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Interactions between rural migration and land use change in the forest villages in the Gökçay Watershed

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Abstract: This study was carried out to analyze the spatial and temporal pattern of land use/land cover change (from 1955 to 2008) and migration movement (from 1935 to 2007) in the Gökçay River Watershed. To assess this period, the necessary data were obtained from forest stand maps (1955 and 2008) and evaluated by using Geographic Information Systems. Maps of the study area dated 1955 and 2008 have been analyzed, and land use type and change on the land pattern have been investigated. The data reveal that the percentage of forest area, which was 47% in 1955, rose to 50% in 2008; the percentage of rangeland area increased from 2% to 7%, and the percentage of agricultural area went up from 25% to 27%. The percentage of degraded forest area was 1% in 1955 and increased to 2% in 2008. The biggest change was observed in the forest opening areas. Forest openings decreased from 24% to 12%. These areas have been converted to forest, agricultural, and settlement areas. The population of the watershed area was 5561 in 1935, however, dropping by 73.2%, it fell to 1486 according to data in the latest census of 2007.

Key words: Land use, mountainous forest villages, rural migration

Gökçay havzasında dağlık orman köylerinde kırsal göç ve arazi kullanım türleri değişimi arasındaki etkileşimler

Özet: Bu çalışma Gökçay Nehir Havzası'nda 1955–2008 yılları arasında arazi kullanım türleri, arazi örtüsü ve 1935–2007 yılları arasındaki göç hareketlerini analiz etmek için yapılmıştır. Arazi kullanım türleri ve arazi örtüsündeki değişimi belirlemek için 1955 ve 2008 yılları meşcere haritaları coğrafi bilgi sistemlerinde değerlendirilmiştir. Yapılan incelemeler sonucu 1955 yılında havzanın % 47'si orman iken 2008 yılında % 50'ye, mera alanları % 2 iken % 7'ye, işlenen tarım alanları % 25'ten % 27'ye yükselmiştir. Bozuk orman alanları 1955 yılında % 1 iken 2008 yılında % 2 olmuştur. Havza arazi kullanımında en büyük değişim orman içi açıklık alanlarda olmuştur. Bu alanlar % 24'ten % 12'ye azalmıştır. Orman içi açıklık alanlar orman, tarım ve yerleşim alanı olarak kullanılmıştır. Havza nüfusu, ev takip formları, nüfus sayım verileri kullanılarak değerlendirilmiştir. Buna göre nüfus 1935 yılında 5561 kişi iken % 73.2'lik azalma göstermiş ve 2007 yılı son nüfus sayımında 1486 kişiye gerilemiştir.

Anahtar sözcükler: Arazi kullanımı, kırsal göç, orman köyü

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Introduction

Drylands cover about 41% of the Earth's land surface and are home to more than 38% of the total global population of 6.5 billion (Reynolds et al. 2007). On the other hand, in excess of 2 billion people live in dry lands areas, over 90% in developing countries (Carlsson et al. 2008). Between 10% and 20% of these lands are severely degraded. The consequences of this degradation are estimated to affect directly some 250 million people in the developing world, an estimate likely to expand substantially in the face of climate change and population growth (Reynolds et al. 2007). During the 20th century, the world population more than trebled from about 1.5 billion in 1900 to 5.2 billion in 1990. Currently, the world population is growing by 1.3% per year compared to 2.0% growth in the late 1960s. More than 90% of the population growth takes place in tropical regions. About 80% of the population lives in developing regions; Asia accounts for 61% of the world total. The rate of population growth is declining and population will reach around 8.9 billion in 2050 (Hartemink et al. 2008). Population increases in semi-arid and arid regions and changes in regional climate have often led to degradation of the land, and sometimes to the collapse of societies in these regions. The problem is as old as civilization. The analysis of the relationship between soils and societies has largely concentrated on the influence of the latter over the former throughout history, particularly emphasizing the soil degradation processes that have occurred as a result of inappropriate land management practices (Hillel 1991; Blaikie and Brookfield 1997).

Changes in land use/land cover (LULC) have important consequences on the management of natural resources. Land use/land cover changes (LULCCs) are affected by human-induced activities and growth, socio-economic factors, decrease of the forests, grazing, agricultural activities, government policies and environmental factors such as drought (Zhao et al. 2003; Doygun and Alphan 2006; Kamusoko and Aniya 2007; Hartemink et al. 2008). Socio-economic changes in rural especially mountainous regions are mainly influenced by land-based economies closely related with the structure and function of landscapes because agriculture, forestry and mining still constitute major economic activities (Lambin et al. 2003).

