EVALUATING DIGITAL ELEVATION MODELS IN THE ATMOSPHERIC CORRECTION PROCEDURE FOR DIFFERENT SATELLITE IMAGE DATA (BARTIN CASE STUDY, TURKEY)

Ayhan Ateşoğlu, Metin Tunay

University of Bartın, Department of Forestry, BARTIN, Turkey; aatesoglu@yahoo.com; mtunay74@ttmail.com

ABSTRACT

The most valuable information to be obtained from remote-sensing sensors is radiation in a certain band-width reflected from a certain object. However, different illuminations originated from rough terrains and especially from atmosphere change radiation values of objects. Different correction algorithms are applied to satellite image data in order to prevent the effects of these errors. Removing atmospheric and topographic effects from images taken by sensor is beneficial especially for vegetation-based studies. Removing topographic effects within the scope of atmospheric correction will increase the accuracy and reliability of conducted studies. This study used digital elevation model constructed on contour lines with 10 m interval on topographic map with 1:25000 scale, applied atmospheric correction procedure on Landsat ETM+, Aster (VNIR) and Spot (HR-VIR) images, and made visual and digital analyses on images obtained as a result. The accuracy of the slope and the aspect analysis that will be obtained through the DEM information will be compensating the reflections that have negative effect apart from the target pixel. The Landsat image data has been the best resulting satellite image data regarding the experimental application. In the spot image data, the value that has a good contrast as the visibility value had been chosen. The Aster image data has been evaluated, a more negative table has been discovered problems caused by DEM. The precision of the DEM information is related with the geometrical resolution of the satellite image data. The accuracy of slope and aspect analyses that is subject to atmospheric correction depends on the digital elevation model created on the basis of complete resolution

INTRODUCTION

Due to different clarifications arising from various changes and rugged terrains on the world atmosphere, the spectral reflection values of satellite image data has been changing. The atmospheric correction procedure is an application towards gaining the real reflection value information regarding the surface temperatures and the objects through the satellite image data. In addition to this, the atmospheric correction is also used for avoiding the clarification effects that causes mistakes for presenting the reflections on the earth towards the image. With the atmospheric correction, the object is provided to be handled with the Digital Numbers (DN) close to the real reflection values for the analysis and investigation of reflection values (DNs) perceived by the detector in a specific period of time and in an atmospheric condition. The real target in here is to convert the electromagnetic energy value which had reached to the detector (the radiometric measurement) into the reflection value of the real object and to take notice of the atmospheric effects on the measured spectral reflection value (1-3). In this study, the atmospheric correction procedure had been applied to the images of Landsat ETM+, Aster (VNIR) and Spot (HR-VIR) by using the digital elevation model created through the contour lines which are present in every 10 m. on the topographic map with a scale of 1:25000, and the visual and digital analyses had been made through the result images. In the application, the ATCOR-3 module on the PCI Geomatica 9.1 software which is used for the rugged terrains had been used. In terms of the atmospheric correction, the advantages and disadvantages of the digital elevation model which is used on the satellite image data on different resolutions had been indicated.

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As the study area, the field with 1750 hectares that covers Mugada and its inner circle that takes place on 41^0 37′ 44″ north latitude and 32^0 11′ 59″ east longitude had been chosen. On choosing the study area, having the topographical structure to be broken had been effective in terms of evaluating the results (Figure 1).

