STUDYING THE POSSIBILITY OF THE USE OF LANDSAT SATELLITE IMAGERY IN SEPARATING *Fagus orientalis* & *Carpinus betulus* MIXTURE IN THE NORTH FORESTS OF IRAN

(CASE STUDY OF THE CHOA JIEH FOREST)

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Commission PS, WG VII / 3

KEYWORDS: Remote sensing, Landsat, forestry, Satellite, Thematic, Imagery

ABSTRACT:

In recent years satellite knowledge and technology of remote sensing have had many improvements. Using of satellite imagery is developing in different land studies every day. Earth resources technology satellites supply digital imagery from trees and other objects based on their spectral reflections. Hence we want to study the possibility of separating different percentages of *Fagus orientalis* and *Carpinus betulus* mixture based on their spectral reflections.
In this study, landsat-7 Enhanced Thematic Mapper plus (ETM^+) digital imagery (24 Jun 2000, middle of growth season) of the study area were acquired. At first, typology map of the study area was prepared, then, sample plots were selected randomly-systematic in three areas with the mixture of *Fagus orientalis* and *Carpinus betulus*, on the map of 1:25000 scale. After field surveying, four groups of mixture have been determined, that include: first group (pure composition of *Fagus orientalis*), second group (mixture of 80% *Fagus orientalis*, 20% *Carpinus betulus* and others), third group (mixture of 70% *Fagus orientalis*, 30% *Carpinus betulus* and others), fourth group (mixture of 60% *Fagus orientalis*, 40% *Carpinus betulus* and others). Roads of the study area and sample plots were digitized and the images were geometrically corrected (RMSE=0.703). The digitized roads and sample plots were overlaid on the ETM^+ bands 1, 2, 3, 4, 5 and 7. All of the digital numbers (DNs) of sample plots were extracted. Differences among groups were analyzed using t-test. The results showed that the ETM^+ imagery (middle of growth season) could separate pure composition of *Fagus orientalis* from the mixture of 70% *Fagus orientalis*, 30% *Carpinus betulus* and others and lower percentages.

1. INTRODUCTION

In recent years new satellite information technology of remote sensing had a considerable improvement in using satellite information in different land studies. Earth resources technology satellites supply digital imagery from trees and other objects based on their spectral reflections. Hence we want to study the possibility of separating different percentages of *Fagus orientalis* and *Carpinus betulus* mixtures based on their spectral reflections.
There is a mixture of *Fagus orientalis* and *Carpinus betulus* in an extensive area in the northern forests of IRAN. *Carpinus betulus* is a light demanding species, and after harvesting or clear-cutting in forest, it quickly grows and dominates other young trees. If we do not pay attention to thining of the forest, *Carpinus betulus* will grow quickly and occupy the *Fagus orientalis* sites and won't let them grow normally. To remedy this problem, foresters must support the growth of *Fagus orientalis* and prevent *Carpinus betulus* growth, with their proper action (Tabatabaii 1973). To understand domination of the *Carpinus betulus* in *Fagus orientalis* sites, in the extensive forest areas, providing typology map of forest and forest inventory is essential. Since typology maps of forest are necessary for accurate planning and managing forest, it is hoped that the findings of this research could be used in recognizing and providing typology maps of forest trees.

