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Full Length Research Paper

Factors of land use/cover change: A case study from Turkey

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Land use/cover change impacts ecosystem services and functions such as forest health, biodiversity, and water production. Monitoring and assessing land use/cover changes provides an effective and accurate evaluation of human impact on the forest ecosystems. This study aims to determine spatial and temporal changes in land use/cover at a particular time period in a typical forest ecosystem of Turkey using geographical information systems (GIS). Specifically, the objective of this study is to analyze the main factors driving land use/cover change and the impacts of such changes in local and global perspective. Results showed that the total forested areas decreased from 5089 ha (41% of the study area) to 4426 ha (36% of the study area) during a 21 year period, which figures a net decrease of 663 ha (5%) forest areas and the average annual deforestation rate was 32 ha. Conifer forest (161 ha) completely transitioned to other cover types over 21-year period. Three major factors including distance from villages, distance from roads, and ground elevation were considered in evaluating forest disturbance. The results showed that these factors influence the reforestation/deforestation rates. Besides, forest disturbance was found to be closely related to distance from villages, distance from roads, and elevation.

Key words: Deforestation, geographical information systems (GIS), human activities, land use/cover change, proximity analysis.

INTRODUCTION

Various researchers have monitored and discussed land use/cover changes using remote sensing and GIS in international scale (Wakeel et al., 2005; Dewan and Yamaguchi, 2009; Lele and Joshi, 2009; Mondal and Southworth, 2010; Bakr et al., 2010; Ruelland et al., 2010) and national scale in Turkey (Yıldırım et al., 2002; Musaoglu et al., 2006, 2007; Kılıç et al., 2006; Güler et al., 2007; Sivrikaya et al., 2007; Başkent and Kadıoğulları, 2007; Çakır et al., 2007; Keleş et al., 2008; Yuksel et al., 2008; Sivrikaya et al., 2009; Keleş et al., 2009). Particularly, most of the studies in Turkey have discussed land cover changes in forest ecosystems. These studies generally documented the spatial and temporal land use/cover and forest cover changes and the historical dynamics of forest ecosystems including ecosystem structure (example, crown closure, development stage, and tree composition) and spatial analysis with FRAGSTATS. However, there have been only a few studies attempting to document and analyze the main factors (example, topography, distance from road and residential areas) driving land use/cover change.

Karanth et al. (2006) investigated impacts of human activities related factors on land use/cover change in Bhadra Wildlife Sanctuary in India. They examined the specific ecological impacts associated with communities of thirteen villages in the study area. The results from the spatial analysis indicated that the sizes of the sample villages, distance from the villages, and proximity to other villages were the major indicators of land use/cover change and forest disturbance around the villages. The smaller villages had resulted in lower disturbance compared to larger villages. They also found that forest disturbance increased as distance from the villages decreased. The proximity to other villages increased the

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disturbance due to higher access rate by multiple villages.

Triantakonstantis et al. (2006) utilized geographic information systems (GIS) and remote sensing (RS) to assess the effects of human activities related landscape characteristics on land use/cover changes in the Dadia Forest in northeastern Greece. These characteristics included topography (elevation and slope), forest density, and distance from the roads and urban areas. It was reported that the forest areas, which were farther away from roads and located on high elevation with steep slopes, were less likely to be degraded. Besides, the land use/cover chance mostly occurred in lands near the urban settlements.

Kelarestaghi and Jeloudar, (2011) examined the dynamic patterns of land use/cover change considering socioeconomical (that is, distance from road networks and residential areas) and physical factors (topography) in Lajimrood Drainage Basin in northern parts of Iran. They integrated GIS and RS technologies to investigate spatial patterns of land use/cover changes. The results from the study indicated that deforestation was common in the areas near the permanent settlements and road network. It was also reported that serious deforestation occurred due to conversion of forest into the croplands in the areas where topographic conditions were adequate for agricultural developments.

In some previous studies, the spatial analysis has been used to evaluate the factors influencing land use/land cover (Karanth et al., 2006; Triantakonstantis et al., 2006; Kelarestaghi and Jeloudar, 2011), while modeling has been also used in other studies in international scale (Jin-feng et al., 2005; Huang et al., 2007). However, there are only few attempts to evaluate the main factors which affect land use/cover change in Turkey. In this paper, spatial and temporal changes in land use/cover at a particular time in a typical forest ecosystem of Turkey were investigated using GIS. Specifically, the objectives of this study are: (a) to analyze the temporal and spatial land use/cover changes in as 21-year period 1987 and 2008, (b) to analyze the main factors driving land use/cover change and the impacts of such changes in local and global perspective, and (c) to consider the implications of the rates and patterns of change on conventional management activities that create future forest conditions.

METHODS

The study area

Cumaova planning unit, located (310000–332000E, 4520000–4537000N, UTM ED50 datum zone 36N) in Düzce in the northwestern part of Turkey, is selected as study area (Figure 1). Within the 12378.2 ha of total area, 4425.8 ha is covered by forest according to forest inventory results in 2008. The forest is state property managed by the Düzce Province Forest District Directorate under the General Directorate of Forestry. The altitude varies between 60 and 990 m above sea level with an average slope of 33%. Climate regime is characterized by hot summer, a mild winter, and rain through out all seasons. However, there is a two-month dry season in summer. The main soil types in Düzce city and most part of Cumaova planning unit is silt and brown forest soil type. In terms of species distribution, forests can be categorized as pure broadleaf (*Fagus orientalis* Lipsky and *Quercus* sp) forests and mixed (*Pinus nigra* Arnold., *Pinus sylvestris* L., *Quercus* sp, *Fagus orientalis* Lipsky, *Tilia* sp, *Carpinus betulus* L., *Castanea sativa* Mill.) forests.

Database development

The spatial database, developed as part of this study, consisted of forest stand type maps for the years of 1987 and 2008. The forest stand type maps used in this research were first scanned, saved in *.tiff format and then registered to the digital topographic maps. Rectified forest stand type maps were digitized using GIS (ArcGIS 9.3) with a 1/2000 to 1/5000 screen view scale and maximum root mean square (RMS) error under 10 m. The associated attribute data were entered into the computer to create the spatial database of the area.

The following basic categories of land use were identified from each forest stand type map: (1) conifer forest (CF), (2) broadleaf forest (BF), (3) mixed forest (MF), (4) degraded forest (DF), (5) forest openings (FO), (6) hazelnut (Fn), (7) agriculture (Z), (8) settlement (Is), and (9) mining (Oc). A brief explanation of each of the land use/cover classes is given in Table 1.

