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Daganzo, C., 1996. Two paradoxes of traffic flow on networks with physical queues. II.Symposium Ingenieria de los Transportes, Madrid, 22-24 May 1996, pp. 55-62.

Online Document (Web) Reference: FAO. 2006. Rural radio transmissions and rural youth in Mali. http://www.fao.org/sd/dim_kn1/kn1_060202_en.htm (Accessed: 27 February 2006).

Article by DOI: Asakawa, S., Yoshida, K., Yabe, K., 2004. Perceptions of urban stream corridors within the greenway system of Sapporo, Japan. *Landscape and Urban Planning*, in press doi:10.1016/S0169-2046(03)00158-0.

Thesis: Güner, H.T., 2016. The Miocene flores and vegetation of the Yatağan Basin, Western Anatolia. Unpublished Ph.D. Thesis, İstanbul University, Institute of Sciences, p. 185., İstanbul, Turkey.

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Original Article

Distribution, biology, morphology and damage of *Cinara cedri* Mimeur, 1936 (Hemiptera: Aphididae) in the Isparta Regional Forest Directorate

Isparta Orman Bölge Müdürlüğü sedir ormanlarında *Cinara cedri* Mimeur, 1936 (Hemiptera: Aphididae)'nin yayılışı, morfolojisi, biyolojisi ve zararı

Şükran Oğuzoğlu, Mustafa Avcı

Department of Forest Engineering, Süleyman Demirel University, Faculty of Forestry, Isparta, Turkey

ABSTRACT

In 2015-2016, a study was performed examining the distribution, colony dispersion in tree canopies, occurrence rate in shoots at different ages, morphology, and the damage of the cedar aphid (*Cinara cedri* Mimeur 1936) (Hemiptera: Aphididae) This study was completed alongside biological observations in the Isparta Regional Forest Directorate. This study was conducted across 46 sites at an elevation of 820-1738 meter (m) and the distribution of this species was determined by a survey. Compared to other sites, the *Cinara cedri (C. cedri)* population was found to be higher in 10 sites with young stands with an average height of 1000-1200 m. These sites were established through plantation. Colonies were typically observed on the shoots from the previous year and on branch axils. They were found to feed on shoot tips and trunks of young trees and preferred shoots with a diameter of 1.0-1.5 centimeter (cm) on the southern and eastern aspects of the trees. It was observed that *C. cedri* mostly fed on shoots of the previous year, which caused the needles to dry and turn red. Damage was observed especially on young trees from which the dried needles fell and defoliation was concentrated particularly on the shoot tips and tops of the trees. It was found that honeydew was secreted by those insects fed with sap, and this secretion then covered the needles, shoots and branches, resulting in fumagine. The populations overwintered as eggs and then nymphs hatched during the first week of April. The adult stage was reached after completing four nymph periods over a time span of between one week and 10 days. These adults then reproduced parthenogenetically, with winged viviparous individuals appearing between May and June, and oviparous emerging in October. The final stage of the cycle was a period of mating and then egg-laying.

Keywords: Cedar aphid, *Cinara cedri*, damage, Isparta, life cycle

ÖZ

Çalışma, 2015-2016 yıllarında Isparta Orman Bölge Müdürlüğü'nde, sedir yaprak biti (*Cinara cedri* Mimeur 1936) (Hemiptera: Aphididae)'nin yayılışı, türün ağaç tepe tacındaki koloni dağılımı ve farklı yaşlardaki sürgünlerde bulunma oranı, morfolojisi, biyolojisi ile zararı tespit edilmiştir. Çalışma, 820-1738 m arasında yükseltiye sahip 46 alanda gerçekleştirilmiştir. Plantasyon sahaları, genç meşcere ve ortalama 1000 m yükseltide bulunan 10 alanda diğer alanlara göre *C. cedri*'nin popülasyonunun daha fazla olduğu belirlenmiştir. Kolonilerin genellikle bir önceki yıla ait sürgünlerde ve dal koltuğunda bulunduğu, ayrıca sürgün ucu ile genç ağaçların gövdesinde de beslendikleri, ağacın güney ve doğu bakıdaki 1,0-1,5 cm çapındaki sürgünleri tercih ettiği görülmüştür. *C. cedri*'nin çoğunlukla bir önceki yıla ait sürgünlerde beslendiği ve ibrelerin kuruyup kızarmasına yol açtığı gözlenmiştir. Zararın özellikle genç ağaçlarda olduğu, kuruyan ibrelerin döküldüğü ve yapraksızlaşmanın ağacın sürgün uçları ile tepe kısmında olduğu görülmüştür. Zararlının öz suyu ile beslenmesi nedeniyle ballı madde salgıladığı ve ballı maddenin dalların üzerini kapladığı ve fumajin oluşumuna neden olduğu belirlenmiştir. Popülasyonlar kışı yumurta döneminde geçirmiş, Nisan ayının ilk haftasında yumurtadan çıkan kanatsız viviparların yaklaşık bir hafta ile 10 günlük sürede dört nimf dönemini tamamlayarak erginliğe ulaşmışlardır. Mayıs-Haziran aylarında kanatlı viviparların görüldüğü, ekim ayının son haftasında oviparların ortaya çıktığı ve çiftleşerek yumurta bıraktıkları gözlenmiştir.

Anahtar Kelimeler: *Cinara cedri*, Isparta, sedir yaprak biti, yaşam döngüsü, zarar

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INTRODUCTION

Taurus cedar (*Cedrus libani* A. Rich.) is one of four cedar species distributed across the world. The Taurus cedar, which is naturally found in Turkey, Lebanon and Syria, is distributed across approximately 482.391 hectares (ha) in Turkey, 2.300 ha in Lebanon and 400 ha in Syria (Aksoy and Özalp, 1990; Aytar et al., 2011; Khuri et al., 2000; OGM, 2015). The Taurus cedar is one of the most commonly used tree species in the plantations of Turkey after the Crimean pine (*Pinus nigra* J. F. Arnold subsp. *pallasiana* (Lamb.) Holmboe) (Boydak, 2014; Yaltırık, 1988).

Cinara cedri was identified in 1936 by J. M. Mimeur in Morocco *Cedrus atlantica* (Mimeur, 1935). *C. cedri* is an aphid belonging to the Hemiptera order and Aphididae family and especially chooses cedar species as a host (Binazzi et al., 2015; Lieutier and Ghaioule, 2005; Mimeur, 1935). Due to the quality of cedar wood and its wide use as an ornamental plant, *C. cedri* is distributed across different areas of the world along with its host. This species was first recorded in Turkey in 1959 in Gaziantep on *C. libani* (Tuatay and Remaudiere, 1964). This species was found in Ankara, Konya (Center, Akşehir), Burdur (Center, Bucak-Sobya-Kızılgöl, Çeltikçibeli), İstanbul (Dolmabahçe-Bahçeköy-Yıldız), Hatay (Karaağaçlı), Eskişehir, Afyon, Isparta (Şarkikaraağaç-Kızıldağ), Antalya (Center, Elmalı-Çığlıkara, Kaş-Sütleğen-Çereli), Samsun (Bafra), Bartın, Tekirdağ, Adana, Karaman, Niğde, Osmaniye, Mersin, Kahramanmaraş and Kastamonu (Aslan, 2014; Aytar, 2006; Çanakçıoğlu, 1975; Düzgüneş et al., 1980; Görür et al., 2009; Uygun et al., 2000; Ülgentürk et al., 2012, 2013; Ünal and Özcan, 2005).

C. cedri causes damage by sucking the sap from the shoots and leaves of cedar trees which consequently leads to the needles turning red and drying out (Tuatay, 1999). The secreted honeydew sticks to leaves and shoots causing occlusion of the stoma and lenticels. Additionally, the fungus growing on this secretion leads to fumagine, thereby blocking photosynthesis of the tree. Several fly and bee species are also attracted to the honeydew and the trees which are also damaged from disease-related factors associated with these species. Loss of increment is observed on the damaged trees and their seed production yield decreases (Binazzi et al., 2015; Çanakçıoğlu, 1975; Núñez-Perez and Tizado, 1996). Despite its damaging effects, this species provides nutrition for ants, bees and fly species due to its honeydew secretion and is important for the continuation of the ecological balance. It is known that ants that visit aphids on plants increase honeydew secretion, which facilitates the predation of some harmful insects by ants and keeps away the natural enemies of aphids (Ülgentürk et al., 2012).

A semi-arid climate is the influencing environment across 35% of Turkey and most of this area is potential plantation fields. In recent years, the majority of plantation studies have been performed in semi-arid areas. Cedar is a species which is commonly used in semi-arid areas. Therefore, it is very important to protect the existing cedar forests and to identify the species that cause damage to cedar forests whilst undertaking efforts to control these species with a view to establishing healthy forests.

The purpose of this study was to contribute to the control of the species by determining the morphological features of *C. cedri* that damages cedar forests, as well as its distribution, damage and biology.

MATERIAL AND METHODS

The study was conducted in the natural and plantation cedar forests of Isparta Regional Forest Directorate in 2015-2016. While collecting samples from shoots where *C. cedri* was found, the shoot diameter of the colony, distance to shoot tip, and colony width were measured and recorded in the field report along with information regarding coordinates, elevation, aspect, and stand in the areas where *C. cedri* was found. Furthermore, the egg, nymph and adult stages of *C. cedri,* in addition to features such as the part of the tree they feed on, whether it causes colour change damage, formation of fumagine, distribution of the colony on the tree canopy, and colony density were investigated and photographed. Both nymphs and adults were cultivated and monitored in laboratory conditions, and information on their biology and morphology was recorded. Adults were placed in Eppendorf tubes with 70% alcohol, prepared as per Martin (1983) and were categorized as per Blackman and Eastop (2012).

The identification key for global aphid species belonging to the genera *Cedrus* is presented below (Blackman and Eastop, 2012).

Key to aphids on *Cedrus* (Blackman ve Eastop, 2012):

1 Antenna processus terminalis/ basal part of last antennal segment more than 1. siphunculi long and tubular, swollen distally .....*Illinoia morrisoni*
- Antenna processus terminalis/ basal part of last antennal segment less than 1. siphunculi are broad hairy cones 2
2 Rostral segment V short, flask-shaped, pointed only at tip, hardly longer than its basal width. siphunculi cones with few hairs, in 1-2 rings around pore .....*Schizolachnus pineti*
- Rostral segment V acutely pointed, dagger-shaped, usually twice or more as long as its basal width. siphunculi cones large and dark with numerous hairs 3
3 Antenna 5-segmented. Dorsal hairs of aptera club-shaped, ornamented with numerous barbules .....*Cinara laportei*
- Antenna 6-segmented. Dorsal hairs normal, pointed 4
4 Hairs on body and appendages short; those on antenna III maximally about as long as basal diameter of segment .....*Cinara curvipes*
- Hairs mostly long; longest hairs on antenna III maximally more than 2 × basal diameter of segment 5
5 Body lenght 3.0 mm or less. Dorsal length of hind tarsus I distinctly longer basal width 6
- Body lenght more than 3.0 mm. Dorsal length of hind tarsus I shorter than basal width 7
6 Aptera with 0-1 secondary rhinaria on antenna III. antenna IV longer than antenna VI. abdominal tergit 1-6 without any extensive dark sclerotisation .....*Cinara cedri*
- Aptera with c. 5 secondary rhinaria on antenna III, antenna IV shorter than antenna VI, and abdominal tergit 1-6 with an extensive pattern of dark sclerotisation .....*Cinara deodarae*

7 Aptera with hind tarsus II less than 4 × hind tarsus I. antenna III with more than 40 long hairs, very few of these less than 2 × basal diameter of segment. Body length 3.8-7.8 milimeter (mm) .....*Cinara confinis*

- Aptera with hind tarsus II 4 or more × hind tarsus I. antenna III with less than 30 hairs of very variable length, often less than 2 × basal diameter of segment. Body length c.3.3 mm .....*Cinara indica*

RESULTS AND DISCUSSION

Hosts of *Cinara cedri*

C. cedri was observed on *C. libani* in the study field. However, according to the literature, it was also observed on *C. atlantica*, *C. deodora*, *C. brevifolia*, *Thuja* sp., *Pinus* sp., *P. brutia* (Binazzi et al., 2015; Görür et al., 2009; Lieutier and Ghaioule, 2005; Ülgentürk et al., 2013; Ünal and Özcan, 2005).

Distribution of *Cinara cedri* in the forests in the study field and effects of different field and stand characteristics on the distribution of *Cinara cedri*

As a result of the survey conducted to determine the distribution of *C. cedri* in Isparta Regional Forest Directorate's natural and plantation forests, the presence of the species was noted in 46 fields where the studies were conducted (Figure 1).

When the stand structure of the study sites was investigated, it was observed that 26 sites contained a cedar-Crimean pine mixed stand, 18 sites had a pure cedar stand, one site had a fir-cedar stand, and one site contained a cedar-Kasnak oak stand. Nine sites were found to be natural and 37 sites were identified as plantation forests. When the sites were assessed in terms of stand age, it was observed that 33 sites had young stands, 11 sites had mixed stands and two sites had old stands. The four areas (Isparta-center, SDU campus, Gökçay Park and Ayazmana Park) are close to the settlement area, therefore stand properties of these areas were not given (Table 1). In review of literature, no information was found regarding stand characteristics or aspects of the sites where *C. cedri* was found. Çanakçıoğlu and Mol (1998) and Usta and Keskin (1992) stated that when the population of *C. cedri* became dense, they preferred young seedlings in particular. It was found that *C. cedri* was intensely distributed (particularly across young stands established in plantations) in the study sites Bucak, Atabey, Gönen, Keçiborlu, Yukarıgökdere-Beşkuyu, Uluborlu, Isparta-center, SDU campus, Eğirdir-center, Gökçay Park and Yalvaç City Forest. The species distribution was found between elevations of 820 m (Bucak) and 1738 meter (m). Regarding dense populations, observations were recorded at elevations between 1000-1200 m.

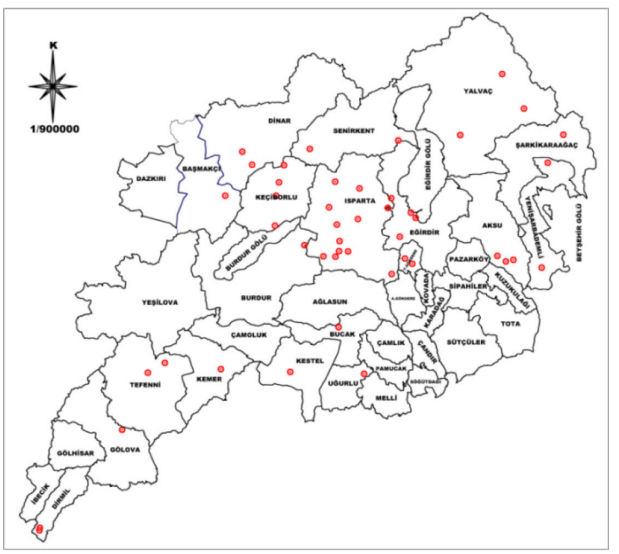


Figure 1. Locations of *Cinara cedri* detected in Isparta Forest Regional Directorate

Serttaş et al. (2012) stated that *C. cedri* was found in the Antalya-Çığlıkara Nature Protection Area at an average elevation of 1830 m. Çanakçıoğlu (1975) had reported *C. Cedri* in the same place at an elevation of 1000-1750 m, in Ankara Atatürk Forest Farm at 900 m, in İstanbul Bahçeköy at 110 m, in Antalya-Kaş-Çerçeli at 1710 m, in Burdur at 925 m, in Eskişehir at 790 m and in Afyon at 1020 m. Tosun (1975) reported the occurrence of *C. cedri* in the garden of Antalya Regional Forest Directorate at 40 m, in the Isparta-Şarkikaraağaç-Kızıldağ cedar forest at 1300 m, Burdur-Bucak-Sobya Kızılgöl forest at 1600 m, in Burdur-Çeltikçibeli region at 950 m. The elevations at which *C. cedri* presence was identified in this study were similar to those reported in the literature.

Morphology

Egg

In the study, it was observed that when the *C. cedri* eggs were first laid at the end of October and November, they were light brown in colour and subsequently turned a dark glossy brown. It was found that eggs were laid generally on the needles at the tip of shoots, with a few of them on the needles of the shoots from the previous year, forming either a single line or two lines (Figure 2). It was noted that similar conclusions which were given in the study of Çanakçıoğlu (1975). Çanakçıoğlu and Mol (1998) and Usta and Keskin (1992) stated that eggs were dark brown and glossy, 0.7-1.0 mm in length and 0.2-0.3 mm in width. According to the measurements recorded in this study, eggs were 0.43 mm in width and 1.17 mm in length - greater than those values reported in the literature.

Nymph

It was observed that the dark coloured stripes on the thorax and abdomen area appearing towards the 4th nymph stage became clearer and the head area of those individuals that were a light bronze grey brown during the 1st nymph stage turned from dark brown to light brown. Moreover, it was found that during the 1st nymph stage, the thorax and abdomen were thin and long, yet towards the 4th nymph stage they were enlarged. It was observed that the density of the waxy layer varied amongst

Table 1. Characteristics of the land and stand of 46 *Cinara cedri* detected localities in study area

No	Locality	Altitude (m)	Aspect	Coordinate	Nature/Plantation	Stand property*
1	Isparta-Center	1043	Plain	37°46'43''N-30°32'49''E	Plantation	-
2	Isparta-SDÜ Campus	1019	East	37°49'49''N-30°32'05''E	Plantation	-
3	Bucak-Karapınar Village	820	Southwest	37°21'46''N-30°22'00''E	Plantation	Sa
4	Isparta-Sağ Âşık Tomb	838	West	37°21'46''N-30°39'26''E	Plantation	Sc2
5	Eğirdir-Barla	1182	East	37°55'04''N-30°44'49''E	Plantation	SÇka
6	Dinar-Tekin Village	874	Plain	38°03'04''N-30°09'07''E	Plantation	Sa0
7	Başmakçı-Sarıköy	1024	Plain	37°54'40''N-30°05'24''E	Plantation	Sc1
8	Dinar-Dikici	931	West	38°00'40''N-30°11'32''E	Plantation	Sa
9	Keçiborlu	1067	North	37°54'57''N-30°17'28''E	Plantation	Sa
10	Gelendost	951	Plain	38°07'17''N-31°00'54''E	Plantation	Sa0-2
11	Eğirdir-Center	976	Northwest	37°52'24''N-30°49'36''E	Plantation	Sa0
12	Isparta-Çobanisa Village	1716	West	37°47'49''N-30°47'04''E	Nature	Scd1
13	Yukarıgökdere-Beşkuyu	1738	South	37°43'44''N-30°48'25''E	Nature	Scd2
14	Isparta-Güneyce	880	West	37°40'45''N-30°45'22''E	Plantation	ÇkSab2
15	Isparta-Gökçay Park	1153	Plain	37°44'49''N-30°32'45''E	Plantation	-
16	Isparta-Hisartepe	1485	Northwest	37°43'45''N-30°31'56''E	Plantation	SÇka0
17	Yenişarbademli	1415	Southwest	37°42'33''N-31°20'52''E	Nature	ÇkSc3
18	Aksu	1213	South	37°43'35''N-31°12'21''E	Plantation	ÇkSa
19	Aksu-Yakaafşar	1275	Northeast	37°44'36''N-31°10'19''E	Plantation	Sa0
20	Aksu-Yaka	1326	North	37°43'55''N-31°14'08''E	Plantation	ÇkSa
21	Atabey	1041	South	37°56'45''N-30°37'14''E	Plantation	SÇka
22	Gönen	1086	East	37°57'55''N-30°31'24''E	Plantation	ÇkSab2
23	Keçiborlu-Center	1042	West	37°57'29''N-30°18'03''E	Plantation	Sa1
24	Keçiborlu-Özbahçe Village	1337	Northwest	38°00'45''N-30°19'07''E	Plantation	ÇkSb3
25	Keçiborlu-Senir Town	1026	Southeast	37°49'17''N-30°17'24''E	Plantation	Sa
26	Senirkent-Kapıdağ	1507	North	38°06'00''N-30°46'10''E	Nature	Sc1
27	Isparta-Senirce Village	1025	East	37°53'03''N-30°30'06''E	Plantation	Sa
28	Altınyayla-Kumluağıl	1604	South	36°50'19''N-29°24'19''E	Nature	SÇkcd2
29	Altınyayla-Tamtır	1564	South	36°50'48''N-29°24'23''E	Nature	SÇkcd2
30	Çavdır	1150	Southeast	37°09'51''N-29°42'51''E	Plantation	Sab2-1
31	Tefenni	1138	Southeast	37°20'47''N-29°48'27''E	Plantation	ÇkSab2
32	Karamanlı	1121	Northwest	37°22'45''N-29°52'23''E	Plantation	Sa-3
33	Kızıldağ NP**	1421	North	38°02'22''N-31°21'52''E	Nature	Sc3
34	Çarıksaraylar	1301	South	38°07'43''N-31°25'28''E	Plantation	ÇkSab2
35	Yalvaç-City Forest	1116	Northwest	38°18'58''N-31°10'36''E	Plantation	SÇkbc2
36	Yalvaç-Bağkonak	1136	West	38°12'31''N-31°15'57''E	Plantation	SÇka0
37	Burdur-Gökçebağ Village	1169	North	37°45'46''N-30°24'31''E	Plantation	Sa0
38	Bucak-Katran Mountain	1136	North	37°21'54''N-30°05'38''E	Nature	GScd1
39	Isparta-Kuleönü	1025	West	37°50'58''N-30°37'02''E	Plantation	SÇka0

Table 1. Characteristics of the land and stand of 46 *Cinara cedri* detected localities in study area (continue)

No	Locality	Altitude (m)	Aspect	Coordinate	Nature/Plantation	Stand property*
40	Büyükgökçeli	1047	North	37°53'13''N-30°44'04''E	Plantation	ÇkSa
41	Eğirdir-Center	1016	Northeast	37°51'27''N-30°50'45''E	Plantation	Sa0
42	Uluborlu	1150	Northwest	38°03'58''N-30°25'09''E	Plantation	Sa3
43	Isparta-Ayazmana Park	1045	North	37°44'48''N-30°34'54''E	Plantation	-
44	Bucak-Seydiköy	892	East	37°30'27''N-30°33'07''E	Plantation	Sb3
45	Kasnak Oak NPA**	1192	Southeast	37°42'46''N-30°50'11''E	Nature	SMkcd2
46	Gölcük NP***	1400	Southeast	37°43'45''N-30°29'05''E	Plantation	ÇkSab2

*Stand property: Main tree species; S: *Cedrus libani*; Çk: *Pinus nigra*; Mk: *Quercus vulcanica*; G: *Abies cilicica*
Age classes of stands according to diameter of 1.30 m; a: 0-7.9 cm, b: 9-19.9 cm, c: 20-35.9 cm, d: 36-51.9 cm, e: >52 cm
Canopy closure; 0: 1-10%, 1: 11-40%, 2: 41-70%, 3: 71-100%.
**NPA: Nature Protection Area; ***NP: Nature Park

Figure 2. Egg, nymph and adult form of the *Cinara cedri* populations respectively

individual specimens. In winged specimens, morphologically similar features were found in transition to the nymph phase. However, wing colours were different in head, thorax and siphunculi. Wings that were bright white during the 1st nymph phase turned darker at the 4th nymph phase. In the winged specimens, the siphunculi area and legs were darker in colour and there were black and grey coloured stripes on the head and thorax area. It was observed in the study that the head, thorax and abdomen area along with the intersection area of the femur and tibia was dark in colour whereas the legs and antennae were yellowish brown (Figure 2). Antenna, leg, abdomen and thorax characteristics were similar to the findings reported by Çanakçıoğlu (1975), Çanakçıoğlu and Mol (1998) and Cebeci (2003).

Mendel et al. (2016) and Cebeci (2003) stated that winged specimens did not have dark coloured stripes and the wings were a greyish-yellow colour. In this study, however, it was observed that some individuals had grey-white wings while some had dark stripes on their wings (Figure 2). This was interpreted to signify that *C. cedri* might have morphological variations under the influence of ecological features.

Adult

In the study, it was observed that adults were generally a dark/black colour in the head region with dark coloured stripes on the thorax and abdomen. It was found that the legs and antennae were dark compared to the nymph stage. However, specimens whose bodies were red in colour were also observed (Figure 2). Usta and Keskin (1992) stated that the head region in adults was dark; Görür (2014) stated that adults' head regions were black in colour - similar to the findings of this study. Çanakçıoğlu (1975) stated that both the winged and wingless viviparous insects had a length of 3.0-4.4 mm while Usta and Keskin (1992) reported lengths ranging from 3.0-3.8 mm. In this study, the average length of adults was found to be length 3.09 mm and width was 1.71 mm - these values were similar to those reported in the literature.

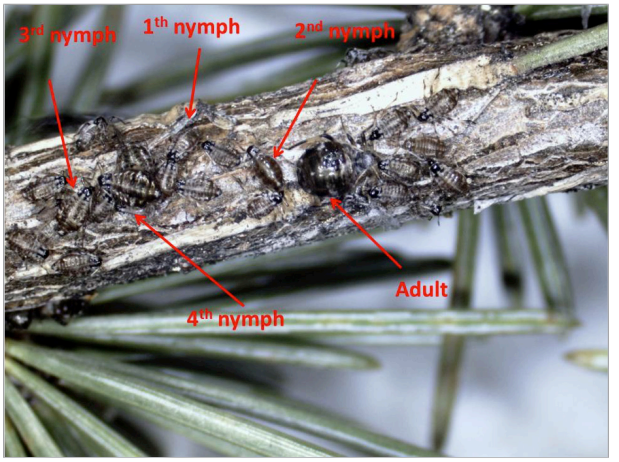


Figure 3. Nymph stages and adult of the *Cinara cedri* on a shoot (29 April 2016)

Biology

In this study, unhatched eggs were also observed in addition to the wingless viviparous specimens that hatched on 03.04.2016. Çanakçıoğlu (1975) stated that the eggs in the İstanbul Bahçeköy Park of the Faculty of Forestry did not hatch on 05.03.1965 - some hatched on 08.04.1965 while most of them hatched on 19.04.1965, which was similar to the findings of this study. In this study, it was observed that a maximum of nine eggs were laid on a needle and Usta and Keskin (1992) and Çanakçıoğlu and Mol (1998) reported similar findings. It was found that wingless viviparous individuals completing four nymph phases in 10 days became adults after parthenogenetically reproducing and these specimens hatched between May and June. In contrast, oviparous individuals were observed to copulate and lay eggs in October-November (Görür et al., 2009).

It was observed that while there was a significant rise in the population twice a year during June and September, the species completed its lifecycle on a single host (Figure 3). These

Figure 4. Damage on needles of *Cinara cedri*

findings are similar to those reported by Usta and Keskin (1992), Çanakçıoğlu and Mol (1998) and Toper Kaygın and Çanakçıoğlu (2003).

Damage

It was observed that *C. cedri* mostly fed on the shoots of the previous year and caused the needles to dry out and turn red.

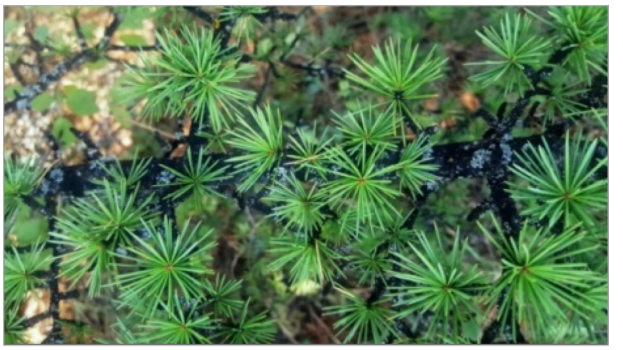
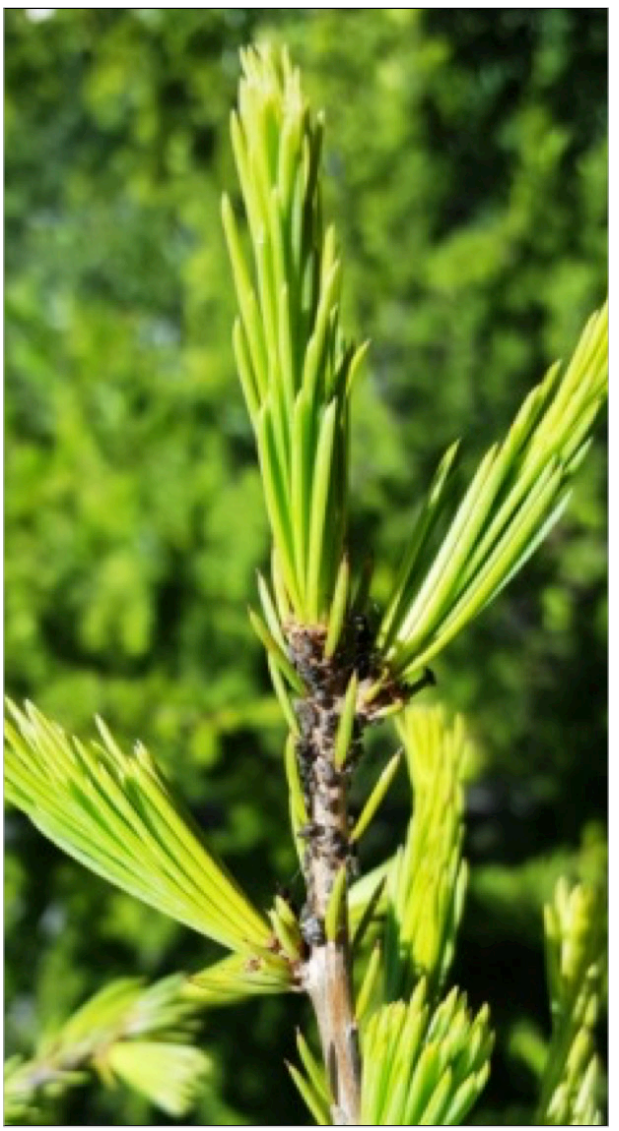


Figure 5. Honeydew on needles and fumagine formation



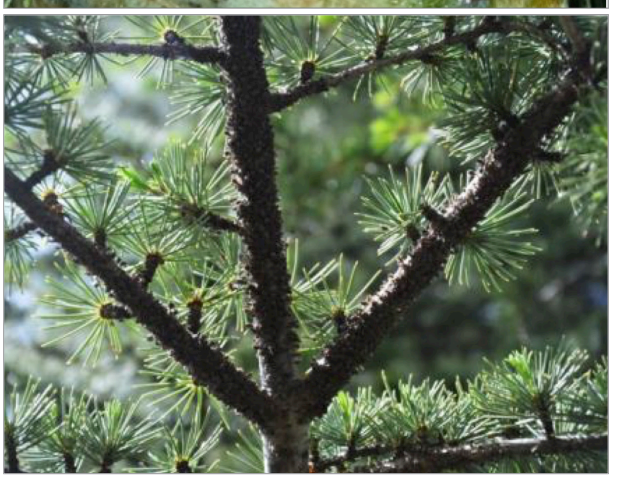


Figure 6. *Cinara cedri* colonies at the end of shoot and cone petiole

Damage was found on young trees in particular, from which the dried needles fell, and that defoliation occurred on shoot tips and canopies. The signs observed in this study were similar to those reported in literature (Binazzi et al., 2015; Çanakçıoğlu, 1975; Düzgüneş et al., 1980; Núñez-Pérez and Tizado, 1996; Tuatay, 1999; Usta and Keskin, 1992; Ünal and Özcan, 2005). Although it was stated in the literature that the seed production capacity of dried needles decreased and led to increment loss, this was not observed in this study. In our study, it was found that the damage was high particularly in Uluborlu and Bucak-Karapınar sites (Figure 4). Binazzi et al. (2015) stated that *C. cedri* might form dense colonies under suitable micro-climate conditions while Mendel et al. (2016) stated that there might be significant loss of needles due to the damage of the species and that would cause the tree to lose its vitality. As it was stated by Çanakçıoğlu and Mol (1998) and Usta and Keskin (1992), the population during high density periods preferred young seedlings in particular, while damage from the species was also found on young trees in this study in Uluborlu and Bucak-Karapınar.

It was found that since *C. cedri* fed on sap, there was a honeydew secretion and honeydew covered the needles, shoots and branches. It was observed that bees were attracted to this honeydew and that fungi growing on honeydew led to fumagine on trees. Intense fumagine formation was found especially in Uluborlu and Bucak-Karapınar (Figure 5). It was also found that colony presence was very high in city centres, parks and gardens and that honeydew secretion dripped on roads, sidewalks and on cars in carparks. Fumagine formation was also reported by many other authors (Binazzi et al., 2015; Çanakçıoğlu, 1975; Düzgüneş et al., 1980; Núñez-Pérez and Tizado, 1996; Tuatay, 1999; Usta and Keskin, 1992; Ünal and Özcan, 2005) and the first damage to this species in our country was observed in the plantation fields in the Mediterranean region (Aytar, 2006).

Dispersal across the tree canopies and occurrence rate on the shoots at different ages of colonies of *Cinara cedri*

In this study, colonies of *C. cedri* were mostly seen on shoots in south and east sections, while fewer were observed on shoots in north and west sections. Çanakçıoğlu (1975) stated that *C. cedri* colonies were only observed on those sections of the cedar that were exposed to light. Colonies were observed particularly on lower branches of both old and young trees, and on the trunks, shoots, shoot tips, branches, branch axils, and cone stems of young trees (Figure 6). Similar findings were also noted in the literature (Aytar, 2006; Çanakçıoğlu and Mol, 1998; Düzgüneş et al., 1980; Tuatay, 1999; Usta and Keskin, 1992; Ünal and Özcan, 2005). However, no information was found in the literature regarding the observation on cone stems. Görür (2014) stated that *C. cedri* was also feeding intensely in trunk cracks. In this study, *C. cedri* was not found in trunk cracks but it was observed on the trunks themselves of young trees.

