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*Full Length Research Paper*

# Land use-cover change processes in Urban fringe areas: Trabzon case study, Turkey

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**Urban settlements account for only two percent of the Earth's land surface, however, over half of the world's population resides in cities (United Nations, 2001). High population density in urban areas has resulted in a large-scale modification of the environment in urban fringe. Urbanization is a complex process of converting urban fringe and rural land to urban land uses and has caused various impacts on ecosystem structure, function and dynamics (Luck and Wu, 2002). On one hand, the high rate of urbanization causes high density in settlement limited areas of cities, on the other hand, it costs increases to society due to the resulting unplanned and uncontrolled urbanization and land use with the skirts, especially in urban fringe of natural habitat/ landscape pieces and the corrupted use of urban areas without taking into account natural law or the ecological balance (Aydemir et al., 1993). Suburban, urban fringe and rural development are a leading cause of biodiversity loss and natural resource degradation in Trabzon province. The detection and analysis of land use changes in the urban environment is an important issue in planning. Remote sensing and geographic information systems (GIS) are considered as appropriate and efficient techniques for this type of studies. These techniques were used to investigate the effects of urbanization on ecosystem structure (landscape) and to quantify urban growth of Trabzon urban area. Changes of landscape pattern from 1987 to 2008 were analyzed by FRAGSTATS with four metrics, indicating that the diversity and landscape fragmentation are positively related to the degree of urbanization. The study showed that the percentage of urbanization in Trabzon Centrum increased from 4.72 in 1987 to 6.27 in 2008 based on supervised classification of images. Cumulative urbanization accounted for 1.55% of the whole area of Trabzon (254 ha) and 32.8% of the settlement area of the Trabzon from 1987 to 2008. This translates to an annual rate of urbanization of 1.35% between 1987 and 2008.This study demonstrated additional insights into landscape change by integrating the spatial and the temporal perspectives and targeting the forms of residential developments towards urban fringe.**

**Keywords:** GIS, land use/land cover change, remote sensing, urban fringe, fragmentation, urbanization.

## INTRODUCTION

The most important characteristics of recent century have been technologic developments and elatedly rapid urbanization. This fact has led to many types of environmental and socioeconomic problems at various degrees in developing countries such as Turkey (Longley, 2002; Leao et al., 2004). Understanding the growth and change brought on by urbanization is critical to those who study urban dynamics and those who manage resources and provide services in these rapidly changing environments (Clark and Jantz, 1995; Wright, 1996; Aysan et al., 1997; Sancar, 2000; Chen, 2002; Yang, 2002; Sanchez, 2004). Urbanization is a result of a rapid population increase caused by a mass immigration from rural areas to urban areas in Turkey. Together with this, unplanned and thus uncontrolled urbanization (development of urban, urban fringe and rural area) result in the destruction of green areas and water resources.

Urban settlements are the most important human habitat. Approximately 60% of the world population lives

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in cities and town (United Nations, 1995), generating almost 80 % of the global economic output. However, the metabolism of urban activities (that is, land use) has become a treat to the global environment (WRI, 1996). In developing countries, besides high rate of urbanization, urban, urban fringe and rural areas are developed spontaneously, unplanned and/or uncon-trolled, hence ecological resources cannot be cared intentionally. On one hand, the high rate of urbanization causes high density in settlement limited areas of cities, on the other hand, it costs increases to society due to the resulting unplanned and uncontrolled urbanization and land use with the skirts, especially in urban fringe of natural habitat/ landscape pieces and the corrupted use of urban areas without taking into account natural law or the ecological balance (Aydemir et al., 1993). Land use change can play an important role in environmental changes and contribute to global change and biodiversity loss (Chen et al., 2001; Wang et al., 2006). Changes in urban (fringe) land-use have important consequences for natural resources, especially natural habitat ecosystems, through their impacts on soil and water quality and climatic systems (Chen et al., 2001) resulting in serious environmental problems from macro to micro scale. Understanding of land use changes is essential for sustainable management of natural resources and urban areas as it allows decision makers to take a broader view of urban system and its components (Doygun and Alphan, 2006).

