ISFOR 2017 International Symposium on New Horizons in Forestry
18-20 October 2017 | Isparta - Turkey

Oral presentation

Evaluation of different supervised classification algorithms for crown closure classes: A case study of Yapraklı Forest Planning Unit, Çankırı

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Abstract: Remote sensing and Geographic Information Systems (GIS) provide novel occasions for forest inventory and ecosystem values. Forest inventory has been made by field measurements and remote sensing methods. Field measurements are mostly expensive, cumbersome and time-consuming. Recently, satellite images have been used successfully for large area applications, such as for national forest inventories. The use of satellite images has played significant role in determining forest stand attributes such as crown closures, development stages and land use. However, remote sensing methods have been used to estimate and monitor forest stand parameters with reasonable accuracy levels in large areas. Remote sensing technologies have been successfully used in carrying out of forest inventories and have played a vital role in estimation of forest stand parameters at a low cost and plausible effort with adequate accuracy. There are many algorithms that can be used to classify satellite images. Support vector machines (SVM), highest probability, maximum likelihood (MLC), closest distance, classifier of Mahalanobis, artificial neural networks and decision trees are some of them. The objective of this research was to classify crown closure classes using Landsat TM satellite image with different supervised classification algorithms in Yapraklı Forest Planning Unit. For this purpose, the MLC method and linear, polynomial, radial and sigmoid kernel functions for SVM were used. The SVM method radial function and the MLC gave better results than others did. The result showed that the MLC was estimated with a 0.6002 kappa statistic and 72% overall accuracy assessments, respectively. The SVM radial function for these values was 0.6797 and 80%.
Keywords: Crown closure, Image classification, Landsat TM, Maximum likelihood classification, Support vector machine

1. Introduction

Remote sensing are being investigated in almost every aspect and are being continuously improved especially in the field of forestry. One of the remote sensing techniques researched and developed in forestry is satellite image classification. Some of these techniques such as maximum likelihood, support vector machines, neural network, decision trees are widely used to different criteria such as development stage, crown closure, tree species, land use. Moreover, new techniques are always being investigated for image classification and evaluated for maximum accuracy and ease of use (Günlü et al., 2008; Kavzoğlu and Çölkesen, 2010; Otukei and Blasckhe, 2010; Günlü et al., 2011; Srivastava et al., 2012; Günlü, 2012; Taati et al., 2014; Bulut and Günlü, 2016). We focused on estimating crown closure with remote sensing techniques.

Crown closure is an indicator for productivity of forests. Especially, it is an effective parameter to decide on silvicultural applications. Remote sensing studies are used effectively in estimating this parameter. In this study, we compared performance of image classification techniques (maximum likelihood, SVM linear, SVM polynomial, SVM radial and SVM sigmoid kernel functions) in terms of crown closure.

2. Material and method

2.1. Study area

Our study area, Yapraklı Forest Planning Unit is located in Ankara Regional Forest Directorate with a total area of 29380.30 ha (Figure 1). It is bounded by 563243-572062 on the east longitudes and 4501061-4522167 on the North latitudes (ED 1950, UTM Zone 36N). Average altitude, precipitation and temperature of study area are 1348 m, 397.7 mm and 11.1 C°, respectively. The study area is covered by trees that include Black pine, Scots pine, Fir, Cedar, Oak and Poplar (Table 1).

