ANALYSIS OF LAND USE/LAND COVER CHANGES FOLLOWING POPULATION MOVEMENTS AND AGRICULTURAL ACTIVITIES: A CASE STUDY IN NORTHERN TURKEY

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Abstract. This study analyzes the changes in spatial and temporal patterns of land use/cover from 1999 to 2014 in the city of Kastamonu, which is located at the center of the western Black Sea Region of Turkey. In this study, Kastamonu constitutes the study area, which is 65% covered with forests. Remote sensing, geographical information systems, and economic and demographic variables have been used for the analysis. The results showed that 0.2% of forested areas have been converted to settlement areas, and 8.5% have been converted to agricultural lands during this period. On the other hand, 12.5% of settlement areas and 30.4% of agricultural lands were transformed into forested area in the same period. A net increase of 15.1% (108768.2 ha) happened in forest areas between 1999 and 2014. The annual percentage of forestation for forest areas within the study period was 0.94% in Kastamonu. In Kastamonu, the most important factor in the increase of forested areas is demographic movement, which decreased agriculture and animal husbandry due to declining populations in rural areas between 1999–2017. The abandoned agricultural areas have turned into forest areas. Grazing pressure on forests has decreased with the decrease in animal husbandry. This has been effective in structural improvements and spatial increase of forest areas. However, the development of substitute products in wood, widespread use of solar energy systems in rural areas, and the construction of more insulated buildings are other factors that are effective in increasing forest areas.
Keywords: *spatiotemporal analysis, land use/cover change, socio-economic impact on forest, Kastamonu, Turkey*

Introduction

The importance of forest ecosystems is ever increasing, as forested ecosystems maintain the Earth's ecological balance. Pollution and destructive effects from rapid increases in population coupled with rapid industrial development require us to be more sensitive about forests (Seçkin, 1995). In fact, forest areas simultaneously fulfill many ecological, economic, social, and esthetic functions. Forested areas provide many important functions such as reducing all types of air pollution (Yigit et al., 2016; Sevik et al., 2016), reduce noise (Aricak et al., 2016), have a psychologically positive effect (Cetin and Sevik, 2016a), help save energy (Cetin and Sevik, 2016b), and are an important economic resource (Tunçtaner et al., 2007; Sevik, 2012); further, they prevent erosion (Özel et al., 2015; Sevik et al., 2017), reduce wind speed, hold soil through their roots and prevent rain and streams from carrying the soil away, and protect wild life and hunting sources (URL1, 2004; Güneş Şen and Aydın, 2017). Furthermore, open green

areas with plants are important for human activity (Ertekin and Özel, 2010; Cetin et al., 2017; Özel and Ertekin, 2012). These functions, therefore, play a greater role, particularly in highly populated areas. However, when the amount and structure of forested area change, there may be problems in completely fulfilling these functions.

The history of permanent forest destruction dates back to the Neolithic period (Kaplan et al., 2009; Ostlund et al., 2015). However, destruction started to occur during the Industrial Revolution at the end of the eighteenth century (Simpson et al., 2003). According to research by the Food and Agriculture Organization, 16 million ha of forested area were lost between 1990 and 2000, and 13 million ha of forested area were lost between 2000 and 2010 (FAO, 2010). In fact, forest destruction occurs because of the effect of various factors such as ecological (tree species, composition, etc.), natural regeneration capacity, productivity and natural disasters (Ostlund et al., 2015; Trbojevic et al., 2012).

The effects of forest destruction do not remain at a regional level and may have a global impact. According to previous studies, deforestation is the second-largest source of anthropogenic carbon dioxide emissions and causes a net reduction of carbon storage in terrestrial ecosystems (De Sy, et al., 2015). Moreover, forest destruction leads to various effects, such as a decrease in biological diversity, endemics of rare living creatures, and even loss of generations (De Sy et al., 2015; Ochoa-Quintero et al., 2015; Barlow et al., 2016). According to the results of a study conducted in South America, the total deforested area and related gross carbon losses from 1990 to 2005 reached 57.7 million ha and 6.460 gigatonnes of carbon, respectively (De Sy, et al., 2015). In other studies, the deforestation rate was reported to be 3.74–4.09 million ha per year in 1990s and 3.28–4.87 million ha per year in 2000s (Hansen et al., 2010; Harris et al., 2012; Eva et al., 2012; Achard et al., 2014). Carbon loss related to deforestation was calculated as 306–698 petagrams per year in 1990s and 322–845 petagrams of carbon per year in 2000s (Baccini et al., 2012; Harris et al., 2012; Eva et al., 2012; Achard et al., 2014; Houghton, 2012; Tyukavina et al., 2015). Therefore, the loss in forested area is not only a loss of the ecosystem but also has numerous consequences, some of which occur on the global scale and may directly or indirectly affect people, plants, and animals.