The local authorities are hardly able to manage the pace of urban and rural development and its impact on environment. Among many other factors, ecosystem degradation, habitat loss and fragmentation are the principal causes of biodiversity loss in the world (Whitcom et al., 1981; Terborgh, 1989; Chaves and Arango, 1998; Etter, 1998). The main problem is the dilemma between the protection of environment and urbanization. One of their spatial displays has been increased fragmentation and uniformity of eco-systems (landscapes) and cities. The rates, scales and causes of urban change have had large impacts on cities and have generated strong reverse processes (Barber, 2000; Borsdorf, 2000; Toledo et al., 2000, Rovira, 2000; De Mattos, 2002; Borsdorf, 2003). Cities have become more vulnerable and globalization has reduced their security and independence (Troy, 2002).

Conventional surveying and mapping methods cannot deliver the necessary information in a timely and cost-effective manner. Remote sensing (RS) and geographic information systems (GIS), given their cost effectiveness and technological soundness, are increasingly being used to develop useful sources of information and to support decision making in connection with a wide array of urban applications (Souleyrette and Anderson, 1998; Cowen and Jensen, 1998; Lo and Yang, 2002). GIS and RS technique are very useful to urban planners and have been used increasingly in urban, rural and regional studies (Lee, 1990; Yeh, 1990; Chen, 1992; Yaakup and Healy 1994; Da costa 1999; Ballaney and Bindu, 2003). Particularly, GIS provide a powerful tool in geo-environmental evaluation process to support the urban land use planning (Dai, 2001; Reis, 2003). Satellite images are potentially useful source of information on landscape structure.

Furthermore, both technologies can be used to identify and map urban land cover with a fine spatial resolution (Jensen, 1996; Ridd and Liu, 1998; Madhavan et al., 2001; Yang, 2002; Tapiador and Casanova, 2003). RS along with GIS tools are used now to gather, store, retrieve, analyze, display and output data related to the urban and urban fringe environment and can provide planners with certain data sets (Donnay et al., 2001; Bahr, 2001) that help in managing the urban and urban fringe areas. We used GIS and RS technologies to make a first attempt towards analyzing the conservation and fragmentation state of natural ecosystems in potential growth areas of Trabzon settlement. This approach has not been undertaken previously in this part of urban fringe areas. We conducted a preliminary analysis of the representativeness of natural protected areas and ecosystem fragmentation analysis of the region to provide an assessment as to the present state of the ecosystems in this area.

Studying changes in land-use pattern using remotely-sensed data is based on the comparison of time-sequential data. Change detection using satellite data and GIS can allow for timely and consistent estimates of changes in land-use trends over large urban areas (Prakash and Gupta, 1998; Güler et al., 2007). Additionally, some spatial statistic programs like FRAGSTATS offer a comprehensive choice of landscape metrics and have been used to quantify landscape structure. Spatial statistics facilitate the comparison of landscapes (land use) and the evaluation of processes. FRAGSTATS is a spatial pattern analysis program that was implemented by decision makers, urban planners and ecologists to analyze land use fragmentation describing the characteristics of land use, components of those land use (McGarigal and Marks, 1995; Keleş et al., 2008). The advantage of FRAGSTATS is that the calculations are implemented in a fully integrated fashion in a GIS and consequently easy to apply to digitals map (McGarigal and Marks, 1995; Raines, 2002; Başkent and Keleş, 2005; Başkent and Kadıoğulları, 2007; Kadıoğulları et al., 2008; Çakır et. al., 2008; Keleş et al., 2008; Kadıoğulları and Başkent, 2008; Günlü et al., 2009).

## MATERIALS AND METHODS

### Study area

The study area is located in Trabzon province and covers approximately 16416 ha of the area. The study region extends along ED 50 datum Zone 37 551240–568500 E, 4530800–4542510 N on the East Black Sea Region of Turkey (Figure 1). The Trabzon city, the centre of the Black Sea region in Turkey, is an open door