In the study, the colonies were found on shoots with a diameter of 1.0-1.5 cm. Núñez-Pérez and Tizado (1996), stated that *C. cedri* individuals existed densely on 1.5 cm-diameter branches, which was consistent with the measurements recorded in this study. The thickest shoot diameter was found in shoots located in Bucak-Karapınar with 4.7 cm. Mendel et al. (2016) stated that sometimes colonies covered trunks at a diameter of 5-6 cm. The distance of the colony to the shoot tip was found to be 22.14 cm on average and the width of the colony was 4.11 cm. In the literature no information was found regarding the distance of the colony to the shoot tip and the width of the colony.

CONCLUSION

According to the findings in the areas studied, in general, intensive damage of *C. cedri* was not found. A small number of colonies were observed - mostly on shoots - and (apart from a few sites) yellowing and abscission of leaves along with formation of fumagine were not found intensely. It was found that the *C. cedri* population was higher in those 10 sites established by plantation with young stands and located at an average elevation of 1000-1200 m compared to the others. However, on the trees in the Uluborlu cedar plantation forest, a high amount of fumagine formation from previous years, along with yellowing in some trees and contraction and decrease in needles were observed. In the Bucak-Karapınar village cedar-Crimean pine plantation forest, needle contraction and decrease along with yellowing of trees were identified, yet fumagine formation was observed to be less dense. Furthermore, in city centres, parks and gardens, colonies were much denser and honeydew secretion dripped on roads, sidewalks and cars in carparks.

Many aphid species can easily increase their population size on a variety of hosts and this highlights the importance of the control of these species. As aphids are the prey of many species including Hymenoptera, Coleoptera, Diptera and Neuroptera orders, they have a lot of natural enemies. Therefore, in ecosystems where aphids are intensely observed, biological control is considered more beneficial as opposed to chemical control with its many known side effects. However, in order to switch to biological control, natural enemies should initially be identified. This study is part of a master's thesis and in this study natural enemies of the pest were identified. In this study, it can be stated that natural enemies were effective and kept the balance of the pest population throughout the study field in general.

It is suggested that during forestry activities, as well as identifying natural enemies, the inclusion of other species where possible, preservation of in-forest bushlands and increasing efficiency via a variety of natural enemies, would help maintain the balance of *C. cedri* populations in cedar plantations. Thus, chemical intervention would no longer be required. In populated areas, however, the use of bio-insecticides may be recommended in order to avoid exposure to intense honeydew secretion and fumagine formation. Moreover, the collection and extermination of shoots on which eggs and colonies are found or enabling parasitoid emergence could help contribute to the control of the species.

Ethics Committee Approval: This study does not contain an approach involving humans or animals as a subject. Based on this, ethics committee approval was not necessary for this study.

Peer-review: Externally peer-reviewed.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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İSTANBUL UNIVERSITY
CERRAHPAŞA

Original Article

Development planning approach for children with orthopaedic disabilities; example of Eymir Lake (Ankara)

Ortopedik engelli çocukların iyileştirilmelerine yönelik planlama yaklaşımı: ODTÜ Eymir Gölü örneği (Ankara)

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ABSTRACT

The aim of this study is to provide the re-planning of Lake Eymir, located in the city of Ankara with the participation of shareholders and children with orthopedic disabilities as the main user group. Post-occupancy evaluation was implemented in the research and techniques, and surveys, observations, and interviews with experts were used. Behavioral maps showing the activities of the subjects were created using geographical information systems. People's rude manners, limited means of transport, and economic problems prevent children with disabilities from visiting open green areas. It is suggested that Lake Eymir and its surroundings should be convenient for developing activities for children with disabilities. A convenient and accessible passage should be planned to achieve this.

Keywords: Behavioral mapping, children with orthopedic disabilities, Eymir Lake planning, landscape, post-occupancy evaluation

ÖZ

Çalışmanın amacı, Ankara kenti yakın çevresinde bulunan Eymir Gölü'nün doğal çevre değerlerinin paydaşların katılımı ve ortopedik engelli çocukların kullanıcı kesimler olarak gözlemlenmesi doğrultusunda yeniden planlanmasını sağlamaktır. Araştırmada kullanım Sürecinde Değerlendirme Metodu (POE) uygulanmıştır. Bu kapsamda anket oluşturma, gözlem yapma ve ilgili uzmanlarla görüşme teknikleri kullanılmıştır. Gözlem sonucunda coğrafi bilgi sistemi kullanılarak deneklerin yapmış oldukları etkinliklerin gösterildiği davranış haritaları oluşturulmuştur. Başta çevredeki insanların rahatsız edici tavırları, ulaşım olanağı kısıtlılığı ve mevcut ekonomik sorunlar, bu engelli çocukların açık yeşil alanlara gitmesini engellemektedir. Eymir gölü ve çevresinin, ortopedik engelli çocuklara yönelik geliştirilen etkinliklere uygun olması ve bu kapsamda erişilebilirliğin sağlandığı uygun geçiş yollarının yeniden düzenlenmesi önerilmektedir.

Anahtar Kelimeler: Davranış haritalaması, Eymir Gölü planlaması, kullanım sonrası değerlendirme, ortopedik engelli çocuklar, peyzaj

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INTRODUCTION

Today, many scientists have been conducting studies the effects of natural and organized environment on human health and healing (Erickson, 2012; Harris, 1996; Marcus & Barnes, 1999; Söderback et al., 2004; Stigsdotter & Grahn, 2003; Ulrich, 1999; Whitehouse et al., 2001). One point that the present study takes into consideration is the planning of green networks of inner and outer urban to create healing environments, as accessible and suitable places, for disabled persons.

To achieve this, it is necessary to have a participative management approach in which the related experts, state and non-state organizations, and also managers of governmental institutions play a role. When the magnitude of the orthopedic disabilities of population is compared to the general population in Turkey, (Barış & Uslu, 2009; Maralcan et al., 2003; Sakız & Woods, 2015; Yalçın, 2012; Yorulmaz, 2010), it is not possible to mention an area planning that contains wide fields, has rich

recreational diversity and brings the healing features of the natural environment values to the forefront, except for the limited-sized and numbered replannings made for the treatment of the disability (Akın, 2006). The fact that there have been partial improvements for the disability in some areas of the existing parks is not sufficient to say that these kinds of park areas have the healing quality for the disability. In this case, a process that constitutes all the green web components within the city needs to be initiated with a participatory approach (Şafak & Pouya, 2016). Participatory approach can be defined as joint actions of people, landscape architects and, city planners with the objective of formulating development plans and selecting the best available alternatives for their implementation (URL 1).

Within the immediate environment and hinterland of the city, city forests, wetlands, wide city parks providing wide mobility can be given as examples of these green web components when considering the natural environment values (vegetation, water resources, birds and other living creatures) as well as the healing and treating features for the disability. It has been reported that 12/29 percent of the population in Turkey has mental or physical disabilities and out of this percentag, 9 million people are at the age of 1-12 who have special needs. According to the Ministry of Education,there are 1 million and 100 thousand disabled children agred between 4 and 18 and among them 45 thousand ones have vision impairment, 130 thousand ones have hearing impairment, 500 thousand of them have mental and emotional disabilities, and 300 thousand of them suffer from physical disabilites. Enrollment rate in Disabled Children School is around 2% (Pouya et al., 2018; Şafak & Pouya, 2016).

In this study, the Lake Eymir located in the immediate environment of Ankara city is replanned in accordance with the participation of shareholders and observation of the children with orthopedic disabilities as user groups. In the study, students with orthopedic disabilities aged 8-12 in the Dogan Chaglar Special Education School (DCSES) in Ankara were chosen as subjects.

The reason for choosing this age group is that it is the age group in which awareness about environment and nature starts to shape for the first time if we look at the literature on the pertinent subject. In addition, it constitutes the periods of time when

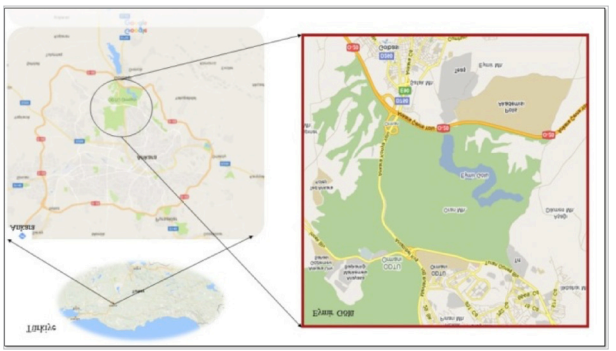


Figure 1. The location of Eymir Lake and its surroundings in Ankara

the interest towards environment intensifies and physical and mental mobility reaches its highest level. Also, it is highly important for the children to be in relation to natural areas in terms of their development (Ünver, 2014).

The aims of this study are:

- To systematically evaluate the usage process of the Lake Eymir-Mogan which is planned for visitors' recreational (one-day) usage, located in the immediate environment of Ankara city and whose implementation is conducted in terms of the children with orthopedic disabilities.
- To determine the level of meeting the need and requirement of the user with orthopedic disabilities in this field, to identify the place performance value.
- To determine what kind of activities this area is designed and for what kind of activities the children with orthopedic disabilities use this area.
- To determine whether the area meets the needs and demands of the children users with orthopedic disabilities or not.

MATERIAL AND METHODS

Study Area

As to the study area, the Lake Eymir recreation area and its surroundings is located in the Ankara city macro form and is one of the limited open green areas (Figure 1) (Beklioğlu, 2000; Eyyubi, 2004). The Lake Eymir recreational area, which is located in Ankara city macro form and one of the limited open green areas, is among the privileged areas for increasing urban life quality and creating an image for the city as well as its ecological contributions with its immediate environment to the city ecosystem (Figure 2) (Bilgin, 2009) and for this reason this area has been chosen as the research area. Middle East Technical University is responsible for the management of the area (Gürer, 2014; İnce, 2002; Köç, 2006; Sarıemir, 2009). The reason for choosing this area as a research area is

Also, the area of the Dogan Chaglar Special Education School was used as a material together with students with orthopedic disabilities used as subjects. The reasons for preferring this school are:

- It is a unique Special Education school that has the most ancient history located in Ankara (Elementary, Secondary and High School) (TR. Altındağ District Governor, 2013).
- In every step of the study; the construction of this school (administrative, educational, social, and physical) has enabled to conduct observation studies with children aged 8-12, surveys with the families and teachers, and interviews.

The method used in the study is Post Occupancy Evaluation Method (POE). This method, which constitutes many techniques, is the main method of the study (Groat & Wang, 2002; Preiser, 2002; Presier et al. 1988; Sherman et al. 2005; Whitehouse et al. 2001). Systematical observation, survey, interview technique methods have been used among the techniques, according to the aims of the study. The stages of POE in the Study

Method: Stage I: POE Planning Stage, Stage II: POE Management Stage, Stage III: POE Application Stage (Figure 3).

Stage I: POE Planning Phase

Making Presentation in DCSES

Before starting the study, a presentation consisting of detailed information about the main goal of the study, its scope, and implementation studies was made to the school administrators, teachers, families and, students. The presentation consisted of information about the positive effects of the natural areas on the orthopedically disabled children and the activities that children can do in the Eymir area.

Identification of the subject group

The student group aged 8-12 from Ankara DCSES was selected as the subject in the study. There were also children who had mental and speech disorders among them. It was deemed suitable to choose ones with orthopedic disabilities having different characteristics among them and to use them as subjects in order to observe the children's behaviors and reactions on a large scale. The number of the sample observed in this study was four. In this type of observation, given the study purposes, it was not possible to have the natural observation and therefore, the samples were taken to the environment. This, in turn, had a set of limitations and difficulties (such as hard transportation, parent accompany etc.). So this issues made us focus on only four cases.

Getting permissions needed for the study

After deciding to conduct surveys, interviews and observation practices about the study, the researchers received permission in order to work in Turkey Governorship of Ankara, Directorate of National Education, DCSES and to enter into the Middle East Technical University Presidency, General Secretariat, area of Lake Eymir and its surroundings on 20-25 May.

Figure 2. Eymir Lake Area

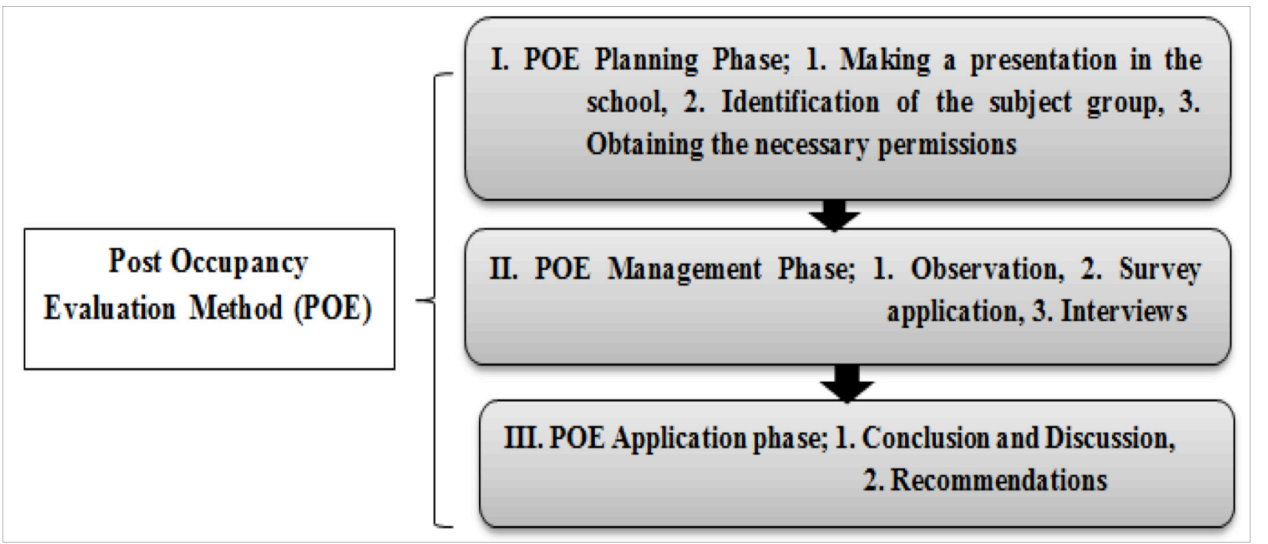


Figure 3. The basic design of the research

POE Management Phase

This stage consisted of three main steps; systematical observation study, survey study with the parents of the children with orthopedic disabilities and ınterviews.

First Step: Systematical Observation

Observation study was organized as a 6-day fieldwork on 20-25 May. This study was conducted with a 15-person team consisting of 4 children with orthopedic disabilities chosen from DCSES, at least one parent that accompany children (mother-father), the counselor from the school, 4 professional observers (academician group), a driver and Antalya Representative of Orienteering Federation (as a one day participant).

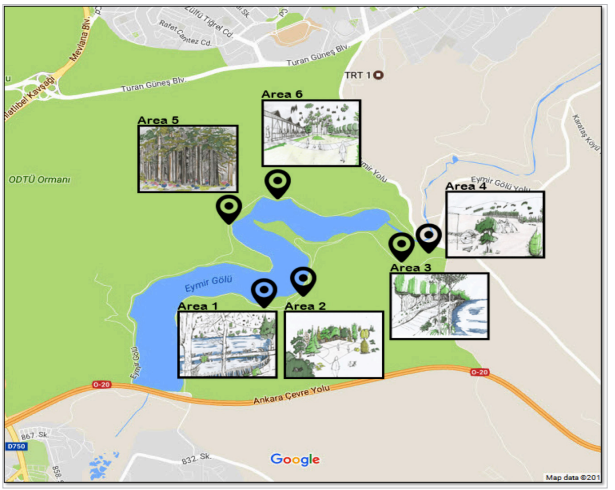


Figure 4. Selection of sub-spaces for the observation technique in Lake Eymir

Before starting the observation study, all the places in the area and the activities conducted were explained in order to examine this area and its surroundings. The activities that could be conducted by the children with orthopedic disabilities aged 8-12 were determined. Six sub-places were chosen in the area (Table 1).

Observers took part in the activity as well, because of the fact that the observation tour was an unstructured one. 1 observer for each child was picked and charged from the observer group consisting of the academicians. "A Notation Chart" was used and developed in order to make it easy to observe and record (digitize) the data when it was necessary on the observations. The data obtained through the observations were recorded instantly in whipstitches. These records were kept with the notes taken on the notation chart, observation forms filled right after the observations, and physical recorders (photograph and video recorders).

On the first day of the observation study, children were brought to area 3 which had been planned beforehand in the field of Lake Eymir. Each child was helped to get on a bike. The bikes were 3-wheeled. Children safely sat on the back and their seat belts were fastened. On the second day of the observation study, children were brought to the horse riding area, in other words to the area 4. Each child was brought to the horse riding area, was helped to get on a horse safely and was toured around the children horse riding area 4-5 times with the help of the employees. On the third day of the observation, children were brought to area 1. Area 1 was a premise located on the south side of the lake in an access point to water as explained in the previous chapter. Children viewed the most beautiful

Table 1. 6 sub-places were chosen in the research area in order to do planned activities

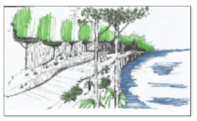
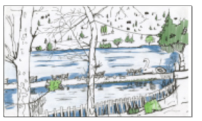
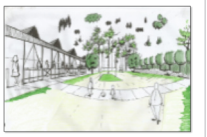
1-day	2-day	3-day	4-day	5-day	6-day
To get on a bike	The horse riding	Sightseeing & took photographs	Trip to the forest	Orienteering activities	Playing with the ball
					

Table 2. The description of three orienteering activities

Game 1	Labyrinth orienteering was conducted as sorting numbers from 1 to 9. The aim of the game was to find the numbers that had been splattered randomly in the activity area and provide them to sort the numbers from 1 to 9 in an order. While doing this sorting, snapping the checkpoints on the floor into the slots through a thread with the electronic ring given to the participants, in the meantime focusing their attention and making believe them that they could do this was among the main goals.
Game 2	Puzzle orienteering. The aim of this game was to complete the whole puzzle by matching A4-sized 25 orienteering symbols on the paper with the dispersed and tiny symbols. While completing the puzzle, the aim of the game was for the participants to see the piece in the fastest way through ensuring eye, hand, symbol coordination and put it in its place as a puzzle piece. All the children completed this stage successfully.
Game 3	Snake orienteering. In this game, children followed the snake figure on the picture drawn on the map and passed through the funnels. Participants reached their targets by showing the designated route on the map to the group leaders (Orienteering trainer or observation group) and by going forward in order to pass through the funnels.

landscape of the lake and took photographs in this area. In this area, the observers taught children how to take photographs with a camera. On the fourth day of the observation, children were brought to area 5 in order to observe their stimulation senses. This area was on the north of the lake and right on the roadside. Because of the fact that this area was inclined, bringing them to the area with wheelchairs and their mobility was performed with the support of their parents, observers and the counsellor (Figure 4). On the fifth day of the observation, children were brought to area 2. This area was designed as a basketball field. This area was preferred because of its flat floor and impervious surface in order to conduct orienteering activities to the children. Orienteering trainer in the activity designed three different games. Preparations were made before starting the game. The description of the games explained in Table 2.

On the last day of the observation study (sixth day), they went to the other area which was area 6. It was chosen as the most convenient place for playing with the ball because there was a huge lawn in the area. Children were brought to the lawn after eating something and in this area, they played with the ball with the observers.

Preparing Behavioral Maps

The data obtained from the notation charts were evaluated via using ArcGIS10.0 program in order to digitalize them. Data points were obtained via GPS and activity routes were determined through following the subjects during the activities. The information of which activities, in which places and for how long they were conducted was digitalized with the Behavioural Maps in Geographical Information System (GIS).

Second Step: Survey Study with the Parents of the Children with Orthopedic Disabilities

Reasons for making the survey with the parents; to get informed about the performance level of the natural areas around them and about the sufficiency and suitability level of the existing natural areas in Ankara for the disabled children, and to determine what the issues and problems are in terms of them. To know the thoughts of the parents on the subjects of the design of the natural areas (for example area of Eymir) and to suggest them for designers.

The Survey study conducted in this stage consisted of 2 parts as A and B. Questions were usually asked as test form. In addition to that, choices were given in order to give hint in some questions but they were open-ended questions in order that children can write other answers.

Third Step: Interviews

The last stage of the study was to make interviews. Interviews were made to 4 different groups face to face in accordance with various disciplines with special goals. These were teachers in DCSES (How can the presence of orthopedically disabled children aged 8-12 in the natural areas contribute to them from the viewpoint of the teachers? and so on.), principal or vice principal of the school (Does he believe in the importance of taking children to these areas and giving education there? and so on.), director or administrator of the area of Lake Eymir which is affiliated to METU (Is there any healing or educative effect of the area of Lake Eymir on the disabled children? and so on.), Doctor/ Psychologist Related to the Education and Rehabilitation of the orthopaedic disabilities (What kind of benefits do the natural areas have in terms of the health of the disabled children? How should be the design of the natural areas towards the disabled children? and so on).

RESULT AND DISCUSSION

Results of Behavioral Maps

According to the behavioral maps of all the participants, they faced walking problems in all areas (mostly in area 5). Pavements, ramps, and passageways in the areas were not convenient for the proceeding and access to wheelchairs. When the behavioral maps of the participants were compared, it was seen that the participants had shown different behaviours from each other. But some small details were obtained. For example, it was detected that Participant 1 had shown more interest in the animals and birds in the area, wanted to watch and pet the animals s/he came across to, talked and had more conversation with the people around while riding a bike, paid more attention to red flowers (Dutchman's breeches), and succeeded in standing up and shooting the ball with the help of his/ her mother while playing with the ball.

It was observed that the participants had to ask for help from their parents and the observers while riding a horse, playing orienteering games, riding a bike, playing with the ball, and wandering in the areas. The participants conducted the activities with different speed and quality because of the fact that their physical properties and disability levels were different.

Results of the Observation Forms by the Observers

According to the comments of the observers, it was noticed that almost all the participants had the walking problem with wheelchairs in the chosen sub-places in the area of Lake Eymir. Ramps, pavements, and roads in the areas weren't convenient for them. It was observed that children wanted to touch the water in area 2 but couldn't touch due to the fact that they were in wheelchairs and the water level was low. It was observed that children wanted to touch the water in area 2 but couldn't touch due to the fact that they were in wheelchairs and the water level was low. According to the comments of the observers, the presence of the disabled children in the natural areas showed that it was beneficial for their education. It was seen that the children fancied taking landscape pictures in area 2 and being in the natural areas and playing together made the disabled children socialize more and increased their self-esteem. Orienteering games in area 2 and ball-playing activities in area 6 gave them the opportunity to interact with each other and participants got information about geographical skills, map-read, field survey, and geographical sub-

jects. The area of Lake Eymir and other natural areas like that affect disabled children positively in terms of spirit, the sound of nature; the sound of water, the sound of birds, the sound of leaves, all of them are the factors that bring peace and happiness to the children. It was observed that the facilities in the area of Lake Eymir, for example especially the entrances of WCs, restaurants, and cafes were not designed convenient for the disabled children (Figure 5).

Results of the Survey Conducted by the Parents

Results of the survey conducted by the parents are shown in Table 3.

Results of the Interviews Made with the Teachers of DCOHES

When the teachers were asked whether they used open-green areas of the school or not, all the teachers said that outdoors were important for disabled children but that the schoolyard wasn't convenient for that because some of the children had the mental disability as well as physical disabilities. Thus, they suggested that education settings could be created in the schoolyard. According to the teachers, disabled children do not use schoolyard much and they spend their out of school time at their homes. They also said that plants and animals outside the school drew their attention and they were like a therapy and thought to be positive for them to socialize.

Table 3. Results of the survey conducted by the parents

- 79, 3% of the children use wheelchairs and 51% of these children have mental problems. In addition to their orthopedic disabilities, 51, 72% of the children have mental problems and 31, 01% of the children have speech disorders.
- When analyzing the question "How do the parents took part in the research spend their spare time with their children?", it is stated that 25, 9% watch TV, 20, 9% rest in the home, 19, 2% visit relatives-friends, and 11, 7% go to parks. It could be deduced that parents spend their time mostly at home environment instead of taking their children outdoors.
- 23% of the parents couldn't go to open-green areas with their disabled children, 51, 7% couldn't go because they are annoyed from the looks of the people around, 21, 9% have transportation problems and economic shortages.
- In the study, families stated that they preferred these areas mostly on weekends (58, 9% of the families) and they spent maximum 1-3 hours in these areas (59% of the families).
- In the surveys, families stated that animals, birds (18, 1%), nature sounds of the environment, and water elements (12, 3%) drew the attention of 22, 1% of the children in outdoors.
- It was stated that 43% of the children showed interest in flowers and fruit trees and they wanted to touch them.

Figure 5. Pictures taken in the area during the observations

Results of the Interview Made with the Director/ Manager of the Lake Eymir

The area of the Lake Eymir is open to all kinds of pedestrian use but automobile entrance only belongs to the METU personnel. Any kind of construction is prohibited because of the fact that the area of the Lake Eymir is under protection but road alteration is possible. Activities of the METU rowing team and walking, running, bike-riding activities that everybody could do are provided in the area. Wild animals, fresh air, water activities, natural plants and all elements associated with nature show healing and rehabilitation effects on the disabled children. It is seen that the facilities and activities in the area aren't convenient for the disabled children but road alterations and increase in sports facilities in the future will be beneficial for these children.

Results of the Interview Conducted with the Principal of DCSES

The principal of the school believes that natural environments are beneficial for the disabled children especially in terms of education. Courses can be given and technical visits can be conducted in schoolyard and schoolyard will be altered for the disabled children in the future. The principal of the school said that the disabled children didn't have important differences from normal children but the disabled children needed more care and their problems stemmed from health problems aside from their orthopedically disabled. He stated that trip programs, picnic activities, and similar organizations for them to socialize were organized for the disabled children but it is important in these trips and picnic activities that the physical place should be accessed easily by the students.

Results of the Interview Made with the Related Groups Intended for the Education and Rehabilitation of the Orthopedically Disabled

The number of factors affecting the development of a child increases and changes if there is orthopedically or health deficiency in the child. Aside from the issues that deficiency caused, factors like education level of the family, socio-economic situation, number of siblings, and their environment play a big role in the development of the child. Usually, the problems of the children with orthopedic disabilities are; no physical, language, speech, mental, social, and emotional features unique to them, balance disorder, limitation of movements like walking, running, and climbing, lack of self-esteem, poor motor coordination, adjustment problems, writing difficulties.

Natural and green areas in Ankara city are not useful enough for the disabled children, because of the fact that children with orthopedic disabilities cannot benefit from gardens and parks and there are a lot of reasons for that. Access problem (Families have access problems due to the fact that these parks and natural areas are usually distant, they can only go by their own cars because they cannot go on foot or by public transport vehicles), design drawbacks of the natural areas (especially, roads are not convenient for wheelchair and walking stick users), annoying looks and reactions of the people around are counted among the reasons. Natural areas are the places used for game therapy. Tactile activities; sand and water paintings, trees planted in the garden that provide smells, touchable surfaces or surfaces that direct the child can be conducted in these areas.

Figure 6. Suggested arrangements for Eymir Lake and its surroundings

Suggestions for the Re-Planning of Lake Eymir and its Surroundings

Altering the Lake Eymir in order to easily access and use the area is more important than making special designs. Decreasing the limitations to the minimum in the natural areas like Lake Eymir and its surroundings in terms of the disabled people and considering them in the design, practice and rearrangement studies should be among the most important goals. In area 5, children had trouble accessing and wandering the area and their families took them to the area. Special walking trails should be constructed in the area, in this way, these areas can transform into an accessible and usable one (Figure 6).

In all the sub-places chosen in the area of the Lake Eymir, it was observed that the usual cause of walking problems was that the flagstones weren't convenient. Width, slope and flooring of pedways and, pavements shouldn't limit the movements of the disability. Curbstones of the pavements are some of the most faced obstacles and poor stones should be especially used in the junction points (Figure 7).

In order for the wheelchair user to make contact with, touch or reach to the plant, elevated flower boxes should be 90 cm from the floor on a minimum 120 cm-wide pedway. Around the Lake Eymir, for example, the heights of the flower pots in area 2 are short, thus disabled children devoid of smelling and discovering them, flower boxes with different heights should be present in the area (Figure 8). Observing terraces can be built in some places of the lake, in this way, children can easily watch the landscape and take pictures (Figure 9). It was observed that some activity areas weren't convenient in the area of Lake Eymir. One of them was the horse-riding area. It was seen that the children with orthopedic disabilities had trouble while getting on the horse and its reason was that some tools were lacking in the area (Figure 10).

CONCLUSION

The study information is analyzed from the post-occupancy evaluation method which includes the questionnaire, interview and, observation. Specifically referring to the questionnaire the analysis in this research is done through the same method as Soltani, et al. (2012) in Malaysia. The result shows that there is a considerable demand for improving the current design and status to boost the needs of children with disabilities in Turkey, especially in Ankara city. Additionally, nature and greenery spaces have healing effect that allows disabled children to socialize themselves with normal children thus, can enhance their confidence level.

The article used behavioral maps to evaluate the designed area in terms of disabled children with the difference that researchers was carried out in the school garden. Similarly, this evaluation method is used by Hussien, 2012 and Hussein & Daud, 2014, research. Overall, the results are roughly the same that children with disabilities are able to play games and participant on similar activities in green space along with other normal kids. In this research, the most important problem of the Eymir lake after its assessment was the routes and the connectivity of the paths, that prevented the accessibility of disabled children especially orthopedic disabled children. This result is the same as Hussein & Daud, 2014 article finding. Moreover the remarkable result of this article was that children with disabilities going to the semi-open spaces around the city are affected by the financial status of the family, the acceptance of disability in the society around and simplicity to access vehicles and transportation services.

Figure 7. Arrangements to be made in Eymir Lake and its surroundings

This study needs to be discussed in a more integrated approach in order for the Lake Eymir and its surroundings to fulfill their healing function especially in terms of the children with orthopedic disabilities. There should be complementary elements of the integrative planning that will be conducted specifically to this area. Functional analysis and filthiness analysis of natural values of all data layers' levels of interaction and bearing capacity studies (ecologic, physical, visual, economic, and social) resulted from recreational use should be conducted. For this, there is a need for a management plan. The

Figure 8. The size of the flowerpots in the area should be arranged according to the children with disabilities

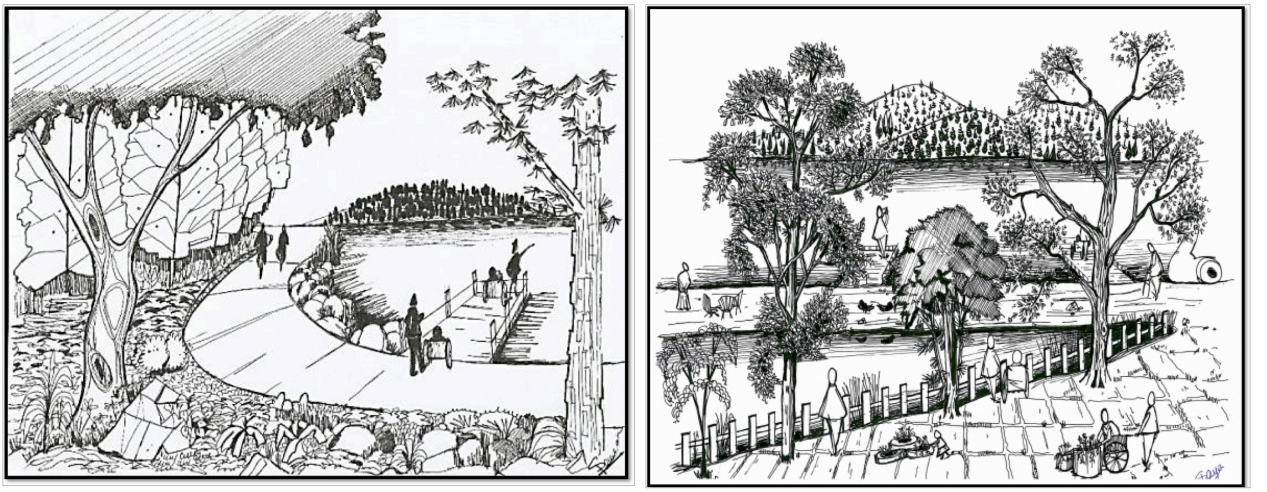


Figure 9. Viewing terraces must be built to watch the scenery around Eymir Lake and take pictures (Perspectives by Sima Pouya)

Figure 10. Arrangements to be made in the horse riding area

management plan should put forward the organization model in the first step responsible for the area management. An interdisciplinary plan involving the opinions of all parts should be materialized with a participatory approach for the area. The planning should involve levels that provide the protection, improvement, social benefit, and economic development of the area. The importance of the area in terms of people should be again put forward with a vision paper with an approach that represents different layers of society and all walks of life. The disability that represents an important part of the society is included as well. Important functions of the area like protection, creating economic value, social utilization, and economic rehabilitation should describe the parts of the area and zoning should be conducted in this way. The features put forward by different function sections will give hints about which needs are put forward by which activities in which places. This planning approach is resource-based and environmentally sensitive and it will help to define the recreation areas.

Informed Consent: Verbal informed consent was obtained from children who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.P., Ö.D.; Design - S.P., Ö.D.; Supervision – Ö.D., S.P.; Resources - S.P., Ö.D.; Materials – S.P.; Data Collection and/or Processing – S.P.; Analysis and/or Interpretation - S.P., Ö.D.; Literature Search – S.P.; Writing Manuscript – S.P.; Critical Review - S.P., Ö.D.