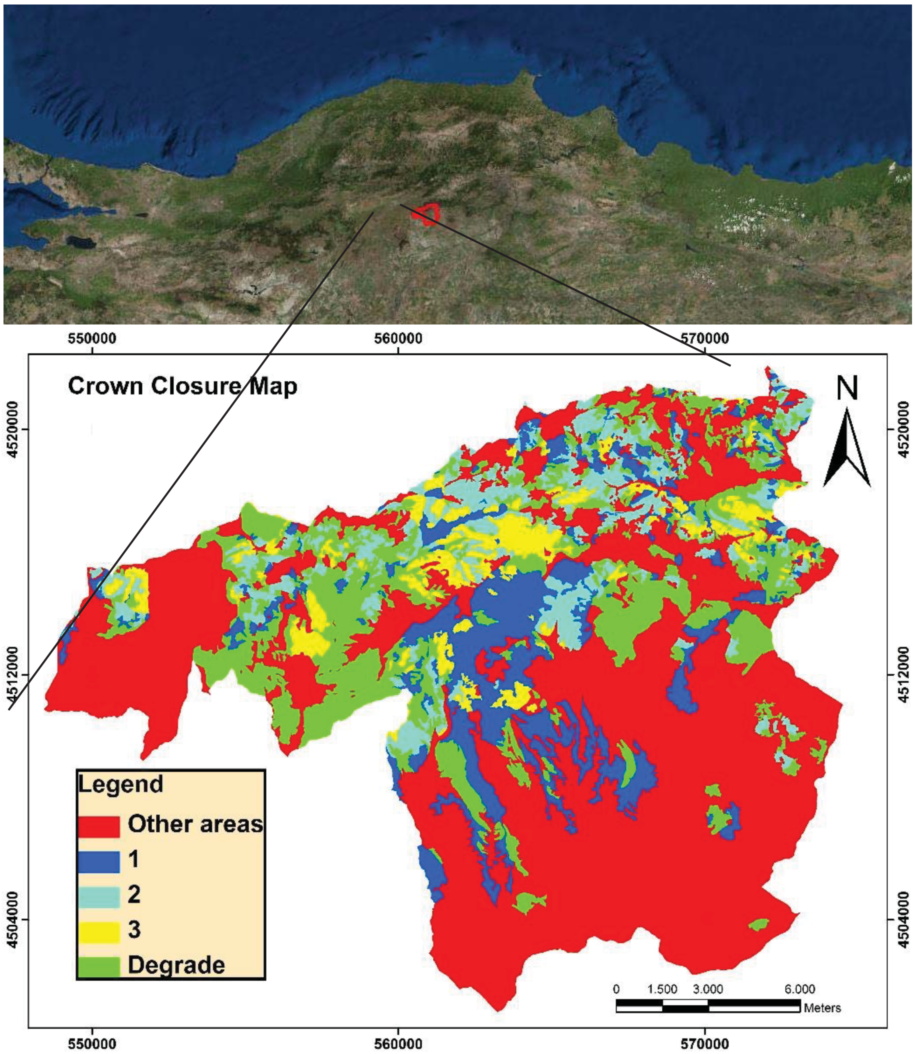

Figure 1. Study area

2.2. Satellite image and classification

The Landsat TM satellite image, which was consisted of six spectral bands (TM1, TM2, TM3, TM4, TM5 and TM7) with 30 m spatial resolution, was acquired on 2010. Stand map of Yapraklı Forest Planning Unit was used as reference data. Supervised classification methods that maximum likelihood, SVM linear, SVM polynomial, SVM radial and SVM sigmoid were applicated with ENVI 5.2 software. Five different crown closure classes were created. These classes are 1 (%11-40), 2 (%41-70), 3 (%71-100), degrade (%0-10) and other areas (settlement, agriculture). Signatures for each classes were taken through stand map and five different supervised classification methods were tested for crown closure. The most accurate parameters for SVM methods were found through trial and error (Table 1).

Table 1. SVM classification parameters

Methods	p	g	r	d
SVM Linear	200			
SVM Radial	1000	0.150		
SVM Polynomial	1000	0.150	1	6
SVM Sigmoid	100	0.150	1	

p: penalty parameter, g: gamma, r: bias and d: degree of kernel polynomial

3. Results and discussion

The most accurate classification was applicated with SVM radial method. It’s kappa statistics value was 0.6797 and overall accuracy was 79.6704 %. The lowest result was obtained for SVM sigmoid method. Kappa statistics and overall accuracy of this method were 0.5577 and 72.3290%, respectively. Performance criteria and confusion matrix of all methods were represented (Table 2-7).

Table 2. Performance of supervised classification methods

Classification method	Kappa statistics	Overall accuracy (%)
Maximum likelihood	0.6002	72.1903
SVM linear	0.5933	74.4955
SVM polynomial	0.6792	79.6241
SVM radial	0.6797	79.6704
SVM sigmoid	0.5577	72.3290

Table 3. Confusion matrix of maximum likelihood method

Class	Other areas	Degrade	1	2	3	PA (%)	UA (%)
Other areas	4500	71	94	8	2	76.40	96.26
Degrade	435	1162	94	74	9	63.22	65.50
1	896	353	809	114	18	63.95	36.94
2	59	243	229	572	92	61.31	47.87
3	0	9	39	165	755	86.19	78.00

