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TLC and GC-MS analysis of fermented wood *"Nikhra"* petroleum ether fraction of Combretaceae spp. *Combretum hartmannianum* and *Terminalia laxiflora*

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Abstract

This study aims to analysis fractions (petroleum ether, chloroform, methanol and aqueous) fermented wood Nikhra of Combretaceae spp (*Combretum hartmannianum* and *Terminalia laxiflora*) analysis it by using chromatographic and spectroscopic analysis. Petroleum ether Nikhra fraction analysis with TLC and spray TLC with vanillin H_2SO_4 (pink) (B1, B2), Rf values (0.84, 0.81), were expected to be phenolic, with vanillin HCL (red) compounds spots (B2) with Rf values (0.81) was expected to be catechin and with vanillin H_3PO_4, blue-violet zones compounds spots (A1, A2, A3), (B1, B2, B3, B4), with Rf values (0.88, 0.78, 0.67), (0.84, 0.81, 0.67, 0.59), respectively were expected to be lignans. Petroleum ether fermented wood*"Nikhra"* fraction was divided into two types of compounds classes aromatic and non-aromatic and hence compounds were classified to phenolics and terpenoids compounds by GC/MS. Fragrant aromatics or terpenoids were targeted in this part of study. GC-MS analysis gave a spectrum of fragrance aromatic compounds (phenolics) in the petroleum ether Nikhrafractions of *T. laxiflora*, was Lup-20(29)-en-3-ol, acetate, (3β) and Tetracosamethyl-cyclododecasiloxane, main terponoids compounds were eicosamethylcyclodecasiloxane. Main fragrance aromatics compound in the petroleum ether Nikhra fraction of *C. hartmannianum* was 2-tert-Butyl-5-(hydroxtmethyl)-4-formylfuran, and main terponoids compound was Tetracosamethylcyclododecasiloxane.

Key words: *Combretaceae, Combretum hartmannianum, Terminalia laxiflora,* Gas Chromatography, Thin-layer chromatography (TLC)

Introduction

The resinous heartwood of *C. hartmannianum* and *T. laxiflora*, trees are usually used in Sudanese fragrances, the scented heart wood is used as perfume and the root bark is used to treat wound and strains, the macerated stem bark of *T. laxiflora* serves as antiseptic to wash mouth in order to resist gingivitis and thrush serves as wound dressing, diuretic management, pile and yaws treatment(Ivory coast), anti-skin inflammation, sores and ulcers treatment (Sierra Leone), eye lotion(Gambia), hair perfume, severe jaundice and chewing stick (Cameroon) across other African

countries (Abbiw, 1990; Daniel, 1990; Batawila *et al.*, 2005). The barks decoction of *T. laxiflora* is used for malaria (Doka and Yagi, 2009). *Dokhan* and *Bakhour* are a traditional processes used by Sudanese married women to make their own perfume, rarely single female use them for medical purpose (Mariod *et al*., 2014). The present study, is designed to analyze fractions (petroleum ether, chloroform, methanol and aqueous) of fermented wood Nikhra-Combretaceae spp (*Combretum hartmannianum* and *Terminalia laxiflora*) by using chromatographic and spectroscopic analysis.

Materials and Methods

Collection of plant materials

Natural fermented hardwood *"Nikhra*" of *Combretum hartmannianum* and *Terminalia laxiflora* were collected from Kordofan state, Sudan. They were, carefully, washed, oven-dried for 1 h at 50°C and ground into a fine powder.

Plant materials preparation and extraction

100 g of ground powder of each plant *Nikhra* were extracted by Soxhlet apparatus using methanol. The methanolic extract was fractionated, sequentially, using solvents of increasing polarity namely petroleum ether, chloroform, and aqueous. Fractions were dried using a rotary evaporator and stored at 4°C for further analysis (Fyhrquist *et al.*, 2002).

Thin Layer Chromatographic (TLC) analysis

TLC was performed on a pre-coated silica gel TLC plates grade F254 (E-Merck, Darmstadt, Germany) to determine the number of compounds present in petroleum ether *Nikhra* fraction. Sample was spotted at 1.0 cm from the bottom of silica gel plates using capillary tubes. Development of the chromatogram was done in closed tanks, in which the atmosphere has been saturated with eluent vapor by wetting a filter paper lining. The chromatogram was visualized under UV light (366 nm and 254 nm), Natural Product Reagent (NPR), H_2SO_4, HCL and H_3PO_4 acid reagent spray. The R_f values of the compounds were calculated using the following formula.

R_f = distance travelled by the compound/Distance travelled by the solvent front

GC-MS Analysis

Petroleum ether Nikhra fraction was subjected to GC MS analysis to identify the various bioactive compounds present. The sample was analyzed in GCMS- QP2010 Plus from Delhi University (DU) India. ACQ Mode Scan: 40m/z to 600m/z, Column flow is 1.21mL/min and total flow is 16.3ml/min. Flow control with linear velocity is 40.9cm/sec. The identification of compounds was done using computer matching of mass spectra with those of standards (WILEY8. LIB. and NIST11.library).

Results and Discussion

Thin layer chromatographic analysis

The presence of flavonoids was confirmed by their color change from quenching fluorescence (254nm) to yellow or orange color for flavonoid and prominent blue color in case of flavonoidal acids or other phenolic acids (366 nm) after spraying with Natural Product Reagent (NPR) (Table 1). Polyphenols (phenolic acids, flavanoids) has been detected using NPR (366 nm). Fluorescence

behavior of flavonoids in response to NPR is structure dependent. Flavonoids e.g. quercetin and myrecitin develops orange color and those of kaempferol and isorhamntin yellow to green colors. Flavones glycosides of luteolin develops orange colors and those apigenin yellow to green (Wagner and Bladt, 1996).

Vanillin H_2SO_4 is a universal reagent that detects components of the petroleum ether fraction, terpenoids, phenols etc., typical pink to purple colors were developed upon spraying with vanillin H_2SO_4 (heat 110° C). All phenolic at UV 254 nm show prominent quenching, and they give blue fluorescence at UV 366 nm (Wagner and Bladt, 1996). After spraying fraction of the petroleum ether of fermented wood of *T. laxiflora* and *C. hartmannianum* by vanillin H_2SO_4, they showed typical pink and purple zones of phenolic. Accordingly compounds spots (B1, B2), R_f values (0.84, 0.81), were expected to be phenolic.

Vanillin HCL is specific reagent that detects components of catechin. All catechin at UV 254 nm show prominent quenching, and they give blue fluorescence at UV 366 nm (Wagner and Bladt, 1996). After spraying the petroleum ether fraction of fermented wood of *T. laxiflora* and *C. hartmannianum* by vanillin HCL, they showed typical red zone of catechin, accordingly compounds spots (B2) with R_f value (0.81) was expected to be catechin. Lignans are formed by oxidative coupling of *p*-hydroxyphenylpropeue units, often linked by an oxygen bridge. They are found in fruits, foliage, heartwood and roots. All lignans at UV 254 nm show prominent quenching, and they give blue fluorescence at UV 366 nm (Wagner and Bladt, 1996). After spraying the petroleum ether fraction of fermented wood of *T. laxiflora* and *C. hartmannianum* by vanillin H_3PO_4, they showed typical red to blue-violet and brown zones of lignans. Accordingly, compounds' spots (A1, A2, A3), (B1, B2, B3, B4), with R f values (0.88, 0.78, 0.67), (0.84, 0.81, 0.67, 0.59) were respectively expected to be lignans (Table 1).

Table 1. TLC profile of the petroleum ether fraction of fermented wood of *T. laxiflora* (A 1-4) and *C. hartmannianum* (B 1-8) sprayed by NPR, Vanillin H_2SO_4, Vanillin HCL, and Vanillin H_3PO.

Spot No	R_f Value		UV Reaction		Reaction to diagnostic reagents				Expected Metabolite			
	254 nm	**366 nm**	**254 nm**	**366 nm**	**NPR 366**	**Van H_2SO_4**	**Van HCL**	**Van H_3PO_4**	**NPR 366 nm**	**Van H_2SO_4**	**Van HCL**	**Van H_3PO_4**
A1	0.88	-	Quenching	Yellow	Yellow	-	-	Red	-	-	-	Lignan
A2	0.78	-	Quenching	Blue	Blue	-	-	Red	Phenolic	-	-	Lignan
A3	0.67	-	Quenching	Blue	Blue	-	-	Red	Phenolic	-	-	Lignan
A4	0.13	-	Quenching	Blue	Blue	-	-	-	Phenolic	-	-	-
B1	0.84	0.64	Quenching	Yellow	Yellow	Yellow	-	Red	Phenolic		-	Lignan
B2	0.81	0.55	Quenching	Yellow	-	purple	Red	Red	-	Terpernoid	Catechin	Lignan
B3	0.67	0.45	Quenching	Blue	Blue	-	-	Red	Phenolic	-	-	Lignan
B4	0.59	-	Quenching	Blue	Blue	-	-	Red	Flavanoid	-	-	Lignan
B5	0.38	0.23	Quenching	Yellow	Yellow	-	-	-	Flavanoid	-	-	-
B6	0.30	0.21	Quenching	Yellow	Yellow	-	-	-	Flavanoid	-	-	-
B7	0.24	0.16	Quenching	Blue	Yellow	-	-	-	Flavanoid	-	-	-
B8	0.18	0.09	Quenching	Blue	Yellow	-	-	-	-	-	-	-

GC-MS Analysis

The chemical composition of *Nikhra* petroleum ether fractions of *T. laxiflora*, and *C. hartmannianum* were analyzed by GC/MS. The compounds identified by matching their

fragmentation patterns in mass spectra with those stores in NIST library with the help of HPCHEM software published mass spectra. Petroleum ether fractions were divided into two types of compounds classes aromatic and non aromatic and hence compounds were classified to phenolics and terpenoids compounds by GC/MS. Fragrant aromatics or terpenoids were targeted in this part of study by http://research.easybib.com.

Main fragrance aromatic compounds (phenolics) in the petroleum ether Nikhra fraction of *T. laxiflora*, (Fig. 1) was Lup-20(29)-en-3-ol, acetate, (3β) which representing 15.71% and Tetracosamethyl-cyclododecasiloxane repeated in different concentrations the highest one was (3.02%) (Fig. 2), total compounds (34.56%) and main terponoids compounds was eicosamethylcyclodecasiloxane (2.69%) total fragrance aromatic compounds (10.08%) (Fig. 3).

Main fragrance aromatics compounds in the petroleum ether Nikhra raction of *C. hartmannianum* was 2-tert-Butyl-5-(hydroxtmethyl)-4-formylfuran (7.73%) total fragrance aromatic compounds (11.85%) (Fig. 4), and main terponoids compounds was Tetracosamethylcyclododecasiloxane (2.36%) total fragrance aromatic compounds (7.54%) (Fig. 5).

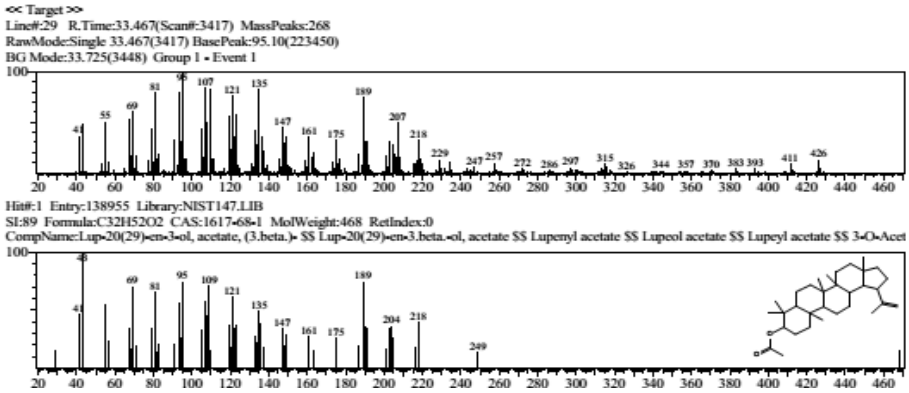

Fig. 1. Fragrant aromatic compounds (phenolics) in the petroleum ether Nikhra fraction of *T. laxiflora* (Lup-20(29)-en-3-ol, acetate,(3.beta-)

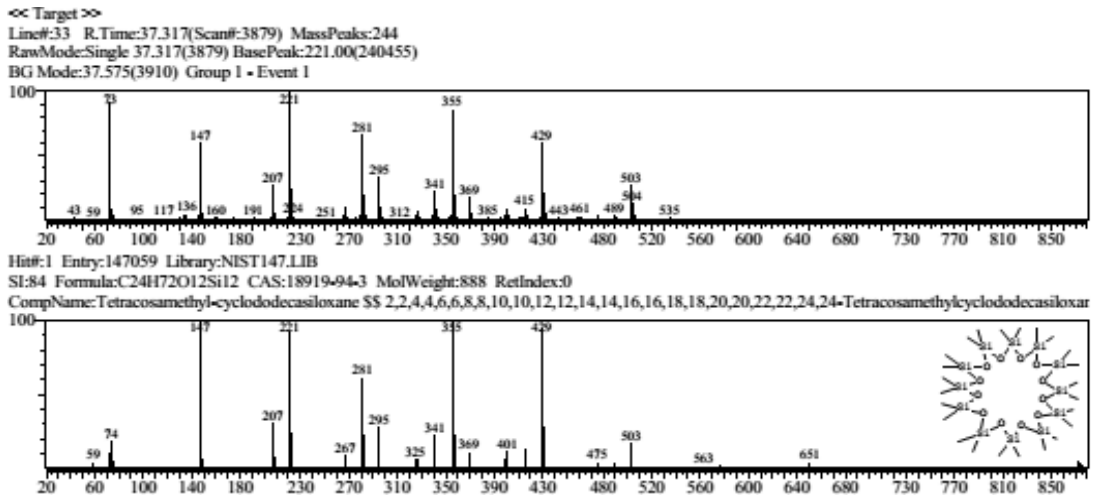

Fig. 2. Fragrant aromatic compounds (phenolics) in the petroleum ether Nikhra fraction of *T. laxiflora* (Tetracosamethyl-cyclododecasiloxane).

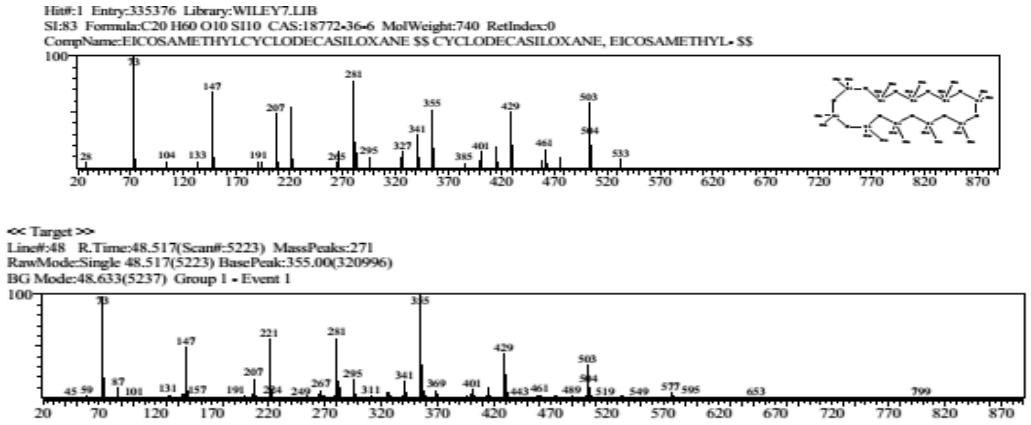

Fig. 3. Fragrant aromatic compounds (terpenoids) in the petroleum ether Nikhrafraction of *T. laxiflora* (Eicosamethylcyclodecasiloxane).

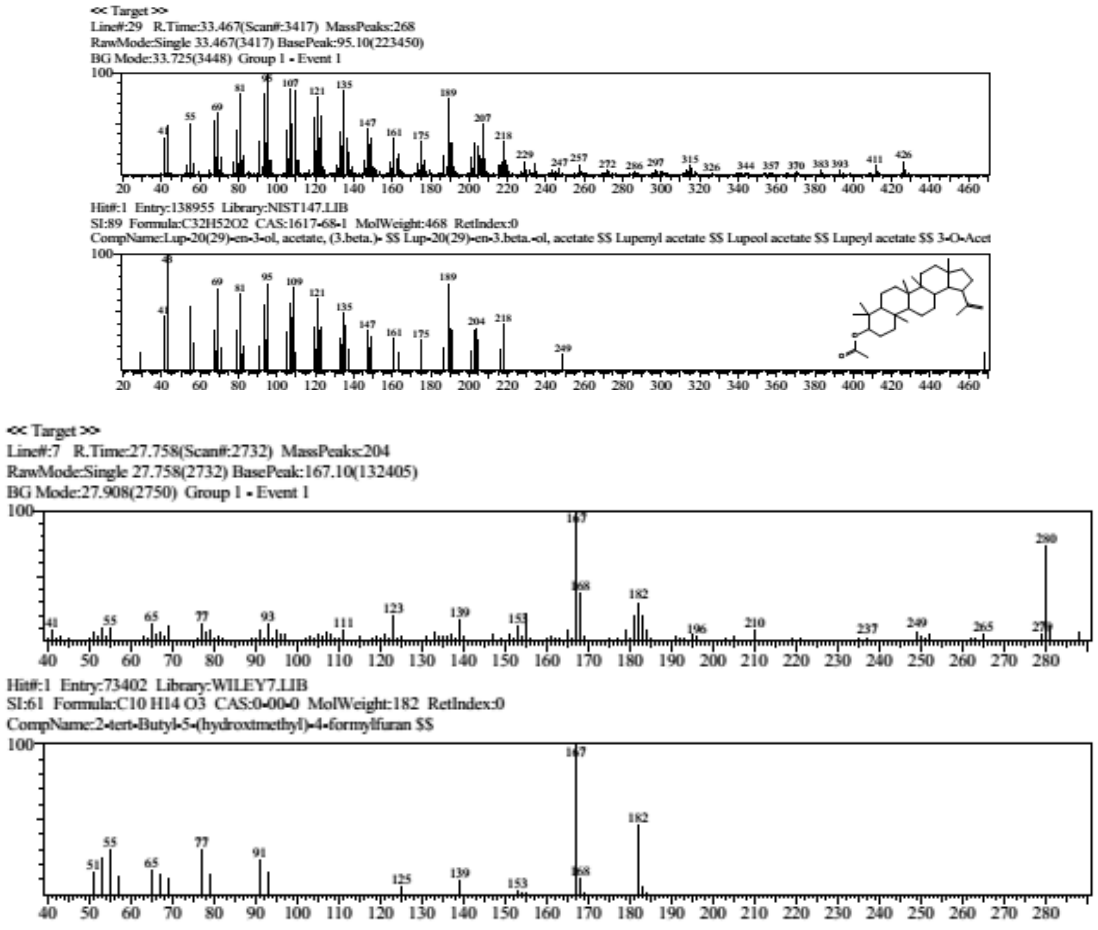

Fig. 4. Fragrant aromatic compounds (phenolics) in the petroleum ether Nikhrafraction of *C. hartmannianum* (2-tert-Butyl-5-(hydroxtmethyl)-4-formylfuran).

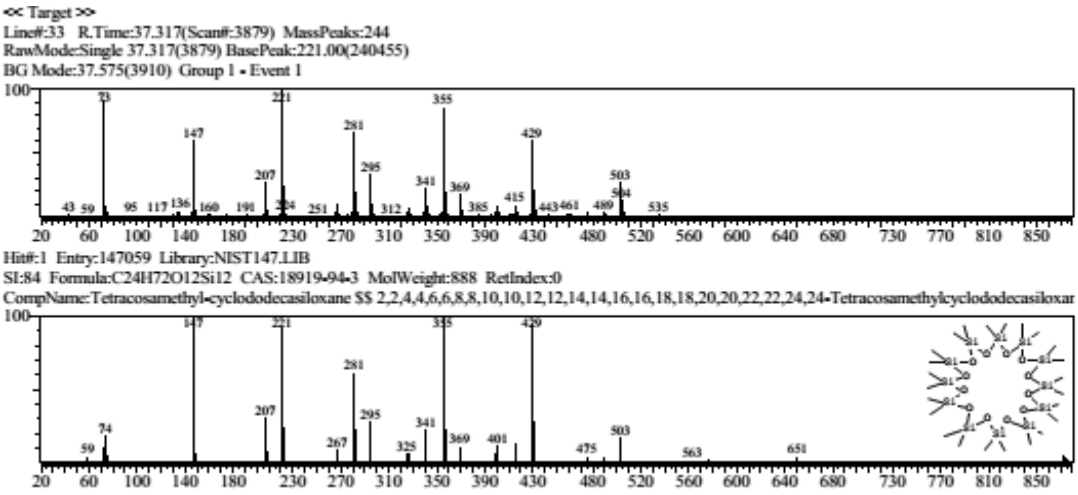

Fig. 5. Fragrant aromatic compounds (terpenoids) in the petroleum ether Nikhrafraction of *C. hartmannianum* (Tetracosamethyl-cyclododecasiloxane)

We observed that petroleum ether Nikhra fraction of *T. laxiflora* have many fragrance aromatics compounds in high concentrations opposite of the petroleum ether Nikhra fraction of *C. hartmannianum* has only two fragrance aromatics compounds in low concentrations.

CONCLUSIONS

Polyphenolics and terpenoids were expected to be responsible for the fragrances in the petroleum ether Nikhra fraction. Fragrance in the petroleum ether Nikhra fraction which have different scents were proved to be polyphenols by TLC after spraying with NPR, specific reagent for detects components: catechin (van HCL), terponoids (van H_2SO_4) and lignans (van H_3PO_4). GC/MS analysis of the petroleum ether Nikhra fraction revealed that the total fragrant compounds phenolics and terponoids for *T. laxiflora* (44.64%), while those of *C. hartmannianum* which is mostly used for treatment health problems were (19.39%).

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The effects of the increased doses of leonardite applications on the content of some macro and micro nutrient elements of pak choi (*Brassica rapa* L. subsp. var. *Chinensis* L.) plant

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Abstract
The present research has been contented to determine the effects of the increased leonardite application on the some macro and micro nutrient elements of pak choi (*Brassica rapa* L. subsp. var. *Chinensis* L.) plant. The research was designed as 3 replications according to the randomized block experimental design. Leonardite was applied to the parcels with 4 doses and as the 1st dose: 0 ppm m^{-2}, the 2nd dose: 60 ppm m^{-2}, the 3rd dose: 120 ppm $m^{-2}$and the 4th dose: 150 ppm m^{-2}. According to research results, the total N content of the plant samples were determined of 5.43 %, 5.58 %, 5.69 %, and 5.73 % for four leonardite doses respectively. The contents were determined as P (0.40 %, 0.42 %, 0.41 %, 0.41 %); K (5.49 %, 5.73 %, 5.83 %, 6.01 %); Ca (1.85 %, 1.91 %, 2.06 %, 2.29 %); Mg (0.12 %, 0.13 %, 0.13 %, 0.14 %); and S (3.39 %, 4.65 %, 4.83 %, 4.84 %) and some micro elements contents were obtained as Fe (96, 110, 112, 120 $mgkg^{-1}$); Cu (5, 8, 18, 24 $mgkg^{-1}$); Mn (12, 16, 22, 94 $mgkg^{-1}$); and Zn (32, 34, 36, 37 $mgkg^{-1}$) for four doses, respectively. According to the results, the effects of the increasing doses of the leonardite application on some macro and micro nutrient elements contents of pak choi plant were determined statistically significant. These increases were found to be significant at the level of 5 % statistical degree, except P and Mg nutrient elements.
Key words: Leonardite, nutrient element, *Brassica rapa* L. subsp. var. *Chinensis* L., exotic vegetable.