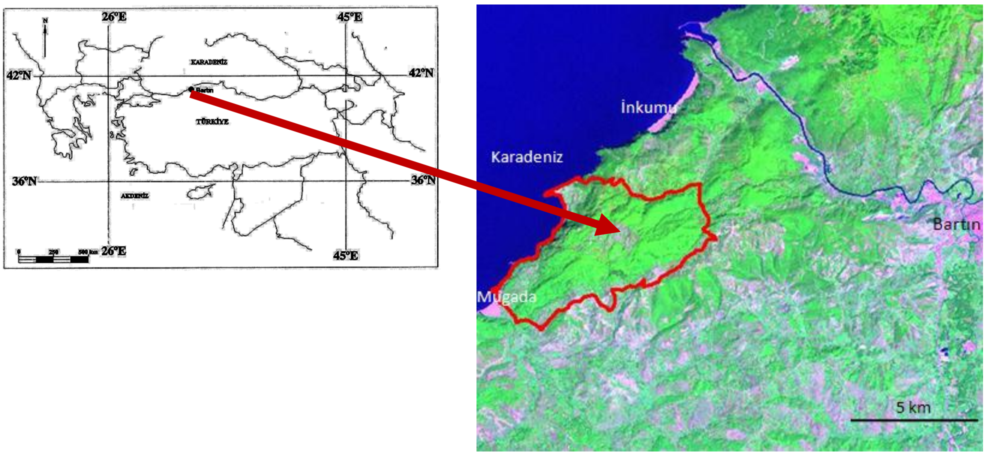

Figure 1: The geographical position and the ETM 7-4-1 image of the study area.

According to the meteorological data, the relative humidity is around 80% on the study area that has a considerably wet climate. When the slope distributions (4) of the study area are examined, 40% of the area is sloping, 33% of it is steep and 19% of it is much steep. The flat and close to the flat part of the area is take place at only 6% of the total area.

METHODS

In the study, the satellite images of Landsat ETM+, Spot (HR-VIR) and Aster (VNIR) had been used. Two topographical maps with a scale of 1:25000 (Zonguldak E28-d2, E28-d3) had been used for creating the digital elevation model (DEM). The DEM data in the remote sensing discipline is being used on the geometrical, topographical and atmospheric correction procedures of the satellite images. In order to create the digital elevation model of the study area, the contour lines that were present in every 10 meters on the topographic map had been digitized.

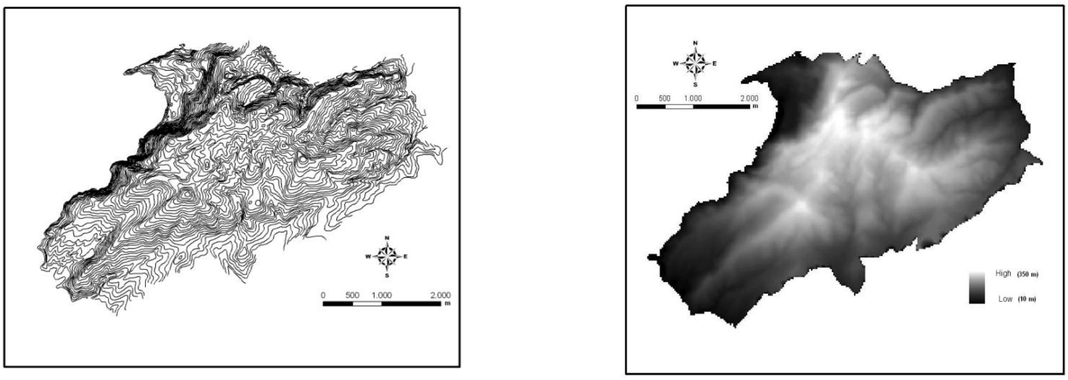

Figure 2: The topographic structure and the digital terrain model of the study area.

In the study, also for the rugged terrains, the module of used atmospheric correction algorithm PCI Geomatica V9.1-ATCOR-3 had been used. In this context, in the atmospheric correction (ATCOR-3) application, the proper criteria regarding the parameters below had been determined before the implementation of the application.