The transitions were also evaluated using periodic results of forest management plans. 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.

Urbanization is considered as one of the most important factors that threats forest ecosystems and drives land use/cover change (Yu et al., 2010). The ecological effects of urbanization are associated with human activities such as development of new residential areas and road networks near forested areas. In Turkey, there are more than 20000 villages, located in and around the forested areas (GDF, 2007). These villages host approximately 7.5 million people with limited income. The locations of these villages are highly correlated with a range of elevation which is suitable for settlements. In order to provide access to these villages and to perform main forestry activities, over 200000 km of forest roads is planned to be constructed in Turkey (Eroglu et al., 2003). Therefore, distance from village, distance from roads, and ground elevation were selected as factors affecting land use change in this study area. In order to examine how the distance from the roads and villages, and ground elevation affect the land use change, proximity analysis was carried out.

First of all, we determined centers of 14 villages in planning unit using 1/25000 scaled topographic map and created point layer named village center using ArcGIS 9.3. Multiple buffer zones were generated with a buffer distance of 500, 1000 and 1500 m around the village center using point layer. This layer and the land use polygon themes for 1987 and 2008 were overlaid and land use change was assessed in multiple buffer zones around village center.

We created line layer named road and roads in planning unit were digitized using ArcGIS 9.3. Multiple buffer zones were generated with a buffer distance of 100, 200 and 300 m around the road using line layer. This layer and the land use polygon themes for 1987 and 2008 were overlaid and land use change was assessed in multiple buffer zones around roads.

Elevation contour lines in 1/25000 scaled topographic map were digitized with 10 m interval and elevation data were added into the database. In order to indicate the effects of different elevation categories on land use changes, planning unit was divided into four elevation categories as 0 to 250, 250 to 500, 500 to 750 and 750 to

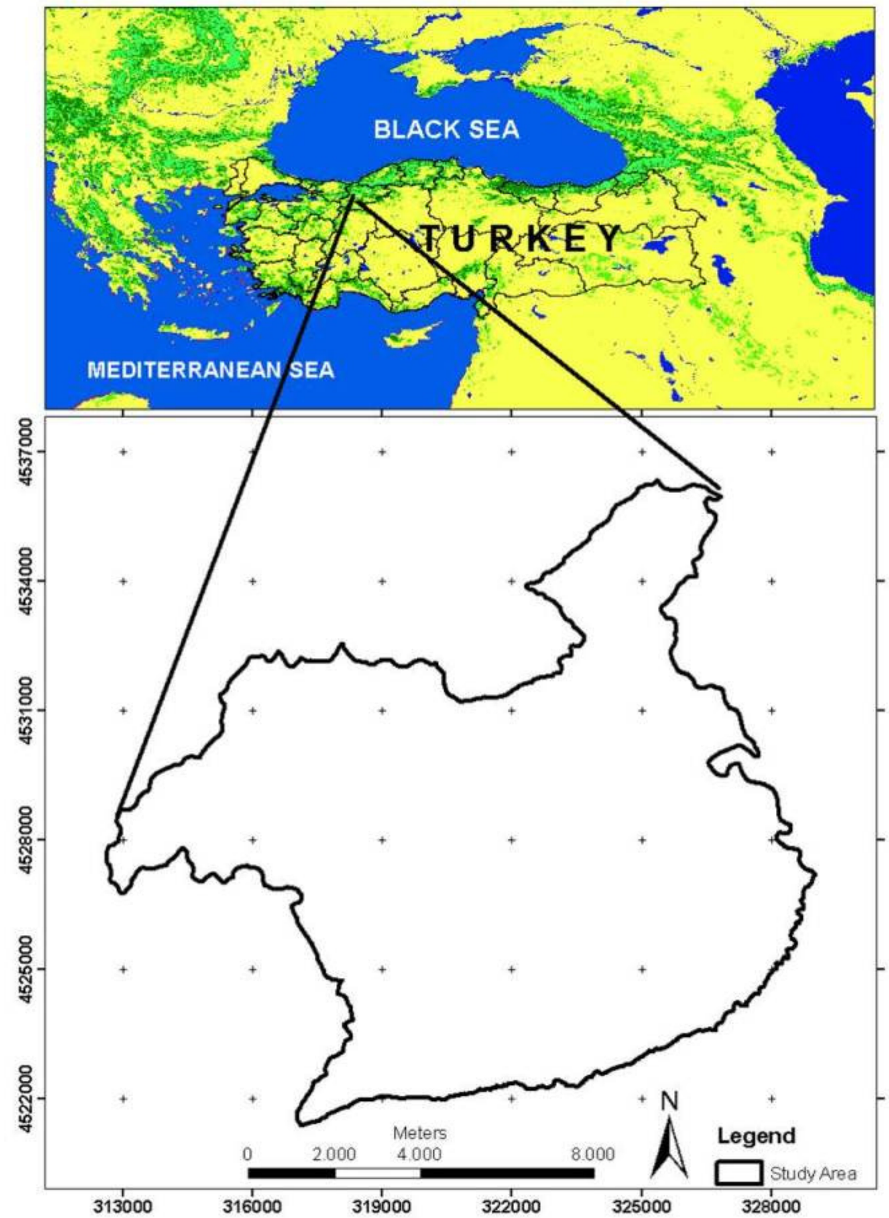

Figure 1. The geographic location of the study area.

Table 1. Descriptions of land use/cover classes.

Land use/land cover classes	Description
Conifer forest (CF)	Forest areas with pure conifer trees whose stand crown closure is greater than 10%
Broadleaf forest (BF)	Forest areas with pure broadleaf trees whose stand crown closure is greater than 10%
Mixed forest (MF)	Mixed (BF-CF, CF-BF) forest areas whose stand crown closure is greater than 10%
Degraded forest (DF)	Forest areas whose stand crown closure is less than 10%
Forest openings (FO)	Treeless areas
Hazelnut (Fn)	Areas covered by *Corylus maxima*
Agriculture area (Z)	Agricultural lands
Settlement area (Is)	Settlements areas
Mining area (Oc)	Mining Area

1000 m. Then, elevation polygon layer with four elevation categories was generated in GIS. This layer and the land use polygon themes for 1987 and 2008 were overlaid and land use change was assessed in elevation categories.