Introduction

The cabbage-kind vegetables are known and consumed almost in every part of the world (Tirasoglu et al., 2005). The pak choi is such as vegetable which belongs to this family.

Pak choi (syn. *Brassica Chinensis* L. (1759), *Brassica Campestris* L. subsp. *Chinensis* (L.) Makino, 1912, *Brassica rapa* L. subsp. *Chinensis* (L.) Hanelt, 1986) is a vegetable, known since the 5th A. D., which is widely seen China and Taiwan. It is classified in the group which is known as Chinese vegetables (Dixon, 2007; Eryilmaz Acikgoz, 2016). Its leaves are edible and it needs some 50-60 days for vegetation (Opena et al. 1988; Larkcom, 2007).

The most common waste material in our country is vegetable fertilizers which are not used as compost and leonardite because of wrong procedure of usage, which in addition to the above the usage in the current wrong form, has lots of environmental side effects (Bellitürk, 2016). The Leonardite may have effects on the plant improvement (Chen and Aviad, 1990). According to Tan (2003) these effects include development of the soil properties such as aggregation, aeration, permeability, water holding capacity, micronutrient transport and availability.

Another effects are those, which suppose uptake of humic matters into the plant tissue out coming in diverse biochemical effects (Chen and Aviad, 1990; Nardi, *et al.*,2002; Escobar, *et al.*, 1996). According to Ece et al., (2007) extreme apply of chemical fertilizers can be induce environmental pollution. For this reason, native alternates to chemical fertilizers are increasing in agricultural output.

According to Akinremi et al., (2000) leonardite is abundant in organic substance (50-75%) and its humic acid content could change between 30-80%. According to Chen and Aviad, 1990 effects of humic acid including fertilizers on plant yield and nutrient uptake depend on humic acid source, concentration, application type, plant species and cultivars. According to Akinremi et al., 2000; Dursun et al., 2002; Serenella et al., 2002; Cimrin and Yilmaz, 2005; Unlu et al., 2010 humic compounds rise plant nutrients and intake of nutrient from soil. This research was done to state the effects of the increasing doses of the leonardite application on some macro and micro mineral material content of pak choi.

Materials and Methods

The high tunnel unheated greenhouse covered by polyetilen (PE) with UV additive of Namik Kemal University, Vocational College of Technical Sciences, Plant and Animal Production Department was used for the experiments which were carried out in late autumn, Tekirdag city (Turkey) (40°98' N, 27°48' E) in 2014.

The 134^0C variety of pak choi (Chiltern Seeds Firm) was used for the research. Seeds were sown in multicelled trays filled with peat (Klasmann-Deilmann, PotgroundH, Germany). Some properties of the used peat are as follow: 160-260 mg/L N, 180-280 mg/L P_2O_5, 200-150 mg/L K_2O, 80-150 mg/L Mg, pH: 6, 70 % organic matter, and 35 % C.

When the seedlings became 2 to 3 true leaves (21days for pak choi after seed sowing) they were planted to pre-prepared places in the high tunnel cold greenhouse with 10×10 cm intervals and 10 plants in each parcel (Figure 1).

Figure 1. A general view of research (Original, 2014).

The research was designed according to the randomized block design as 3 replications. The leonardite was applied to the parcels with 4 doses. These doses are the 1st dose: 0 ppm m^{-2}, the 2nd dose: 60 ppm m^{-2}, the 3rd dose: 120 ppm m^{-2}, and the 4th dose: 150 ppm m^{-2}. According to the soil analysis results, NH_4NO_3 and KH_2PO_4 fertilizers were applied for each parcel.

The plants were harvested 50 days after the seed sowing. Some chemical properties of the commercial leonardite that was purchased in Turkey and research area soil can be seen in the Table 1 and Table 2, and some climate data in cold greenhouse are given in the Table 3 below.

Table 1. Some chemical characteristics of leonardite, (W/W)

pH	Organic matter,%	Moisture, %	Total humic+fulvic acide, %
5.2	60.6	42.9	59.1

Table 2. Some chemical and physical characteristics of research area soil.

Soil property	Analysis result
pH, 1: 2.5	6.7
$ECx10^6$	156
Lime ($CaCO_3$), %	6.2
Organic matter, %	1.1
Ca, %	0.7
P_2O_5, kg da^{-1}	12.1
K_2O, kg da^{-1}	63.4
Mg, mg kg^{-1}	320.6
Fe, mg kg^{-1}	8.9
Cu, mg kg^{-1}	1.4
Zn, mg kg^{-1}	0.8
Mn, mg kg^{-1}	10.7

According to Table 2, the experiment soil is identified as having neutral reaction, no salt, medium lime, organic matter insufficiency, medium phosphorus content, and Mg, Fe, Cu, Zn and Mn content sufficiency.

Table 3. The mean of some climate data in cold greenhouse during the months of the research.

Months	Mean temperature (^{0}C)	Max. temperature (^{0}C)	Min. temperature (^{0}C)	Mean humidity (%)
October	16.01	19.02	13.05	89
November	12.40	14.80	10.00	87
December	9.40	12.50	6.40	88

The harvested plants were brought to the laboratory immediately; plants were washed with distilled water as two times; they were dried in a 68^{0}C drying-oven until their weight got stabilized, and they were ground and prepared for the analysis. Then, nitrogen content of the samples was determined by the Kjeldahl method, and P, K, Ca, Mg, S, Fe, Cu, Zn and Mn were determined by ICP Optical Emission Spectrometry (ICP-OES) (Kacar and Inal, 2010).

The experiment analysis results were evaluated applying SPSS 21 statistical program. ANOVA variance analysis was done on the research results and Duncan multiple comparison tests was done on this research results.

Results and Discussion

The Effect of Increasing Doses Leonardite Application on Some Macro Nutrient Elements Contents of Pak Choi.

The effects of the increasing doses leonardite application on some macro nutrient elements contents of the pak choi were presented in the table 4 below.

Table 4. The effect of leonardite application on some macro nutrient element (N, P, K, Ca, Mg, S) contents of pak choi, %, *, **

Doses***	N	P	K	Ca	Mg	S
I	5.43**c**	0.40**ns**	5.49**c**	1.85**c**	0.12 **ns**	3.39**c**
II	5.58**b**	0.42**ns**	5.73**b**	1.91**c**	0.13 **ns**	4.65**b**
III	5.69**a**	0.41**ns**	5.83**b**	2.06**b**	0.13 **ns**	4.83**a**
IV	5.73**a**	0.41**ns**	6.01**a**	2.29**a**	0.14 **ns**	4.84**a**

*: The values mean of three replications, **: each element was evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %, ns: non-significant, ***: (I: 0 ppm m^{-2}, II: 60 ppm m^{-2}, III: 120 ppm m^{-2}, and IV: 150 ppm m^{-2}).

According to Table 4, the total N content of the plant samples were determined of 5.43 %, 5.58 %, 5.69 %, and 5.73 % for four leonardite doses respectively. The contents were determined as P (0.40 %, 0.42 %, 0.41 %, 0.41 %); K (5.49 %, 5.73 %, 5.83 %, 6.01 %); Ca (1.85 %, 1.91 %, 2.06 %, 2.29 %); Mg (0.12 %, 0.13 %, 0.13 %, 0.14 %); and S (3.39 %, 4.65 %, 4.83 %, 4.84 %) for four doses, respectively. According to the results, the effects of the increasing doses of the leonardite practice on some macro nutrient elements contents of pak choi were determined statistically significant. These increases were found to be significant at the level of 5 % statistical degree, except P and Mg nutrient elements.
According to Chen and Aviad, 1990 influences of humic acid having fertilizers on nutrient uptake addict to humic acid resource such as leonardite, concentration, practice type, plant species and cultivars.

According to David et al., 1994 leonardite attend to increase available N, and diverse plant nutrients, such as K.

According to Fernandez et al., 1996 foliar application of leonardite to young olive plants stimulated shoot growth while they were growing without the supplement of mineral elements to the irrigation water. Foliar application of leonardite extracts stimulated shoot growth and supported the concentration of K, Ca in leaves.
According to Chen and Aviad, 1990; Nardi, et al., 2002; Escobar, et al., 1996 leonardite may have direct and indirect effects on the plant growth. Direct effects are those, which require uptake of humic matters into the plant tissue resulting in diverse biochemical effects.
Many researchers from various regions who work on various plants also revealed that the increasing doses of the leonardite application cause a significant rise in the N, P, K, Ca, Mg, S content of the plants (Topcuoglu and Onal, 2006; Saglam et al., 2012; Turan et al., 2012; Kucukyumuk et al., 2014). And these results are similar to our research.

The Effect of Increasing Doses Leonardite Application on Some Micro Nutrient Element Contents of Pak Choi.

The effects of increasing doses leonardite application on some micro nutrient element content of pak choi are presented in the Table 5 below.

Table 5. The effect of leonardite application on some micro nutrient element contents of pak choi, mg kg^{-1}, *, **

Doses***	Fe	Cu	Zn	Mn
I	96.63**c**	5.08**c**	32.87**c**	12.30**d**
II	110.60**b**	8.98**c**	34.43**b**	16.70**c**
III	112.37**b**	18.92**b**	36.37**a**	22.93**b**
IV	120.94**a**	24.38**a**	37.73**a**	94.87**a**

*: The values mean of three replications, **: each element was evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %, ns: non-significant, ***: (I: 0 ppm m^{-2}, II: 60 ppm m^{-2}, III: 120 ppm m^{-2}, and IV: 150 ppm m^{-2}).

According to Table 5, and some micro elements contents were obtained as Fe (96, 110, 112, 120 $mgkg^{-1}$); Cu (5, 8, 18, 24 $mgkg^{-1}$); Mn (12, 16, 22, 94 $mgkg^{-1}$); and Zn (32, 34, 36, 37 $mgkg^{-1}$) for four doses, respectively. According to the results, the effects of the increasing doses of the leonardite practice on some micro nutrient elements ingredient of pak choi were determined statistically significant. These increases were found to be significant at the level of 5 % statistical degree.

According to Fernandez et al., 1996 foliar application of leonardite to young olive plants stimulated shoot growth while they were growing without the supplement of mineral elements to the irrigation water. Foliar application of leonardite extracts stimulated shoot growth and supported the concentration of Fe in leaves.

In a research by Sozudogru et al. (1996), which was conducted by using bean plant, some similar results emerged with the research mentioned previously, where 5 different doses of humic acid (0, 30, 60, 90 and 120 mg kg^{-1}) were implemented to the plants. As a result, a significant increase was observed in the Fe, Zn and Mn ingredient of the bean plant with the increasing doses of humic acid.

In an experiment carried out by using tomato plant under greenhouse conditions. It was proven that the leonardite applied to plants has positive effects on the amount of tomato fruit production. Furthermore, the Fe, Zn and Mn nutrition content of plant leaves increases with the leonardite application (Topcuoglu and Onal, 2006).

The research by Turan et al., 2012 the results show that the humic acid applied for the leaf increases the dry matter amount of the corn plant and the amounts of Cu and Zn, which are taken from the soil by the plant.

In a greenhouse experiment carried out by Gunaydin (1999) with corn plant, some 0, 50, 100, 150, 200 and 250 mg kg^{-1} humic acid are applied to the plants. At the end of the experiment, significant increases were observed in the Fe, Cu, Zn and Mn ingredient of corn plant with the increasing doses of humic acid applications. These results are similar to our research.

Conclusions

The present research which aims to investigate the effects of the increasing doses of the leonardite application on the pak choi with regard to some macro and micro nutrient elements of the content, significant increases in the pak choi of the N, P, K, Ca, Mg, S, Fe, Cu, Zn and Mn nutrient elements were determined as compared to the control group. According to the experiment results, the increasing doses of the leonardite application provide the increasing in the pak choi of some macro and micro nutrient elements. These increases are important with a 5 % statistical degree, except for P and Mg nutrient elements.

The organic fertilizers and soil improvers, such as the leonardite, are commonly used in agriculture in the recent years. As a consequence, the excessive and unconscious use of the chemical fertilizers in agriculture has caused serious problems in the quality of the agricultural products. Besides, much of the soil in Turkey has insufficient organic matter (Akca et al. 2003; Adiloglu et al., 2018; Belliturk, 2018; Adiloglu and Saglam, 2015; Adiloglu and Karaman, 2015). The use of organic materials in agriculture,

such as leonardite, in eliminating the insufficiency of the organic matter content and in maintaining the productivity of soils, therefore, is highly needed.

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Effects of landscape evolution stages on soil properties distribution in Yancheng National Nature Reserve, China

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Abstract

A typical wetland in the core area of Yancheng National Nature Reserve was chosen as study area. Using three periods of remote sensing images in 1992, 2002 and 2011, different successional stages of landscape have been discerned. And then by employing a space-for-time substitution approach, related environmental factors of soil was analyzed. The analysis results showed that the landscape types and its successional time were the important factors that influenced the spatial distributions of soil characteristic. The detailed results revealed: (1) The *Spartina* marsh succession time was longer, more reduction effect of soil water and salt content, more with the accumulation effect on soil nutrients; (2) The *Suaeda* marsh succession time was longer, more accumulation of soil water and salt content, more with the weakening effect on soil nutrients; (3) The moisture, salinity of soil decreased more and more, soil nutrient increased more and more as the grass marsh existed longer time. This study could help us to evaluate the degradation of wetland and the effect of wetland restoration, as well as to help us to achieve the balance between utilization and reservation.
Keywords: Landscape evolution, coastal wetland, space-for-time substitution, soil properties, Yancheng National Nature Reserve

Introduction

Yancheng National Nature Reserve (YNNR) is one of the most important landscape evolution of China and one of the most complex typical muddy coastal wetlands in the world ecosystem type. The YNNR is one of the world's major winter habitats for red-crowned cranes. It is also a stop-over site for over 300 species of migratory birds from Northeast Asia and Australia (Zhu et al. 2004). So, the habitat of those birds need to be focused, especially the change of its landscape. Currently, studies into the evolution process of coastal wetlands, ecosystem health and reconstruction and ecosystem service values are at the forefront of national wetland research (Sean 2002; Roychoudhury et al. 2003; Zhang et al. 2013). The YNNR has attracted attention from scholars since the 1980s (Zhu and Xu 1982; Zhu et al. 2004) for studies into topography, sedimentation, hydrology, ecology, sustainable development and evolution of landscape (Zhang 1986; Zhang 1991; Shen et al. 2006). The study of landscape evolution which related to ecological process in YNNR is sorely lacked. Although some studies noted the effects of hydrogeomorphologic processes on wetland landscape in coastal area (Gao et al. 2005;

Yao et al. 2009), research results in the relationships between soil processes and the evolution of landscape are very limited.

On the issues of landscape evolution, most of researches focus on identifying the landscape evolution of time and space dynamic using remote sensing methods (Clarkson 1998; Odland 2002; Bender 2005), and landscape evolution is one of the main factors that control the soil properties (Gamboa and Galicia 2011). Vegetaion changes in the landscape can make effective on soil charicteristics and soil charicteristics as a reaction will be on vegetation. Vegetation changes under the forces of nature (not due to human activity) in landscape can be regarded as landscape evolution. Although many studies have focused on the effect of different landscape evolution on the soil properties, the effects of landscape conversion on the soil properties are not fully understood due to the variability of tillage systems and the shortage of historical soil data (Pellegrino et al. 2011). It is generally accepted that the dynamics of landscape is best studied by long-term observations and experiment (Gosz 1996). With regard to soil data shortages, remote sensing, and geographical information system are typically used to identify the changes in landscape and soil properties (El-Shikha et al. 2007), as well as the spatial variability of soil properties in ecosystems (Grunwald et al. 2007). Appropriate space-for-time substitution (SFT) can aid planning of observations and experiments for further study.

The vegetation landscape-soil system, a part of the coastal ecosystem, is a dramatically dynamic and developmental process (Ouyang et al. 2013). The soil develops continuously to reach a balance that relates with vegetation climax along the vegetation landscape succession (Zhang et al. 1990). A quantitative investigation of the soil characteristic evolution and its mechanism in terms of landscape evolution is vital to the study of the development tendency of the coastal system (Li et al. 2013). The core area of YNNR was chosen as the study area to provide a scientific foundation for constructing the eco-environment and rehabilitating the water storing and regulating capacity of the soil. The intact series in the natural landscape evolution on coastal area can be found in this area. The soil characteristics at different landscape evolution stages can be analyzed by SFT in YNNR. Through the collection and analysis of soil samples, the relationship of the process of landscape succession and soil factors can be obtained in YNNR. It provides an in-depth understanding and the basic reference of the coastal wetland ecosystem in the process of succession.

Materials and methods

Study area

The Yancheng coastal marshes are located in the coastal zone of Jiangsu Province, East China (Fig.1). In 1983, YNNR was established to help conserve rare bird species and their habitats. As the marsh area has a rich biodiversity, YNNR was accepted as a member of the UNESCO Man and Biosphere Reserve network in 1993 and was admitted as Northeast Asian Crane Reserve Network Site in 1997 and as an East Asia-Australian Migratory Shorebirds Network Site in 1999. The coast of YNNR is accreting annually with the mudflats moving about 50 to 200 meters seawards per year in the study area (Wang et al. 2006). Its original landscape comprises coastal salt marsh, so the variety of vegetation is poor and dominated by salt tolerant plants. The vegetation landscape had a typical landward succession sere type (Wan et al. 2001): (1) the pioneer species *Spartina alterniflora* dominates the elevated part of the intertidal zone; (2) a *Suaeda salsa* and *Suaeda glauca* community is dominant in the high tidal zone and (3) in the supratidal zone, *Aeluropus littoralis* and *Phragmites australis* are prevalent. The original vegetation landscape of the YNNR was comprised of *Suaeda salsa*, *Phragmites communis Trin* and *Imperata*. In 1963 and 1979, common cordgrass (*Spartina land anglica* C.E. Hubbard) and smooth cordgrass (*Spartina alterniflora Loisel*) were introduced from England and the United States respectively, and after the 1990s, they became the two dominant plants of the intertidal zone in the YNNR (Li et al. 2005).

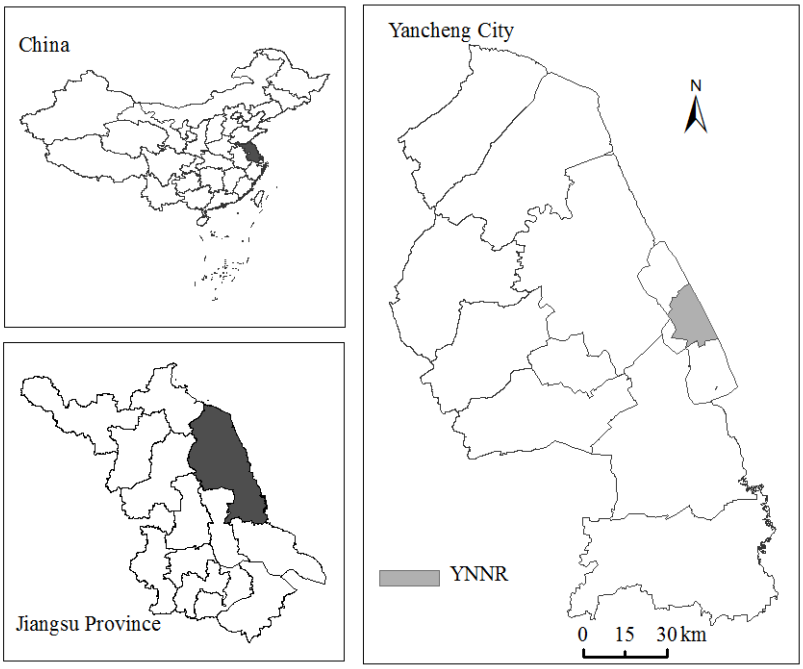

Fig.1 Location of the core area of YNNR

Methods

Reconstruction of landscape history

Landscape types of vegetation were derived from Landsat TM data obtained in June, 1992; May, 2002; and April, 2011, respectively (Table 1). In order to highlight the evolution of vegetation landscape, classification of vegetation landscape was a main concern. A system of landscape classification was established in which landscapes were grouped into 4 categories: the grass land, the *Suaeda* land, the *Spartina* land and the mudflat. The mathods was conducted before in our researches (Wang et al, 2014). All image processing was undertaken using the image analysis software ENVI 4.7. A supervised classification merging the maximum likelihood classify (MLC) and normalized difference vegetation index (NDVI) was used to classify the images with a classification accuracy of above 85% for all classes.

Table 1. Data source for the Thematic Mapper (TM).

Type	TM	TM	TM
Path	119037	119037	119037
Acquisition time	June 11, 1992;	May 20, 2002;	April 23, 2011
Used band	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7

Landscape evolution was a relatively long time span. Under the condition of lack of long-term observation data, we used the “space for time substitution” method to test the impact of time on the relationships between landscape evolution and soil because the landscape evolution over large time scales are beyond the duration of normal observations. This method assumes that important events and processes are independent of space and time (Pickett 1989; Fukami and Wardle 2005). Thus, the landscape configuration in vegetation zones of different ages can represent the evolution of the landscape. Landscape evolution in YNNR was mainly decided by natural factors. Affected by the tidal process, the elevation, soil and hydrology in YNNR was changed by sedimentation with the result of landscape evolution.

Soil sampling

In April 2011, we collected soil samples based on the age of vegetation, with a total of 54 samples being obtained. Each sample consisted of a 500 g mixture of soil from a 0-30 cm profile obtained with the quartering method. All samples were air-dried in the laboratory and then analyzed for soil organic matter (SOM), available phosphorous (AP), available potassium (AK), total nitrogen (TN), total phosphorus (TP) and soil salinity (SS). Soil moisture (SM) was measured in situ using a soil moisture sensor (PICO-BT, made in Germany), and represented in %. SOM, AP, AN, AK, TN and TP are strong indicators of the soil fertility status, while SS indicates the degree of plant desalinization.