Digital Elevation Model; It is the most important critical point of the atmospheric correction; it is the resolution of the used digital elevation model (DEM). Generally, a DEM resolution which is 0.25

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times of spatial resolution of the satellite image data is enough (5). *Aerosol types*; there are 4 different aerosol types as they arise in Rural, Settlement, Desert and Sea coast (PCI Geomatica 2005). Atmospheric conditions; the standard atmospheric definition is expressed with the values of pressure, temperature, water vapor and ozone density (6). *Solar Zenith and Azimuth*; those parameters express the position of imaging satellite according to the sun. *Visibility;* the visibility is a meteorological statistics value in which the optical depth, a precise period of time and the opacity of the ground atmosphere is calculated. *Adjacency effect,* it is a value definition which is used for the radiation values of inner circle where there are different reflections not to affect the requested target pixel reflection value (7). *Calibration Files*; the best results for the atmospheric accuracy are gained with the standard calibration files prepared for every detector

RESULTS

All of the atmospheric correction parameters for every used satellite image data are given in Table 1. For the Landsat ETM+ image used in the study, the atmospheric correction process made by using good contrast value (Vis: 25km) had been observed to resolve the negativities on different view enlightenments especially sourced from the topography (Figure 3). The shade effect sourced from the topographic differences on the study area creates the spectral differences that cause as it is in a different structure for the shaded and light-receiving parts of the stand. With the atmospheric correction procedure, these kinds of mistakes sourced from the topography are precluded and homogeneity is provided by removing the spectral differences in the stand (Figure 4).

Table 1: Atmospheric correction parameters

	Landsat ETM+ (30 m)	**Spot (HR-VIR) (20 m)**	**Aster (VNIR) (15 m)**
Date (DD/MM/YY)	04/07/2000	27/07/2005	22/10/2005
Sun Azimuth (º)	127.7101082	146.30	166.160724
Sun Elevation (º)	63.1439777	64.68301	36.40635
Digital Elevation Model (was calculated from contour; m) 10m			
Aerosol Types	Rural		
Atmospheric Conditions	Humid	Humid	Fall
Calibration Files*	Geomatica_V91\atcor\cal\landsat7\ etm_standard1 Geomatica_V91\atcor\cal\landsat7_pan\ landsat-7_pan) Geomatica_V91\atcor\cal\spot Geomatica_V91\atcor\cal\aster		
Visibility (km)	25	25	10
* created by Richter for the PCI Geomatica software (8). **Adjacency effect is calculated for the area around every pixel for maximum 200 pixels.			

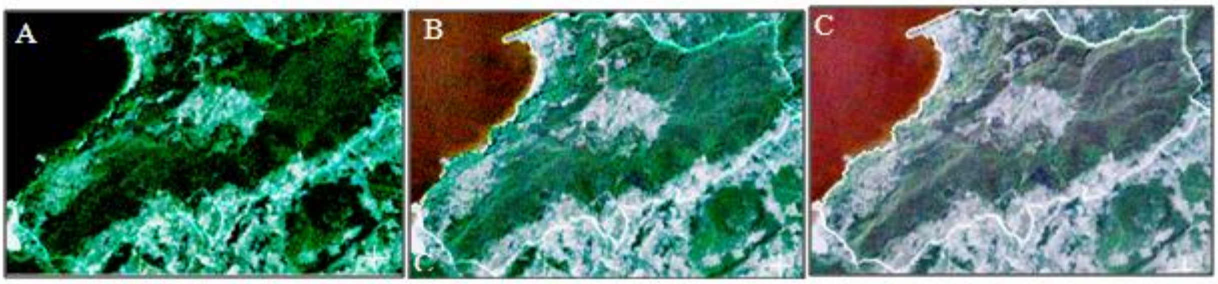

Figure 3: Low contrast (vis. <10km) (A), normal contrast (vis.=15 km) (B), High contrast (vis.= 25 km) (C).

When the band correlations on the image data before and after the atmospheric correction of the Landsat image data are examined, the high correlation is observed to continue for the visible area. In addition to this, after the correction, all of the negative correlations before the correction show a positive change on the same rate (Table 2).