Outstanding factors among the causes of forest destruction are as follows: changes in land use; turning forested areas into agricultural or settlement areas; climate changes; and forest fires (Chauchard et al., 2010; Schweizer et al., 2017; Kucuk et al., 2017; Cabral and Costa, 2017). Previous studies have suggested that each of these three factors are fundamentally human-derived. Forested areas are destructed and used for different purposes to fulfill the demands of the increasing population, and the change in the global climate arising from the destruction of the ecosystem caused by human activities damages the forested areas at a significant level. In addition, > 90% of forest fires break out as a result of human activities (Harvey, 2016; Šturm and Podobnikar, 2017).

However, human activities (i.e., anthropogenic factors) are the biggest factor that contributes to forest destruction. At this point, economic activities, population sizes, and people's beliefs emerge as the main factors determining the impact of human activities in a forest (Ostlund et al., 2015; Bayramoğlu and Kadıoğulları, 2018). High-quality forested areas are intensely exposed to the human effect because of plank timber production. Pressure from rural and urban populations cause legal and illegal increases in these utilizations. With respect to changes in population and movements, forests are positively affected on the one hand and negatively affected on the other. To maintain

and manage the biodiversity, it is important to understand the dynamics of forest losses and consequences of human effects, which are the leading cause for such losses (Puyravaud, 2003; Lele and Joshi, 2009; Sen et al., 2015). In this context, such areas should be continuously monitored, and solutions should be developed to avoid current inconveniences and pressures on forests. This monitoring is particularly crucial for biologically rich areas. In this manner, contemporary data would be obtained for sustainable forest management, which would allow decision makers to perform more accurate analyses.

In this study, we analyzed the spatial and temporal changes in land use and land cover during 1999–2014 in Kastamonu City, which is in the Black Sea Region in northwest Turkey. In addition, some socio-economic variables have been examined in relation to changes in the land use/cover. This study fills the gap through a large-scale analysis of land use/cover change using stand-type maps occurring in air photo data, particularly focusing on the Kastamonu forests during the 1999–2017 period.

Study area

Kastamonu Province is located in the western part of the Black Sea Region in Turkey between the north latitudes of 41–42 and east longitudes of 33–46 (*Fig. 1*). Its surface area is 13108 km^2 (Öztürk and Özdemir, 2013).

Figure 1. *Geographic location of the Kastamonu Province*

There are two national parks in the study area: The Küre Mountains National Park, which that Protected Areas Network parks certification, and the Ilgaz Mountain National Park (Anonymous, 2014; Öztürk and Ayan, 2015). Moreover, the Küre Mountains are home to five distinct habitat types, which are categorized as endangered habitats, as per the Bern Conventions (BERN) (KMNP, 2017).

Ilgaz Mountain National Park (IMNP) contains approximately 10% of plant species in Turkey; 64 of these plant species are endemic. IMNP has been identified as one of Turkey's most important plant areas by WWF. The protected natural forests in the IMNP create suitable habitats for many mammal species. Grizzly bear, deer, wolf, fox, wild boar, roe deer, rabbit and otter are some of the mammals in this area (URL2, 2016). At the same time, IMNP is recognized as one of the "97 Important Bird Areas" in Turkey due to predatory birds (URL3, 2017). Another important point in terms of species diversity is the Küre Mountains National Park. In this national park, 1050 plant species, including 158 endemic species, have been identified (URL2, 2016); 59 of these plant taxa are endangered (URL3, 2017).

More than 65% of Kastamonu is covered with forest; 48% of the general area is productive productive woodland; 17% is degraded forest; and 35% is forestless (URL4, 2017; Güneş Şen, 2015).

In Kastamonu, economically the most important sector is agriculture. Agricultural activity depends on vegetative production and forestry because the country is located on a rich forest belt. The agricultural area covers only 28% of the total land of the province. There are some agricultural products in this area, e.g., wheat, barley, and potatoes. Sugar beets, cannabis, and garlic are also produced as industrial crops (URL5, 2014; URL6, 2006). According to 2017 data, the population of Kastamonu is around 360366 persons. The population makes up approximately 0.5% of the country's population. Forty-eight percent of the population live in the city center, and the remaining population live in districts and villages (TUIK, 2017). The population status of Kastamonu Province according to the years is shown in *Table 1*. There are 21 municipalities, including the city center and 1071 villages in the Kastamonu Province.

Table 1. *Urban and rural population of Kastamonu Province (2000–2015)*

Years	Urban population	Rural population	Total population
2000	174020	201456	375476
2007	184685	175681	360366
2010	196162	165060	361222
2015	226868	145765	372633

As shown in *Table 1,* the total population decreased by 2843 persons (0.8%) in Kastamonu. When we look at the rural population, it can be seen that the decline in the population is almost 28%.

Materials and methods

There are various methods for collecting, analyzing, and presenting natural resources data to explain forest dynamics. In particular, the use of remote sensing and geographic information systems (GIS) can greatly shorten and simplify the analysis process

(Gautam et al., 2003). Analysis of temporal changes in area use and covers in Kastamonu Province was performed in two steps. In the first step, stand-type maps for 1999, 2009, and 2014 were quantified and rectified using Arc/Info GIS, and a data set was created for temporal change analysis. In the second step, temporal changes and transitions in the land cover were analyzed.