Soil nutrient properties were measured in triplicate samples according to spectrophotometric methods. Soil sample was air-dried, ground and screened though 100-mesh sieve before analyzing. SOM was determined using the hydrated heat-photoelectric colorimetry method, with $K_2Cr_2O_7$, H_2SO_4 (analytical pure) and $C_6H_{12}O_6H_2O$ (chemical pure) as chromogenic reagents. Soil AP was measured using the photoelectric colorimetry method, with $NaHCO_3$ and Mo–Sb–VC as the chromogenic reagents. Soil AK was extracted from air-dried soil samples by shaking with 50ml ammonium acetate/acetic acid solution for 30 minutes, and then used the extract flame photometric method. TP was determinate by fusion-colorimetry, and TN was determinated by using the semimicro-Kjeldahl method (Zhai et al., 2006). The extract was filtered and the concentrations was determined with a continuous-flow analyzer (EASYCHEM, made in Italy).The measurement error was within 0.5 mg/kg for all nutrient properties.

Data analysis

Data layers of different vegetation landscape were identified with vegetation age zones in order to test the effects of vegetation landscape age on soil. The age of vegetation landscape can be plotted against time series using remote sensing image.

The soil property data and vegetation landscape data were overlaid to determine the relationship in between based on a plot of the mean±SD. The statistical analysis software SPSS 22 for Windows (Chicago, USA) was applied for the data analysis in this study.

Results

Temporal dynamics of vegetation landscape

From the analysis of the vegetation distribution based on the remote sensing in the three separate years, it was found that the area of spartina land and grass land increased dramatically (from 16 km^2 and 82 km^2 in 1992 to 37 km^2 and 89 km^2 in 2002, and then to 57 km^2 and 98 km^2 in 2011 respectively). *Suaeda* land increased from 54 km^2 in 1992 to 66 km^2 in 2002 and then decreased severely to 32 km^2 in 2011(Fig. 2). The width of vegetation landscape presented the same change trends as vegetation landscape speared ever father seawards. As *Spartina* was introduced into the area between 1960s and 1970s, the landscape and hydrogeomorphologic condition gradually changed because of the function in bank protecting, wave defending and silt promoting.

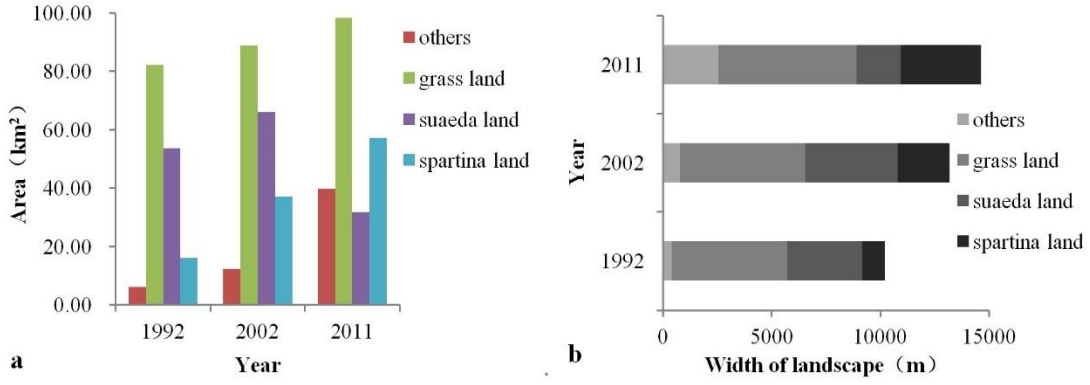

Fig. 2 The area (a) and the width (b) of vegetation landscape types in different years

Distinguish of space for time substitute

Overlaying the maps of vegetation landscape, the characteristics of space for time can be identified by taking 10 years as the time scale. Six samples have belonged to the mudflat for more than 20 years, which can be abbreviated to G>20a. Six samples were located in mudflat from 1992 to 2002 and then substituted by *Spartina* land gradually, which means *Spartina* land in these six samples were less than 10 years (M<10a). In 1992, five samples were covered by muldflat, and then replaced by *Spartina* land, which means *Spartina* land in these five samples were more than 10 years and less than 20 years (10a<M<20a). In the same way, eight samples can be classified to 10a<J<20a, twelve samples can be abbreviated to J>20a, eight samples can be abbreviated to 10a<H<20a, nine samples can be abbreviated to H>20a (Fig. 3).

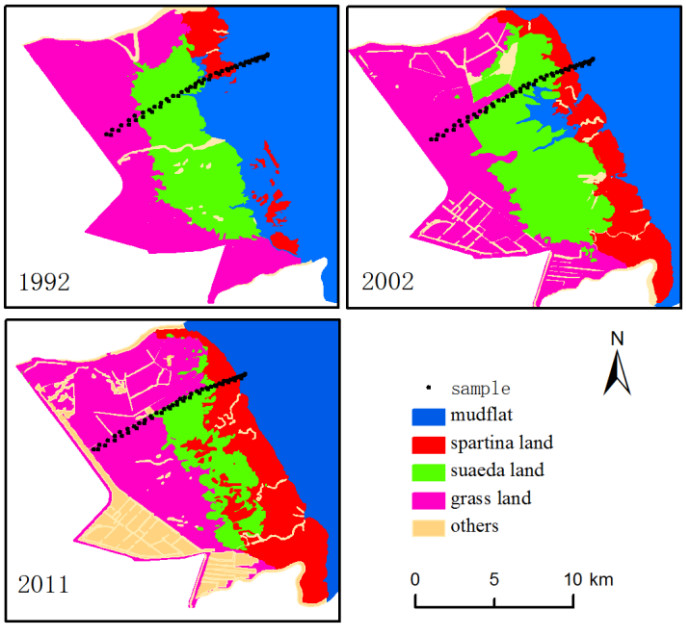

Fig. 3 Soil sampling sites and the change of landscape in YNNR from 1992-2011

Current vegetation landscape and soil characteristic content

With the samples of YNNR obtained during the investigation, the statistical analysis of the soil characteristic contents of the four current landscape types indicated that some of the soil indexes differ among the landscape (Table 2). The amounts of SM and SS were higher in the mudflat soils and lower in the grass and *Suaeda* land soils. The amounts of SOM, TN, TP, AP and AK in *Suaeda* and *Spartina* land were significantly higher than the corresponding amount in mudflat. The standard deviation (SD) of the soil properties in mudflat was higher than those for other landscape.

Table 2. Description of soil characteristics in the current landscape types.

landscape	SM(%)	SS(%)	SOM(%)	TN(mg/kg)	TP(mg/kg)	AP(mg/kg)	AK(mg/kg)
mudflat (G)	55.23±15.27^{a}	1.18±0.61^{a}	0.38±0.11^{a}	93.51±48.96^{a}	821.42±320.17^{a}	4.58±2.56^{a}	97.38±46.20^{a}
spartina land (M)	42.99±10.43^{a}	1.09±0.58^{b}	1.04±0.41^{b}	490.28±230.23^{b}	830.48±133.16^{a}	14.81±9.33^{b}	197.85±86.11^{b}
suaeda land (J)	44.50±5.21^{b}	1.02±0.31^{b}	1.06±0.37^{b}	406.59±162.41^{b}	638.59±66.17^{b}	12.49±7.81^{b}	169.32±71.10^{b}
grass land (H)	37.83±2.15^{c}	0.54±0.27^{c}	1.00±0.26^{b}	310.51±138.11^{b}	600.23±63.03^{b}	7.74±2.61^{ac}	120.49±24.97^{a}

$^{a, b \text{ and } c}$ Mean values in columns are significantly different (P<0.05). Values are the mean±SD.

Soil properties during different evolution of landscape

Soil moisture and salinity response

The amounts of SM in the stage of G>20a and M<10a were 55.23% and 52.37%, which are significantly higher than that of other landscape evolution types. The amount of SM in 10a<J<20a and J>20a were the second highest of the analyzed landscape evolution stages, followed by H>10a and then H>20a. The

soil salinity contents in M<10a and 10a<H<20a were higher than that in 10a<M<20a and H>20a. The results indicated that the amounts of SM and SS in landscape were affected by the evolution years. According to Table 3, the SD of SM in G>20a and J>20a were higher, with values of 10.27 and 5.58, respectively. The trend of the SM was similar to that of the SS.

Table 3. Description of Soil moisture and salinity in the different landscape evolution stages

Stages	SM(%)			SS(%)		
	mean±SD	min	max	mean±SD	min	max
G>20a	55.23±10.27[a]	40	90	1.23±0.62[a]	1.03	1.38
M<10a	52.37±5.52[a]	45.5	61.9	1.52±0.81[a]	0.75	2.45
10a<M<20a	33.60±2.69[b]	30.67	35.97	0.96±0.32[b]	0.80	1.02
10a<J<20a	43.85±4.72[b]	36.43	51.96	0.94±0.39[b]	0.54	1.82
J>20a	45.15±5.58[b]	39.21	59.49	1.10±0.63[b]	0.51	2.18
10a<H<20a	38.43±1.56[c]	36.87	40	0.64±0.32[b]	0.43	1.01
H>20a	37.23±2.31[c]	34.36	41.29	0.44±0.26[b]	0.14	.87

[a, b and c] mean values in columns are significantly different (P<0.05). Values are the mean±SD. The landscape of mudflat, spartina land, suaeda land and grass land can be abbreviated to G, M, J and H.

Soil organic matter, total nitrogen and total phosphorus response

The soil organic matter (SOM) content in the various landscape evolution stages ranged from 0.26% (G>20a) to 1.17% (10a<M<20a). The total nitrogen (TN) content in 10a<J<20a was significantly higher than the amounts in other stages, and the amounts of the total phosphorus (TP) in M<10a and 10a<M<20a were high, while that in G>20a was the smallest among all the analyzed stages (Table 4).

Table 4. Description of SOM, TN and TP in the different landscape evolution stages

	SOM(%)			TN(mg/kg)			TP(mg/kg)		
	mean±SD	min	max	mean±SD	min	max	mean±SD	min	max
G>20a	0.26±0.12[a]	0.16	0.48	162.74±28.98[a]	80.20	195.22	553.53±229.17a	221.00	753.79
M<10a	0.91±0.50[b]	0.33	1.74	476.03±204.25[b]	115.25	832.68	862.75±122.52b	713.29	935.48
10a<M<20a	1.17±0.11[b]	1.06	1.27	504.54±250.18[b]	355.39	793.37	798.21±171.00b	678.37	994.03
10a<J<20a	1.11±0.35[b]	0.70	1.79	526.94±166.41[b]	363.27	745.31	659.58±91.33a	477.89	816.20
J>20a	0.95±0.39[b]	0.00	1.70	286.23±65.03c	204.14	454.07	617.60±41.47a	496.69	678.37
10a<H<20a	0.98±0.27[b]	0.70	1.25	274.26±59.83c	224.21	340.52	580.22±106.06a	459.10	656.44
H>20a	1.01±0.27[b]	0.56	1.58	346.77±149.52c	219.91	684.39	620.25±46.91a	521.75	687.77

[a, b and c] mean values in columns are significantly different (P<0.05). Values are the mean±SD. The landscape of mudflat, spartina land, suaeda land and grass land can be abbreviated to G, M, J and H.

Available phosphorous and available potassium response

The 10a<J<20a soil had the highest AP content among all evolution stages. The M<10a and10a<M<20a have significantly higher AK content than the 10a<J<20a, as well as all the other landscape evolution stages. The landscape evolution can cause the AP content in the *Suaeda* land to decrease dramatically. Except for the SD of 10.01 for the AP in the10a<J<20a soil, the SD of the AP in the other landscape evolution stages were relatively small (1.25-6.65). However, the SD of the AK content ranged from 17.24 to 96.87, and the mean values of the AK content ranged from 67.81 to 198.43 mg/kg (Table 5).

Table 5. Description of AP and AK in the different landscape evolution stages.

	AP(mg/kg)			AK(mg/kg)		
	mean±SD	min	max	mean±SD	min	max
G>20a	3.13±1.56a	1.01	5.96	67.81±30.20a	42.02	100.84
M<10a	13.62±6.75b	5.11	35.71	198.43±96.87b	101.00	340.30
10a<M<20a	12.22±1.25b	10.84	13.28	197.27±78.75b	117.62	275.08
10a<J<20a	19.69±10.01b	9.52	33.68	175.78±64.64b	128.28	340.30
J>20a	9.97±2.24b	5.96	13.46	162.86±76.50b	92.51	340.30
10a<H<20a	8.80±2.50ab	6.05	10.93	118.67±17.24ab	102.71	136.95
H>20a	6.68±2.55ab	4.36	12.53	122.30±27.91ab	84.38	170.47

[a, b and c] mean values in columns are significantly different (P<0.05). Values are the mean±SD. The landscape of mudflat, spartina land, suaeda land and grass land can be abbreviated to G, M, J and H.

Soil physicochemical indices and vegetation characteristics

The data of plant height, average coverage, ground biomass and underground biomass were collected in the same place of soil samples. Compared to other vegetation communities, plant height, the ground and underground biomass of *Spartina* land were higher (Table 6). The average vegetation height of *Spartina* marsh, *Suaeda* marsh, and grass marsh were 1.50 m, 0.35 m and 0.70 m, respectively. Their average coverage was 87.5, 62.5 and 92.5%, respectively. The aboveground biomass of *Spartina* marsh was 1.14 kg/m2, which was the highest value. The underground biomass of *Spartina* marsh was the highest value similarly.

Table 6. Characteristics of vegetation under different landscapes.

	plant height（cm）	average coverage（%）	ground biomass（kg/m^2）	underground biomass（kg/m^2）
G	0	0	0	0
M	155	87.5	1.14	0.955
J	35	62.5	0.135	0.08
H	69.5	92.5	0.44	0.565

The relationship between the characteristic of plants and soil factors was shown in Table 7. Vegetation coverage had a significant positive correlation between soil organic matters. The correlation coefficient was 0.907. It also had a significant positive correlation between biomass and soil total nitrogen, including aboveground and underground biomass, which reflected the kind of interdependent relationship between vegetation characteristics and soil properties.

Table 7. Relationship between soil and vegetation characteristics.

	SM	SS	SOM	TN	TP	AP	AK
plant height	-0.520	-0.195	0.566	0.694	0.384	0.656	0.877*
average coverage	-0.861*	-0.624	0.907**	0.653	-0.437	0.459	0.417
ground biomass	-0.568	-0.294	0.506	0.907**	0.391	0.587	0.893*
underground biomass	-0.479	-0.224	0.451	0.875*	0.385	0.480	0.806*

** means significantly different (P<0.01), * means significantly different (P<0.05)

Discussions

We used the space for time substitution method to investigate the effects of time on landscape changes and found that grass land and *Spartina* land in the YNNR did show a generally increasing trend with time. Since the 2002, the reduction of *Suaeda* land has accelerated. The time of landscape evolution for one type can play an important role in the soil indicators. The longer time *Spartina* land settled, the lower content moisture, salinity of soil contained, the higher content of the soil nutrient contained, but the condition was just the reverse of *Suaeda* land. These findings are consistent with the temporal evolution trend observed for some soil properties (Li et al. 2007; Sun et al. 2011) and for biodiversity (Shen et al. 2006; Sun et al. 2012).

Soil properties improved as landscape evolved from mudflats to vegetation, as indicated by soil fertility such as organic matter, total nitrogen, and total phosphorus, available phosphorous and available potassium. An earlier study of the YNNR also found that moisture and salinity concentration levels decreased after vegetation settled and evolved (Yao et al. 2009). Soil properties differed significantly among evolution types. The variation of TN in the 10a<J<20a zone was much higher than in J>20a types. This could have occurred because the soil in J>20a zone of our study area is rather old when compared to 10a<J<20a and the soil nutrition easily lost with lower biomass of *Suaeda* land. Nutrient levels in the soil of *Spartina* land (10a<M<20a and M<10a) were high when compared to that in the *Suaeda* land, which is consistent with a study of *Spartina* in YNNR that revealed that higher biomass can improve and maintain soil fertility (Ren et al. 2011). Because of none disturbing of any human

activity, sampling sites was restricted along the unique road towards sea. The landscape is under the rule of belt shaped distribution along the coastline. The soil properties in the former studies (170-460mg/kg for TN, Mao et al. 2009; 550-850mg/kg for TP, Zhong et al. 2010) seems to have similar level than the soil in our study area (162-562mg/kg for soil TN, and 553-862mg/kg for TP, Table 4). However, when compared to the TN in surface sediments of agriculture nearby study area (830mg/kg) (Mao et al. 2010), and the concentration of soil organic matter in our study area was much lower.

Landscape of vegetation evolution depends on soil as the important environmental conditions. On the contrary, the characteristics of the vegetation community inevitably affect soil properties. The soil in one stage not only reflects the result of interaction between vegetation community and the soil before, at the same time also determines soil foundation and the initial state of subsequent vegetation community (Pang et al. 2004). Coastal wetland vegetation characteristics have important influence on the tidal flat soil. The vegetation coverage, distribution area, especially plant biomass can change the soil properties (such as nutrient content) (Mao et al. 2010). Due to the differences of vegetation coverage, biomass, plant height, root length, the accumulated rate of soil nutrient in sediments are vary (Ren et al. 2011).

The growth of *Spartina* grass plays a controlling role in tidal flat sedimentation with the advantage to the nutrient storage (Mayer et al. 1988). There were the highest height, the highest coverage and the highest biomass of *Spartina* land. It had a significant positive correlation between biomass and soil total nitrogen.

Although the results from this study were obtained from two sampling strips, the trend of change in landscape with time and variation of soil properties under different evolution stages can be used as a reference for other part of YNNR. Therefore, the results presented herein will provide scientific support for future management. The results about effects of time and landscape evolution on the soil also contribute to the overall understanding of the relationship between landscape patterns and processes.

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Determination of mushroom consumption preferences by using fuzzy analytic hierarchy process

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Abstract

Mushrooms are delicious, nutritious and consumed foods known as dietary and protein sources. Along with the rapid growth of the world population, the increasing tendency of people to alternate medicine has increased the consumption of mushrooms of which useful/medical features are revealed by scientific studies. As in every consumption behavior, consumption of mushrooms is also a result of preferences. The purpose of this study is to determine mushroom consumption preferences using the fuzzy analytical hierarchy process (AHP). First of all, it was created the analytic hierarchy process, which has the choice of mushrooms and (if any) sub-criteria. The generated AHP was converted into comparative matrices and replied to the experts. Received answers are transformed into fuzzy numbers and the importance levels of preferences are ranked according to their calculated weights.
Keywords: Fuzzy analytical hierarchy process, mushroom, consumption preference

Özet

Mantarlar, lezzetli, diyetetik ve protein kaynağı olarak bilinen ve tüketilen besinlerdir. Dünya nüfusunun hızla çoğalmasının yanında, insanların alternatif tıpa eğilimlerinin de artmasıyla birlikte tıbbi/faydalı özelliklerinin bilimsel çalışmalarla ortaya konan mantarların tüketim miktarları daha da artmıştır. Her tüketim davranışında olduğu gibi mantar tüketimi de birtakım tercihler sonucu oluşur. Bu çalışmanın amacı bulanık analitik hiyerarşi prosesi kullanarak mantar tüketim tercihlerinin belirlenmesidir. Öncelikle mantar seçimi tercihlerinin ve alt kriterlerinin olduğu analitik hiyerarşi prosesi oluşturmuştur. Oluşturulan AHP karşılaştırmalı matrisler haline getirilmiş ve uzman kişiler tarafından cevaplandırılmıştır. Alınan cevaplar bulanık sayılara dönüştürülerek tercihlerin önem düzeyleri, hesaplanan ağırlıklarına göre sıralanmıştır.
Anahtar kelimeler: Bulanık analitik hiyerarşi prosesi, mantar, tüketim tercihi

Introduction

The world population is growing rapidly, and people's feeding behavior is changing with the increased speed of population. People have tended to focus more natural products in order to be able to lead a healthy life. Mushroom is also one of the natural products. Because mushrooms have many medicinal properties such as antioxidant (Sevindik et al. 2018) antimicrobial (Baraza et al. 2016), anticancer (Patel and Goyal 2012) proven by scientific studies. In addition, 90-95% of the mushrooms are water (Manzi et al.2001) and so are a dietary nutrient. Also, mushrooms have low fat (Kavishree et al. 2008) and high protein (Danell and Eaker 1992), thus, making this group of foods more attractive. Especially in this sense, mushrooms can be suggested to close the protein lack of vegetarian people.

Many species of mushrooms are cultivated and produced throughout the world. The most commonly produced mushroom species in our country is *Agaricus bisporus*, known as the white parasol mushroom. This sorting is followed by *Pleurotus ostreatus* named beech mushroom on the market (Eren and Pekşen 2014). Although mushroom production in Turkey is not long before, it has a tendency to increase the production day by day. The mushroom production, which was 15,000 tons in 2004, reached 21,559 tons in 2010, and in 2017 it increased by 219% to 40,874 tons compared to 2004 (TUIK 2018).

There are some reasons why mushrooms are preferred, bought and consumed, as with other purchased product group. Many products are produced in order to satisfy unlimited consumers' desires and needs. These individual activities constitute consumption behaviors of people (Kızılaslan and Kızılaslan 2008; Zikmund and d'Amico 1998). Consumption is actually Multi-Criteria Decision Making (MCDM) behavior because it occurs by evaluating more than one criterion. MCDM is the final choice by resulting in the evaluation of the consequent limitations such as classification, sorting, elimination, etc. (Yoon and Hwang1995). There are many MCDM techniques in the literature that are also used in real life. One of them is the Analytical Hierarchy Process (AHP) developed by Satty in 1977 (Saaty 1977). This method is a mathematical method that evaluates both quantitative and qualitative priorities, taking into account the priorities that groups or individuals use when making decisions. However, using of crisp value to evaluate qualitative factors is a disadvantage of this method. In order to avoid this disadvantage, the use of fuzzy numbers instead of crisp numbers has been proposed (Karsak and Tolga 2001). Fuzzy numbers are a component of the concept of fuzzy logic. They were first proposed by Zadeh in 1965 (Zadeh 1965). In this theory, unclear expressions such as 'low', 'middle', 'high' are used instead of certain expressions such as 'yes' or 'no'. This allows the consumers to express themselves better, to reflect their feelings fully.

Some scientific researches have been carried out to determine the consumption of mushrooms and consumption habits in Turkey. Özkan et al. (2000) investigated the consumption of mushrooms and consumption behavior in Ankara and Antalya provinces. Like mentioned above, there are also researches of Kahramanmaraş and Trabzon province investigated by Paksoy and Aksüt (2012) and Yılmaz et al(2016)respectively. Knowing what consumers are paying attention to when purchasing goods or services is crucial to the continuity and profitability of the business for those who market or service the consumer behavior analysis service (Kızılaslan and Kızılaslan, 2008). The importance given to consumer behavior will provide both producers and consumers satisfaction. In this study, mushroom consumption preferences were determined using by the fuzzy analytical hierarchy process because of its superiority to classical AHP.