2. MATERIALS AND METHODS

The aim of this investigation is to study the possibility of separating different percentages of *Fagus orientalis* and *Carpinus betulus* mixtures in the northern forests of IRAN based on their spectral reflections. The study area is a portion of Asalem forest in Guilan province that provides adequate area of different mixtures of *Fagus orientalis* and *Carpinus betulus*. It is between 48°, 45` to 48°, 53` longitude and 37°, 34` to 37°, 39` latitude. Coordinates of the area based on UTM maps are 307000-310000 E and 4165000-4168000 N.
Landsat-7 Enhanced thematic mapper plus (ETM^+) digital imagery (24 Jun 2000, middle of growth season) of study area were acquired. The ETM^+ instrument is an eight-band multispectral scanning radiometer capable of providing high-resolution information of the Earth's surface which its nominal ground sample distances or "pixel" size is 30 meters in the visible, near and short-wave infrared bands. To acquire ground data at the study area, at first, compartments containing different mixtures of *Fagus orientalis* and *Carpinus betulus* were selected. Then, sample plots were chosen on the map of 1:25000 scale (prepared from aerial photos of 1994) applying randomly systematic method.
The size of ground plots in applying remotely-sensed data in forestry study is normally one hectare (Oladi 1997). Therefore, plots size were considered 100m × 100m (1 hectare) which is 3 pixels × 3 pixels (9 pixels) on the satellite imagery. The intervals between the plots were chosen 90 meters from each other on the ground (3 pixels on the satellite imagery). In total 37 plots were selected. Plots were chosen on three areas on the ground with regard to the availability of different mixtures of *Fagus orientalis* and *Carpinus betulus*. Distance and azimuth of first plot were calculated in relation to one control point (i.e., sharp bend of road). In order to get as much accuracy as possible slop correction were made in the study area. Diameters

at breast height (d.b.h) and canopy closure of the trees were measured in each plot. Thereafter, percentages of different mixture of the all tree types, in the plots, were calculated and classified in four groups. It is worthwhile to mention that after obtaining ground data and measuring different mixtures percentages, 9 plots were excluded from total of plots due to crown closure of less than 60% or domination of other species than *Fagus orientalis* and *Carpinus betulus*.

Four groups of mixtures have been obtained encompassing: I) pure composition of *Fagus orientalis*, II) 80% *Fagus orientalis*, 20% *Carpinus betulus* and others, III) 70% *Fagus orientalis*, 30% *Carpinus betulus* and others, and IV) 60% *Fagus orientalis*, 40% *Carpinus betulus* and others. Each group includes 7 plots and in total 28 plots were selected.

The ETM^+ imagery was geometrically corrected using 1:25000 maps with RMSE = 0.703. Roads of the study area and sample plots were digitized. The digitized roads and sample plots were overlaid on the ETM^+ bands 1, 2, 3, 4, 5 and 7. Then, all of the digital numbers (DNs) of sample plots were extracted (figure 1).

3. RESULTS

After extracting the DNs of the plots, average of their DNs were calculated for all bands (except band 6, table 1). From table 1, it is obvious that there is disorder among the means of plots in bands, 1, 2, 3 and 4. Therefore, they cannot be separated. This is due to the narrow dynamic range of DNs in bands 1,2, and 3.This narrow range of DNs reflects plants′ efficient absorption of the ultra-violate and the visible region of the spectrum for the energy required for photosynthesis. Chlorophyll absorbs approximately 80 to 90% of the incident energy in the visible part of the spectrum (0.4 to 0.7 µm, band 1, 2 and 3). Although band 4 represented a wider DNs range than bands 1, 2, and 3, this band showed lower sensitivity to different mixture of *Fagus orientalis* and *Carpinus betulus* than bands 1, 2, and 3. Result of this study is similar to the finding of other researchers (Spanner et al. 1990 and Oladi 1997).

Table 1, revealed that there is differences among all groups in band 5, except between third and fourth groups. Result of band7