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CERRAHPAŞA

Original Article

Geology and woods of a new fossil forest from the Early Miocene of Gökçeada (Turkey)

Gökçeada'nın Erken Miyosen döneminden yeni bir fosil ormanın jeolojisi ve ağaçları

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ABSTRACT

In Gökçeada, metamorphic, sedimentary and volcanic rocks from the period covering the Paleozoic to the Upper Miocene periods have formed outcrops over time. A newly identified fossil forest site in Gökçeada covers an area of approximately 1.5 square kilometers of land situated near the coastline. Silicified trees in the area from the early Miocene period were observed to present three phases of pyroclastic deposition, namely: the complete silicification phase, the half silicification phase and the coal phase. The purpose of this study is to present the paleobiology and paleoecology of the wood flora and the geological formation of the fossil forest site, and to evaluate this information in terms of paleoclimatology. Sixteen (16) petrified pieces of wood thought to have originated from the upper slopes and found on the sea shore were collected, with three planes of thin sections taken from each one. A total of 12 types of woods were identified, as follows: three conifers (*Cupressinoxylon, Sequoioxylon* and *Pinoxylon*) and nine angiosperms (*Alnoxylon, Carpinoxylon, Ostryoxylon, Palmoxylon* type 1 and 2, *Fagoxylon, Quercoxylon* sect. *Ilex, Laurinoxylon* and *Platanoxylon*). The wood composition in Gökçeada is similar to that of the wood flora of the Miocene in Lesvos, showing the presence of riparian, well-drained lowland and coastal trees.

Keywords: Çanakkale, Early Miocene, Gökçeada, petrified wood, pyroclastics

ÖZ

Gökçeada'da metamorfik, tortul ve volkanik kayaçlar Paleozoyik'ten Üst Miyosen'e kadar uzanmaktadır. Silisleşmiş ağaçlar erken Miyosen döneminden olup üç farklı evreye sahip piroklastiklerde gözlenmiştir. Bu fazlar tam silisleşme fazı, yarım silisleşme fazı ve kömür fazıdır. Yeni fosil orman alanı yaklaşık 1.5 kilometrekarelik bir alanı kapsamakta ve deniz kıyısına yakın yerlerde bulunmaktadır. Çalışmanın amacı, bu fosil ormandaki ağaçları tespit etmek, fosil orman alanı oluşumu belirlemek ve paleoklimatolojik açıdan değerlendirmektir. Üst yamaçlardan deniz kıyısına taşınan 16 adet taşlaşmış ağaç parçası toplanmış ve her birinin üç yönünden ince kesitler alınmıştır. Toplam 12 farklı odun tipi tespit edilmiştir. Bunlar üç kozalaklı (*Cupressinoxylon, Sequoioxylon* ve *Pinoxylon*) ve dokuz angiosperm cinsidir (*Alnoxylon, Carpinoxylon, Ostryoxylon, Palmoxylon* tip 1 ve 2, *Fagoxylon, Quercoxylon sect. Ilex, Laurinoxylon* ve *Platanoxylon*). Gökçeada'daki ağaç bileşimi, Midilli Adası'nın Miyosen yaşlı ağaç florasına oldukça benzemektedir. Bu ağaç bileşimi nehir kıyısı, iyi drenajlı alçak kesim ve kıyıya yakın bir orman varlığını göstermektedir.

Anahtar Kelimeler: Çanakkale, Erken Miyosen, Gökçeada, piroklastik, silisleşmiş ağaç

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INTRODUCTION

Palaeobotany studies concerning petrified wood have revealed valuable information about forests dating back to the late Oligocene and the late Miocene forests as well as the climate of Turkey (e.g. Özgüven, 1971; Sayadi, 1973; Selmeier, 1990; Dernbach et al., 1996; Akkemik et al. 2009; Aytuğ and Şanlı, 1974; Eroskay and Aytug, 1982; Şanlı, 1982; Aras et al. 2003; Akkemik and Sakınç, 2013; Akkemik et al., 2016; Akkemik et al., 2017; Bayam et al., 2018). These studies showed that forests were composed of both conifers and broad-leaved trees. In riparian forests there were trees such as palmae,

Salix, Populus and *Liquidambar*, in swampy areas there were *Sequoia, Taxodium* and *Glyptostrobus*, and in well-drained lands, the forests were composed of *Pinus, Juniperus, Picea, Cedrus, Podocarpus*, *Quercus* (*ilex* type), *Acer, Ulmus, Zelkova, Prunus, Salix, and Fraxinus* etc. The resulting climate produced from this vegetation structure was a warm climate from the late Oligocene to the middle Miocene periods. The genera of *Taxodioxylon*, *Pinoxylon*, *Quercus* and *Alnus* were identified in the well-known fossil forests site, *Lesvos Petrified Forest* by Süss and Velitzelos (1994 a, b) and Velitzelos (1996, 1997).

A new petrified forest (fossil forest) site was found located on the island of Gökçeada, which is one of the larger islands in the Aegean Sea. Petrified wood can be found on both the soil surface and within the soil. Small and large wood pieces can be found in the material that has moved downwards from the upper slopes. The geology of the island was well-studied. Akartuna (1950) and Okut (1975) performed the first significant geological studies in Gökçeada, and these studies were used widely during the construction of geological maps. Following this, the characteristics of Tertiary volcanism in Gökçeada was investigated in detail by Ercan et al. (1995), Temel and Çiftçi (2002), Kesgin and Varol (2003), Varol and Baykal (2008), Koral et al. (2008), and at this point the island's 1/100000 scale geology map was published by Ilgar et al. (2008). More recently, Basaran et al. (2015 and 2016) studied Gökçeada's geopark potential, and Sarı et al. (2015) examined in detail the magmatic and volcanic rocks of Gökçeada.

The purpose of this study was to present the wood flora and formation of the fossil forest site, and to evaluate this data in terms of paleoclimatology.

MATERIALS AND METHODS

Gökçeada is an Aegean island, located at the entrance of Saros Bay to the north of the Aegean Sea, west of Gelibolu, and to the north of Lesvos (Figure 1). The fossil forest site is located on the south of the island. Silicified trees were found in an area up to 200 m above sea level. They were found in materials propelled along during the volcanic eruption and surfaced with the wear of the material above (Figure 2). A total of 16 samples were collected from the area. Preservation states were variable - while many of the samples were well-preserved, some were quite poorly preserved. However, most of the samples were of sufficient condition for identification.

For wood identification purposes, we took thin sections from three planes (the transverse section (TS) radial longitudinal section (RLS) and tangential longitudinal section (TLS)) from all specimens. Identification of the silicified woods was performed at the Tree-ring Research and Wood Anatomy Laboratory in the Forest Botany Department of the Faculty of Forestry, Istanbul University.

For identification, the wood anatomy reference book collection housed in the Forest Botany Department of the Faculty of Forestry, University of Istanbul were used (e.g. Jacquiot 1955; Greguss 1955; Greguss 1967; Barefoot and Hankins 1982; Fahn et al. 1986; Schweingruber 1990; Tidwell 1998; Eliçin 1977; Akkemik and Yaman, 2012). Additionally, an online database called InsideWood (http://insidewood.lib.nsc.edu), was another informative reference for wood identification. When using specific terminology, together with the aforementioned references, we followed the descriptions given in the IAWA Committee (1989) for hardwood identification and IAWA Committee (2004) for softwood identification wherever possible.

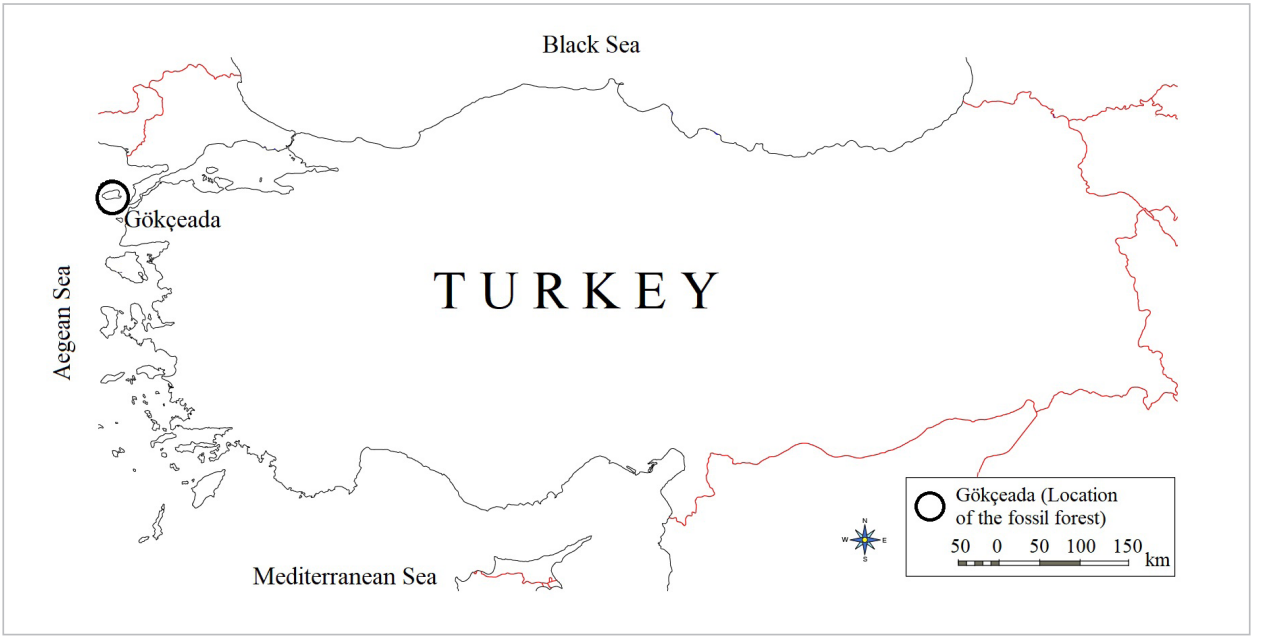

Figure 1. Location map of the study area

General Geology of Gökçeada

The general geology of Gökçeada was summarized based on the related reference (Akartuna, 1950; Okut, 1975; Akartuna and Atan, 1978; Ercan et al., 1995; Temel and Çiftçi, 2002; Kesgin and Varol, 2003; Varol and Baykal, 2008; Koral et al., 2008; Ilgar et al, 2008; Başaran et al., 2015, 2016; Sarı et al., 2015) as follows (Figure 3). The oldest unit in the study area is the Late Ediakaran/Early Paleozoic age Çamlıca Metamorphics, containing a sericite schist, a chlorite schist, slate and marble. This unit is located on Dağiçi Tepe on the north-west of Gökçeada and have fault outcrops. Çamlıca Metamorphites have been unconformably overlaid by the Early Eocene age Karaağaç formation. The Karaağaç Formation includes submarine fan deposits, rhyolitic lavas, sandstone, claystone marl alternations and formed outcrops between Gizli Liman and Mutludere in Gökçeada. These rhyolitic volcanic rocks, cutting across the Çamlıca metamorphites and intruding into the Karaağaç Formation, are the oldest volcanic units in the study area. These units were seen to be of columnar shape and composed of rhyolitic lava and tuffs (Temel and Çiftçi, 2002).

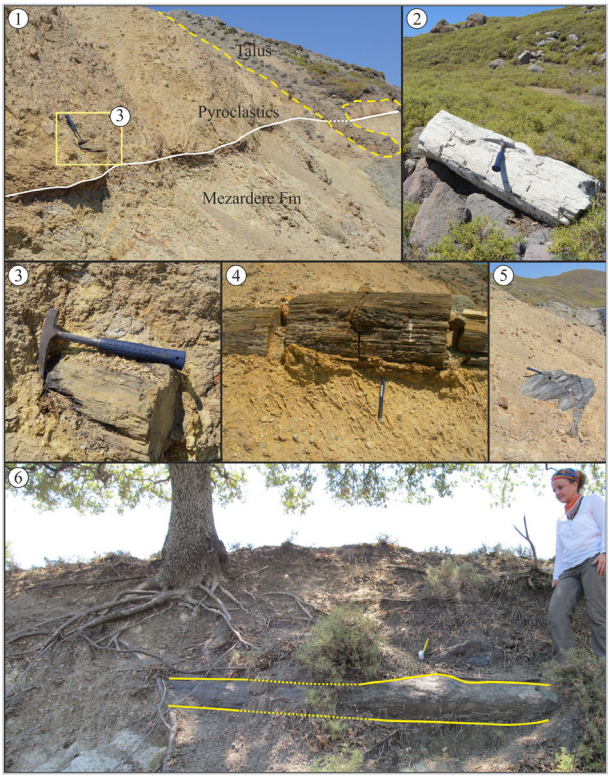

Figure 2. Some fossil wood in the field. 1-4) Petrified woods, 5) A wood sample, which has turned to coal, 6) A long petrified wood stem

The Middle Eocene age Koyunbaba Formation is composed of platform carbonates and overlies the Karaağaç Formation unconformably. This unit starts with conglomerate at its base and continues with conglomerate-sandstone-siltstone and marl alternations towards the top.

The Soğucak Formation conformably covers the Koyunbaba Formation and is characterized by an abundance of Nummulites sp. fossils (Varol and Baykal, 2008). This formation is composed of shallow marine carbonates. The Middle-Upper Eocene aged Ceylan Formation is composed of claystone-sandstone-shale intercalations and lies conformably on the Soğucak Formation. This formation has been conformably overlaid by the Early Oligocene age Mezardere Formation which is composed of conglomerate-sandstone-siltstone and marl alternations. Both the

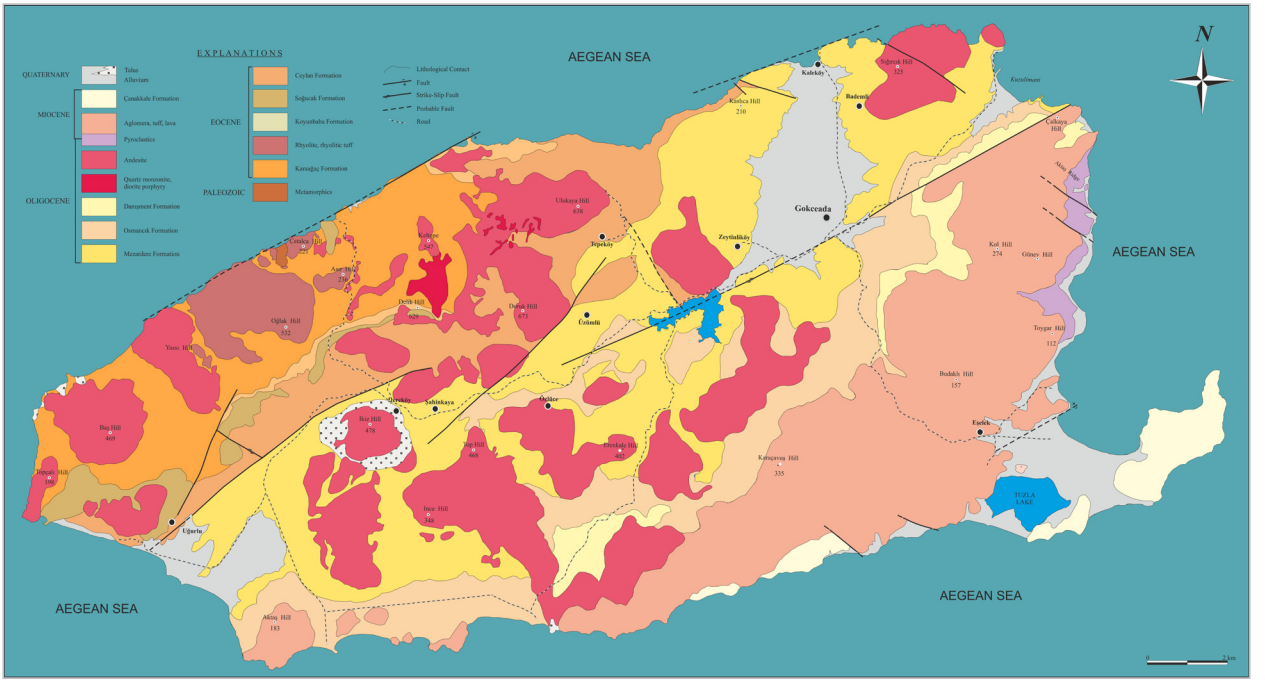

Figure 3. Geological map of the study area (Modified after Koral et al., 2008 and Sarı et al., 2015)

Ceylan and Mezardere sedimentary units are turbiditic deposits of a deep marine sedimentary environment. These units are cut by subvolcanics at different levels. The lower parts of these subvolcanics are identified as the Mutludere Intrusion, which consists of diorite-monzodorites (Sarı et al., 2015).

The Late Oligocene age Gökçeada Ignimbrite in the east and south part of the Island, is composed of pumice flows and lies uncomformably on the Mezardere Formation. The Early Miocene age Kesmekaya volcanics are covered by these pumice flows and composed of basaltic andesite, andesitic lava and pyroclastic rocks. The entire section is covered by the Upper Miocene age Çanakkale Formation in the study area (Figure 3).

RESULT AND DISCUSSION

Formation Pattern of the Fossil Forest

The fossil forest was analysed in the pyroclastics in the study area (Figure 2). This fossil forest was observed in three different levels within this unit. These phases are (1) the complete silicification phase, (2) the semi-silicification phase and (3) the coalification phases. These phases, observed within the same unit, indicated that the trees were the same age but were formed in different sedimentary environments in a short interval. The main volcanic activities of the Early Miocene period completely buried these forest after which, complete silisification occurred. These samples were clearly observed in the study area. Pyroclastic flow swept the majority of the forest towards the sea and some of this banked on the shore zone. The Semi-silicification and coalification phases also occurred in these banked forest units. Due to the tectonic uplift of the Island, burned out segments of forest were observed as coal fragments in cliffs and were rapidly eroded. This fossil forest, located in the east part of the study area, occurred within the Early Miocene age pyroclastic debris flow and Quaternary colluvial fan deposits.

Wood Flora of the Fossil Forest

Twelve different wood types of conifers and broad-leaved trees were identified (Table 1). All woods were catalogued by adding "xylon" at the end of the name such as *Alnoxylon, Pinoxylon*, *Fagaceoxylon* and *Seqoioxylon*. *Quercus* woods can be identified as section levels (sec. *Cerris*, sec. *Ilex*, sec. *Quercus*). In Gökçeada, *Quercus* woods were identified as *Quercoxylon* section *Ilex* (evergreen oaks) (Table 1). The name *Sequoioxylon* includes the genera *Sequoia, Sequoiadendron* and *Metasequoia*, due to having very similar wood features. The identification details and wood features were given for each wood type below.

Systematic palaeobotany

***Cupressinoxylon* (Cypress)**
Family CUPRESSACEAE Rich. ex Bartling 1830
Genus CUPRESSINOXYLON Göppert 1850

Material: Material no. 4.

Locality: East of Eşelek Village - Gökçeada, and near to the coastline.

Age: Early Miocene

Wood description: Tree-ring border distinct. Gradual transition from earlywood to latewood. No resin canal in cross section; axial parenchyma very common, and horizontal walls slightly nodular. Cross-field pitting cupressoid. 2-3 (1-4) pits per cross-field. Rays homogenous. Ray height 1-15 cells (mostly 6-7 cells), uniseriate or sometimes partly biseriate. Pitting on radial walls of tracheids uniseriate. Tracheidal pitting also common on the tangential walls (Plate I).

Discussion: The name of this type of wood was proposed as *Cupressinoxylon* by Bamford et al (2002). Due to having cupressoid type cross-field pits, gradual transition from earlywood to latewood, wood growth ring boundary distinct, 1-15 cells of ray height, abundant axial parenchyma cells, tracheidal pitting on tangential walls, and slightly nodular walls of axial parenchyma cells (Figueiral et al., 1999; Klusek, 2014; Pujana et al., 2014), wood identification leads us to *Cupressinoxylon*. Similar woods

Table 1. Woods identified and their sample numbers. The gymnosperms listed first and then angiosperms in the table

Sample No	Groups	Family	Identification
4	Gymnosperms	Cupressaceae	*Cupressinoxylon*
211p			*Sequoioxylon*
260		Pinaceae	*Pinoxylon*
3	Monocotyledonous	Araceae	*Palmoxylon* type 1
259			*Palmoxylon* type 2
231	Dicotyledonous	Betulaceae	*Alnoxylon*
1			*Carpinoxylon*
2			*Ostryoxylon*
257		Fagaceae	*Fagoxylon*
5e, 5ece2, 202			*Quercoxylon section Ilex*
1ok, 5, 261		Lauraceae	*Laurinoxylon*

were described from the early Miocene of central Anatolia as *Juniperus* by Akkemik et al. (2016). *Juniperus* woods have very low ray cells and a space between tracheids in cross-field (Akkemik et al., 2016). Today, the genus of *Cupressus* L. is represented by one species (*Cupressus sempervirens* L.) across the Mediterranean region, and is common in coastal areas.

***Sequoioxylon* (Redwood)**
Family CUPRESSACEAE Rich. ex Bartling 1830
Genus SEQUOIOXYLON Torrey 1923

Material: Material no. 211p.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Distinct tree-ring border with 2-13 rows of latewood tracheids. No resin canal in cross-section; axial parenchyma common, and horizontal walls generally smooth or slightly nodular. Rays homogenous in general, and there are rarely ray tracheids present. Cross-field pitting is taxodioid and rarely cupressoid. Ray height is 3-15 cells, uniseriate or rarely partly biseriate (Plate II).

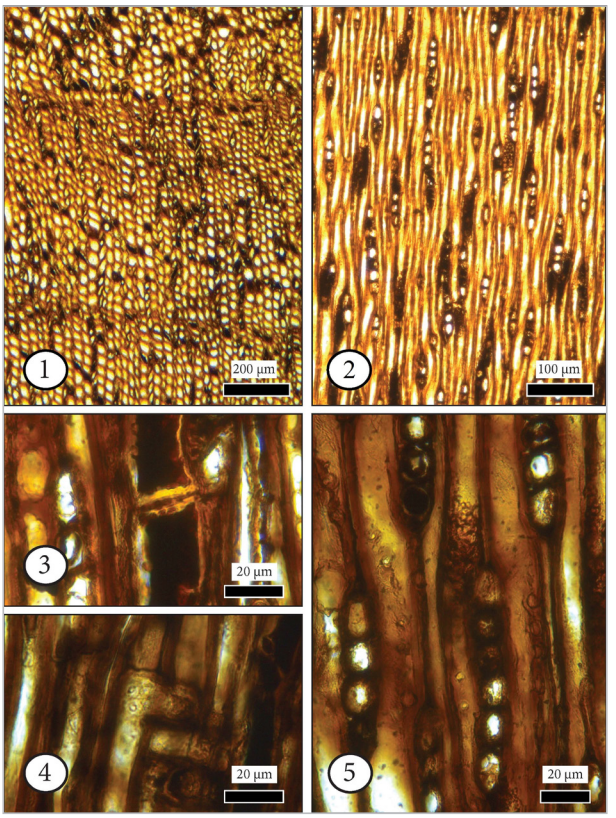

Plate I. *Cupressinoxylon* sections. 1) A transversal section with dense axial parenchyma, 2) Tangential section, 3) Slightly nodular end wall of axial parenchyma, 4) Cupressoid type cross-field pits, 5) Tracheidal pitting on tangential walls of tracheids

Discussion: This type of wood is very common in the European part of Turkey (Özgüven, 1971; Akkemik et al., 2005; Sakınç et al., 2007; Akkemik and Sakınç, 2013), in Çamlıdere (Akkemik et al., 2009), and in Kızılcahamam (Bayam et al, 2018). Today, this genus is extinct throughout Europe and Asia.

***Pinoxylon* (Pine)**
Family PINACEAE Sprengel ex F. Rudolphi, 1830
Genus PINOXYLON Knowlton 1900

Material: Material no. 260.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Growth ring boundaries distinct, and a gradual transition from earlywood to latewood. Longitudinal resin canals visible with thin-walled epithelial cells. Tracheid pitting in radial walls in earlywood uniseriate. Latewood tracheids thick-walled, and no helical thickening. No axial parenchyma observed. Rays are heterogeneous and those without horizontal resin canals, exclusively uniseriate, rays with resin canals partly multiseriate. Ray tracheid present, but walls not

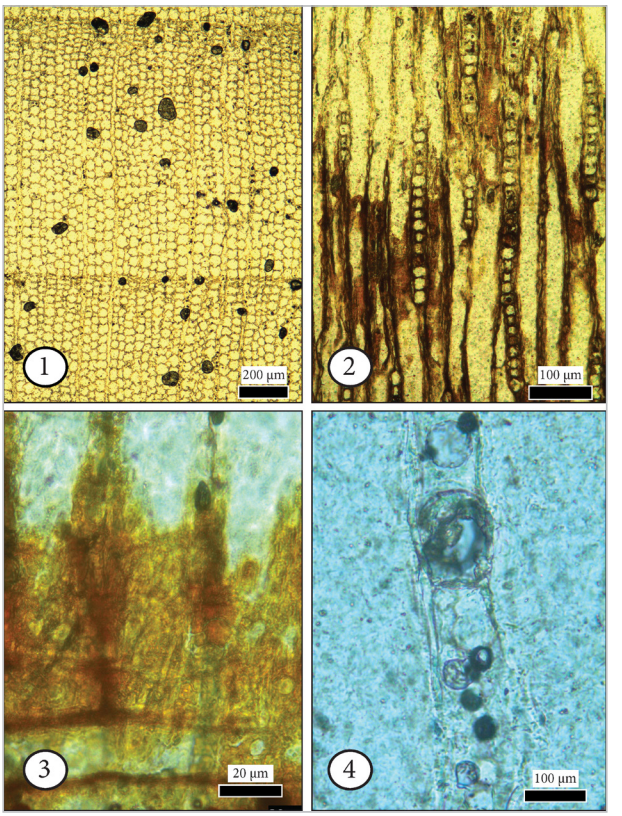

Plate II. *Sequoioxylon* sections. 1) Transversal section without resin canal, 2) Tangential section with high rays, 3) Taxodioid type cross-field pits on radial section, 4) Smooth end wall of axial parenchyma

visible clearly on the section. Pinoid type of cross-field pits distinct, and two pits per cross-field observed in general. Ray height 1-12 cells (Plate III).

Discussion: This type of wood was identified from Early Miocene of Central Anatolia (Akkemik et al., 2016; Bayam et al., 2018) and in Lesvos (Velitzelos and Zouros, 1997). Vertical resin canals, heterogenous rays with ray tracheids and horizontal resin canals, and pinoid type of cross-field pits are the clear features of pine woods. All these features were observed in the petrified wood, and then it was identified as *Pinoxylon*. Today, it is represented by 5 different 2-needle species in Turkey. Pinoid type cross-field pits may be used in identification of the modern species by using the key given in Akkemik and Yaman (2012). The fossil wood is rather similar to the modern *Pinus pinea* L. with their cross-field pits, therefore this wood may be named *Pinus* cf. *pinea*.

***Palmoxylon* (Palms)**
Family ARECACEAE Schultz Sch. 1832
Genus PALMOXYLON Schenk 1882

Material: Material no.s. 3 and 259.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description of type 1 (Sample No: 3): The wood is made up of small vascular bundles, measuring around 200-300 µm in diameter, scattered in loosely packed parenchymatous ground tissue. They comprise 4-8 wider and around 100 µm in length, closely spaced metaxylem vessels together with more small ones. The shapes of the metaxylem vessels are clearly ellipsoid (Plate IV).

Wood description of type 2 (Sample No: 259): The wood has small vascular bundles, measuring less than 200-250 µm in diameter. They are distributed throughout the parenchymatous ground tissue through the wood. They comprise numerous, small (less than 50 µm in diameter) closely spaced metaxylem vessels together with smaller ones. The shapes of the metaxylem vessels are clearly circular (Plate V).

Discussion: This type of monocotyledon wood was identified from Seben Fossil Forest in Bolu for the first time (Akkemik et al., 2016). It is also found in Lesvos island (Zouros et al., 2004). These two types of wood are different from the wood found in Seben Fossil Forest, which had 2-4 vessels in each vascular bundle found (Akkemik et al., 2016). The modern palm wood in Turkey is *Phoenix theophrasti*, and mostly restricted to the southwest Anatolia (Boydak, 1983, 1985). This identification may be

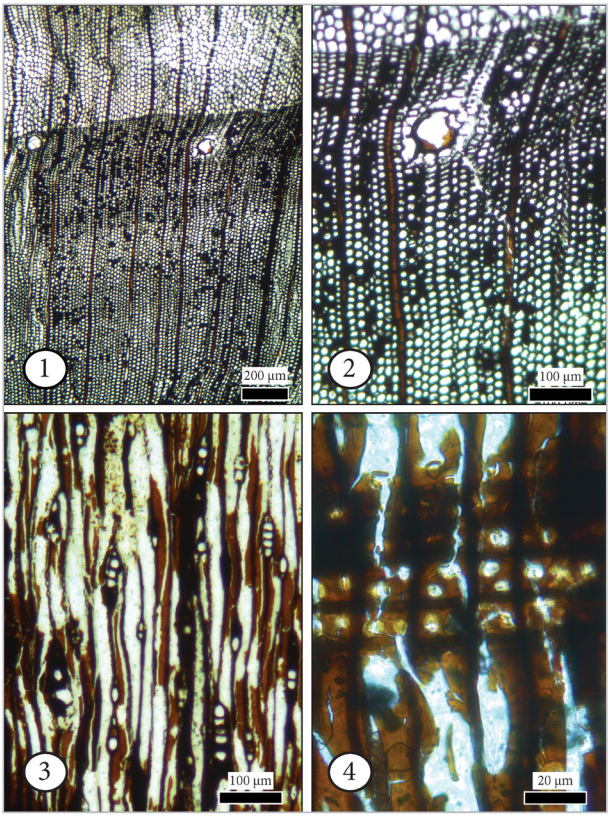

Plate III. *Pinoxylon* sections. 1-2) Transversal sections with resin canal, 3) Tangential section with horizontal resin canal, 4) Heterocelluler rays with pinoid (slightly windows-like)

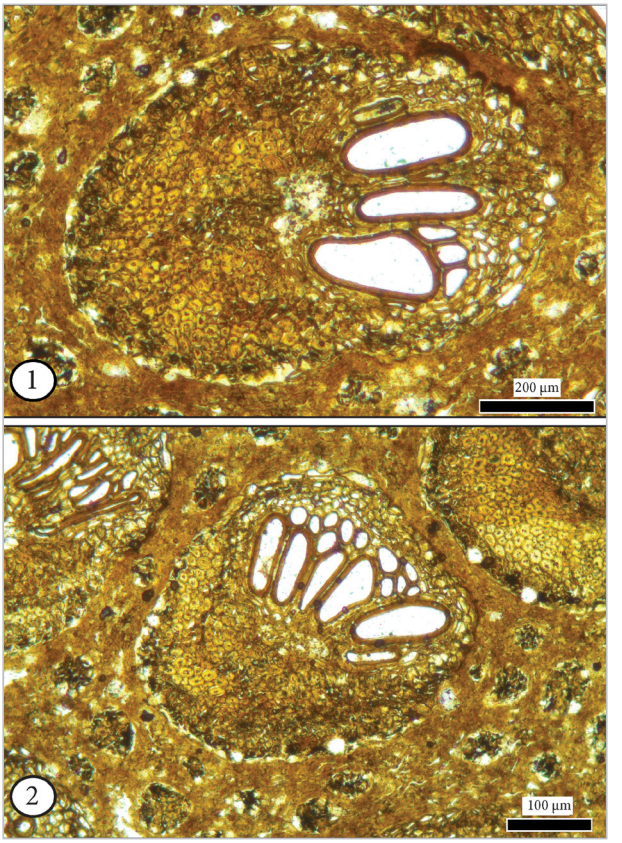

Plate IV. *Palmoxylon* type 1. 1) Transversal section of the wood, 2) Vascular bundle with elipsoid vessels elements

considered as an indicator genus for paleoclimatic evolution of the early Miocene of Gökçeada.

***Alnoxylon* (Alder)**
Family BETULACEAE Gray 1822
Genus ALNOXYLON Felix 1884

Material: Material no. 231.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Growth ring boundary generally distinct. Wood diffuse porous, and vessels arranged in no specific pattern, solitary or commonly in radial multiples of 2-4 or more. Solitary vessel outline angular. Perforation plate scalariform with 10-30 bars. Intervessel pits opposite and small. No helical thickening observed. Mean tangential diameter of vessel lumina 50-100 µm in earlywood and less than 50 µm in latewood. 40-100 vessels per square mm. Rays were exclusively uniseriate and all rays procumbent. Aggregate rays visible. Ray number per square mm more than 12. Maximum ray height could not be observed (Plate VI).