Material and Methods

In this study, the fuzzy AHP method developed by Buckley (1985) was implemented. This method has some steps to be used. Firstly, the experts evaluate each criterion and express linguistically the importance of each criterion. The fuzzy decision matrix is obtained in the data collected from the experts as below;

$$\tilde{C}^k = \left[c_{ij}\right]_{nxn} = \begin{bmatrix} 1 & \tilde{c}_{12} & \tilde{c}_{13} \dots & \tilde{c}_{1n} \\ \tilde{c}_{21} & 1 & \tilde{c}_{23} \dots & \tilde{c}_{2n} \\ . & . & . \dots & . \\ . & . & . \dots & . \\ \tilde{c}_{n1} & \tilde{c}_{n2} & \tilde{c}_{n3} \dots & 1 \end{bmatrix} \quad (1)$$

k=1, 2, ….., p

i, j=1, 2, …., n

where, $\tilde{C}^k$ is fuzzy decision matrix that represents the importance degrees of criteria given k[th] expert, p is the number of experts, n is the number of criteria. c_{ij} indicates the fuzzy comparison value of criterion i to creation j.

In the second stage, the linguistic answers given by experts for pairwise comparisons are transformed into triangular fuzzy numbers. The linguistic scale used to assess the main and sub-criteria in this study is shown in table 1.

Table 1. Linguistic expressions and corresponding triangular fuzzy numbers

Equally important	(1,1,1)
Moderately more important	(1,3,5)
Strongly more important	(3,5,7)
Very strongly more important	(5,7,9)
Demonstratively more important	(7,9,9)

If there are more than one expert in the evaluation of the criteria, the aggregation process is carried out. There are many aggregation methods such as weighted average and geometric average method. The geometric mean method is used in this study. Aggregated pairwise matrix is given in the following equation;

$$\tilde{C} = \begin{bmatrix} 1 & \tilde{c}_{12}\tilde{c}_{13} \dots \tilde{c}_{1n} \\ \tilde{c}_{21} & 1 \quad \tilde{c}_{23} \dots \tilde{c}_{2n} \\ . & . \quad . \quad \dots \quad . \\ . & . \quad . \quad \dots \quad . \\ \tilde{c}_{n1}\tilde{c}_{n2}\tilde{c}_{n3} \dots & 1 \end{bmatrix} \quad (2)$$

where $\tilde{C}$ is the aggregated pairwise comparison matrix. After the aggregated pairwise comparison matrix is obtained, the calculation of the criteria weights is performed. Fuzzy weight matrix is determined by Buckley's method as below;

$$\tilde{r}_i = (\tilde{c}_{i1} \otimes \tilde{c}_{i2} \otimes \dots \otimes \tilde{c}_{in})^{1/n} (3)$$

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_i + \tilde{r}_i + \dots + \tilde{r}_i)^{-1} (4)$$

where $\tilde{r}_i$ is the geometric mean of the fuzzy comparison value of criterion i to each criterion, $\tilde{w}_i$ is the fuzzy weight of the i[th] criterion. At last stage, defuzzification and normalization operations are applied. In this study, centroid method is used in order to convert the fuzzy weight into crisp value. Centroid method is defined as below,

$$w_i^c = \frac{w_l + w_m + w_u}{3} \quad (5)$$

where w_i^c is the crisp value of the i[th] criteria. w_l, w_m, w_u that represent triangular fuzzy numbers indicates the lower bound the middle value and the upper bound, respectively. These values should be normalized to be more understandable and comparable. The normalization process is performed as follows,

$$(w^N{}_i)^c = \frac{w_i^c}{\sum_{i=1}^{n} w_i^c} \quad (6)$$

Application

In this study, preferences of mushroom consumption were asked to the four experts. The two experts were selected from academicians who consume mushrooms at least once a week and who know the production of mushrooms. The remaining two experts were selected from the business man who trades mushrooms and specializes in consumer preferences All main and sub-criteria used in the study are given Figure 1.

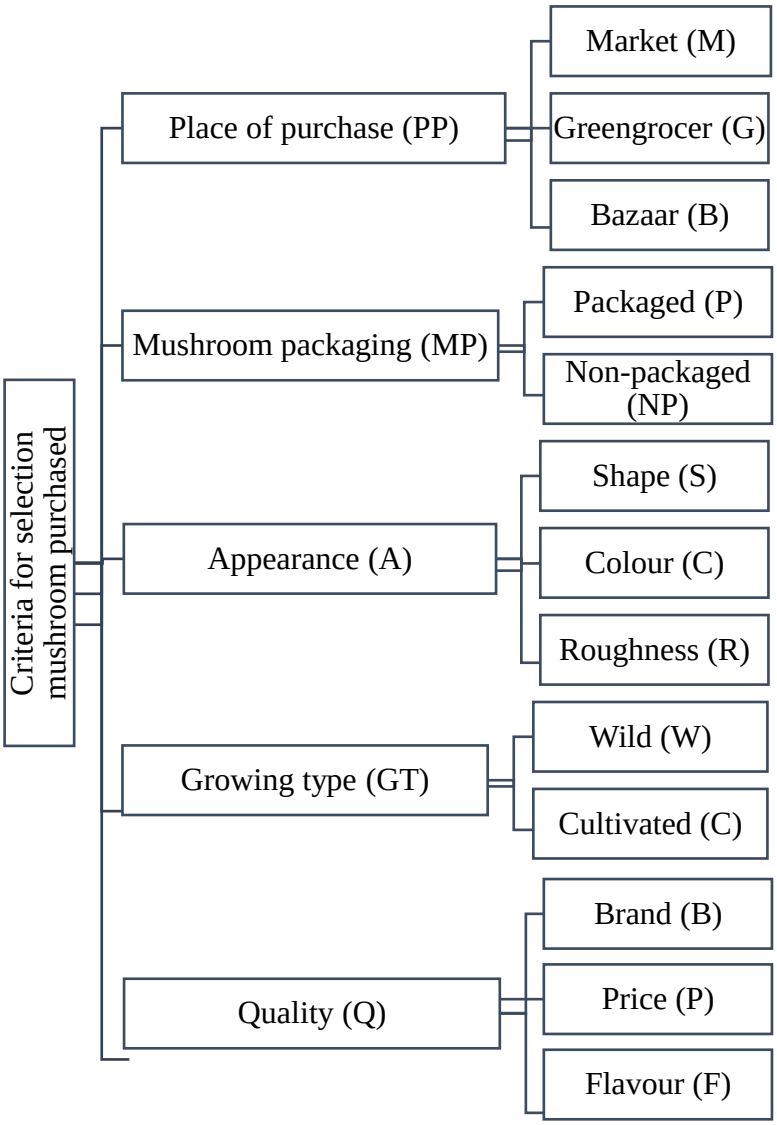

Figure 1. All main and sub-criteria used in the study

The linguistic answers given by experts have turned into fuzzy numbers. Linguistic terms used to evaluate the criteria and sub-criteria are given in Table 1.

The geometric mean method is used in this study to aggregate the preferences of four experts. Aggregated pairwise comparisons for the main criteria, place of purchase sub-criteria, mushroom packaging sub-criteria, appearance sub-criteria, growing type sub-criteria and quality sub-criteria are given in Table 2-7, respectively.

Table 2. Aggregated pairwise comparisons for the main criteria

	Place of Purchase (PP)	Mushroom Packaging (MP)	Appearance (A)	Growing type (GT)	Quality (Q)
PP	(1.000,1.000,1.000)	(0.377,0.447,0.577)	(0.354,0.386,0.467)	(0.128,0.155,0.252)	(0.118,0.137,0.192)
MP	(1.732,2.236,2.645)	(1.000.1.000.1.000)	(0.253,0.333,0.377)	(0.111,0.134,0.183)	(0.192,0.204,0.252)
A	(2.140,2.590,2.817)	(2.645,3.000,3.948)	(1.000.1.000.1.000)	(0.313,0.354,0.437)	(0.810,1.000,1.233)
GT	(3.956,6.422,7.770)	(5.438,7.453,9.000)	(2.284,3.000,3.474)	(1.000.1.000.1.000)	(0.863,0.939,1.064)
Q	(5.206,7.296,8.451)	(3.956,4.879,5.196)	(0.810,1.064,1.341)	(0.863,1.000,1.158)	(1.000.1.000.1.000)

Table 3. Aggregated pairwise comparisons for the 'place of purchase' sub-criteria

	Market (M)	Bazaar (B)	Greengrocer (G)
M	(1.000,1.000,1.000)	(1.967,4.212,6.299)	(1.495,2.140,2.590)
B	(0.158,0.237,0.508)	(1.000,1.000,1.000)	(0.332,0.508,0.939)
G	(0.386,0.467,0.668)	(1.064,1.967,3.006)	(1.000,1.000,1.000)

Table 4. Aggregated pairwise comparisons for the 'mushroom packaging' sub-criteria

	Packaged (P)	Non-packaged (NP)
P	(1.000,1.000,1.000)	(3.482,4.486,4.879)
NP	(0.204,0.222,0.287)	(1.000,1.000,1.000)

Table 5. Aggregated pairwise comparisons for the 'appearance' sub-criteria

	Shape (S)	Color (C)	Roughness (R)
S	(1.000,1.000,1.000)	(0.863,1.158,1.524)	(2.140,3.408,4.212)
C	(0.655,0.863,1.158)	(1.000,1.000,1.000)	(2.432,2.817,3.000)
R	(0.237,0.293,0.467)	(0.333,0.354,0.411)	(1.000,1.000,1.000)

Table 6. Aggregated pairwise comparisons for the 'growing type' sub-criteria

	Cultivated (C)	Wild (W)
C	(1.000,1.000,1.000)	(1.527,1.844,2.006)
W	(0.498,0.542,0.654)	(1.000,1.000,1.000)

Table 7. Aggregated pairwise comparisons for the 'quality' sub-criteria

	Brand (B)	Price (P)	Flavor (F)
B	(1.000,1.000,1.000)	(0.939,1.233,1.524)	(0.192,0.204,0.252)
P	(0.655,0.810,1.064)	(1.000,1.000,1.000)	(0.111,0.125,0.169)
F	(3.956,4.879,5.196)	(4.786,6.852,8.451)	(1.000,1.000,1.000)

The weights of criteria were calculated after the aggregation of pairwise comparisons according to Buckley's method. Then, the weights were defuzzificatied and normalized. The degrees of importance of all main and sub-criteria are given in Table 8.

Table 8. The degrees of importance of all main and sub-criteria

Main and sub-criteria	Fuzzy weights	Normalized crisp weights	Relative crisp weights
Place of Purchase (PP)	**(0.037,0.048,0.075)**	**0.051**	
Market (M)	(0.312,0.586,0.993)	0.564	0.028
Bazaar (B)	(0.081,0.139,0.306)	0.157	0.008
Greengrocer (G)	(0.162,0.274,0.494)	0.277	0.014
Mushroom Packaging (MP)	**(0.050,0.068,0.097)**	**0.069**	
Packaged (P)	(0.452,0.684,1.012)	0.688	0.047
Non-packaged (NP)	(0.254,0.315,0.402)	0.311	0.021
Appearance (A)	**(0.138,0.181,0.256)**	**0.185**	
Shape (S)	(0.310,0.465,0.657)	0.460	0.085
Colour (C)	(0.295,0.396,0.536)	0.394	0.072
Roughness (R)	(0.108,0.138,0.204)	0.144	0.026
Growing type (GT)	**(0.272,0.395,0.544)**	**0.389**	
Cultivated (C)	(0.379,0.545,0.776)	0.552	0.214
Wild (W)	(0.376,0.454,0.545)	0.447	0.173
Quality (Q)	**(0.219,0.306,0.417)**	**0.303**	
Brand (B)	(0.117,0.146,0.199)	0.150	0.045
Price (P)	(0.086,0.108,0.154)	0.113	0.034
Flavour (F)	(0.552,0.745,0.966)	0.735	0.222

Results

Criteria weights which calculated according to Buckley's method are compared each other. Figure 2 shows the degrees of importance for main criteria among themselves. The results can be ranked according to their importance as follows: growing type > quality > appearance > mushroom packaging > place of purchase. Consumers first consider the growing type of mushroom when they buy mushrooms. After the growing type of mushroom, the quality of the mushroom is the most important criterion for consumers.

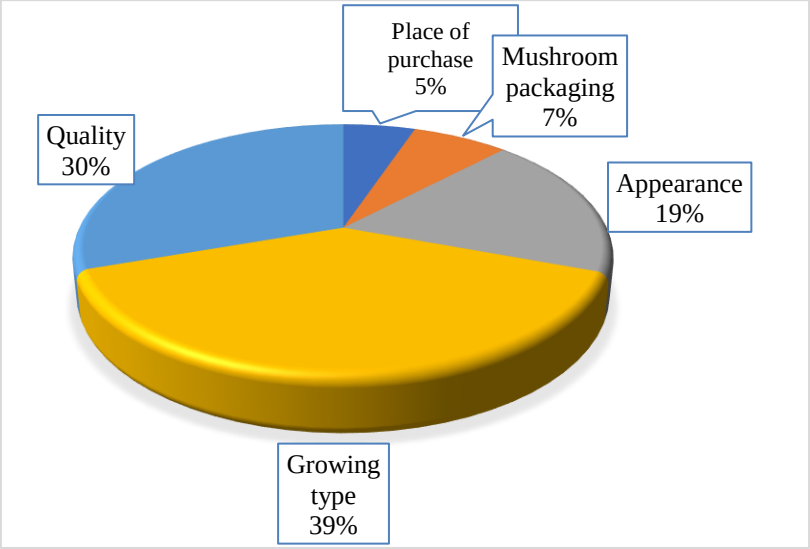

Figure 2. The degrees of importance for main criteria

The degrees of importance for the 'place of purchase' sub-criteria are shown in Figure 3. According to the results, consumers prefer to buy mushrooms primarily (56%) from the market. This result may be due to the higher confidence in the markets.

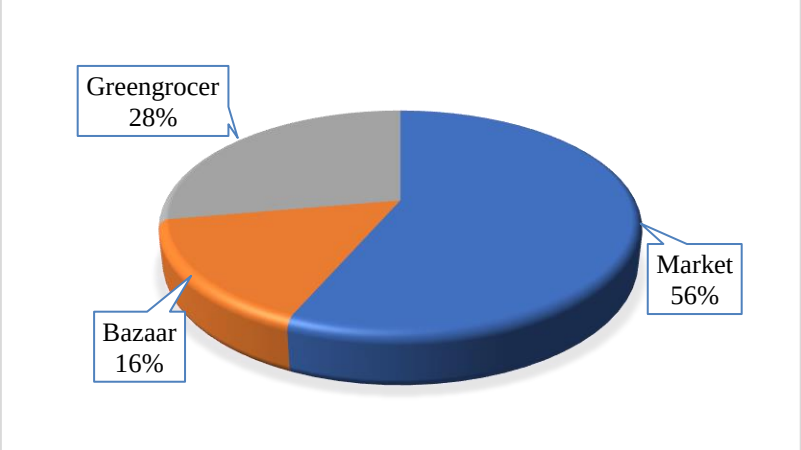

Figure 3. The degrees of importance for the 'place of purchase' sub-criteria

Figure 4 displays the sub-criteria of mushroom packaging. As can be seen, packaged mushroom is the more significant with 69% weight than non-packaged mushroom. it can be said that consumers find packaged products more reliable / healthier.

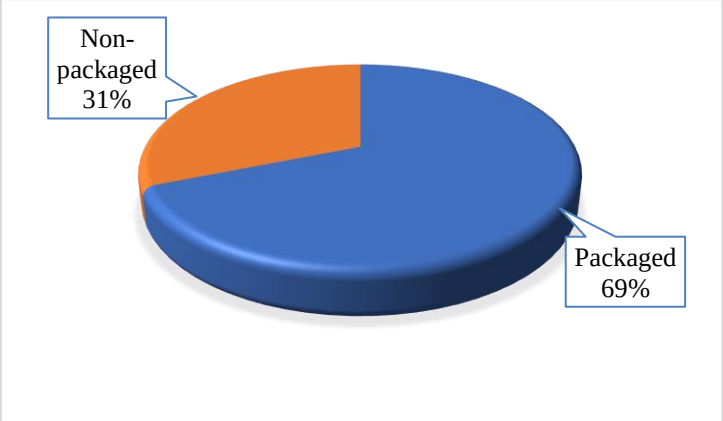

Figure 4. The degrees of importance for the 'mushroom packaging' sub-criteria

Figure 5. Displays the sub-criteria of appearance of mushroom. As can be seen at Figure 5, the most significant sub-criteria is shape of mushroom with %46 weight.

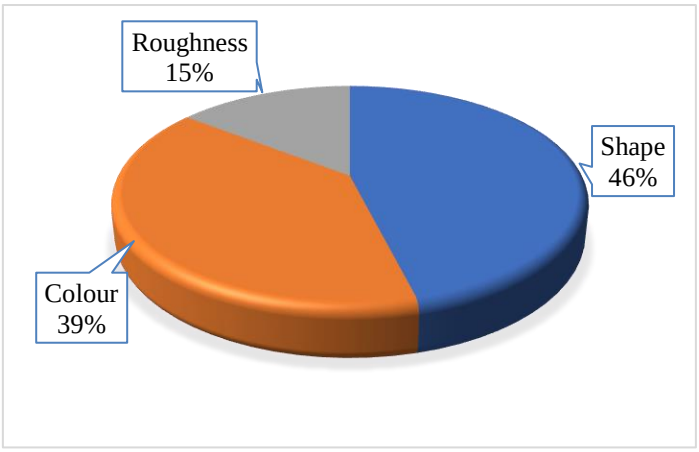

Figure 5. The degrees of importance for the 'appearance' sub-criteria

Figure 6, which examines the sub-criteria of growing type of mushroom, shows the cultivated mushrooms are important than wild mushrooms. Consumers may prefer cultivated mushrooms because of fear of poisoning of wild mushrooms.

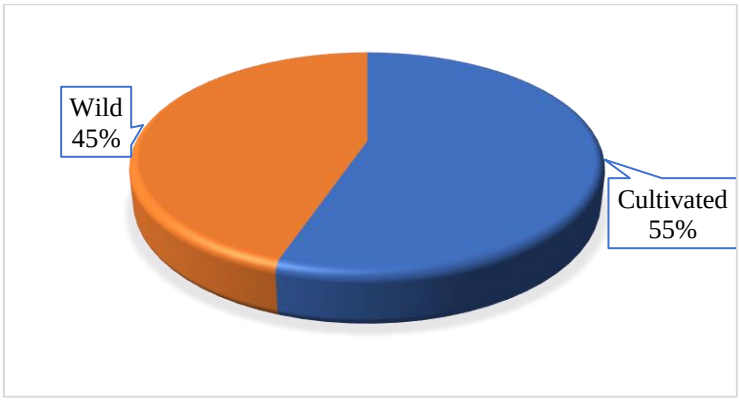

Figure 6. The degrees of importance for the 'growing type' sub-criteria

Figure 7 depicts the weights of the sub-criteria of mushroom quality. Among the all sub-criteria flavor of mushroom is the most significant criteria with %74 weight. According to the results, consumers pay less attention to brand and price of mushrooms %15 and % 11 weight, respectively.

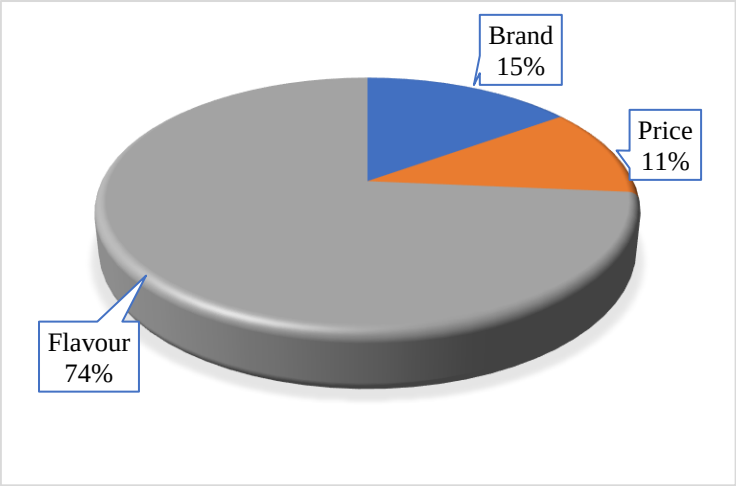

Figure 7. The degrees of importance for the 'quality' sub-criteria

Conclusion

In this study, mushroom consumption preferences were investigated using the fuzzy AHP. Surveys were answered by expert consumers. The important findings of the study can be listed as follows.

- Growing type of mushroom is the most significant criteria, among the all main criteria.
- The most important criteria is the market among the place of purchase sub-criteria.
- Packaged mushrooms are preferred ton on-packaged mushrooms.
- The weight of cultivated mushroom are higher than wild mushroom weight.
- When the mushroom quality sub-criteria are all evaluated together, flavour is the most important sub-criteria.

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Appendix

Appendix 1. Main criteria survey

	Demonstratively more important	Very strongly more important	Strongly more important	Moderately more important	Equally important	Moderately more important	Strongly more important	Very strongly more important	Demonstratively more important	
Place of Purchase										Mushroom Packaging
Place of Purchase										Appearance
Place of Purchase										Growing type
Place of Purchase										Quality
Mushroom Packaging										Appearance
Mushroom Packaging										Growing type
Mushroom Packaging										Quality
Appearance										Growing type
Appearance										Quality
Growing type										Quality

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Flora of Gürün district (Sivas) and its immediate surroundings

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Abstract

This study was carried out in order to reveal the flora of Sivas-Gürün county center and its environs which are located in Iran-Turan flora region and are under the influence of continental climate. In the field of research, between 2012 and 2015, 328 genera and 661 plant taxa belonging to 82 families were identified as a result of field studies carried out during the vegetation periods. 80 of these taxa are endemic. 10 of the families containing highest taxa were identified as Asteraceae (76 taxa, 14%), Fabaceae (46 taxa, 8%), Brassicaceae (45 taxa, 8%), Labiatae (44 taxa, 8% (42 taxa, 8%), Caryophyllaceae (26 taxa, 5%), and Scrophulariaceae (21 taxa, 4%) respectively. The phytogeographical distribution of the identified taxa consist of: 154 taxa (28%) Iranian-Turanian element, 35 taxa (6.4%) European-Siberian element and 16 taxa (3%) Mediterranean. Both of identified taxa are cosmopolitan. 148 taxa identified in the study were determined as new records for B6 square. As a result, Gürün county and its environs are very rich in terms of floristics and they are typical representatives of Iran-Turan flora region.

Keywords: Sivas, Gürün, B6, flora, botany

Özet

Bu çalışma karasal iklim etkisi altında olan ve İran-Turan flora bölgesi içinde yer alan Sivas-Gürün ilçe merkezi ve çevresinin florasını ortaya koymak amacıyla yapılmıştır. Araştırma alanında 2012-2015 yılları vejetasyon dönemlerinde yapılan arazi çalışmaları sonucunda 82 familyaya ait 328 cins ve 661 bitki taksonu tespit edilmiştir. Bu taksonlardan 80'i endemiktir. Tespit edilen taksonların dahil olduğu familyaların en fazla takson içeren 10 tanesi sırasıyla Asteraceae (76 takson, % 14), Fabaceae (46 takson, % 8), Brassicaceae (45 takson, % 8), Labiatae (44 takson, % 8), Poaceae (42 takson, % 8), Caryophyllaceae (26 takson, % 5), ve Scrophulariaceae (21 takson, % 4) familyalarıdır. Belirlenen taksonların fitocoğrafik dağılımı; 154 taksonla (% 28) İran-Turan elementi, 35 taksonla (% 6.4) Avrupa-Sibirya elementi, 16 taksonla (% 3) Akdeniz elementinden oluşmaktadır. Belirlenen 2 taksonda kozmopolittir. Çalışma kapsamında tespit edilen 148 takson ise B6 karesi için yeni kayıt olarak belirlenmiştir. Sonuç olarak Gürün ilçesi ve çevresi floristik açıdan çok zengin olup İran-Turan florası bölgesinin tipik bir temsilcisi durumundadır.