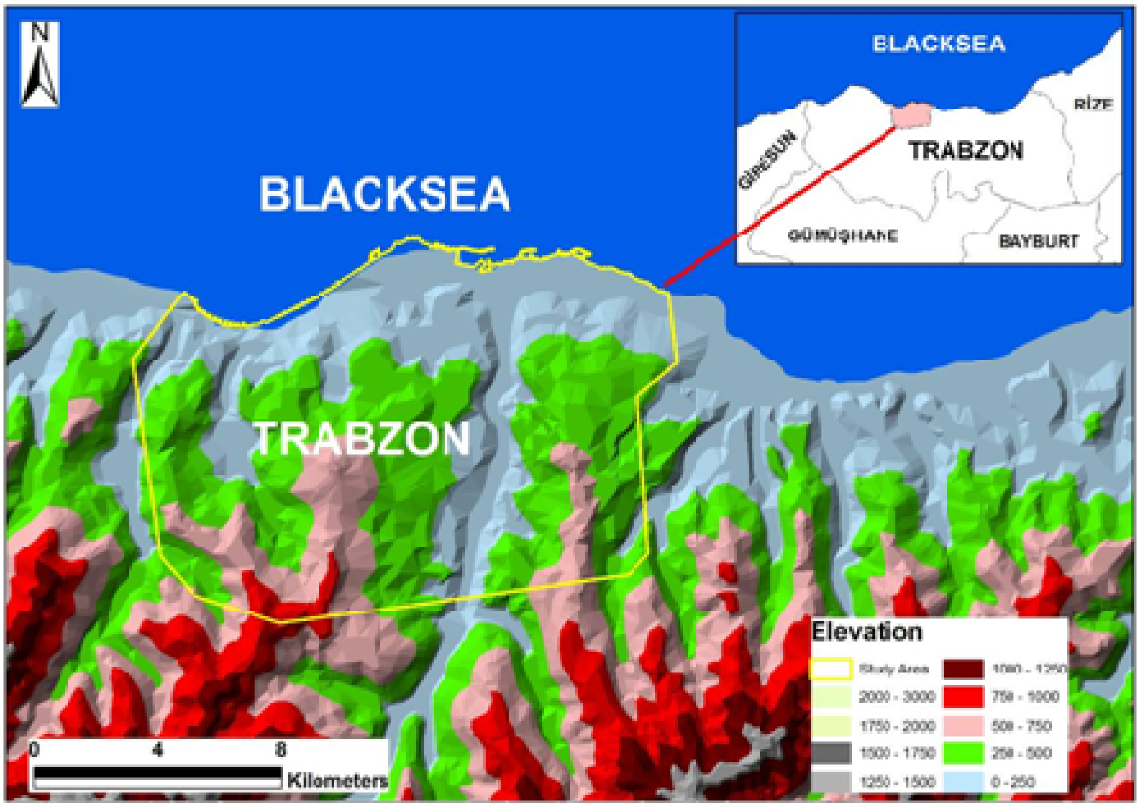


**Figure 1.** The geographic location of the study area.

to Asia for West Black Sea region and Turkey. The second Center of World Trade in Turkey has just been build here. In addition, having an international airport and a large sea port provides an easy land and sea arrival opportunities as important characteristics of Trabzon City. While these features increase the importance of Trabzon, the city Trabzon, however, has been negatively affected by the poor economical development. Emerging of shore-trade and consequently improving commercial activities and activation of regional tourism caused to immigration from surrounding cities or rural areas to Trabzon. In addition to this, increasing population density due to local population growth caused to changes in urban land-use pattern. All these conditions indicate a dense housing and commercial area demand in the future (Reis et al., 2003).

The data used in this research are topographic urban use maps of 1/25000 scale for the year 1984 and 1/1000 scale for 2002 and 2005, a Landsat TM satellite image of 24.09.1987 and a QuickBird image of 17.09.2008. The topographic urban use maps, used as ground rectification, were originally generated from both the stereo interpretation of black and white aerial photos and ground measurements. The Landsat and QuickBird images were interpreted with ERDAS image analysis program.

Demographic dynamics of Trabzon is mostly dominated by migration of rural population to urban centers both within and outside of the district between 1970 and 2008 (Table 1) (Republic of Turkey, State Institute of Statistics). This table shows that there was an important change in population of Trabzon over 30 years. Human population increased from 659,120 to 748,982 inhabitants in the period of 1970 and 2008. However, rural population increased during the first (1970–1985) period, but reversed during the second (1985–2008) period while total human population and urban population constantly increased from 1970 to 2008 in centrum of Trabzon.