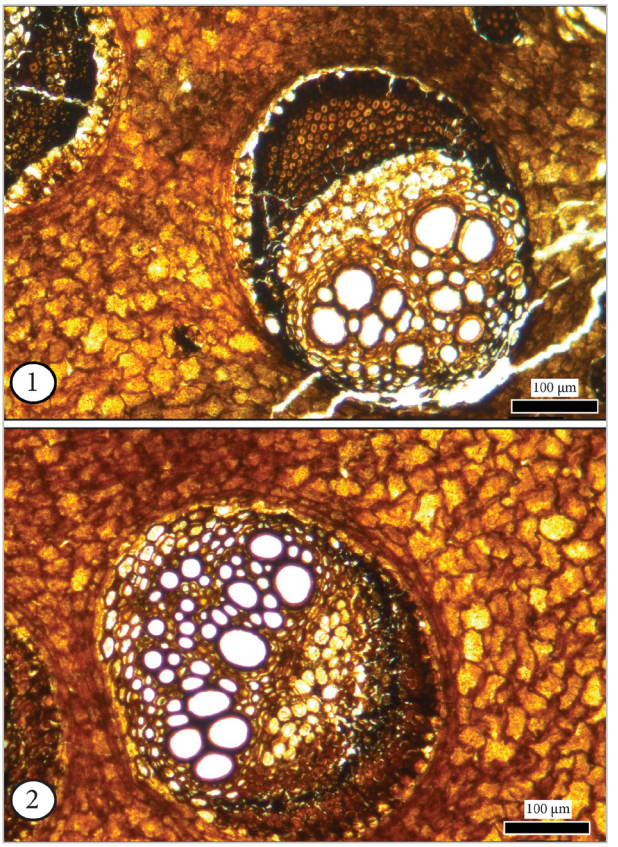

Plate V. *Palmoxylon* type 2. 1) Transversal section of the wood, 2) Vascular bundle with rounded vessels elements

Discussion: Features such as vessel diffuse porous, aggregate rays, vessels in radial rows of up to 4 or more, scalariform perforation plates (with 20-30 bars) are the characteristics for *Alnus* wood (Akkemik and Yaman,2012). We determined all these features on the wood. *Alnoxylon* was also determined by Selmeier (2001) from the middle to the late Miocene of North West Anatolia. Selmeier and Velitzelos (2000) described *Alnoxylon* from the early Miocene of Lesvos Island and from Oligocene volcanic series of Thrace, NE Greece. This genus was one of the most common trees in riparian vegetation during Miocene (Denk et al, 2017a; Güner et al., 2017). Today, the genus *Alnus* is represented by two species in Turkey, *Alnus glutinosa* (L.) Gaertn. and *Alnus orientalis* Decne. They are the main elements of riparian vegetation.

***Carpinoxylon* (Hornbeam)**
Family BETULACEAE Gray 1822
Genus CARPINOXYLON Vater 1884

Material: Material no. 1.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

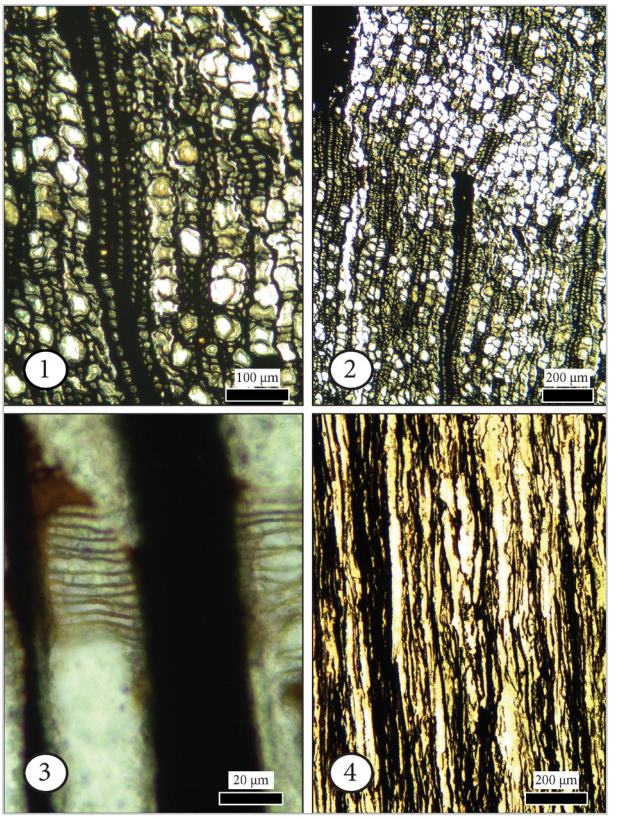

Plate VI. *Alnoxylon* sections. 1-2) Transveral section with aggregate rays, 3) Scalarifom perforation plates, 3) *Tangential section of the wood*

Wood description: Growth ring boundaries indistinct. Wood diffuse porous and vessels arranged in radial multiples, and generally in a dendritic pattern. Radial clusters of vessels very common and solitary vessels rather rare. Perforation plate simple. Fibers thick-walled. Axial parenchyma commonly apotracheal diffuse and diffuse-in-aggregate, and in narrow and short tangential bands. Ray width 1-3 seriate, and in some rays, one to four rows of square marginal cells present. Rays per millimeter more than 12, and ray height 1-30 cells (Plate VII).

Discussion: *Carpinus* wood has growth rings having distinct or indistinct boundary, diffuse porous and vessels in radial multiples, simple or scalarifom perforation (with 2-3 bars), and aggregate rays (Akkemik and Yaman, 2012). In the fossil wood, similar features were observed. However, clearly indistinct growth ring boundary, dendritic arrangement of vessels and lower rate of aggregate rays are small changes from the modern represantatives. This genus is represented by two species in Turkey - *Carpinus orientalis* Mill. and *Capinus betulus* L. in the humid and well-drained lowlands and upland forests.

***Ostryoxylon* (Hophornbeam)**
Family BETULACEAE Gray 1822
Genus OSTRYOXYLON Ü. Akkemik 2018

Material: Material no. 2.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.
Age: Early Miocene

Wood description: Growth ring boundaries distinct with 1-2 rows of marginal fiber cells. Wood diffuse-porous, and vessels arranged in radial multiples 2-4 or more (up to 13 vessels). Perforation plates simple and intervessel pits mostly alternate. Mean tangential diameter of vessel lumina less than 50 µm. Vessel frequency 50-100 per square mm. Helical thickening on vessels very common. Axial parenchyma present and diffuse. Rays width 1-4 seriate, and aggregate rays present. Rays heterocellular; body ray cells procumbent with mostly 1-4 rows of upright and / or square marginal cells. Rays per mm were more than 12. Maximum ray height up to 71 cells (Plate VIII).

Discussion: In spite of the fossil wood of *Ostrya* being very similar to that of *Carpinus*, the presence of helical thickening in *Ostrya* wood is the main difference between these two genera. This type of wood may have procumbent or heterocellular rays, simple or scalariform perforation plates, 1-3 seriate or 4-to 10 seriate of rays together with helical thickening in vessels (Suzuki and Watari, 1994; Jeong et al., 2009). Because our wood has very similar features to those of the fossil wood *Ostrya*, we have identified this wood as *Ostryoxylon*. This is the first description of this fossil-genus in Turkey. The modern representative of this genus is *Ostrya carpinifolia* Scop. in Turkey, and grows in well-drained

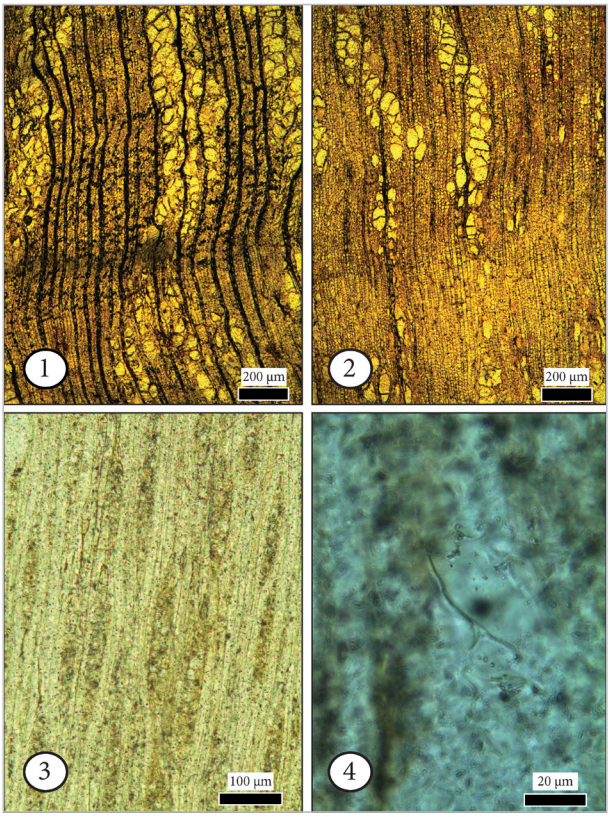

Plate VII. *Carpinoxylon* sections. 1-2) Transversal sections of the wood, 3) Rays in tangential section, 4) Simple perforation plate

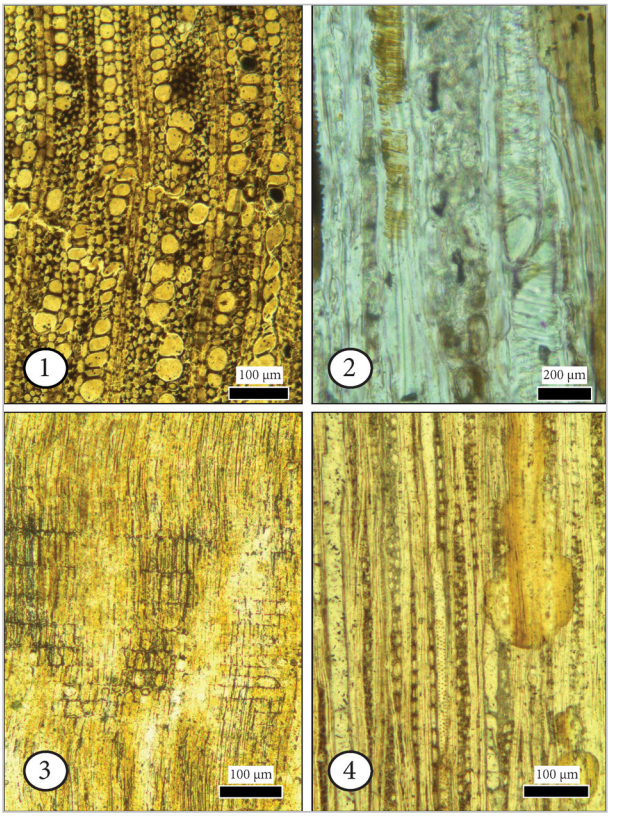

Plate VIII. *Ostroyoxylon* sections. 1) Transversal section, 2) Simple perforation plates and helical thickening on the walls of vessels, 3) Heterocellular rays, 4) Rays in tangential section

upland forests in the Mediterranean region and lowland and upland forest of Black Sea region of Turkey.

***Fagoxylon* (Beech)**
Family FAGACEAE Dumort. 1829
Genus FAGOXYLON Stopes and Fujli 1910

Material: Material no. 257.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Growth ring boundary distinct. In the border of growth ring, vessel number decreases and thick-walled fibers increase. Wood diffuse to semi-ring porous. Pores frequent and more than 100 per square mm. Vessels solitary and clustered. Intervessel pits opposite and alternate. Perforation plate mostly simple, rarely scalariform. Mean tangential diameter of vessel lumina around 50 µm. No helical thickening observed. Axial parenchyma commonly apotracheal diffuse and diffuse-in-aggregate. Rays uniseriate to multiseriate. Width of multiseriate rays more than 10 cells. All ray cells procumbent. Rays per millimeter 4-12, and height of multiseriate rays more than 1 mm (Plate IX).

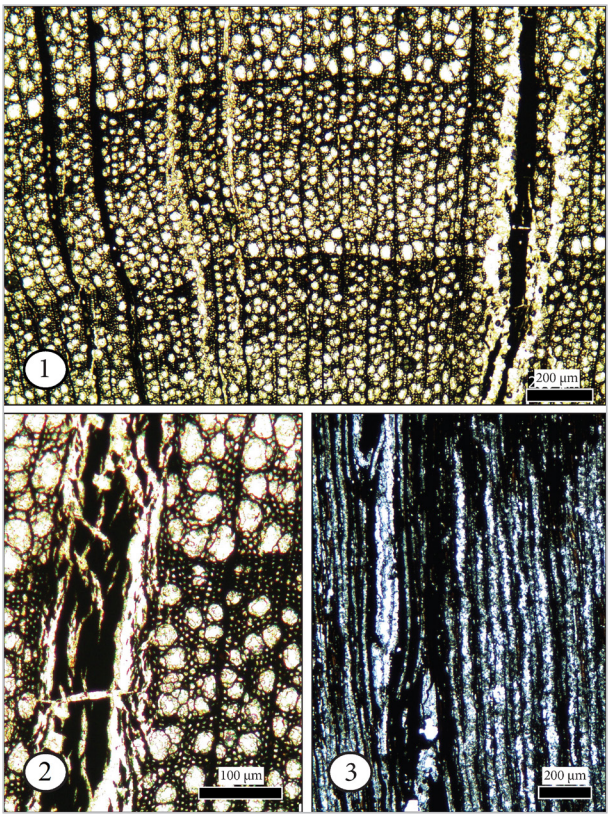

Plate IX. *Fagoxylon* sections. 1-2) Transversal section with narrow and very wide rays. Wood semi-ring porous, 3) Tangential section of the wood

Discussion: *Fagoxylon* was described in Turkey for the first time. The presence of distinct annual ring boundary, diffuse porous, distribution of 1-3 seriate and more than 10 seriate of rays through wood, and long rays (>1 mm) showed the features of the wood of *Fagus*. Leaves and other macrofossils of the genus *Fagus* were identified by Denk et al. (2017a) and Güner et al. (2017) from a different region of Turkey. This was a common genus in the early Miocene forests (Denk et al., 2017a; Güner et al., 2017). Today, this genus is represented by two species (*Fagus orientalis* Lipsky and *F. sylvatica* L.) in the lowland and upland humid forest sites of Turkey.

***Quercoxylon* section *Ilex* (Evergreen oak)**
Family FAGACEAE Dumort. 1829
Genus QUERCOXYLON Hofmann 1929 Section ILEX

Material: Material nos. 5e, 5ece2, and 202.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Growth ring boundaries mostly distinct or indistinct, and wood diffuse porous. Transition from earlywood vessels to latewood indistinct, and from one ring to the next. Vessels exclusively solitary, these solitary vessels are rounded, and walls of vessels are thick. Perforation plate simple. Mean tangential diameter of vessel lumina 100-200 µm in earlywood, and 50-100 µm in the latewood, and 5-20 vessels per square mm. Axial parenchyma commonly diffuse, in narrow and short tangential bands and scanty paratracheal. Rays in two distinct sizes, uniseriate and multiseriate (more than 10-seriate and extremely broad). In multiseriate rays, height more than 1 mm. All ray cells procumbent, and 4-12 rays per millimeter. Tyloses common in vessels of earlywood (Plate X).

Discussion: The former studies showed that evergreen sclerophyllous oaks (*Quercus* section *Ilex*) of Turkey belong to a wider Eurasian group of evergreen oaks (Denk & Grimm, 2009; Denk & Grimm, 2010; Hubert et al., 2014; Hipp et al., 2015). This type of wood is rather common in the early Miocene through Turkey (Akkemik et al., 2016; Bayam et al., 2018). Today, Turkey is represented by three evergreen oak species. They are *Quercus coccifera*, which is a common macchie element, *Q. ilex* which is a rare macchie element growing throughout the coastal areas of Black, Aegean and the Mediterranean Seas, and *Q. aucheri*, which is an endemic species growing locally in southwestern Turkey and the Greek island of Kos.

***Laurinoxylon* (Laurel)**
Family LAURACEAE Juss. 1789
Genus LAURINOXYLON Felix 1890

Material: Material nos. 1ok, 5, and 261.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Growth ring boundaries distinct, marked by thick-walled latewood fibres. Vessel diffuse-porous, and arranged in no specific pattern, solitary, and radial multiples of 2-3 vessels. Perforation plates simple. Intervessel pits alternate and small-sized (4-7 µm). Shape of the alternate pits polygonal. Mean tangential diameter of vessel lumina 50-100 µm and the number of vessels per square mm 20-40. Axial parenchyma was scanty paratracheal, and strand length 1 to 4 cells. Ray width 1 to 3 cells, and body ray cells procumbent with one row of upright and/or square marginal cells. 4-12 rays per mm. Oil cells commonly present, and associated with ray parenchyma (Plate XI).

Discussion: *Laurinoxylon* including the the genera, *Laurus* and *Ocotea* is one of the most common wood types in the Miocene time. Many different woods of this morphogenus have been identified (Prakash et al., 1971; van der Burgh et al., 1973; Iamandei and Iamandei, 1997; Cevallos-Ferriz et al., 2016; Jud and Dunham, 2017). The presence of oil and/or mucilage cells in rays, diffuse porous, distinct boundary of growth ring, 1-3 seriate of ray cells, vasicentric type of axial parenchyma are the typical features of *Laurinoxylon*. We observed all of these features. Güner et al. (2017) and Denk et al. (2017a) identified Laucaceae type leaves from western and central Turkey as well. Today, only one genus and species of Lauraceae, *Laurus nobilis* L., represents the family in Turkey. This species grows in the warm, humid and semi-humid lowland areas throughout coastal Turkey.

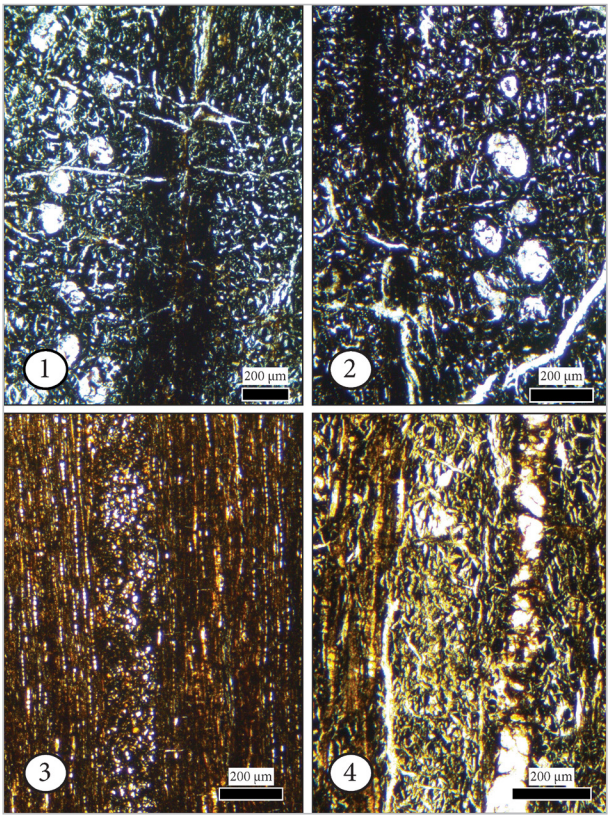

Plate X. *Quercoxylon* sect. Ilex sections. 1-2) Transversal sections, 3) Tangential section with narrow and very wide rays, 4) Vessel with simple perforation plate

***Platanoxylon* (Plane)**
Family PLATANACEAE T. Lestib. 1826
Genus PLATANOXYLON E. Hofmann 1952

Material: Material no. 258.

Locality: East of Eşelek Village - Gökçeada, and on the coastline.

Age: Early Miocene

Wood description: Growth rings boundary distinct, marked by distended rays and by thick-walled and radially flattened latewood fibers. Wood diffuse-porous, and vessels arranged in no specific pattern, and generally solitary and rarely in radial multiples. Shape of the solitary vessel outline angular. Perforation plates both simple and scalariform. Scalariform perforation plates mostly with 10-20 bars. Intervessel pits opposite. Vessel diameter 50-100 µm. Vessel frequency 40-100 per square mm. Axial parenchyma diffuse-in-aggregates and scanty paratracheal. All ray cells procumbent (homocellular). Rays distended at growth ring boundaries, and mostly multiseriate, larger rays commonly both 4- to 10-seriate and > 10-seriate. Ray height generally more than 1 mm. Prismatic crystals common in procumbent ray cells (Plate XII).

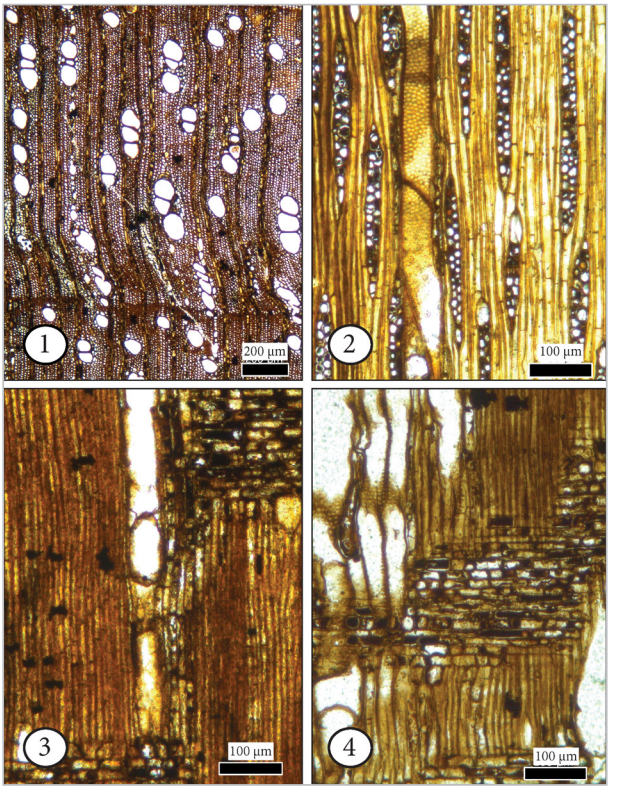

Plate XI. *Laurinoxylon* sections. 1) Transversal section with diffuse porous, 2) Tangential section with 1-3 rows of rays, 3-4) Heterocellular rays with oil cells on the borders, and simple perforation plates

Discussion: Wood of *Platanus* is rather similar to that of *Fagus* (Akkemik and Yaman, 2012). Woods of both of these two genera were described in this study. In *Platanoxylon*, the features are (1) rays distended at growth ring boundaries, (2) rays densely multiseriate (>10 seriate), (3) vessels exclusively solitary (90% or more), (4) perforation plates predominantly scalarifom, and (5) prismatic crystals common in rays. In contrast, *Fagoxylon* has (1) different sizes of rays, (2) no prismatic crystals in rays, (3) both simple and scalariform perforation plates. This type of wood, *Platanoxylon*, was described for the first time in Turkey. Today, *Platanus orientalis* L. is the unique plane species in the Mediterranean Basin. The fossil plane described here may be the ancestor of the present species.

Paleoclimatology of the Fossil Forest

The petrified wood materials collected from the coastline were materials which had moved from the upper areas to the shoreline. It was possible to evauate a total of 12 wood types, belonging to different vegetation units defined by Denk et al. (2017a,b,c), as evidence of this movement (Table 2).

Among the 12 different wood types, *Pinoxylon* and *Cupressinoxylon* may be considered as members of well-drained (lowland and) upland conifer forests. *Sequoioxylon* may be a member of a swamp, riparian or well drained lowland forest type. *Palmoxylon* woods may be seen as plants indicating subtropical, humid forest and, swamp or riparian vegetation. Two types of palm woods are members of these types of forests together with *Alnoxylon* and *Platanoxylon* (Table 2).

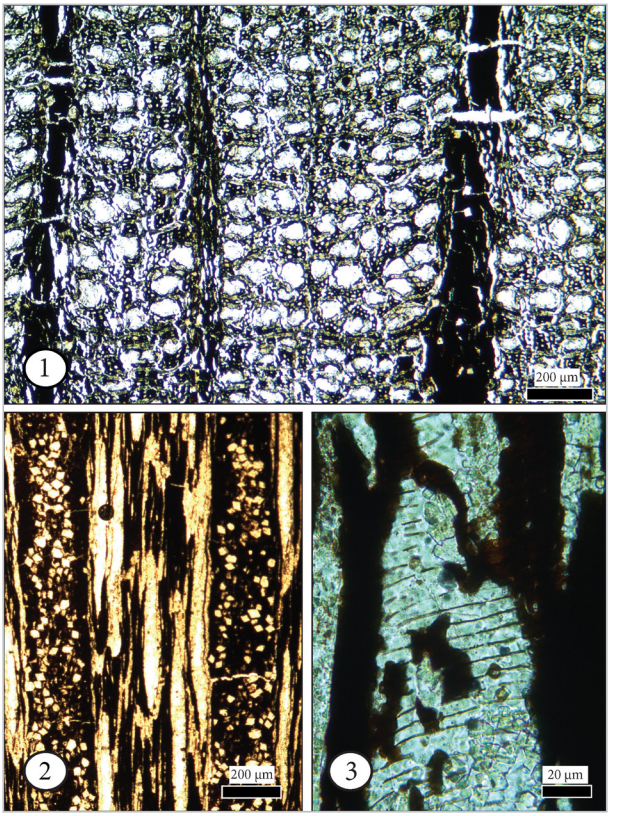

Plate XII. *Platanoxylon* setions. 1) Transversal section with wide rays and diffuse porous, 2) Wide rays with prismatic crystals, 3) Scalariform perforation plate

Finally, we can conclude that the following wood genera might be members of a forest from the lowlands to the uplands in the early Miocene of Gökçeada: *Palmoxylon, Sequoioxylon, Alnoxylon, Platanoxylon, Laurinoxylon, Cupressinoxylon, Quercoxylon* section *Ilex, Pinoxylon, Carpinoxylon, Ostryoxylon,* and *Fagoxylon*. Very similar results to the petrified woods of the Island Lesvos (Velitzelos et al., 2014) were obtained. *Sequoioxylon* (known as *Taxodioxylon gypsacum* in Lesvos), *Palmoxylon, Fagoxylon, Alnoxylon, Laurinoxylon* and *Quercuxylon* section *Ilex* were also identified from the island of Lesvos.

Within this wood vegetation the presence of palm trees may indicate that the climate in Gökçeada was both subtropical (warm and humid) and mountainous. The early Miocene palaeobotany studies on macrofossils (Denk et al., 2017a,b,c; Güner et al., 2017), microfossils (Akgün et al., 2007; Akkiraz et al., 2011), and petrified woods (Akkemik et al., 2005; Akkemik et al., 2009; Akkemik and Sakınç, 2013; Akkemik et al., 2016 and 2017; Bayam et al., 2018) revealed that the climate during the early Miocene period was subtropical warm and humid. The results from this study also supported the presence of a similar climate type in Gökçeada.

CONCLUSION

Petrified wood materials revealed a very rich wood flora in Gökçeada with 12 types of different woods (*Palmoxylon type 1 and type 2, Sequoioxylon, Alnoxylon, Platanoxylon, Laurinoxylon,*

Table 2. The genera identified and their vegetation units

Identification	Vegetation Unit*
Pinoxylon	VU0, VU3-VU7
Cupressinoxylon	VU5, VU7
Sequoioxylon	VU3, VU4, VU5
Palmoxylon type 1	VU0, VU4
Palmoxylon type 2	VU0, VU4
Alnoxylon	VU3, VU4
Carpinoxylon	VU5
Ostryoxylon	VU5
Fagoxylon	VU5, VU6
Quercoxylon section Ilex	VU5, VU6, VU7
Laurinoxylon	VU4, VU5
Platanoxylon	VU4

*From Denk (2017) and Güner et al (2017): Vegetation Unit (VU) 0: Subtropical, moist or dry light forest. VU 1: Aquatic. VU 2: Bogs, wet meadows. VU 3: Swamp forest. VU 4: Riparian forest. VU 5: Well-drained lowland forest (VU5a - *Quercus drymeja*, Fagaceae gen. et spec. indet. various, VU5b - edaphically and aspect wise dry forest). VU 6: Well-drained upland forest (*Fagus-Cathaya*). VU 7: Well-drained (lowland and) upland conifer forest including hammocks

Quercoxylon section *Ilex, Pinoxylon, Cupressinoxylon, Carpinoxylon, Ostryoxylon* and *Fagoxylon)*. Knowledge on the early Miocene flora and climate of Aegean Basin was increased with these findings, and we can conclude that the climate and the wood flora of Gökçeada are rather similar to those of Lesvos - which had a subtropical warm and humid climate. Due to having a rich fossil wood flora, the fossil forest in Gökçeada should be protected, and considered as a geosite. Furthermore, the area should then become a designated tourism route after protecting the petrified woods.

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CERRAHPAŞA

Original Article

Physical and social barriers for disabled urban park users: case study from Kastamonu, Turkey

Engelli kent parkı kullanıcılarının fiziksel ve sosyal sorunları: Kastamonu kenti örneği

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ABSTRACT

More than a billion people in the world suffer from some kind of disability, which can affect quality of life. Some people experience physical or social disadvantages depending on the nature of their disabilities. The social disadvantages stem from civic policies that do not take into consideration the needs of disabled people, standards that are not fulfilled and people's prejudices. In this study, barriers that disabled people experience in physical and social environments are examined in terms of open areas and greenspaces. To this end, popular parks in Kastamonu from Turkey were chosen as the study area. In the scope of the study, a questionnaire was given to 124 disabled persons and the relatives of disabled persons and 382 individuals who currently do not have any disabilities. Multivariate linear regression was used in order to evaluate the questionnaire data. The study results indicate that disabled individuals encounter physical and social barriers, and they also confirm that non-disabled people often complain about the same problems as disabled people with regard to the management and running of public parks. Moreover, the study reveals that the actions of public law corporations toward disabled people are not sufficient and public information and awareness-raising activities also fall short.

Keywords: Barrier, disabled, physical environment, social environment, urban park

ÖZ

Dünyada bir milyardan fazla insan herhangi bir tür engellilik yaşamakta, bu durum ise yaşam kalitesini olumsuz yönde etkilemektedir. Engel durumuna bağlı olarak kişiler fiziksel ya da sosyal dezavantajlar yaşamaktadır. Bu durum çoğunlukla uygulanan politikaların engelli insanların ihtiyaçlarını göz önünde bulundurmamasından, standartların yerine getirilmemesinden ve insanların önyargılarından kaynaklanmaktadır. Bu çalışmada engelli kişilerin fiziksel ve sosyal çevrede yaşadıkları dezavantajlar açık ve yeşil alanlar özelinde irdelenmeye çalışılmıştır. Bunun için Türkiye'de Kastamonu ilinde bulunan ve en fazla kullanılan parklar çalışma alanı olarak seçilmiştir. Çalışma kapsamında 124 engelli ve engelli yakınına, 382 adet şu anda engeli bulunmayan bireye anket uygulaması yapılmıştır. Anket verilerinin değerlendirilmesi için multivariate linear regression gerçekleştirilmiştir. Çalışma sonuçları engelli bireylerin parkları kullanımında fiziksel ve sosyal engellerle karşılaştığını gösterirken, şu an engelsiz olan bireylerinde kent parklarını kullanımında engelli bireylerle aynı sorunlardan şikayetçi olduğu tespit edilmiştir. Ayrıca yapılan çalışma kamu tüzel kişiliklerinin engellilere yönelik yaptığı çalışmaların yeterli olmadığını gösterirken, bilgilendirme ve bilinçlendirme konusunda da eksiklikler olduğunu göstermiştir.

Anahtar Kelimeler: Engelli, fiziksel çevre, kent parkı, kullanım olanakları, sosyal çevre

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INTRODUCTION

Everybody is temporarily or permanently disabled at a certain period of his/her life time as he/she cannot or would not healthfully carry out his/her physical or mental activities. It is stated that more than a billion people, or, in other words, 15% of world population suffer from some kinds of disability (WB, 2017). Around 200 million of them have remarkable difficulties in continuing their lives. Yet, everyone is equal and must have equal rights. Therefore, the aim of the Convention on

the Rights of Persons with Disabilities (CRPD), which was adopted in 2006, is stated as "to encourage, ensure and preserve all disabled people to benefit from fundamental freedoms and all human rights completely and equally and to increase the respect towards their personal dignity of being a human being (UN, 2006).

While World Health Survey states the number of disabled people at the age of 15 and over as 785 million (15.6%), Global Burden of Disease survey estimates the number around 975 million (19.2%). While World Health Survey estimates that 110 millions of these people (2.2%) have respectable difficulties in performing their functions, Global Burden of Disease estimates the number of severe disablements in the categories of disabilities such as quadriplegia, severe depression or blindness, as 190 million (3.8%). According to the measurements of Global Burden of Disease survey, 13 million out of 95 million (0.7%) disabled children (between the ages of 0-14) are stated "severe disabled" (WHO, 2011). According to the results of Turkey Disabled Survey conducted by Turkish Statistical Institute in 2002, nearly 12.29% of total population in Turkey and nearly 12.98% of Black Sea Region are disabled (TSI, 2017a). When the families of disabled individuals are added to these numbers, it is obvious that an unignorable number of the total population is either disabled or live with disabled people and, thus, are affected by negative living conditions.

It is possible to encounter people in different age groups, levels of education, occupations, physical and mental structures and socio-economic status in living spaces. Each individual within society has the right of benefiting from equal opportunities. A modern and ergonomic living space means an area which can be accessible by everyone (Altınçekiç and Erdönmez, 2001). State administration is responsible for providing citizens with the opportunity of benefiting from government services equally (Akyılmaz et al., 2017; Gülan, 1988). In the 10th, 42nd, 51st and 60th Acts of the Turkish Constitution on labour matter, it is arranged that everyone is equal before the law and the State is responsible for ensuring the equality of people. It is also arranged that the state has to take necessary measures to rehabilitate people with special needs, it has to preserve children, women and those with physical and mental disabilities privately in terms of working conditions, it has to protect disabled people and take precautions to help them adapt to community life. "United Nations Convention on the Rights of Persons with Disabilities (CRPD) was put into force on 18/12/2008 in Turkey, and the Code about Handicapped no 5378 was enacted". Apart from these legal regulations, a great many legal regulations have been enacted in order to enable people with disabilities to live independently by being respected, given dignity and to take part in every aspect of life.

Disability is a term that comprises a person's non-adaptation to the environment. What is meant by adaption of disabled individuals to the environment is rendering the physical environment for their use. In other words, it is the reducing of physical handicaps. The main objective here is to give disabled people the right of inclusion to daily life. Physical environment should be made suitable for disabled individuals to achieve this purpose. Hence, Tufan (2006) uses the statement that "People who are called disabled are those who are prevented by some barriers in physical environment".