Although the rural population living in or around forests is gradually decreasing, it still accounts for an important share of the total Turkish population. Rural people were free to exploit forests until the late 1800s, when the Forest Regulations were promulgated (1870) to impose certain restrictions (Toksoy et al. 2008). Mountainous regions of Turkey have been affected by significant LULCC since the 1950s, particularly deforestation and conversion to cropland and rangeland (Özden et al. 2004). Between 1938 and 2007 in Turkey, rangeland area dropped by approximately 70% from 41 to 12 million hectares (Mha), while arable cropland increased by about 80% from 13.3 to 24 Mha (SIS 2007). In the rural regions forest areas are converted to other uses, mainly cropland and rangeland even if the land is not suitable for the utilization purpose. The conversion of forests to other land uses causes increased water erosion, mass movements, soil compaction by trampling, and alteration of the hydrologic cycle. When the land resources of Turkey are analyzed, it is observed that 6.4 Mha unsuitable for agricultural use, are currently under agricultural use. These lands are generally steep and highly sloped, and under a high erosion risk as their soils are not deep enough (Göl 2007). Deforestation for opening farmlands and grazing has been a widespread issue, in particular in the highlands of Turkey. Additionally, semi-arid climate and rough topography prevailing in the central Anatolia result in a vulnerable ecosystem that is unable to recover from human interruption. The major reasons for changing land use type in Turkey are population growth and migration. The population of Turkey, which was 13 million in 1927, reached 70.5 million in 2007 (Göl et al. 2010). Population growth in villages led to conversion of areas which are not suitable for agricultural use into agricultural lands. This conversion turned these areas to arid lands through erosion due to shallow soil, high degree of slope, and irregular precipitation. These areas are generally cleared from forest and rangeland areas through illegal activities. Rural people, particularly those living in forest settlements have degraded natural sources because of poverty. According to the 1930 population data 75% of the population lived in villages. The 2007 census, on the other hand, indicated that 70.5% of Turkey's population lived in urban areas

(SIS 2007). A rapid migration was experienced from villages to the cities until the 1990s. This situation changed in the last 2 decades. Immigration from rural areas to the urban areas has slowed down and also in some regions people returned to their villages.

In the last 50 years mountainous region forests of Turkey have undergone a major change. The rise of the rural population and poverty resulted in rapid degradation of forests and the conversion of forests to agricultural and rangeland areas. Agricultural activities decreased not only forest areas but also rangeland areas. In the 1930s, while Turkey had a rangeland area of 40 Mha, today it has dwindled to only 12-15 Mha. In the last 20 years, this process began to be reversed. Turkey, undergoing a transition process from an agricultural society to an urban society, experienced a rapid migration from rural areas to cities and industrial centers. As a result of the migration, agricultural and cultivated areas obtained from mountainous regions were abandoned. The lands that were cultivated by primitive animal power, now naturally turned into rangeland or forest since tractors cannot reach sloped areas and there is not enough work power. This research aims to introduce the effects of this migration movement on LULC types in the Gökçay River Watershed.

Materials and methods

Site description

The study area is located in Çankırı province, Ilgaz district, the Gökçay River Watershed (41°04′N, 40°55′E) (Figure 1). The elevation in the catchment ranges from 790 m to 2546 m. There are 2 major valleys oriented north and east (Figure 1) (GDF 2008).

All field measurements were performed in the Gökçay River Watershed (120 km^2). The region is located in the middle of the humid Black Sea and arid central Anatolia zone, which is characterized by continental climate and warm summers and cold winters. According to the Thornthwaite water-balance model, the prevailing climate is semi-arid, mega-thermal with moderate water surplus in winter and that is coded as $C_1B'_1sb'_3$. The mean annual temperature is 10.1 °C and precipitation is 484 mm (SMS 2007). Topography and slope show great variations and hilly and rolling physiographic units are particularly common in the study area.

Soil layers associated with morphstructural units were classified as Entisol and Inceptisol, according to Soil Survey Staff (1999).

