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Land cover classification using various remote sensing datasets with PlanetScope SuperDove Data in GEE

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Abstract

Planet operates the Earth observation satellites PlanetScope (PS) and SkySat (SS). The PlanetScope satellite constellation consists of multiple launches of groups of satellites. Consisting of approximately 130 satellites, PlanetScope is capable of examining the entire Earth's surface every day. The aim of this study is to investigate the effect of Green I (b3 band 513-549nm) and Yellow (b5 band 600-680nm) bands of PlanetScope PSB.SD sensor on different land cover classes. In addition, the interaction of these bands with various index-based algorithms calculated from Sentinel-2 satellite images was examined. The results showed that different datasets had different overall accuracies. This study was carried out with the Google Earth Engine (GEE), a cloud computing platform with a very comprehensive database of remote sensor data and satellite images designed for the analysis of geographic data. By comparing the data sets, the effect of the GreenI and Yellow bands of the Planetscope Superdove (PSB.SD) sensors in two different study areas, Karataş and Doğubeyazıt districts, also shows in different classes. As a result, a highly accurate land cover classification was established in the study areas. The results can be critical in choosing bands and indexes depending on the study area and class type decided in a land cover classification.

1. Introduction

With the commercial use of remote sensing satellites, the increase in the number of satellite systems launched for various purposes, and the general vision capabilities of satellites and the technological development of sensor systems, satellite images are used effectively in many application areas. Working on these data requires a long time and money. However, in recent years, remote sensing data processing has moved from traditional methods to cloud-based platforms. Among these systems, Google Earth Engine (GEE) is a cloud-based geospatial analytics platform that allows users to highly effectively solve key challenges of managing, storing, processing and analyzing huge volumes of data. The creation of land use/land cover (LULC) maps that show how the land is used for various human purposes or the physical features of the earth's surface is a remote sensing challange. The partnership between Google and Norway's International Climate and Forests Initiative (NICFI) has led to the addition of NICFI PlanetScope Basemaps (more than 700 geospatial high-resolution, 4.77 m, datasets) to GEE's public data catalogue. The availability of PlanetScope (PL) data at GEE is an important step forward for detecting and monitoring LULC dynamics in high resolution, including small-scale distortions in tropical landscapes. In land cover classification, machine learning techniques give better results than standard classifiers. Machine learning classifiers include RandomForest (RF); It is one of the most effective, accurate and widely used classifiers. RF for remote sensing data classifier is the most widely used machine learning method in the context of GEE. As remote sensing satellites have different spectral resolution, the comparison of the results obtained from different bands can be of great benefit for different studies. The innovative PlanetScope SuperDove (PSB.SD) collects data in the green and yellow regions of the electromagnetic spectrum, making a uniqe set of data. The aim of this study is to evaluate the accuracy advantages of combining the Green-I (b3 band) and Yellow (b5 band) bands in the 8-band satellite image of PSB.SD with variouse indexes while examining the accuracy of the LULC classification. With this methodology, the success of various datasets for multiple classes was investigated.

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2. Method

2.1. Study araea

Karataş district of Adana province was determined as the first study area (144.208 km[2]). Karataş was established within the natural borders of the Seyhan and Ceyhan rivers in the Mediterranean Region. The lands of the district in Çukurova have a completely flat plain land structure. The district has natural beaches on the Mediterranean coast. In Karataş the summers are hot and humid, and the winters are with a temperate climate well above the average temperatures. Therefore, it is an important region in terms of agricultural areas. It is possible to find different products in agricultural lands every period. PlanetScope satellite images in April-May were filtered in this region. At this date, while some of the agricultural lands had green crops, the crops in some of them turned yellow (brown appearance), and in some agricultural areas, the agricultural lands appear empty due to new plantings. For this reason, while determining the land cover classes, agricultural areas were expressed with 3 different classes. For the purposes of this study, a total of 7 land cover classes were determined. These; residential areas (urban), water areas (water), forest (forest), bare land (bare land), agricultural areas 3 different classes (green agriculture crops), Brown agriculture crops (brown crop), bare cropland (empty field).

