

# Comparison of Spatio-Temporal Changes in Forest Ecosystem Functions from 1996 to 2018: A Case Study from Türkiye

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## Article History

Received: 21.08.2023

Accepted: 02.11.2023

Published: 15.12.2023

## Research Article



**Abstract** – The objective of this study was to determine the temporal changes in forest ecosystem values (economic, ecological, and socio-cultural functions) for the 1996, 2009 and 2018 planning periods. For this purpose, forest management plans and forest cover type maps were used to reveal the changes in forest ecosystem values for the planning periods. Temporal changes in forest ecosystem functions were discussed in terms of economic, ecological and socio-cultural functions which are three essential functions. There has been a decrease in the amount of area for economic purposes in the region in the following planning periods. A general decrease in areas for economic purposes and a general increase in areas for ecological purposes were determined during the planning periods. While there was not any area for socio-cultural purposes in the 1996 planning period, there was an area of 1631 ha in the 2009 planning period and 1575 ha in the 2018 planning period. Demands of the society and the changes in forest management planning approaches over time, changes have occurred in forest functions. Depending on these changes, decreased in production forests and increases in non-production forests (ecological and socio-cultural) were observed.

**Keywords** – Forest ecosystem functions, planning approach, functional planning, national park

## 1996-2018 Yılları Arasında Orman Ekosistemi Fonksiyonlarındaki Mekansal-Zamansal Değişimlerin Karşılaştırılması: Türkiye'den Bir Örnek Çalışma

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## Makale Tarihiçesi

Gönderim: 21.08.2023


Kabul: 02.11.2023

Yayın: 15.12.2023

## Araştırma Makalesi

**Öz** – Bu çalışmada, 1996, 2009 ve 2018 planlama dönemlerinde, orman ekosistemi değerlerinde (ekonomik, ekolojik ve sosyo-kültürel işlevler) zamansal olarak meydana gelen değişimlerin belirlenmesi amaçlanmıştır. Bu amaçla planlama dönemlerine ait orman ekosistemi değerlerinde meydana gelen değişikliklerin belirlenmesi için orman amenajman planları ve meşcere tipi haritaları kullanılmıştır. Orman ekosistemi fonksiyonlarındaki zamansal değişimler, üç temel fonksiyon olan ekonomik, ekolojik ve sosyo-kültürel fonksiyonlar açısından ele alınmıştır. Birbirini takip eden planlama dönemlerinde ekonomik amaçlı alan miktarında azalma olmuştur. Planlama dönemlerinde ekonomik fonksiyonlu alanlarda genel bir azalma, ekolojik fonksiyonlu alanlarda ise genel bir artış tespit edilmiştir. 1996 planlama döneminde sosyo-kültürel fonksiyonlu alan bulunmazken, 2009 planlama döneminde 1631 ha, 2018 planlama döneminde ise 1575 ha alan bulunmaktadır. Toplumun talepleri ve orman amenajman planlama yaklaşımlarında zamanla meydana gelen değişikliklerle birlikte orman fonksiyonlarında da değişiklikler meydana gelmiştir. Bu değişimlere bağlı olarak üretim ormanlarında azalma, üretim dışı ormanlarda ise (ekolojik ve sosyo-kültürel) artışlar gözlenmiştir.