Deforestation rate for successive years of land use/cover maps was estimated using forest area (productive forest and degraded forest). In order to calculate the average annual deforestation rate (%), we supposed that this rate may not remain stable and the following formula was employed (Armenteras et al., 2006; Lele and Joshi, 2009):

$$\text{Deforestation rate (\%)} = [\ln(F_{t2}) - \ln(F_{t1})] \times 100/(t_2 - t_1) \quad (1)$$

$$\text{Annual deforestation rate (ha/year)} = (F_{t2} - F_{t1})/(t_2 - t_1) \quad (2)$$

Where, F indicates the forest area in hectares, and t_1 and t_2 represents initial year and final year, respectively.

RESULTS

Temporal land use/cover change trajectories

As analyzing the changes in land use/cover, the final land use/cover maps of 1987 and 2008 are given in Figure 2 and the area under different land use/cover type in Table 2. According to results from the maps, the total forested area decreased from 5089 ha (41% of the study area) to 4426 ha (36% of the study area) during a 21 year period, which figures a net decrease of 663 ha (5%) forest areas. Forest openings are accepted as non-forest areas. The most notable changes of land use/cover in the study areas were declined in degraded forest (forest areas with stand crown closure of less than 10%) and an increase in productive forest (forest areas with stand crown closure of more than 10%). In 1987, degraded forest in the study areas was about 17.8% which is an estimated area of 2198 ha, but by 2008, it was found that the total area of degraded forest has decreased substantially by about 1.5% (about 180 ha). There was a net decline of 2018 ha in degraded forest as opposed to a net increase of 1356 ha in productive forest areas during 1987 to 2008. Agriculture area increased 1290 ha and settlement areas also increased 687 ha. Other remarkable changes were determined in hazelnut areas and conifer forest. Hazelnut areas were not classified in 2008 while they were 1130 ha in 1987. Besides, a 161 ha of existing conifer forest in 1987 was disappeared in 2008.

Spatial land use/cover change trajectories

Comparison of the change of each land cover class from 1987 to 2008 was analyzed and evaluated by means of the transition from one land cover class to other land cover class to see the intertemporal dynamics of landscape (Table 3). Classes that were converted from non-forest to forest were grouped as reforestation and those that were converted from forest to non-forest were grouped as deforestation. A broad level analysis showed that about 1362 ha (11% of the study area) forest areas changed into non-forest while 699 ha (6% of the study area) non-forest areas changed into forest areas, with a decline of 663 ha (5%) forest areas. In other words, the deforested areas cover 1362 ha of the total study area from 1987 to 2008 (Figure 3). The reforested areas cover 699 ha in the same period. About 24 and 131 ha of conifer forests converted to broadleaf forest and mixed forest, respectively. As a result of this process, conifer forest was disappeared in 2008 in the study area. 131 ha (81% of all conifer forest) conifer forest, 749 ha (34% of all broadleaf forest) broadleaf forest, and 427 ha (20% of all degraded forest) degraded forest converted to mixed forest. Approximately 380 ha mixed forest and 543 ha degraded forest changed to broadleaf forest. Among the land cover groups, 1443 ha forest area and 4507 ha non-forest area in 1987 remained unchanged until 2008 (Table 4). During a 21 year period, the average annual deforestation rate was 31.6 ha/year and equivalent to 0.66% according to Formula 2.

Landscape characteristics

The landscape characteristics which were studied in this paper consist of the three parameters namely distance from the villages, distance from the roads, and ground elevation. In order to examine how the distance from the villages affected the reforestation or deforestation, we generated buffer zones from the village edges in 1987 and in 2008. And then, we examined the reforestation or deforestation that occurred in each buffer. The buffer zones were designated as 500, 1000 and 1500 m distance.

Results show that (Figure 4, Table 5) the forest area in the first buffer zone (0 to 500 m distance from village center) decreased from 250 ha for 1987 to 182 ha for 2008, with a 26.9% of deforestation rate. The forest area in the third buffer zone (1000 to 1500 m distance from village center) decreased from 1144 ha for 1987 to 1019 ha for 2008, with a 10.9% of deforestation rate. A broad level analysis showed that the rate of deforestation steadily decreased as distance from village center increased. The rate of deforestation was 26.9% in the first buffer zone, 25.7% in the second buffer zone and 10.9% in the third buffer zone. We therefore conclude that the distance from the village affects the neighboring forest area significantly. That is, the closer an area is to the village center, the more likely that the area will be deforested. In other words, as distance from village center increased, forest degradation decreased. Our study indicated that forest disturbance was related to distance to village and human activities.

According to distance from road, the biggest forest area took place in second buffer zone (200 m distance from road) in both 1987 and 2008 (Figure 5, Table 6). Forest area in the same buffer zone decreased from 1987 to 2008. The forest area in the first buffer zone (0 to 100 m