Dominant tree species of natural forest are Uludağ fir (*Abies nordmanniana* subsp. *bornmülleriana* Mattf.), Scots pine (*Pinus sylvestris* L.), and Austrian black pine (*Pinus nigra* Arnold.) (GDF 2008). Most part of the natural forest has been fragmented and degraded by human activities such as clearance for agriculture, rangeland, and vegetable gardens. The major crops grown in the area are wheat (*Triticum* spp.) and barley (*Hordeum* spp.), which are harvested once per year. Crop rotation of legumes/cereals is a common practice in the watershed. Fruit trees including apple, apricot, almond, plum, and walnut are grown in the area. Improper farming practices and uncontrolled expansion of rural settlement is common in the area.

Database development

The spatial database, developed as a part of this study, consisted of LULC type maps derived from forest stand maps (1955 and 2008) (GDF 1955; GDF 2008) and field surveys during 2008. Forest stand maps were digitized and processed using a Geographic Information System (ArcGIS 9.0) with a maximum root mean square (RMS) error under 5 m, the associated attribute data were entered into the computer and a spatial database of the area was created.

The basic categories of land cover were identified from the forest stand map: Changed from cultivated area to rangeland 10 years ago (CR_{10}), Changed from cultivated area to rangeland 50 years ago (CR_{50}), Conifer forest (CF) including *Pinus nigra* Arnold., *Pinus sylvestris* L., *Abies nordmanniana* subsp. *bornmülleriana* Mattf., Native rangeland (NR), Forest openings (FO), Cultivated area (CA), Degraded forest (<10% crown closure) (DF), and Settlement area (SA).

Demographical data pertaining to Turkey and the study area were obtained from the Turkish Statistical Institute. The variations in population and number of animals are presented in tables and graphs on a yearly basis.

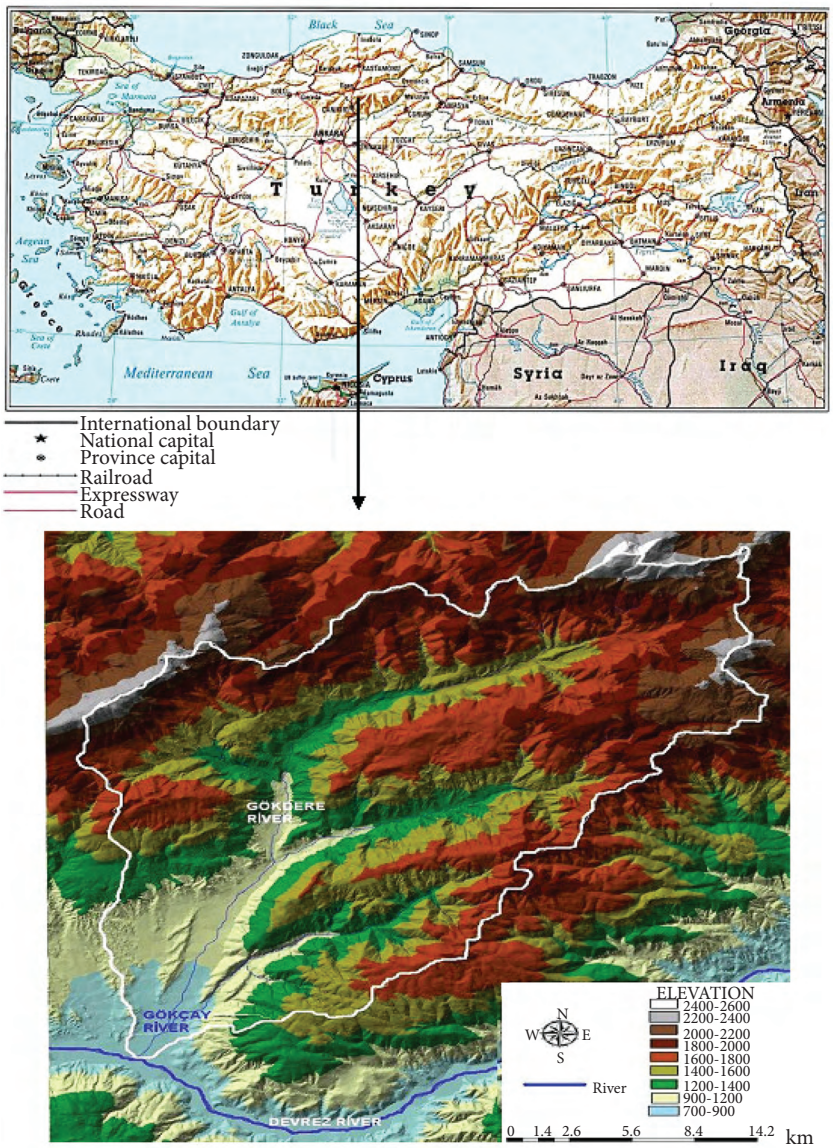

Figure 1. Location and physical maps of the study area.