**Anahtar Kelimeler** – Orman ekosistem fonksiyonları, planlama yaklaşımı, fonksiyonel planlama, milli park

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## **1.Introduction**

Forests are highly complex biotic communities that encompass many of the life forms on Earth and provide a variety of products and services in terms of economic, ecologic, and socio-cultural (Başkent, Terzioğlu & Başkaya, 2008; Forest Europe, 2020). Global forest resources are also an essential element for the conservation of biological diversity, conservation of water and soil resources, recreation, ecotourism, carbon sequestration (Karahalil et al., 2018) as well as meeting the needs of the society for wood and non-wood forest products (Başkent & Yolasığmaz, 2000; Kuvan et al., 2011; Miura et al., 2015; Gamfeldt et al., 2013; Keleş et al., 2017; Bozali, 2020; Bilici & Akay, 2021; Khaiteer & Erechtkhoukova, 2022). In the period up to the 20th century, the term "value" was not used much for products and services offered by forests. Instead, it was replaced by different terms such as "profit" (Pilli & Pase, 2018). Afterward, non-wood forest products and services, environmental-ecological functions (reducing climate change, protecting biological diversity, protecting soil and water, etc.) and tourism-recreation functions of forests gained importance both in Türkiye and in the world (Bozali, 2021; Kadioğulları et al., 2014; Keleş et al., 2007; Kuvan et al., 2011; Kuvan et al., 2018). In 1963, forest inventory studies were initiated with the Five-Year Development Plans in Türkiye. In the 1963-1972 period, forest management plans covering the whole country were prepared (Zengin et al., 2013). In the early 2000s, studies were carried out with the idea of functional planning in Türkiye. In this framework, "Ecosystem-Based Functional Planning" which is based on the ecosystem, participatory approach, and functional planning, entered into force in 2008 (GDF, 2021). Contrary to previous management plans with a focus on wood production current management plans are in the form of a balance of economic, ecological, and social-cultural functions of forests in accordance with international processes (Sivrikaya et al., 2005; Başkent et al., 2007; World Bank Group, 2017; Başkent & Kaspar, 2022). In terms of area, 42.3% of Türkiye's forest resources are allocated to economic function including the production of firewood, roundwood, and non-wood forest products, 48.5% to ecological function including watershed and erosion control and the remaining 9.2% to social-cultural function (GDF, 2021). Due to the meaning of forests for today's humanity, it has become impossible to allocate every part of it to wood raw material production. Therefore, a management approach in which the use of some forests by humans is completely prohibited or limited use has become necessary. These forests or areas are called protected areas. In addition to the protected area classifications made by international organizations such as IUCN, as seen in the example of Türkiye, protected area qualifications that emerged with the laws of the countries are also found (TOD, 2019).

Protected areas are generally perceived as natural places where nature reveals its development potential and as devoid of human presence as possible (Lee, 2016). The term of protected area is an abbreviation for National Parks, nature reserves, wildlife areas and wildlife management areas (Shafer, 2015). Protected areas not only contribute to the formation of healthy ecosystems and help threatened species, but also provide many more benefits to humans (Bertzky et al., 2012). Protected areas also provide economic benefits by promoting tourism, enabling infrastructure investments, and contributing to the continuity of valuable forest ecosystem services (Miranda et al., 2014). Much of the ecotourism experience and recreational land setting depends on the sustainability of forested lands (Blaj, 2014; Winter et al., 2019). Protected areas offer important opportunities for tourism and recreation as well as the protection of natural resources (Cheung et al., 2022). Protected areas and National Parks within the framework of intense visitor demands and developing sustainability constitute one of the most essential forms of recreational use today (Breiby et al., 2022). While protected areas such as National Parks and nature reserves are essential for the conservation of biodiversity, they are only one of many tools for responsible management of forest resources (Dimitrakopoulos & Jones, 2021)

In Türkiye, the concept of National Park for protection was included in the laws for the first time thanks to the 25th article of the Forest Law No. 6831, which entered into force in 1956. Yozgat Çamlığı was declared as Türkiye's first National Park in 1958 with the implementation of the law (Kılıç & Kervankıran, 2019). There

are 43 National Parks and 229 Nature Parks in Türkiye with a total area of 845814 and 102505 ha, respectively (Birben, 2019). These areas are protected due to the national and international interests in the conservation of natural resources and biological diversity and important in terms of carbon sequestration. The aim of this study is to determine the changes in forest ecosystem functions in the Yenice Forest Planning Unit according to the forest management plans and forest cover type maps in 1996, 2009 and 2018.