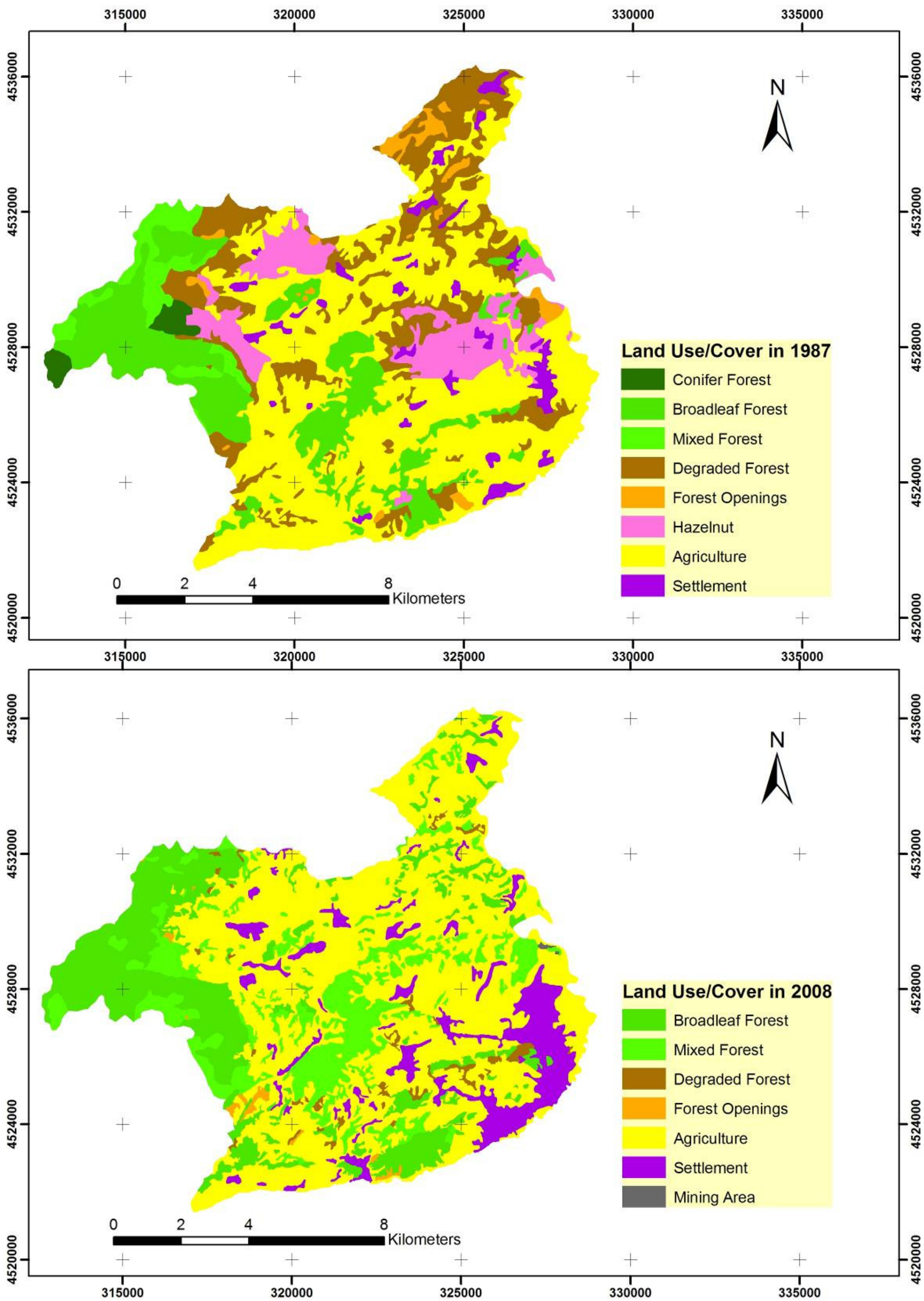

Figure 2. Land use/cover map of the study area.

distance from road) decreased from 888 ha for 1987 to 708 ha for 2008, with a 20.7% deforestation rate. A broad level analysis showed that the rate of deforestation was steadily decreased and the rate of deforestation was

Table 2. Temporal land use/cover change in the study area.

Land use class	Year					
	1987		2008		Difference	
	ha	%	ha	%	ha	%
CF	161.0	1.3			-161	-1.3
BF	2235.5	18.1	2477.6	20.0	242.1	1.9
MF	493.8	4.0	1768.7	14.3	1274.9	10.3
DF	2198.3	17.8	179.5	1.5	-2018.8	-16.3
FO	252.8	2.0	63.2	0.5	-189.6	-1.5
Fn	1130.3	9.1			-1130.3	-9.1
Z	5450.2	44.0	6739.8	54.4	1289.6	10.4
Is	456.3	3.7	1143	9.2	686.7	5.5
Oc			6.4	0.1	6.4	0.1
Total	12378.2	100.0	12378.2	100.0		

Table 3. Spatial land use/cover change in the study area.

Change from (1987)	Change to (2008)							Total
Land use class	BF	MF	DF	FO	Z	Is	Oc	
Conifer forest	23.5	130.6		0.2	6.7			161.0
Broadleaf forest	1280.1	748.8	30.2	0.8	172	3.6		2235.5
Mixed forest	379.6	97.4	0.5	2	14.3			493.8
Degraded forest	542.8	427.1	65.7	12.6	1084.8	65.3		2198.3
Forest openings	12.8	26.6	2.2	3.2	201.7		6.3	252.8
Hazelnut	21.5	75.6	11.5		970.9	50.7	0.1	1130.3
Agriculture	214.8	262.2	68.7	44.4	4170.2	689.9		5450.2
Settlements	2.5	0.4	0.7		119.2	333.5		456.3
Total	2477.6	1768.7	179.5	63.2	6739.8	1143	6.4	

20.3% in the first buffer zone, 17.5% in the second buffer zone, and 12.8% in the third buffer zone. Results show that as distance from road increased, deforestation percent decreased. That is, the closer an area is to the village center, the more likely that the area will deforest. Therefore, the accessibility to the forested areas directly affects the impacts on forests.

Elevation results show that the biggest forest area was in the second buffer zone (250 to 500 m) in 1987 while in the third buffer zone (500 to 750 m) in 2008 (Figure 6, Table 7). The forest area in the first buffer zone decreased from 529 ha for 1987 to 127 ha for 2008, with a 24.0% deforestation rate. A broad level analysis showed that the rate of deforestation was steadily decreased and the rate of deforestation was 24.0% in the first buffer zone, 17.3% in the second buffer zone, 9.5% in the third buffer zone and 6.6% fourth buffer zone. We therefore conclude that as elevation increased, forest degradation decreased. Our study indicated that forest was intensely affected by human activities which led to forest degradation.

DISCUSSION

This study analyzed the spatial and temporal pattern of land use/cover in a forest planning unit in the northwestern part of Turkey during 1987 to 2008 period using GIS. Besides, we carried out proximity analysis to examine how the distance from the villages and road, and elevation affected the land use change.

As an overall change, there was a decrease of 663 ha in total forested areas. In other words, almost 5% of forest areas existing in 1987 had been replaced by non-forest areas by 2008. There was an increase of 1976 ha in sum of settlement and agricultural areas. Overall, although the forested areas decreased slightly, the qualitative aspect of the forest resources improved considering natural composition, configuration of forest landscape, and quantity of productive forests.