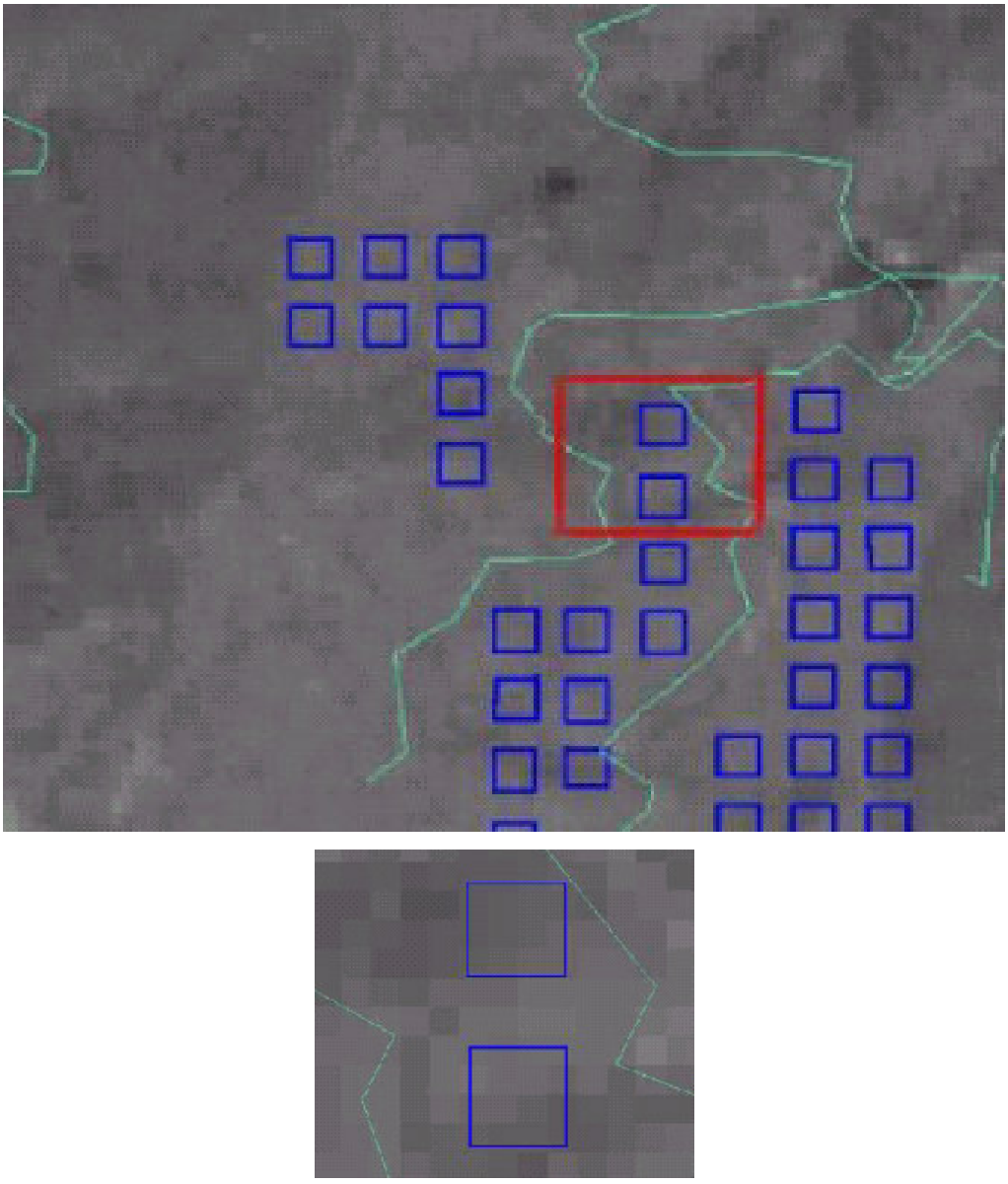

Figure 1. Image of ETM^+ bands 5 with roads and digitized sample plots

Number of groups	Number of plots	$\bar{x}$ (Average of DNs)					
		b1	b2	b3	b4	b5	b6
First group	12	72.7778	58.0000	44.7778	117.8889	101.6667	48.6667
	24	71.4444	57.4444	43.7778	121.1111	103.1111	48.3333
	25	72.1111	57.4444	44.4444	124.4444	100.1111	45.7778
	27	73.0000	56.6667	43.3333	122.0000	101.3333	46.6667
	28	72.3333	56.2222	42.2222	122.0000	94.7778	43.1111
	32	72.5556	55.3333	42.6667	118.6667	92.3333	42.1111
	33	73.6667	56.2222	42.6667	125.4444	97.7778	43.2222
Second group	3	73.3333	59.7778	45.3333	131.8889	107.1111	49.1111
	7	72.6667	59.8889	45.4444	126.7778	106.7778	50.7778
	13	72.2222	59.8889	46.3333	116.3333	105.1111	51.6667
	17	72.2222	59.7778	43.8889	123.5556	106.7778	50.7778
	21	73.1111	57.7778	44.6667	125.3333	105.6667	48.5556
	22	72.1111	56.7778	43.0000	118.5556	106.4444	46.1111
	23	73.3333	57.8889	42.4444	122.2222	104.1111	47.2222
Third group	4	74.2222	61.5556	46.2222	133.8889	112.6667	51.7778
	5	73.1111	60.2222	44.0000	124.4444	108.7778	50.4444
	8	74.2222	61.5556	46.1111	134.8889	112.0000	51.5556
	10	73.8889	60.3333	44.7778	132.4444	114.1111	53.6667
	19	72.1111	59.5556	45.2222	123.3333	109.4444	52.4444
	20	72.3333	59.8889	45.7778	123.1111	107.5556	50.0000
	29	74.3333	61.0000	40.8889	135.3333	111.8889	51.0000
Fourth group	1	74.4444	62.1111	45.8889	133.6667	113.4444	51.5556
	9	74.2222	61.2222	47.1111	129.5556	109.0000	50.3333
	14	74.1111	58.8889	45.0000	132.7778	110.8889	50.7778
	16	72.2222	59.7778	43.7778	123.5556	107.8889	50.3333
	18	72.6667	60.8889	45.1111	130.1111	113.1111	53.4444
	26	73.7778	61.5556	45.7778	137.0000	114.1111	51.7778
	30	75.0000	61.5556	47.4444	133.7778	111.7778	50.2222

Table 1. Average of DNs in relation to ETM^+ data of 24 Jun 2000.

analyses showed that there is difference between first group with third and fourth groups. This band, also, revealed that there is interference among all other groups. Moreover, average DNs increases in band 5 and 7 from group 1 to 4, especially in band 5. Therefore, the minimum DNs are related to the first group and the maximum DNs are related to the third and fourth groups. The reason for minimum DNs of first group than other groups is due to different spectral reflectance of *Fagus orientalis* and *Carpinus betulus* tree leaves. Based on empirical experience of experts, leaves of *Fagus orientalis* and *Carpinus betulus* trees of study area in accordance to date of imagery acquisition (July), color of *Fagus orientalis* leaves is darker than that of *Carpinus betulus* trees. Canopy crown of *Fagus orientalis* seems much darker than *Carpinus betulus* canopy crowns; therefore, spectral reflectance of *Fagus orientalis* is less than that of *Carpinus betulus*.