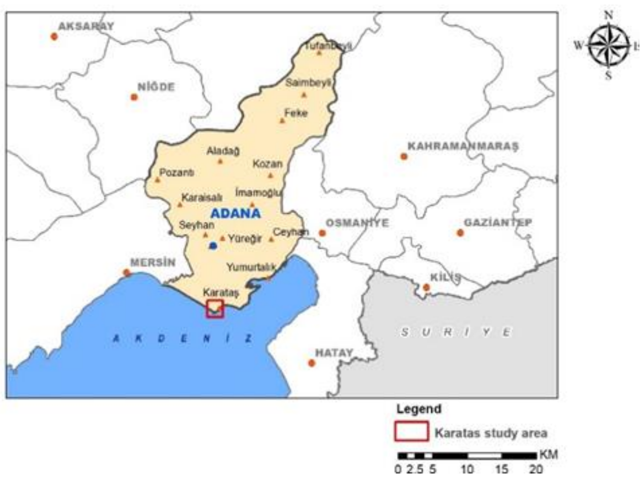

Figure 1. Karataş study area

Doğubeyazıt district of Ağrı province was determined as the second study area (150.557 km2). The lands of the district are made up of plains and volcanic mountains. Part of the plain, where rocks and hills can be seen from place to place, is barren. The high parts and foothills of the mountains are large pasture areas. The rainy season is spring and autumn. Planetscope satellite images from April-May in this region were filtered. The purpose of filtering these months is evident in the PlanetScope satellite image, due to the spring rains and pasture areas and grassland areas. The fact that the rocks and elevation are high is a factor in determining this area as the second study area. For the purposes of this study, 6 land cover classes were determined. These are; settlement areas (urban), pasture areas (pastures), bare land, cliffs (rocks), grassland (grassland) and road (road).

Figure 2. Doğubeyazıt study area

2.2. Methods

The PlanetScope satellite, launched in November 2018, has sensors with enhanced spectral resolution. Second-generation sensors from PlanetScope satellites (known as Dove-R or PS2.SD) have a sensor plane divided into four separate horizontal strips (one per radiometric band) along the flight path. Third-generation PlanetScope sensors (known as SuperDove or PSB.SD) are currently in orbit and produce images with 8 spectral bands. It is set to 0.3 pixels for PlanetScope products (PS2.SD and PSB.SD devices).

Table 1. PlanetScope PSB.SD Spectral Bands

PSB.SDSpectral Bands	Band No	Wavelength (nm)
Coastal Blue	b1	431-452 nm
Blue	b2	465-515 nm
Green I	b3	513-549 nm
Green II	b4	547-583 nm
Yellow	b5	600-620 nm
Red	b6	650-680 nm
Red-Edge	b7	697-713 nm
NIR	b8	845-885 nm

For this study, index-based algorithms created from Green I and Yellow bands from PSB.SD bands and Sentinel-2 satellite images were used.

Planet offers two geometry types (Basic and Ortho) for PlanetScope images. The basic scene products are designed for users with advanced image processing and geometric correction features. The product is not orthorectified or corrected for terrain disturbances. Ortho Scenes represent single-frame image captures with additional postprocessing as acquired by a PlanetScope satellite. PlanetScope Ortho Analytic 8B Scene Level 3D ortho geometry from Planetscope Satellite Image product processing levels was used.

In this study, we use PSB.SD sensor bands (8 bands) from Planetscope satellite for land cover classification for Karataş and Doğubeyazıt districts and Sentinel images integrated into GEE to investigate different datasets. GEE is a cloud computing platform designed to store and process huge datasets for analysis and final decision making (Kumar & Mutanga 2018). All the steps in the methodology were done in GEE. After Planetscope images were integrated into GEE, visualization processes were performed.

The Planetscope satellite image of Karataş district was filtered for the months of April and May, when the land cover on the study area was fully developed and the land cover classes were thought to be better utilized. The first dataset of the study area includes all bands of the Planetscope satellite image dated 11 May 2021 with minimal cloudiness. Different indices (NDVI -Normalized vegetation difference index, NDWI -Normalized water difference index) were created with Planetscope satellite bands (Table1). The slope data of the study area was created using NASA SRTM Digital Elevation (30m) data integrated into GEE. Optimal datasets were searched by adding these data to the dataset.

The satellite image of Doğubeyazıt district, from April and May, which are thought to benefit better from the land cover classes on the study area, were filtered. The first dataset of the study area includes all bands of the Planetscope satellite image dated May 14, 2021, with minimal cloudiness. The slope data of the study area was created using NASA SRTM Digital Elevation (30m) data integrated into GEE. In addition, different indexes were created with Planetscope and Sentilen-2 satellite bands. NDVI (Normalized vegetation difference index) and EVI (Improved vegetation index) indexes were calculated with Planetscope, and UI (Urban index) and KBRI (Karst bare-rock index) indexes were calculated with Sentinel-2 (Table2). The slope data of the study area was created using NASA SRTM Digital Elevation (30m) data integrated into GEE. Optimal datasets were searched by adding these data to the dataset.

