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Multitemporal analysis (1975-2011) of vegetation changes in urban land uses: Case of the city of Bartın, Turkey

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Abstract

Land use and physical planning have an integrative function especially for environmental planning. The most important factor is vegetation for this planning. The purpose of this study was to determine vegetative changes from 1975 to 2011 in Bartın urban area. Vegetation status analysis is the best indicators for understanding the contribution of land use in urban land. In the present study Landsat satellite images data belonging to 1975-1987-2000-2011 were used, data about altitude, slope groups of the Bartın municipal border were obtained. Vegetation change analysis and visual analyses of the study area were studed. According to the results of vegetation status analysis, 537.29 ha of area (14.59 %), lost its vegetation quality between 1975 and 2011. The corresponding ratio of the area included in green areas, which was out of vegetation area, remained at negative 3.33 %. This result showed that urban structuring in the regions out of vegetation was quite high. When the analysis made by using a slope groups map and the results obtained in the study were taken as the basis, the sum of class 1 and 2 farmland where level and gentle slopes lands within the area of study was 1805.96 ha The results showed that vegetation contribution on the ecological quality of study area was decreasing continuously and the effect it had on urban ecosystem was negative.

Key words

Geographic information systems, Urban land use planning, Vegetation analysis

Introduction

The ecosystem is generated by living and non-living things in an effort to maintain a balance in the environment where people live. The green areas of a city are significant in terms of creating new habitats and healthy environments. These areas increase the quality of the environment, both ecologically and economically (Ozdemir, 2009). It is essential that sustainability of these areas be maintained by preserving the balance dynamics on the basis of landscaping.

The balance dynamics in urban landscape changes quite rapidly and often in a negative way through human factor (Bulut *et al.,* 2010). While fast and irregular cases of migration to the cities result in unplanned developments without a foundation or equipment, farming areas are rapidly disappearing. The rapid increase in population and fast developments in technology are the biggest challenges in establishing a livable environment and maintaining its sustainability. Fertile farming areas next to urban areas are replaced by industrial and residential centers. The fact that our cities get extremely crowded limiting areas such as public spaces that need to be left for green areas that increase land income. As a result, big cities in Turkey are devoid of green space and recreational areas (Ozguner, 2003). Several desired qualities of urban environments, altered and modified by human hands, are lost in this way.

What is needed to be done by the people with awareness of ecosystem and who work in cities is to protect, develop and manage the green space system in urban fields. These ecologic cells present in cities and in nearby environments should be supported with alternative arrangements. Incorrect decisions taken regarding green space should be stopped and it should be prevented that green space is transformed into areas of other purposes (Bulut *et al.,* 2010; Duran *et al.,* 2012). Planning for this purpose needs proper foundations, including sufficient information. While any kind of urban land use has unique structure, the situation is same in terms of vegetation. It would be beneficial to know the vegetation lands with such characteristic structure in planning the identification of natural areas in the environment and temporal change. Shaw *et al.* (1998) stresses that identification of vegetation structure of land is a significant indicator in understanding the contribution of that field to natural life (Deniz *et al.,* 2008).

Maintaining and protecting the sustainability of urban vegetation is possible with rational planning. Indeed, this process starts with a macro scale and is composed of micro-scaled planning phases. Most of the environmental changes and use of field on an urban scale occur as a result of conflict between preservation and resource management (Steinhardt and Volk, 2002). Analysis and inquiry into relationship in terms of different uses of current land in urban areas have a significant role in which physical planning needs to be adopted. Also, making analysis and inquiry, using Remote Sensing (RS) and Geographical Information Systems (GIS) techniques with quantitative basis is obligatory for planning activities to be faster and more accurate (Ducci, 1999; Murayama, 2001; Efe *et al.,* 2012). Recently developed space technology ensures reliable and accurate information in following earth is resources and mapping the use of land/vegetation. Using of RS technologies for urban land and its integration with GIS will shed light on acquiring important information for the region by analysing the condition of the vegetation (Tunay and Atesoglu, 2008; Li *et al.* 2011).

The present study examines the changes in vegetation and use of land within the provincial boundaries of the city of Bartın. For this purpose, analyses of the changes, particularly in vegetation between 1975 and 2011, were made using multi-temporal satellite data and GIS software. The findings of the study will contribute in forming plans for the future of urban development and urban environmental management in terms of urban ecosystem.

Materials and Methods

Study area : The field of research is the provincial boundaries of the city of Bartın in Western Black Sea Region in Turkey where located a field of approximately 37 km^2 (Fig. 1). The land, deeply fragmented by the River of Bartın, and its branches has a rough appearance. There are narrow but deep valleys in lands where river gets wider and in between the quite steep slopes of the mountains. As one goes down to the city center of Bartın and nearby places, level meadows are seen. Kocacay and Kocanazcay streams, that make up the two main branches of the most important river in Bartın, Bartın River, come together in the center of Bartın and reach the Black Sea in the Bogaz region, passing along a 14 km road.

Landsat MSS, TM and ETM and satellite image data with different dates, whose geographical definition and geometric adjustment were made based on WGS 84 UTM 36N coordinate system, were used in the study (Table 1). Detailed information about Landsat satellite images can be obtained from Lillesand *et al.,* (2004).