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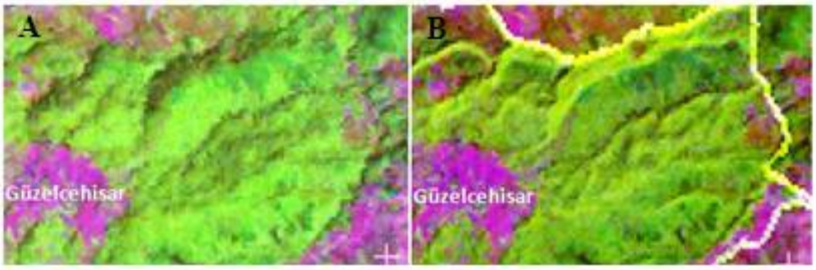

Figure 4: The change of spectral reflections sourced from the topography before (A) and after (B) the atmospheric correction (7,4,1).

Table 2: The correlation coefficients between the spectral band values of before and after the atmospheric correction of the Landsat image data.

Bands	1	2	3	4	5	7	Bands	1	2	3	4	5	7
1	1						1	1					
2	0.78	1					2	0.92	1				
3	0.81	0,97	1				3	0.91	0.96	1			
4	0.28	0.30	0.22	1			4	0.20	0.47	0.39	1		
5	0.20	0.70	0.66	0.84	1		5	0.52	0.73	0.70	0.85	1	
7	0.54	0.88	0.87	0.55	0.90	1	7	0.71	0.86	0.83	0.63	0.89	1

In the SPOT HR-VIR image data, 25 km. value that had a good contrast as the visibility data had been chosen and the visual evaluation had been made. The shade effects sourced from the topography had been observed to be resolved especially from the effects on the slopes according to the other visibility values. As well as the azimuth for the Aster (VNIR) image had been quite bad, the negativities based on the topography became prominent. For the visibility values based on the normal and high contrast on the atmospheric correction phase, differences has been observed on the reflection values on both sides of the slopes in the areas where the shade effect had seen.

CONCLUSIONS

At the helm of processes that become prominent on correcting the satellite image data that has different geometrical resolution atmospherically, there are digital elevation information (DEM), the sensor information, and the definition of current atmospheric conditions. Especially the precision of the DEM information is related with the geometrical resolution of the satellite image data that we are working with. The accuracy of the slope and the aspect analysis that will be obtained through the DEM information will be compensating the reflections that have negative effect apart from the target pixel.

The Landsat image data has been the best resulting satellite image data regarding the experimental application. According to the results of the visual analyses before and after the atmospheric correction, the image data that has a good contrast value (Visibility = 25 km.) had been chosen. The chosen corrected image data had been determined to resolve the negativities based on the topography. When the band correlations on the image data before and after the correction had been examined, even though no important change had been observed, the relations between the visible region and the infrared region had been resulted on low coefficient as it should be.

In the spot image data, the value that has a good contrast (25 km.) as the visibility value had been chosen and the visual evaluation had been made. When the changes between the spectral reflection values before and after the atmospheric correction had been examined, the apparent differences between the reflection values on the infrared region again show that the knowledge inferences especially for the forest areas through the image data are more significant. A change on

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this context has quite importance for the vegetation index images that will be made especially based on red band and near infrared band after the atmospheric correction.

Similarly, when the Aster image data has been evaluated, a more negative table has been discovered according to the other satellite images. For the Aster image data where the low contrast value had been chosen, in the image data that has higher contrast value, especially the slopes that are kept in the backyard based on the topography had been determined to have brightness values on normal reflection. For this reason, as the negativity based on the topography regarding the both slopes changed, other way regarding the high brightness value after the correction the negativities had been experienced. The reason of this is that as the acquisition of Aster image data is early in the mornings {08.44. 00} on local time, the satellite point of view and the sun lights are too low. As it is also the image data that has the highest geometric accuracy (15 m) in the study, having quite low resolution of digital elevation model produced with 10 m. intervals had caused the increase of negativity and not having the expected accuracy results for the atmospheric correction process.

The accuracy of slope and aspect analyses that is subject to atmospheric correction depends on the digital elevation model created on the basis of complete resolution. Due to the result of the atmospheric correction made, the negativities based on the topography had also been removed. In this context, positive results will be provided for the remote sensing studies investigated of the information content level that is effective especially on spatial resolution such as reaching higher accuracies.

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