## **2. Materials and Methods**

### **2.1. Description of the study area**

The study area covers Yenice Forest Planning Unit and these areas are located in Black Sea backward region of Türkiye (Figure 1). Yenice Forest Planning Unit is in the Ankara Regional Directorate of Forestry, and it is bounded by 556438-572166 on the East longitudes and 4548797-4530827 on the North latitudes (WGS 1984, UTM Zone 36N). Ilgaz Mountain National Park is located around the Yenice Forest Planning Unit and a protected area that is rapidly increasing in use with the attractiveness of its natural, cultural, and recreational riches. The area of 1118 hectares was declared a National Park in 1976 due to the national and international quality and importance of its resource values. The area offers different opportunities to visitors throughout the year and serves educational, tourism, recreation, and sporting purposes (GDF, 2009a). The variable topography, forest areas, ski slopes and hotels in Ilgaz Mountain National Park constitute the unique character of the region (GDF 2009b). There are two social groups interacting with Ilgaz Mountain National Park. One of these groups is the local people living around the protected area, who maintain their interaction with the area throughout the year and the other group is the visitors who interact with the area for a short time, whose usage patterns and expectations from the area can change (GDF, 2009a).

The study area is 12832 ha. The amount of total productive and non-productive forest area is 7621 ha (58%) and 2197 ha (17%) respectively. Total area covered by forest is 9619 ha and 75% of the study area. The main tree species in the region are *Pinus nigra* subsp. *pallasiana* (Black pine), *Pinus sylvestris* (Scots pine), *Abies nordmanniana* subsp. *equi-trojani* (Fir), *Quercus* sp. (Oak), *Fagus orientalis* (Oriental Beech), *Carpinus betulus* (Hornbeam), *Juniperus* sp. (Juniper) and *Populus* sp. (Poplar). Elevation is between 875 and 2544 m and mean slope is 19.92%. Annual minimum, maximum and mean temperatures are -25.0, 42.4 and 10.6 °C, respectively. Annual total mean precipitation is 425.65 mm (Anonymous, 2018).