Anahtar Kelimeler: Sivas, Gürün, B6, flora, botanik

Giriş

Dünya genelindeki ekonomik gelişime ve sanayileşmeye paralel olarak insanoğlunun çevreye verdiği zararın geniş boyutlara ulaştığı günümüzde, geçde olsa doğada geriye kazanım çalışmaları hız kazanmıştır. Bu çalışmaların bilinçli bir şekilde ilerleyerek, başarıya ulaşması için biyolojik zenginliğin ortaya konulması gerekmektedir. Öyle ki, yok olmak üzere olan, azalan, nesli tükenme tehlikesi altında olan taksonların başka bir deyişle gen kaynaklarının ortaya çıkartılması telafisi mümkün olmayan kayıpların önlenmesine katkı sağlayacaktır. Bu bağlamda floristik çalışmalar, floranın anlaşılması,

türlerin yayılış alanlarının daha iyi bir şekilde belirlenmesi ve varsa yeni türlerin saptanması açısından önemli bir katkı sağlamaktadır.

Ülkemiz bulunduğu coğrafi konum, farklı flora bölgelerinin kesişiminde bulunması, farklı iklim ve habitatlara sahip olması nedeni ile oldukça zengin bir floraya sahiptir. Dünyanın en önemli flora bölgelerinden birisi olan ülkemizde bugüne kadar yapılan floristik çalışmalar sonucunda, 11.931 bitki taksonu tespit edilmiştir ve bu zenginlik içerisinde 4028 takson endemiktir (Güner ve diğ., 2012; Özhatay ve diğ., 2017).

Bu floristik zenginlik genel hatlarıyla tanımlanmış olmakla beraber, floristik çalışmalar (Yıldırımlı, 1994; Mutlu ve Erik, 1996; Dönmez, 1998; Akpulat ve Çelik, 2005; Karakuş, 2009; Tunçkol ve Akkemik, 2013; Kılıç ve diğ., 2017; Yüce Babacan ve Eker, 2017), Türkiye'nin birçok yerinde halen yeni taksonların ve kareler için yeni kayıtların olduğunu göstermektedir. Bu çalışmalar aynı zamanda endemik taksonların da yayılış alanlarının daha da detaylı saptanmasına olanak sağlamaktadır.

Flora ve endemik takson çeşitliliğinin fazla olduğu alanlardan biri de büyük flora alanlarının geçişinde yer alan kısımlardır. Örneğin Anadolu çaprazı olarak adlandırılan alan floranın zengin ve endemik tür çeşitliliğinin fazla olduğu yerlerden biridir (Kaya ve Aksakal, 2005). Araştırma alanı İç Anadolu Bölgesi içinde yer almakta olup Anadolu çaprazına komşudur. Bu bölgenin Doğu ve Güneydoğu Anadolu Bölgesine geçiş bölgesinde yer alması nedeni ile bitki çeşitliliğinin fazla olması, yörede artan turizm faliyetlerinin ve yapılaşmanın varlığı, alanda flora üzerine olumsuz etkilerin belirlenmesi bu alanın çalışma alanı olarak seçilmesinin temel nedenleri arasında yer almaktadır.

Çalışmamıza konu olan Gürün ilçesinde yapılan floristik çalışmalardan Karakuş (2009)'un "Tohma vadisi (Gürün-Darende) Florası" ile ilgili yaptığı yüksek lisans çalışmasında alanda 80 familya, 312 cins ve 680 tür tespit edilmiştir. (Karakuş, 2009). Dönmez (1998) ise "Gövdeli Dağı (Kayseri-Sivas) Florası" ile ilgili yaptığı doktora çalışmasında alanda 82 familya, 383 cins, 965 tür saptamıştır. Alanda en yoğun bulunan familyaları *Asteraceae* (133), *Fabaceae* (90), *Lamiaceae* (78), *Brassicaceae* (76), *Caryophyllaceae* (67), *Poaceae* (54), *Apiaceae* (39), *Liliaceae* (39), *Rosaceae* (37), *Scrouphulariaceae* (34) olarak tespit etmiştir. En büyük cins ve tür sayılarını ise *Astragalus* (32), *Silene* (23), *Alyssum* (16), *Centaurea* (15), *Salvia* (14), *Veronca* (13), *Minuartia* (12), *Allium* (11), *Dianthus* (9), *Euphorbia* (9) olarak belirlemiştir.

Bu çalışma ile Gürün ilçesi ve yakın çevresinin florası sistemli bir biçimde araştırılarak yöreyle ilgili güncel bir flora kaydının ortaya konulması, alanın içinde yer aldığı B6 karesi için yeni kayıtların ve endemik bitkilerin tespitinin yapılması amaçlanmıştır.

Materyal ve yöntem

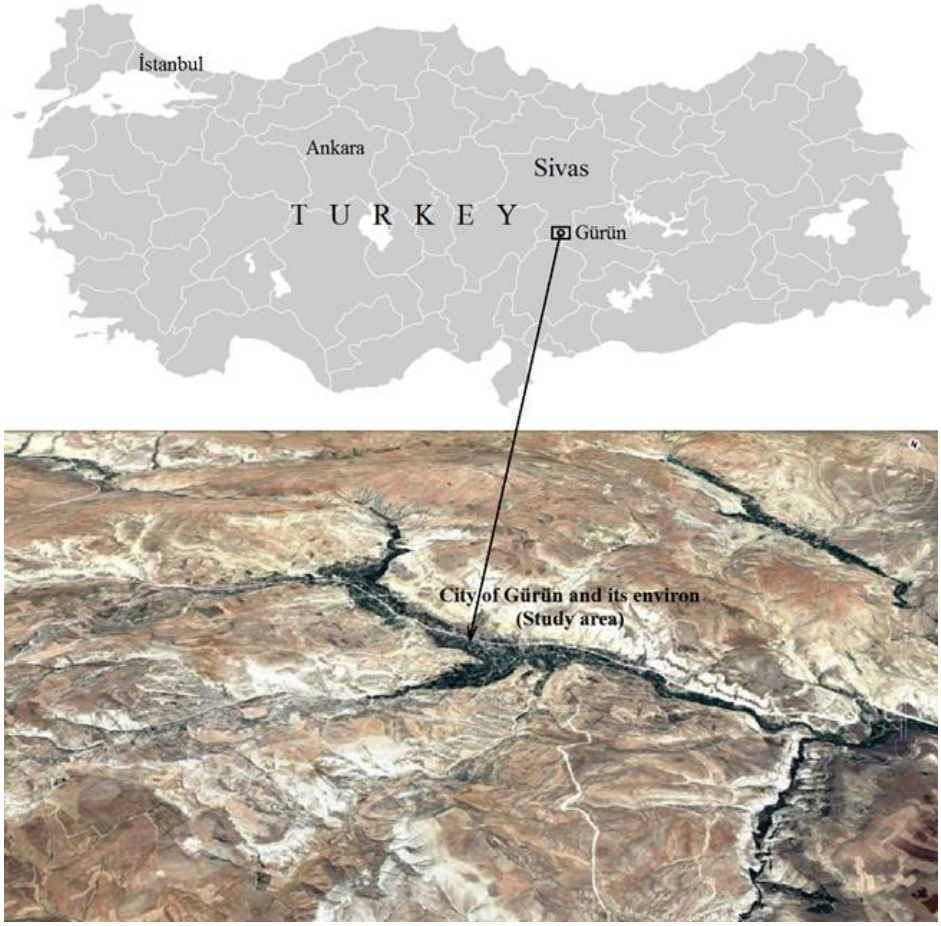
Çalışma Alanı

Araştırma alanının yer aldığı Gürün ilçe merkezi, Sivas'ın güneyinde il merkezine 137 km uzaklıkta bulunan Akdeniz Bölgesi, Doğu Anadolu Bölgesi ve İç Anadolu Bölgesinin kesiştiği; $37^0$04'31" doğu boylamı ile $38^0$43'05"-$38^0$58'28" kuzey enlemleri arasında yer almaktadır. Üç bölgeyi birbirine bağlayan "anahtar şehir" konumundaki Gürün, Tohma Havzası'nın da en önemli mevkiinde bulunmaktadır. Doğusunda Malatya'ya bağlı Darende ve Kuluncak, güneyinde Kahramanmaraş'a bağlı Elbistan ve Afşin, batısında Kayseri'ye bağlı Pınarbaşı ve Sarız, kuzeyinde ise Kangal ilçeleriyle çevrilmiş olup 2792 km^2 yüzölçümüne sahiptir (Şekil 1).

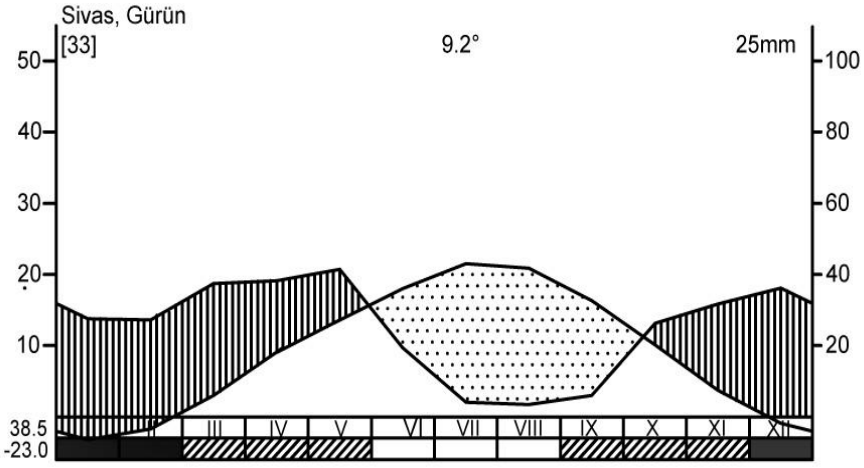
Tarih boyunca yerleşim alanı olarak kullanılan ve önemli bir ulaşım ağının da merkezinde bulunan Gürün ilçesi, genellikle yüksek bir plato görünümündedir. Yer yer bu platoyu kesen dereler derin

kanyonlar oluşturmaktadır. Ayrıca jeolojik yapısı, akarsuları ve gölleri ile doğal peyzaj karakteristikleri açısından da önemli bir yerleşim merkezidir.

Rakımı 1250 m olan ilçe, yüzey şekilleri bakımından da dağlık ve engebeli bir yapıya sahiptir. Alanda bulunan toprakların tekstürü tınlı, kumlu-tınlı ve kumlu-killi-tınlı bünyeye sahiptir. Diğer bir anlatımla orta bünyeli topraklardan oluşmaktadır (Günek, 1995). İlçenin toprakları, genellikle yörede görülen yarı kurak iklim şartları ve bu iklim şartlarında havza tabanlarında oluşan step ve havza çevresindeki ormanların tahribi ile sahaya yerleşen antropojen step vejetasyonunun özelliklerini yansıtan topraklardan oluşmaktadır. Dolayısıyla bu tür bir özellik gösteren alan topraklarının karakterine sahiptir (Boyraz, 2003). Gürün ilçesinin bağlı olduğu Kayseri Meteoroloji Bölge Müdürlüğünden (2015) alınan veriler doğrultusunda ilçenin 1964-1996 (Daha sonraki yıllara ait veriler Gürün meteoroloji istasyonu kapatıldığından elde edilememiş ancak meteoroloji istasyonuna göre yaklaşık veriler olduğu doğrulanmıştır) yılları arasındaki meteorolojik verileri incelendiğinde yıllık ortalama sıcaklığın 9,2 C^0 olduğu, ortalama en düşük sıcaklığın -7 C^0 ile ocak ayında, en yüksek sıcaklığın ise 29,9 C^0 ile ağustos ayında yaşandığı görülmektedir. En fazla yağış 117,2 mm ile ilkbaharda görülmekte olup ortalama yıllık yağış miktarı 300 mm'dir (Şekil 2). İklim açısından değerlendirildiğinde alan, karasal iklimin etkisi altında yer almaktadır.



Şekil 1: Araştırma alanının konumu.
Figure 1: Location of the research area.



Şekil 2: Walter Yöntemi'ne göre Gürün ilçesi sıcaklık ve yağış ilişkisini gösteren iklim diyagramı.
Figure 2: According to Walter's method, Gürün district is the climate diagram showing the relationship between temperature and precipitation.

Örneklerin toplanması ve teşhisler

Çalışma alanındaki doğal ve egzotik bitkilerden toplam 3251 bitki örneği toplanmıştır. Toplanan bitkilerin coğrafi konumları ve yükseltileri kaydedilmiştir. Alınan örnekler, herbaryum tekniğine uygun olarak kurutulmuş, etiketlenmiş ve herbaryum materyalleri haline getirildikten sonra İ.Ü. Orman Fakültesi ISTO Herbaryumuna getirilmiş, burada uygun durumdaki örneklere ISTO no verilerek kayıt altına alınmıştır. Teşhislerde başta ISTO Herbaryumu referans örnekleri olmak üzere, yukarıda verilen kaynaklardan da faydalanılmıştır. Teşhis edilen örnekler, flora bölgelerine göre gruplandırılmış, endemizm durumları saptanmış ve çalışma alanının frositik özellikleri değerlendirilmiştir.

Bu çalışma kapsamında Türkiye'nin florası ile ilgili P.H. Davis tarafından yapılan sınıflandırma kullanılmıştır. Çalışma kapsamında bölgenin florasının belirlenebilmesi için ilk olarak Davis (1965-1985)'in Flora of Turkey adlı çalışması ile Polunin (1981), Zohary (1966-1972), Yaltırık ve Efe (1996)'nin eserlerinin yanı sıra Gürün ve yakın çevresinde Dönmez (1999) tarafından yapılan doktora çalışması (Gürün Gövdelidağı ve yakın çevresinin floristik kompozisyonu) ve Karakuş (2009) tarafından yapılan (Gürün-Darende arası florası) yüksek lisans çalışması incelenmiştir. Bunun yanı sıra internet ortamında yer alan yurt içi ve yurt dışı bitki türlerinin herbaryum örneklerini sunan sayfalar da incelenmiştir (Anonim-a, Anonim-b, Anonim-c). Ayrıca bitkilerin tehdit kategorilerinin belirlenmesinde Ekim vd., (2000) tarafından hazırlanan "Türkiye Bitkileri Kırmızı Kitabı" dikkate alınmıştır.

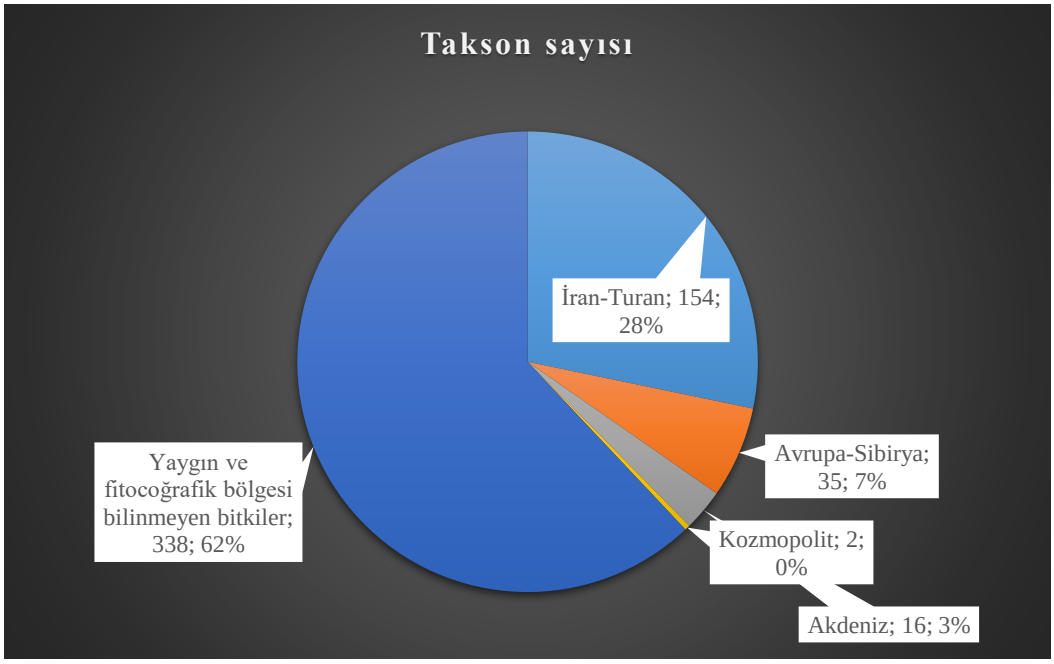
Bulgular

Araştırma alanında toplanan 3251 örneğin teşhisi yapılmış ve 82 familyaya ait 328 cinse dâhil 545 doğal takson saptanmıştır (Ek-1, Ek-2). Araştırma alanı ile ilgili tespit edilen bulgular aşağıda başlıklar halinde verilmiştir.

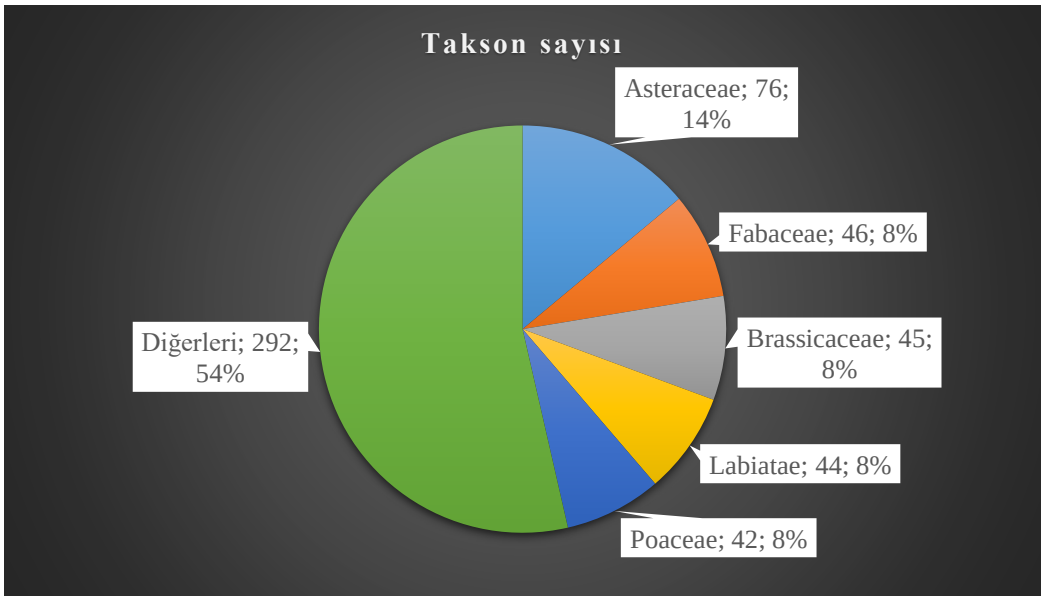
Floraya ilişkin bulgular

Bu çalışma ile Gürün ilçe merkezi ve yakın çevresinde 82 familyaya ait 328 cins ve 661 bitki taksonu tespit edilmiştir. Bu taksonlardan 545'i doğal olup 4 tanesi Pteridophyta, 541 tanesi ise Spermatophyta'dır. Bu 541 Spermatophyta'nın 4 tanesi Gymnospermae, 537'si Angiospermae'dir. Belirlenen taksonların fitocoğrafik bölgeler içindeki dağılımı Şekil 3'de gösterilmiştir. Taksonların önemli bir kısmı İran-Turan elementidir.

En çok bitki türünü içeren ilk 5 aile ve bu ailelerdeki takson sayısının toplam flora sayısına oranı Şekil 4'de verilmiştir. Araştırma alanında, Asteraceae ailesi 76 (% 14) takson ile en yüksek sayıda taksonu içerir. Alanda diğer yüksek sayıda takson içeren aileler: Fabaceae-46 takson (% 8), Brassicaceae-45 takson (% 8), Labiatae-44 takson (% 8), Poaceae-42 takson (% 8)'dir.



Şekil 3: Araştırma alanında tespit edilen türlerin fitocoğrafik bölgelere göre dağılımı.
Figure 3: Distribution of species determined in the research area according to phytogeographical regions.



Şekil 4: En çok bitki türünü ve bunların oranlarını içeren 5 familya.
Figure 4: Five families including the most plant species and their proportions.

Gürün ilçe merkezi ve yakın çevresi zengin bir floraya sahiptir. Özellikle açık alanların fazlalığı, ormanlık alanların seyrek ve kapalılığının oldukça düşük olması otsu bitki çeşitliliğini artıran önemli faktörlerden biridir.

3.2. Endemik bitkilere ilişkin bulgular

Araştırma alanında 19 familyaya ait 80 endemik takson belirlenmiş olup alanın endemizm oranı % 14,67'dir (Tablo 1; Şekil 5). Belirlenen bu endemik taksonların 61 tanesi İran-Turan, 3 tanesi ise Akdeniz fitocoğrafik bölgesine aittir. Bu taksonların tehdit kategorileri değerlendirildiğinde, bunların 55'inin en az tehlikede olduğu, 6'sının nesli tükenme tehlikesi altında olduğu (*Tchihatchewia isatidea* Boiss., *Arenaria sivasica* Kit Tan & Sor., *Fumana trisperma* Hub.-Mor. & Reese, *Helianthemum germanicopolitanum* Bornm., *Astragalus brachypterus* Fisch., *Marrubium globosum* Montbret & Auch.), 6'sının hassas olduğu (*Acantholimon acerosum* (Willd) Boiss. ssp. *parvifolium* Bokhari, *Paronychia cataonica* Chaudhri, *Astragalus melitenensis* Boiss., *Cousinia sivasica* Hub-Mor., *Tanacetum densum* Schul. Bip. ssp.*sivasicum* Hub.-Mor.& Gri., *Salvia eriophora* Boiss. &Kot.), 9'nun tehdit altında olmaya yakın türler (*Haplophyllum telephioides* Boiss., *Alyssum caespitosum* Baumg., *Matthiola anchoniifolia* Hub.-Mor., *Dianthus zederbaueri* Vierh., *Hypericum thymopsis* Boiss., *Hedysarum candissimum* Frey., *Thymus pectinatus* Fisch.&Mey. var. *pectinatus*, *Verbascum natolicum* Hub.-Mor., *Elymus erosiglumis* Melderis) olduğu tespit edilmiştir. Ayrıca bu endemik türlerden *Onosma bornmuelleri* Haus.&Born., *Achillea cappadocica* Hskn.&Bornm. *Helianthemum germanicopolitanum* Bornm., *Anthemis aciphylla* Boiss. var. *aciphylla* ve *Alcea calvertii* (Boiss.) Boiss. B6 karesi için yeni kayıttır.