Results

Demographic processes from 1935 to 2007 in Turkey

The population of Turkey, which was 16.1 million in 1935, reached 70.5 million in 2007. While 77% of the population lived in villages in 1935, this percentage fell to 30% in 2007 (Table 1) (SIS 2007).

Total population of villages and cities showed a steady increase between 1935 and 2007. However, the percentage of village population in the total population constantly decreased. Between 1980 and 2000, the population of the villages fell to 21%. After 2000, migration movements slowed down (Table 1). The percentage of migration from villages to cities was 17% until 1980, 22% from 1980 to 1985, 17% from 1985 to 1990, and 17% from 1995 up to now (Table 2). Internal immigration, which is a detailed and comprehensive case, is taken into consideration in 3 approaches in literature.

Table 1. Demographic changes in cities and villages in Turkey (1935-2007) (SIS 2007).

Census Years	Population (million)			Proportion of city and village population in total (%)		
	Total	Urban	Rural	Urban	Rural	Average Annual Decrease in Rural Areas (%)
1935	16.10	3.80	12.30	23.00	77.00	--
1940	17.80	4.27	13.53	24.39	75.61	0.28
1945	18.80	4.70	14.10	24.94	75.06	0.11
1950	20.90	5.22	15.68	25.04	74.96	0.02
1955	24.10	6.99	17.11	28.79	71.21	0.75
1960	27.80	8.89	18.91	31.92	68.08	0.63
1965	31.40	10.68	20.72	34.42	65.58	0.50
1970	35.60	13.53	22.07	38.45	61.55	0.81
1975	40.30	16.93	23.37	41.81	58.19	0.67
1980	44.70	19.22	25.48	43.91	56.09	0.42
1985	50.70	26.87	23.83	53.03	46.97	1.82
1990	56.50	33.33	23.17	59.01	40.99	1.50
2000	67.80	43.39	24.41	64.90	35.10	0.59
2007	70.50	49.35	21.15	70.00	30.00	0.73

Table 2. Migration rates for various periods in Turkey, 1975-2000 (SIS 2007).

Places of Residence	Periods				Total
	1975-1980	1980-1985	1985-1990	1995-2000	
From village to city	610,067	860,438	969,871	1,168,285	3,608,661
(%)	17.02	22.53	17.95	17.46	
From city to village	692,828	490,653	680,527	1,342,518	3,206,526
(%)	19.33	12.84	12.60	20.06	

These are:

- Cost–benefit approach

-Selectivity approach

-Repulsive and attractive forces approach

The approach of repulsive and attractive forces that determine internal immigration investigates the reasons for the internal immigration from the point of both of internal and external immigration centers (Gür and Ural 2004; Özdemir 2008). In order to determine the causes of migration in the research area interviews were made with elderly people and village heads. As a result of these interviews, it was determined that people generally migrate for finding jobs, education for their children, in search of better living conditions, and migration of one of the family individuals. Tanfer (1983) claims that interprovincial migration was dominated by young and single males. According to the 2007 census, the rate of net migration in the study area was –24.9% (SIS 2007). Although migration movements in Turkey in general slowed down, this finding indicates that migration is still common in the watershed area.

The changes in village population in Turkey had various impacts on the natural sources and land-use types. Until the 1980s, population growth and technological developments in agriculture like use of tractors, chemicals, and fertilizers caused rapid degradation of rangelands and forests for agricultural purposes. From the 1950s, due to the migration of the young population from villages to cities and loss of workforce, the lands in mountainous and sloped areas were abandoned. These abandoned sloped lands were naturally covered with forests and rangeland vegetation.

Population structure of the watershed area

Substantial migration movements from villages to cities in Turkey observed since 1950s were also experienced in the Gökçay River Watershed. The data of the Turkish Statistical Institute indicate that the population of the watershed area was 5561 in 1935; however, dropping by 73.2%, the figures decreased to 1486 in the recent census of 2007 (Figure 2). As indicated in the figure below, the watershed in the present study area is a migration region. It was reported in the interviews conducted during the field study that especially the young population migrated to big cities due to employment, education, poverty, etc. concerns.