Both providing special education and enabling the right of benefiting from the physical environment are significant in integrating disabled people with society. However, it is known that disabled individuals encounter social barriers as well, and it is sometimes more difficult to overcome them. The first step to take in overcoming these barriers is the acknowledgement of the disabled by society and sharing the same environment with them. Learning to live with the concept of disability and disabled individuals from childhood would start the process of tolerance and cohesion. Yet, there are great deficiencies in both the perception of "disabled" in society and adaptation of the physical environment for the disabled. These restrictions cause disabled people not to benefit from the environment sufficiently as society routinely does. In the survey held by the Turkish Statistical Institution in 2012 in the areas of registered disabled people about the suitability of physical environment planning to their use, it is determined that 66.9% of them state that pavements, pedestrian ways and crosswalks are not proper. Again in the same survey, it is indicated that 43.3% disabled individuals' state that parks and green areas are not suitable for the use of disabled people. That 34.4% of disabled people do not have any idea about whether the parks and green areas are suitable for their use or not is an attention-grabbing result (TSI, 2017b).

The survey indicates that one of the areas that disabled people encounter problems is parks. Parks are the areas which the city-dwellers use in order to relax, where they find serenity and rest both physically and mentally. Parks are among the public goods presented to the common use of everyone in Turkish Law (Gülan, 1999; Ayanoğlu, 1992; Aydın, 1999). Although benefiting from these areas is the right of disabled people as well as other individuals, social and physical restrictions prevent disabled people from using them sufficiently. For disabled people to benefit from parks sufficiently by removing limitations is primarily possible by identifying the limits, that is determining the problems.

In this study, the aim is to identify factors limiting disabled people from benefiting from parks in the city centre. For this reason, a questionnaire has been conducted to both disabled and non-disabled individuals by interviewing them in and out of parks. By evaluating the questionnaires, it is aimed to determine to what extent disabled individuals benefit from parks, and the physical and social reasons that impede their use of parks. It is also aimed to identify the viewpoint of society to disabled individuals and the level of their interest and knowledge about the problems that disabled individuals encounter.

MATERIALS AND METHODS

Study area

Kastamonu province is located in the north of Turkey, in the West Black Sea Region (Figure 1). Sinop is in the east, Bartın and Karabük are in the west, Çankırı is in the south and Çorum is in the south-east of the city. The north of the city is surrounded by the Black Sea. Founded on Karaçomak valley, the centre of the city is a remarkably old settlement. Researches on the area indicate that the first settlement in Kastamonu dates back to paleolithic age. The city was domineered by Candaroğulları for a long time as 168 years after the settlement of Turks to Anatolia, then it was dominated by the Ottoman Empire in the 14th century and became a city in the 19th century (Bakırcı, 2005).

The population of Kastamonu was determined as 372,373 people (KCP, 2017). Registered disabled people living in Kastamonu were stated as 10,714 people according to National Disabled People Database (NDD, 2013). In the neighbouring cities, the following numbers of disabled people were stated: Bartın 6,571, Karabük 5,674, Sinop 5,650, Çankırı 3,773 (NDD, 2013; Açıkgöz, 2017).

As Kastamonu has the largest disabled population in the region, it has been chosen as the research area. Since the study is carried out in city parks, Kışla Park, Sinanbey Park, Cevizli Park, Cumhuriyet Meydanı Park, İsfendiyarbey Park and Terminal Park have been preferred as they are the most preferred and the most easily accessible ones.

Material

In the scope of the study, in order to determine the problems that the disabled encounter, a survey on 124 disabled and the relatives of disabled, and 382 non-disabled individuals was conducted. Disabled individuals and their families were reached through a special training centre for the disabled in Kastamonu province. Since the parks in the city centre were chosen for the study, the population of Kastamonu city centre (city centre: 146,103 persons (KCP, 2017) was used as a base with 95% confidence level and 0.05 margin of error while determining the number of questionnaires (Yazıcıoğlu and Erdoğan, 2004). The main materials of the study are comprised of parks chosen as the study area and questionnaires.

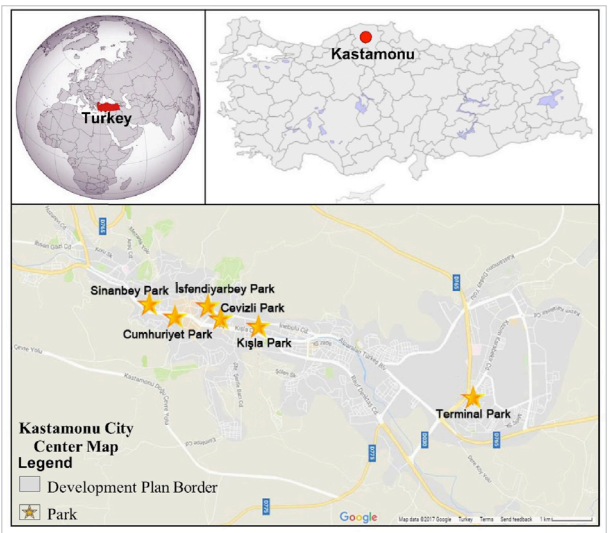

Figure 1. Location map for study areas

In the scope of the survey study conducted to disabled people, participants were asked questions about their demographic features, their disability states, their utilization of parks, encountered problems, to what extent parks meet the needs of disabled individuals, barriers preventing disabled people from integrating with society, the level of knowledge about the rights of disabled people and the expectations of disabled people from formal institutions. In the survey conducted to non-disabled people, their demographic features, whether they use the parks or not, their feelings and thoughts when they are in the same environment with disabled people and their level of knowledge about the studies concerning disabled people were tried to be identified.

Method

Likert Scale was used in the survey study in order to identify the attitudes of participants to the use of urban parks and physical and social problems of disabled people. In the responses received according to the Likert Scale, the average value was used as a base and the evaluations were carried out accordingly. Physical and social problems and expectations of disabled people were tried to be identified through the analyses. There is no ethics committee approval certificate. The study is not about collecting personal or private information.

SPSS package (Statistical Package for Social Sciences Program, Version 19.0, IBM, New York, United States) was used in analysing the data obtained from the research. Multivariate linear regression was carried out in order to find out whether there existed a relationship between the use or non-use states of city parks by participants and disability status. While the use of city parks was chosen as the dependent variable, physical and social factors such as disability status, age, education, income status, transportation and free time were assessed as independent variables (Equation 1);

$$Y=A+b1x1+ b2x2+ b3x3$$

"Y" expresses dependent variable (the status of individuals' usage of city parks), "A" shows the invariance coefficient, "bn" indicates independent variable coefficient and "xn" symbolizes independent variable (gender, age, income status, disability status, transportation etc.).

In order to test the presence of an autocorrelation problem among the variables in the regression model, the Durbin-Watson coefficient is calculated. Durbin-Watson coefficient ranges between zero and four. If the value is close to two, it shows the absence of an autocorrelation problem (Fox, 1997). All analyses were conducted at the 0.01 level of significance.

RESULTS AND DISCUSSION

In the scope of the study, first, the factors affecting the status of all individuals' usage of city parks were identified and then, the result was explained under the following subtitles since two different questionnaires were applied to disabled and non-disabled individuals.

Factors Affecting the Use of Urban Parks

According to the regression analysis results in order to determine factors affecting the use of urban parks in Kastamonu, it was identified that income status, disability status, free time status, reactions of other people using the parks, the suitability of the parks for usage and accommodation variables were significant according to the 0.01 significance level and the maintenance of parks variable was significant according to the 0.05 significance level. The effect of determined factors on the individuals' use of city parks were identified as 61% (R^2: 0.611) (Table 1). No auto correlation was found between those variables (Durbin-Watson coefficient: 1.814). As a result of the F test carried out for the total relevance of the model, the model was found to be statistically significant in total (sig:0.000<0.001) (Table 1).

Multi regression model for the factors affecting the use of urban parks was found out as below (Table 1) (Equation 1):

Equation 1

Use of urban parks=1.270 + (-0.036) x income status x (-0.082) x disability status + 0.093 x transportation status + 0.070 x the suitability of parks for use + 0.185 x free time status + 0.063 x the reactions of other people using the park + 0.030 x maintenance of parks It was identified that there was an inverse relationship between the individuals' use of parks and their income and disability states. As the income status (β: -0.036) and the disability status (β: -0.082) increased, the use of urban parks decreased (Table 1).

Survey Results Applied to Disabled People

According to the survey results applied to disabled people in order to identify physical and social barriers encountered in urban parks in Kastamonu, it was found that 44.4% of participants were between 31-40 age group, 33.1% were high school graduates and 32.3% had a monthly income between 1,000-1,500 TL. It was also identified that 38.7% of participants were physically disabled while 23.4% were mentally disabled (Table 2).

When the disabled people were asked about whether they were satisfied with using the same parks with non-disabled people, 62.9% stated that they liked it. When they were asked about their acceptance by non-disabled persons, 34.7% stated that they were sometimes accepted while 19.4% stated that they did not gain acceptance (Table 3).

When they were asked about whether parks in Kastamonu met the needs of disabled people, 58.1% of disabled participants stated that it did not meet their needs while 36.3% stated that it partially met their needs. It was observed that 51.6% of disabled people were not informed about the works of municipality and non-governmental organizations concerning disabled people, 44.4% of them were not aware of the applications concerning legislation on disability. Moreover, 72.2% of participants stated that the applications of formal institutions were insufficient in meeting the needs of disabled people (Table 4).

When they were asked about the kinds of arrangements to be made in parks in order to meet the physical needs of disabled people, they stated that problems that made the access to the parks difficult should be resolved (avg:4.19), proper decking materials should be used (avg: 4.08) and furniture should be arranged according to the disabled (avg: 3.96). When problems that disabled people encounter were examined within a social perspective, the reasons preventing

Table 1. Coefficients of factors that affect the use of Kastamonu urban parks

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	1,270	,052		24,639	,000
Income	-,036	,013	-,078	-2,756	,006
Disability status	-,082	,021	-,129	-3,875	,000
Transportation status	,093	,015	,249	6,143	,000
Suitability of parks for use	,070	,017	,189	4,180	,000
Free Time Status	,185	,015	,415	12,219	,000
Reactions of other people using the parks	,063	,024	,112	2,684	,008
Maintenance of parks	,030	,016	,084	1,962	,050
R,782[a] R Square,611 Adj. R Square 0,606 Std. Error 0.448 Durbin-Watson 1,814 F 111,915 Sig. .000[a]					

[a]: Significant at a level of 1%

disabled people from integrating with society were stated by the participants as the negative view of society to disabled people (avg: 3.83), that local governments did not constitute sufficient social environment for the disabled (avg: 3.83) and that state institutions and organizations did not carry out necessary work (avg: 3.81). Moreover, the status of the disabled (avg:3.64) was also stated as one of the significant barriers in integrating with society. When the one who had the most significant role in integrating the disabled with society was asked, it was stated that this role mostly belonged to the non-disabled (avg: 4.13). Moreover, the families of the disabled (avg: 3.82) possessed an important role in integrating with society (Table 5).

Survey Results Conducted to Non-Disabled People

According to the survey results conducted to non-disabled people so as to identify physical and social barriers encountered while using the urban parks in Kastamonu, it was stated that 30.9% of participants were between the ages of 21-30, 63.9% were university graduates, 29.1% earned between 0-500 TL monthly income and 28.0% earned 2,500 TL and over (Table 2).

It was determined that 95.5% participants did not feel uncomfortable about using the same parks with the disabled. When whether the disabled gain acceptance by the non-disabled in parks was asked, 39.8% stated that they sometimes gained acceptance while 30.6% stated that they gained acceptance (Table 3).

Table 2. Demographic Features of Kastamonu Urban Park Users

		Disabled		Non-disabled		Total	
Demographic features	Groups	n	%	n	%	n	%
Age	15-20	3	2,4	112	29,3	115	22,7
	21-30	22	17,7	118	30,9	140	27,7
	31-40	55	44,4	81	21,2	136	26,9
	41-50	35	28,2	51	13,4	86	17,0
	>50	9	7,3	20	5,2	29	5,7
	Total	124	100	382	100	506	100
Education	primary education	4	3,2	21	5,5	25	4,9
	high school	37	29,8	92	24,1	129	25,5
	university	41	33,1	244	63,9	285	56,3
	postgraduate	42	33,9	25	6,5	67	13,2
	Total	124	100	382	100	506	100
Income	0-500	13	10,5	111	29,1	124	24,5
	501-1000	24	19,4	46	12,0	70	13,8
	1001-1500	40	32,3	57	14,9	97	19,2
	1501-2500	20	16,1	61	16,0	81	16,0
	>2501	27	21,8	107	28,0	134	26,5
	Total	124	100	382	100	506	100
Disability status	Non-disabled	0	0	382	100	382	75,5
	Mentally disabled	29	23,4	0	0	29	5,7
	Physically disabled	48	38,7	0	0	48	9,5
	Visually disabled	4	3,2	0	0	4	0,8
	Speech handicapped	8	6,5	0	0	8	1,6
	Hearing impaired	7	5,6	0	0	7	1,4
	Other	23	18,5	0	0	23	4,5
	Physical, speech, other impaired	1	0,8	0	0	1	0,2
	Speech, hearing impaired	1	0,8	0	0	1	0,2
	Physical, visual, hearing impaired	1	0,8	0	0	1	0,2
	Mentally, physical, visual, speech impaired	1	0,8	0	0	1	0,2
	Mentally, physical, speech impaired	1	0,8	0	0	1	0,2
	Total	124	100	382	100	506	100

It was identified that 54.7% of non-disabled participants stated that urban parks in Kastamonu did not fulfill the needs of the disabled and 40.8% stated that they partially fulfilled their needs. When they were asked whether they were aware of the works of the municipality and non-governmental organizations concerning the disabled in the city of Kastamonu, 53.9% of non-disabled participants had the answer "no". Also 52.6% of participants stated that they did not know anything about the laws and regulations conducted for the disabled. Moreover, 65.2% of participants stated that the applications of public legal entities were insufficient in meeting the needs of disabled people (Table 4).

According to spatial context, when the physical arrangements like urban furniture, pavement, signs etc. to be made in parks in order

Table 3. The attitudes of Kastamonu urban park users

		Disabled		Non-disabled		Total	
Demographic features	Groups	n	%	n	%	n	%
Are you pleased with using the park together with other individuals?	Yes	78	62,9	365	95,5	443	87,5
	No	22	17,7	12	3,1	34	6,7
	Sometimes	24	19,4	5	1,3	29	5,7
	Total	124	100	382	100	506	100
Do the disabled people gain acceptance by the non-disabled people in the park?	Yes	41	33,1	117	30,6	158	31,2
	No	24	19,4	68	17,8	92	18,2
	Sometimes	43	34,7	152	39,8	195	38,5
	I have no idea	16	12,9	45	11,8	61	12,1
	Total	124	100	382	100	506	100

Table 4. Identification on the usage status of Kastamonu urban parks by disabled people

		Disabled		Non-disabled		Total	
Demographic features	Groups	n	%	n	%	n	%
Do the parks in Kastamonu meet the needs of disabled people?	Yes	7	5,6	17	4,5	24	4,7
	No	72	58,1	209	54,7	281	55,5
	Partially	45	36,3	156	40,8	201	39,7
	Total	124	100	382	100	506	100
Do you know the studies of municipality and non-governmental organizations	Yes	30	24,2	74	19,4	104	20,6
	No	64	51,6	206	53,9	270	53,4
for the disabled people?	I have no idea	30	24,2	102	26,7	132	26,1
	Total	124	100	382	100	506	100
Do you know the laws, regulations etc. enforced for disabled people?	Yes	36	29,0	87	22,8	123	24,3
	No	55	44,4	201	52,6	256	50,6
	I have no idea	33	26,6	94	24,6	127	25,1
	Total	124	100	382	100	506	100
Are the applications sufficient in meeting the needs of disabled people?	Yes	12	9,7	20	5,2	32	6,3
	No	92	74,2	249	65,2	341	67,4
	I have no idea	20	16,1	113	29,6	133	26,3
	Total	124	100	382	100	506	100

to meet the needs of disabled people were asked, it was stated that furniture should be arranged properly (avg: 3.48). Arrangements such as removing the transportation difficulties (avg:2.97), removing the deficiencies of traffic signs (avg:2.67), enabling sufficient lightning (avg:2.71) were stated unimportant (Table 5).

From a social perspective, when the reasons preventing disabled people from integrating with society were observed it was determined as the following: negative view of society towards the disabled (avg:3.48), that the municipality did not constitute sufficient social environments for the disabled (avg:3.77) and that public institutions and organizations such as governorship, ministry, etc. did not fulfill adequate studies (avg:3.60). Moreover, the status of the disabled was stated as not being a significant factor in integrating with society (avg:2.97) (Table 5).

It was determined that non-disabled individuals had the most significant role in integrating the disabled with society (avg:4.19). Besides, public institutions and organizations such as governorship and ministry (avg:3.62), municipalities (avg:3.42), non-governmental organizations (avg:3.54) and the families of the disabled (avg:3.29) were stated as having a significant role in the integration of the disabled with society (Table 5).

CONCLUSION

Although it is emphasized in all kinds of international platforms that each individual should have equal rights and freedom, disabled people, forming a significant part of society, still encounter many physical and social problems during their lives. Though societies seem to make efforts to solve these problems, researches indicate that disabled people still encounter physical and social barriers. The results of the study conducted in Kastamonu city centre supports these identifications.

Factors affecting the usage status of urban parks physically and socially have tried to be determined by regression analysis carried out in the scope of the study. According to the survey results, conducted with both disabled and non-disabled people, the most significant factor affecting the usage of parks in Kastamonu is identified as the free time status of individuals (β:0.185). However, when the factors in terms of physical and social barriers that the users face at parks are evaluated, the most important physical barriers are identified as transportation status (β:0.093). The accessibility of parks is the most significant issue for all individuals. The disability status of individuals (β:-0.082) comes up as one of the factors affecting the use of

Table 5. Identifications about the physical and social barriers encountered by the disabled people in the usage of Kastamonu urban parks

		Significance Level Average	
Demographic features	Suggestion	Disabled	Non-disabled
What kind of arrangements should be carried out in order for the parks to be used by everyone?	Problems making transportation difficult should be removed	4,19	2,97
	Signs should be used	3,36	2,67
	Adequate lightning should be enabled	3,38	2,71
	Proper decking should be used	4,08	3,16
	Furniture usable by everyone should be used	3,96	3,48
	Hygiene and maintenance should be attached importance	3,83	3,30
	It should be safer	4,28	3,31
Reasons of preventing the disabled from integrating with the society	Status of the disabled	3,64	2,97
	Negative viewpoint of society to the disabled	3,83	3,48
	Municipality do not constitute adequate physical and social environment for the disabled	3,65	3,77
	Institutions such as governorship and ministry do not carry out adequate studies	3,81	3,60
To whom does the role of integrating the disabled with the society belong most?	To the disabled himself/herself	2,85	2,65
	To the family of the disabled	3,82	3,29
	To the municipality	3,55	3,42
	To the institutions such as governorship and municipality	3,77	3,62
	To the non-governmental organizations	3,49	3,54
	To the non-disabled people	4,13	4,19

parks. The results of the study indicate that the increase in the disability status of individuals impedes the usage of parks. Another factor affecting the use of parks is the suitability of parks (β:0.07) for the use of individuals. One of the social barriers determined in the study is that the use of parks depends on the reactions of other people using the park. Though both disabled and non-disabled people state that they do not feel uncomfortable using the parks together, it is identified by the regression analysis conducted to them that the reactions of other individuals affect themselves, indeed. It is thought that this result comes up as disabled and non-disabled people's opportunities in using the parks together are limited. Similar results are seen in the studies of Prellwitz and Tamm (1999), Talay et al. (2010), Moore and Lynch (2015). Income status of the individuals and maintenance of parks are observed as the other factors affecting the use of parks. It is observed that the use of parks have decreased depending especially on the improvement of income. It may depend on the decrease in the free times of people whose income have increased and show that they do not get service in the quality and diversity as they have expected, depending on the increase in their income.

It is stated both by the disabled and non-disabled individuals that parks in Kastamonu are insufficient in meeting the needs of disabled people physically. Insufficient arrangements in meeting the needs of the disabled at parks are stated as furniture (dustbin, sitting unit, signs, etc). Moreover, the necessity to remove transportation difficulties is emphasized by the participants. In sum, it is observed that deficiencies determined by disabled and non-disabled people are common.

When problems encountered by disabled people are examined socially, it is determined that disabled and non-disabled people refer to the same points. Reasons preventing the disabled from integrating with society are stated primarily coming up as local governments, state and public legal entities do not fulfill necessary work. The negative view of society towards the disabled and their status are determined as forming further barriers in integrating with society. It is because when disabled and non-disabled people are asked whether they feel uncomfortable using the same park together, the majority of them state that they do not feel uncomfortable (the disabled 62.9% and non-disabled 95.5%).

While both groups state that the most significant role in the integration of disabled people with society belongs to the disabled themselves, it is stated that the local government and other public legal entities play a significant role, as well. Therefore, if disabled people are provided with necessary opportunities by the local government and public legal entities and necessary arrangements are made in parks, it is thought that there would be nothing to prevent the use of parks by disabled and non-disabled people together.

One of the remarkable results of the study is that the disabled and non-disabled participants have stated that they are not aware of the studies of the local government and/or non-governmental organizations concerning the disabled. It comes to existence that the local government and other public legal entities should inform the interest groups as well as make the necessary arrangements at parks (Akyılmaz, 2000). In Turkey, in order to provide full participation of the disabled to social life, it is ensured in the 2nd provisional article of the law no 5378 that current formal institutions that belong to state institutions and organizations, current roads, pavements, crosswalks, open and green areas, sports areas and similar social and cultural areas and any structures built by natural and legal persons and open to public service should be accessible to the disabled. The 8-year period allotted to fulfill these applications started on 7/7/2005 (OG, 2005). Yet, both this study and the study conducted by Sirel et.al. (2012) at Adana Çukurova University Campus, Alp's study (2014) regarding İstanbul University Beyazıt Campus, the study of Olgun and Yılmaz (2014) regarding Niğde Kızılelma Park, True and Türel's study (2013) regarding Izmir, Bayraktaroğlu and Büke's study (2015) concerning Istanbul Fenerbahçe-Pendik coastline indicate that studies in Turkey are not at a sufficient level and that the interest groups are not adequately informed about the studies.

However, in the 3rd subclause of the 5th article of United Nations Convention on the Rights of Persons with Disabilities, which Turkey became part of in 2008, the following statement "Contracting countries take all necessary steps to make reasonable arrangements concerning the disabled in order to ensure equality and remove discrimination" appears and it is stated in the scope of the convention that active campaigns should be designed, started and continued in order to increase the awareness concerning the disabled in all parts of society, including the families, and in order to raise awareness in society for ensuring respect for the rights and human dignity of the disabled (OG, 2009). It is determined with this study that society in fact is not aware of the legal and physical arrangements and there still exists prejudice towards the disabled within society in a social sense.

Consequently, the study results indicate that disabled people still do not have the same rights as other individuals and the rate of using communal areas is far from being equal. Although local governments and other public legal entities conduct the necessary studies in terms of legal and physical aspects, the studies are not at a sufficient level and individuals are not informed of these studies. Factors affecting the use of urban parks should be assessed according to their importance as soon as possible and the deficiencies should be eliminated without wasting time. The disabled should be enabled to live independently and to participate in all areas of life. It should not be forgotten that each individual is disabled at some point of his or her life.

Ethics Committee Approval: There is no ethics committee approval certificate. The study is not about collecting personal or private information.

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Original Article

Visual assessment of rural landscape with different characters

Farklı karakterdeki kırsal peyzajların görsel değerlendirmesi

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ABSTRACT

Rapid urbanization and urban structuring made in resonse to intense and stressful living conditions has been putting undue pressure on city residents. In addition, the harmful effects of urban and industrial pollutants increases with every passing day. For these reasons, the existence and nature of rural areas become even more important as the aesthetic and functional roles of rural sites grow. The visual value of the landscape is the initial data that reflects the identity of the area and the beginning of landscape planning. Visual quality has a particularly decisive value for the goals of minimizing intervention and making the right planning decisions for rural areas. This study aimed to conduct visual evaluation on rural areas that feature different characters. Visual Landscape Quality Analysis was performed on designated rural settlements (10 villages situated in Bayburt). Results showed that the highest rated landscape unit was Vegetation Landscape (M = 0.78), with Path Landscape ranking second (M = 0.71), and followed by Agricultural Landscape in third rank (M = 0.70). The Cultural Landscape ranked the least (M = −0.43).

Keywords: Bayburt, visual landscape, visual quality

ÖZ

Hızlı kentleşme ve kentsel yapının ortaya çıkardığı yoğun ve stresli yaşam koşulları, kent halkı üzerinde baskı oluşturmaktadır. Ayrıca kentsel ve endüstriyel kirleticilerin yarattığı zararlı etkiler her geçen gün artmaktadır. Bu noktada kırsal alanların varlığı ve niteliği daha da önem kazanmakta, estetik ve fonksiyonel rolü büyümektedir. Bir peyzajın görsel değeri, alanın kimliğini yansıtan ilk veri ve planlamanın başlangıcıdır. Görsel kalite, özellikle kırsal alanlarda müdahalenin minimuma indirilmesi, doğru plan kararları alınması açısından belirleyici bir değer olmaktadır. Bu çalışmada, çalışma alanında yer alan farklı karakterdeki kırsal alanlar için görsel değerlendirme elde edilmek istenmiş, belirlenen örnek kırsal yerleşimler (Bayburt ilinde yer alan 10 köy) üzerinde Görsel Peyzaj Kalite Analizi uygulanmıştır. Peyzaj üniteleri bütününde; en yüksek puan alan peyzaj ünitesi Bitki Örtüsü (M=0,78), ikincisi ise Yol Peyzajı (M=0,71), üçüncüsü ise Tarımsal Peyzaj (M=0,70) olmuştur. Kültürel peyzaj ise son sırada yer almıştır(M=-0,43).

Anahtar Kelimeler: Bayburt, Görsel kalite, görsel peyzaj

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INTRODUCTION

Turkey, which is on the route for EU(European Union) membership process, has been the side of many of the international agreements on the environment, and has been trying to reflect these agreements to its internal legal system (Erdem and Coskun, 2009). Ecological values were discussed in the political agenda in Europe for many years (Rio declaration) and the visual quality received less attention. However, changes were observed with the European Landscape Agreement (2000), and a new landscape concept was developed that was integrated with visual, cultural, and social landscape quality together with ecological functions. The importance and difficulty of integration has been emphasized in many studies (Tress et al., 2005, 2007; Fry et al., 2009). Fry et al. (2009), which schematized the common ground between visual and ecological landscape characters as the *set of intersections*.

Today, the interest on interesting landscape (symbolic, historical, etc.) is decreasing, and the concept of planning and management of ordinary landscape is becoming the subject matter in the agenda. There is no consensus on the qualities, values and needs of these common cultural landscapes. According to Vouligny et al. (2009), the intense agricultural usage area landscapes are a good example in this context.

According to Özgüc (l999), the attractiveness and pleasing effects of a place give us the visual quality of that place. The physical factors of the source, which affects the user's perceptions, need to be defined in this context. Landscape quality assessment is an active study field in environmental perception studies, and it is also an important component in environmental planning and management, and for this reason, it is one of the important chains that must not be ignored (Meitner, 2004). In a reasonable and healthy landscape planning work, the planner has to reveal and consider the aesthetic interpretation of the society about the present source before the interpretation of his/her own aesthetic values (Özgüc, 2008).

Not only do the visual components of landscape provide us with an aesthetical value, but they also show us the relation between cultural, economic and biological phenomena. In fact, it is possible to establish a relation between the beauty of the landscape and the wealth of it in terms of bio-ecological factors. Although it is not always possible to apply landscape Visual Landscape Quality Assessment (VLQA) techniques, this quality must be considered as a source that must be preserved to protect rural landscape variety (Angileri and Toccolini, 1993).

The required methodological frame and steps that are necessary for the sensitivity of the visual properties must be applied and emphasized (Krause, 2001);

- The landscape units must be limited with characteristic shaping of the area, structural elements (topography, water, vegetation, colonization) and their landscape mosaic orders,
- Separation of the macro, meso and micro structures within a single landscape part (image, local elements and the structure of the view may be isolated according to the obstacles present in the area),
- Determining the preservation demands, certain interactions and disruption type sensitivities,
- Investigating the disruption levels that will be caused by the ways that will be proposed for equalization, avoiding or minimizing considerable and continuous disruptions.

The assessment of the visual aesthetic quality of a landscape has developed at a significant level in recent years. Objective, reliable and accurate digital measurements and models are the bases in this respect (Palmer and Hoffman, 2001; Roth, 2006). There are two main landscape aesthetics theories paradigms that are based on landscape assessment methods; "objective" paradigm (visual quality according to landscape features), "subjective" paradigm (the landscape quality "in the eye of the audience"). The analysis of the relations between the visual quality and structural features of the landscape is an active study field in which environmental perception research is what counts. The relations between landscape structure and perception are less known; however, it will be extremely advantageous to know them (Fuante de Val et al., 2006). Psycho-physiological model, on the other hand, assumes that the physical features of landscape define the psychological reaction of the observer (Winchcombe and Revell, 2004).

In this study, VLQA was performed in different village types sampling area located within the borders of the city of Bayburt. The aim of the study is to make a VLQA, to analyze the natural and cultural values in rural characteristics in detail, and to make some recommendations. It is also the aim of the present study to form a basis for future studies that will be conducted in the area and in similar areas.

MATERIALS AND METHODS

Material

Bayburt has an elevation of 1400-3350 m, and is located on 40°10′ Northern and 40°15′ Eastern longitude. Bayburt is in Coruh Basin and surrounded by Soğanlı Mountain in the North, Otlukbeli Mountain in the South, Mescit Mountain in the East and Giresun Mountain in the west. VLQA was performed in the 10 villages that were included as the sampling in the study. The villages were ranging through many different areas that showed ecological and morphological differences in a line stretching from north-south part of the city, and for this reason, the area has many different climate types, specific values and character areas (Figure 1). The study was established different landscape types like Plain Village, Mountain Village, Water Shore Village, and Forest Village. The villages that were determined as the study area were Calıdere, Helva, Masat, Aslandede, Camlıkoz, Bayraktar (Bayburt/Central village), Sırataslar, Kılıckaya, İncili (Bayburt/Aydıntepe district) and Devetası (Demirozu district) Villages.

Method

The basic idea of the VLQA is to determine the rural identity in the samples of rural residential areas that have different characteristics in Bayburt. In this context, it was also aimed in the present study that the landscapes that have high visual quality value are determined, the advantages and disadvantages brought by different ecological and cultural features in this residential area are revealed, and the differences in the assessments of the experts and other society members are defined. As a result of these assessments, the Rural Landscape Visual Value was defined in the present study.

Many methods have been applied for Visual Landscape Analysis and Assessment until our present day (Paquette and Dammon, 2003; Arriaza et al., 2004; Turk, 2006; Rogge et al., 2007; Gruehn and Roth, 2008; Lokocz et al., 2011; Cloquell-Ballester et al., 2012; Özhancı et al., 2013). In this study, a Visual Quality Evaluation Method that is specific and suitable for the present study area was formed by making use of the Scenic Beauty Estimation Method-Daniel and Boster, 1976 and various other studies to determine the rural landscape features of the study area.

The residential tissues (housing areas) in the general silhouette and villages have been dealt with in architectural terms. In this respect, VLQA was made by considering the bases of the Gestalt Hypothesis and architectural principles. The landscape characteristics of the rural residential areas, which were determined as the study area, were divided into 5 Units to perform visual evaluation, and the photographs of these areas were evaluated according to various parameters by experts and public. Then, the data obtained in the study were evaluated in statistical terms.

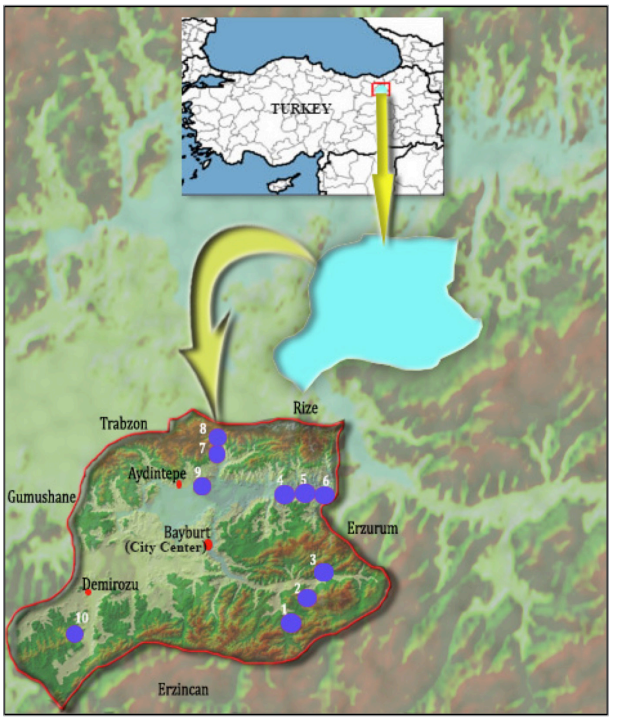

Figure 1. The location of Bayburt and rural settlement (1. Calıdere, 2. Helva, 3. Masat, 4. Aslandede, 5. Camlıkoz, 6. Bayraktar, 7. Sırataslar, 8. Kılıckaya, 9. İncili, 10. Devetası)

Photographing Process and Classification

The photographing process in the study area was performed in 2011-2012 August-September period. Nikon D40 Pro camera was used in the field work performed in 10 villages that were selected as the study area; between 10:00-15:00 (to reduce the solar effect to the lowest level). Nearly 5000 photographs were sifted through by experts according to the purpose of the study, and 55 photographs were chosen to be used in the evaluation process. The photographs were taken at the eye level, and the distance was kept at the same level in every village for the desired photograph type. For the purpose of making a better evaluation, the images that would be evaluated by the expert team and public were classified under 5 Landscape Character Units, which are;

1. General Silhouette (G), which refers to the images in which rural residential areas and landscape areas are included in the frame (Figure 2).

