

DETERMINING CURRENT LAND COVER AND POTENTIAL HAZELNUT PLANTATION AREAS USING GIS & RS IN NE BLACK-SEA REGION OF TURKEY, TRABZON

S.Reis^{a*}, T. Yomralioglu^a

^a KTU, Faculty of Architecture and Engineering, Dept. of Geodesy and Photogrammetry Engineering, GISLab, 61080, Trabzon, Turkey – (sreis, tahsin)@ktu.edu.tr

Commission PS WG II/6

Keywords: GIS, RS, Land Cover, Agriculture, Analysis, Landsat ETM+, Hazelnut, Trabzon

ABSTRACT

In Turkey, hazelnut grows mostly in the Eastern Black Sea Region of the country, and has also a vital impact on regional economical development. Most important task is to determine what areas exactly hazelnut grows and how it can be grown-up productively in the region. The principle aim of this study is, firstly, to create a methodology for determining existing and potential hazelnut plantation areas, using GIS/Remote Sensing techniques in order to help hazelnut policies developers and economists. This study was done in the province of Trabzon which is one of the most hazelnut produced area of Turkey. In this study, Landsat ETM+ image was used to generate a current land cover classification. Using the supervised classification method, overall accuracy was determined as 84.7%. As for hazelnut growing areas, an 87.9% overall accuracy percentage was reached. It was determined that there is an area of 71.401 hectares hazelnut plantation area in the Trabzon province. Because hazelnut production exceeds the consumption in Turkey, some new regulations have been released to find new land use policies since 1983. By putting into practice these regulations that restrict hazelnut plantation areas, a more efficient and productive hazelnut harvest policy should be reached. As a result, potential hazelnut areas were determined and examined with respect to raster-based spatial analysis functions of GIS.

1. INTRODUCTION

Turkey has the highest hazelnut production rate in the world. The rate is 77% of the whole world production (Koksal, 2000). Hazelnut is harvested mostly in the Black Sea Region of Turkey. There are shortages in such data as hazelnut growing up areas, characteristics of the hazelnut gardens (topography, soil type, age and densities of hazelnut groves, number of the types in the hazelnut gardens, etc.), consumed hazelnut amounts in domestic market and remaining hazelnut amount in private sector at the end of the each harvest season in Turkey. Especially in the studies specifying hazelnut locations, valuable data is much more intensive. However, the most important and primary requirement of having an effective hazelnut policy is the existence of the reliable data on these issues (State Planning Organization, 1999).

In order to supervise hazelnut harvesting process to increase production rates in every year, spatially based information produced by different institutions should be accurately collected and analyzed in such an effective way. Today, Geographic Information System (GIS) is a powerful tool for collecting, processing and analyzing of spatial information (Longley, et al, 2001; Yomralioglu, 2002). Remote Sensing (RS) has also an important role providing data in quick mode for GIS, especially for determining of land cover analyses (Maxwell, et al, 2003; Oetter, et al, 2000). RS is accepted as an effective way to acquire the data for agricultural products with accurate and time related manner in wide areas. Especially, Landsat satellite images have been used successfully for classifying different crop types since 1970 (Lobell, et al, 2003; Cohen et al., 2002).

In the early 1980's, because of the hazelnut production was more than the domestic consumption, exportation, and raised stocks, restriction of the hazelnut areas was raised. A Law numbered 2844 and named as "The Act about Planning of the Hazelnut Production and Determining of the Planting Areas" was put into practice in 1983 to provide the production is realized in most appropriate areas and respect to demand (Turkey Official Gazette, 2002). With this law, it has been targeted that the hazelnut areas would be reduced by 100.000 hectares (European Commission, 2000). With the new arrangements with this law, the provinces where hazelnut harvested were restricted and some criteria were introduced for the production process for some provinces in 2002. Thus, it has been aimed that the areas suitable for hazelnut harvesting and the rest of it could be specified. However, applying of this law has not been realized yet. In this study, a procedure has been developed for specifying the most appropriate hazelnut growing areas in order to provide a base data for agricultural decision-makers.

2. METHODS

2.1 The Study Area

The Province of Trabzon is situated between 39° 15' - 40° 15' WE Longitudes and 41° 8' - 40° 30' NS Latitudes in the middle of East Black Sea Region of Turkey (Figure 1). In the province, increasing elevation beginning from the sea-level exceeds 3000 m in some areas. Generally, mountains, hills and high plateaus take part in inner land of the region. The province is the most important trade centre in the region with the features of having a rich historical and cultural wealth.