## Methods

### *Geometric correction of landsat images*

Subsets of QuickBird image was rectified using 1/1000 scale topographic urban use maps with UTM projection (ED 50 datum) using first order nearest neighbor rules. A total of 30 ground points were used to register the QuickBird image with the rectification error of less than 1 pixel. The TM images, however, were registered to the already registered QuickBird image through image-to-image registration technique with rectification errors of less than 0.5 pixels.

The topographic maps of 1984 used in this research were first scanned, saved in tiff format and then registered in the same manner as with the Landsat TM image. Rectified topographic maps were digitized with a 1/3000 to 1/5000 screen view scale with Arc/Info 9.2$^{TM}$ GIS. This allowed the direct comparison of the features between the images and topographic maps during the selection of sample plots to be used in image classification and accuracy assessment of classified images. Topographic maps of 2002 and 2005 years were gathered from Regional Directory of Trabzon as vector format and used in the classification of QuickBird image.

### *Image classification of the 1987 landsat TM and 2008 quickbird images*

Ground reference data was obtained from more than 40 ground

**Table 1.** Demographic change in Trabzon City.

| | Years | 1970 | 1975 | 1980 | 1985 | 1990 | 2000 | 2008 |
|---|---|---|---|---|---|---|---|---|
| Centrum | Urban | 80795 | 97210 | 108403 | 142008 | 143941 | 214949 | 220860 |
| | Rural | 51567 | 58847 | 66892 | 74211 | 72664 | 68284 | 62649 |
| | Total | 132362 | 156057 | 175295 | 216219 | 216605 | 283233 | 283509 |
| Trabzon province | Urban | 138435 | 171570 | 186580 | 239553 | 303612 | 478954 | 390797 |
| | Rural | 520685 | 547438 | 544465 | 546641 | 492237 | 496183 | 358185 |
| | Total | 659120 | 719008 | 731045 | 786194 | 795849 | 975137 | 748982 |

**Table 2.** Confusion matrix for the Landsat TM (1987) image supervised classification.

| Class Name 1987 | Reference Totals | Classified Totals | Number Correct | Producers Accuracy (%) | Users Accuracy (%) | Kappa |
|---|---|---|---|---|---|---|
| Water bodies | 74 | 74 | 74 | 100.00 | 100.00 | 1.0000 |
| Open Areas | 36 | 33 | 28 | 77.78 | 84.85 | 0.8237 |
| Settlement | 35 | 33 | 27 | 77.14 | 81.82 | 0.7894 |
| Vegetation areas | 81 | 86 | 79 | 97.53 | 91.86 | 0.8809 |
| Overall Kappa Statistics = 0.9076 | | | | Overall Classification Accuracy = 92.97% | | |

**Table 3.** Confusion matrix for the QuickBird (2008) image supervised classification.

| Class Name 2008 | Reference Totals | Classified Totals | Number Correct | Producers Accuracy (%) | Users Accuracy (%) | Kappa |
|---|---|---|---|---|---|---|
| Water bodies | 32 | 32 | 32 | 100.00 | 100.00 | 1.0000 |
| Open Areas | 38 | 36 | 29 | 76.32 | 80.56 | 0.7717 |
| Settlement | 33 | 30 | 26 | 78.79 | 86.67 | 0.8469 |
| Vegetation areas | 107 | 112 | 107 | 100.00 | 95.54 | 0.9233 |
| Overall Kappa Statistics = 0.9148 | | | | Overall Classification Accuracy = 93.75% | | |