As there are no earth coordinates on the RS data which were not geometrically adjusted, they cannot be used for map purposes (Lillesand and Kiefer, 2004). In practice, Geocover data which were produced from Landsat data were examined. GeoCover LC has an independent assessment of accuracy. The accuracy analysis of these images was made by Earth Sat (Geymen and Baz, 2007). For the purpose of transforming Geocover images into UTM coordinate system, 21 ground control points such as roads, rivers, coastal lines and cutting points of objects with line characteristics can be selected on the image and that can be clearly and accurately defined on a 1:25000 scaled standard topographical map were chosen for the images in general. As it is not desired to change the original reflection values in the geometric transformation process implemented on Landsat satellite images, "Nearest Neighbor Resampling", which is one of the resampling methods, was applied.

The first affine transformation was used in geometric transformation processes. Since deformation along both axes would not be same in the adjustment process made, affine transformation was preferred. The number of earth control points and their root mean square errors (RMS) are shown in Table 2.

The vegetation index images of each satellite image data were formed in order to identify the land use according to the purpose of the study. Vegetation index was based on a quite different reflection of vegetation on near infrared and visible red bands (Atesoglu and Tunay, 2010). Vegetation index, mostly used in practice, was the Normalized Difference Vegetation Index (NDVI). The algorithm of NDVI was the ratio of the sum of the difference between near infrared band and red band. Classified result image data were formed from vegetation image data generated. In assessing RS data, the related modules of PCI EASI/PACE image processing software were used. Arc View 9.1 program, an ESRI software, was used for GIS practices.

NDVI image data set was formed for each image by making geometric adjustments of the four different satellite image data. Height and slope maps for the field of study were generated by drawing the Bartın district boundary in GIS setting using the contour lines passing every 10 m on the 1:25000 scaled topographical maps. Uncontrolled classification was done on each NDVI image data by cutting satellite image data within the framework of Bartın district boundaries. Controlled classification was made in such a way that each class formed as a result of uncontrolled classification (30 classes were selected in total) would be a control field. Two classes as "vegetation" and "out of

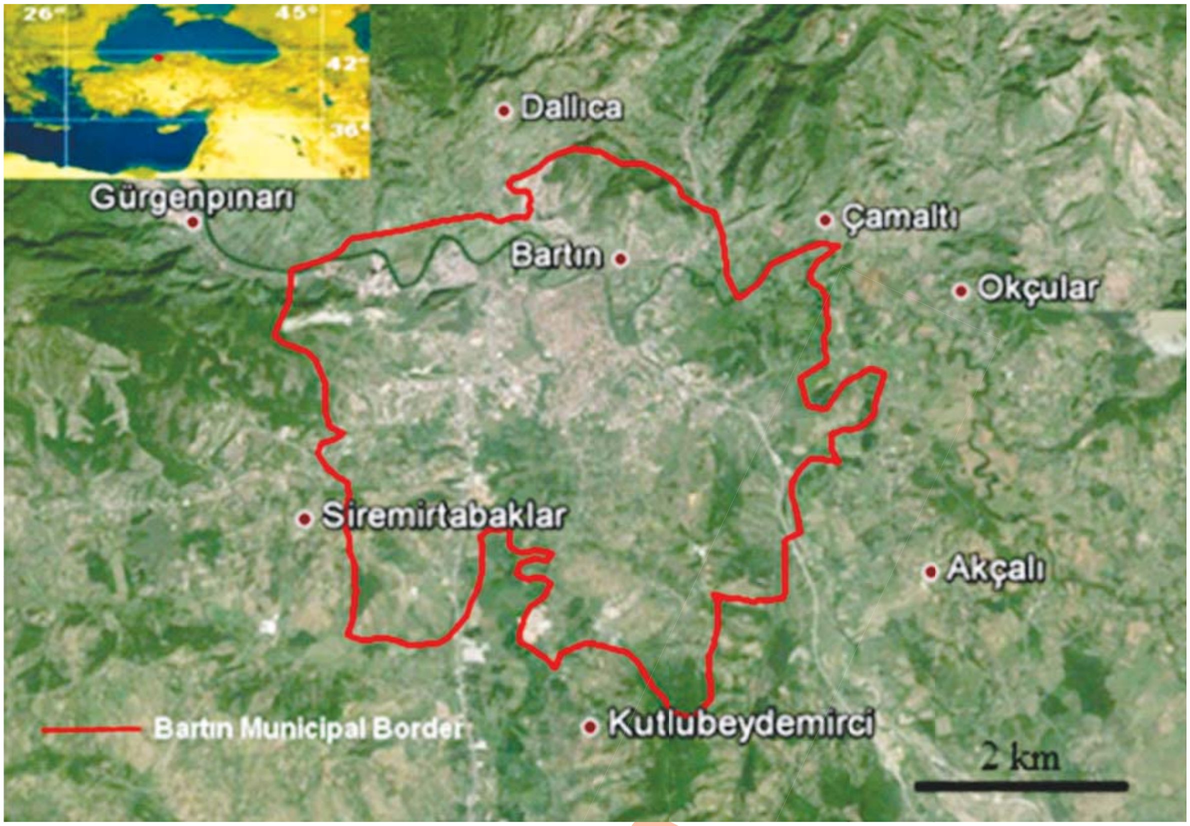

Fig. 1 : Fields studied in the City of Bartin on the Western Black Sea Region in Turkey

Table1 : Characteristics of satellite images used

Satellite-Sensor	Acquisition Date	Resolution (m)
Landsat MSS	16.06.1975	57
Landsat TM	25.07.1987	28.5
Landsat ETM	21.08.2000	28.5
Landsat TM	25.06.2011	30

Table 2 : Number of earth control points used and the root mean square errors (RMS)

Satellite-Sensor-Date	Ground Control Points (GCP)	RMS errors (± pixel)
Landsat MSS (1975)	21	0.7852
Landsat TM (1987)	21	0.6114
Landsat ETM (2000)	21	0.5895
Landsat TM (2011)	21	0.6245

vegetation” were made in order to determine the presence of vegetation potential. Final images were produced regarding the results found by making the vegetation changes between 1975 and 2011 and the inter-transferring classes of both classes Raster Calculator and Reclassify Analysis (Fig. 2).