* Corresponding author

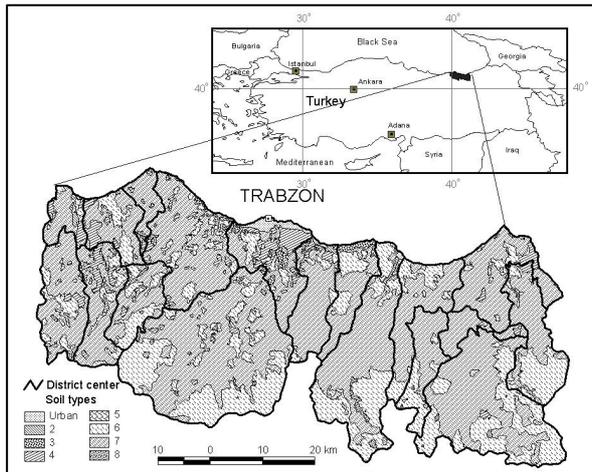


Figure 1. Study area:
(Trabzon Province with its administration sections)

2.2 Soil Data

In Turkey, The General Directorate of Rural Services realizing its activities under the Ministry of Agriculture and Rural Affairs is responsible for production of soil related information. Produced by this institution, maps scaled 1/100.000 were digitized. Land use types (LUT) are 8 classes on this map. Respect to soil damage and restrictions, these classes are range from I. to VIII. Besides, agricultural lands are divided into 4 classes. Having I. degree importance, agricultural lands are named as absolute agricultural classes. These agricultural classes involve I. and II. degree classes and the other classes lands having needed irrigation except forest lands and moorlands. Having II. degree importance agricultural lands involve III. class land use capability lands. Having III. degree importance agricultural lands involve vineyards-gardens and special product lands which are in other than I., II. and III. class lands. IV. class lands are named as the other lands. These classes involve the lands except I., II. and III. agricultural lands (Balci, 1996).

2.3 Relief Data

Digital Elevation Model (DEM) was digitized from 1/100.000 scaled Standard Topographic Maps. Contours on these maps are drawn with a 50m elevation differences. DEM of the study area was created by using ArcView 3.2 and ArcGIS 8.2 GIS software's. Slope Map (classified in percentage) and Elevation Figures were generated by using this DEM. Pixel dimensions of this Slope Map are 25x25m. When considered in view of slope, three fourth of the total area of Trabzon province consist of areas with a slope rate of above 30%. Besides, areas with a slope rate of 50% or above constitute 40% of the total area of the province (Reis, 2003).

2.4 Remote Sensing Imagery and Land Cover

In the Eastern Black Sea Region of Turkey, the principle challenges in generating land cover types are rough topographic structure, rich in turns of plant species and scattered agricultural lands. Therefore, some difficulties were encountered in processing remotely sensed data in the region. In this study, a single date image of Landsat ETM+ (Path 173; Row: 32) on October 19, 2000 were used to generate

land cover types. Using the image, after extracting an application area of approximately 120x90 km covering administrative boundaries of Trabzon province, some other required further studies were implemented on this area. Landsat ETM+ image has 6 multi-spectral bands with 30m resolution, 2 thermal bands with 60m resolution and a panchromatic band with 15m resolution.

For the study, a total of ten land cover classes are chosen. These are pasture, water, deciduous, coniferous, mix wood, green tea, hazelnut, rocky, settlement and agriculture. Training area data for these classes were obtained using mobile GPS in two different seasons (for May&September). Supervised classification process was realized. During the classification process each of the following algorithms were tested: Minimum Distance, Mahalanobis Distance and Maximum Likelihood with several thresholds. It was seen that the Standard Maximum Likelihood Method provides the best result with multi-spectral bands (123457) when the supervised approach is used. Afterwards, to analyze this classification, the overall accuracy percentage, user's and producer's accuracy and the Kappa Coefficient that provide the statistical evaluation of these accuracy values were calculated. The overall accuracy of this classification was 84.68% and the Kappa Coefficient was 0.829. The hazelnuts producer's and the user's accuracy were realized respectively 87.9 % and 83.5 %.

3. DETERMINATION OF THE POTENTIAL HAZELNUT AREAS

Turkey state was brought into force a law numbered 2844 in 1983, named as "The act about planning of the hazelnut production and determining of the planting areas", for gaining the most yield from the hazelnut plants and balancing the world markets harvest of the hazelnuts. The last regulation was done in January 2002 for constricting the hazelnut areas and enhancing the hazelnut productivity. According to this regulation the harvesting of hazelnut can be done the areas as follows;

- in the areas of which maximum elevation is up to 750 m.
- in III.class agricultural areas and slope is more than 6%.
- in IVth or upper class of the land use ability areas (Turkey official gazette, 2002).

Because of the resolution of land use map, obtained from satellite image, is 28m the analysis of Potential Hazelnut Areas (PHA) is done in grid format of which pixel dimension is 28m. In this analysis procedures all data coverage are transformed into a pixel dimension in 28m. The criterions given above are used to determine the PHA in GIS context. The spatial analysis module in ArcView for carrying out this aim was used (Esri, 1996). According to this analysis, it is assigned that there is total 101.384 ha PHA in Trabzon province which is 21.8% of entire the province.