Table2. Spectral indices used in the Karataş study area

Index	Bands	PlanetScope-PSB.SD	Equation
NDVI	Red,NIR	b6, b8	(b8 – b6) / (b8 + b6)
NDWI	Green, NIR	b4, b8	(b4 – b8) / (b4 + b8)

Table3. Spectral indices used in the Dogubeyazit study area

Index	Bands	PSB.SD	Sentinel	Equation
NDVI	Red,NIR	b6, b8	-	(b8 – b6) / (b8 + b6)
EVI	NIR,Red, Blue	b8, b6, b2	-	2.5 * ((NIR - R) / (NIR + 6 * R - 7.5 * B + 1))
UI	SWIR2, NIR	-	B12, B8	(SWIR2-NIR)/(SWIR2+NIR)
KBRI	SWIR1, NIR	-	B11, B8	(SWIR1-NIR)/(20*sqrt (SWIR1+NIR)

RandomForest classifier, one of the GEE classification algorithms, was used for both study areas. Accuracy analysis of the classification process was performed. Accuracy analysis is based on comparison of sample classified cells selected from the classified image with reference cell classes. Accuracy assessment is an important factor in remote sensing analysis results.

In this study; While 170 sample points were randomly selected from the total land classes for the Karatas area, 280 sample points were selected for the Doğubeyazıt area. Overall accuracy and kappa values were tested as two accuracy measures for all classes. The overall accuracy provides information on the proportion of reference points mapped correctly, while the Kappa Coefficient means that the classification is based on randomly assigned sample points only.

3. Results and Discussion

The results of statistical analyzes, general accuracy and kappa values are presented in Table 3 for Karatas study area and Table 4 for Doğubeyazıt study area.

The first data set of the Karataş study area includes all of the PlanetScope PSB.SD bands (8 bands). In the second data set, the Green-I (b3) and Yellow (b5) bands are removed from the dataset, resulting in a decrease in the accuracy criteria. The addition of the slope data to the first dataset improves kappa and accuracy values. As the NDWI Index did not cause any change in the data set (dataset-5), the Coastal Blue (b1) band was removed from the dataset and the kappa value was calculated again and it was observed that the results increased slightly (dataset-6). Better accuracy values were obtained by adding the Urban index (UI) to the dataset (dataset-7). Finally, the b1 band was removed from the cluster again and the best accuracy value was achieved. As a result, the effect of certain indexes calculated from PlanetScope satellite bands and Sentinel 2 satellite bands on land cover classification accuracy was examined.

The first data set of Doğubeyazıt study area includes all of the PlanetScope PSB.SD bands (8 bands). In the second data set, the yellow (b5) band was removed and it was observed that the accuracy values decreased. It is understood that the importance of the Yellow band in the accuracy criterion is great for this study area. It is seen that the accuracy value increases when the GreenI (b3) band is removed from the data set. Adding NDVI Index and Green I (b3) band together to the data set increases the accuracy criteria again (dataset-5). This shows that the efficiency of some bands in accuracy measures increases by adding them to the data set with certain indexes. In later data sets, the best accuracy values are achieved by adding SLOPE, UI (Urban Index), KBRI (Karst Bare-Rock Index), EVI (Enhanced Vegetation Index) data. Due to the high elevation difference of the Doğubeyazit study area, the factor in reaching the best classification criterion of the SLOPE data is large.

Table4. Datasets used in Karataş study area

No	Dataset	OA	KAPPA
1	b1+b2+b3+b4+b5+b6+b7+b8	0.76	0.72
2	b1+b2+b4+b6+b7+b8	0.74	0.69
3	b1+b2+b3+b4+b5+b6+b7+b8+SLOPE	0.78	0.74
4	b1+b2+b3+b4+b5+b6+b7+b8+SLOPE+NDVI	0.80	0.76
5	b1+b2+b3+b4+b5+b6+b7+b8+SLOPE+NDVI+NDWI	0.80	0.76
6	b2+b3+b4+b5+b6+b7+b8+SLOPE+NDVI+NDWI	0.81	0.77
7	b1+b2+b3+b4+b5+b6+b7+b8 +SLOPE+NDVI +NDWI+UI	0.82	0.79
8	b2+b3+b4+b5+b6+b7+b8 +SLOPE+NDVI +NDWI+UI	0.84	0.81