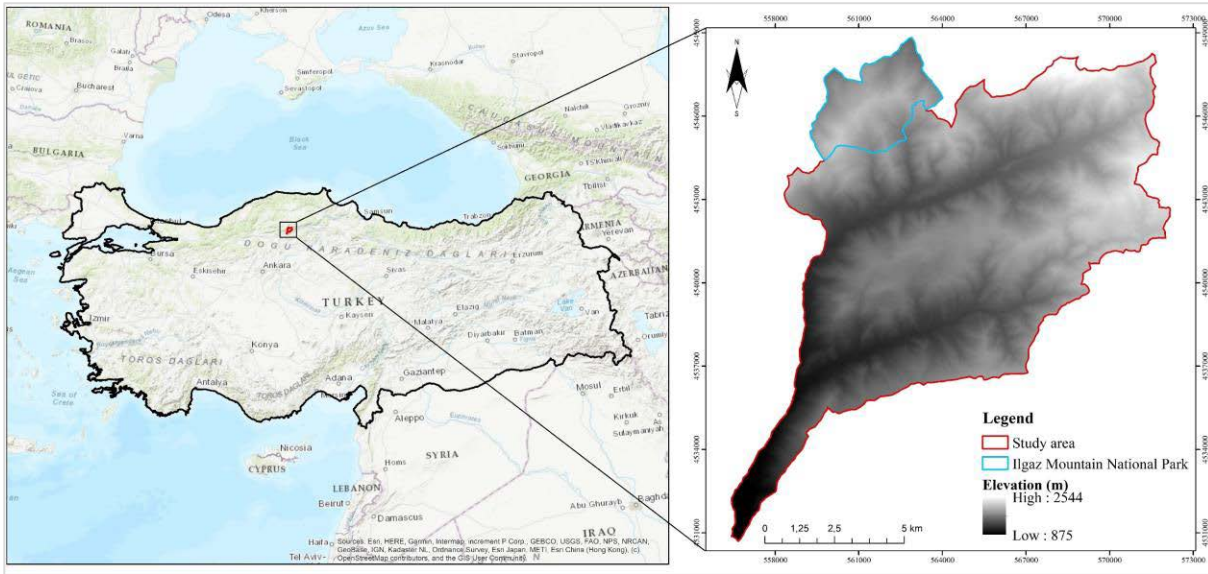


Figure 1. Location of the study area, including the elevation map

## 2.2. Data collection and methods

Forest management plans and forest cover type maps of Yenice Forest Planning Unit prepared in 1996, 2009 and 2018 by the Türkiye General Directorate of Forestry were used. Forest ecosystem functions were mapped by using combined forest cover type maps. In addition, spatial databases were designed for each forest planning period and detailed area distributions were determined for forest ecosystem functions. ArcGIS program was used for combining the forest cover type maps, mapping the forest ecosystem function, and designing spatial database.

## 3. Results

### 3.1. Spatio-temporal change of forest ecosystem functions

The areal variation of the main forest functions in the study area was determined for three planning periods. It was seen that socio-cultural functions have not yet been included in the forest management plans for the 1996 planning period (Figure 2). In addition, the economic area in the 1996 planning period was more than the other planning periods. In ecological functional areas, a large increase was determined in the planning periods after 1996. While the socio-cultural functions in the region were included in the forest management plans in the 2009 planning period, the area amount increased further in 2018 and reached 1575 ha. The total area covered by forest ecosystem functions has also increased during the planning periods. While the forest ecosystem functions covered an area of 9619 ha in the 1996 planning of the region, it covers an area of 11259 ha in 2009 and 11331 ha in the 2018 planning period.

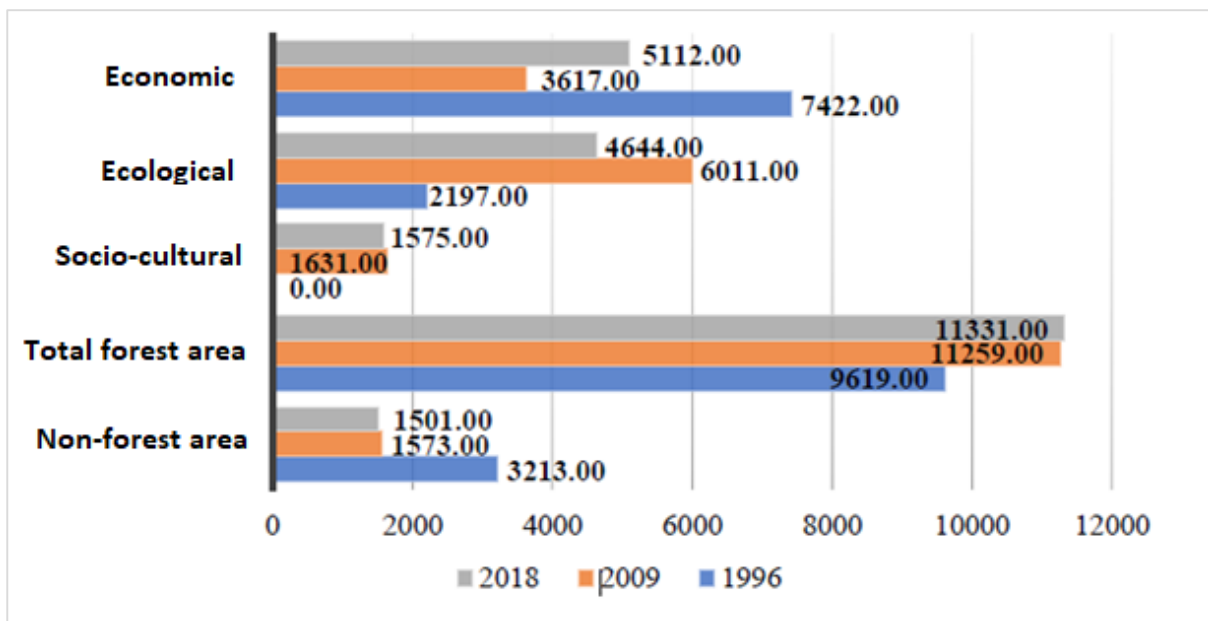


Figure 2. Areal change (ha) of the main forest values in 1996, 2009 and 2018 planning period