The conifer forest in the study area (161 ha) was completely transformed to other cover types during the 21-year period. A broad level analysis showed that 24 and 131 ha conifer forest converted to broadleaf forest

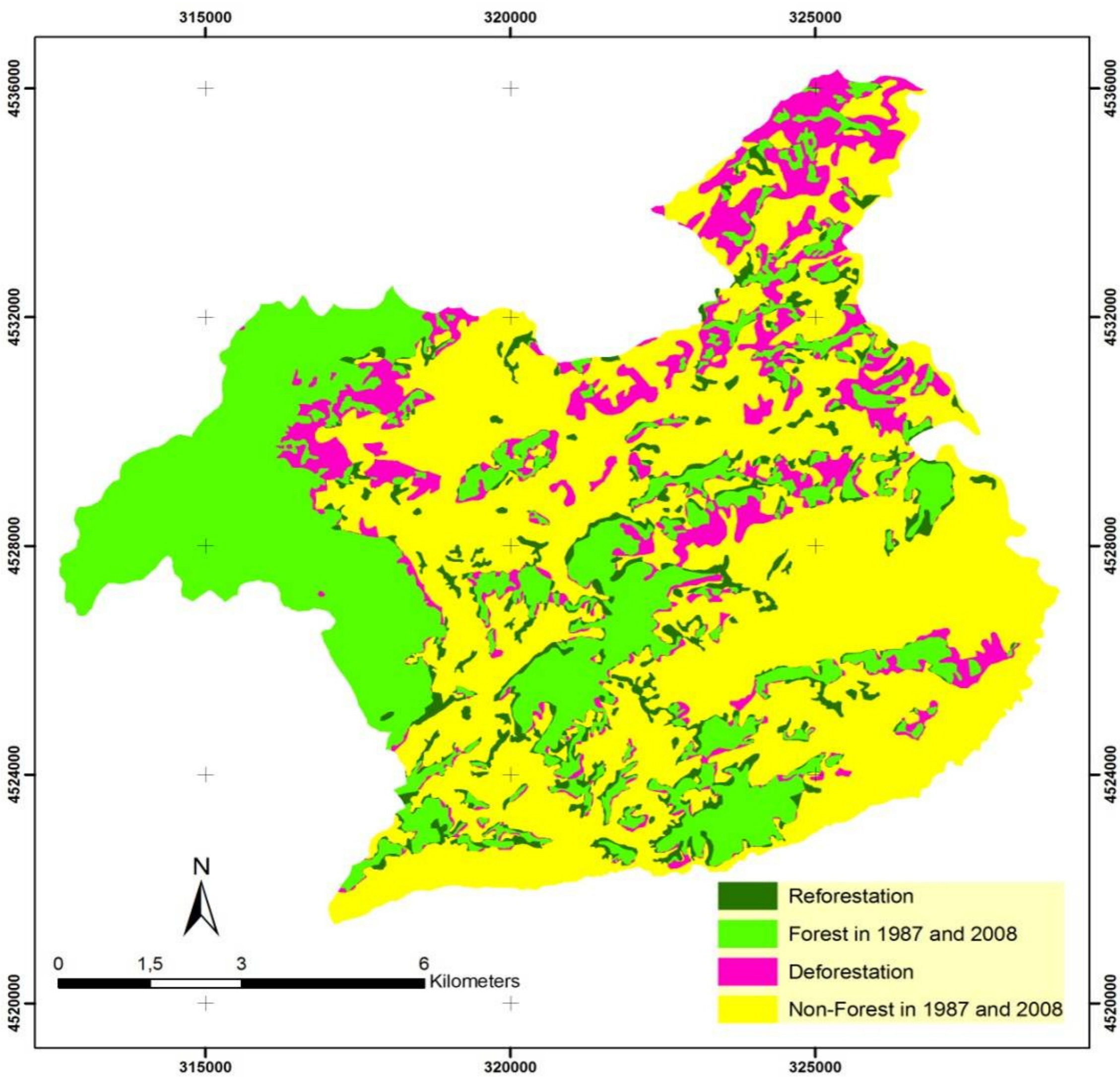

Figure 3. The map of reforestation and deforestation in the study area.

Table 4. Changes in land use/cover types in Cumaova between 1987 and 2008.

Land Cover	Percent of forest cover in 1987			Net gain/loss (ha)
	Unchanged in 2008	Lost to other classes in 2008	Gained from other classes in 2008	
CF		161.0		-161.0
BF	1280.1	955.4	1197.5	242.1
MF	97.4	396.4	1671.3	1274.9
DF	65.7	2132.6	113.8	-2018.8
FO	3.2	249.6	60.0	-189.6
Fn		1130.3		-1130.3
Z	4170.2	1280.0	2569.6	1289.6
İs	333.5	122.8	809.5	686.7
Oc			6.4	6.4

and mixed forest, respectively. According to inventory survey in 1987, conifer forest area was natural regeneration area. Some patches of conifer forest was unsuccessful in regenerating and therefore 24 ha area