This study used data-gathered stand-type maps produced by the General Directorate of Forestry for years 1999, 2009, and 2014. These maps were then scanned and registered at the 1:25000 scale using first-order nearest-neighbor rules with UTM projection. We then used ArcGIS® software to overlay the maps and compute changes in land area over time as well as changes between classes of land cover and/or land use (Cakir et al., 2008).

A rough-level classification approach was employed in the study area. Classification refers to a broad simplification of large land-use types and land covers defined by type composition and nonforested areas (Karahalil et al., 2009). Eleven land cover classes were included in the analysis (*Table 2*).

Table 2. *Land use/land cover classes description*

	AL	Agricultural land
	SA	Settlement areas
	W	Areas covered with standing water
	PM	Productive mixed wood
Land use/cover classes	PPC	Productive[*] pure stands composed of coniferous trees
	PPB	Productive pure stands composed of broad-leaved trees
	DPC	Degraded[**] pure stands composed of coniferous trees
	DPB	Degraded pure stands composed of broad-leaved trees
	DM	Degraded mixed wood
	OA	Forest land, meadow, and mining field
	AF	Areas for forestation

[*]Productive forest (PF): Productive forest with a > 10% estimated tree crown cover
[**]Degraded forest (DF): Degraded forest with a < 10% estimated tree crown cover

In addition, forest management plans and information about demographic change, economic conditions, and living standards of local people were obtained and evaluated to determine socio-economic factors and administrative intervention influencing changes in land use.

After that, the data were analyzed to identify changes in land use and land cover over time; the study supplemented these findings by examining forest management plans and socio-demographic data to understand potential contributors to the changes of land use and land cover.

The annual rate of decrease or increase should be also revealed to the impact of a decrease in forest sources on the protection of biodiversity. For this purpose, the annual rate of forestation was calculated using *Equation 1* (Puyravaud, 2003).

$$P = \left(\frac{1}{t_2 - t_1} \ln \frac{A_2}{A_1}\right) \times 100 \qquad \text{(Eq.1)}$$

where P is the percentage of forestation/deforestation per year, and A_1 and A_2 are the amount of forest cover at time points t_1 and t_2, respectively.

In addition to those listed above, changes that have occurred in forested areas and population movements, which are considered to have the greatest impact on this change, as well as the number of large and small cattle, amount of arable land, and yield of farming activities were comparatively evaluated and interpreted.

Results

Spatial and temporal changes in land use/cover

The land use/cover status of Kastamonu Province for the years 1999, 2009, and 2014 were determined as a result of analyses. The results are shown in *Table 3* and *Figures 2*, *3*, and *4*.

Table 3. Evolution of selected landscape variables in the study area from 1999 to 2014

Year	1999		2009		2014	
Class	ha	%	ha	%	ha	%
OA	23560.2	1.85	312.4	0.02	6040.3	0.48
AF	8624.3	0.68	2721.7	0.21	2745.9	0.22
DPC	49423.6	3.89	79833.5	6.28	78315.7	6.17
DM	85434.1	6.73	10315.7	0.81	10621.9	0.84
DPB	111002.2	8.74	89508.0	7.05	88627.9	6.98
SA	21059.2	1.66	23152.4	1.82	23489.8	1.85
W	454.0	0.04	1020.8	0.08	1000.7	0.08
PPC	222055.4	17.48	360646.5	28.39	360529.6	28.38
PM	112648.2	8.87	127449.8	10.03	125227.2	9.86
PPB	139947.2	11.02	163217.5	12.85	165956.6	13.06
AL	496053.6	39.05	412083.9	32.44	407706.4	32.10
Grand total	1270262.1	100.00	1270262.1	100.00	1270262.1	100.00