Table 4. Confusion matrix of SVM linear method

Class	Other areas	Degrade	1	2	3	PA (%)	UA (%)
Other areas	5454	540	325	36	2	92.60	85.80
Degrade	313	961	382	173	25	52.29	51.83
1	118	212	425	105	29	33.60	47.81
2	5	114	122	495	108	53.05	58.65
3	0	11	11	124	712	81.28	82.98

Table 5. Confusion matrix of SVM polynomial method

Class	Other areas	Degrade	1	2	3	PA (%)	UA (%)
Other areas	5475	339	318	22	2	92.95	88.94
Degrade	269	1191	163	140	8	64.80	67.25
1	144	234	685	163	46	54.15	53.85
2	2	73	92	548	118	58.74	65.79
3	0	1	7	60	702	80.14	91.17

Table 6. Confusion matrix of SVM radial method

Class	Other areas	Degrade	1	2	3	PA (%)	UA (%)
Other areas	5505	337	309	24	1	93.46	89.14
Degrade	241	1162	158	130	8	63.22	68.39
1	142	257	695	161	48	54.94	53.34
2	2	81	97	553	128	59.27	64.23
3	0	1	6	65	691	78.88	90.56

Table 7. Confusion matrix of SVM sigmoid method

Class	Other areas	Degrade	1	2	3	PA (%)	UA (%)
Other areas	5416	643	285	46	1	91.95	84.74
Degrade	349	867	463	186	27	47.17	45.82
1	125	195	373	98	16	29.49	46.22
2	0	125	139	456	131	48.87	53.58
3	0	8	5	147	701	80.02	81.42

All classification methods have generally low accuracy for classification of degrade, 1 and 2 crown closure classes. The reason for this, reflectance values of these classes were close to each other in training areas. So, classification methods were not distinguished correctly. The highest accuracy rate was obtained for other areas and 3 crown closure classes. The most accurate methods in terms of producer accuracy were SVM radial (other areas), SVM polynomial (degrade) and maximum likelihood (1,2 and 3 crown closure). The most accurate methods in terms of user accuracy were maximum likelihood (other areas), SVM radial (degrade) and SVM polynomial (1, 2 and 3 crown closure). In addition that all classification maps were displayed (Figure 2).