Tablo 1: Gürün ilçe merkezi ve çevresinde endemik taksonlar ve tehdit kategorileri.
Table 1: Endemic taxa and threat categories in and around Gürün district.

ANGİOSPERMAE-DİKOTİLEDON	**Familya**	**Bitki Adı**	**Element**	**Tehdit Kategorisi**
	ACANTHACE	*Acanthus hirsutus* Boiss.	-	LC
	PAPAVERACEAE	*Glaucium acutidentatum* Hausskn. & Bornm.	**Ir-Tur.**	LC
		Papaver triniifolium Boiss.	**Ir-Tur**	LC
	PLUMBAGINACEAE	*Acantholimon acerosum* (Willd) Boiss. ssp. *parvifolium* Bokhari	**Ir-Tur.**	VU
	RUBIACEAE	*Asperula stricta* Boiss. ssp. *latibracteata* (Boiss.) Ehrend.	**Ir-Tur.**	LC
	RUTACEAE	*Haplophyllum myrtifolium* Boiss.	**Ir-Tur.**	LC
		Haplophyllum telephioides Boiss.	**Ir-Tur.**	NT
	CRUCIFERA	*Aethionema lepidioides* L.	**Ir-Tur.**	EN
		Alyssum caespitosum Baumg.	**Ir-Tur.**	NT
		Alyssum lepidoto-stellatum (Hausskn.&Bornm.)	**Ir-Tur.**	LC
		Alyssum macropodum Boiss.&Bal. var. *macropodum*	**Ir-Tur.**	LC
		Alyssum pateri Nyar ssp. pateri	**Ir-Tur.**	LC
		Alyssum stylare (Boiss.&Bal.)	**Ir-Tur.**	LC
		Erysimum uncinatifolium Boiss.	-	LC
		Isatis aucheri Boiss.	**Ir-Tur.**	LC
		Matthiola anchoniifolia Hub.-Mor.	**Ir-Tur.**	NT
		Tchihatchewia isatidea Boiss.	**Ir-Tur.**	EN
	CARYOPHYLLACEAE	*Arenaria acerosa* Boiss.	-	LC
		Arenaria ledeboriana Fenzl var. *parviflora* Boiss.	**Ir-Tur.**	LC
		Arenaria sivasica Kit Tan & Sor.	**Ir-Tur.**	EN
		Dianthus zederbaueri Vierh.	**Ir-Tur.**	NT
		Saponaria prostrata Willd. ssp. *anatolica* Hedge	**Ir-Tur.**	LC
		Silene caryophylloides (Poiret) Otth in DC. ssp. *stentoria*	**Ir-Tur.**	LC
	CISTACEAE	*Fumana trisperma* Hub.-Mor. & Reese	**Ir-Tur.**	EN
		Helianthemum germanicopolitanum Bornm.	-	EN

	GUTTIFERAE	*Hypericum thymopsis* Boiss.	**Ir-Tur.**	NT
	ILLECEBRACEAE	*Paronychia cataonica* Chaudhri	**Ir-Tur.**	VU
	LEGUMINOSAE	*Astragalus campylosema* Boiss. ssp. *campylosema*	**Ir-Tur.**	LC
		Astragalus condensatus Ledeb.	**Ir-Tur.**	LC
		Astragalus brachypterus Fisch.	**Ir-Tur.**	EN
		Astragalus hirsitus Vahl.	-	LC
		Astragalus lamarckii Boiss.	**Ir-Tur.**	LC
		Astragalus melitenensis Boiss.	**Ir-Tur.**	VU
		Astragalus noeanus Boiss.	**Ir-Tur.**	LC
		Ebenus laguroides Boiss. var. *laguroides*	**Ir-Tur.**	LC
		Hedysarum aucheri Boiss.	**Ir-Tur.**	VU
		Hedysarum candissimum Frey.	**Ir-Tur.**	NT
		Hedysarum pestallozzae Boiss.	**Ir-Tur.**	LC
		Hedysarum pogonocarpum Boiss.	-	LC
		Onobrychis armena Boiss.&Huet	-	LC
	MALVACEAE	*Alcea calvertii* (Boiss.) Boiss.	**Ir-Tur.**	LC
	APIACEAE	*Bupleurum heldreichii* Boiss. & Bal.	**Ir-Tur.**	LC
	ASTERACEAE	*Achillea cappadocica* Hskn.&Bornm.	**Ir-Tur.**	LC
		Anthemis aciphylla Boiss. var. *aciphylla*	**D. Akd.**	LC
		Anthemis armeniaca Freyn & Sint.	**Ir-Tur.**	LC
		Cousinia sivasica Hub-Mor.	-	VU
		Hieracium bornmuelleri Freyn.	-	LC
		Scorzonera suberosa C.Koch	**Ir-Tur.**	LC
		Scorzonera tomentosa L.	**Ir-Tur.**	LC
		Tanacetum densum Schul. Bip. ssp. *sivasicum* Hub.-Mor.& Gri.	**Ir-Tur.**	VU
		Tragopogon aureus Boiss.	-	LC
		Tripleurospermum monticolum Bornm.	-	LC
	CONVOLVULACEAE	*Convolvulus galaticus* Rot. ex Cho.	**Ir-Tur.**	LC
	CAMPANULACEAE	*Asyneuma limonifolium* (L.) Janchen	-	LC
		Asyneuma linifolium (Boiss. & Heldr.) Bornm. ssp. *linifolium*	**D. Akd.**	LC
	BORAGINACEAE	*Nonea stenosolen* Boiss.	**Ir-Tur.**	LC
		Onosma bornmuelleri Haus.&Born.	**Ir-Tur.**	LC
		Paracaryum cappadocicum Boiss&Bal.	**Ir-Tur.**	LC
		Paracaryum cristatum Boiss. ssp. *cristatum*	**Ir-Tur.**	LC
	LAMIACEAE	*Marrubium cephalanthum* Boiss.& Noë	**Ir-Tur.**	LC
		Marrubium globosum Montbret & Auch.	**Ir-Tur.**	EN
		Phlomis armeniaca Willd.	**Ir-Tur.**	LC
		Salvia cryptantha Monb.&Auch.	**Ir-Tur.**	LC
		Salvia eriophora Boiss. &Kot.	**Ir-Tur.**	VU
		Salvia hypargeia Fisch. & Mey.	**Ir-Tur.**	LC
		Scutellaria orientalis ssp. *bicolor*	**Ir-Tur.**	LC
		Scutellaria orientalis ssp. *pectinata* (Benth.)	**Ir-Tur.**	LC
		Sideritis libanotica Labill. ssp. *linearis* Bornm.	-	LC
		Stachys cretica L. ssp. *anatolica* Rech.	**Ir-Tur.**	LC
		Thymus cappadocicus Boiss. var. *globifer* Jalas	-	VU
		Thymus pectinatus Fisch.&Mey. var. *pectinatus*	**Ir-Tur.**	NT
		Thymus sipyleus Boiss. ssp. *sipyleus*	-	DD
	SCROPHULARIACEAE	*Linaria corifolia* Desf.	**Ir-Tur.**	LC

		Scrophularia libanotica Boiss. var. *cappadocica* R.Mill	**Ir-Tur.**	LC
		Verbascum natolicum Hub.-Mor.	**Ir-Tur.**	NT
		Veronica cinerea Boiss.&Bal.	**D. Akd.**	LC
ANGİOSPERMA-MONOKOTİLEDON	IRIDACEAE	*Iris sari* Schott ex Baker	**Ir-Tur.**	LC
		Iris schachtii Markgr	**Ir-Tur.**	LC
	GRAMINEAE	*Elymus erosiglumis* Melderis	**Ir-Tur.**	NT
		Festuca anatolica Markgr.-Dannenb. ssp. *anatolica*	-	LC

Yeni kayıtlara ilişkin bulgular

Bu çalışma ile B6 karesinde 148 yeni bitki türü kaydedilmiştir. Ek-1'de gri renkli boyanmış türler B6 karesi için yeni kayıtlardır. Yeni kayıtlar fitocoğrafik bölgelere göre değerlendirildiğinde, bunların 6 tanesinin Akdeniz'e, 17'sinin Avrupa-Sibirya'ya ve 19'unun ise İran-Turan fitocoğrafik bölgelerine ait olduğu tespit edilmiştir (Davis, 1965-1985). Endemik türlerin haricindeki diğer türlerin de genellikle İran-Turan ve Avrupa-Sibirya fitocoğrafik bölgesi içinde yer alan türler olduğu tespit edilmiştir.

Tartışma ve Sonuç

Bu çalışma ile alanda 82 familyaya ait 328 cins ve 661 bitki taksonu tespit edilmiştir. Bu taksonlardan 545'i doğal olup 4 tanesi Pteridophyta, 541 tanesi ise Spermatophyta'dır. Bu 541 Spermatophyta'nın 4 tanesi Gymnospermae, 537'si Angiospermae'dir. Belirlenen taksonların 154'ü İran-Turan elementi, 35'i Avrupa-Sibirya elementi, 16'sı Akdeniz elementidir. Belirlenen 2 takson da kozmopolittir. Alanda belirlenen bu taksonların yoğun olarak İran-Turan fitocoğrafik bölgesine ait olmasının nedeni bu bölgenin etkisi altında olmasıdır. Ancak bölgenin güney yamaçlarında ise çok az da olsa Akdeniz elementine ait taksonlar da tespit edilmiştir. Ayrıca alanda tespit edilen taksonların 148'i ise B6 karesi için yeni kayıt, 80'i endemiktir. Belirlenen bu endemik taksonlardan 6'sı nesli tükenme tehlikesi altında, 6'sı hassas, 9'u da tehdit altında olmaya yakın taksonlardır. Bulgular kısmında detaylı bir şekilde değinilen bu 21 endemik türün alanda korunması çok gerekli ve önemlidir.

Çalışma kapsamında belirlenen taksonların daha önce bu alanda çalışma yapan Karakuş (2009) ve Dönmez (1998)'in çalışmaları ile benzerlik gösterdiği belirlenmiştir. Özellikle Tohma vadisi boyunca çalışma yapan Karakuş'un çalışmasında belirlenen 80 familya, 312 cins ve 680 taksonun bu çalışmada tespit edilen takson ve takson sayısı ile büyük oranda örtüştüğü, daha çok kırsal ve dağlık alanlarda tespit edilen taksonların da Gövdeli Dağı florasını çalışan Dönmez (1998)'in çalışması (82 familya, 383 cins, 965 tür) ile büyük oranda örtüştüğü tespit edilmiştir.

Sonuç olarak bu çalışma Gürün ilçesi ve çevresinin floristik açıdan ne denli zengin olduğunu ve İran-Turan floristik bölgesinin tipik bir temsilcisi olduğunu göstermesi açısından önemli bir çalışma olmuştur. Ayrıca bu çalışma Türkiye florasının zenginliğini belirlemek için floristik çalışmaların halen gerekli olduğunu ortaya koymuştur.

Öneriler

Çalışma alanı olan Gürün ilçesinde ikinci konut yapımının artması ve aşırı otlatma nedeniyle başta endemik taksonların dağılımı olmak üzere nadir ve doğal türler olumsuz yönde etkilenmektedir. Araştırma kapsamında tespit edilen endemik türlerin çoğu da alanın yüksek, dağlık bir plato özelliği göstermesi nedeniyle insan müdahalesinin olmadığı alanlarda tespit edilmiştir. Bu floristik çeşitliliğin ve birçok alana göre sayısı bir hayli fazla olan endemik türlerin korunması için alandaki yapılaşmanın

kontrollü bir şekilde planlanması gerekmektedir. Endemik türlerin yoğun olarak görüldüğü alanlar yapılaşmanın dışında tutulması gereklidir.

Bu tür çalışmalar belirli bir bölgedeki türlerin teşhisi, doğal bitki örtüsünün ve endemik türlerin tanınması ve bu türlerin korunması için büyük önem arz etmektedir. Ayrıca bu tür çalışmalar Türkiye'nin doğal zenginliklerinin korunması ve gelecek nesillere aktarılması için de oldukça önemlidir. Ülkemizin bu şekilde çalışılmamış daha çok sayıda bölgesi bulunmaktadır. Bu çalışma ile flora çalışmalarına ilişkin bir boşluk doldurulmuş, bölgenin endemik, nadir ve doğal türleri, insan yerleşimlerindeki egzotik türlerin tespiti yapılmış, kentleşmenin etkilerine ilişkin bulgulara ulaşılmıştır. O nedenle bu türden çalışmaların devam etmesi ülkemiz için yararlı olacaktır.

Teşekkür

Bu çalışma İstanbul Üniversitesi Bilimsel Araştırma Projeleri Yürütücü Sekreterliğinin 41382 numaralı "Gürün (Sivas) ilçe merkezinin biyotoplarının özellikleri ve haritalanması üzerine araştırmalar" adlı doktora tezi projesi olarak desteklenmiştir.

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Ek 1: Araştırma alanında tespit edilen doğal taksonların listesi.
Appendix 1: List of natural taxa identified in the research area.

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
1	CUPRESSACEAE	*Juniperus excelsa* M.Bieb.	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37367
2		*Juniperus oxycedrus* L. ssp. *oxycedrus*	Gökpınar Yolu Badem Toplulukları	38.43764-037.15368	1459	21.07.2015	37368
3	EQUISETACEA	*Equisetum ramosissimum* Desf.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1440	21.07.2015	37447
4	EPHEDRACEA	*Ephedra major* Host.	Suçatı Kalaycık Mevki	38.51333-094.47.941	1436	20.05.2015	37525
5	PINACEAE	*Pinus nigra* L. ssp. *pallasiana* (Lamb.)	Kirazlık Mahallesi Konut Alanları	38.72348-037.26027	1277	17.08.2015	37729
6	ACANTHACE	*Acanthus hirsutus* Boiss. **(EN)**	Yeni Mahalle Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	21.07.2015	37585
7	ACERACEAE	*Acer negundo* L.	Gürün İlçe Merkezi	38.72224-037.27155	1302	14.06.2014	37633
8	AMARANTHACEAE	*Amaranthus retroflexus* L.	Gürün Anadolu Lisesi Bahçesi	38.72012-037.27412	1301	17.08.2015	37764
9	ANACARDIACEAE	*Cotinus coggyra* Scop.	Nuri Açıkalın Parkı	38.42653-037.16455	1315	01.08.2013	Foto1
10		*Rhus coriaria* L.	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	21.05.2015	37448
11	ASCLEPIADACEAE	*Vincetoxicum canescens* (Willd.) Decne. var. *canescens*	Şuğul Mahallesi Dağlık Yamaçları	38.44231-037.13644	1427	21.07.2015	37665
12	BUXACEAE	*Buxus sempervirens* L. **(Av-Sib.)**	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1440	09.05.2014	Foto2
13	BERBERIDACEAE	*Berberis vulgaris* L.	Burçevi Mahallesi Konut Alanları	38.43700-037.14368	1373	21.05.2015	37744
14		*Berberis crataegina* DC. **(Ir-Tur.)**	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	37678
15	BORAGINACEAE	*Anchusa azurea* Mill. var. *azurea*	Çayboyu Mahallesi Kavak Plantasyonları	38.43349-037.17744	1313	21.05.2015	37486
16		*Anchusa leptophylla* Roemer&Schultes ssp. *leptophylla*	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	11.05-2013	37472
17		*Arnebia densiflora* (Nordm.) Ledeb.**(Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37485
18		*Alkanna orientalis* (L.) Boiss var. *orientalis* (L.) Boiss	Aksu Mahallesi Konut Alanları	38.42922-037.16599	1363	21.05.2015	37696
19		*Asperugo procumbens* L. **(Av-Sib.)**	Şuğul Mahallesi Konut Alanları	38.44205-037.13.984	1398	19.05.2015	37471
20		*Cerinthe minor* L.ssp. *auriculata* (Ten.) Domac	Boğaziçi Mahallesi Konut Alanları	38.44195-037.21326	1281	21.07.2015	37478
21		*Cynoglossum montanum* L. **(Av-Sib.)**	Terzioğlu Dağı Yamaçları	38.43784-037.15119	1368	22.05.2015	37470
22		*Echium italicum* L. **(Akd.)**	Gürün-Sivas Karayolu Yol Kenarı	38.75886-037.28363	1551	25.06.2013	37661
23		*Heliotropium europaeum* L. **(Akd.)**	Gürün Endüstri Mes. Lisesi Bahçesi	38.74157-037.23380	1365	21.07.2015	37667
24		*Lappula barbata* (Bieb.) Gürke **(Ir-Tur.)**	Karayar Mah. Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37477
25		*Lappula squarrosa* (Retz).	Karayar Mah. Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37875
26		*Lithodora hispidula* ssp. *versicolor* Meik. **(D. Akd.)**	Suçatı Kalaycık Mevki	38.51333-037.47941	1436	01.08.2013	37655
27		*Lithospermum officinale* L. **(Av-Sib.)**	Karayar Mahallesi Konut Alanları	38.72799-037.24837	1282	15.05.2013	37476
28		*Moltkia coerulea* (Willd.) Lehm. **(Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.05.2014	37654
29		*Myosotis lithospermifolia* Bornm.	D-300 Karayolu Yol Kenarları	38.72441-037.25153	1291	15.05.2013	37474

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
30	BORAGINACEAE	*Nonea melanocarpa* Boiss. **(Ir-Tur.)**	Tohma Çayı Kavak Plantasyonları	38.73473-037.23894	1306	19.05.2015	37695
31		*Nonea stenosolen* Boiss. **(EN, Ir-Tur.)**	Boğaziçi Mahallesi Kayalık Alanlar	37.364355-38.745737	1350	22.07.2015	37653
32		*Onosma aucheranum* DC. **(D. Akd.)**	Gölpınar Dinlenme Tesisleri Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37475
33		*Onosma bornmuelleri* Haus.&Born. **(EN, Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37849
34		*Onosma molle* DC **(Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	14.05.2014	37548
35		*Paracaryum cappadocicum* Boiss&Bal. **(EN, Ir-Tur.)**	Gölpınar Dinlenme Tesisleri Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37656
36		*Paracaryum cristatum* Boiss. ssp. *cristatum* **(EN, Ir-Tur.)**	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37473
37	CAMPANULACEAE	*Asyneuma limonifolium* (L.) Janchen ssp. *limonifolium* **(EN)**	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	11.05.2014	37868
38		*Asyneuma linifolium* (Boiss. & Heldr.) Bornm. ssp. *linifolium* **(EN, D. Akd.)**	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37731
39		*Asyneuma lobelioides* (Wild.) **(Ir-Tur.)**	Gürün-Sivas Karayolu Ağaçlandırma Alanı	38.44120-037.16872	1453	21.05.2015	37738
40		*Campanula pinnatifida* Hub.-Mor. var. *robusta* Hub.-Mor.	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	37720
41		*Campanula rapunculoides* L. ssp. *rapunculoides*	Şuğul Mahallesi Bahçe Alanları	38.43992-037.13830	1338	21.07.2015	37599
42	CAPRIFOLIACEAE	*Lonicera caprifolium* L.	Ketençayır Mah. Konut Alanları	38.72369-037.24885	1304	14.06.2013	37586
43		*Sambucus nigra* L. **(Av-Sib.)**	Işıtan Mahallesi Konut Alanları	38.43276-037.16386	1357	17.08.2015	Foto3
44	CARYOPHYLLACEAE	*Arenaria acerosa* Boiss. **(EN)**	Terzioğlu Dağı Yamaçları	38.44524-037.14431	1277	19.05.2015	37539
45		*Arenaria ledeboriana* Fenzl var. *parviflora* Boiss. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37463
46		*Arenaria sivasica* Kit Tan & Sor. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	37534
47		*Cerastium chlorifolium* Fisch. & Mey.	Tohma Çayı Kenarı Kavak Plantasyonları	38.73473-037.23894	1306	24.06.2013	37531
48		*Dianthus orientalis* Adams	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	27.06.2013	37462
49		*Dianthus zederbaueri* Vierh. **(EN, Ir-Tur.)**	Şuğul Mahallesi Dağlık Yamaçları	38.44231-037.13644	1427	21.07.2015	37464
50		*Gypsophila perfoliata* L.	Gürün Anadolu Lisesi Bahçesi	38.72012-037.27412	1301	17.08.2015	37536
51		*Gypsophila pilosa* Hudson.	D-300 Karayolu Yol Kenarları	38.72441-037.25153	1291	15.05.2013	37408
52		*Gypsophila sphaerocephala* Fenzl ex Tehihat var. *cappadocica*	Burçevi Mahallesi Dağlık Yamaçları	38.42776-037.13717	1611	21.07.2015	37855
53		*Minuartia juniperina* (L.) Maire & Petitm	Karatepe Jand. ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	20.05.2014	37538
54		*Phryna ortegioides* Pax & K.Hoffm	Şuğul Mahallesi Bahçe Alanları	38.43992-037.13830	1338	21.07.2015	37879
55		*Saponaria prostrata* Willd. ssp. *anatolica* Hedge **(EN, Ir-Tur.)**	Karatepe Jand. ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	20.05.2014	37530
56		*Silene armena* Boiss. var. armena	Şuğul Mahallesi Çalı Topluluğu	38.44534-037.14248	1306	21.06.2014	37533

