М.А. Гендельманның 110 жылдығына арналған «Сейфуллин оқулары – 19» халықаралық ғылыми - практикалық конференциясының материалдары = Материалы международной научно-практической конференции «Сейфуллинские чтения – 19», посвященной 110-летию М.А. Гендельмана». - 2023.- Т. I, Ч. IV. – P. 263-267.

UDC№63.630.631.6

CHANGE IN STAND CHARACTERISTICS OF TAURUS FIR (*Abies cilicica* subsp. *cilicica*) IN THE LAST 20 YEARS UNDER THE EFFECT OF CLIMATE CHANGE (THE EXAMPLE OF KAHRAMANMARAŞ-GÖKSUN FOREST ENTERPRISE)

Orhan GÜLSEVEN*
Kastamonu University, Institute of Science, Sustainable Forestry Doctorate Program, Kastamonu, Turkey
Sezgin AYAN
Kastamonu University, Faculty of Forestry, Department of Silviculture, Kastamonu, Turkey
**Corresponding author: orhan.gulseven@hotmail.com*

Abstract: Climate change, the effect of which has been increasing since the end of the 19th century and its effects have reached threatening dimensions, can also have positive or negative effects on forest ecosystems. The Mediterranean basin, in which Turkey is also located, is among the countries that can be significantly affected by climate change in terms of both its geographical location and ecology. *Abies cilicica* subsp. *cilicica* which is one of the Mediterranean fir taxons is a very important species that is in the commonly Taurus Mountains in the south of Turkey. It is a sensitive species against climate change due to its distribution area and ecological demands. Change of stand characteristics of pure and mixed stands under the effect of climate change *A. c.* subsp. *cilicica* in Göksun Forest Enterprise (GFE) which has the northmost distribution area of the species was researched. In the results of the study; In GFE, the average temperature in the working area increased by 1.5 °C between 2000 and 2020. Also, it was determined that the distribution area of *A. c.* subsp. *cilicica* increased by 1811.77 ha. Between 2000 and 2020, a decrease of 17.23% was observed in pure stands and an increase of 18.84% in mixed stands.

Keywords: Climate change, stand characteristics, mixed stand, pure stand, Taurus fir

INTRODUCTION

The impact of climate change on ecosystems is of great concern to forest scientists and ecologists today. At the root of these concerns is our lack of a full understanding of the ecological process. However, it is known that ecosystems will be affected by climate change and the habitats of some species will be suppressed, and species whose habitats are suppressed will try to survive by adapting to new conditions or changing their distribution areas. Species with limited habitats will inevitably end their existence (Hughes, 2000; McLachlan et al., 2005; Parmesan, 2006; Root and Schneider, 2006; Schivo et al., 2019). Climate has a great impact on the development and reproduction of many species that form the basis of the ecosystem (Guisan and Thuiller, 2005; Lawler et al., 2009). Conservation of biodiversity is a key goal that requires both the

quantification of biodiversity and the monitoring of its losses in order to reduce the impacts of climate change on ecosystems (Balmford, 1996). Therefore, In recent years, it is of great importance to protect the species that may be damaged under the influence of climate and to support them when necessary. *Abies cilicica* subsp. *cilicica* is catogarized "*endangered species*" due to their distribution area has decreased gradually in Turkey (IUCN, 2021). In the climate change reports of the General Directorate of Meteorology (GDM), Turkey, it is stated that the region that will be most affected by the temperature and precipitation factors for the coming years is the Mediterranean region. (URL-1). In this study, it is aimed to examine the spatial changes of the northernmost part of the distribution area and the change of stand characteristics in the last 20 years, since the distribution area of the Taurus fir, which is the object species for the study, is located in the Mediterranean region and is among the priority species to be affected.

MATERIAL AND METHOD

Stand Type Maps for the years 2000 and 2020 were provided by from the planning unit of the General Directorate of Forestry in Turkey to determine the stand establishments of the Taurus fir. After that, it was stated that distribution area of the species in plans by using *ArcGIS*. The climate data of the region were obtained from World Bank Group under climate change information portal segment (URL-2). It was used *Google EarthPro packet programme* to show and determine that spread area of the species and regional directorate wich is belonging. The reason of that the the region is located in northmost of the species spread area. It was choosed Göksun Forestry Enterprise Directorate of Kahramanmaraş Regional Directorate of Forestry as a study area. The reason of this the the regıon is located in northmost of the species distribution area and the potential effect on their spread area of climate change (Figure 1).