Results and Discussion

The city of Bartın has a rich and wide vegetation area due to its current climatic characteristics. Given that a proportioning is made over the provincial boundaries of Bartın today, the ratio of area used apart from vegetation in 1975, 1987, 2000 and 2011to the total area is 16.37, 20.27, 18.67 and 19.44 % respectively (Table 3). The city of Bartın has a high ratio of vegetation. It is observed that Bartın city center in 1987 and afterwards has become definite. By 2011, there was a change in vegetation as a field of use as a result of the city center and its developing aspects, which is included in the classification of “settlement” (Fig. 3). There have also been some changes in farming lands and their usage apart from the city center. Although there was a decrease in the land outside vegetation between 1987 and 2000, there was an increase in areas out of vegetation between 1975 and 2011.

The areas taken out of vegetation are given in Table 4 within the scope of current data by years. An area of 12.4 % lost its qualification of being a green area between 1975 and 1987. This ratio was 8.8 % between 1987 and 2000 and 9.1 % between 2000 and 2011. In general, 537.29 ha (14.59 %) lost its vegetation qualification between 1975 and 2011. In contrast, there have also been some transformations into green areas. In parallel with the use of land, the effect of transformation to vegetation on agricultural areas is significant. When examined in terms of years, 8.2 % green area gained the qualification of green area between 1975 and 1987. This ratio was 11.50 % between 1987 and 2000 and 7.0 % between 2000 and 2011. When the change from 1975 to 2011 is considered, the ratio of transformation into green area is 11.26%.

458.24 ha area has been out of vegetation between 1975 and 1987. It can be said that change in this period resulted due to use of land for farming purposes by local people. The region which gained the status of a city in 1991 went through an urban development process, particularly after this period. It was found that area out of vegetation between 1987 and 2000 was mostly in the city center and toward the direction of development. The change in this direction continued between 2000 and 2011 and change in land that mak up the city as a whole was detected. When the vegetation changes between 1975 and 2011 were assessed, the city's development and its directions of development could clearly be seen with the effect of industrial areas (Fig. 4).