The spatio-temporal changes of forest ecosystem functions in 1996, 2009 and 2018 were given in Figure 3 and Table 1. As seen in Table 1, 7422 ha (58%) of the total area was assigned to economic function and 2197 ha (17%) ecological function in 1996. Between 1996 and 2009, there was a net decrease of 3805 ha in the area of economic functions. However, there is a -31 percent change in the economic function from 1996 to 2018. While the percentage of ecological function area within the total area was 23% in 1996, it was 53% in 2009 and 41% in 2018. The area of socio-cultural functions in total forest area decreased from 13 % in 2009 to 12 % in 2018. Forest ecosystem function improvement (1576 ha) was assigned to some areas in the 2009 planning period and these areas were assigned to nature protection functions in the 2018 plan period (Figure 3). In addition, Nature Park (420 ha) and tourism (319 ha) values were added in the 2018 plan period. Many stands that were operated for production purposes in the 1996 planning period were assigned to seed orchards, soil protection, national park and aesthetics functions in the 2009 and 2018 planning periods. In addition, forest areas and non-forest areas are shown in Figure 4.

Table 1  
Temporal changes of forest ecosystem values for study area in the years of 1996, 2009 and 2018 planning periods

Main forest function	Primary forest function	Management goal	Forest management plans					
			1996		2009		2018	
			Area (ha)	%	Area (ha)	%	Area (ha)	%
Economic	Production of wood products	Wood Production	7422	58	3617	28	5112	40
Ecological	Protection	Nature protection	2197	17	-	-	1526	12
		Forest ecosystem improvement	-	-	1576	12	-	-
		Seed orchards	-	-	149	1	148	1
		Nature Park	-	-	-	-	420	3
		National Park	-	-	1122	9	1118	9
	Erosion prevention	Soil protection	-	-	3164	25	1432	11
Socio-cultural	Aesthetics	Aesthetics	-	-	1631	13	1256	10
	Ecotourism and recreation	Tourism	-	-	-	-	319	2
Forest Function Area			9619	75	11259	88	11331	88
Non-forest area			3213	25	1573	12	1501	12
The overall total			12832	100	12832	100	12832	100