The forested area in Kastamonu Province is 832024.8 ha, according to the stand-type maps from forest management plans. This area constitutes 63.5% of the Kastamonu Province. On the basis of analysis performed in 1999, approximately 39.05%, 1.66%, 19.36%, 37.37%, and 56.72% of the total area subject to analysis was calculated as the agricultural area, settlement area, degraded area, productive land, and forested area, respectively; whereas, in 2009, approximately 32.44%, 1.82%, 14.14%, 51.27%, and 65.42% of the total area were calculated as the agricultural area, settlement area, degraded area, productive land, and forested area, respectively. In 2014, the ratio of the settlement area in Kastamonu increased to 1.85%, while the ratio of the agricultural area decreased to 32.10%, but there was no significant change in the forested area, and the ratio of forested to total area was 65.28%.
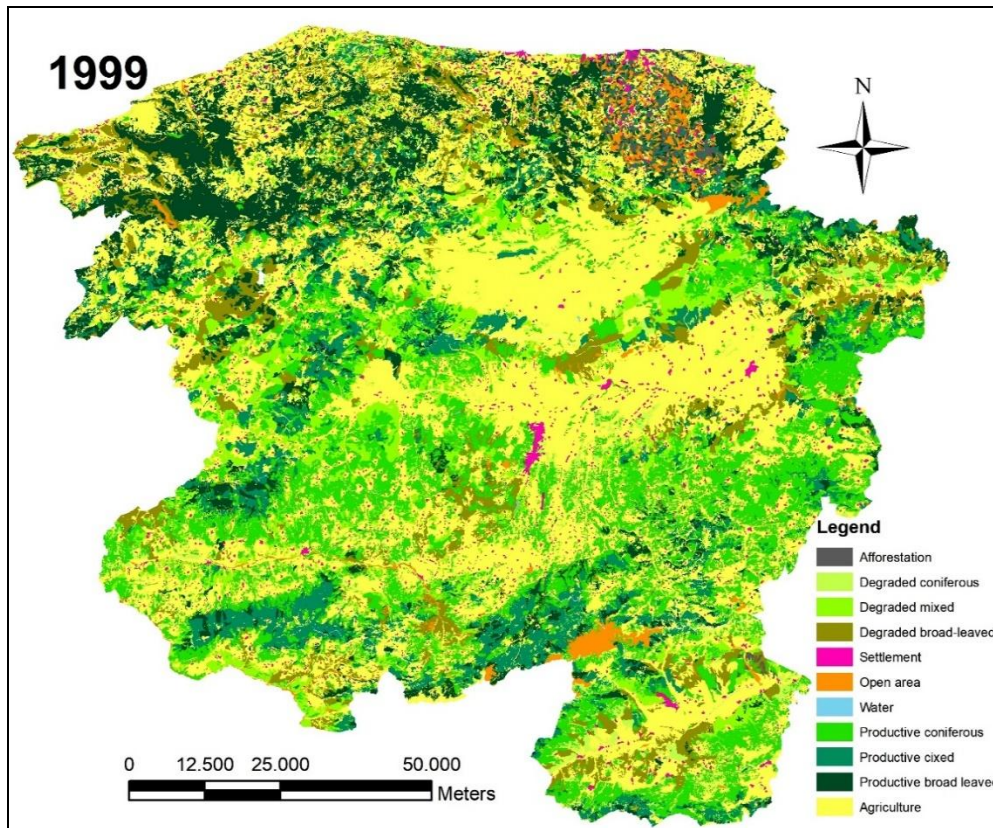
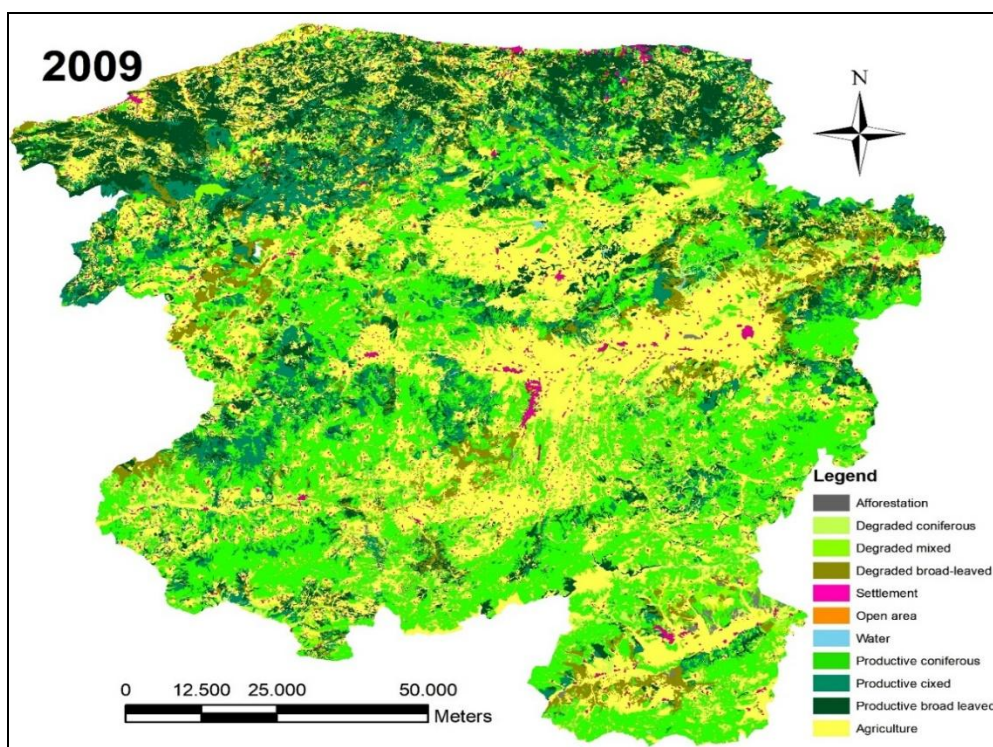***Figure 2.*** *Land use/cover status of Kastamonu Province in 1999*