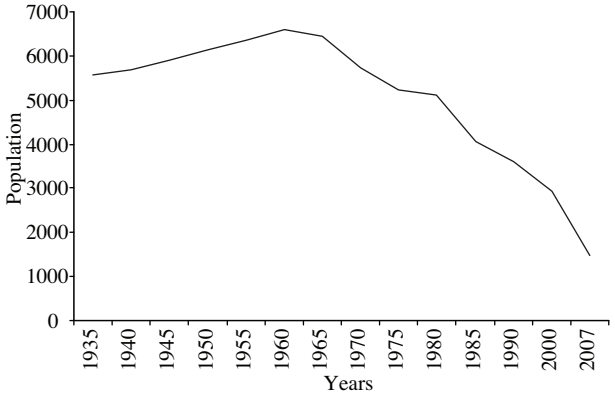

Figure 2. Change of population in the watershed between 1935 and 2007.

There were 21 settlement areas (villages or highland villages) in the watershed. The population of the watershed area was 5561 in 1935, which began to increase. In 1960, the population of the watershed area reached a peak with a population of 6592. In 1965, the population decreased to 6442. Although the migration slowed down between 1975 and 1980, the rate of migration increased in the following years and the population of the watershed area decreased to 1486 in 2007. In 1935, the biggest village was Kaleköy, with a population of 715; the smallest one was Satılar, with a population of 112. From 1935 to 1955, the biggest village in the watershed area was Kaleköy, which had a population of 722. After 1960, the biggest village in the watershed was Hacıhasan, with a population of 522. Between 1935 and 1970, the smallest village in the watershed area in terms of population was Satılar village, which had a population of 107. From 1970 to the present, the smallest village in the watershed area was Kurmalar village with an average population of 60. According to the latest 2007 census, the biggest village in the watershed area was Hacıhasan village, with a population of 179, and the smallest one was Şıhlar, with a population of only 8. Population statistics indicated that from 1935 to the present, the number of female dwellers in the villages was higher than that of males. For example, in 1935, the number of females in the watershed area was 3145 and the number of males was 2487. According to the 2007 census, there was a female population of 762 and a male population of 724 in the watershed area. This result indicates that from 1935 onwards,

the migration of male work force has continued in the watershed area.

The investigations conducted in the watershed area indicated that active population migrated from the region and the remaining dwellers of the villages consisted mainly of old people and children. This population structure declined economic activities in the watershed area. The observations in the watershed indicated that abandoned agricultural lands were covered with forests. As a result of the migration of active workforce to the cities, animal husbandry sector significantly worsened in the watershed.

As indicated in Table 3, there is a steady fall in animal production in Turkey, particularly in terms of water buffalo, indigenous cattle, indigenous sheep, hair goat, and Angora goat. However, the numbers of culture race, hybrid race, and merino sheep have increased. This finding indicates that while open-air enterprises have fallen animal husbandry activities in barns have risen.

Figure 3 indicates the variations in the number of animals in Ilgaz district, which covers the Gökçay River Watershed. According to the figure, the number of cattle was 13,490 in 1981, which decreased to 3772; the number of sheep was 22,310, which fell to 2276; the number of goats was 21,715, which fell to 1506. After 1997, no official livestock census was taken; however, the observations performed in the study area indicated that this dramatic decrease in the number of animals continued.

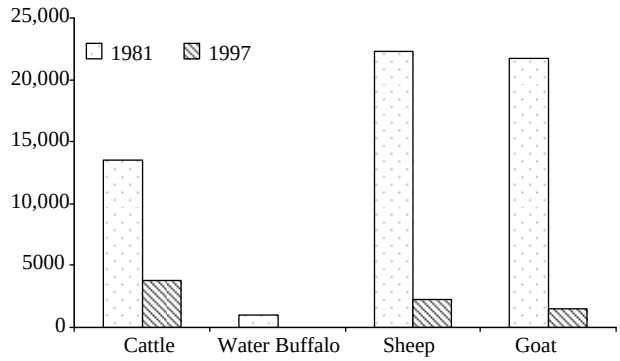

Figure 3. Changes in the number of animals in the Ilgaz district (from 1981 to 1997).