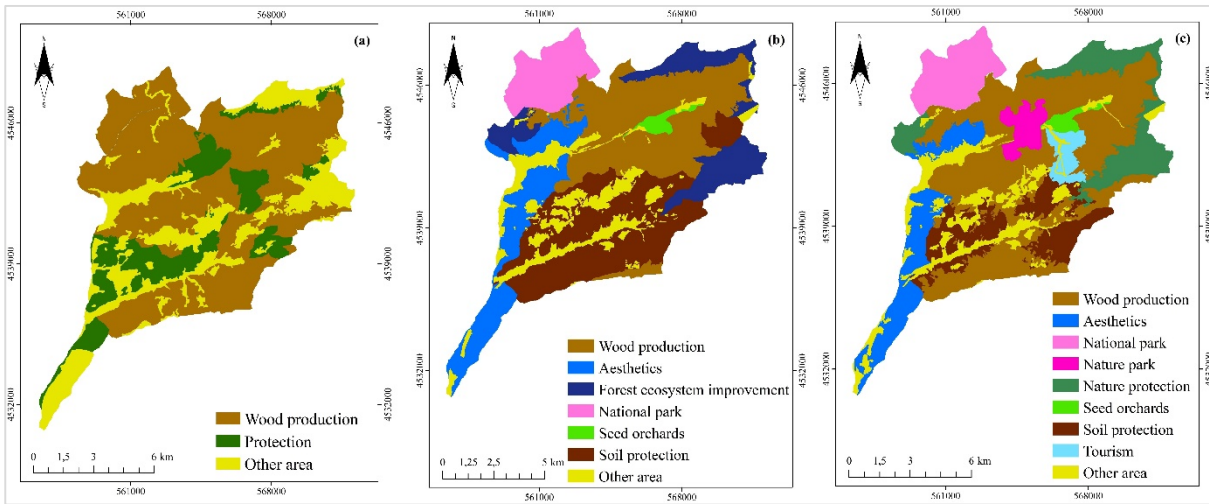


Figure 3. Forest ecosystem values of the study area in 1996 (a), 2009 (b) and 2018 (c) planning period

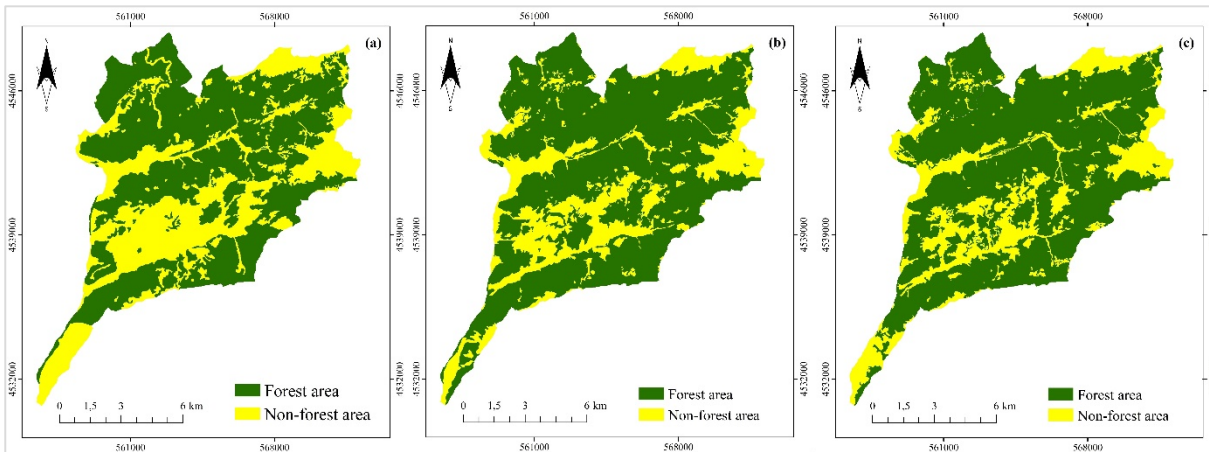


Figure 4. Forest and non-forest areas in 1996 (a), 2009 (b) and 2018 (c) planning period

#### 4. Discussion

It is of great importance for sustainable forest management to create a balance between the economic, ecological, and social functions of forests and to regulate the relations between society and forest in line with society's expectations for forest resources. In this study, which three different management plan periods were examined, it was revealed that socio-cultural and ecological forest functions increased significantly, especially in the last two periods, 2009-2018, while there was a decrease by half in the forest areas operated in terms of economic value. The main functions of forests are analyzed in Türkiye's forest asset statistics prepared for the years 2004, 2012, 2015 and 2020. It is seen that while there was a 5% decrease in the forest areas operated for economic purposes in the 2004-2020 period, the forest areas operated for ecological purposes maintained their ratio in the same period. On the other hand, the ratio of forest areas operated for socio-economic purposes, which has a rate of 3% according to 2004 forest asset data, has been calculated as 9% with a 3-fold increase compared to 2020 data (GDF, 2021). Serious changes in the management of forest ecosystems and forest functions during the three forest management planning periods were found. When the planning periods were examined, it was seen that there was a shift in forest functions from economic functions to ecological and socio-cultural functions in the last two planning periods. The leading factor in achieving this result was the change in the management system in Türkiye's forest planning (Anonymous, 2008; Keleş et al., 2017).