data points as signatures for each satellite image. The training points were equally distributed to each cover type with at least 10 points per land use type. For the supervised classification of the 1987 image, the topographic maps of 1984 were used to create ground signatures. Likewise, the topographic maps of 2002 and 2005 were combined to create ground signatures for the supervised classification of the 2008 image. These ground reference points were sampled on the land use type maps, derived from the 2005 IKONOS image and verified through ground measurements undertaken by the Regional Directory Teams in 2005. In order to classify land use types from the images, signatures were taken from the ground corrected stand type maps and adjusted based on the Principle Components Analysis-PCA and unsupervised classification image. Before the classification of QuickBird image, this image eliminated 10 x 10 pixels (6 x 6 m). Supervised maximum likelihood classification methods were employed in the analyses. Then the 1987 and 2008 images were checked for accuracy using ground data points that were not used in the original classification process together with other points of known condition, such as forest areas visually surveyed with binoculars, urban areas and rock outcrops identified in the image. Equal Control Point methods were used in Erdas Imagine 9.0$^{TM}$ program with at least 30 points for each class (Erdas Field Guide, 2002). The accuracy assessment of image was checked for each image and accepted if the accuracy was higher than 80%. After the accuracy assessment, QuickBird image eliminated with 5 x 5 pixel to access the same pixel size of Landsat TM image (30 x 30 m), all images were clumped and vectorized in Erdas Imagine 9.0$^{TM}$ program. These coverages were preprocessed to eliminate areas less than 0.1 ha for spatial landscape analysis with FRAGSTATS program.

Landsat TM image (1987) was classified for four land use types successfully. But settlement areas and open areas were classified with a lower accuracy than other classes (81%) (Table 2). However, this is generally acceptable as the overall classification accuracy is much higher (90%) with the Kappa statistics (Conditional Kappa for each Category Class) value of 0.9297.

QuickBird image (2008) was also classified into four land use type classes successfully. Settlement and open area classes were again not distinguished successfully from each other (80% and 86%) (Table 3). Notwithstanding this, QuickBird image classification is generally acceptable due to a higher overall classification accuracy of 91% and Kappa statistics (Conditional Kappa for each Category Class) value of 0.9375.

### *Transition and spatial analysis of land use types*

In addition to analyzing the changes in the amount of land use types, the temporal transitions among the land use types are also documented and evaluated to see the temporal dynamics of Landscape. The transitions were evaluated using both periodic satellite images. The land use polygon themes for 1987 and 2008 were overlaid and the area, converted from each of the classes to any of the other classes, was computed. The rate of change for each class was calculated by the following formula (Puyravaud, 2003).

$$P = \frac{100}{t_2 - t_1} \ln \frac{A_2}{A_1} \quad (1)$$

where P is percentage of land use change per year and A1 and A2 are the amount of land use type at time t1 and t2, respectively.

The spatial dynamics of land use types refer to the temporal change in the size, number, shape, adjacency and the proximity of patches in a landscape. We used limited number of landscape metrics or measurements as proxy to quantify and spatially analyze the change in spatial structure as demonstrated by Başkent and Jordan (1995) and McGarigal and Marks (1995).

Specifically, we used FRAGSTATS, McGarigal and Marks (1995) to quantify landscape structure of Trabzon Centrum for each of the land use classes. FRAGSTATS calculates a number of spatial metrics for each patch, for each cover class as well as for the entire landscape. We analyzed selected metrics for the land use class for the landscape in 1987 and 2008. Some class-level metrics were computed for the land use type maps of 1987 and 2008 years. The metrics are class Percent of Landscape (PL), Number of Patch (NP), Largest Patch Index (LPI), Mean Patch Size (MPS), Patch Density (PD; number of patches per 100 ha), Percent of Landscape (%) and Area Weighted Mean Shape Index (AWMSI).

## RESULTS

### Temporal change and transition among land cover/land use type

Landscape changes between 1987 and 2008 were mapped using classified satellite images. There was a net increase of 254 ha in settlement areas as opposed to a net decrease of 1280 ha in open areas. Vegetation areas increased 1287 ha and water bodies decreased 159 ha. The cumulative urbanization accounted for 1.5% of the Trabzon as a whole (254 ha) and 32.7% of the settlement area of the Trabzon from 1987 to 2008. This translates to an average 1.3% annual rate of urbanization (Figure 2).

The transition among major land use types between 1987 and 2008 was also determined based on satellite images. According to satellite images, major transition of land use type between 1987 and 2008 years relates to the 1803 ha vegetation areas created from open areas (Table 4). This is probably a result of increase of agriculture and forest areas. However, 573 ha vegetation areas were converted into open areas, that would be explained by land clearing for settlements or some other social pressure would cause the change. However, there was a net area of 1803.1 ha shift from open areas to vegetation areas.