Land use/land cover change (LULCC)

The land use/land cover (LULC) maps for the years 1955 and 2008 are presented in Figure 4. Percentage and quantity of each LULC types are given in Table 4. Results indicate that the LULCC have changed the character of the study area. The main trend observed in the study was the decrease in FO areas including rangeland in the forest at the terms of CF, NR, CA, and SA. Forest opening has decreased from 2810 ha (24%) to 1327 (12%) (Table 4). Maps of the study area covering the period 1955 to 2008, have been analyzed, and LULCC on the land pattern have been introduced.

Table 3. Livestock by type and races in Turkey (heads) (SIS 2007).

Type of Livestock	Years				
	1991	1995	2000	2005	2007
Cattle Culture	1,253,865	1,702,000	1,806,000	2,354,957	3,295,678
Cattle Cross Bred	4,033,375	4,776,000	4,738,000	4,537,998	4,465,350
Cattle Domestic	6,685,683	5,311,000	4,217,000	3,633,485	3,275,725
Buffaloes	366,150	255,000	146,000	104,965	84,705
Sheep Domestic	39,590,493	32,985,000	27,719,000	24,551,972	24,504,211
Sheep Merino	841,847	806,000	773,000	752,353	971,082
Goats Ordinary	9,579,256	8,397,000	6,828,000	6,284,498	6,095,292
Goats Angora	1,184,942	714,000	373,000	232,966	191,066

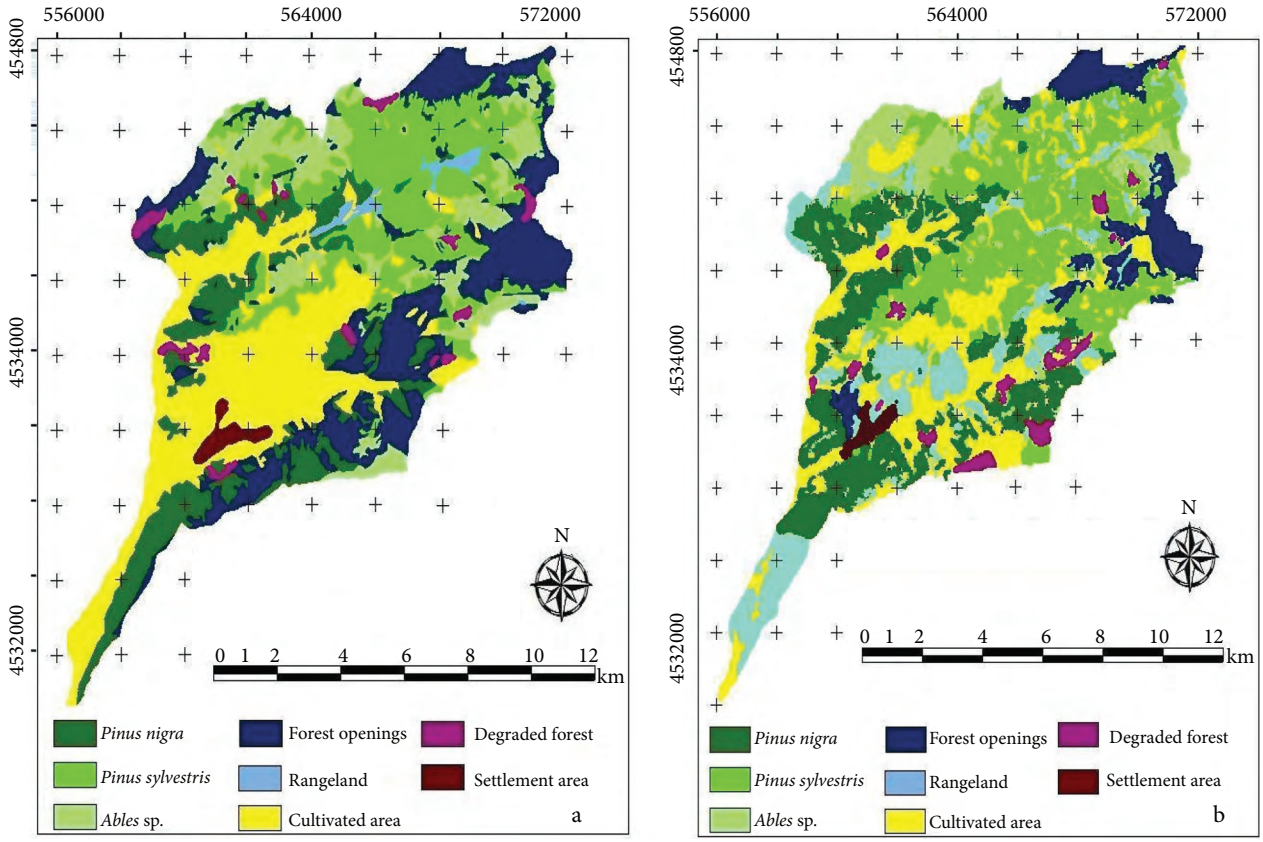

Figure 4. Land use/land cover change in the Gökçay river watershed in 1955 (a) and 2008 (b).