Beginning with the planned period in the 1960s in Türkiye, the rate of urban population started to increase. The urban population ratio, which was 32% in this period exceeded the rural population ratio and increased to 59% since 1990. As of 2021, the urban population ratio was announced as 93%. Urbanization is also an important factor affecting the change in forests and forestry in Türkiye (Keleş et al., 2017; Günşen & Atmış, 2019). The decrease in rural population due to migration has changed the pressure on forest resources. For instance, the decrease in land clearing for agriculture and natural forest regeneration of the abandoned lands has led to an increase in forest areas. In addition, one of the findings of the study was stated as an increase in forest areas with the increasing total population (Ünal et al., 2019). The needs of the citizens such as heating, education, settlement, recreation, tourism and employment constitute the urban-based pressures on the forests. With the increase in the rate of urban population, the expectations of the society from forests have become more diversified and also there has been an increase in the demands for social and cultural opportunities. With this changing demand the General Directorate of Forestry has allocated more recreation areas and urban forests to meet these demands (Atmış et al., 2012; Sağlam & Elvan, 2017). In the study of Erol and Yıldırım (2017), it was concluded that only the population would have an increasing effect when considered in terms of the variables affecting the changes in forests operated for their social value. According to Yılmaz et al. (2006) especially in large and crowded settlements, the recreational and urban characteristics of forests were prioritized and therefore the importance of the social functions of forests was expected to increase day by day. In the study of Kuvan et al. (2011), it has seen that the production functions of forests were important but social values would take priority in the future. According to Türker et al. (2014), ecotourism activities contribute to raising the awareness of local people about environmental protection. It should not be ignored that forest ecosystems have ecologically and socially important functions and provide the services necessary for the sustainability of life-support systems on a local and global scale (Keleş et al., 2017).

Erol and Yıldırım (2017) reported that socioeconomic variables were effective in the change of the surface areas allocated to the functions of forests. The effect of population and education was more than the mentioned variables. According to Erol and Yıldırım (2017), although the population's contribution to forest areas with economic values was to increase the forest area, the effect of the education factor on forest areas, which has an economic value, was negative. On the other hand, it was also revealed by Erol and Yıldırım (2017) in the same study that education has an increasing effect on forest areas operated for ecological value. Previous studies have also shown that the development of recreational activities and non-timber forest production improve the contribution of forest ecosystems to the well-being of local and national populations and help to reduce damage to ecosystems (FAO 2016). It is important for a sustainable management that all interest groups are considered in balancing the expectations about protected areas (Sarvašová et al., 2014). Studies within the scope of long-term development plans for Ilgaz Mountain National Park also showed that local people see themselves as excluded from the National Park. This situation will cause the real owners of the area to be alienated from the National Park and thus to decrease their ownership and protection motives. In order to provide the local people, who are in close interaction with the protected areas, the opportunity to protect and adopt the protected areas more, it is an important issue to be employed in the facilities in the National Park as well as to offer other income generating activities.

## **5. Conclusion**

Natural ecosystems have an important role in regulating and restoring ecological processes and life support units on Earth. In this study, focusing on temporal changes in forest ecosystem functions were determined for the 1996, 2009 and 2018 planning periods for Yenice Forest Planning Unit. Planning periods show that although the economic function maintains its priority in forest ecosystem values, the socio-cultural function has increased in 2009 and 2018 in line with the demands of people from the forests. Therefore, the importance of



ecosystem management, which balances people's supply and demands from forest ecosystems, is increasing regarding nature protection.

### Acknowledgments

I would like to thank to Türkiye General Directorate of Forestry for providing data used in this study. I would also like to thanks Assistant Professor Sinan Bulut and Professor Alkan Günlü for their help.

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