4. DISCUSSION

In Trabzon, there is an area of 164.370 hectares between the elevations of 0-750 m, which is used as a criterion in determining the general PHA. While 101.384 hectares of this area is assigned as PHA, it is determined without taking into consideration of the existing land cover. When the current land cover is considered so as to determine the PHA, it will be seen that the PHA will become less than the calculated one obtained from Landsat ETM+ satellite image. According to the results of analyses with land cover map, as given on

the Table 1, the deciduous and current hazelnut areas mostly overlapped on the planted hazelnut areas. The general PHA, which is determined according to existing land cover, consists of deciduous trees (51.4%) and the current hazelnut areas (27.9%). When the forest (including deciduous, coniferous and mix wood) and settlement areas were extracted from general PHA, the rest of the area was found 47.296 hectares (28.71%) which was called as ideal PHA. It is stated before that the existing current hazelnut areas determined from Landsat ETM+ satellite image was calculated as 71.402 hectares. When compared the results mentioned above with regulations about hazelnut plant, it was seen that much more current hazelnut area amounting to 24.105 ha (5.17%) was determined.

Land cover type	PHA (ha)	Rate (%)
Deciduous	52094	51.4
Hazelnut	28263	27.9
Agriculture	14386	14.2
Pasture	2347	2.3
Green Tea	2219	2.2
Coniferous	940	0.9
Settlement	531	0.5
Mixwood	516	0.5
Rocky	80	0.1
Total	101376	

Table 1. The planted hazelnut areas according to land cover

When the forest, settlement and current agricultural areas are subtracted from the general PHA, there exists a remaining PHA area of 32.909 hectares (7.06%). Therefore, it appears that there are 38.492 ha (8.26%) extra hazelnut planted areas in Trabzon. And thus, when forest, settlement and agricultural areas are eliminated, the areas where hazelnut

Production is allowed in accordance with current regulations are quite restricted in the province. The map showing current hazelnut planted areas together with the calculated PHA is presented in Figure 2.

The current hazelnut areas are determined as 49.270 hectares in a study conducted by Trabzon Agriculture and Rural Affairs in 2001. When this reported data and data extracted from satellite image about the current hazelnut areas for the same region were compared, there appears a total of 22.131 hectares difference in current hazelnut areas. The hazelnut harvest for the year of 2001 in Trabzon province is 64.863 tones (Anonymous, 2001). Besides, the quantity of hazelnut in a hectare is changeable between 600-1000 kg in Turkey. The average hazelnut yield in an acre in Turkey is approximately 100 kg (Martı, 2001). Consequently, in order to be able to reach the proposed hazelnut yield for Trabzon, it is clearly seen that an area of between 64.000 - 100.000 hectares is required.

5. CONCLUSION

In this study, the procedures were applied to determine the current and potential hazelnut harvesting areas in Trabzon, Turkey. First of all the planted hazelnut areas were determined using a Landsat ETM+ satellite image. The Landsat satellite has a crucial role for determining land cover. Especially, spectral resolution of Landsat is very important in determining land cover. In this study, adequate results were obtained in determining the hazelnut areas by doing the classification procedures of Landsat ETM+ satellite image. Finally, using the ability of GIS, PHA is determined with some criteria that existing regulations are required for a sustainable hazelnut production policy.