Table 4. Change of land use/land cover in the study area from 1955 to 2008 (GDF 1955; 2008).

Land Use/ Land Cover		Areas of Land Uses Types				Change in Watershed (%)
		1955		2008		
		ha	(%)	ha	(%)	
Conifer Forest (CF)	*Pinus nigra*	1764	15	2307	20	5
	Pinus sylvestris	2423	19	2643	22	3
	Abies bornmülleriana	1566	13	1069	8	-5
Native Rangeland (NR)		157	2	958	7	5
Forest Opening (FO)		2810	24	1327	12	-12
Cultivated Area (CA)		3057	25	3346	27	2
Degraded Forest (DF)		188	1	270	2	1
Settlement Area (SA)		165	1	210	2	1
	Total	12,130	100	12,130	100	

Total CF increased from 5753 ha (47%) to 6019 ha (50%) during the 53 year period, with a net increase of 266 ha (2% of the whole study area) mainly due to forestation. There are no forestation areas in the watershed. Migration to cities provided an opportunity to eliminate human pressure from forest areas, probably resulting in a positive consequence for the forests (Karanth et al. 2006; Sivrikaya et al. 2007). NR has risen from 157 ha (2%) to 958 ha (7%), and CA from 3057 ha (25%) to 3346 (27%). The percentage of DF lands was 1% in 1955, which increased to 2% in 2008 (Figure 5).

When the demographical characteristics and LULCCs were evaluated, interesting results were obtained. Rapid population growth until the 1980s raised the need for agricultural lands. Meanwhile, sloped forest areas and rangelands, which were not in fact suitable for agriculture, were converted into agricultural lands. The most potent forces affecting natural vegetation arise from the direct effects of an expanding human population (e.g. habitat destruction for agriculture, human settlement, land for grazing) and indirect effects (e.g. pollution) (Grime 1997; Mwavu and Witkowsski 2008). The determination of the use potential of land is a necessary condition for land use planning to proceed on a rational and sustainable basis (Kılıç 2003). The migration of the young population from villages to cities led to the abandonment of these agricultural lands. Both the local people and key informants were concerned about the fact that land-use and cover changes in the area occurred with the decrease in agriculture land and forest opening, threatening the availability of land for further increases in rangeland. This change was attributed to a number of factors/drivers, including the rapid human migration, using tractors for cultivation, decreasing range cattle and forestation. Similarly, studies elsewhere indicate that ecological dynamics in human-influenced landscapes are strongly affected by socio-economic factors that influence landuse decision-making (Berry et