2. Natural Landscape / Vegetation (VG), which refers to the Vegetation and landscape areas located in and around rural residential areas (Figure 3).

3. Road Landscape (RL), which refers to the main road destination and landscape that are included in the rural residential area and that enable users to reach the rural residential areas (Figure 4).

Figure 2. Examples of the general silhouette images used in visual quality analysis

Figure 3. Examples of the vegetation images used in visual quality analysis

Figure 4. Examples of the road landsape images used in visual quality analysis

4. Agricultural Landscape (AL), which refers to the images that include the agricultural areas, landscapes and surrounding areas, which are one of the main components of rural residences (Figure 5).

5. Cultural Landscape (Housing texture) (CL), which refers to the images in which there are residential areas, mosques, alleys and squares, which are in the focal point of the rural residence (Figure 6).

Figure 5. Examples of the agricultural landscape images used in visual quality analysis

Figure 6. Examples of the cultural landscape images used in visual quality analysis

Assessment Process

Assessment of Public

In this study, a public assessment was also performed in the scope of the VLQA, which was conducted to obtain the opinions on Visual Quality of the landscape of the city of Bayburt. Many previous studies were reviewed, and the questionnaires, analyses and data analyses were made by using the most ideal evaluation parameters.

The participants of the study were Architecture and Design Faculty, Landscape Architecture Department 2nd Grade students (46), Fine Arts Faculty, Music Department (23) and Traditional Handcraft Department students (21), Science Faculty Geography Department students (42), Literature Faculty Turkish Language and Literature Department students (30) and the residents of Erzurum (46), which makes a total of 6 different groups, and 208 people.

The evaluation process started with a briefing on the purpose of the study which was also intended to avoid problems that might occur due to misinterpretations. Then, all the images were presented to the participants as a slideshow, and the participants were asked to evaluate each image between -2 and +2 scores within 15 seconds (-2: completely repulsive,-1: repulsive, 0: neutral, +1: attractive, +2: very attractive).This evaluation was performed only to familiarize the participants to the images, and this process was not used in further analyses.

In the last stage, the participants were asked to rate the images between -2 and +2 range in terms of naturalness, openness, variety, order, trust, cohesion and the fineness of the sceneries (Table 1).

Expert Evaluation

In this stage, the images of different character areas were evaluated by an expert group consisting of Landscape Architecture Department academicians by using a series of landscape and architectural parameters. The evaluation form was presented to the expert group, and they were asked to make evaluations on the photographs according to the given range of points. The aim of this evaluation was to define the relation between expert evaluation and the evaluation of the people. Then, in order to determine the real value of the landscape, the participants were asked to choose the most proper statements that fit their viewpoints.

Evaluation of the Classified Photographs over Parameters

In general silhouette and vegetation assessment, the evaluation of the landscape features and assessment of the images (9 general silhouette and 12 vegetation) taken from the residential areas were made by the expert group. Eleven main titles were used in the evaluation, which were visual area, visual area depth, closure, continuance, water, dominant vegetation, topography, cultural elements, and sky.

The real value of the landscape, based on the statement "For humans, the landscape that is independent from its functions is the real landscape", in the last stage, the experts were asked to choose one of the statements; "Landscape must be developed", "Landscape may stay as is", "Landscape may be completely eliminated, or converted into another landscape". In addition, the vegetation images were questioned in terms of the most ideal landscape function (Rogge et al., 2007). The evaluation list is given in Table 2.

In road landscape, eight images that were taken from the residential areas were evaluated in terms of degree of naturalness, the rhythm of the road, the contribution of the topography, the sense of area, traditionalism level, surprises, dominant vegetation, the quality of the scenery road, the effectıveness of the skyboard line, the type of the landscape through which the landscape road passes. In addition, the images were also questioned in terms of the real value of the landscape. The evaluation list is given in Table 3.

Agricultural landscape is another basic component of the visual evaluation. Eleven agricultural area images taken from

Table 1. The parameters used in public evaluation

PARAMETER / Definitions	
Naturalness	Give Low points if you perceive a clear inconsistency between the "current natural scenery features" and "the scenery features that seems to be given place by humans in the scenery" in the image.
Openness	If you think that it is difficult or confusing to interpret the image, give a low point.
Variety	If you think that the image has various elements that are different from each other, give a high point; and if not, give a low point.
Order	If you perceive that the image has ranked elements or it has a clear order of things, give a high point.
Reassurance	If you perceive that the components of the image recalls risks or dangers, give low point; if the image presents a hospitable, danger-free and safe perception, give a high point.
Cohesion	If there are foreign elements that are not integrated with the rest of the landscape elements, give a low point.
The beauty of the scenery	Give a point to the image according to the beauty of the scenery.

the study area by the expert group were evaluated in terms of the landscape features and elements. There were 14 main titles in the evaluations, which were visual area, visual area depth, and vegetation around it, agricultural products, topography, cultural elements, color, composition, perceptibility, variety, openness, and order. In addition, the images were also questioned in terms of the real value of the landscape and the most ideal landscape function. The evaluation list is given in Table 4.

Cultural landscape (housing texture) is another component of visual evaluation. 15 residential area images that were taken by the expert group were evaluated in terms of agricultural features and elements. There were 8 main titles in the evaluation; similarity, closeness, topography contribution, sense of area, traditionalism level, definable form, image clarity, and the sustainability of the streets. In addition, the images were also questioned in terms of the real value of the Landscape and the most ideal Landscape function. The evaluation list is given in Table 5.

Table 2. Features used in the evaluation of general silhouette and vegetation images by the expert group

	SCORING					
Parameters	1	2	3	4	5	6
VISUAL AREA	Closed	Filtered	Open			
VISUAL AREA DEPTH	<100m	100 m-2 km	>2 km			
CLOSURE	No	There is				
CONTINUANCE	No	There is				
WATER						
*Water flow	No Flow	Flow				
*Water source type	No water	River	Lake	Dam		
* Water ratio	0–25%	25–50%	50–75%	75-100%		
DOMINANT VEGETATION						
* Covered with vegetation area ratio	0–25%	25–50%	50–75%	75-100%		
* Vegetation type	No egetation	Herbaceous plants and shrubs	Culture plants	Mixed shrubs and trees	Trees	Forest
TOPOGRAPHY	Plain/ near flat	Partially wavy	Partly mountainous	Mountainous	Valley	
CULTURAL ELEMENTS						
* Presence of man-made positive elements / places and typical houses	Not at all	One item	Two items	Three or more		
* The existence of man-made negative elements / roads, industry, energy lines etc.	Three or more	Two items	One item	Not at all		
* Proportion of man-made elements	75-100%	50–75%	25–50%	0–25%		
SKY						
*Sky ratio	0–25%	25–50%	50–75%	75-100%		
*Presence of significant skyline	No	There is				
THE REAL VALUE OF THE LANDSCAPE	Landscape may be, completely eliminated or converted into another landscape	Landscape must be developed	Landscape may stay as is			
IDEAL LANDSCAPE FUNCTION (for vegetation images)	Existing use	Agricultural use	Recreation / Tourism	Protection		

Statistical Analysis

The 'SPSS 10.0' Statistical Package Program was used in the analysis of the questionnaires that were used in visual quality analysis. The One-Way Variance Analysis (ANOVA), Regression Analysis and Correlation Analysis (Spearman's RHO) were used in the analyses of the data.

RESULTS AND DISCUSSION

Scoring the General Attractiveness and Comprehensive Questioning

The beauty of the scenery scores (-2,-1, 0,+1,+2 range) that were given by 207 participants for 56 different images to which VLQA was applied were evaluated and ranked according to Visual Preference Score (VPS) (Table 6.). 55.7% of the participants were female, and 61,35% were living in the city center with their families, 55.56% lived in a cold-climate area.

The images VG5, VG6, VG8, VG9, VG11 from the Vegetation Images; AL1, AL2, AL7 from Agricultural Landscape Images; CL14 from Cultural Landscape Images; RL7 from Road Landscape Images were determined to have the highest "beauty of the scenery scores". The first three images were VG6 (M=1.40), VG11 (M=1.37) and VG5 (M=1.28), respectively (Figure 7).

As a result of the evaluations, the images with the lowest "beauty of the scenery score" were CL2, CL8, CL7, CL4, CL3, CL1, CL9 and G4, respectively (Figure 8.).

Table 3. Features used in the evaluation of road landscape images by the expert group

	SCORING					
Parameters	1	2	3	4	5	6
DEGREE OF NATURALNESS	Incompatible with natural tissue floor type+vegetation+ sign boards +energy transmission lines	Partially compatible with natural tissue floor type+vegetation+ sign boards + energy transmission lines	Compatible with natural tissue floor type+ vegetation+ sign boards +energy transmission lines			
THE RHYTHM OF THE ROAD (compliance with natural forms)	Stable	Partially mobile	Active			
THE CONTRIBUTION OF THE TOPOGRAPHY	Low	Medium	Clear			
THE SENSE OF PLACE (the power to represent the geography in which it is located)	Low	Medium	Clear			
TRADITIONALISM LEVEL (Originality)	No traditional structure	Some traditional structures	Completely traditional structures			
SURPRISES	No	There is				
DOMINANT VEGETATION						
* Covered with vegetation area ratio	0–25%	25–50%	50–75%	75-100%		
* Vegetation type	No vegetation	Herbaceous plants and shrubs	Culture plants	Mixed shrubs and trees	Trees	Forest
THE QUALITY OF THE SCENERY ROAD	Low	Medium	Clear			
THE EFFECTIVENESS OF THE SKYBOARD LINE	Low	Medium	Clear			
THE TYPE OF THE LANDSCAPE THROUGH WHICH THE LANDSCAPE ROAD PASSES	Cultural Landscape	Agricultural Landscape	Meadow-grassland	Mountain Ecosystem		
THE REAL VALUE OF THE LANDSCAPE	Landscape may be completely eliminated, or converted into another landscape	Landscape must be developed	Landscape may stay as is			

In the whole of the landscape character unit groups, the highest score belonged to Vegetation Unit (M=0,78); and the second highest score belonged to Road Landscape Unit (M=0,71). The Cultural Landscape was the last item in the list (Table 7). As a matter of fact, the differences between the different types of images were found to be statistically significant in One-Way Variance Analysis (ANOVA) results (f value =419.732, p=0.000<.01) (Table 8.).

The Visual Quality Parameter Scores of the Images

The Regression Analysis was applied to determine at which level the visual quality parameters were effective on the beauty of the scenery factor. The results of the analysis are given below (Table 9).

In this respect, the independent variables can explain the 47.4% of the variance in the dependent variables. In addition. accord-

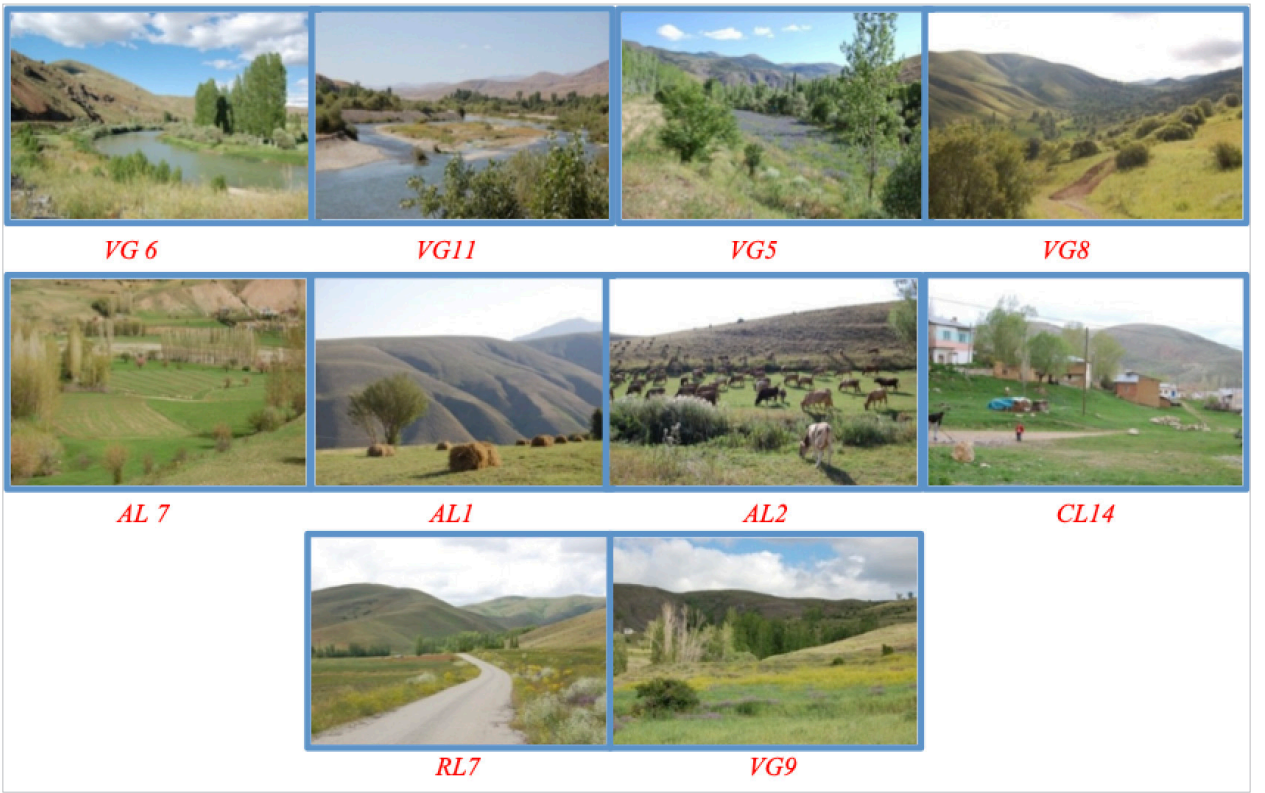

Figure 7. The images with highest score of landscape beauty

Figure 8. The images with lowest score of landscape beauty

ing to the significance value in Anova, the value was $p < 0.01$; for this reason, the model was found to be significant (Table 10).

The relation between all the parameter and the beauty of the scenery was significant at p<0,01 level. However, there was no statistically significant relation between the beauty of the scenery and 'openness' parameter. It was understood that the factor that had the highest effect on the beauty of the scenery was 'Naturalness', and 'trust' and 'cohesion' followed this (Table 11). This situation may be characterized with the following formula;

$y=0.213+0.245x_1+0.045x_2 + 0.079x_3 + 0.166x_4 + 0.081x_5+ 0.290x_6$

In the image with the highest beauty of the scenery score in visual landscape quality parameters, the distribution of the scores was as; naturalness (M=1.56); openness (M=1.19); variety (M=0.74); order (M=0.90); reassurance (M=0.72) and cohesion (M=-0.92).

Expert Evaluation

The scores given to the images as a result of expert evaluation in general silhouette images and their VPS scores are given in Table 12.

The scores given to the images as a result of expert evaluation in vegetation images and their VPS scores are given in Table 13.

The scores given to the images as a result of expert evaluation in agricultural landscape images and their VPS scores are given in Table 14.

Table 4. Features used in the evaluation of agricultural landscape images by the expert group

	SCORING				
Parameters	1	2	3	4	5
VISUAL AREA	Closed	Filtered	Open		
VISUAL AREA DEPTH	<100m	100 m-2 km	>2 km		
VEGETATION AROUND IT					
*Covered with vegetation area ratio	0–25%	25–50%	50–75%	75-100%	
* Vegetation type	No vegetation	Herbaceous plants and shrubs	Culture plants	Mixed shrubs and trees	Trees
AGRICULTURAL PRODUCTS	Inactive in view	Active in view			
TOPOGRAPHY	Plain / near flat	Partially wavy	Partly mountainous	Mountainous	
CULTURAL ELEMENTS					
* Presence of man-made positive elements / places and typical houses	Not at all	One item	Two items	Three or more	
* The existence of man-made negative elements / roads, industry, energy lines etc.	Three or more	Two items	One item	Not at all	
* Proportion of man-made elements	75-100%	50–75%	25–50%	0–25%	
COLOR					
*Number of color	One color	Two color	Three or more		
*Color harmony	Clear color harmony	Poor color harmony			
COMPOSITION					
*Focus	No focus image	Focus image			
PERCEPTIBILITY					
*Kitle-Bosluk Oranı	Low	Medium	Clear		
VARIETY	Low	Medium	Clear		
OPENNESS	Low	Medium	Clear		
ORDER	Low	Medium	Clear		
THE REAL VALUE OF THE LANDSCAPE	Landscape may be completely eliminated, or converted into another landscape	Landscape must be developed	Landscape may stay as is		
IDEAL LANDSCAPE FUNCTION	Existing use	Meadow-grassland	Recreation / Tourism	Protection	

The scores given to the images as a result of expert evaluation in road landscape images and their VPS scores are given in Table 15.

The scores given to the images as a result of expert evaluation in cultural landscape images and their VPS scores are given in Table 16.

The images that had the highest average scores in expert evaluation in expert evaluation are CL5 (M=2.90) from CL images; VG6 (M=2.65) from VG images; AL3 (M=2.65) from AL images; RL1 (M=2.58) from RL images; G1 (M=2.31) from G images (Figure 9).

According to the results of the correlation analysis (Spearman's RHO). which was conducted to question the relation between the landscape features and VPS scores. it was observed that the relation with the vegetation rate was significant in GS images. the relation with water flow and water source type was very significant in VG images. and the relation with the existence of man-made positive elements; and the relation with topography contribution was significant in CL images. The results for all landscape units are given in Table 17.

The common features of the high point area vegetation images were that they had dominant naturalness in them. integrity and

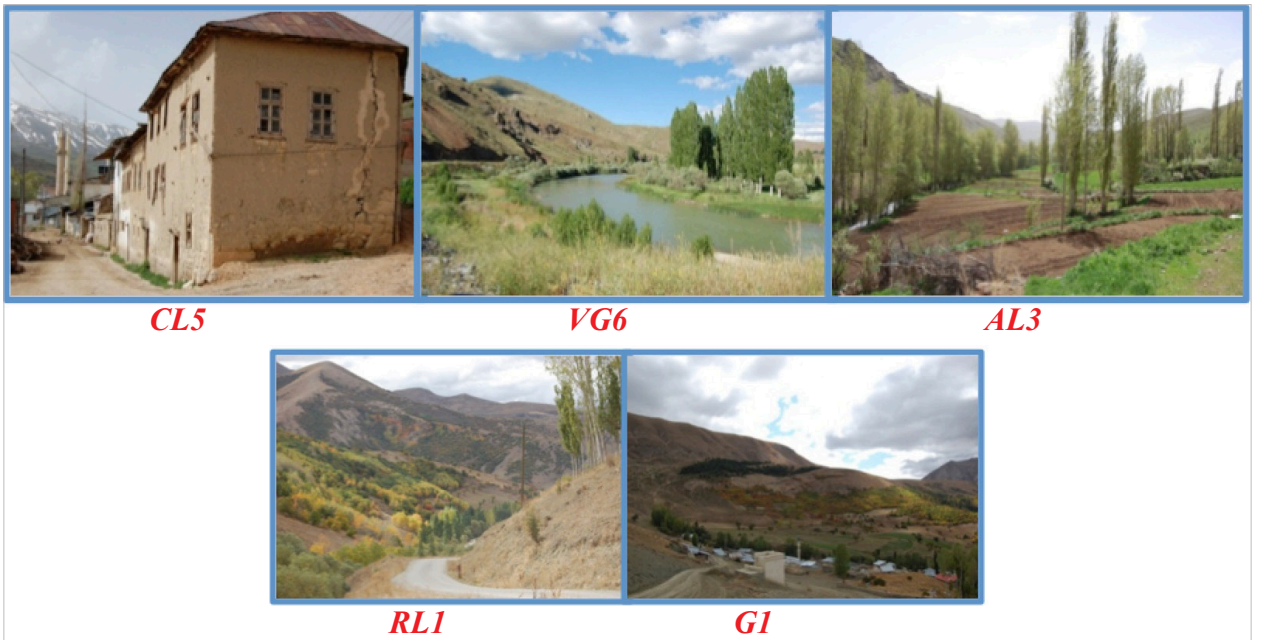

Figure 9. The highest rated images in Experts Review

Table 5. Features used in the evaluation of cultural landscape images by the expert group

	SCORING		
Parameters	1	2	3
SIMILARITY	Low	Medium	Clear
CLOSENESS	Low	Medium	Clear
TOPOGRAPHY CONTRIBUTION	Low	Medium	Clear
SENSE OF AREA	Low	Medium	Clear
TRADITIONALISM LEVEL	No traditional structure	Some traditional structures	Completely traditional structures
DEFINABLE FORM	Yok	Var	
IMAGE CLARITY	Low	Medium	Clear
THE SUSTAINABILITY OF THE STREETS	Low	Medium	Clear
THE REAL VALUE OF THE LANDSCAPE	Landscape may be completely eliminated, or converted into another landscape	Landscape must be developed	Landscape may stay as is
IDEAL LANDSCAPE FUNCTION	Existing use	Recreation / Tourism	Potection

Table 6. Average score of landscape beauty of the images made GPKD

Landscape Types	Photo cod	VPS and Std. Deviation	Landscape Types	Photo cod	VPS and Std. Deviation
GENERAL SILHOUETTE (GS)	G1	0.02±1.31	ROAD LANDSCAPE (RL)	RL1	0.73±1.24
	G2	0.13±1.28		RL2	0.93±1.13
	G3	0.43±1.27		RL3	0.39±1.22
	G4	-0.44±1.28		RL4	0.67±1.20
	G5	0.72±1.23		RL5	0.73±1.22
	G6	0.63±1.28		RL6	0.66±1.25
	G7	0.30±1.19		RL7	0.99±1.14
	G8	0.21±1.22		RL8	0.70±1.31
	G9	0.75±1.20			
VEGETATION (VG)	VG1	0.34±1.09	AGRICULTURAL LANDSCAPE (AL)	AL2	1.10±1.14
	AL1	1.14±1.15		AL3	0.94±1.13
	VG2	0.97±1.25		AL4	0.37±1.75
	VG3	0.13±1.30		AL5	0.58±1.20
	VG4	0.24±1.40		AL6	0.61±1.23
	VG5	1.28±1.01		AL7	1.24±1.03
	VG6	1.40±0.97		AL8	0.47±1.23
	VG7	0.24±1.35		AL9	0.44±1.26
	VG8	1.27±1.04		AL10	0.50±1.26
	VG9	0.99±1.13		AL11	0.31±1.33
	VG10	0.83±1.20			
	VG11	1.37±1.02			
	VG12	0.29±1.26			
CULTURAL LANDSCAPE (CL)	CL1	-0.74±1.30			
	CL2	-1.00±1.23			
	CL3	-0.86±1.17			
	CL4	-0.88±1.18			
	CL5	-0.14±1.34			
	CL6	-0.28±1.35			
	CL7	-0.91±1.13			
	CL 8	-0.92±1.14			
	CL 9	-0.69±1.29			
	CL10	-0.75±1.22			
	CL11	-0.29±1.30			
	CL2	-0.20±1.39			
	CL13	-0.43±1.30			
	CL14	1.03±1.14			
	CL15	0,64±1,30			

Table 7. The scores obtained by the landscape character units

Landscape Character Unıt	VPS and Standart Deviation
GENERAL SILHOUETTE	0.31±1.30
VEGETATION	0.78±1.30
ROAD LANDSCAPE	0.71±1.22
AGRICULTURAL LANDSCAPE	0.70±1.24
CULTURAL LANDSCAPE	-0.43±1.38

that they did not have any negative and inconsistent elements. In addition. in all images. almost an image pool appeared with the contribution of the topography. In the "Scenery/Traffic Island" Theory of Appleton (1975). topography plays a significant role in the evaluation of the spatial structure of the landscape. This is closely related with the feeling that landscape has a typical or panoramic view (Hagerhall. 2001; Fuente de Val et al. 2006).

The AL7 image. which was taken from Masat Village agricultural landscape. shows a neatly-planned agricultural parceling.

Table 8. ANOVA test showing the results of inter-group and intra- group analysis of different units of images

	Sum of squares	Sd	Mean squares	f	p
Between groups	2832.518	4	708.130	419.732	.000*
Within groups	19199.199	11380	1.687		
Total	22031.717	11384			

*p<0,01, statistically very significant

Table 9. The Regression model between landscape beauty and parameters

R	R^2	Adjusted R^2	Std. error of the estimate
0,689[a]	0.474	0.473	0.79

Table 10. Anova Test between landscape beauty and parameters

Model	Sum of squares	Sd	Mean squares	F	p
Regression	1165.216	6	194.203	310.029	0.000[a]
Residual	1292.266	2063	0.626		
Total	2457.483	2069			

Table 11. The Regression Analysis results of the interpretation of landscape beauty

	Unstandardized coefficient		Standardized coefficient		
	B	Std. Hata	Beta	t	Significance
CONSTANT	0.213	0.037		5.768	0.000
Naturallness(x_1)	0.245	0.024	0.039	1.872	0.000
Openness (x_2)	0.045	0.019	0.084	4.250	0.061
Variety (x_3)	0.079	0.025	0.188	9.830	0.000
Order (x_4)	0.166	0.024	0.170	6.920	0.000
Safety (x_5)	0.081	0.019	0.093	4.225	0.000
Cohesion (x_6)	0.290	0.023	0.301	12.616	0.000

Table 12. The average scores VPS and landscape features of general silhouette images

	G1	G2	G3	G4	G5	G6	G7	G8	G9
MEAN SCORE	2.31	1.69	1.75	2.19	2.5	2.19	1.60	1.94	2.19
VPS	0.02	0.13	0.43	-0.44	0.72	0.63	0.30	0.21	0.75

the cultural plants among them. and the residential area in the background. The Populus sp. and Prunus sp.. which are placed in a certain order. agree with the linear structure of the agricultural landscape.

Cultural Landscape images received low scores in general evaluation and the CL14 image (Helva Village) ranked 7th among the first group. When the details are considered. it is observed that this image reflects the natural structure better when compared with other images. Image is a network of parts with humans animals green elements and trees. In the background the mountain silhouette strengthens the effect. In expert evaluation it was included in images that had low scores. It was observed that this image was weak in terms of the architectural features that were questioned.

Table 13. The average scores VPS and landscape features of vegetation images

	VG1	VG2	VG3	VG4	VG5	VG6	VG7	VG8	VG9	VG10	VG11	VG12
MEAN SCORE	2.47	2.35	2.23	2.06	2.47	2.65	2.35	2.12	2.00	1.88	2.59	2.00
VPS	0.34	0.97	0.13	0.24	1.28	1.40	0.24	1.27	0.99	0.83	1.37	0.29

Table 14. The average scores VPS and landscape features of agricultural landscape images

	AL1	AL2	AL3	AL4	AL5	AL6	AL7	AL8	AL9	AL10	AL11
MEAN SCORE	2.05	1.75	2.65	2.45	2.25	2.15	2.2	2.2	1.6	2.35	1.8
VPS	1.14	1.10	0.94	0.37	0.58	0.61	1.24	0.47	0.44	0.50	0.31

Table 15. The average scores VPS and landscape features of road landscape images

	RL1	RL2	RL3	RL4	RL5	RL6	RL7	RL8
MEAN SCORE	2.58	1.92	2.50	1.75	2.50	1.83	2.25	2.00
VPS	0.73	0.93	0.39	0.67	0.73	0.66	0.99	0.70

Table 16. The average scores VPS and landscape features of cultural landscape images

	CL1	CL2	CL3	CL4	CL5	CL6	CL7	CL8
MEAN SCORE	2	2.6	2.4	2.2	2.9	1.7	2.1	1.3
VPS	-.74	-1.0	-.86	-.88	-.14	-.28	-.91	-.92
	CL9	CL10	CL11	CL12	CL13	CL14	CL15	
MEAN SCORE	2.3	2.4	2.7	2.1	2.6	1.5	2.3	
VPS	-.69	-.75	-.29	-.20	-.43	1.03	.64	

Table 17. The correlation analysis between landscape characteristics and VPS scores

Landscape Unit	Landscape features	VPS	Significance
General silhouette	DOMINANT VEGETATION		
	Covered with vegetation area ratio	0.725*	0.027
Vegetation	WATER		
	Water flow	0.753**	0.005
	Water source type	0.753**	0.005
	CULTURAL ELEMENTS		
	Presence of man-made positive elements / places and typical houses	0.585*	0.046
Cultural Landscape	THE CONTRIBUTION OF THE TOPOGRAPHY	0.549*	0.042

*p<0.05. statistically significant

**p<0.01. statistically very significant

The weakest feature of the rural residential areas was that it is not possible to see an efficient architectural character. Together with the new and uncontrolled construction. The culture of wooden adobe and stone structures that dominated in the past have been lost and architecturally unidentified structures appeared in the area. This attracts the attention both in construction technique and in the colors used. In this context. plans must be made in further studies to regain the architectural character; and the village townhouse culture. Which has been brought until our present day through a tradition that exists almost in every village. must be placed in the very center of this structure. The governmental buildings that are built by the state (school. healthcare center. etc.) must also reflect this culture. Tempesta (2010) conducted a study on rural areas and reported that traditional structures contributed to the visual value of the landscape; however. other manmade elements weakened this effect and left a deep and negative trace. However which is more important is that these traditional structures must represent a certain architectural identity. The basic source of the visual activity is the existence of this identity. RL7 image is the image of a road landscape near Devetası Village. The natural vegetation which surrounds the road as a belt. Increases the quality of the image with its colors. While the trees bring the vertical effect in the skyboard line of the road. The active topography is another component in the background. In this image. The clarity and naturalness come to the forefront together with the topography contribution. which is also the case in vegetation images.

The G9 image is the only image with high score in its group (General Silhouette). The thing that makes it unique is the efficiency of the water element in the landscape. In the image of Aslandede Village. It attracts attention that there appear bends and curves when the Coruh River passes through the village and runs towards the plain. It brings the wealth of morphology of the valley to the forefront in its group.

In the whole of the unit groups the highest score belongs to the area landscape unit vegetation. The second highest score belongs to the road landscape unit and the third highest score belongs to agricultural landscape unit. The cultural landscape ranked the last in this context. As a matter of fact Lokocz et al. (2011) conducted a preference study and reported that natural landscape photograph category (including the road images) ranked the first and agricultural landscapes followed it.

When industrial elements are included in rural landscape. there appear changes in negative ways in concepts like fineness and naturalness. Meanwhile asphalt roads also cause negative changes in these concepts (Cloquell-Ballester et al.. 2012). In this study. the road images that were used in the evaluations did not cause a negative effect because it did not create a direct contrast with the natural texture. The natural vegetation of the area must be preserved. and must be evaluated together with the colorful road landscape. Stations and facilities must be established to enable people find the opportunity of stopping by or spending the night and watch the vista points where the vegetation can be watched in the best manner in the roads with scenery.

In the analysis that was made to determine to which extent the visual quality parameters were effective on the beauty of the scenery factor. It was determined that there was no statistically significant relation between the beauty of the scenery and 'openness' parameter. The 'naturalness' was the factor that had the highest effect on the beauty of the scenery (Purcell and Lamb. 1984; Hartig. 1993; Hagerhall et al.. 2004; Cloquell-Ballester et al.. 2012). and 'trust' and 'cohesion' followed this.

The images that had the highest average scores in the expert evaluation were CL5. VG6. AL3. RL1. and G1. The CL5 image. which is the image of a cultural landscape of the Masat Village residential area. has several architectural elements like the clarity and continuity. In other images it was observed that aside from the agricultural landscape image. The water and especially the topography elements increase the visual efficiency aside from the agricultural landscape image.

In the literature the two determiners that are effective on the preference have been reported as "attracting people to visit and see" and "worth preserving" concepts (Sevenant and Antrop, 2009). The "attracting people to visit and see" concept has been considered as the need of humans to discover and as the discovery behavior in the literature (Hagerhall, 2000). "Attractive vegetation", "being not under the influence of humans" and "being not disrupted" refer to the naturalness level that is perceived (Sevenant and Antrop, 2009).

It was observed that the results of the evaluation done by the experts do not overlap with the evaluation of the people. As a matter of fact the indicators that have visual and ecological importance may not be interpreted in the same manner in both viewpoints. The differences expressed by this indicator may be positive in terms of ecological aspect and negative in terms of visual aspect. The visual and ecological function scale of humans shows differences. For example if we are talking about an open area in a landscape. a major-scale open area may be perceived as positive in terms of visual aspect and a minor-scale open area will have many ecological functions (Fry et al.. 2009).

When the relation between the landscape features and visual preference scores was considered. It was determined that the relation with *the rate of area covered with vegetation* is important in general silhouette images and the existence of the *water flow. water source type and manmade positive elements* is significant in vegetation images and the relation between the topography contribution is significant in cultural landscape images. As a matter of fact studies conducted so far revealed that the elements that were perceived as natural developed landscape; and anthropogenic elements deteriorated the visual quality (Schroeder. 1988; Franco et al.. 2003; Arriaza et al.. 2004; Rogge et al.. 2007; Palmer. 2008; Tempesta. 2010). In addition another important point that must be kept in mind is the level of the effect created by the perspective of the image. The photographer must add a perspective comment before the viewer.