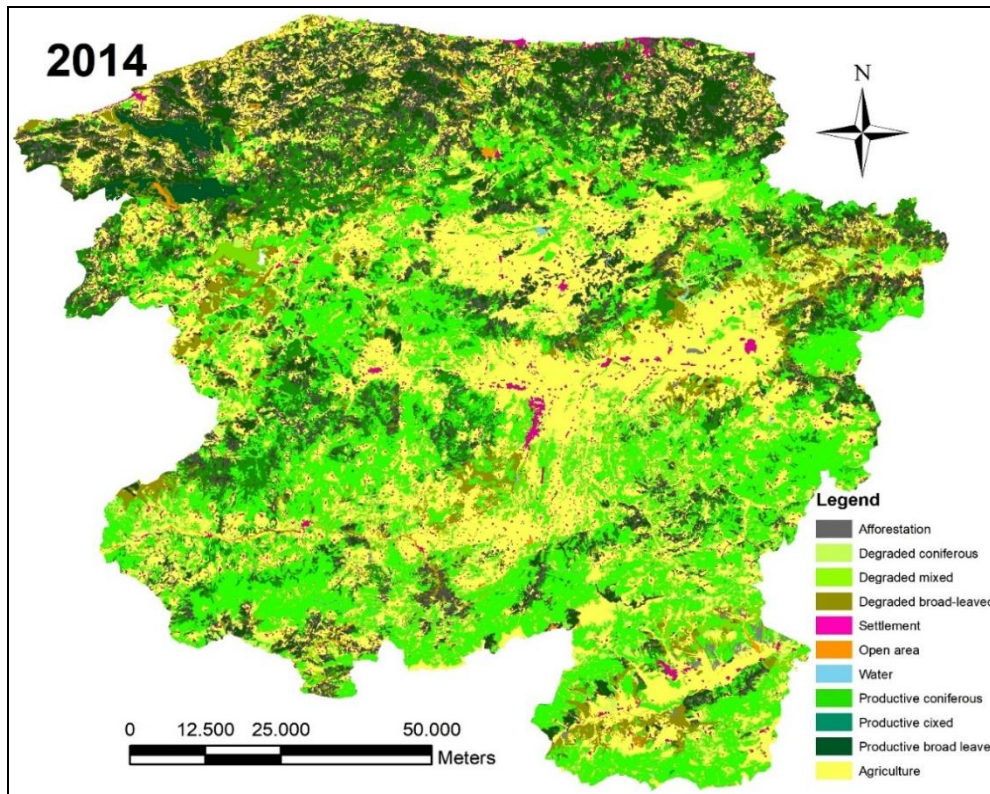***Figure 3.*** *Land use/cover status of Kastamonu Province in 2009*

Figure 4. *Land use/cover status of Kastamonu Province in 2014*

Transition among land use/land cover types

The results of analyses regarding the use of land use/cover in Kastamonu are shown in *Tables 4*, *5*, and *6*.

Table 4. *Transition matrix of land use/cover changes in Kastamonu Province from 1999 to 2009*

					1999–2009						
Changed from	OA	AF	DPC	DM	DPB	SA	W	PPC	PM	PPB	AL
OA	39.9	2.9	1491	21.4	2183.1	132.3	88.7	2099.9	1313.2	6496.4	9691.6
AF	0	314.6	204.5	30.4	327.6	31.1	0	1532.7	1449.9	4378.5	355
DPC	3.7	111.2	18514.5	805.9	3628.7	115.5	12	17396.8	2700.3	1304.9	4830
DM	12.6	241.3	14625	5356.2	8526.9	87.8	24.3	20690.4	18556.4	11880.4	5432.7
DPB	27	345.2	6791.7	1592.2	40408.3	123.5	41	11173.7	11406.9	28983.1	10109.6
SA	25.9	11	226.8	28.2	280.7	12467.2	5.7	393.9	183.6	619.9	6816.2
W	1.5	0	14.5	0	3.9	3.5	203.3	4.1	12.1	24.9	186.2
PPC	51.1	652.2	8955	690.5	2652.8	189.4	22.7	175744.8	20511.3	5182.9	7402.8
PM	0.1	40.3	3873.6	133	5583.7	43.3	72.9	65018.5	22932.4	11041.4	3909.2
PPB	0.5	0.9	1726.5	77.1	4406.7	72.2	8.4	26157.8	35480.4	68194.3	3822.3
AL	150	1002.3	23410.4	1580.6	21505.6	9886.7	541.8	40434	12903.1	25110.7	359528.4

Table 5. *Transition matrix of land use/cover changes in Kastamonu Province from 2009 to 2014*