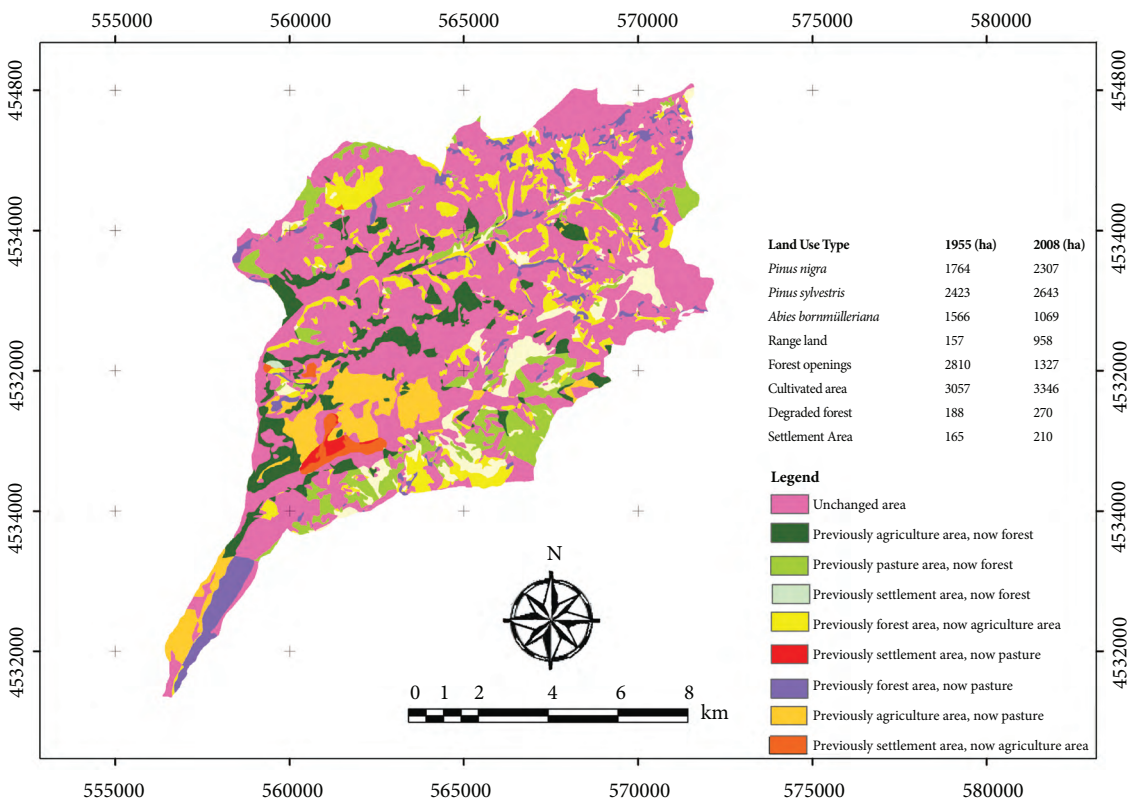

Figure 5. The amount of land use change in the Gökçay River watershed.

al. 1995). In field studies carried out in 2008, it was observed that the agricultural lands in sloped areas where tractors cannot reach were covered with rangeland or forest vegetation. Both the local people and key informants explained that the quantity of livestock had been decreasing.

Another significant change occurred in forest cover type. Uludağ fir forests decreased by 5% (from 1566 ha to 1069 ha), while black pine and Scots pine forests increased by 8% (from 4187 ha to 4950 ha).

Discussion

Rural people in drylands often rely on a combination of rain-fed agriculture, livestock rearing, and other income generating activities that are extremely vulnerable to the climate change impacts anticipated under most models. Soil formation and water supply are already at unsustainable levels. Desertification and loss of biological potential will constrain drylands transforming into productive ecosystems.

Changes in the LULC are a result of complex interactions between physical, biological, economic, political, and social factors. Socio-economic development, decrease of the human and livestock population, and a change in livestock type have all influenced changes in the traditional pattern of woodland utilization (Salehi et al. 2008). Different LULC types and vegetation restoration had different effects on soil properties. The effect of LULCC on the physical and chemical properties of soil should be taken into account to accurately examine and stimulate ecosystem dynamics in the highland mountain ecosystems of Turkey.

Increasing population and indiscriminate cultivation of agricultural land makes most of the land less productive. This kind of pressure on forestland resources threatens the stability of forests and land-use management. Misuse of land in forest villages is the main factor causing the increase in rural poverty and the degradation of forests. Problems are encountered in the use of natural resources in the forest villages of Turkey. Therefore, it is necessary to intervene to end this misuse of land. An intervention should be made under the following headings to prevent further misuse: problems regarding in-forest settlements should be solved; practices providing income generation and food security should be carried out; farm forestry and community forest applications should be developed; and undamaged forest resources should be protected with buffer zone forest management practices.

Expansion of forest lands is one of the most important outcomes of migration from rural areas to cities. The lands cleared from the forests for agricultural purposes between 1930 and 1960, when a significant part of the population lived in villages, were abandoned after migrations. These abandoned lands turned to forest with the seeds spreading from nearby forests. In the last 20 years, forest areas of Turkey have increased from 20.2 Mha to 21.2 Mha.

Another important outcome of migration from rural areas to cities is the reduced animal husbandry practices. As a result of the dramatic fall in number of animals as indicated in Table 3, the pressure on croplands and rangelands decreased as well. Particularly the damage of the goats on forests gradually diminished. In addition, the properties of rangelands, which lost their quality due to excessive and irregular grazing, were observed to improve.

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