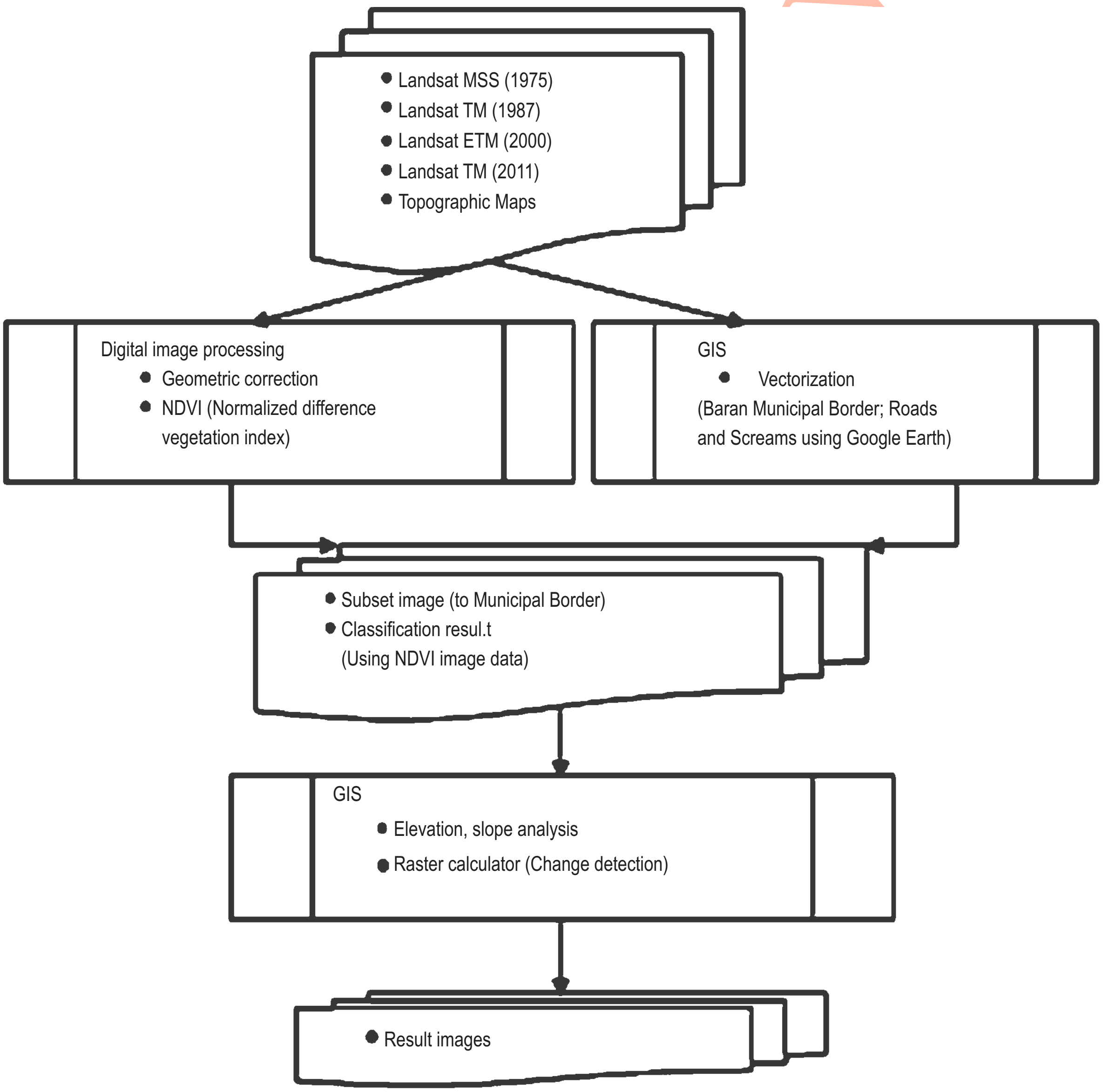

Fig. 2 : Work flow chart for vegetation changes between 1975-2011 in the city of Bartin of Turkey

Table 3 : Annual distribution of vegetation change in terms of area

Year	´Vegetation´ area(ha)	´Out of vegetation´ area (ha)
1975	3079.56	602.64
1987	2935.74	746.46
2000	2994.76	687.44
2011	2966.16	716.04

Table 4 : Distribution of areas out of vegetation based on years

Year	The sum of 'out of vegetation' area (ha)
1975-1987	458.24
1987-2000	319.62
2000-2011	335.34
1975-2011	537.29

Table 5 : Regional distribution of areas out of vegetation between 1975 and 2011 according to slope groups (Ozhan, 1991)

Slope Groups (º)	Area (ha)	'Out of vegetation' area (ha)
0-2 (level and nearly level)	1565.38	270.63
2-6 (gentle slopes)	240.58	62.10
6-25 (sloping)	1268.02	162.09
25-45 (steep slopes)	608.22	42.47
45 < (very steep slopes)		

Kocanazcayı, one of the two branches of Bartın River, join with another branch of the river in Bartın city center. The change of altitude within the boundaries of the municipality showed a change between 10-230 m The region where settlement was more intense within the boundaries of municipality was the leveled region among three hills and the area which was nearly leveled (Fig. 5). By 2011, an area of 498.24 ha in the sum of area 'out of vegetation' (716.04 ha) formed in the region where settlement, elevation groups: 10-30 m was intense. This ratio corresponded to 70 % of the total region.

When the areas out of vegetation between 1975 and 2011 were examined in terms of slope groups, 50.37 % (270.63 ha) of the change emerged in the "level and nearly level" slope group. This ratio increased to 61.93 % in total together with the part which was "gentle slopes". A total of 30.17 % of the area out of vegetation were in the "sloping" class (Table 5). These areas showing change mostly emerged as a result of intensely populated regions (Fig. 6).

Vegetation change analysis provides significant data in terms of land use within the municipal boundaries of Bartın from the past to the present. The corresponding ratio of the area included in green areas, which was out of the green areas, remained at - 3.33 %. While vegetation cycle in terms of land use between 1975 and 1987 resulted from the farming areas, the city center of Bartın and the development of the city later on could be seen clearly. This result showed that urban structuring in the regions out of vegetation was quite high. In a study conducted by Ozcan (2002) on behalf of Bartın Municipality, it is stated that urban income increased after municipalities were given the authority to make and confirm construction plans based on the Law of Construction number (3194) that entered into force in 1985, and the following construction plan revisions, and that an uncontrolled or unplanned urbanization began in the city of Bartın. When data from the State Institute of Statistics were examined, it was found that the total urban population between 1970 and 2000 increased from 22000 to 48000 (TurkStat, 1996; TurkStat, 2011). When the final results of the general census in 1990 and 2000 were examined, it was seen that Bartın center district population increased from 32000 to 36000. Increase in both the number of buildings and population proved that area lying out of vegetation in the city center were primarily used for settlement purposes.

The Ministry of Agriculture and Rural Affairs (1991) used the statements "generally located in level areas" for *class* 1 farmlands and "seen more in gentle slopes (2–6 %) regions" for class 2 farmlands when defining the characteristics of soil ability classes. Within this scope, the Ministry of Agriculture and Rural Affairs (2003) stated that 5.6 % of the city of Bartın in general was located on *class* 1 farmland while 1.7 % was located on second class farming land in the land classification of the city of Bartın in the master plan of the city. When the analysis was made by using a slope groups map and the results obtained in the study were taken as basis, the sum of *class* 1 and 2 farmland where level and gentle slopes lands within the area of study was 1805.96 ha and its ratio was 49.05 %. In a study conducted by Acıksoz *et al.* (2008) within the center district boundaries of the city of Bartın based on land use maps of 1986, it was found that 49 % of the settlement areas according to land ability classes were on *class* 1 farmland, which was quite valuable for farming. The areas out of vegetation between 1975 and 2011 were assessed in terms of slope groups and it was seen that an area of 332.73 ha (61.73 %) was on the *class* 1 and 2 farmlands. Majority of this land was used in settlement and industrial areas. As a result of such unplanned uses, problems such as use of farming land for purposes other than intended, use of riversides for industrial facilities and allowing structuring in places that were not suitable for residing came from the forest (Celikyay, 2004).