CONCLUSION

In Visual Quality Analysis. it was determined that the VG6. VG11. VG5. VG8 and VG9 images had the highest scores in Vegetation Images; the AL7. AL1. AL2 images had the highest scores in Agricultural Landscape Image; CL14 had the highest score in Cultural Landscape Images; RL7 had the highest scores in Road Landscape Images in terms of "the beauty of the scenery score"; and the first three images were VG6. VG11 and VG5. respectively. The images that had the highest scores in each Landscape Character Unit were G9 in the GS Unit; B6 in the VG Unit; Y7 in the RL Unit; T7 in the AL Unit; K14 in the CL Unit. As a whole of the unit groups. The Area Landscape Unit Vegetation had the highest score; the Road Landscape Unit had the second highest score; the Agricultural Landscape Unit had the third highest score; and the Cultural Landscape ranked the latest. It was determined that there was no statistically significant relation between the beauty of the scenery and 'openness' parameter; and the factor that had the highest effect on 'the beauty of the scenery' was 'naturalness'; and 'trust' and 'cohesion' followed it.

The images that had the highest Landscape Feature Scores in expert evaluations were K5. B6. T3. Y1. and G1. The K5 image. which is one of the Cultural Landscape Images from Masat Village residential area has several architectural elements like image clarity and continuity. In other images it attracts attention that aside from the agricultural landscape image. Visual efficiency is also increased by especially water and topographical elements.

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Original Article

Estimating diameter at breast height (DBH) from diameter at stump height (DST) in triple mixed stands in the region of Artvin in Turkey

Artvin yöresindeki üçlü karışık meşcerelerde kütük çapı ile göğüs çapı ilişkisi

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ABSTRACT

Diameter at breast height is used as an independent variable in the calculation of most tree or stand parameters because it can be measured easily and has high correlation with tree variables. But, it is necessary to estimate the size of the DBH of the tree concerned to have knowledge of the tree which has been separated from the area. In this study, DST-DBH relationships were investigated on stands where Oriental Spruce (So), Scots Pine (Ps) and Eastern Black sea Fir (Fb) were mixed. For this purpose, 206 trees (69 So, 69 Ps and 68 Fb) were used which were cut from 23 different sample areas taken in fully closed SoPsFb and PsSoFb stands in Artvin. According to the statistics analysis; models that best explain the variability of the DBH are power for spruce, quadratic for pine and linear models for fir. These models can explain the variance of DBH in triple mixed stands by 95.2% for spruce, 96.5% for pine and 96.4% for fir, and standard errors of models are 1.850, 1.598 and 1.643 respectively. As a result, these models, which at a certain height of success in predicting DBH, can be used by practitioners at fully closed triple mixed stands in Artvin.

Keywords: Diameter at breast height, diameter at stump height, regression analysis, triple mixed stands

ÖZ

Göğüs çapı, kolay ölçülebilir olması ve diğer ağaç değişkenleriyle yüksek korelasyona sahip olmasından dolayı, tek ağaç veya meşcere parametrelerinin birçoğunun hesaplanmasında bağımsız bir değişken olarak kullanılmaktadır. Ancak ormanlık alandan ayrılmış olan ağaç hakkında bilgi sahibi olabilmek için göğüs çapı büyüklüğünü tahmin etmek gerekmektedir. Bu çalışmada, Doğu Ladini (L), Sarıçam (Çs) ve Doğu Karadeniz Göknarı (G) karışık meşcerelerinde göğüs çapı-kütük çapı ilişkisi araştırılmıştır. Bu amaçla Artvin'de tam kapalı olan LÇsG ve ÇsLG meşcerelerinden alınan 23 farklı örnek alandan kesilmiş olan 206 ağaç (69 adet L, 69 adet Çs ve 68 adet G) verisi kullanılmıştır. Yapılan istatistiksel analizlere göre, göğüs çapındaki değişkenliği açıklayan en iyi modeller Ladin'de power, Sarıçamda kuadratik ve Göknarda ise doğrusal modeller olmuştur. Bu modellerin üçlü karışık meşcerlerde göğüs çapı değişkenliğini açıklama oranları Ladin için %95,2, Sarıçam için %96,5 ve Göknar için de %96,4 ve bu modellerin hataları da sırasıyla 1.850, 1.598 ve 1.643 şeklinde bulunmuştur. Sonuç olarak, göğüs çapını tahmin etmede belli başarı seviyesinde olan bu modeller, Artvin'deki tam kapalı üçlü karışık meşcerelerde uygulayıcılar tarafından kullanılabilir olarak bulunmuştur.

Anahtar Kelimeler: Göğüs çapı, kütük çapı, regresyon analizi, üçlü karışık meşcereler

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INTRODUCTION

The most basic variable, used for measurements made in sample areas, is the diameter at the breast height (DBH) in forestry applications (Kangas and Maltamo, 2006; Bettinger et al, 2018). The most common measure used to calculate the dimensions of living and dead trees is DBH. The height of the breast is accepted as 4.5 feet (1.37 meters) from the ground level (Bettinger et al., 2009; 2018).

The diameter at breast height (DBH) corresponding to a height of 1.3 meters is measured in all of the repeated forest inventory (Pretzsch, 2009). Because the DBH is the main variable, which is easy to

measure and highly correlated with many dependent variables of a single tree. (Vanclay, 1994). Therefore; the DBH is the dependent variable which uses the most common numerous fields including the calculation of the tree volume, the identification of the stand structure, and the selection of the sample plots for the inventory (Dorado et al., 2006; Mısır, 2010).

Many features such as height, volume, biomass, double bark thickness and crown wide can easily be calculated using the measure of DBH. Especially stand volume which is one of the most important variables in forest management is usually assessed based on the DBH and height of the tree (Rupsys & Petrauskas, 2010; Ogana, Osho & Varela, 2018), so DBH is an important parameter for the tree volume. The most commonly used variable DBH when estimating the tree volume in forestry (Kalıpsız, 1999). Therefore, the volume equations used the most common in the forestry is the single entry tree volume equations which depend on the DBH (Kalıpsız, 1999; Şenyurt, 2012).

Table 1. The relationship studies between DST - DBH in Turkey

Tree species	Researchers
Calabrian pine	Uğurlu & Özer, 1977
Scots pine	Özer, 1981
Fir	Forestry Research Institute, 1981
Oriental beech	Forestry Research Institute, 1982
Black pine and Scots pine	Yavuz, 1996
Ash	Yavuz, 2000
Black pine, Cedar and Calabrian pine	Özçelik, 2005
Fir, Oriental beech and Black pine stands	Durkaya & Durkaya, 2011
Scots pine	Şenyurt, 2012
Oriental beech	Ercanlı et al., 2015
Chestnut	Sağlam et al, 2016
Red pine and Black pine	Sakıcı & Yavuz, 2016
Oriental beech and Kazdağı Fir mixed stands	Sakıcı & Özdemir, 2017

As a result of overturning, breakage, drying or the illegal cutting of trees, only the stumps remain in the forested areas, so it is necessary to know the DBH in order to estimate the tree volume separated from these areas. In such cases, it is necessary to use these stump dimensions to estimate the DBH and volume of the tree (McClure, 1968; Bylin, 1982; Kozak, & Omule 1992; Wharton, 1984; Chhetri, & Fowler, 1996; Corral-Rivas et al., 2007; Özçelik et al., 2010; Milios et al., 2016). That is why foresters are usually faced with the problem of determining and confirming the DBH of felled trees (Shrivastava, & Singh, 2003). Foresters who are usually confronted with the problem of determining the DBH of felled trees, can estimate the volume of felled trees using the relationship model of DST-DBH (Diéguez-Aranda et al., 2003; Şenyurt, 2012). In this way the models estimating DBH using stump measurements will also benefit forest managers as well as researchers (Chhetri, & Fowler, 1996). The determination of DBH is possible by regression and correlation studies between DST values as independent variables and DBH as dependent variables. (Shrivastava, & Singh, 2003).

The studies on the relationship model between DST and DBH in Turkey were given in Table 1 (Uğurlu & Özer, 1997; Forestry Research Institute, 1981; Forestry Research Institute, 1982; Giray, 1982; Yavuz, 1996; Yavuz, 2000; Özçelik, 2005; Durkaya & Durkaya, 2011; Şenyurt, 2012; Ercanlı et al., 2015; Sağlam et al, 2016; Sakıcı & Yavuz, 2016; Sakıcı & Özdemir, 2017).

In this study, the aim was to model the regression analysis of the relationship between the DST and the DBH for all species separately in the triple mixed stands (Oriental spruce, Scots pine and Eastern Black sea Fir) of Artvin.

MATERIALS AND METHODS

Material

Within the scope of the study, for the purpose of determining the relationship between the DST and the DBH; A total of 206 tree data were used from 23 different sample areas cut from the fully closed Oriental spruce-Scots pine-Eastern Black sea fir (SoPsFb) and Scots pine-Oriental spruce-Eastern Black sea fir (PsSoFb) triple mixed stands spreading in Artvin. In the triple mixed stands, the sample plots were selected from places where the three tree species were located and adjacent to each other. In

Table 2. Statistical information about sample trees

Tree species	Variable	n	Mean	Standard deviation	Minimum (cm)	Maximum (cm)
O. spruce	DST (cm)	69	27.2	9.6	9.3	57.1
	DBH (cm)		23.4	8.2	8.3	52.1
S. pine	DST (cm)	69	34.7	10.2	13.5	57.0
	DBH (cm)		29.8	8.6	10.9	44.0
E.B. fir	DST (cm)	68	27.3	10.3	10.5	56.7
	DBH (cm)		24.4	8.7	9.4	46.1

O.spruce: Oriental spruce; S.pine: Scots pine; E.B. fir: Eastern Black Sea fir

the triple mixed stands where sample areas were taken, almost equal number of trees were selected from each species, and statistical information on these sample trees is given in Table 2.

Method

Within the scope of the study, DST-DBH relationships for each species were investigated using DST and DBHs separately measured for Oriental spruce, Scots pine and Eastern Black sea fir species. According to Pond, & Froese (2014); choosing the most accurate model to estimate DBH from the DST is very important in terms of repositioning the tree, predicting the state of the tree before leaving the habitat, or estimating the volume of the tree separated from the forest area. For this reason, while the DST-DBH relationships were being investigated, the most appropriate regression models were used for the distribution of each tree species (modal 1-5; Table 3).

Table 3. Mathematical expressions of the models selected for evaluation

Mathematical form	Model	
$dbh = b_0 + b_1\ dst$	Linear	(1)
$dbh = b_0 + b_1\ ln(dst)$	Logarithmic	(2)
$dbh = b_0 + b_1\ d_{st} + b_2\ dst^2$	Quadratic	(3)
$dbh = b_0\ (dst^{b1})$	Power	(4)
$dbh = e^{(b0 + (b1 / dst))}$	S-Curve	(5)

dbh: diameter at breast height, dst: diameter at sump height, b_0, b_1 and and b_2: regression parameters

The regression analyzes of the study were made by using the SPSS statistical program (SPSS 19.0 Institute Ins., 2010) and the following five success criteria were taken into consideration in determining the success from the tested models (modal 6-10).

Adjusted Coefficient of Determination (R^2_{adj})
$$R^2 adj. = 1 - \left(\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2\,(n-1)}{\sum_{i=1}^{n}(y_i - \bar{y}_i)^2\,(n-p)}\right) \quad (6)$$

Root Mean Squared Error (RMSE)
$$RMSE = \sqrt{\frac{\sum(y_i - \hat{y}_i)^2}{n-p}} \quad (7)$$

Mean Error (ME)
$$ME = \frac{\sum(\hat{y}_i - y_i)}{n} \quad (8)$$

Mean Absolute Percentage Error (MAPE)
$$MAPE = \frac{\sum|\hat{y}_i - y_i|}{\sum y_i} x100 \quad (9)$$

Total Percentage Error (TPE)
$$TPE = \frac{\sum \hat{y}_{i_i} - \sum y_i}{\sum y_i} x100 \quad (10)$$

Ethics committee approval is not required for this research.

RESULTS AND DISCUSSION

The adjusted coefficients of determination, standard errors, mean errors, mean absolute error percentages, total error percentages, significance levels and F ratios for the 5 different regression models tested in the study are in Table 4 and their coefficients are also given in table 5.

According to the results, the models that reflect best the relationship between the DST and the DBH are determined as power for Oriental spruce, quadratic for Scots pine and linear model for Eastern Black sea fir. These models are able to explain the

Table 4. Success criteria of DST and DBH models

Tree species	Modal	$R^2_{adj.}$	R	RMSE	R	ME	R	MAPE	R	TPE	R	F	P	∑R
O. spruce	1	0.945	(3)	1.917	(3)	-1.0E-12	(2)	6.13	(2)	-4.5E-12	(2)	1180.38	0.000*<	(11)
	2	0.891	(5)	2.712	(5)	-1.3E-12	(3)	7.98	(4)	-5.5E-12	(3)	556.55	0.000<	(20)
	3	0.945	(2)	1.927	(4)	5.2E-13	(1)	6.17	(3)	2.2E-12	(1)	584.30	0.000*<	(11)
	4	**0.952**	**(1)**	**1.850**	**(2)**	**-0.07**	**(4)**	**6.08**	**(1)**	**-0.30**	**(4)**	**1363.69**	**0.000<**	**(12)**
	5	0.899	(4)	1.818	(1)	-0.27	(5)	8.28	(5)	-1.16	(5)	592.04	0.000<	(20)
S. pine	1	0.960	(3)	1.716	(2)	-1.4E-12	(1)	4.34	(3)	-5E-12	(1)	1632.62	0.000*<	(10)
	2	0.945	(5)	2.009	(4)	3.1E-12	(2)	5.04	(4)	1.1E-11	(2)	1172.73	0.000<	(17)
	3	**0.965**	**(2)**	**1.598**	**(1)**	**1.6E-11**	**(3)**	**3.97**	**(1)**	**-5.4E-11**	**(3)**	**946.46**	**0.000<**	**(10)**
	4	0.973	(1)	1.729	(3)	-0.02	(4)	4.30	(2)	-0.05	(4)	2434.01	0.000<	(14)
	5	0.947	(4)	0.076	(5)	-0.16	(5)	5.67	(5)	-0.54	(5)	1218.78	0.000<	(24)
E.B. fir	**1**	**0.964**	**(3)**	**1.643**	**(3)**	**-3.2E-13**	**(1)**	**4.95**	**(3)**	**-1.3E-12**	**(1)**	**1818.06**	**0.000<**	**(11)**
	2	0.942	(5)	2.093	(4)	-1.5E-11	(3)	6.63	(4)	-6.1E-11	(3)	1094.96	0.000<	(19)
	3	0.971	(2)	1.484	(1)	-2.8E-12	(2)	4.55	(1)	-1.1E-11	(2)	1104.13	0.000*<	(8)
	4	0977	(1)	1.625	(2)	-0.02	(4)	4.82	(2)	-0.1	(4)	2806.05	0.000<	(13)
	5	0.945	(4)	2.439	(5)	-0.20	(5)	7.23	(5)	-0.83	(5)	1146.22	0.000<	(24)

*There are meaningless parameter/parameters in these models

R^2_{adj}: Adjusted Coefficient of Determination; RMSE: Root Mean Squared Error; MAPE: Mean Absolute Percentage Error; TPE: Total Percentage Error; R: Range; ∑R: Total range

Table 5. Model coefficients by species

		Tree species					
		O. spruce		S. pine		E.B. fir	
Model	Parameter	Value	p	Value	p	Value	p
1	b_0	0.798	0.257*	1.252	0.093*	**1.781**	**0.000**
	b_1	0.833	0.000	0.823	0.000	0.830	0.003
2	b_0	-46.861	0.000	-58.376	0.000	-43.842	0.000
	b_1	21.861	0.000	25.211	0.000	21.124	0.000
3	b_0	1.621	0.323*	**-4.187**	**0.020**	-2.004	0.077*
	b_1	0.773	0.000	**1.170**	**0.000**	1.120	0.000
	b_2	0.001	0.577*	**-0.05**	**0.001**	-0.005	0.000
4	b_0	**0.988**	**0.000**	0.896	0.000	1.050	0.000
	b_1	**0.959**	**0.000**	0.988	0.000	0.952	0.000
5	b_0	3.968	0.000	4.183	0.000	3.995	0.000
	b_1	-20.923	0.000	-26.057	0.000	-20.261	0.000

*Shows meaningless parameter

O.spruce: Oriental spruce; S.pine: Scots pine; E.B. fir: Eastern Black Sea fir

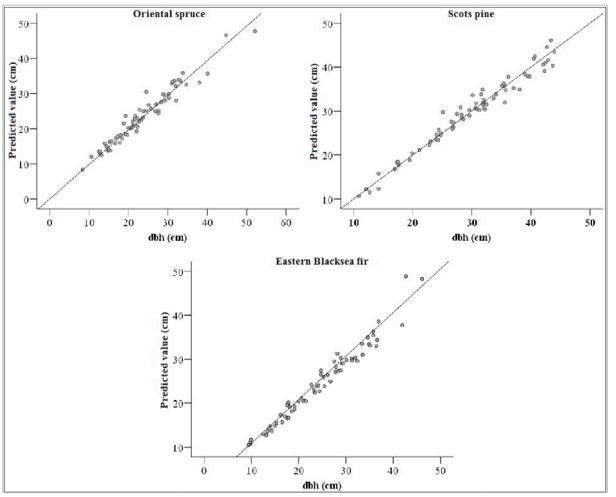

Figure 1. Relationship between model results and measured values

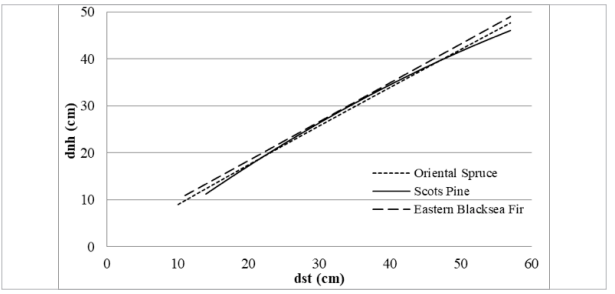

Figure 2. DST – DBH relation for three species according to model results
DST: diameter at stump height; DBH: diameter at breast height

Table 6. Models of relationship between DST and DBH according to tree species

Tree species	Model
O. spruce	$dbh = 0.988 \times dst^{0.959}$
S. pine	$dbh = -4.187 + 1.170 \times dst - 0.05 \times dst^2$
E.B. fir	$dbh = 1.781 + 0.830 \times dst$

O.spruce: Oriental spruce; S.pine: Scots pine; E.B. fir: Eastern Black Sea fir

variability of the DBH in SoPsFb or PsSoFb triple mixed stands by 95.2% in Oriental spruce, 96.5% in Scots pine and 96.4% in Eastern Black sea fir.

The most successful models, which were determined at the results of sorting according to error values, are given below with their coefficients (Table 6). Additionally the relationship between the results of these models and their measured values are shown in Figure 1 and also the graphics of these models in Figure 2.

The distributions of standardized residuals, which are the difference measured between predicted values obtained from the selected models and the observed values, are shown in Figure 3 and also the distributions according to standardized predicted values of standardized residuals are shown in Figure 4.

CONCLUSION

As a result of tests and calculated error criteria, the models which have a suitable reliability level for fully stocked SoPsFb and PsSoFb triple mixed stands in Artvin were obtained. The

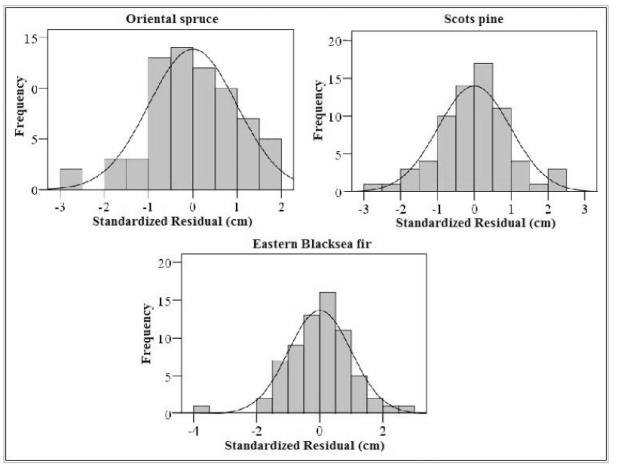

Figure 3. Distribution of standardized residuals for three species

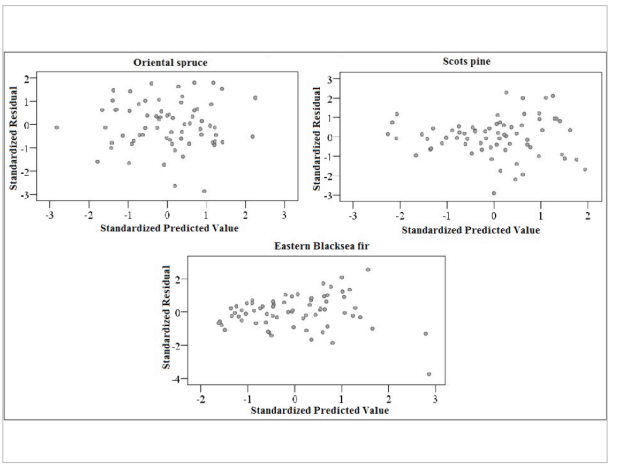

Figure 4. Distribution of standardized residuals according to standardized predicted values

Table 7. Diameters at breast height (DBH) corresponding to the diameters at breast height (DST) for O. spruce, S. pine and E.B. fir

	O. spruce	S. pine	E.B. fir		O. spruce	S. pine	E.B. fir
dst (cm)		dbh (cm)		dst (cm)		dbh (cm)	
10	9.0	-	-	34	29.0	29.7	30.0
11	9.8	-	10.9	35	29.8	30.6	30.8
12	10.7	-	11.7	36	30.7	31.4	31.7
13	11.6	-	12.6	37	31.5	32.2	32.5
14	12.4	11.2	13.4	38	32.3	33.0	33.3
15	13.3	12.2	14.2	39	33.1	33.8	34.1
16	14.1	13.2	15.1	40	33.9	34.5	35.0
17	14.9	14.2	15.9	41	34.7	35.3	35.8
18	15.8	15.2	16.7	42	35.5	36.0	36.6
19	16.6	16.2	17.5	43	36.4	36.8	37.5
20	17.5	17.2	18.4	44	37.2	37.5	38.3
21	18.3	18.1	19.2	45	38.0	38.2	39.1
22	19.1	19.1	20.0	46	38.8	38.9	40.0
23	20.0	20.0	20.9	47	39.6	39.6	40.8
24	20.8	21.0	21.7	48	40.4	40.3	41.6
25	21.6	21.9	22.5	49	41.2	41.0	42.4
26	22.4	22.8	23.4	50	42.0	41.7	43.3
27	23.3	23.7	24.2	51	42.8	42.3	44.1
28	24.1	24.6	25.0	52	43.6	43.0	44.9
29	24.9	25.5	25.8	53	44.4	43.6	45.8
30	25.7	26.4	26.7	54	45.2	44.3	46.6
31	26.6	27.2	27.5	55	46.0	44.9	47.4
32	27.4	28.1	28.3	56	46.8	45.5	48.3
33	28.2	28.9	29.2	57	47.6	46.1	49.1

O.spruce: Oriental spruce; S.pine: Scots pine; E.B. fir: Eastern Black Sea fir; dbh: diameter at breast height; dst: diameter at stump height

adjusted coefficients of determination for the models obtained are above 95% and are similar to other studies. These developed models will serve as a tool for detecting the DBH values of Oriental spruce, Scots pine or Eastern Black sea fir which of felled trees from SoPsFb or PsSoFb triple mixed stands. Thus, the volume of felled trees will be able to be calculated. Lastly, through these models, the DBH-DST table, which is valid separately for the three types, was also created (Table 7). These models and the created table can be used in the range of 9-57 cm for Oriental spruce, 14-57 for Scots pine, and 11-57 cm for Eastern Black sea fir in the Oriental spruce, Scots pine and Eastern Black sea fir for triple mixed stands which are spread in the region of Artvin in Turkey. Apart from that, other models having a meaningful parameters will be alternatively preferred for stands where the selected models do not give proper results.

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Original Article

Physical and mechanical properties of wood impregnated with quebracho and boron compounds

Kebrako ve borlu bileşikler ile emprenye edilen ahşap malzemenin fiziksel ve mekanik özellikleri

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ABSTRACT

In recent years, alternative natural impregnation materials are being sought as substitutes for chemical impregnation materials used for conserving wooden materials; therefore, such natural materials have acquired significance in the forest products industry. In this study, the boron compounds borax and boric acid, which are abundant raw materials in Turkey, and quebracho, a natural impregnation material, were used. For the impregnation process, aqueous solutions of 1%, 3%, and 5% boron compounds were utilized. The test samples were impregnated according to ASTM D 1413-76 principles. Oven-dry density, retention rate, bending strength, elastic modulus, compression strength parallel to fibers, bonding strength parallel to fibers, and screw holding strength tests of the impregnated samples were measured, and the results were compared with those of control samples. The retention, oven-dry density, comprehension parallel to fibers, and screw holding strength of the samples were found to be higher than those of the control samples, whereas bending strength, elastic modulus, and bonding strength parallel to fibers were lower. After impregnation, it was observed that there was a decline in strength values and a rise in retention rates with the increase in the concentrations of boron compounds. The values for samples impregnated with borax were higher than those for the samples impregnated with boric acid.

Keywords: Boron compounds, impregnation, natural impregnation materials, oriental beech, quebracho

ÖZ

Son yıllarda orman ürünleri sanayisinde önemli bir yer işgal eden ahşap malzemelerin korunmasında kullanılan kimyasal emprenye maddelerinin yerine alternatif doğal emprenye maddeleri aranmaktadır. Bu çalışmada, Ülkemizde hammadde olarak bol bulunan borlu bileşikler (boraks ve borik asit) ile doğal emprenye maddelerinden olan kebrako kullanılmıştır. Emprenye işleminde borlu bileşiklerin %1, 3 ve 5'lik sulu çözeltileri kullanılmıştır. Deney örneklerinin emprenyesi ASTM D 1413-76 esaslarına göre yapılmıştır. Emprenyeli örneklerin tam kuru yoğunluk, retensiyon miktarı, eğilme direnci, elastikiyet modülü, liflere paralel basınç direnci, liflere paralel yapışma direnci ve vida tutma direnci testleri yapılarak kontrol örnekleri ile kıyaslanmıştır. Sonuç olarak, yapılan testler sonucunda retensiyon, tam kuru yoğunluk, liflere paralel basınç ve vida tutma dirençleri kontrol örneklerinden daha yüksek çıkmıştır. Eğilme direnci, elastikiyet modülü ve liflere paralel yapışma dirençleri ise kontrol örneklerinden daha düşük çıktığı tespit edilmiştir. Emprenye sonrası deney örneklerinde borlu bileşiklerin konsantrasyonları arttıkça direnç değerlerinde düşüş, tam kuru yoğunluk ve retensiyon miktarlarında ise artış görülmektedir. Borlu bileşiklerden boraks ile emprenye edilen örneklerde değerler borik asit ile emprenye edilenlerden daha yüksek çıkmıştır.

Anahtar Kelimeler: Borlu bileşikler, doğal emprenye maddeleri, doğu kayını, emprenye, kebrako

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INTRODUCTION

Wood as used in various areas is the only natural renewable raw material that doesn't damage the environment. The physical and mechanical properties of wood, its anatomic structure and chemical composition enable it to be used in a wide variety of products (Bozkurt and Erdin, 1997). Use

of wooden materials has been sustained since the dawn of humankind. An organic living creature, wood is utilized in many areas and its use is increasing day by day. Some of the reasons for the use of wood in so many areas are: its high strength despite its lightness, its anatomic structure, its easily processable nature, its ability to hold screw and nail (Aslan, 1998; Hafızoğlu et al., 1994; Baysal, 1994). In addition to its many favourable features as stated above, it has certain undesirable properties. As an organic material, its inflammability, its natural vulnerability to destruction by insects and to decomposition by fungus, the fact that its size changes according to equilibrium humidity depending on the relative humidity & temperature of the weather, and its fading colour under the sun's rays are considered to be undesirable features of the wooden material.

Mankind understood that wooden materials need to be preserved in their usage areas centuries ago and thereby they started to take various precautions for this purpose. Archaeological excavations and inspections carried out on the ribs of sunken ships have revealed that the partial carbonization of the wood was one of the first precautions that was taken to preserve wooden materials 4000 years ago (Huş, 1977). Even though some wooden materials possesses a natural durability and show stability and strength in the face of external effects thanks to their own anatomic and chemical structure, they cannot endure outside weather conditions for a long period of time. Therefore, wooden materials are impregnated with several chemical substances, surface treatments are applied with various layering and preservative substances appropriate for usage area, or it is protected with non-chemical constructive precautions (natural, biological and alternative wood conservation) (Kurtoğlu, 1984). According to usage area, some processes like drying, impregnation and surface treatments are applied to increase the usage life of wooden materials by making them more durable against physical, chemical and biological factors. The most commonly applied protection method for wooden materials is to treat them with an appropriate chemical and method according to usage area Şen and Hafızoğlu, 2001). In the event that the wooden material is used without treating with such chemical substances with respect to its usage area, it is damaged due to impacts like insect, fungi, dampness, fire etc. Thereupon, it requires repair, replacement and maintenance expense to avoid the early end of its economic life (Richardson, 1987; Yalınkılıç et al., 1995). With the intention of preventing the destruction of the wood by biological pests, it has been determined that impregnation with boron compounds will extend usage life with experiments (Winandy, 1990).

It is agreed that Boron compounds are the only impregnation material that demonstrates both insecticide and fungicide properties against insects and fungi destroying wooden materials. Boron compounds can also be used effectively against pests like termites and insects at the same time. When compared with traditional impregnation substances, boron compounds are responsible for lower levels of environmental damage, causing very small amounts of acute toxicity. Boron compounds are no more toxic than common salt to humans and animals, and they are colourless and odourless. They don't have corrosive effects and they are resistant to combustion. Nowadays, boron compounds are accepted as one of the safest chemicals utilized as a preservative impregnation substance. Since their negative effects on humans and environment are at minimum levels, their use is gaining more and more importance. Because they have less toxic properties than other impregnation materials containing heavy metals, boron compounds are considered to be the most significant impregnation materials of the future. Apart from their activities against pests like fungi and termites, usage areas of boron compounds multiply thanks to increasing the resistance to combustion (Lloyd, 1998; Kartal and Green, 2002; Yaşar and Atar, 2017).

Some boron compounds used in both the commercial sense and scientific testing with the purpose of wood protection, are boric acid, borax, sodium perborate, magnesium borate, ammonium borate, diammonium octaborate, triethyl borate, ammonium pentaborate, zinc fluorate, ammonium fluoborate, disodium octaborate and copper metaborate (Karayazıcı et al., 1980). Boron compounds are applied to solid wooden materials in impregnation processes with many compressed and unpressurised procedures.

There are tannins which have the potential to be used as biopreservatives. The word tannin is a rather broad term and covers compounds in various chemical compositions. Tannins have significant importance among phenolic substances which make up of 20-30% of wood. The most important part of phenolic substances is made up of a system known as lignin. Tannins are phenolic compounds that can be dissolved in phlobaphene and are a coloured substance, and lignin can be dissolved in water and organic solvents (Hafızoğlu, 1984). Tannins are amorphous substances and they also known as tannic acid. Their colours vary between light straw and dark mahogany. Tannins are water-soluble polyphenolic compounds, which are found intensely in high-rise structured trees like chestnut, oak, acorn, and sumac, their chemical structure varies widely and their molecular weight can reach up to 20000 daltons. Tannins, which can be found in bark, roots, leaves, fruit and seed parts of plants, display visual characteristics ranging from light yellow to white in colour, from shiny to matt and they have loose structured acrid tasting compounds (Khanbabaee and Ree, 2001). Tannins are found in many barks, some coniferous tree types, chestnut and oak trees. Tannins have protective features against fungal diseases of wood (Kırcı, 2000).

Impregnation is the process applied by various methods with the purpose of protection of wooden material, an anisotropic material, against numerous biotic and abiotic issues (Bozkurt and Erdin, 1997). The success and protection level of the impregnation process depends on the net dry impregnations substance adhesion to the wood (retention) and the penetration depth of the impregnation substance in the wood, along with the impregnation substance and the characteristics of the wood (Baysal et al., 2003). The natural durability classifications of wooden material according to weight loss: less than 5 years are referred as nondurable, between 5 and 10 years are less durable,

between 10 and 15 years are moderate durable, between 15 and 20 years are durable, and 25 years and more are categorized as very durable class (Bozkurt et al., 1993). On the determination of this duration, the chemicals used in the impregnation process are as important as the properties of the wooden material. Each chemical used has different characteristics and impact areas. Therefore, the most suitable impregnation material for each condition should be chosen bearing in mind the impacts which will be encountered in the usage locations of the wooden materials (Yalınkılıç et al., 1995).

The purpose of this study, is to attempt to reduce the damage and adverse affects occurring in the environment as a consequence of impregnation processes utilizing boron compounds through the use of natural impregnation materials which do not harm nature.

MATERIALS AND METHODS

Material

In this study, the oriental beech, which is frequently used in indoor applications and has a wide distribution in Turkey, is used as a sample material. The oriental beech used in the preparation of samples was grown in the province of Gümüşhane in the Kürtün district in Alacadağ at about 1200 m altitude. Test samples were prepared from parts of the wood without defects (paying attention to fiber direction) and they were then dried until they reached air-dried moisture gradient (12%).