The spatial structure of land use maps developed for the study area for the years 1987 and 2008 was evaluated based on landscape characteristics and indices generated by FRAGSTATS. The evaluations were based on NP, AWMSI, MPS, PD, PSCV, CA and LPI. The structure of land use maps were quantified respectively as NP (3377, 4861), AWMSI (15.375, 17.434), MPS (4.861 ha, 3.412 ha) and LPI (49.07, 55.35) (Table 5).

The land use change from 1987 through 2008 can be seen effectively in the use of 253.5 ha (75.3%) areas indicating converted mostly from open areas to settlement. The fact that the most of the converted areas happened to be on the Southern skirts of Trabzon province may issue from strict delineation of Trabzon city with other adjacent municipalities in the East-west linear urban form direction.

In this period, new settlement use constituted a large part of the change (253.5 ha, 75.3%) increasing from 774.7 ha in 1987 to 1028.2 ha in 2008. Other important areas included vegetation use, which increased to 1281.6 ha. During the same period, water bodies decreased to approximate 160 ha, being replaced by new settlements and vegetation uses (Table 4).

Water bodies showed important decrease, from 166.7 ha. to 7.1 ha. These areas included drainage (dry stream), stream areas, lake and filled sea areas. The large part of changes in water bodies comes from exempted areas in the Environment Impact Assessment (EIA) and new highway construction areas gathered from the sea filled areas from Black Sea, the beach. The sea filled areas are used for public services and recreational purposes.

### Urban growth patterns

In recent decades, the growth of Trabzon is not only related to the population's socio-economic condition, but also to the availability of urban facilities and accessibility to the infrastructure. New residential areas for social housing are, for example, located on the Southern skirts of Trabzon. In urban parts, the natural ecosystems were poor in quality and replaced by new settlements uses, whether inside on the Urban fringe (the periphery) of the consolidated Urban area. The rural landscape surface also decreased considerably from 1987 to 2008, the growth of Trabzon province expanded from 774.7 ha to 1028.7 ha. encompassing the Rural settlement located on the urban fringe.

Even if the urban skirts is outside the city urban fringe /plan boundaries, as an extension of urban, it continues to provide resources (spread of urbanization, recreation areas, food etc) to the urban and its population. As the settlements or buildings in those areas are not considered and envisaged as part of the urban fringe plan, new settlements with different densities and sizes were generated by them. These areas were generally created either using the open areas or an intervention of vegetated areas. This approach is generally valid application that applies to all rural areas.

**Table 4.** The transition matrix of land use change in Trabzon from 1987 to 2008.

| Land use 1987 | Land use 2008 | | | | |
|---|---|---|---|---|---|
| | Open areas | Settlement | Vegetation | Water bodies | Total |
| Open areas | 707.0 | 343.4 | 1803.1 | 0.3 | 2853.8 |
| Settlement | 212.1 | 463.9 | 97.6 | 1.1 | 774.7 |
| Vegetation | 573.2 | 157.9 | 11890.4 | 0.2 | 12621.7 |
| Water bodies | 81.0 | 63.1 | 17.2 | 5.5 | 166.7 |
| Total | 1573.4 | 1028.2 | 13808.3 | 7.1 | 16416.9 |