Bartın-Zonguldak-Ankara highway district together with the industrial and housing areas is located on a farming land that is parallel to one of the branches of Bartın stream. What's more, a great part of the city of Bartın is located on a first degree seismic zone. There is an active fault line passing through Amasra–Cakraz line connected to the Northern Anatolia fault line (Kuscu *et al.,* 2004).Particularly, the area around Bartın river, around Bartın stream and its surroundings where the slope is level and nearly level, is risky in terms of ground. While being the first degree seismic zone, Bartın also has the risk of flood as the city is established around the Bartın River. Despite all these negatives

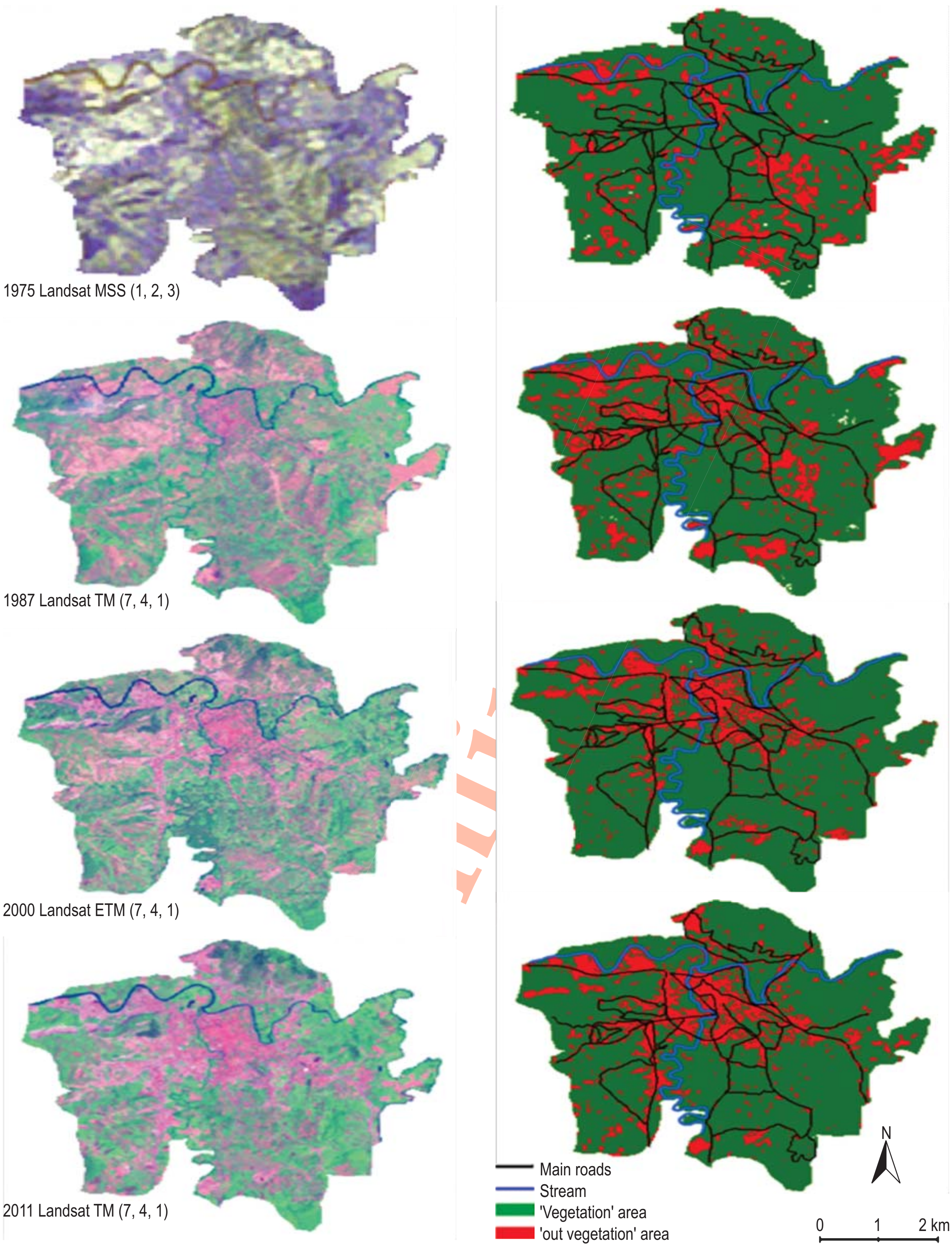

Fig. 3 : The satellite images used and image data classified over NDVI data set of Bartin City