To compare the averages of four different mixture groups in band 5 and 7, statistical analyses were applied using T-test.

4. CONCLUSION

Statistical analyses of this study showed that in band 5, there is a significant difference at level 95 and 99% probability between means of third group (mixture of 70% *Fagus orientalis*, 30% *Carpinus betulus* and others) with first group (pure composition of *Fagus orientalis*) and between means of fourth group (mixture of 60% *Fagus orientalis*, 40% *Carpinus betulus* and others) with first group, but in other comparisons between means in bands 5 and 7, some of comparisons are not significant and some of them are significant. Therefore, it shows the ability of band 5 in separating different mixtures of all aforementioned groups. It means that ETM^+ band 5 is able to separate pure composition of *Fagus orientalis* from: i) mixture of 70% *Fagus orientalis*, 30% *Carpinus betulus* and others ii) mixture of 60% *Fagus orientalis*, 40% *Carpinus betulus* and others in middle of growth season, however, it is not able to completely separate pure composition of *Fagus orientalis* from the mixture of 80% *Fagus orientalis*, 20% *Carpinus betulus* and others and other groups from each other. Result of ETM^+ band 7 analyses showed that this band is not able to significantly separate all means different groups. It proves that the ability of separating different mixtures in this band is lower than band 5. Many studies have shown that Landsat satellite data has relatively good ability in separating and inventorying of different forest species. Oladi (1988) used Landsat Multi Spectral Scanner (MSS) to separate pure forests of two species of Beech and Oak with 80% accuracy from each other. Poso et al. (1987) could provide a method of forest inventory for pine and broad leaves trees using Landsat-MSS and TM imagery. According to a study of Baker (1992) Landsat-TM imagery is able to provide very good information about invading plants into the plantations. Result of this study shows a relatively good ability

of Landsat- ETM^+ imagery in separating mixture of two species of *Fagus orientalis* and *Carpinus betulus* from each other.

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