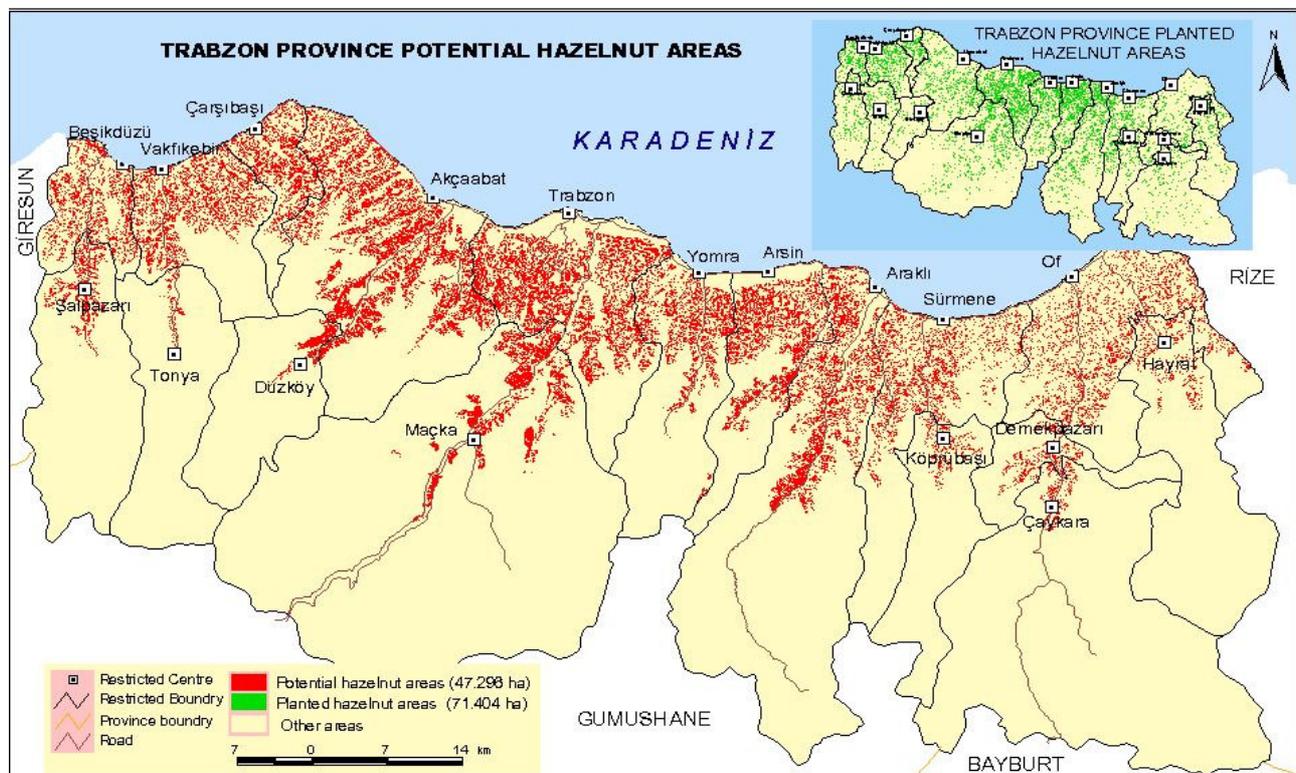


Figure 2. The current and potential hazelnut areas of Trabzon

References

- Anonymous, 2001, Trabzon İli 2001 Yılı Çalışma Raporu, Tarım il müdürlüğü, Trabzon.
- Balcı, N., 1996, Toprak Koruması, İ.Ü. Basımevi ve film merkezi, İstanbul.
- Cohen, Y. and Shoshany M., 2002, A national knowledge-based crop recognition in Mediterranean environment, International Journal of Applied Earth Observation and Geoinformation, 4, pp. 75-87.
- ESRI, 1996, ArcView Spatial Analyst, Redlands, USA.
- European Commission, 2000, 2000 regular report from the commission on Turkey, <http://www.euturkey.org.tr>, (accessed 16 April. 2003)
- Köksal, I., 2000, Inventory Of Hazelnut Research, <http://www.fao.org>, (accessed 20 Dec. 2002)
- Lobell, D.B., Asner, G.P., Monasterio, J.I.O. and Benning, T.L., 2003, Remote sensing of regional crop production in the Yaqui Valley Mexico: estimates and uncertainties, Agriculture, Ecosystems and Environment, 94, pp 205-220.
- Longley, P.A., Goodchild, M.F., Maguire, D.J ve Rhind D.W., 2001. Geographic Information Systems and Science, Bath Press, London.
- Marti, J., T., 2001, World hazelnut production, <http://www.aoi.com.au>, (accessed 11 March 2003)
- Maxwell, S.K., J.R. Nuckols, M.H. Ward and R.M. Hoffer, 2003, An automated approach to mapping corn from Landsat imagery, Computers and electronics in agriculture, 43, pp.43-54.
- Oetter, D.R., Cohen, B.C., Berterretche, M., Maiersperger, T.K. and Kennedy, R.E., 2000, Land cover mapping in an agriculture setting using multiseasonal thematic mapper data, Remote Sensing of Environmental, 76, pp.139-155.
- Reis, S., 2003, Çevresel planlamalara altlık bir coğrafi bilgi sistemi tasarımı ve uygulaması: Trabzon il bilgi sistemi (TIBIS) modeli, Phd thesis, Graduate school of natural and applied science, Karadeniz Technical University, Trabzon.
- State Planning Organization, 1999, VIII. Bes yıllık kalkınma planı fındık özel ihtisas komisyonu, <http://plan8.dpt.gov.tr>, (accessed 05 Jan.. 2004)
- Turkey Official Gazette, 2002, Fındık üretiminin planlanması ve dikim alanlarının belirlenmesi ile fındık yerine alternatif ürün yetistirmeyi tercih eden üreticilerin desteklenmesine dair esas ve usuller hakkında yönetmelik, January 2002, no:24637.
- Yomralıoğlu, T., 2002, Coğrafi Bilgi Sistemleri: Temel Kavramlar ve Uygulamalar, ISBN 975-97369-0-X, Seçil Ofset, İstanbul.