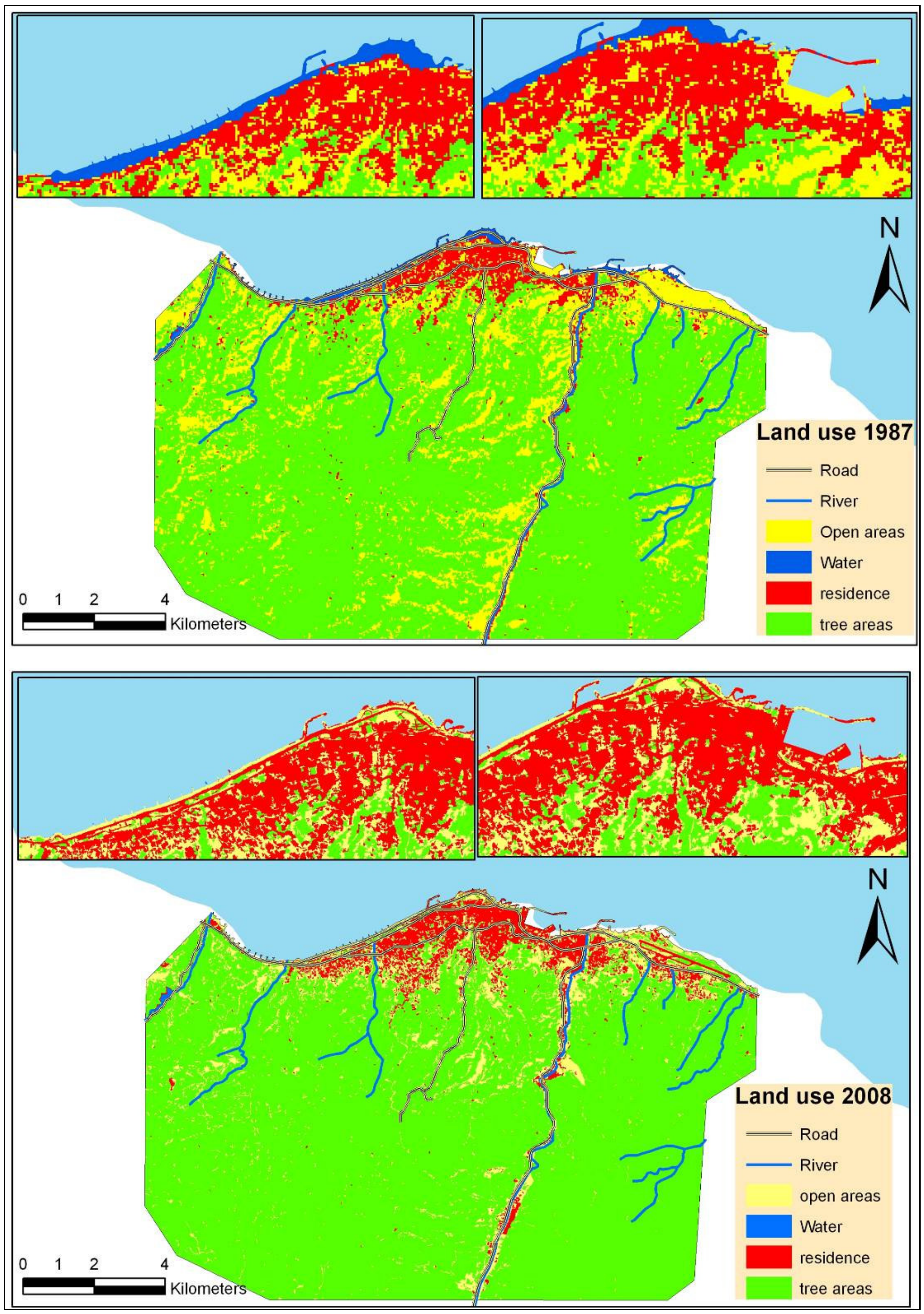


**Figure 2.** Land use change from 1987 to 2008.

**Table 5.** Change of Land use Pattern in Trabzon city (1987-2008).

| Land Use | Class Area (ha) | | Number of Patches | | Mean Patch Size (ha) | | Percent of Landscape (%) | | Largest Patch Index (%) | | Patch density (number of patches per 100 ha) | | Patch size coefficient of variation (%) | | Area-weighted Mean Shape Index | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 2008 | 1987 | 2008 | 1987 | 2008 | 1987 | 2008 | 1987 | 2008 | 1987 | 2008 | 1987 | 2008 | 1987 | 2008 |
| Vegetation | 12621.7 | 13808.1 | 409 | 616 | 30.860 | 22.416 | 76.88 | 84.11 | 49.07 | 55.35 | 2.491 | 3.752 | 1458.6 | 1813.1 | 18.737 | 18.548 |
| Open areas | 2853.8 | 1573.4 | 2440 | 2955 | 1.170 | 0.532 | 17.38 | 9.58 | 1.75 | 0.61 | 14.863 | 18.000 | 626.3 | 477.4 | 3.546 | 4.790 |
| Settlement | 774.7 | 1028.7 | 498 | 961 | 1.556 | 1.070 | 4.72 | 6.27 | 2.44 | 4.14 | 3.033 | 5.854 | 1157.6 | 2048.3 | 6.769 | 21.922 |
| Water bodies | 166.7 | 7.1 | 30 | 279 | 5.559 | 0.028 | 1.02 | 0.05 | 0.42 | 0.04 | 0.183 | 1.699 | 256.8 | 1383.6 | 3.329 | 2.453 |
| Landscape | 16416.9 | 16416.9 | 3377 | 4811 | 4.861 | 3.412 | 100.00 | 100.00 | 49.07 | 55.35 | 20.570 | 29.305 | 3230.7 | 4274.2 | 15.375 | 17.434 |