2009–2014											
Changed from	**OA**	**AF**	**DPC**	**DM**	**DPB**	**SA**	**W**	**PPC**	**PM**	**PPB**	**AL**
OA	117.1	0	6.9	0.5	6.7	14.5	1	33.4	28.6	24.3	79.3
AF	3.6	2124.8	53.5	49.4	42	4.1	1.4	228.2	2.2	14.2	198.3
DPC	191.3	50.3	44784.9	87.2	2311	239.5	25.7	17789.7	2509	2061.4	9783.5
DM	29.5	29.6	254.8	6755.3	135.6	25.6	1.3	1354.8	272	267	1190.3
DPB	379.3	60.1	1444.1	229.5	61181.9	297.3	59.5	4978.7	3266.7	7629.1	9981.7
SA	66.7	14.3	345	28.4	383	13750.2	8.1	521.1	190.4	389.3	7456.1
W	31.4	0	47.8	0.9	66.2	8.1	604.2	24.9	8.4	24.6	204.4
PPC	306.9	193.5	16898.5	1358	4704.2	534.6	19.8	289959.6	12679	7720.1	26272.3
PM	111.6	6.4	2559	272.6	3372.1	200.3	12.7	11646.5	92376.8	9754.9	7136.8
PPB	415.5	8.2	2026.5	344.9	7995	490	50.3	7280.2	8289.9	120952.3	15364.7
AL	3829.2	254.7	10013.1	1100.8	11305.6	7909.7	213.3	26325.4	6818.4	15185.3	329128.3

Table 6. *Transition matrix of land use/cover changes in Kastamonu Province from 1999 to 2014*

1999–2014											
Changed from	**OA**	**AF**	**DPC**	**DM**	**DPB**	**SA**	**W**	**PPC**	**PM**	**PPB**	**AL**
OA	1771.1	5.5	1429.7	21.5	1819.4	167.2	51.2	2714	1363.7	6300.3	7916.6
AF	16.1	287.8	214.4	41.2	388.8	77.1	0	1468.2	1367.9	4200.9	561.9
DPC	107.2	116.9	13233	723.6	3403.4	226.7	13.2	20399.5	2290.5	1609.4	7300.1
DM	277.2	249.4	12939.7	4186.2	8166.6	170	24.5	22646.1	17705.8	11600.2	7468.6
DPB	877	354.5	5876.1	1730.4	34279.9	267.1	69.9	12741.7	11572.5	29290	13943.3
SA	70.8	18.2	396.1	46.1	470.4	9323.5	8.2	675.1	280.4	771.4	8998.9
W	28.8	0	28.8	0.9	26.1	4.8	126.3	15.9	20.2	29.8	172.4
PPC	227.8	615.2	13211.2	1360.5	3891.3	403.5	45.4	157223.9	21131.3	6845.4	17099.9
PM	86.2	38.7	4883.1	237.6	5715	123.6	81	62788.5	21239.5	10773.7	6681.3
PPB	214.8	5.5	2373.8	251.9	6267.5	213.2	12.1	25655.7	32878.8	63401.3	8672.7
AL	2363.3	1054.2	23729.8	2022.2	24199.6	12513.2	568.9	54201	15376.7	31134.2	328890.6

Areal and qualitative improvements in forested areas have attracted increasing attention. An increase of approximately 35% in total productive forested areas from 1999 to 2014 has drawn attention, while 65.56% of degraded forests in 1999 maintained their degraded forest quality in 2014. Approximately 42% of degraded coniferous forests turned into productive coniferous forests, and 8% of these forests turned into productive leaved or mixed forest, while 26% of degraded broad-leaved forests turned

into productive broad-leaved forest; 22% of these forests turned into productive mixed or productive coniferous forest, and > 60% of degraded mixed forests turned into productive forest. Approximately 24% of productive forest also turned into degraded forested area from 1999–2014. Apart from that, > 30% of agricultural areas turned into forested areas, and 2.52% of these areas turned into settlement areas; whereas 66.3% of these areas maintained their agricultural area quality. This ratio indicates that the agricultural area was the highest-rated area that turned into settlement areas.

Analysis of the forestation/deforestation rate

Forestation/deforestation ratios of Kastamonu were determined for 1999–2009, 2009–2014, and 1999–2014. Ratios obtained from this analysis are shown in *Table 7*.

***Table 7.** Forestation/deforestation ratios of Kastamonu Province*

	1999–2009	2009–2014	1999–2014
Productive forest	3.16	0.01	2.11
Degraded forest	−3.14	−0.23	−2.17
Total forest	1.43	−0.04	0.94

As shown in *Table 7,* productive forests have a positive forestation rate, while degraded forests have a negative value, that is, degraded forests generally decrease. The annual forestation ratio from 1999 to 2009 decreased to 3.16% for productive forests and to −3.14% for degraded forests. The annual forestation ratio from 2009 to 2014 decreased to 0.01% for productive forests. The deforestation ratio for degraded forests decreased and regressed to −0.23%. When the study period is evaluated in general, the annual forestation ratio for the general forestation area was 0.94%. The forestation ratio for degraded forests was negative, while this ratio was positive for productive forests.