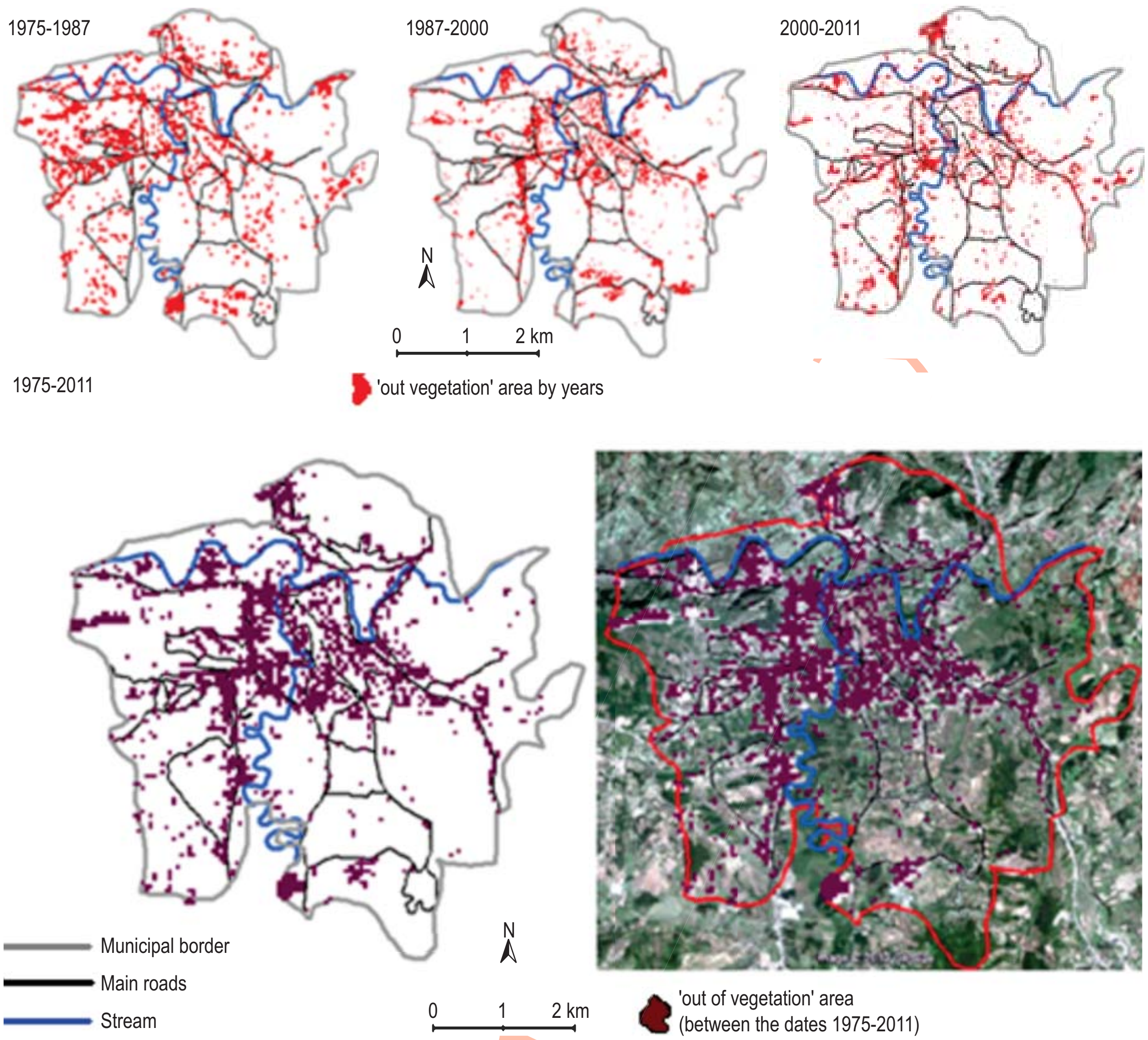

Fig. 4 : Areas out of vegetation

and everything known, it is the most striking example of improper use of land as housing and industrial areas are established on these areas.

The land use decisions regarding field of work affect the physical condition of the environment and the natural biotopes including the presence of vegetation, and thus ecology adversely. Between 1975 and 2011, the use of areas out of vegetation in the settlement of dwelling and industrial regions, especially within the process of urban development adversely affected the urban ecosystem. The results of the study demonstrate the faults in land use. Similarly, increase in the intensity of dwelling and industrial areas decreases vegetation in urban element from past to present. Hence, vegetation contribution on the ecological quality of urban land is continuously decreasing and the effect it has on urban ecosystem is negative (Wakode *et al.,* 2014).

The reality of misuse of land and its dangers were analyzed through the study conducted. Farming lands within the scope of the field of work are used for purposes other than those intended. Settlement and industrial facilities are established by the rivers. All natural landscape areas in relation to natural environment damage vegetation areas the most important element of urban landscape areas. There is no conformance to the following which constitute the basic principles of planning; protection of natural resource values, considering the natural potential of land use and providing urbanization case without eliminating natural landscape elements. This planless condition