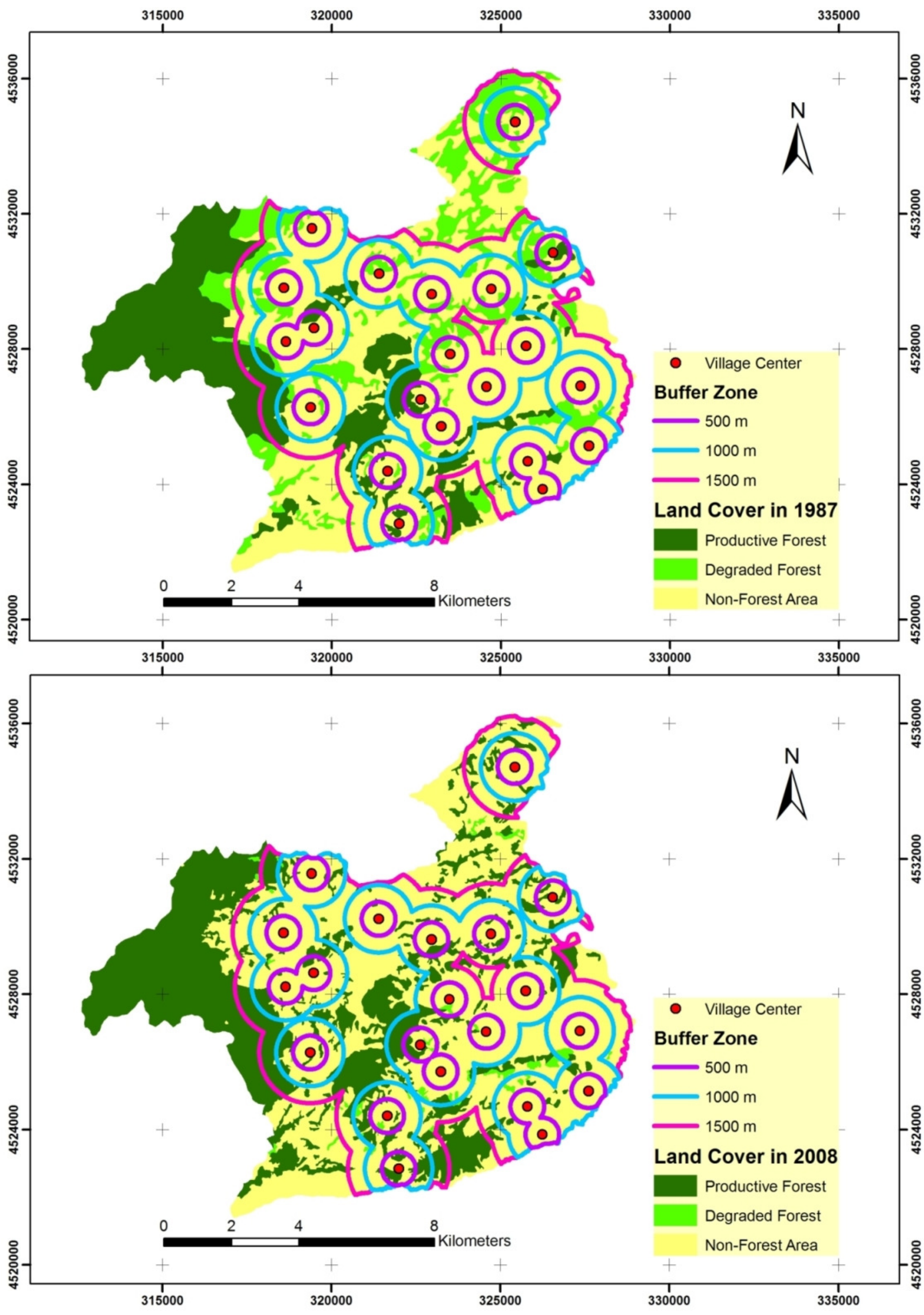

Figure 4. The map of forest cover change in village buffer zone.

was replaced with broadleaf forest (*Fagus orientalis* Lipsky). There were many understorey broadleaf seedlings in the overstorey of conifer trees in 1987. The broadleaf seedlings well developed with the conifer overstorey by the end of the period. In this way, 130.6 ha conifer forest changed into the mixed forest.

The remarkable changes were determined in hazelnut areas. Hazelnut areas were not classified in 2008 while they covered 1130 ha in 1987. This change may be explained by the fact that hazelnut areas were classified

Table 5. Forest cover change in village buffer zone.

Buffer zone (m)	Land cover type	Years		Difference	
		1987	2008	(ha)	%*
0-500	Forest area	250.2	182.8	-67.4	26.9
500-1000	Forest area	1136.6	844.6	-292.0	25.7
1000-1500	Forest area	1144.0	1019.4	-124.6	10.9

*Deforestation percent: 100- (F_{t2}/F_{t1}) ×100.

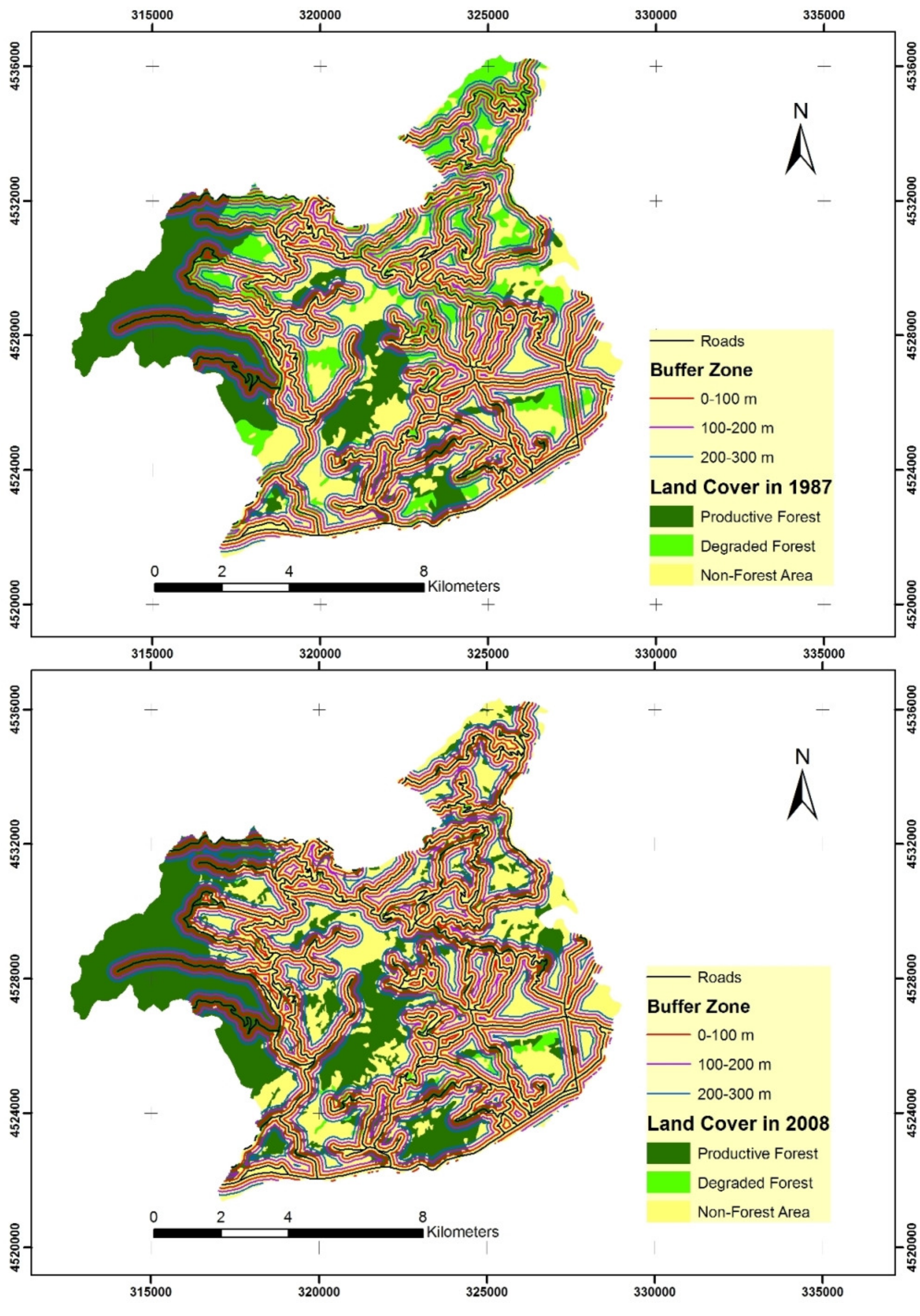

Figure 5. The map of forest cover change in road buffer zone.