Residential land activities in Trabzon urban fringe continue the developments into new residential neighborhoods, particularly in the proxymately of main rural access routes within the urban fringe. However, this unplanned or haphazard rapid growth causes upheavals in the operation of the urban land management.

The scattered and disorganized residential deve-lopments and constructions on properties in Trabzon rural/ urban fringe cause residential buildings to be distributed over the land properties with different sizes. 498 patches of residential areas detected in 1987 increased to 961 pieces of patches in 2008 in the study area (Table 4). The traditional scattered and disordered pattern of residential areas increased almost 100% within the boundaries of the study area from 1987 to 2008. Large pieces of residential land use patches continue to increase during the process of land development. The scattered and fragmented pattern of residential land uses particularly in road crossovers or axis also changes in size over time. The average size of patches of settlements decreased from 1.55 ha to 1.07 ha. The decrease in settlement patch sizes is due mainly to the increase in number of settlement patches, rough terrain conditions and rare or non-existence of collective settlement concept in the study area.

## DISCUSSION AND CONCLUSION

The city skirts are absolutely under the pressure of spontaneous urbanization process. Such developments remain under pressure and cause for the planning stage to be undeveloped, for the rural areas or unplanned urban skirt to be self developed within the framework of auto-dynamics of development. This fact impedes or deteriorates the use of rural resource, rural viability and rural development policies. Additionally, the spontaneous residential developments cause unsustainably or rural landscape in terms of ecosystem and make a holistic approach for the protection of natural resources impossible. Resolving the problems appeared around the urban skirts that are not evaluated within plans is of vital importance as the problems trigger global warming, shortages in water resources, degradation of bio-diversity and the sustainably of ecosystems.

The data used in this study confirms the tendency to continue increases in urban land use developments for residential settlements, increase in urban expansions and decreases in arable land (local plant cover) located on the urban fringe. Urban sprawl has prevailed, especially after 1985 and the densification processes is more recent. The emergence of rural areas outside Trabzon city, along the rural main routes of transport, has generated empty rural spaces and extended the city's urban pattern through axes of accessibility. This spontaneous expansions and spread of residential developments may in future continue to fragment the natural vegetation structure. So, new holistic policy schema must be designed for the appropriate developments of rural and urban settlements particularly in the skirts of urban areas.

The percentage of urbanization in the Trabzon Centrum increased from 4.72 in 1987 to 6.27 in 2008 based on supervised classification of images. Cumulative urbanization accounted for 1.55% of the whole area of Trabzon (254 ha) and 32.8% of the Settlement area of the Trabzon from 1987 to 2008. This translates to an annual rate of urbanization of 1.35% between 1987 and 2008. Another study achieved for Trabzon province by Keles et al. (2008) is an indication of an annual rate of deforestations of 0.41% between 1987 and 2000 years. Another similar study about urbanization of Trabzon province showed an annual rate of urbanization of 3.13% from 1960 to 2000 years (Reis et al., 2003). Also, a research conducted by Günlü et al. (2009) showed that an annual rate of urbanization of 1.98% in Rize province, a neighborhood province of Trabzon.

Besides, the same researchers in another study area in Turkey showed that annual rate of urbanization is 4.19% in İnegöl district (Baskent and Kadıoğulları, 2007). Trabzon has experienced changes in its urban morphology and its socio-spatial structure due to the increase in population and mobility, the emergence of new urban expansion areas and population migrations from rural to urban. This study clearly showed that there is a still spontaneous urban development and expansion in Trabzon province and the traditional development models may not explain the organization of the urban spaces in cities in Turkey. These uncontrolled and spontaneous developments of settlements in the study are covered within the city development plans in the next or future periods. Such concept almost becomes an automatic or default process and highly impedes the future plans as it continues to fragment the land use patterns and causes to change the planned land use decisions.

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