Table 5. Datasets used in Doğubeyazit study area

No	Dataset	OA	KAPPA
1	b1+b2+b3+b4+b5+b6+b7+b8	0.74	0.67
2	b1+b2+b3+b4+b6+b7+b8	0.71	0.64
3	b1+b2+b4+b5+b6+b7+b8	0.75	0.68
4	b1+b2+b4+b5+b6+b7+b8+NDVI	0.75	0.69
5	b1+b2+b3+b4+b5+b6+b7+b8+NDVI	0.76	0.70
6	b1+b2+b3+b4+b5+b6+b7+b8+NDVI+SLOPE	0.81	0.77
7	b1+b2+b3+b4+b5+b6+b7+b8+NDVI+SLOPE+UI	0.83	0.79
8	b1+b2+b3+b4+b5+b6+b7+b8+NDVI+SLOPE+UI+KBRI	0.84	0.80
9	b1+b2+b3+b4+b5+b6+b7+b8+NDVI+SLOPE+UI+KBRI+EVI	0.85	0.81

Table6. Karataş user and producer accuracy for the individual classes using the investigated datasets

Class	Urban	Green Crops	water	Forest	Bare Land	Brown Crops	Bare Cropland
1	87/93	100/65	88/78	80/100	89/42	92/100	58/92
2	93/93	85/65	88/78	70/88	78/39	92/92	61/85
3	87/100	95/73	94/75	80/89	89/45	92/100	63/89
4	93/93	95/66	88/82	70/88	89/57	92/85	74/93
5	93/100	95/70	88/78	90/90	100/50	92/92	66/96
6	93/100	100/65	88/78	70/100	89/67	92/79	74/93
7	93/100	90/62	88/82	70/88	100/64	92/92	79/97
8	93/100	100/69	88/78	70/100	100/69	92/92	82/97

Table7. Doğubeyazıt user and producer accuracy for the individual classes using the investigated datasets

Class	Urban	Pastures	Bare Land	Rocks	Grassland	Road
1	99/91	79/69	73/65	0/0	88/97	48/42
2	100/89	72/61	69/66	10/20	81/97	48/45
3	100/93	77/64	78/67	16/50	81/100	48/53
4	100/93	75/66	77/64	16/45	84/100	43/53
5	100/92	75/73	78/66	10/25	88/97	48/48
6	99/93	81/69	80/70	10/25	86/95	52/55
7	99/94	89/75	78/75	60/88	83/97	52/55
8	100/96	87/77	83/77	56/93	85/97	57/57
9	100/99	85/73	85/78	60/94	83/100	57/57
10	100/99	96/76	88/78	44/92	85/98	52/65

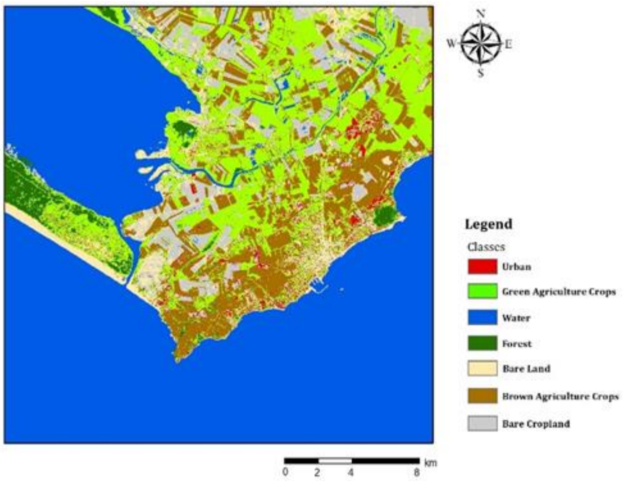

Figure 3. Karataş- sınıflandırma sonucu (dataset-8)

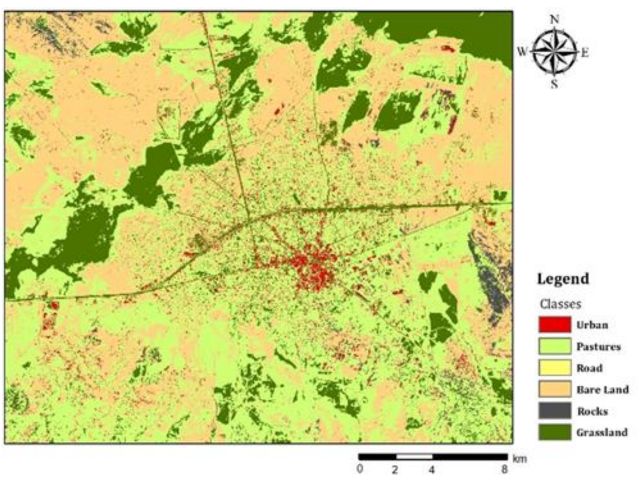

Figure 4. Doğubeyazıt- sınıflandırma sonucu (dataset-9)

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