Discussion

This study particularly indicates that significant changes have occurred in the forest structure, and the changes show similar results of other studies conducted in Turkey. Previous studies showed that the current forested area increased by 15% during 1999–2014 (107768.2 ha). However, despite the decrease of 28% (68294.4 ha) in the degraded forest areas, the productive forest areas increased from 37% (177062.6 ha). In a study covering the period from 1987 to 2000 in the Kastamonu Province, it was determined that 111466 ha of forest area have increased, while open areas of 112888 ha have decreased. In this period, forested areas increased by 8.43% in total (Turan et al., 2010). Similar results were obtained in a study conducted in the Daday District of Kastamonu. In the study, it was determined that the productive forest areas in the Daday region increased by 92.4% between 1970 and 2010. On the other hand, corrupt forested areas decreased by 57.7% (Zengin et al., 2018). These results show that forested areas in Kastamonu are steadily increasing. In 1987, 32.1% of Kastamonu was covered with forest (Turan et al., 2010), while it increased to 63.5% in 2017.

Similar results were obtained by studies in Turkey. In a study conducted in Gümüşhane Province, it was determined that forested areas increased by 6.54% (6928 ha), and the annual forestation ratio increased to 0.50% during 1987–2000 (Kadıoğulları and Başkent, 2008). In a study conducted in Macka, located in the northeast of Turkey, it was determined that high mountain forests showed an increase of 200.6 ha during 1973–2008 (Sen et al., 2015). In a study conducted in Koprulu Canyon, Karahalil et al. (2009) found that the percentage of stands decreased by 5.6% during 1965–1984 and increased by 8.04% during 1984–2008. The cumulative forest accretion accounted for 1.9% (548.7 ha) of the whole area of NP. This rate translates to an annual amount of 12.7 ha forest improvement (Karahalil et al., 2009).

It could be thought that two important factors are effective in changing the land use/cover in Kastamonu. The first effective factor is population movement, especially immigration from rural areas to city centers and other cities, which is important for land use/cover changes in the area (*Table 1*). The change in Kastamonu's urban population during 1990–2015 is shown in *Table 1*. According to the results presented in this table, the urban population of Kastamonu decreased to 372633 persons as of 2015, whereas the total urban population was 423611 persons in 1990. The rural population decreased from 274901 persons in 1990 to 145765 persons in 2015, whereas the urban population increased from 148710 persons in 1990 to 226868 persons in 2015. When these figures are evaluated in general, it is observed that the urban population in 2015 is approximately 1.5 times more than the urban population in 1990. The rural population decreased by approximately 47% from 1990 to 2015. This is an indicator of mass migration from village to town. Along with urban–suburban migration, there is also population migration from the province to the other provinces. The total population, which was 423611 in 1990, declined by 12% in 2015 to 372633. These migratory movements could have different effects on land use and cover. Conversion of agricultural land to forest as a result of a decrease in rural population has been the main factor for increase in forests (*Fig. 5*). It was determined that agricultural areas were converted to forested and settlement areas. Although the decrease in rural population has a positive impact on forests, population increase in city centers leads to conversion of forested areas into settlement areas. In total, 1404.1 ha of forested area was converted to settlement areas during 1990–2014.
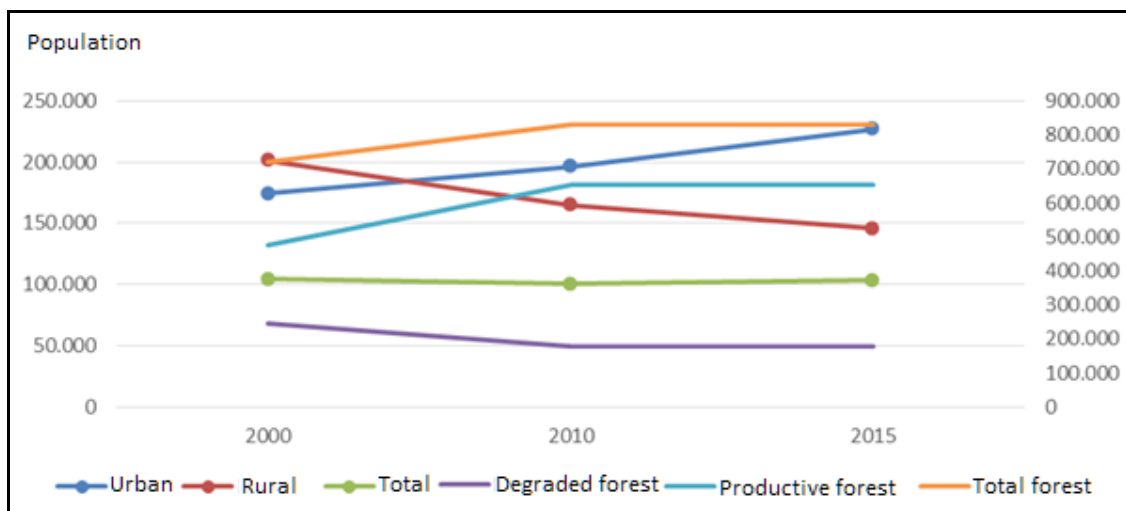