Quebracho, which contains plenty of tannins and is readily available commercially, is used as a natural impregnation substance. Quebracho extract is dark coloured and contains tannin in a ratio of 80% (Figure 1). The colour darkens with contact with light. Quebracho settles quite easily. Its natural pH value is 4,9 (URL-1, 2015).

Table 1. Size and standards of test samples used for determining of the physical properties

Number	Test Name	Dimensions (mm)	Standard
1	Retention	20 x 20 x 30	[1]ASTM D 1413–07
2	Oven-Dry Density	20 x 20 x 30	[2]TS2472

[1]ASTM: American society for testing and materials; [2]TS: Turkish standards

Quebracho was used in the impregnation process and the solution was prepared first. The solution was prepared by dissolving 5% mineral tannin in water with respect to weight quantity. The impregnation mix was prepared by adding boron compounds (in a concentration suitable for the conducted impregnation process), to the solution. Boron compounds borax (B) and boric acid (BA) were used in aqueous solutions in concentrations of 1, 3 and 5%. In the impregnation process, mixtures of natural impregnation materials and boron compounds were applied. The boron compounds used in the study was supplied by Kırka, Bigadiç and Emet facilities affiliated to Eti mining works.

Method

The Preparation of Samples

Oriental beech (*Fagus orientalis* L.) samples are prepared in accordance with TS standards at the Gümüşhane University Gümüşhane vocational school of higher education furniture and decoration workshop. For each test (retention, oven dry density, bending strength, elastic modulus, bonding strength parallel to fibers, screw holding strength, compression strength parallel to the fibers), 10 samples for each were prepared to use in the study with a total of 420 samples. Test samples were prepared, paying attention to fiber direction and that there weren't any flaws in the wood samples. Any samples not in accordance with required standards or having flaws were isolated and excluded. In this way, the aim was to prevent any errors that might have originated from flaws in the wood samples.

Applied test standards and dimensions of wooden material used in the determination of physical features are given in Table 1 and sample numbers tested are given in Table 2.

Applied experiment methods and dimensions of wooden material used in the determination of mechanical properties are given in Table 3 and sample number is given in Table 4.

Figure 1. Extract and wood of quebracho

Table 2. Amount of test samples used for determining of the physical properties

Physical Properties	Wood Species	Natural Impregnation Materials	Boron Compounds	Concentration (%)	Sample Numbers
Retention	Oriental beech	Qebracho	Boraks	1	p.p.[1]xw.s.[2].xn.i.m.
Oven-Dry Density			Borik asit	3	[3]xb.c[4].xc[5]xr[6]
				5	2x1x1x2x3x10=120

[1]p.p.: physical properties; [2]w.s.: wood species; [3]n.i.m.: natural impregnation materials; [4]b.c.: boron compounds; [5]c: concentration; [6]r: repetition

Table 3. Size and standards of test samples used for determining the mechanical properties

Number	Test Name	Dimensions (mm)	Standard
1	Bending Strength	20 x 20 x 360	TS 2474
2	Elastic Modulus	20 x 20 x 360	TS 2478
3	Compression Strength Parallel to the Fibers	20 x 20 x 30	TS 2595
4	Screw Holding Strength Tests	50 x 50 x 20	TSEN 13444
5	Bonding Strength Parallel to Fibers	20 x 15 x 150	[1]DIN 53225

[1]DIN: Deutsches institut für normung

Table 4. Amount of test samples used for determining the mechanical properties

Mechanical Properties	Wood Species	Natural Impregnation Materials	Boron Compounds	Concentration (%)	Sample Numbers
Bending Strength	Oriental beech	Qebracho	Borax	1	m.p.[1]xw.s.[2].xn.i.m.
Elastic Modulus			Boric Acid	3	[3]xb.c[4].xc[5]xr[6]
Compression Strength P.F.				5	5x1x1x2x3x10= 300
Screw Holding Strength					
Bonding Strength P.F.					

[1]m.p.: mechanical properties; [2]w.s.: wood species; [3]n.i.m.: natural impregnation materials; [4]b.c.: boron compounds; [5]c: concentration; [6]r: repetition

Table 5. Amount of impregnate

Wood Species	Natural Impregnation Materials + Boron Compounds + Concentration	Impregnation Number
Oriental beech	Qebracho + Borax + 1%	1
	Qebracho + Borax + 3%	1
	Qebracho + Borax + 5%	1
	Qebracho + Boric Acid + 1%	1
	Qebracho + Boric Acid + 3%	1
	Qebracho + Boric Acid + 5%	1

Impregnation Process

In this study, a total 6 impregnation process were conducted (Table 5). Cell method was chosen in compliance with ASTM D 1413 principles.

The samples prepared in impregnation process first were subjected to pre-combustion for 30 minutes in the impregnation mechanism, later to impregnation treatment for 30 minutes under pressure of 10 bars (Figure 2). The samples extracted from the impregnation mechanism were kept at a temperature of 20±2 ˚C and in a relative humidity of 65% for conditioning for a week and ensured to reach an equilibrium humidity of 12%. For the determination of retention and oven dry density, the samples were brought to oven dry condition again after impregnation and the essential measurements were carried out. Afterwards, the physical and mechanical tests were carried out on the oven dry samples. After impregnates samples, control samples were subjected to testing and the results were compared statically (Adanur, 2015).

The Determination of Physical Properties

Retention Rate

The impregnation of test samples was carried out according to ASTM D 1413–07 principles. The retention rate (R, kg/m^3) of test samples was calculated using the following equation (Bektaş, 1997):

$$R = \frac{G \times C}{V} \times 10^3 \ (kg/m^3)$$


Figure 2. Impregnating device employed in the impregnation process

In this equation;
G = T2 - T1
T1 : the weight of test samples before impregnation (g)
T2 : the weight of test samples after impregnation (g)
V : Sample volume (cm^3)
C : solution concentration (%)

The Determination of Oven-Dry Density

In the experiment to identify oven-dry density, the principles stated in TS 2472 standard were taken into consideration, wooden materials were prepared in sizes of 20x20x360 mm in accordance with the standard, then they were put in the drying oven. The temperature was gradually raised to 50 ºC, 75 ºC and 103 ± 2 ºC, the samples were kept until their weight reached stability and the samples were brought to an oven dry condition. The samples taken from the drying oven were permitted to cool down by placing in the desiccator with silicon dioxide (silica gel), weighed in an analytic scale with a sensitivity of ±0.01 g, (M_0) value and their sizes were measured using a digital caliper with a sensitivity of ±0.01 g, and their volumes were calculated. The oven dry densities (D_0) were calculated using the equation below (Bektaş, 1997).

$$D_o = \frac{M_o}{V_o} \ (g/cm^3)$$

In this equation;
D_0 : The density in oven dry humidity (g/cm^3)
M_0 : The weight of sample in oven dry humidity (g)
V_0 : The volume of sample in oven dry humidity (cm^3)

The Determination of Mechanical Properties

The Determination of Bending Strength

For determination of bending strength, the principles stated in TS 2474 (1976) standard were followed and the test samples were prepared in 20x20x360 mm sizes in accordance with these standards. The dimensions of the test samples were determined by measuring with a digital caliper with a sensitivity of ±0.01 g. The distances between the midpoints of the cylindric fulcrums, where the test items were placed, were set at 15 times (15x20 mm = 300 mm) the thickness of the test item. Loading was conducted uniformly with a constant fixed speed on the surface of the test item. The loading speed was set to 6 mm/min. Test speeds were set so that the test items would break after 1.5 ± 0.5 minutes starting from loading on test items. The force measurements (Pmax) on the instant of breaking point were read and bending strength (σE) was calculated according to the formula below (Bektaş, 1997; Kasal et al., 2010).

$$\sigma_g = \frac{3.P_{max}.I}{2.b.h^2} \ (N/mm^2)$$

In this equation;
Pmax : The pressure applied at breaking point (N)
I : The space between fulcrums (mm)
b ; The width of test specimen vertical to annual rings (mm)
h ; The thickness of test specimen tangent to annual rings (mm).

When the static bending strength needed to be adjusted to a 12% moisture value, this figure was calculated using the following equation.

$$\sigma_{b12} = \sigma_g \times \left[1 + \frac{\alpha}{W - 12}\right] \ (N/mm^2)$$

In this equation;
α : 0.04 (correction factor for humidity amount)
W : the humidity amount for wood calculated in accordance with TS 2471

The Determination of Elastic Modülüs

In this step, the elastic modulus for the difference of force applied to elastic deformation area (ΔF) was calculated using the difference between deflections in samples (Δf) by means of the equation below (Bektaş, 1997).

$$E = \frac{\Delta . F . L^3}{4 . b . h^3 \Delta f} (N/mm^2)$$

In this equation;
ΔF : the force equal to the difference between the arithmetic means of the lower and upper limits of loading at the elastic deformation area (N)
L ; The space between fulcrums (mm)
Δf : The deflection in net bending area, the difference between arithmetic means of deflection results measured at the lower and upper limits of loading (mm)
b ; Section width of test item (mm)
h ; section thickness of test item (mm)

When the pressure strength needed to be adjusted to a 12% moisture value, this figure was calculated using the following equation.

$$E_{12} = E \times \left[1 + \frac{\alpha}{W - 12}\right] (N/mm^2)$$

In this equation;
α : 0.02 (correction factor for the humidity amount)
W : the humidity value for wood calculated in accordance with TS 2471

The Determination of Compression Strength Parallel to the Fibres

TS 2595 (1976) was the basis for determining compression strength parallel to the fibres. Control and test samples were prepared from wooden material of the dimensions 20x20x30 mm. Before the experiment, the cross-sectional area where the force was to be applied was measured at 0.01 mm sensitivity (axb), the maximum force at breaking point (Pmax) was determined and the compression strength was calculated by the following formula (Bektaş, 1997).

$$\sigma_{w//} = \frac{P_{MAX}}{a . b} (N/mm^2)$$

In this equation;
σ w// : Compression strength parallel to the fibres (N/mm^2)
Pmax : The maximum load (N)
a and b : Cross-sectional dimensions of the test piece (mm^2)

When the pressure strength needed to be adjusted to a 12% moisture value, this figure was calculated using the following equation.

$$\sigma_{12} = \sigma_w \times \left[1 + \frac{\alpha}{W - 12}\right] (N/mm^2)$$

In this equation;
α : 0.05 (correction factor for the moisture value)
W : the moisture value of wood calculated in terms of TS 2471

The Determination of Screw Holding Strength

TS EN 13446 was taken as the basis for determining the screw holding strength. The screw holding strength was conducted in the radial direction. Wooden materials of dimensions 50x50x20 mm were prepared from the test samples. The midpoints of the cross sections of the prepared test samples were determined and screws were inserted in such a way so that 2/3 of the 35 mm screws would enter the wood. In this study, according to the principles frequently favored in the furniture industry and specified in TS 431, screws measuring 3.5x50 mm, made from low carbon steel, with a flat countersunk head, with a star twist and helical gear, were used. The thickness of the test pieces and the depth of penetration were determined by measuring with ± 0.1 mm sensitivity according to EN 325 (Perçin and Ayan, 2012).

The Determination of Bonding Strength Parallel to Fibres

The test specimens used in the test for bonding strength parallel to fibres were bonded with a high quality PVA based and D2 norm wood adhesive, resistant to outdoor conditions. The glue used was polyvinyl acetate (PVA) based - a white glue which is a strong glue that can be used in any kind of wood and becomes transparent when it is dry. It is in D2 norm and it is resistant to medium levels of humidity. It can be diluted with water, is ideal for framing works and has excellent adhesion strength. It is used in hardwoods, MDF, chipboard and any kind of woods where the purpose is to bond it to other materials of its kind. Approximately 10 minutes of application time is needed to ensure adequate adhesion (URL-2).

TS EN 205 was taken as the basis for determining the bonding strength parallel to fibres. The test specimens were prepared from wooden materials with dimensions of 20x15x150 mm. A constant pulling force was applied, homogeneous to the cross section of prepared samples, for 1.5-2 minutes. The maximum force (F) at the moment of breaking was determined by maintaining the application of force until the sample broke. Adhesion strength (σY) was calculated as follows (Uysal and Kurt, 2005).

$$\sigma_Y = \frac{F}{A} = \frac{F}{a \times b} (N/mm^2)$$

In this equation;
σ Y : bonding strength (N/ mm^2)
F : force at the moment of breaking(N)
A : bonding area (mm^2)
b : width of bonding surface (mm)
a : the length of the bonding surface (mm)

RESULTS AND DISCUSSION

Physical Properties

An analysis from statistical information is given average values are in Table 6, an analysis of the variance from statistical information on the determination of retention and oven dry density quantities of the experimental samples is given in Table 7, the least significant difference (LSD) is in Table 8, and graphical representations of results are in Figure 3.

As shown in Table 6, the highest average retention rate of samples in an air-dried state (12%) in test samples was 194.80 kg/m^3

in samples impregnated with a 5% borax solution. It was found that the retention rate increased as the boron compound concentration increased in all impregnation processes that were carried out. In test specimens impregnated with quebracho - which is one of the natural impregnations - the density value in oven dry conditions was found to be 0.57 g/cm^3 in the impregnation with the highest 1% borax. The oven dry density value of the control samples was identified as 0.53 g/cm^3. Full dry density values of the boron compounds impregnated with boric acid solutions seemed to be lower than those impregnated with borax solutions. It was found that as the concentration of boron compound increased in the impregnation solution, the oven dry density values increased.

In Toker's (2007) study, he impregnated oriental beech woods with various concentrations of borax and boric acid. Retention rates were found out to be 4.95 kg/m^3 with 1% boric acid concentration, 13.86 kg/m^3 with 3% boric acid, 26.69 kg/m^3 with 5% boric acid, 5.03 kg/m^3 with 1% borax, 15.20 kg/m^3 with 3% borax and 25.22 kg/m^3 with 5% borax. In this study also, the concentration of the boron compound and the retention rate increase in direct proportions. The results we obtained are consistent with this study. In this study Peker et al., 1999 found the retention rate to be 10.57 kg/m^3 in samples impregnated with (borax + boric acid) by impregnating oriental beech woods with boron compounds, phosphorus compounds, ammonium compounds and organic solvents.

Table 6. Amount of some physical properties of beech wood

		Boron Compounds						
		Borax			Boric Acid			
Impregnation Materials	S.S.	1%	3%	5%	1%	3%	5%	Control
Qebracho		Retention Amount (kg/m^3)						
	M	29.00	96.33	194.80	5.39	45.96	127.56	-
	Sx	3.10	11.53	13.76	2.51	4.36	12.08	-
		Oven-Dry Density (g/cm^3)						
	M	0.57	0.56	0.55	0.53	0.55	0.56	0.53
	Sx	0.04	0.04	0.03	0.04	0.04	0.02	0.03

S.S.: Statistical Symbol, M:Mean, Sx:Standard Deviation

Table 7. Multivariate analysis of variance for the determination of the physical properties of beech wood

		Retention Amount			Oven-Dry Density			
Source of Varience	F. D.	S. S.	S. M.	F. V.	F. D.	S. S.	S. M.	F. V.
Boron Compounds	1	33244.60	33244.60	396.36*	1	0.0034	0.0034	2.67
Solution Concentration	2	211670.31	105835.16	1261.82*	2	0.0007	0.0004	0.29
bc*c	2	4840.08	2420.04	28.85*	2	0.0054	0.0027	2.15
Error	54	4529.25	83.88		54	0.0682	0.0012	
Total	59	254284.24			59	0.0777		

F.D.: Degrees of Freedom; S.S.: Sum of Squares; S.M.: Mean of Squares; F.V.: F Value; *, **: 1% and 5% significance level, respectively

Table 8. Test results of LSD with physical properties of variable of impregnating agents, boron compounds and solutions concentrations

		Retention Amount (kg/m^3)		Oven-Dry Density (g/cm^3)	
Factor	Material	[1]M	[2]LSD	M	LSD
Boron Compounds	Borax	106.71 a	4.7409	0.56 a	0.0184
	Boric Acid	59.64 b		0.54 a	
Solution Concentration	1%	17.20 [3]c	5.8064	0.54 a	0.0225
	3%	71.14 [3]b		0.55 a	
	5%	161.18 [3]a		0.55 a	

[1]M: Mean; [2]LSD: Least significant difference; [3]a,b,c: Mean grouping

In his work, Gür (2003) impregnated the samples, which were prepared from scots pine and red pine woods, with the vacuum pressure technique using Tanalith C and vacsol WR impregnation materials. After the impregnation process, the samples' specific weight were found to increase. By impregnating scots pine and oriental beech woods with certain impregnation substances, the changes that occur in oven dry and air dry densities were investigated. As a result, the air dry density of scots pine was determined to be affected most in vacsol, styrene + MMA, and isocyanate while the oven air density of scots pine was determined to be affected most by vacsol, isocyanate, paraffin + boric acid + borax and isocyanate (Örs et al., 1999). It is observed in literature that impregnated materials increase the density of wooden materials. Studies on beech species around the world indicate that (according to the density classes), air-dry density is between 0.50 – 0.69 g/cm^3 and that the beech enters the group of trees in medium density (Bozkurt and Erdin, 1990). In this study, it was determined that full dry density findings values were close to those in literature.

Figure 3. The average values of physical properties of beech wood impregnated with quebracho and boron compounds

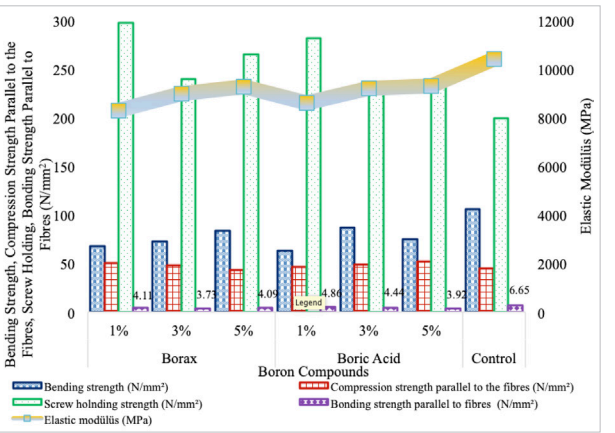

Figure 4. The average values of mechanical properties of beech wood impregnated with quebracho and boron compounds

Table 9. Amount of some mechanical properties of beech wood

Impregnation Materials	S.S.	Boron Compounds						
		Borax			Boric Acid			Control
		1%	3%	5%	1%	3%	5%	
Qebracho		Bending Strength (N/mm²)						
	M	67.40	72.80	83.20	62.60	86.70	75.10	106
	Sx	8.68	9.05	9.43	13.21	12.03	13.73	15.5
		Elastic Modulus (MPa)						
	M	8293	8968	9257	8596	9187	9283	10400
	Sx	821	913	935	1012	1183	1459	1460
		Compression Strength Parallel to the Fibers (N/mm²)						
	M	50.57	48.08	43.42	46.37	48.41	52.07	44.39
	Sx	1.66	2.93	6.09	5.59	2.30	1.97	3.74
		Screw Holding Strength Tests (N/mm²)						
	M	297.40	239.30	264.90	281.80	235.70	234.30	199.36
	Sx	40.35	37.56	11.43	19.95	27.78	50.12	16.13
		Bonding Strength Parallel to Fibers (N/mm²)						
	M	4.11	3.73	4.09	4.86	4.44	3.92	6.65
	Sx	1.32	0.95	0.57	0.91	0.56	1.16	1.95

S.S.: Statistical Symbol; M:Mean; Sx: standard deviation

As a result of the variance analysis conducted, it was determined that the oriental beech samples impregnated with quebracho and boron compounds had a 1% significance level difference between retention rate and boron compounds and solution concentration (Table 7).

As can be seen from Table 8, the highest retention amount of the physical properties in the oriental beech was found 106.71 kg/m^3 in borax among boron compounds and to be 161.18 kg/m^3 in 5% concentration among solution concentrations. The highest oven dry density amount was found 0.56 g/cm^3 in borax among boron compounds and to be 0.55 g/cm^3 in samples impregnated at 3% and 5% among solution concentrations.

In beech samples impregnated with quebracho from natural impregnation substances, it is seen that the retention rates of boron compounds impregnated with borax are higher than boric acid. It has been observed that as the concentration of the boron compounds increases in all impregnation processes, the retention rate also increases. The highest retention rates were obtained at 5% concentration. Oven dry density values were found to be higher than those of control samples without im-

Table 10. Multivariate analysis of variance for the determination of the mechanical properties of beech wood

	Bending Strength (N/mm^2)				Elastic Modulus (MPa)			
Source of Varience	F. D.	S. S.	S. M.	F. V.	F. D.	S. S.	S. M.	F. V.
Boron Compounds	1	1.67	1.67	0.01	1	484201.7	484201.7	0.24
Solution Concentration	2	2787.63	1393.82	11.48*	2	7435143.3	3717571.7	1.82
bc*c	2	1407.63	60.43	0.01*	2	198723.3	99361.7	0.05
Error	54	6559.00	121.46		54	110080990.0	2038536.9	
Total	59	10755.70			59	118199058.3		
	Compression Strength Parallel to the Fiber				Screw Holding Strength Tests (N/mm^2)			
Boron Compounds	1	38.08	38.08	1.38	1	4133.40	4133.40	0.94
Solution Concentration	2	5.51	2.75	0.10	2	29738.80	14869.40	3.39**
bc*c	2	424.78	212.39	7.68*	2	1830.00	915.00	0.21
Error	54	1492.64	27.64		54	415117.00	3843.68	
Total	59	1961.01			59	518697.70		
	Bonding Strength Parallel to Fibers							
Boron Compounds	1	2.77	2.77	1.94				
Solution Concentration	2	2.64	1.32	0.92				
bc*c	2	2.76	1.38	0.96				
Error	54	77.19	1.43					
Total	59	85.36						

F.D.: Degrees of Freedom; S.S.: Sum of Squares; S.M.: Mean of Squares; F.V.: F Value; *, **: 1% and 5% significance level; respectively

Table 11. Test results of LSD with mechanical properties of variable of impregnating agents, boron compounds and solutions concentrations

		Bending Strength (N/mm^2)		Elastic Modülüs (MPa)		Compression Strength Parallel to the Fiber (N/mm^2)		Screw Holding Strength (N/mm^2)		Bonding Strength Parallel to Fibers (N/mm^2)	
Factor	Material	X_{ort}	LSD	X_{ort}	LSD	X_{ort}	LSD	X_{ort}	LSD	X_{ort}	LSD
B. C.	Borax	74.47 a	5.71	8839 a	739.1	47.36 a	2.72	267 a	34.29	3.98 a	0.62
	Boric Acid	74.80 a		9019 a		48.95 a		251 a		4.41 a	
S. C.	1%	65.00 b	6.99	8445 a	905.2	48.47 a	3.33	290 a	41.99	4.49 a	0.76
	3%	79.15 a		9073 a		48.25 a		250 ab		4.09 a	
	5%	79.75 a		9270 a		47.75 a		238 b		4.01 a	

B. C.: Boron Compounds; S. C.: Solution Concentration; MPa: Megapascal; LSD: Least significant difference; a,b,c: Mean grouping

pregnation. The highest full dry density value was in samples impregnated with 1% borax (Figure 3).

Mechanical Properties

An analysis from statistical information is given mean values in Table 9, variance analysis related to bending strength, elastic modulus, compression strength parallel to the fibres, screw holding strength and bonding strength parallel to fibres are shown in Table 10, LSD test results in Table 11, and graphical representations in Figure 4.

In the impregnated test specimens, the bending strength in the case of air dry (12%) was found to be 86.70 N/mm^2 in samples impregnated with the highest 3% boric acid solution. In the control samples, the bending strength value in the case of air-dry (12%) was found to be 106 N/mm^2. The bending strength of the beech samples impregnated with the boron compound mixture and natural impregnation material was found to be lower than the control samples. In the impregnated test samples, the elastic modulus in the case of air dry (12%) was found to be 9283 MPa in samples impregnated with the highest 5% boric acid solution. In the control samples, the elastic modulus in the case of air dry was found to be 10400 MPa. The maximum value of the compression strength parallel to the fibres was found to be 52.07 N/mm^2 in samples impregnated with 5% boric acid. The compression strength parallel to the fibre values of the impregnated specimens were higher than the control samples. The average screw holding strength value was found to be 297.40 N/mm^2 in samples impregnated with the highest 1% borax. In all of the impregnation processes carried out, screw holding strength of the impregnated samples were higher than the control samples. In the control samples, the average screw holding strength value - in the case of air-dry (12%) - was found to be 199.36 N/mm^2. However, in the bonding strength parallel to fibres it was found to be 4.86 N/mm^2 in samples impregnated with the highest 1% boric acid. In the control samples, the average bonding strength in the case of air dry was found to be 6.65 N/mm^2. In all of the impregnated samples the bonding strength values came out lower than the control samples (Table 9).

Reductions in strength created by impregnation substances are related to their chemical structure and their fixation reactions with wood. The impregnation substances containing acidic chromium have a hydrolytic depletion reaction with wood sugars, thus forcing interaction with the cell wall materials. During this process, which is considered a fixation, metals are reduced to a less water-soluble form by oxidation of cell wall components. However, the temperature applied before impregnation and during the fixation process accelerates these hydrolytic reactions that occur in the wood, leading to increases and decreases in mechanical properties (Temiz et al., 2004).

Toker (2007) impregnated beech wood with different concentrations of borax and boric acid in his work and found that the bending strength decreases as the solution concentration increases. He found that while the average bending strength was 101 N/mm^2 in the non-impregnated control samples, it was 89.34 N/mm^2 in the specimens impregnated with borax solution and the average bending strength perpendicular to the fibres was 88 N/mm^2 in the specimens impregnated with boric acid solution. It has been reported that finding low or high values for bending strength may be due to the different materials used. In literature, studies show that the bending strength of the oriental beech wood varies between 100 and 150 N/mm^2 and the average value is around 120 N/mm^2 (Keskin and Togay, 2003). In this study, the bending strength of non-impregnated control samples was determined to be 106 N/mm^2. This value was found to be in accordance with the literature.

The elastic modulus values of beech wood in literature were found to be as follows: Fagus orientalis (Europe) 16000 MPa (Güler and Bektaş, 2000), 15700 MPa (Bozkurt et al., 2000), 13082 MPa (Malkoçoğlu, 1994) Fagus orientalis (Andirin) 12750 MPa (Güler and Bektaş, 2000), Fagus orientalis (Iran) 11820 MPa (Güler and Bektas, 2000). In this study, elastic modulus of non-impregnated control samples was determined to be 10400 MPa.

The compression strength parallel to fibres values of beech wood were determined to be 57.2 N/mm^2 (Malkoçoğlu, 1994), 60 N/mm^2 (Bozkurt et al., 2000) and 62.9 N/mm^2 (Erdinler, 1999) in different studies conducted in literature. In the control samples, the compression strength parallel to the fibres value in the case of air dry (12%) was found to be 44.39 N/mm^2 - similar to the value in literature. The findings relating to the determination of compression strength parallel to the fibres which we obtained are similar to those in the work of Keskin.

Açıkel (2007) found out that if the screw holding strength is ordered from high to low according to the impregnation substance it is as follows: boric acid, borax, immersol-aqua and that in particular boric acid, borax and a boric acid + borax mixture have a greater effect on screw holding strength than other impregnation substances. According to the test results, the impregnation process increased the screw holding strength. This may be due to the fact that the impregnation substances enter the cell wall cavity in the tree and affect the contact surface area. It is seen that the screw holding performance values of wooden materials with a high density is high in literature. In this work too, the screw holding strengths increased. The screw holding strength of the impregnated beech samples is higher than the non-impregnated control specimens and shows similarities to the studies in the literature.

Altınok and others (2009) in their study found that borax decreased the bonding strength by 15.6% in PVAc glue, 21.5% in UF glue and 37.7% in PU glue. It is seen in studies in literature that there is a decrease in bonding strength in impregnated wooden materials with pressure applied impregnation methods. Many factors influence bonding strength such as the impregnation method, the amount of retention, and the nature of the impregnation material. In his work Rowell (2005) investigated the factors that influence the bonding strength of wooden materials. As a result of the study, it was determined that many factors influence bonding strength however the most signifi-

cant factors were wood, production method, glue and place of use.

As a result of the variance analysis conducted; it was determined that there was a difference of 1% significance between the solution concentration and the boron compounds * concentration in the change in bending strength. There was a 1% significance level difference between the concentration and the boron compounds * concentration at the parallel pressure strength. A difference in 5% significance was found between screw holding strength and solution concentration (Table 10).

The highest bending strength change was obtained as 74.80 N/mm^2 in boric acid for boron compounds and as 79.75 N/mm^2 for samples impregnated at 5% concentration in terms of solution concentration. The highest elastic modulus values were obtained in specimens impregnated with boric acid at 9019 MPa in boron compounds and 5% concentration at 9270 MPa in solution concentration. The highest change in compression strength parallel to fibres was obtained in samples impregnated in 1% concentration with 48.95 N/mm^2 boric acid for boron compounds and with 48.47 N/mm^2 for solution concentration. The highest screw holding strength value was obtained in samples impregnated in 1% concentration with 267 N/mm^2 borax for boron compounds and 290 N/mm^2 for solution concentration. In the impregnated samples, the highest compression strength parallel to fibres values were obtained in 1% concentration with 4.41 N/mm^2 boric acid for boron compounds and with 4.49 N/mm^2 for solution concentration. It has been reported that finding low or high values relating to the determination of these strength values may be due to the difference in the materials used (Table 11).

As can be seen in Figure 4, the bending strength of the beech samples impregnated was found to be lower than the control samples. The average elastic modulus values were lower than the control samples and the increase in the elastic modulus values increased as the solution concentration increased. It was found that the compression strength parallel to fibres was higher than the strength control samples. In terms of solution concentration, the compression strength parallel to the fibres was determined in the boric acid samples with the highest concentration of 5%. In all of the beech samples impregnated with quebracho and boron compounds, the screw holding strength was higher than the control samples. All of the beech samples were found to have lower bonding strength than the control samples. It can be argued that this decrease is due to the fact that boron compounds negatively affect the chemical structure of the glue used, making it difficult for the glue to penetrate into the wood material, and it also adversely affects adhesion and cohesion forces between the layers (Özçifçi, 2005).

CONCLUSION

As a result of impregnations made, it was found that the retention rate of borax in boron compounds is higher than boric acid. According to this result, it can be said that borax is a better absorber than boric acid. The retention rates increased as the concentration of the boron compounds increased. The highest retention value was detected in samples impregnated with a solution of 5% concentration. This can be explained as the concentration of the boron compound increases, the amount of the substance bonding to the wood increases. As a result of the experiments, the oven dry density values of the impregnated samples were found to be higher than the control samples. This can be interpreted as the fact that the boron compounds used in the impregnation process have salt properties and thus increase the density of the wood material. The average oven dry density value was found to be higher in borax from boron compounds. It was seen that the increase in the boron compound concentration also increased the oven dry density value. It was found that the oven dry density values of the impregnated samples were higher than those of non-impregnated control samples, which is consistent with literature.

After the impregnation process, a general decrease was found in the bending strength perpendicular to the fibres. It was found that as the boron compound concentration increases, the increase in the bending strength parallel to the fibres of the test samples increases. This can be attributed to the impregnation salts in the crystal structure being placed between the micelles in the cell wall, resulting in a decrease in the bonding property of the material. The values in the elastic modulus were found to be lower than the control samples. It was found that in boron compounds values were lower than the control samples and compared to boric acid lower results were obtained from borax. As the solution concentration increased, the elastic modulus values increased. As a result of the experiments conducted, it was found that the compression strength parallel to the fibres were generally higher than the control samples. In the boron compound concentration, the highest value was found in boric acid at 5% concentration. As a result of the tests conducted, the screw holding strength was found to be higher in the impregnated samples than in the control specimens. It was found that borax in boron compounds has higher values than boric acid. As the concentration of the boron compound increased, a decrease in screw holding strength was detected. Despite this decrease, even the screw holding strength values in 5% concentration were higher than the control samples. As a result of the tests made, the bonding strength of the impregnated samples was found to be lower than the control samples. It was found that boric acid in boron compounds have higher results than borax. The highest value in boron compound concentrations was found at 1% concentration.

According to the results of the tests conducted, if we compare the boron compounds with each other, it is determined that in the samples impregnated with borax, retention, oven dry density and screw holding strength values were higher than boric acid, and elastic modulus and bonding strength parallel to fibres values were lower. If we compare the test results with the control samples, oven dry density, compression strength parallel to the fibres and screw holding strengths in the impregnated samples were higher than the control samples. Bending

strength, elastic modulus and bonding strength parallel to the fibres were lower than the control samples.

Alternative impregnation materials, which do not harm nature and humans, should be sought instead of chemical impregnation materials used in the preservation (impregnation) of wood materials, which have occupied a prominent place in the global forest products industry in recent years. In this study, some properties of wood materials were tested by applying mixtures of natural impregnation substances that are rich in boron and tannin - which have enormous potential in Turkey - to wood materials. Thus, it was aimed to increase the use of these materials in the impregnation field and thus contribute to the country's economy and the environment.

In this study, quebracho was used as a natural impregnation material, and borax and boric acid were used as chemical impregnation substances. In works to be conducted later, it may be recommended using different boron compounds with different natural impregnation materials. In addition, this blend can be compared by determining the effects on the wood material by adding other ingredients.

The objective is to increase industrial use of the application of mixtures of boron minerals to wood materials, which have a great potential in Turkey, as well as natural impregnation materials rich in tannins. It follows that this will therefore contribute to the economy of the country.

In addition, natural impregnation materials which are not harmful to nature and human beings should be used rather than chemical impregnation substances used in the preservation (impregnation) of wooden materials – substances which have occupied an important place in the global forest products in recent years.

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