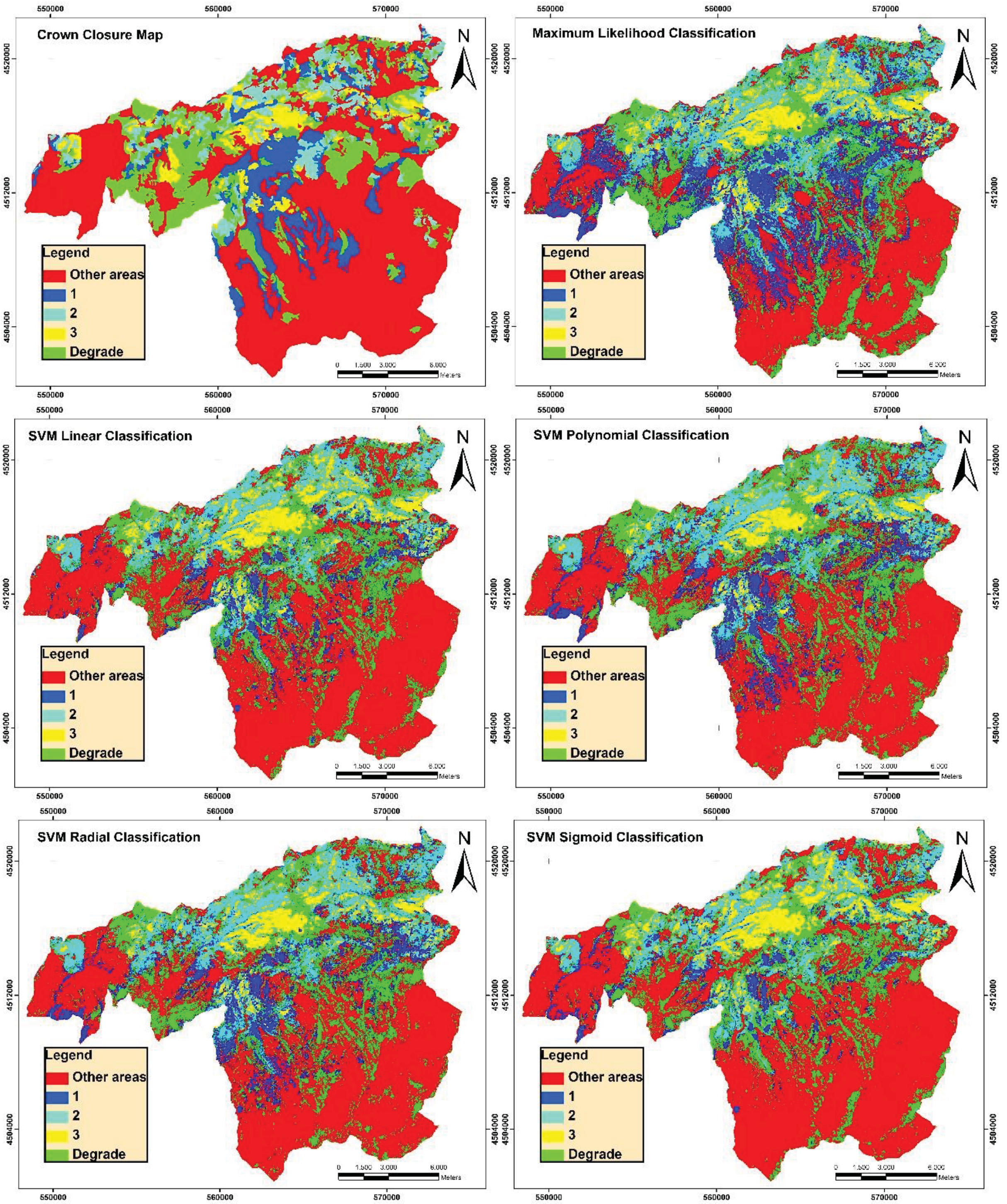

Figure 2. Stand and classification maps

4. Conclusions

In this study, maximum likelihood, SVM linear, SVM polynomial, SVM radial and SVM sigmoid supervised classification methods were compared in terms of crown closure. Landsat TM satellite image was used for classification. Although the most accurate method was SVM radial according to accuracy rate, maximum likelihood, which is the most common classification method, is more suitable for ease of use. In conclusion, it should be applied to different satellite images, fields and parameters so that better comparison of methods can be made.

References

Bulut, S., Günlü, A., 2016. Arazi kullanım sınıfları için farklı kontrollü sınıflandırma algoritmalarının karşılaştırılması. Kastamonu Üniversitesi, Orman Fakültesi Dergisi, 16(2):528-535.

Günlü, A., Sivrikaya, F., Başkent, E.Z., Keleş, S., Çakır, G., Kadıoğullari, A.İ., 2008. Estimation of stand type parameters and land cover using Landsat-7 ETM image: a case study from Turkey, Sensors 2008, 8, 2509-2525.

Günlü, A., Keleş, S., Kadıoğullari, A.İ., Başkent, E.Z., 2011. Landsat 7 ETM+ uydu görüntüsü yardimiyla arazi kullanimi, meşcere gelişim çaği ve meşcere kapaliliğin tahmin edilmesi; Kastamonu-Kızılcasu İşletme Şefliği örneği. I. Ulusal Akdeniz Orman ve Çevre Sempozyumu (26-28 Ekim 2011), 660-667, Kahramanmaraş, Türkiye.

Günlü, A., 2012. Landsat TM uydu görüntüsü yardımıyla bazı meşcere parametreleri (gelişim çağı ve kapalılık) ve arazi kullanım sınıflarının belirlenmesi. Kastamonu Üniversitesi, Orman Fakültesi Dergisi, 12(1):71-79.

Kavzoğlu, T., Çölkesen, İ., 2010. Destek vektör makineleri ile uydu görüntülerinin sınıflandırılmasında kernel fonksiyonlarının etkilerinin incelenmesi. Harita Dergisi, Temmuz 2010, 144:73-82.

Otukei, J., Blaschke, T., 2010. Land cover change assessment using decision trees, support vector machines and maximum likelihood classification algorithms. Int J Appl Earth Obs Geoinf 12:S27–S31.

Srivastava, P.K., Han, D., Rico-Ramirez, M.A., Bray, M., Islam, T., 2012. Selection of classification techniques for land use/land cover change investigation. Adv Space Res 50(9):1250–1265.

Taati, A., Sarmadian, F., Mousavi, A., Pour, C.T.H., Shahir, A.H.E., 2014. Land use classification using support vector machine and maximum likelihood algorithms by Landsat 5 TM images. Walailak Journal of Science and Technology, 12(8): 681-687.