Figure 5. Population of Kastamonu Province and changes in forested areas

When sectoral distribution of gross value added was reviewed, it was observed that the share of the agricultural sector in the developmental zone, including Kastamonu (Sinop, Cankırı, and Kastamonu), is 22.6%; it is well above Turkey's average, which is 9.5%. This study showed that the poverty ratio in the region is high. Agricultural lands in the region are small because of forested areas and their topography. The grains and feed crops have the highest share in plant production. The most significant agricultural activity in conformity with the regional structure is the husbandry activities. The husbandry activities are generally performed by small-scale family enterprises (URL5, 2014). *Figure 6* shows the changes in livestock numbers, amount of arable land, and grain and vegetable production.
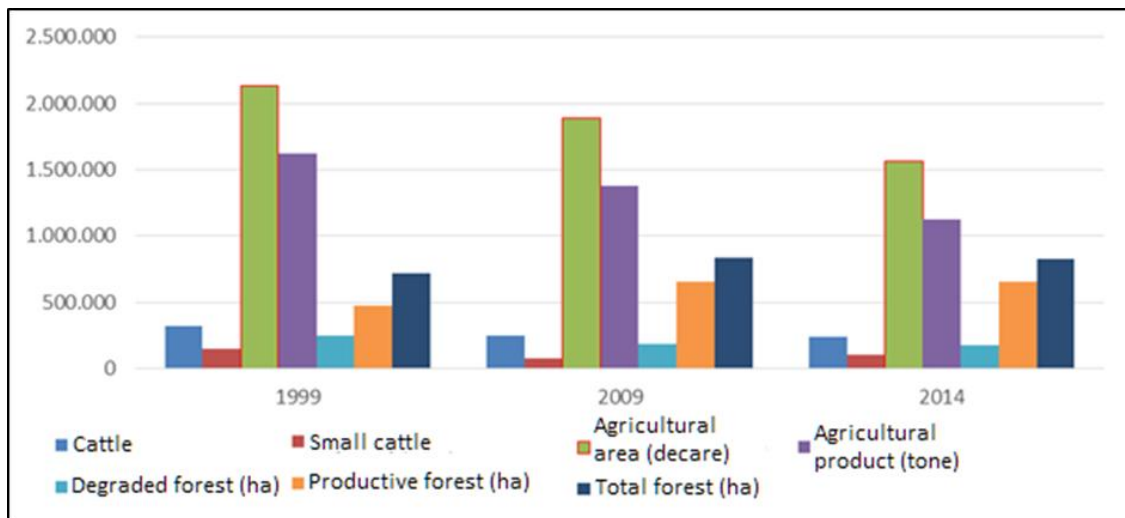
Figure 6. Agricultural variables and changes in forested areas in Kastamonu Province (1999–2014)

The decrease in agricultural activities along with changes in rural population also affect forests. In parallel with the decline in animal numbers, grazing pressure on the forest areas of the animals has decreased. In addition, the use of forests for fuel, lumber, and animal feed by the rural population has decreased. The decrease in all these pressures could have a positive impact on forest growth.

Between 1970 and 2010, in the study conducted in the Daday region of Kastamonu, it was determined that agricultural areas decreased by 57% in parallel with the decrease of the rural population. Particularly, it has stated that the young population leaving the villages is effective in this decrease. This study also found that population movements were concentrated in the city center (Zengin et al., 2018). Another study conducted for Kastamonu Province stated that the main reason for the increase of forest area between 1987–2000 was the population increase (Turan et al., 2010). However, the Kastamonu Forest Regional Directorate found that land use/change is also affected by afforestation activities. The afforestation contributed to the increase of forest areas and the transformation of degraded forest areas into productive forest areas.

Conclusions

This study investigated the spatial changes in land use/cover in Kastamonu in detail. The effects of changes in population and agriculture on forested areas were also revealed. Between 1999 and 2014, forested areas in Kastamonu increased by 15.1% in total. In this period, productive forest areas increased by 37.3% while degraded forested areas decreased by 27.8%. In the same period, the SAs increased by 11.5%, and the ALs decreased by 17.8%. During this change, 42.1% of open areas and 69.6% of agriculture areas have turned into forest areas; 47.2% of degraded forest areas have turned into productive forest areas. At the same time, 0.2% of forest areas and 2.5% of agricultural areas have been converted into settlement areas. The most important factor influencing this change is the migration from rural to urban, particularly after the 1980s. Societies are dynamic, and this dynamism affects the Earth's surface. Therefore, understanding the spatiotemporal changes in land use/cover and associated factors and the dynamics in change are important for sustainable planning of natural resources. However, all those factors should be studied in more detail on the human factor, which has the most influence on this change.

Monitoring and evaluation remain important. These analyses are particularly important for the sustainable management of ecosystems and efficient use of natural resources. For this reason, this monitoring must be elaborated upon and give weight to studies, particularly those in which socio-economic variables and human influence effects on land use are identified.

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