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
57	CARYOPHYLLACEAE	*Silene caryophylloides* (Poiret) Otth in DC. ssp. *stentoria* **(EN, Ir-Tur.)**	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37547
58		*Silene chlorifolia* Sm. **(Ir-Tur.)**	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	27.06.2013	37545
59		*Silene conica* L.	Şuğul Mahallesi Çalı Toplulukları	38.73532-037.23539	1319	09.08.2015	37880
60		*Silene conoidea* L.	Şuğul Kanyonu ve Çevresi	38.45600-037.13718	1311	14.05.2014	37541
61		*Silene dichotoma* Ehrh. ssp. *dichotoma*	Şuğul Kanyonu ve Çevresi	38.43277-037.17757	1304	21.05.2015	37537
62		*Silene marschallii* C.A.Meyer **(Ir-Tur.)**	Şuğul Mahallesi Bahçe Alanları	38.43992-037.13830	1338	21.07.2015	37535
63		*Silene latifolia* Poir.	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	19.05.2013	Foto4
64		*Silene montbretiana* Boiss. **(Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.05.2014	37540
65		*Silene spergulifolia* (Desf.) Bieb. **(Ir-Tur.)**	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37543
66		*Silene supina* Bieb. ssp. *pruinosa* (Boiss.) Chowdh.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37465
67		*Silene vulgaris* (Moench) Garcke var. *vulgaris*	Şuğul Mahallesi Çalı Toplulukları	38.73532-037.23539	1319	09.08.2015	37466
68		*Telephium imperati* L. ssp. *orientale* (Boiss.) Nyman	Şuğul Mahallesi Terzioğlu Dağı Güney Yamaçları	38.44524-037.14431	1277	19.05.2015	37546
69		*Vaccaria pyramidata* Medik. var. *pyramidata*	D-300 Karayolu Yol Kenarları	38.72161-037.27243	1278	14.05.2013	37532
70		*Velezia rigida* L.	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37542
71	CELASTRACEAE	*Euonymus latifolius* L.(Miller) ssp. *latifolius* **(Av-Sib)**	Burçevi Mahallesi Bahçe Alanları	38.43443-037.13935	1461	21.07.2015	37639
72	CHENOPODIACEAE	*Chenopodium album* L. ssp. *album*	Aksu Mahallesi Konut Alanları	38.42922-037.16599	1363	21.05.2015	37722
73		*Chenopodium foliosum* (Moench) Aschers.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37721
74		*Chenopodium chenopodioides* L.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37874
75		*Beta trigyna* Waldst.&Kit.	Özel İdare Müdürlüğü Bahçesi	38.71704-037.27657	1299	09.05.2013	37730
76		*Halimione verrucifera* (Bieb.) Aellen	Terzioğlu Dağı Yamaçları	38.44884-037.14441	1275	19.05.2015	37869
77		*Krascheninnikovia ceratoides* (L.) Güldenst.	Terzioğlu Dağı Yamaçları	38.44884-037.14441	1275	19.05.2015	37494
78		*Bassia scoparia* L.	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37765
79	CISTACEAE	*Fumana trisperma* Hub.-Mor. & Reese **(EN, Ir-Tur.)**	Karatepe Jandarma ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	25.06.2013	37737
80		*Helianthemum canum* (L.) Baumg.	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	11.05-2013	37597
81		*Helianthemum germanicopolitanum* Bornm. **(EN)**	Karatepe Jandarma ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	25.06.2013	37596
82	COMPOSITAE/ ASTERACEAE	*Achillea biebersteinii* Afan. **(Ir-Tur.)**	Başak Bulgur Fabrikası Bahçesi	38.65705-037.3044	1387	22.08.2015	37755
83		*Achillea cappadocica* Hskn.&Bornm. **(EN, Ir-Tur.)**	Yoncalık mevki Tarım Alanları	38.42640-037.12160	1560	19.05.2015	37386

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
84	COMPOSITAE/ ASTERACEAE	*Achillea millefolium* ssp. *millefolium* **(Av-Sib)**	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37802
85		*Achillea wilhelmsii* C. Koch. **(Ir-Tur.)**	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	11.05.2014	37618
86		*Acroptilon repens* L. **(Ir-Tur.)**	D-300 Karayolu Yol Kenarları	38.72161-037.27243	1278	14.05.2013	37671
87		*Anthemis aciphylla* Boiss. var. *aciphylla* **(EN, D. Akd.)**	Pınarönü Mahallesi Konut Alanları	38.72115-037.27216	1300	14.06.2014	37467
88		*Anthemis armeniaca* Freyn & Sint. **(EN, Ir-Tur.)**	Burçevi Mahallesi Tohma Çayı Kenarı Kavak Plantasyonları	38.73473-037.23894	1306	19.05.2015	37619
89		*Anthemis cretica* L.ssp. *anatolica* (Boiss).Grierson	Karşıyaka Mahallesi Kenan Evren Ormanı	38.72067-037.34941	1356	15.06.2013	37382
90		*Anthemis otschyana* Boiss. var. *discoidea* (Bornm.) Grierson	Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	37759
91		*Arctium minus* (Hill) Bernh. ssp. *pubens* (Babington) Avenes	Karşıyaka Mahallesi Kuru Tarım Alanları	37.351829-037.21109	1544	20.05.2015	37613
92		*Artemisia taurica* L.	D-300 Karayolu Yol Kenarları	38.72441-037.25153	1291	15.05.2013	37728
93		*Bellis perennis* L. **(Av-Sib)**	Kurultay Mahallesi Konut Alanları	38.43983-037.16748	1346	21.05.2015	37378
94		*Carduus nutans* ssp. *leiophyllus* (Petr.) Stoj. & Stef.	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	22.08.2015	37436
95		*Carlina oligocephala* Boiss.&Kotschy ssp. *oligocephala*	Hacılar Mahallesi Dağlık Alan	38.39729-037.18200	1338	21.07.2015	37380
96		*Calendula arvensis* L.	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	17.05.2013	37616
97		*Centaurea aegialophila* Wagenitz **(D. Akd.)**	D-300 Karayolu Yol Kenarları	38.72441-037.25153	1315	15.05.2013	37789
98		*Centaurea carduiformis* (DC.) Wagenitz var. *thrinciifolia*	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37393
99		*Centaurea cyanus* L.	D-300 Karayolu Yol Kenarları	38.72441-037.25153	1315	15.05.2013	37381
100		*Centaurea depressa* M.Bieb.	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37394
101		*Centaurea iberica* L.	Çayboyu Mahallesi Konut Alanları	38.42715-037.20118	1457	01.08.2013	37756
102		*Centaurea solstitialis* L.	Burçevi Mahallesi Dere Yatağı	38.43560-037.14447	1319	18.05.2015	37615
103		*Centaurea triumfettii* All.	D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	Foto5
104		*Centaurea urvillei* DC. ssp. *stepposa* Wagenitz, **(Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	Foto6
105		*Centaurea virgata* Lam. **(Ir-Tur.)**	Çayboyu Mahallesi Mezarlığı	38.43378-037.17603	1332	21.07.2015	37433
106		*Chardinia orientalis* O.Kuntze **(Ir-Tur.)**	Boğaziçi Mahallesi Bahçe Alanları	38.44010-037.21528	1280	20.05.2015	37430
107		*Chondrilla juncea* L. var. *juncea*	Hükümet Konağı Bahçesi	38.72141-037.27056	1269	14.06.2014	37622
108		*Cichorium intybus* L.	Şuğul Mahallesi Konut Alanları	38.42313-037.12513	1250	21.07.2015	37627
109		*Cirsium arvense* (L.) Scop ssp. *vestitum* (Wimmer & Grab.) Petrak	D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	37612

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
110	COMPOSITAE/ ASTERACEAE	*Cirsium lappaceum* (Bieb.) Fischer ssp. *anatolicum* Petrak **(Ir-Tur.)**	Karayar Mahallesi Su Bendi Çevresi	38.72480-037.25629	1329	14.06.2013	37668
111		*Cirsium libanoticum* DC. ssp. *arachnoideum* Davis & Paris **(Ir-Tur.)**	Yeni Mahalle Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	22.08.2015	37468
112		*Cirsium vulgare* L.	Karayar Mahallesi Konut Alanları	38.72799-037.24837	1282	15.05.2013	37620
113		*Cnicus benedictus* L. var. *kotschyi* Boiss.	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	11.05-2013	37770
114		*Cousinia sivasica* Hub-Mor. **(EN)**	Şuğul Mahallesi Dağlık Yamaçları	38.44231-037.13644	1427	21.07.2015	37389
115		*Crepis foetida* L. ssp. *rhoeadifolia* (Bieb.) Čelak.	Kirazlık Mahallesi Konut Alanları	38.72348-037.26027	1277	17.08.2015	37690
116		*Crepis sancta* (L.) Babcock.	Yeni Mahalle Konut Alanları	38.43430-037.16949	1342	21.05.2015	37690
117		*Echinops orientalis* Trautv. **(Ir-Tur.)**	Suçatı Bahçe Alanları	38.42702-037.20116	1274	01.08.2013	37625
118		*Gundelia tournefortii* var. *tenuisecta* Boiss.	Gürün-Sivas Karayolu Dağlık Yamaçlar	38.44808-037.17060	1543	21.05.2015	37812
119		*Filago anatolica* (Boiss.&Heldr)	Gökpınar Yolu Badem Toplulukları	38.43764-037.15368	1459	11.07.2015	37848
120		*Helichrysum armenium* DC. ssp. *araxinum* **(Ir-Tur.)**	Karşıyaka Mahallesi Kenan Evren Ormanı	38.72067-037.34941	1356	20.05.2015	37621
121		*Helichrysum noenanum* Boiss	Karatepe Jand. ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	20.05.2014	37383
122		*Helichrysum plicatum* DC ssp. *plicatum*	Karşıyaka Mahallesi Kenan Evren Ormanı	38.72067-037.34941	1356	20.05.2015	37689
123		*Hieracium bornmuelleri* Freyn. **(EN)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37670
124		*Inula aschersoniana* Jonka.	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37614
125		*Inula germenica* L. **(Av-Sib.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	09.08.2015	37388
126		*Inula helenium* ssp. *orgyalis* (Boiss.) Grierson	Şuğul Mahallesi Dere Kenarı ve Sulak Alanlar	38.44786-037.14354	1282	19.05.2015	37390
127		*Lapsana communis* ssp. *intermedia* (Bieb.) Hayek	Gürün Kurultay İ.Ö.O. Bahçesi	38.71701-037.27638	1334	11.05.2013	37469
128		*Onopordum turcicum* Danin. **(Ir-Tur.)**	Şuğul Mahallesi Yoncalık mevki Tarım Alanları	38.42640-037.12160	1560	19.05.2015	37626
129		*Leontodon asperrimus* (Willd.) J.Ball	Hacılar Mahallesi Dağlık Alan	38.39729-037.18200	1338	21.07.2015	37387
130		*Leontodon crispus* Vill. var. *asper* Waldst. & Kit.	Karşıyaka Mahallesi Kenan Evren Ormanı	38.72067-037.34941	1356	20.05.2015	37392
131		*Lactuca serriola* L.**(Av-Sib.)**	Şuğul Mahallesi Çalı Topluluğu	38.44534-037.14248	1306	19.05.2015	Foto7
132		*Logfia arvensis* (L.) Holub.	Terzioğlu Dağı Yamaçları	38.43784-037.15119	1368	22.05.2015	Foto8
133		*Picnomon acarna* L.	Gürün Otogarı ve Karayolu kenarı	38.72161-037.27243	1278	14.05.2013	37395
134		*Pilosella cymosa* L.	Suçatı Elma Dibi Mevki Bahçe Alanları	38.42702-037.20116	1274	20.05.2015	37766
135		*Pilosella maschukensis* (Litw. & Zahn)	Burçevi Mahallesi Dere Yatağı Sulak Alanlar	38.43560-037.14447	1319	18.05.2015	37628
136		*Pulicaria dysenterica* (L.) Bornm.	Yassıcatepe Mahallesi Konut Alanları	38.73810-037.23635	1293	17.05.2013	37669
137		*Reichardia glauca* Matthews **(Ir-Tur.)**	Gölpınar Dinlenme Tesisleri Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37788
138		*Scariola orientalis* (Boiss.) Sojak **(Ir-Tur.)**	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	17.05.2013	37391
139		*Scariola viminea* (L.) F.W.Schmidt	Işıtan Mahallesi Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	Foto9
140		*Scorzonera cana* (C.A.Mey.) Griseb.	Gökpınar Yolu Badem Toplulukları	38.43764-037.15368	1459	11.07.2015	37617
141		*Scorzonera pseudolanata* Grosh.	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	14.05.2014	37769

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
142	COMPOSITAE/ ASTERACEAE	*Scorzonera suberosa* C.Koch ssp. *suberosa* **(EN, Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37623
143		*Scorzonera tomentosa* L. **(EN, Ir-Tur.)**	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37686
144		*Senecio vernalis* Waldst & Kit.,	Ketençayır Mahallesi Konut Alanları	38.72369-037.24885	1304	14.06.2013	37624
145		*Sonchus asper* (L.) Hill ssp. *glaucescens* (Jordan)	Gürün Özel İdare Müdürlüğü Bahçesi	38.71704-037.27657	1299	12.08.2015	37813
146		*Tanacetum densum* Schul. Bip. ssp. *sivasicum* Hub.-Mor.& Gri. **(EN, Ir-Tur.)**	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37692
147							
148		*Taraxacum buttleri* van Soest	Çayboyu Mahallesi Konut Alanları	38.42810-037.17569	1322	22.05.2015	37760
149		*Tragopogon aureus* Boiss. **(EN)**	Şuğul Mahallesi Yoncalık mevki Tarım Alanları	38.42640-037.12160	1560	19.05.2015	37768
150		*Tragopogon angustifolius* Willd.	Karşıyaka Mahallesi Su Kanalı Çevresi	38.42449-037.21438	1421	20.05.2015	37793
151		*Tragopogon buphthalmoides* (DC.) Boiss.	Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	37847
152		*Tragopogon coloratus* Mey. **(Ir-Tur.)**	Gökpınar Mahallesi Kavak Plantasyonları	38.43055-037.20602	1267	21.07.2015	37435
153		*Tragopogon dubius* Scop.	Karatepe Jand. ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	20.05.2014	37693
154		*Tripleurospermum decipiens* (Fisch. & Mey.) Bornm.	Gürün Telekom Lisesi Bahçesi	38.72515-037.29095	1315	11.05.2013	37434
155		*Tripleurospermum monticolum* Bornm. **(EN)**	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	10.05.2014	37757
156		*Tripleurospermum transcaucasicum* Manden.	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37396
157		*Tussilago farfara* L. **(Av-Sib.)**	Işıtan Mahallesi Aksu Deresi Kenarı	38.43041-037.16779	1326	21.05.2015	37767
158		*Xeranthemum longipapposum* Fisch.&Mey.	Suçatı Boğaziçi Mahallesi Bahçe Alanları	38.44010-037.21528	1280	20.05.2015	37379
159	CONVOLVULACEAE	*Convolvulus arvensis* L. **(Kozmopolit)**	Işıtan Mahallesi Konut Alanları	38.43276-037.16386	1357	01.08.2013	37376
160		*Convolvulus compactus* Boiss.	Karayar Mahallesi Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37373
161		*Convolvulus galaticus* Rot. ex Cho. **(EN, Ir-Tur.)**	Şuğul Mahallesi Çalı Toplulukları	38.44534-037.14248	1306	21.06.2014	37374
162		*Convolvulus lineatus* L.	Gökpınar Yolu Ağaçlandırma Alanları	38.42897-037.17593	1391	21.05.2015	37372
163		*Ipomoea purpurea* (L.) Roth.	Şuğul Mahallesi Konut Alanları	38.44884-037.14441	1275	19.05.2015	37375
164	CORNACEAE	*Cornus sanguinea* L. **(Av-Sib.)**	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37489
165	CORYLACEAE	*Corylus avellana* L. var. *avellana* **(Av-Sib.)**	Gürün Postanesi Bahçesi	38.72158-037.27244	1279	12.08.2015	37638
166	CRASSULACEAE	*Sedum album* L.	Suçatı Boğaziçi Mahallesi Kayalık Alanlar	37.364355-38.745737	1350	22.07.2015	37679
167		*Sedum hispanicum* L. var. *hispanicum*	Işıtan Mahallesi Kuru Tarım Alanları	38.42363-037.16677	1450	21.05.2015	Foto10
168		*Sedum sempervivoides* Bieb.	Burçevi Mahallesi Dağlık Yamaçları	38.42776-037.13717	1611	21.07.2015	37676
169		*Rosularia libanotica* (Lab.) Muirh. **(D. Akd.)**	Burçevi Mahallesi Dağlık Yamaçları	38.42776-037.13717	1611	21.05.2015	37630
170	CRUCIFERA/ BRASSICACEAE	*Aethionema arabicum* (L.) Andrz. ex DC.	Işıtan Mahallesi Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	37809
171		*Aethionema armenum* Boiss. **(Ir-Tur.)**	Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	37427
172		*Aethionema lepidioides* L.**(EN, Ir-Tur.)**	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37749
173		*Aethionema membranaceum* DC.**(Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37782

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
174	CRUCIFERA/ BRASSICACEAE	*Aethionema speciosum* Boiss&Hud. **(Ir-Tur.)**	Şuğul Kanyonu Çevresi	38.74524-037.23543	1371	14.05.2014	37801
175		*Alyssum alyssoides* L.	Gökpınar Yolu Ağaçlandırma Projesi	38.42897-037.17593	1391	21.05.2015	37798
176		*Alyssum caespitosum* Baumg. **(EN, Ir-Tur.)**	Karatepe Dağlık Yamaçlar	38.42959-037.15938	1389	21.07.2015	37846
177		*Alyssum condensatum* Boiss. & Hausskn. ssp. *condensatum*	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37564
178		*Alyssum desertorum* Stapf. var. *desertorum*	Gürün-Sivas Karayolu Dağlık Alanlar	38.44808-037.17060	1543	21.05.2015	37566
179		*Alyssum lepidoto-stellatum* (Hausskn.&Bornm.) **(EN, Ir-Tur.)**	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	37795
180		*Alyssum macropodum* Boiss.&Bal. var. *macropodum* **(EN, Ir-Tur.)**	Karayar Mahallesi Karatepe Yamaçlar	38.71556-037.29370	1394	14.06.2013	37794
181		*Alyssum minus* Rothm. var. *minus*	Suçatı Boğaziçi Mahallesi Kayalık Alanlar	37.364355-38.745737	1350	22.07.2015	37797
182		*Alyssum pateri* Nyar ssp. *pateri* **(EN, Ir-Tur.)**	Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	37783
183		*Alyssum stylare* (Boiss.&Bal.) **(EN, Ir-Tur.)**	Burçevi Mahallesi Kuru Tarım Alanları	38.41927-037.12580	1705	21.07.2015	37781
184		*Arabis nova* Vill.	Gürün Endüstri Meslek Lisesi Bahçesi	38.74157-037.23380	1365	13.05.2013	37808
185		*Aubrieta canescens* (Boiss.) Bornm. ssp. *macrostyla*	Gürün Endüstri Meslek Lisesi Bahçesi	38.74157-037.23380	1365	20.08.2015	37803
186		*Barbarea vulgaris* R. Br.	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37750
187		*Boreava orientalis* Jaub. & Spach	Tarihi Burçevi Kalesi ve Çevresi	38.43197-037.13879	1550	21.07.2015	37779
188		*Brassica elongata* Ehrh.	Gürün Emniyet Müdürlüğü Bahçesi	38.72309-037.26242	1272	14.06.2014	Foto11
189		*Camelina hispida* Boiss. var. *hispida*	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	09.08.2015	37432
190		*Camelina microcarpa* Andrz.	Suçatı Kalaycık Mevki	38.51333-38.745737	1436	20.05.2015	37563
191		*Camelina rumelica* Vel.	Şuğul Mahallesi D-300 Karayolu Yol Kenarı	38.43838-037.13628	1353	21.07.2015	37560
192		*Cardaria draba* (L.) Desv. ssp. *draba*	Kirazlık Mahallesi Konut Alanları	38.72348-037.26027	1277	17.08.2015	37799
193		*Capsella bursa-pastoris* (L.) Medik.	Çayboyu Mahallesi Toki Evleri Bahçesi	38.71907-037.29096	1323	25.06.2013	37806
194		*Chorispora tenella* (Pall.) DC.	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	37804
195		*Conringia perfoliata* (Meyer) Busch.	Işıtan Mahallesi Konut Alanları	38.43276-037.16386	1357	01.08.2013	37805
196		*Congringia orientalis* (L.) Andrz.	Gürün Eski Yoncalık İ.Ö.O. Bahçesi	38.73141-037.22683	1361	12.05.2013	37784
197		*Coluteocarpus vesicaria* (L.) Holmboe ssp. *vesicaria* **(Ir-Tur.)**	Karayar Mahallesi Tohma Çayı Kenarı Konut Alanları	38.72799-037.24837	1282	15.05.2013	37796
198		*Crambe orientalis* L. ssp. *orientalis* L.	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37746
199		*Descurainia sophia* Webb ex Prantl.	Burçevi Mahallesi Tohma Çayı Kenarı Kavak Plantasyonları	38.73473-037.23894	1306	19.05.2015	37429
200		*Erysimum uncinatifolium* Boiss. **(EN)**	Terzioğlu Dağı Yamaçları	38.43835-037.15099	1364	22.05.2015	37867
201		*Eruca sativa* Miller	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1440	21.07.2015	37780
202		*Iberis taurica* DC.	Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	37562

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
203	CRUCIFERA/ BRASSICACEAE	*Isatis glauca* Boiss. ssp. *glauca* **(Ir-Tur.)**	Işıtan Mahallesi Konut Alanları	38.42801-037.16619	1348	21.05.2015	37754
204		*Isatis glauca* Boiss. ssp. *sivasica* **(Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37807
205		*Isatis aucheri* Boiss. **(EN, Ir-Tur.)**	Karayar Mahallesi D-300 Karayolu Yol Kenarları	38.72441-037.25153	1315	15.05.2013	37428
206		*Lepidium perfoliatum* L.	Karayar Mahallesi Karatepe Konut Alanları	38.72462-037.25175	1315	15.05.2013	37800
207		*Malcolmia africana* (L.) R. Br.	Şuğul Mahallesi Yoncalık Mevki Tarım Alanları	38.42859-037.12061	1484	19.05.2015	37561
208		*Malcolmia chia* L.(DC.)	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37810
209		*Matthiola anchoniifolia* Hub.-Mor. **(EN, Ir-Tur.)**	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37863
210		*Matthiola longipetala* (Vent.) DC. ssp. *bicornis*	Gökpınar Yolu Kuru Tarım Alanları	38.42331-037.17594	1474	21.05.2015	37565
211		*Sinapis arvensis* L.	Şuğul Mahallesi Çalı Toplulukları	38.44534-037.14248	1306	19.05.2015	37792
212		*Sisymbrium loeselii* L.	Karayar Mahallesi Karatepe Konut Alanları	38.72462-037.25175	1315	15.05.2013	37811
213		*Tchihatchewia isatidea* Boiss. **(EN, Ir-Tur.)**	Terzioğlu Dağı Yamaçları	38.43784-037.15119	1368	22.05.2015	37751
214		*Thlaspi perfoliatum* L.	Karatepe Dağlık Yamaçlar	38.42959-037.15938	1389	21.07.2015	Foto12
215	CUSCUTACEAE	*Cuscuta kotschyana* Boiss. ssp. *caudata* Bornm. & Schwarz **(Ir-Tur.)**	Başak Bulgur Fabrikası Bahçesi	38.65705-037.3044	1387	12.06.2013	37734
216		*Cuscuta planiflora* Ten.	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	37872
217	DIOSCOREACEAE	*Tamus communis* ssp. *cretica* (L.) Kit Tan	Şuğul Mahallesi Konut Alanları	38.44884-037.14441	1275	19.05.2015	37377
218	DIPSACACEAE	*Dipsacus laciniatus* L.	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37422
219		*Scabiosa argentea* L.,	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37787
220		*Scabiosa calocephala* Boiss. **(Ir-Tur.)**	Karayar Mahallesi Konut Alanları	38.72799-037.24837	1282	20.08.2015	37423
221		*Scabiosa rotata* Bieb. **(Ir-Tur.)**	Şuğul Mahallesi Konut Alanları	38.73247-037.24299	1281	15.05.2013	37786
222	EUPHORBIACEAE	*Euphorbia denticulata* Lam. **(Ir-Tur.)**	Karatepe Jandarma ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	25.06.2013	37365
223		*Euphorbia cardiophylla* Boiss.	Karatepe Jandarma ve Şehitlik Anıtı Ormanlık Alanı	38.71334-037.26082	1519	25.06.2013	37862
224		*Euphorbia macroclada* Boiss.	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37449
225		*Euphorbia nicaeensis* All. var. gloreosa	Yeni Mahalle Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	22.08.2015	37845
226		*Euphorbia szowitsii* Fisch. & Mey. var. *szowitsii* **(Ir-Tur.)**	Şuğul Mahallesi Konut Alanları	38.73247-037.24299	1281	15.05.2013	37861
227		*Euphorbia virgata* Waldst.&Kit.	Pınarönü Mahallesi Konut Alanları	38.72115-037.27216	1300	13.06.2013	37366
228	FAGACEAE	*Quercus brantii* Lindl.	Şuğul Mahallesi Terzioğlu Dağı Yamaçları	38.43784-037.15119	1368	22.05.2015	37724
229		*Quercus robur* L. ssp. *robur*	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37715
230	GERANIACEAE	*Erodium absinthoides* Willd. ssp. *armenum* (Trautv) Davis **(Ir-Tur.)**	Suçatı Hacılar Mahallesi Dağlık Yamaçlar	38.44032-037.21554	1251	20.05.2015	37723
231		*Erodium cicutarium* (L.) La'Herit ssp. *cicutarium* La'Herit	Suçatı Hacılar Mahallesi Dağlık Yamaçlar	38.44032-037.21554	1251	20.05.2015	37688