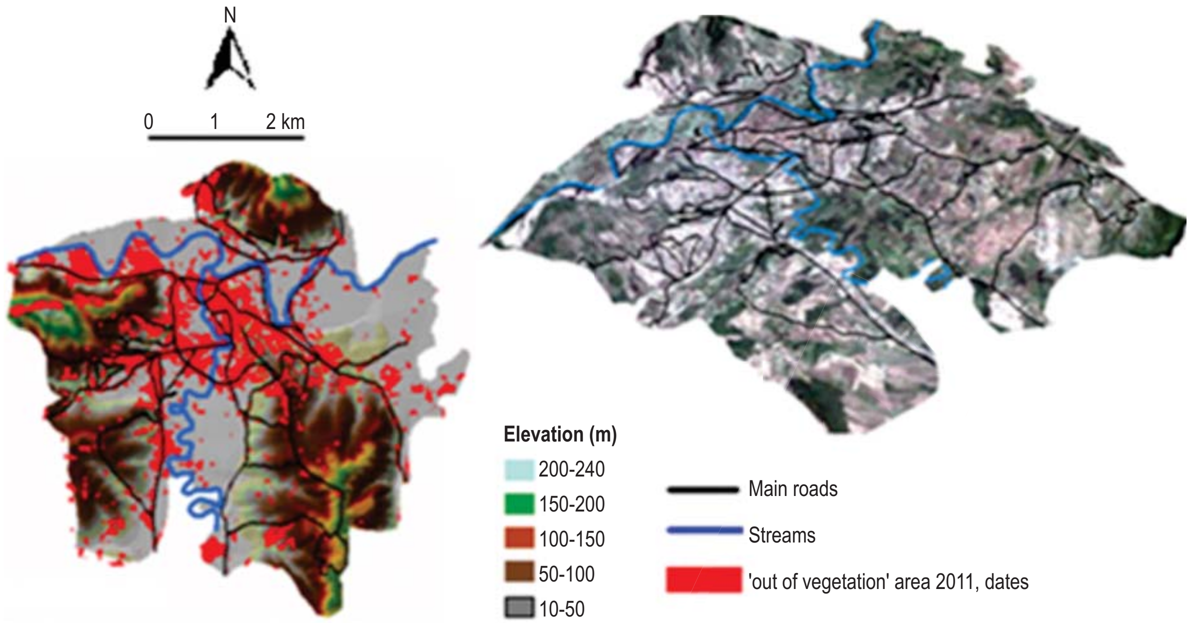

Fig. 5 : Height groups map of Bartın Municipality boundaries and the distribution of areas out of vegetation in 2011

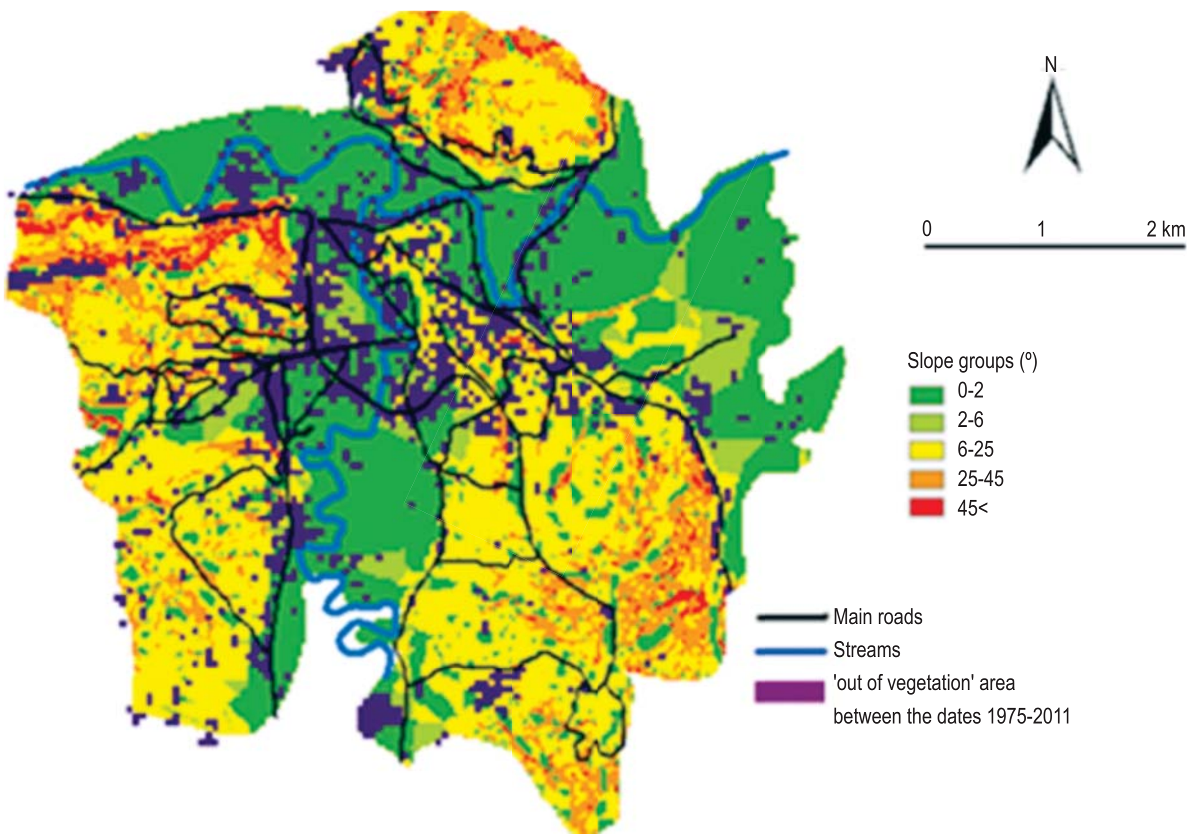

Fig. 6 : Slope groups map of Bartın municipality boundaries and distribution of areas out of vegetation between 1975 and 2011

observed is unsuitable for ecological approaches and methods within the sustainable environment and urban perception.

Solution suggestions should initially be focused on protecting the ecological balance and protecting the vegetation in urban landscape while preventing damage. Regional uses based on land ability classes should be obeyed and urban development should be planned. Since the region is an earthquake zone and it also has a potential flood risk, land use plans must be followed and the use of land for purposes other than intended must be prevented. The region should be protected in terms of its current natural values as well as its tourism potential and assessed by considering the balance of preservation– utilization.