Table 6. Forest cover change in road buffer zone.

Buffer Zone (m)	Land cover type	Years		Difference	
		1987	2008	(ha)	%*
100	Forest area	887.6	707.5	-180.1	20.3
200	Forest area	926.1	764.0	-162.1	17.5
300	Forest area	844.8	736.8	-108.0	12.8

*Deforestation percent: 100- (F_{t2}/F_{t1}) ×100.

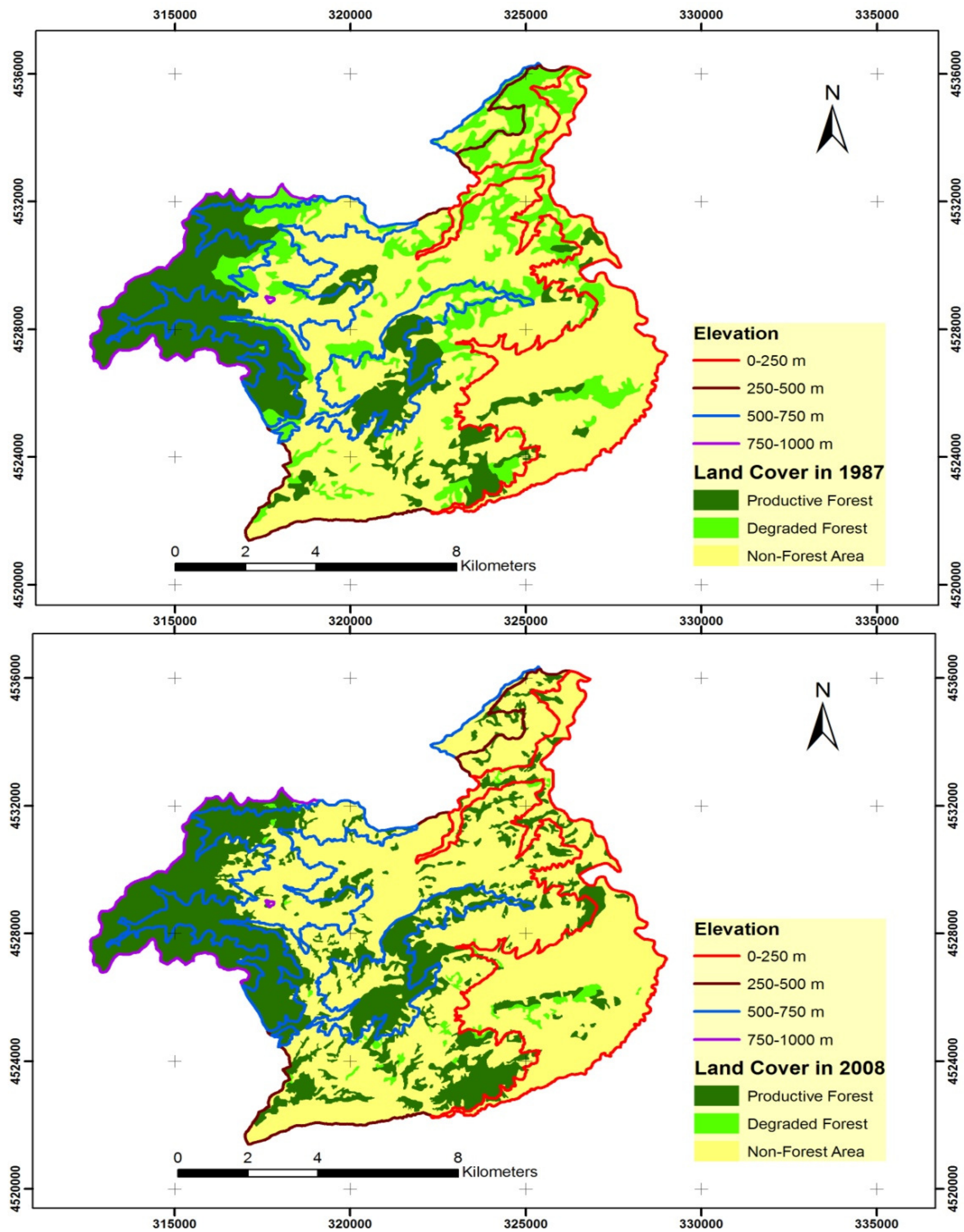

Figure 6. The map of forest cover change in elevation buffer zone.

Table 7. Forest cover change in elevation buffer zone.

Elevation (m)	Land cover type	Years		Difference	
		1987	2008	(ha)	%*
0-250	Forest area	528.5	401.9	-126.6	24.0
250-500	Forest area	1753.6	1450.4	-303.2	17.3
500-750	Forest area	1685.2	1525.7	-159.5	9.5
750-1000	Forest area	1121.5	1047.7	-73.8	6.6

*Deforestation percent: 100- (F_{t2}/F_{t1}) ×100.

as hazelnut stand type in 1987 forest inventory survey. However, hazelnut areas were classified as agriculture areas in 2008 forest inventory survey due to forest management guidelines. Approximately a 109 ha of hazelnut area was converted to forest areas. The most important reasons of this change may well be explained by the fact that demographic movement from rural areas into city centrum. Some villages were abandoned and more people left the rural areas to become resident in urban center. Furthermore, surrounding areas of abandoned villages were covered by young trees resulted from seeds of near forests.

