, 1996*).

Classification

For image classification were chosen Ground control points. Training areas were selected within the area of determined polygons. Data classification was done using Maximum Likelihood Algorithm. The study area classified in to 3 and 7 classes. To improve classification applied a mode filters (3×3, 3×5 and 7×7) (Naseri et al, 2004, Bahadur,2009). Four standards of overall accuracy, kappa coefficient, producer accuracy and user accuracy were employed to evaluate the classification (Congalton and Green, 1999).

Results

Processing

This classification was applied for original bands, fused images, vegetation indices and the first Principal Component Analysis (PCA) combined with original bands using a Maximum Likelihood Method.

For classifications with seven and three classes were selected 6 bands from 12 bands collection Original and synthetic. Table 1 showed the best of the band for classifications.

	Original bands		Selected bands		Fusion bands (Pansharp)	
	Producer accuracy	User accuracy	Producer accuracy	User accuracy	Producer accuracy	User accuracy
forest	98/02	84/93	93/75	93/75	98/56	99/73
agriculture	99/15	100	96/61	98/79	99/29	96/77
fallow	80	68/57	93/37	84/03	63/96	97/55
pasturage	81/16	96/55	90/89	97/29	88	94/07
settlements	50/01	26/59	25	10	52/50	21/05
river	94/25	97/62	93/33	99/99	98/98	98/96
road	50	62/34	76/62	59/30	85/37	65/23
overall accuracy	88/50		87/79		90/73	
kappa coefficient	0/84		0/88		0/63	

Table1. Bands collection for 7 and 3 classes

Bond - prepared	NDVI, PCA1,2,3, LissIII1,2,3, Pansharp, HSV1,2,3, PAN
Bond - Selected	PAN, LissIII1,2,3, Pansharp

Seven and three Classes Classification

Seven land use classes were discriminated based on spectral characteristics of satellite images. These included: forest, agriculture, pasturage, fallow, settlements, river and road. Also for the differentiation forests of other regions, 5 users of agriculture, pasturage, fallow, settlements and road were merged and classification was performed by 3 users (forest, river and other regions). This classification was carried out for original band, bands of fusion and selected band. For post classification was used majority filter in ENVI. The image classification accuracy was further assessed by calculating the overall accuracy and kappa coefficient. Result of confusion matrix gave a highest overall accuracy of 98/80 and calculation of highest kappa coefficient gave 0/84 accuracy from bands merge with 3 classes. A brief result of confusion matrix has been shown in tables 2 and 3 .Percent of land use area has been showed in fig2.

Table 2.The results of confusion matrix for 7 classes by using the maximum likelihood algorithm

Table 3.The results of confusion matrix for 3 classes by using the maximum likelihood algorithm

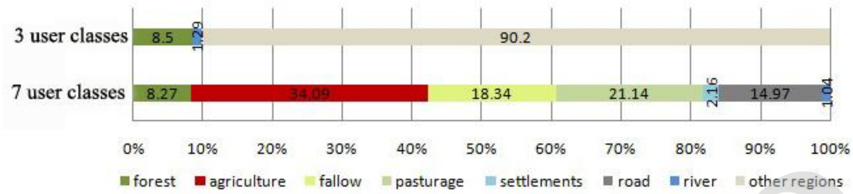


Fig 2. Percent of land use area with 3 and 7 user classes According to Table 3, the highest overall accuracy and producer and user accuracy is related to fusion bands. Also overall accuracy improved in classified with 3 classes. Land use map of fusion bands (Pansharp) is shown in Figs 3 and 4, in addition area statistics of such land use classes is given in table4.

Table 4. The land use area of Fusion bands (Pansharp) in LissIII

Original bands	Selected bands		Fusion bands (Pansharp)			
Producer accuracy	User accuracy	Producer accuracy	User accuracy	Producer accuracy	User accuracy	
forest	96/55	62/71	93/75	51/79	97/62	51/1
river	96/55	95/45	80	85/71	98/81	99/99
Other regions	92/63	99/92	98/55	99/98	100	98/01
overall accuracy	94/01		90/53		98/80	
kappa coefficient	0/74		0/15		0/84	