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References

Acıksoz, S., M. Topay and B. Yılmaz: Problems occurring to the inappropriate land uses: Case of Bartın city. *SDU Faculty of Forestry J.,* **A (1)**, 155-167 (2008).

Atesoglu, A. and M. Tunay: Analysis of Vegetation Changes in Coastal Zones of Bartın**.** *Kastamonu Univ., J. Forestry Facul.,* **10**, 84-95 (2010).

Bulut Z., C. Kılıcaslan, B. Deniz and B. Kara: Sustainable in urban ecosystems and open-green areas. In: Proceedings of the III. National Black Sea Forestry Congress (Ed: M. F. Turker). Artvin Coruh University, Artvin. pp.1484-1493 (2010).

Celikyay, S.: The need for ecological planning. In: Proceedings of the V. National Ecology and Environmental Congress (Ed: F. Evrendilek). Abant Izzet Baysal University, Bolu. pp. 561-567 (2004).

Deniz, B., H. Esbah, E.V. Kucukerbas and U. Sirin: Analysis of vegetation structure in urban land uses: Case of the city of Aydın. *Ekoloji,* **17, 66,** 55-64 (2008).

Ducci, D.: GIS techniques for mapping groundwater contamination risk. *Natural Hazards,* **20,** 279-294 (1999).

Duran, D., H. Gurek and E.K. Sandal: Effects of urbanization on agricultural lands and river basins: Case study of Mersin (South of Turkey). *J. Environ. Biol.,* **33**,363-371 (2012).

Efe, R., A. Soykan, I. Curebal and S. Sonmez: Land use and land cover change detection in Karinca river catchment (NW Turkey) using GIS and RS techniques. *J. Environ. Biol.,* **33**,439-447 (2012).

Geymen, A. and I. Baz.: Monitoring urban growth and detecting land-cover changes on the Istanbul metropolitan area. Pages TMMOB National Geographic Information System Congress, Trabzon-Turkey. Proceedings. pp. 127-134 (2007).

Kuscu, I., J.R. Parke, R.S. Whıte, D. Mckenzle, A.G. Anderson, T.A. Mınshull, N. Gorur and A.M.C. Sengor: The relation between active mass shift and regional tectonic movements in Amasra and vicinity (Southwest Blacksea) region**.** *MTA J.,* **128**, 27-47 (2004).

Lillesand, T.M., R.W. Kiefer and J.W. Chipman: Remote sensing and image interpretation. John Wiley & Sons Inc., New York, pp. 427-524 (2004).

Li, C., J. Yin and L. Liu: Research Overview on Urban Land Use Change Based on Remote Sensing Images. *International Journal of Environmental Science and Development*, **2,**45-48 (2011).

Republic of Turkey Ministry of Agriculture and Rural Affairs: Land Property of İcel province; Provincial report 33 (in Turkish). General Directorate for Rural Services, Ankara (1991).

Republic of Turkey Ministry of Agriculture and Rural Affairs: The Support Project of Provincial Agriculture and Rural Development Master Plans, Bartin Agriculture Master Plan (in Turkish). Republic of Turkey Ministry of Agriculture and Rural Affairs publications, Bartın (2003).

Murayoma, Y.: Geography with GIS. *Geo J.,* **52,** 165-171 (2001).

Ozcan, U.: Sustainable Development Plan (Second Stage), Basic Economic and Human Development Plan. Bartın Manucipality, Unal Press, Bartın (2002).

Ozdemir, A.: The roles of public green space on the formation of participant urban identify. *SDU Faculty of Forestry J.,* **A (1)**: 144-153 (2009).

Ozguner, H.: Functıonal Values of Naturalıstıc in Comparıson to Formal Style in the Urban Landscape. *SDU Foculty of Forestry J.*, **A(2)**, 19-36 (2003).

Ozguner, H.: Functıonal Values of Naturalıstıc in Comparıson to Formal Style in the Urban Landscape. *SDU Foculty of Forestry J.*, **A(2)**, 19-36 (2003).

Ozhan, S.: Land Use Technique. İstanbul University, Faculty of Forestry, İstanbul (1991).

Shaw, W.W., L.K. Haris, M. Livingston: Vegetative characteristics of urban land cover in metropolitan Tucson. *Urban Ecosys.,* **2,** 65-75 (1998).

Steinhardt, U. and M. Volk: An investigation of water and matter balance on the meso-landscape scale: a hierarchical approach for landscape research. *Landscape Ecol.,* **17,** 1-12 (2002).

Tunay, M. and A. Atesoglu: Analysis of Changes in Vegetation Biomass about Amasra and Nearby Places Using Multitemporal and Multisensor Satellite Data. *J. Bartin Fac. Fores.,* **10**, 71-80 (2008).

Tunay, M. and A. Atesoglu: Analysis of Vegetation Changes in Coastal Zones of Bartın**.** *Kastamonu Univ., J. Forestry Faculty,* **10**, 84-95 (2010).

TurkStat: Population Structure (in Turkish), Turkish Statistical Institute publication; 2097, Ankara (1996).

TurkStat: http://www.tuik.gov.tr/PreTablo.do?tb_id=39&ust_id=11. – (accessed on 25 May 2012) (2012).

Wakode, H. B., K., Baier, R., Jha and R. Azzam: Analysis of urban growth using Landsat TM/ETM data and GIS-a case study of Hyderabad, India. *Arab J. Geosci.*, **7**,109–121 (2014).