The most notable changes of land use/cover were decline in degraded forest. In 1987, degraded forest was 2198 ha (17.8% in the study area) while it was estimated as 180 ha (1.5% in the study area) in 2008. In general, forest degradation has been a serious problem in many forested areas in Turkey. According to (GDF, 2006), almost half of the forest area in Turkey was specified as degraded forest (that is, forest areas whose stand crown closure is smaller than 10%). General Directorate of Forestry (GDF) started new project to get the highest efficiency and increase forest area as quality and quantity. Thus, all coppice forests (productive and degraded) were converted to high forests due to the recently initiated conversion policy efforts of GDF with expectation of considerable increase in productive forest. Analyzing the study area from this point of view, 78 ha of degraded forest in 1987 was managed as even aged method and 2120 ha of degraded forest in 1987 was coppice forest and managed as coppice method. During 21 year period, degraded coppice forest converted to high forest, which is productive forest and managed as even aged forest, according to GDF's policy. Thus, approximately half of the coppice forest (2120 ha) altered to productive forest. In this way, productive forest has increased by 2008. A broad level analysis showed that 543 and 427 ha of degraded coppice forest (total of 970 ha) converted to broadleaf forest and mixed forest, respectively. Thus, almost half of the degraded forest (1085 ha) changed to agriculture area in the study area. \

Other remarkable changes were determined in mixed forest which increased from 494 ha (4% of the study area) to 1769 ha (14% of the study area) during a 21 year period, with an increase of 1275 ha (10%) forest areas. Within the context of conversion coppice forest to high forest, 427 ha degraded coppice forest converted to mixed forest. Besides, 749 ha broadleaf forest changed to mixed forest. This change may well be explained by the fact that there were many understorey broadleaf seedlings with different tree types in the overstorey of broadleaf trees in 1987. However, diameter of understorey broadleaf seedlings is lower than 8 cm and these seedlings were not taken into consideration for determining stand type. During the 21 year, the broadleaf seedlings developed well with the broadleaf overstorey and pure broadleaf forest converted to mixed forest. As a result, a significant increase occurred in a mixed forest (14% of the study area).

There was a decrease of 663 ha in total forested areas and during the whole study period, the average annual deforestation rate was 32 ha, equivalent to 0.66 according to Formula 2. Similar results from some important studies in Turkey are also shown. A research by Keleş et al. (2009) in the same region of Turkey stated that the forest cover in the Sarıyer district decreased from 8160 (80.7% of the study area) ha in 1971 to 6917 ha (68.4% of the study area) in 2002 based on stand type map. Cumulative forest disturbance accounted for 12.3% of the whole area of Sarıyer district (1243 ha). This translates to an annual deforestation rate of 0.53%.

Another research by the Keleş et al. (2008) showed that the percentage of forest cover in the Trabzon province decreased from 46.2 in 1975 to 41.6 in 2000 based on supervised classification of Landsat images. Cumulative forest disturbance occurred in 4.6% of Trabzon (24415 ha). This translates to an annual deforestation rate of 0.42%. Another research by the Sivrikaya et al. (2009) figured out that forest cover in the Bulanıkdere forest planning unit in western city of Kırklareli in Turkey decreased from 7432.9 ha in 1985 to 7351.5 ha in 2003 based on the digitized stand type maps. Cumulative forest disturbance occurred in 1.1% of the whole area of Bulanıkdere forest planning unit (81.4 ha). This translates to an annual deforestation rate of 0.06%. Another research by the Günlü et al., (2009) declared that the percentage of forest cover in the city of Rize in Turkey decreased from 50.9 in 1984 to 48.6 in

2007 based on stand type map. Cumulative forest disturbance occurred in 2.3% of the whole area of Rize (2299 ha). This translates to an annual deforestation rate of 0.20%.

Three major factors used to determine forest disturbance in this study are distance from village, distance from road, and ground elevation. The results indicated that these factors influence the deforestation percentages. The deforestation occurred nearby the villages. Deforestation percent in 500 m buffer zone was 26.9% while 10.9% in 1500 m buffer zone. Similar results were found in distance from road and elevation. The percent of deforestation decreased as the distance from road increased. Forest area decreased 180 ha (20.3%) in 100 m buffer zone and 108 ha (12.8) in 300 m buffer zone. Deforestation percent was steadily decreased in elevation category. Deforestation percent was 24.0% in the first buffer zone, 17.3% in the second buffer zone, 9.5% in the third buffer zone, and 6.6% fourth buffer zone. In other words, increasing the elevation, the deforestation percent was reduced. Our study indicated that forest disturbance effects were related to distance from village, distance from road, and elevation. Broad level analysis showed that, by increasing the distance from village, distance from roads, and elevation, the deforestation percent was reduced. This is easily explained that human activities are detrimental to the forest tend to be concentrated near village, roads and elevation (Karanth et al., 2006; Triantakonstantis et al., 2006; Mondal and Southworth, 2010; Wang et al., 2010; Ruelland et al., 2010; Bakr et al., 2010; Kroll and Haase, 2010).

Deforestation is decreasing with increasing distance from village and road and increasing elevation in the present study. These results are quite comparable to similar other research results. Triantakonstantis et al. (2006) figured out that the distance from roads and urban areas influences the reforestation/deforestation. Comparing the mean values (χ^2-test) of the landscape characteristics (elevation, slope, distance from roads and distance from urban areas) in the areas of reforestation and deforestation, Triantakonstantis et al. (2006) figured out significant statistical differences in the slope and the distances from roads and urban areas ($p < 0.001$). The elevation did not show any statistically significant differences but in the present study there is a relationship with elevation and reforestation/deforestation rate. Deforestation decreased as the elevation increased. Karanth et al. (2006) stated that three major factors appeared to influence forest disturbance around village: village size, distance from village, and proximity to other villages. Mondal and Southworth (2010) also reported that increasing distance from park boundary, deforestation decreased. Kelarestaghi and Jeloudar (2011) presented that, by increasing the distance from roads and residential areas and villages, the deforestation rate was reduced.

In Turkey, the economical income of the people living in villages in and around the forested areas is quite low (Alkan and Toksoy, 2008). Forests are natural resources for village households and fuel wood is used for cooking, lighting, and heating. In the study area, fuel wood gathering has always been widespread and traditionally free but illegal activities. Availability and unrestricted access to forest and in some cases fuel wood prices rendered forests vulnerable to over exploitation. Forest structure as qualitative and quantitative was directly affected by human livelihood activities in the study area. The ecological surveys offered evidence about the nature and extent of damage to the forest that surrounded the villages (Karanth et al., 2006). Our results are quite comparable to this result. By increasing the distance from villages, the forest destruction was reduced and accessibility to forest directly effects to forest exploitation in the study area. Extensive grazing of livestock can be expected to have increased soil compaction especially along human and cattle trails and human activities have had serious affects on survival and regeneration of trees (Karanth et al., 2006).

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