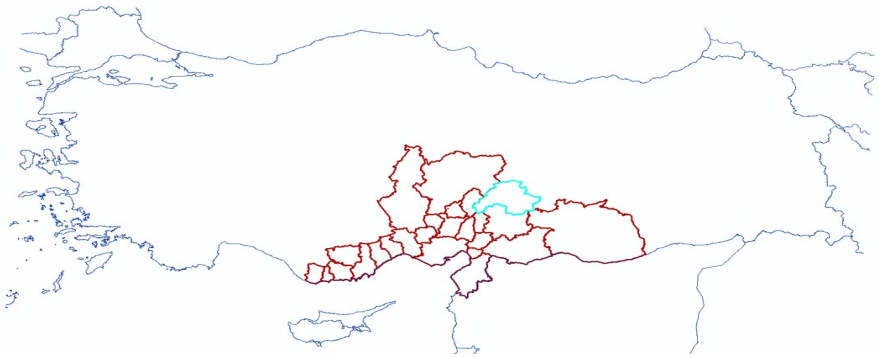

Figure 1. The location of Göksun Forestry Enterprise Directorate on the map of Turkey

RESULTS

THe pure and mixed stand area of *A. c.* subsp. *cilicica* was determined in Göksun Forest Enterprise Directorate of Kahramanmaraş Regional Directorate of Forestry and density of *A. c.* subsp. *cilicica* in mixed areas (Table 1).

Table 1. Information about stand characteristics for Göksun Forest Enterprise based on District Chief

Forest Enterprise	District Chief	Plan data for the year 2000			
		Pure Stand (ha)	Mixed Stand (ha)	The order of the fir in the mixed stand	The species formed by mixed stand
Göksun	Çardak	60,285	3157,074	2-1	S-Ar
	Afşin		3601,487	1	Ar
	Büyükçamurlu	432,66	597,927	1-2	S-Ar
	Göksun	3198,148	4401,494	2-1	S-Ar-Çk
	Yağbasan	295,457	1501,792	1-2	S-Çk-Ar
Total		3986,55	13259,774	17246,32	
%		% 23,11	% 76,89	% 100	
Forest Enterprise	District Chief	Plan data for the year 2000			
		Pure Stand (ha)	Mixed Stand (ha)	The order of the fir in the mixed stand	The species formed by mixed stand
Göksun	Çardak	115,252	1796,061	2-1-3	S-Çk
	Afşin	447,191	1749,728	1-2	Ar-S
	Büyükçamurlu	85,635	1266,617	1-2	S-Çk-Ar
	Göksun	2215,844	8443,348	1-2	S-Ar-Çk
	Yağbasan	435,433	2502,925	1-2-3	S-Çk-Ar
Total		3299,355	15758,679	19058,03	
%		% 17,31	% 82,69	% 100	

S: Taurus cedar (*Cedrus libani*), Ar: Juniper (*Juniperus* sp), Çk: Anatolian black pine (*Pinus nigra* subsp. *pallasiana*)

When table 1 is examined; In Göksun Forest Enterprise Directorate of Kahramanmaraş Forest Regional Directorate; *A. c.* subsp. *cilicica* expanded by 1811.77 ha in terms of total area. While a decrease of 687.19 ha was observed in pure stand establishments within this distribution area, an increase of 2498.91 ha was seen in mixed stands. This increase in mixed stands was realized in District Chiefs of Göksun and Yağbasan, which are located at the westernmost point of the directorate. When the data of 2020 and 2000 are evaluated, it is seen that in these areas where pure stands are transformed into mixed stands, *A. c.* subsp. *cilicica* is in the first place in terms of density in all district chiefs except Çardak. While Taurus fir entered the mix with Taurus cedar and juniper species under Çardak District Chief, juniper was replaced by Anatlian black pine species in 2020. Taurus fir, which creates a mixture with cedar under the District Chief of Afşin, also creates new mixtures with Anatolian black pine under the District Chief of Büyükçamurlu. When figure 2 is examined, the 2000 and 2020 temperature data values of Kahramanmaraş province (it turns blue as the temperature values decrease according to the years, and turns red as the temperature values increase (each strip represents 1 year). While the average temperature was 11.13 °C in 2000 across the province of Maraş, it increased to 12.48 °C in 2020 and increased by 1.5 °C.