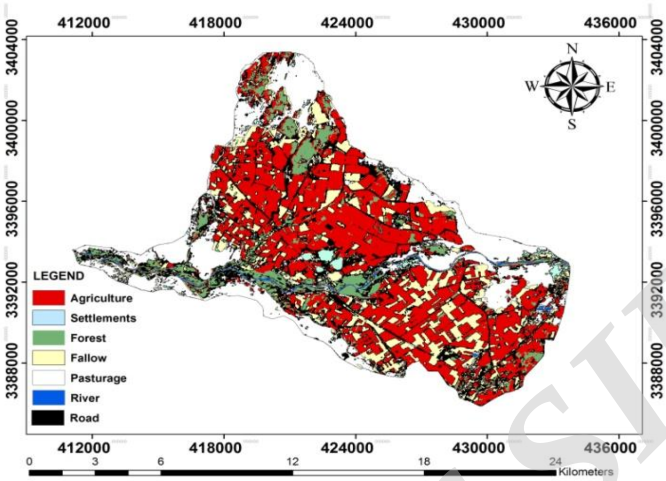
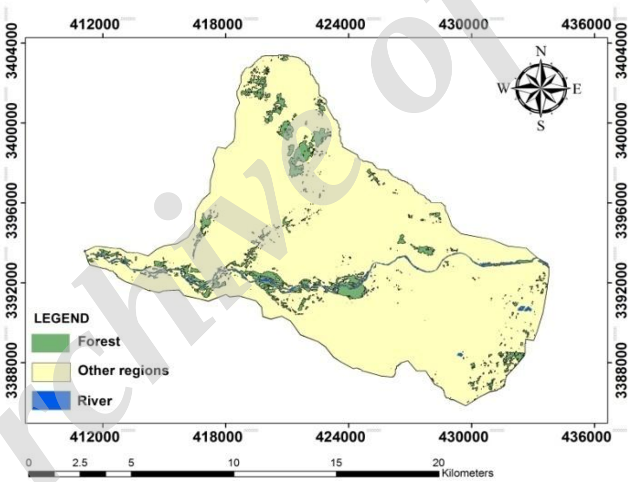


Fig3. Mapping with 7 classes of users in the fusion bands



fusion bands Fig4. Mapping with 3 classes of users in the

Discussion and Conclusions

For forest management should be considered ecological characteristics of landscape the same as land cover/ land use data. It can easily be obtained from remote sensing data classification (Darvishsefat *et al*, 2011). Land cover/land use maps can be used in the detection of climate change because that vegetation cover affects climate and weather conditions (Fisher *et al*, 2005). The aim of this study was mapping of riparian tourism forest Maroon by LissIII sensor. For this purpose, necessary processing was performed.

In this research, such as studies Zarine *et al* (2012), Dolati(2007), Abdi and Ghaderi(2005), Farzadmehr *et al*(2005) and Kuhnell(1996), NDVI index was appropriate for Estimation of vegetation. This result is contrary to studies Goulevitch et al(2002), Fatahi et al(2007), Shirazi et al(2010) and Günlü et al(2008). Also, against of research Rashidi, visual interpretations of satellite data by merge operation improved in this study. The higher classification accuracy of fusion band (Pansharp) than other categories, represents is appropriate accordance with ground truth map. These results are such as assessment of Parma (2009), Latifi et al (2007) and Shataei et al (2007).

From the reasons for this can be cited spectral and spatial value changes and enhance the spectral value. After the image classified by fusion method (Pansharp), the original bands classified have highest accuracy than the selected bands. Images of the original bands are better ability to than Images of selected bands to produce detailed maps. Such as studies Hosseini *et al* (2004), Latifi(2005) and Dolati(2007), classification with 3 classes showed higher accuracy.

This can be due to the combined user that Causes the spectral interference in each other's classes and will be result in unsuitable separability as pasture and fallow and also settlements and border of river so the pixels are classified incorrect. As a result, after merging the classes, was improved overall accuracy, but was obtained the map with fewer details. As was noted, when the number of classes increased, accuracy and Kappa coefficient was reduced that it can be because pixel separability and spectral resolution sensors, however, map was obtained more detailed.

Since the area has a scattered forest and density coverage, are caused Spectral interferences soils and covered areas. As same as abdolahi and shataei (2012) studies, stand scattered of Forest be effective the spectral interference of Forest and non- forest and this will reduce the overall accuracy and Kappa coefficient.

Based on the results, using LISS III data is appropriate for producing mapping of Maroon riparian forest by maximum likelihood classifier. In order to increase the classification accuracy, using the fusion bands methods like pansharp method and different method of merge bands are suggested. Hopefully, this produced land use / land cover map is helpful for management and planning in the riparian tourism forest of Maroon Behbahan in Khozestan province and perhaps be useful for the sustainable ecotourism organizing in the riparian forest of this area.

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