Figure 2. Average temperatures in 2000 and 2020 for Kahramanmaraş

CONCLUSION AND DISCUSSION

Climate change can altered ecosystems as slowly but permanently and threatening. Although it cannot be exact forecast about results and extent of changes that will be happen, ecosystems will have been effected this changing seriously. Göksun exploitation management which is study area is located inside distribution area of *A. c.* subsp. *cilicica* species northmost. It is known that species that cannot adapt to this rapid change of climate narrow their distribution areas, carry their distribution to the north in the horizontal and higher altitudes in the vertical, otherwise they will perish (Hughes, 2000). For this reason, in this study, which handle the northernmost part of its distribution area; With the increasing 1.5°C temperature level, the distribution of Taurus fir increased by 1811.77 ha in the northernmost Göksun Forest Enterprise Directorate. This observed increase supports the distribution of the species to the north. The species it is a filled tree which is located in fogbelt and wants to sheltering espacially in their young age. Many abiotic factors such as temperature, precipitation changes and soil erosion within the distribution areas have affected the closeness and density, which is very important for Taurus fir, and caused the pure stands to lose their quality (Sarıkaya and Avcı, 2002). For this reason, the distribution areas of the species, which struggle with many biotic factors as well as the aforementioned abiotic factors, are decreasing in pure stands. As can be seen in the study, an increase was observed in mixed stands in contrast to the decrease in pure stands in Göksun exploitation management. The species forms mixed stands as with cedar, black pine and juniper which have higher tolerance for light at high altitudes. Among the species it is mixed with, Taurus fir is the highest species in terms of density (except for one chiefdom), which indicates that it maintains its status in the substrate and increases its yield. The distribution of *A. c.* subsp. *cilicica* was changed depend on abiotic factors such as fires, uncontrolled operation of forests, temperature increases because of climate change and biotic factors such as insect

damage, harmful microorganisms. The fight against these biotic and abiotic factors is of great importance (Shaver et.al., 2000; Logan et al., 2003; Björkman et.al., 2011). Protect of the species that is be filled tree in fogbelt ecosystem where located in South of Turkey is very important. Necessary precautions should be taken and the extent to which the species' existence will change with projections for the next years should be determined. In addition, the potential distribution areas of the species should be determined and measures should be taken against necessary situations.And also, the species should plant to suitable areas for spread of them. Finally, it can be say that this situation is necessary for the continuation of the existence of the species in the forest ecology of Turkey.

List of used literature

1. Balmford, A. (1996). Extinction filters and current resilience: the significance of past selection pressures for conservation biology. *Trends Ecol. Evol.* 11, 193–196.
2. Björkman, C., Bylund, H., Klapwijk, M.K., Kollberg, I., Schroeder, M. (2011). Insect pests in future forests: more severe problems? *Forests* 4, 474–485
3. Guisan, A., Thuiller, W. (2005). Predicting species distribution: offering more than simple habitat models. *Ecology Letters* 8 (9) 993-1009.
4. Hughes, L. (2000). Biological consequences of global warming: is the signal already apparent? *Trends in Ecology & Evolution* 2000,15 (2) 56-61.
5. IUCN (2021). The IUCN Red List of Thereatened Species. (Erişim tarihi: 03.04.2022)
6. Lawler, J.J., Shafer, S.L., White, D., Kareiva, P., Maurer, E.P., Blaustein, A.R., Bartlein, P.J. (2009). Projected climate-induced faunal change in the Western Hemisphere. *Ecology* 90 (3) 588-597.
7. Logan, J.A., Régnière, J., Powell, J.A. (2003). Assessing the impacts of global climate change on forest pests. *Front. Ecol. Environ.* 1, 130–137.
8. Mclachlan, J.S., Clark, J.S., Manos, P.S. (2005). Molecular indicators of tree migration capacity under rapid climate change. *Ecology* 86 (8) 2088-2098.
9. Parmesan, C. (2006). Ecological and evolutionary responses to recent climate change. *Annual Review of Ecology, Evolution, and Systematics* 37- 637-669.
10. Sarıkaya, O., Avcı, M. (2002). Batı Akdeniz Toros Göknarı (*Abies cilicica* Carr.) Ormanlarında Ağaç Ölümleri, Orman Mühendisliği Dergisi, 39 (9-10) 20-24.
11. Schivo, F., Bauni, V., Krug, P., Quintana, R.D. (2019). Distribution and richness of amphibians under different climate change scenarios in a subtropical region of South America. *Applied Geography* 103: 70-89.
12. Shaver, G.R., Canadell, J., Chapin, III F.S., Gurevitch, J., Harte, J., Henry, G., Ineson, P., Jonasson, S., Melillo, J., Pitelka, L., Rustad, L. (2000). Global warming and terrestrial ecosystems: a conceptual framework for analysis. *Bioscience* 50, 871–882.
13. URL-1.https://mgm.gov.tr/FILES/iklim/yillikiklim/2020-iklim-raporu (Erişim tarihi 25.02.2023)

14. URL-2.https://climateknowledgeportal.worldbank.org/country/turkey/climate-data-historical (Erişim tarihi 25.02.2023)