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
232	GERANIACEAE	*Geranium collinum* Steph. ex Willd.	Suçatı Boğaziçi Mahallesi Çalılık Alanlar	38.44010-037.21528	1266	20.05.2015	37595
233		*Geranium stepporum* Davis **(Ir-Tur.)**	Yeni Mahalle Konut Alanları	38.43430-037.16949	1342	21.05.2015	37493
234		*Pelargonium endlicherianum* Fenzl.	Pınarönü Mahallesi Terzioğlu Dağı Yamaçları	38.44383-037.16386	1635	21.07.2015	37717
235	GLOBULARIACEAE	*Globularia orientalis* L.	Şuğul Mahallesi Terzioğlu Dağlık Yamaçları	38.44231-037.13644	1427	21.07.2015	37637
236		*Globularia trichosantha* Fisch & Mey.	Pınarönü Mahallesi Terzioğlu Dağı Yamaçları	38.44383-037.16386	1635	21.07.2015	37636
237	GUTTIFERAE / HYPERICACEAE	*Hypericum lydium* Boiss. **(Ir-Tur.)**	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	10.05.2014	37496
238		*Hypericum perforatum* L.	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	10.05.2014	37718
239		*Hypericum retisum* Auch. **(Ir-Tur.)**	Suçatı Boğaziçi Mahallesi Çalılık Alanlar	38.44010-037.21528	1266	20.05.2015	37497
240	GUTTIFERAE / HYPERICACEAE	*Hypericum scabrum* L. **(Ir-Tur.)**	Şuğul Mahallesi Dağlık Yamaçları	38.44231-037.13644	1427	21.07.2015	37714
241		*Hypericum thymopsis* Boiss. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37687
242	ILLECEBRACEAE	*Paronychia cataonica* Chaudhri **(EN, Ir-Tur.)**	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	12.06.2013	37544
243		*Scleranthus annuus* L. ssp. *polycarpus* L.	Yeni Mah. Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	22.08.2015	37529
244		*Scleranthus uncinatus* Schur	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	Foto13
245	JUGLANDACEAE	*Juglans regia* L.	Çayboyu Mahallesi Konut Alanları	38.42810-037.17569	1322	01.08.2013	37445
246	LABIATAE/LAMIACEAE	*Acinos rotundifolius* Pers.	Şuğul Mahallesi Bahçe Alanları	38.43992-037.13830	1338	21.07.2015	37573
247		*Ajuga chamaepitys* (L.) Schreb. ssp. *chia* (Schr.) Arcangeli	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37602
248		*Ajuga salicifolia* (L.) Schreber	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37584
249		*Clinopodium vulgare* L. ssp. *vulgare*	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37711
250		*Eremostachys moluccelloides* Bunge in Ledeb. **(Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37572
251		*Lallamantia iberica* Fisch.	Işıtan Mahallesi Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	37610
252		*Lamium aleppicum* L. Boiss.&Haskn. **(Ir-Tur.)**	Demirciler Parkı	38.72409-037.27070	1283	10.05.2014	37712
253		*Lamium garganicum* L. ssp. *reniforme* R.R.Mill	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37640
254		*Lamium amplexicaule* L. **(Av-Sib.)**	Işıtan Mahallesi Kuru Tarım Alanları	38.42363-037.16677	1450	21.05.2015	Foto14
255		*Marrubium cephalanthum* Boiss. & Noë **(EN, Ir-Tur.)**	Gürün Telekom Lisesi Bahçesi	38.72515-037.29095	1315	11.05.2013	37629
256		*Marrubium globosum* Montbret & Auch. ex Bent. ssp. *globosum* **(EN, Ir-Tur.)**	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	11.05-2013	37574
257		*Marrubium parviflorum* Fisch.&Mey. ssp. *parviflorum*	Burçevi Mah. Kenarı Kavak Plantasyonları	38.73473-037.23894	1306	19.05.2015	37606

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
258	LABIATAE/LAMIACEAE	*Mentha longifolia* (L.) Huds. ssp. *typhoides* (Briq.) Harley	Gürün Kurultay İ.Ö.O. Bahçesi	38.71701-037.27638	1334	17.08.2015	37582
259		*Mentha spicata* L. ssp. *spicata*	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37607
260		*Nepeta italica* L.	Tarihi Burçevi Kalesi ve Çevresi	38.43197-037.13879	1550	21.07.2015	37609
261		*Phlomis armeniaca* Willd. **(EN, Ir-Tur.)**	Gökpınar Yolu Çalılık Alanlar	38.43764-037.15268	1549	21.07.2015	37608
262		*Phlomis pungens* Willd var. *pungens*	Boğaziçi Mahallesi Kavak Plantasyonları	38.43874-037.21408	1219	20.05.2015	37710
263		*Prunella vulgaris* L. **(Av-Sib.)**	Boğaziçi Mahallesi Suluçayır Deresi Kenarı	38.44981-037.21208	1290	20.05.2015	37575
265		*Salvia ceratophylla* L. **(Ir-Tur.)**	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	17.05.2013	Foto15
266		*Salvia cryptantha* Monb.&Auch. **(EN, Ir-Tur.)**	Burçevi Mahallesi Kuru Tarım Alanları	38.41927-037.12580	1705	21.05.2015	37581
267		*Salvia candidissima* Vahl. ssp. *candidissima* **(Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37385
268		*Salvia eriophora* Boiss. &Kot. **(EN, Ir-Tur.)**	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37583
269		*Salvia euphratica* Montbret & ex Benth. var. *euphratica*	Yassıcatepe Mahallesi Terzioğlu Dağı Yamaçları	38.43784-037.15119	1368	22.05.2015	37643
270		*Salvia hypargeia* Fisch. & Mey. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37576
271		*Salvia multicaulis* Vahl **(Ir-Tur.)**	Pınarönü Mah. Terzioğlu Tarım Alanları	38.44179-037.16578	1662	10.07.2015	37604
272		*Salvia staminea* Montb.&Auch. **(Ir-Tur.)**	Yeni Mahalle Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	22.08.2015	37713
273		*Salvia virgata* Jacq.	Şuğul Mahallesi Milli Eğitim Ormanı	38.44459-037.14058	1345	19.05.2015	37605
274		*Salvia verticillata* L. ssp. *amasiaca* **(Ir-Tur.)**	Burçevi Mahallesi Tohma Çayı Kenarı Kavak Plantasyonları	38.73473-037.23894	1306	24.06.2013	Foto16
275		*Satureja hortensis* L.	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	37600
276		*Scutellaria orientalis* ssp. *cretacea* (Boiss. & Hausskn) Edm. **(Ir-Tur.)**	Karatepe Dağlık Yamaçlar	38.42959-037.15938	1389	21.07.2015	37578
277		*Scutellaria orientalis* ssp. *bicolor* **(EN, Ir-Tur.)**	Pınarönü Mahallesi Terzioğlu Dağı Yamaçları	38.43917-037.16347	1577	21.07.2015	37579
278		*Scutellaria orientalis* ssp. *pectinata* (Benth.) Edmo. **(EN, Ir-Tur.)**	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37577
279		*Sideritis libanotica* Labill. ssp. *linearis* Bornm. **(EN)**	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	14.05.2014	37641
280		*Sideritis montana* ssp. *montana* **(Akd.)**	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	11.05-2013	37603
281		*Stachys annua* L. ssp. *annua* L.	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	Foto17
282		*Stachys cretica* L. ssp. *anatolica* Rech. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37708
283		*Stachys lavandulifolia* Vahl var. *lavandulifolia* **(Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37709
284		*Teucrium chamaedrys* L. ssp. *chamaedrys* **(Av-Sib.)**	Burçevi Mahallesi Dağlık Yamaçları	38.43595-037.14360	1323	18.05.2015	37580

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
285	LABIATAE/LAMIACEAE	*Teucrium polium* ssp. *polium* L.	Gökpınar Yolu Üzeri Kuru Tarım Alanları	38.43764-037.15268	1574	21.07.2015	37601
286		*Teucrium multicaule* Montbret & Auch. ex Benth. **(Ir-Tur.)**	Gürün-Sivas Yolu Ağaçlandırma Alanı	38.73405-037.27943	1376	20.05.2014	Foto18
287		*Thymus cappadocicus* Boiss. var. *globifer* Jalas **(EN)**	Şuğul Mahallesi D-300 Karayolu Yol Kenarı	38.43838-037.13628	1353	21.07.2015	37727
288		*Thymus pectinatus* Fisch. & Mey. var. *pectinatus* **(EN, Ir-Tur.)**	Işıtan Mahallesi Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	37571
289		*Thymus sipyleus* Boiss. ssp. *sipyleus* **(EN)**	Burçevi Mahallesi Dağlık Yamaçlar	38.42776-037.13717	1611	21.07.2015	37870
290		*Ziziphora tenuior* L. **(Ir-Tur.)**	Burçevi Mahallesi Kuru Tarım Alanları	38.42404-037.12223	1588	21.05.2015	37611
291	LEGUMINOSAE /FABACEAE	*Astragalus aduncus* Willd. **(Ir-Tur.)**	Suçatı Kalaycık Mevki	38.51333-094.47941	1436	20.05.2015	37510
292		*Astragalus brachypterus* Fisch. **(EN, Ir-Tur.)**	Şuğul Mahallesi Dağlık Yamaçlar	38.44231-037.13644	1427	21.07.2015	37404
293		*Astragalus cretaceus* Boiss.&Kotsc. **(Ir-Tur.)**	Suçatı Boğaziçi Mahallesi Kayalık Alanlar	37.364355-38.745737	1350	22.07.2015	37404
294		*Astragalus densifolius* ssp. *densifolius* Lam.	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37407
295		*Astragalus fraxinifolius* DC. **(Ir-Tur.)**	Suçatı Boğaziçi Mahallesi Kavak Plantasyonları	38.43874-037.21408	1219	20.05.2015	37518
296		*Astragalus hirsitus* Vahl. **(EN)**	Pınarönü Mah. Terzioğlu Dağı Kuru Tarım Alanları	38.44179-037.16578	1662	21.07.2015	37520
297		*Astragalus lamarckii* Boiss. **(EN, Ir-Tur.)**	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	17.05.2013	37458
298		*Astragalus macrocephalus* Willd. ssp. *finitimus* (Bunge) Chamberlain **(Ir-Tur.)**	Hacılar Mahallesi Dağlık Alan	38.39729-037.18200	1338	21.07.2015	37399
299		*Astragalus melitenensis* Boiss. **(EN, Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.05.2014	37398
300		*Astragalus nitens* Boiss. & Heldr.	Burçevi Mahallesi Kuru Tarım Alanları	38.41927-037.12580	1705	21.07.2015	37403
301		*Astragalus campylosema* Boiss. ssp. *campylosema* **(EN, Ir-Tur.)**	Suçatı Boğaziçi Mahallesi Kayalık Alanlar	37.364355-38.745737	1350	22.07.2015	Foto19
302		*Astragalus condensatus* Ledeb. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	Foto20
303		*Astragalus lagurus* Willd. **(Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	Foto21
304		*Astragalus noeanus* Boiss. **(EN, Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37456
305		*Astragalus xylobasis* Freyn &Bornm. var. *angustus* (Freyn&Sint.) **(Ir-Tur.)**	Karşıyaka Mahallesi Dağlık Alanlar	38.42608-037.21535	1385	20.05.2015	37515
306		*Coronilla orientalis* Miller var. *orientalis*	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37512
307		*Coronilla varia* L. ssp. *varia*	Gürün Hükümet Konağı ve Öğretmenevi Bahçesi	38.72141-037.27056	1269	12.08.2015	37514
308		*Ebenus laguroides* Boiss. var. *laguroides* **(EN, Ir-Tur.)**	Şuğul Mahallesi Dağlık Yamaçlar	38.44231-037.13644	1427	21.07.2015	37524
309		*Genista albida* Willd.	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37452
310		*Hedysarum aucheri* Boiss. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37517

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
311	LEGUMINOSAE /FABACEAE	*Hedysarum candissimum* Frey. **(EN, Ir-Tur.)**	Suçatı Hacılar Mahallesi Dağlık Yamaçlar	38.44032-037.21554	1251	20.05.2015	37522
312		*Hedysarum pestallozzae* Boiss. **(EN, Ir-Tur.)**	Karşıyaka Mahallesi Dağlık Alanlar	38.42608-037.21535	1385	20.05.2015	37454
313		*Hedysarum pogonocarpum* Boiss. **(EN)**	Suçatı Kalaycık Mevki	38.51333-094.47.941	1436	20.05.2015	37509
314		*Hedysarum elagans* Boiss. & Huet **(Ir-Tur.)**	Burçevi Mahallesi Su Kanalı Çevresi Dağlık Yamaçlar	38.43595-037.14360	1323	18.05.2015	Foto22
315		*Lathyrus inconspicuus* L.	Burçevi Mah. Kavak Plantasyonları	38.73473-037.23894	1306	19.05.2015	37519
316		*Lotus corniculatus* var. *tenuifolius*	Karayar Mahallesi Su Bendi Çevresi	38.72480-037.25629	1329	14.06.2013	37405
317		*Medicago falcata* L.	Karşıyaka Mahallesi Kuru Tarım Alanları	37.351829-037.21109	1544	20.05.2015	37523
318		*Medicago lupulina* L.	Ketençayır Mahallesi Tarihi Konut Alanları	38.43117-037.16325	1334	21.07.2015	37460
319		*Medicago minima* L.	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	Foto23
320		*Medicago sativa* L. ssp. *sativa*	Gürün Kemal Özalper İ.Ö.O. Bahçesi	38.72910-037.24722	1291	20.08.2015	37397
321		*Medicago varia* Martyn	Suçatı Boğaziçi Mahallesi Çalılık Alanlar	38.44010-037.21528	1266	20.08.2015	37516
322		*Melilotus alba* Desr.	Suçatı Hacılar Mahallesi Dağlık Alanlar	38.44032-037.21554	1251	20.08.2015	37406
323		*Melilotus officinalis* (L.) Desr.	Gürün Devlet Hastanesi Bahçesi	38.72799-037.24837	1288	14.06.2014	37521
324		*Onobrychis armena* Boiss.&Huet **(EN)**	Gökpınar Yolu Badem Toplulukları	38.43764-037.15368	1459	21.07.2015	37400
325		*Onobrychis oxydonta* Boiss.	Burçevi Mah. Su Kanalı Çevresi Dağlık Yamaçlar	38.43595-037.14360	1323	18.05.2015	37401
326		*Onobrychis viciifolius* Scop.	Gölpınar Dinlenme Tesisleri Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37459
327		*Ononis spinosa* L. ssp. *leiosperma* (Boiss.) Sirj.	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37455
328		*Robinia pseudoacacia* L.	Pınarönü Mezarlığı	38.73394-037.27933	1299	25.06.2013	37451
329		*Sophora alopecuroides* L. var. *tomentosa* Boiss. Chamberlain.	Boğaziçi Mahallesi Suluçayır Deresi Kenarı	38.44981-037.21208	1290	20.05.2015	37457
330		*Tetragonolobus maritimus* (L.) Roth.	Boğaziçi Mahallesi Konut Alanları	38.44195-037.21326	1281	21.07.2015	Foto24
331		*Trifolium pratense* L. var. *pratense*	Gürün Sağlık Ocağı Bahçesi	38.72141-037.27056	1269	14.06.2014	37513
332		*Trifolium repens* L. var. *repens*	Karayar Mahallesi Konut Alanları	38.72799-037.24837	1282	15.05.2013	37511
333		*Vicia cracca* L. ssp. *cracca*	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	Foto25
334		*Vicia peregrina* L.	Burçevi Mahallesi Kuru Tarım Alanları	38.42404-037.12223	1588	21.07.2015	37453
335		*Vicia sativa* L. ssp. *sativa*	Burçevi Mahallesi Kuru Tarım Alanları	38.42404-037.12223	1588	21.07.2015	37450
336		*Vicia villosa* Roth ssp. *eriocarpa* P.W.Ball	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	17.05.2013	37402
337	LINACEAE	*Linum austriacum* L.ssp. *austriacum*	Gölpınar Dinlenme Tesisleri Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37555
338		*Linum bienne* Mill. **(Akd.)**	Terzioğlu Dağı Yamaçları	38.43835-037.15099	1364	22.05.2015	37554
339	LINACEAE	*Linum mucronatum* Bertol. ssp. *armenum* (Bordz) Davis **(Ir-Tur.)**	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.05.2014	37556
340	LORANTHACEAE	*Viscum album* L. ssp. *album*	Şuğul Mahallesi Bahçe Alanları	38.43992-037.13830	1338	21.07.2015	37443
341	LYTHRACEAE	*Lythrum salicaria* L. **(Av-Sib.)**	Şuğul Mahallesi D-300 Karayolu Yol Kenarı	38.43838-037.13628	1353	21.07.2015	37487

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
342	MALVACEAE	*Alcea biennis* Winter.	Kirazlık Mahallesi Konut Alanları	38.72348-037.26027	1277	14.06.2013	37733
343		*Alcea calvertii* (Boiss.) Boiss. **(EN, Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37490
344		*Alcea excubita* L. **(Ir-Tur.)**	Şuğul Mahallesi Konut Alanları	38.73247-037.24299	1281	20.08.2015	37664
345		*Alcea hohenackeri* Boiss. Huet	Şuğul Mahallesi Çalı Toplulukları	38.44884-037.14441	1275	19.05.2015	Foto26
346		*Alcea rosea* L.	Karayar Mahallesi Konut Alanları	38.72462-037.25175	1315	20.08.2015	Foto27
347		*Alcea striata* (DC.) Alef. ssp. *rufescens* (Boiss.) Cullen	Cumhuriyet İ.Ö.O Bahçesi	38.72158-037.27244	1279	14.06.2014	37663
348		*Althaea officinalis* L.	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37851
349		*Malva neglecta* Wallr.	Karşıyaka Mahallesi Üzüm bağları	38.51333-094.47.941	1329	21.07.2015	37672
350	MORACEAE	*Ficus carica* L. ssp. *rupestris* **(Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37743
351		*Morus nigra* L.	Şuğul Mahallesi Bahçe Alanları	38.43992-037.13830	1338	21.07.2015	37732
352	MORINACEAE	*Morina persica* L. **(Ir-Tur.)**	Şuğul Mah. D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	11.07.2015	37631
353	OLEACEAE	*Fraxinus excelsior* L.ssp. *excelsior* **(Av-Sib.)**	Nuri Açıkalın Parkı	38.42653-037.16455	1315	09.05.2014	37446
354	ONAGRACEAE	*Epilobium hirsitum* L.	Şuğul Mahallesi Balık Çiftliği Yanı Dere Kenarı	38.44786-037.14354	1282	19.05.2015	37479
355		*Epilobium parviflorum* Schreb.	Suçatı Boğaziçi Mahallesi Kavak Plantasyonları	38.43874-037.21408	1219	20.05.2015	37480
356	ORABANCHACEAE	*Orobanche aegyptiaca* Pers.	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37742
357	PAPAVERACEAE	*Fumaria asepala* Boiss. **(Ir-Tur.)**	Karşıyaka Mahallesi Kuru Tarım Alanları	38.41882-037.21183	1548	20.05.2015	37735
358		*Fumaria kralikii* Jordan **(Akd.)**	Şuğul Mah. D-300 Karayolu Yol Kenarı	38.43838-037.13628	1353	21.07.2015	37739
359		*Hypecoum pendulum* L.	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37591
360		*Glaucium acutidentatum* Hausskn. & Bornm. **(EN, Ir-Tur.)**	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37590
361		*Glaucium corniculatum* (L.)Rud. ssp. *corniculatum* **(Ir-Tur.)**	Şuğul Mahallesi Yoncalık Mezarlığı	38.73141-037.22683	1341	14.05.2014	37736
362		*Glaucum flavum* Crantz.	Şuğul Mahallesi Yoncalık Mezarlığı	38.73141-037.22683	1341	03.06.2013	37740
363		*Glaucium leiocarpum* Boiss.	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37741
364		*Papaver dubium* L.	Karşıyaka Mahallesi Kuru Tarım Alanları	38.41882-037.21183	1548	20.05.2015	37592
365		*Papaver rhoeas* L.	Gökpınar Mahallesi Kavak Plantasyonları	38.43055-037.20602	1267	21.07.2015	37598
366		*Papaver macrostomum* Boiss.&Huet ex Boiss. **(Ir-Tur.)**	Suçatı-Gürün Arası Yol Kenarı	38.43141-037.20257	1334	21.07.2015	37593
367		*Papaver triniifolium* Boiss. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	Foto28
368		*Roemeria hybrida* (L.) DC.	Çayboyu Mahallesi Mağara Alanları	38.43378-037.17916	1332	21.07.2015	37588
369	PLANTAGINACEAE	*Plantago lanceolata* L.	Karayar Mah. Tohma Çayı Kenarı Konut Alanları	38.72799-037.24837	1282	20.08.2015	37716

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
370	PLANTAGINACEAE	*Plantago major* L. ssp. *major*	Karayar Mah. Karatepe Yamaçları Konut Alanları	38.72462-037.25175	1315	20.08.2015	37681
371	PLUMBAGINACEAE	*Acantholimon acerosum* (Willd) Boiss. ssp. *parvifolium* Bokhari **(EN, Ir-Tur.)**	Karayar Mahallesi Mezarlığı	38.76203-037.07573	1287	14.05.2014	37594
372		*Plumbago europaea* L. **(Av-Sib.)**	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	Foto29
373	POLYGALACEAE	*Polygala pruinosa* Boiss. ssp. *pruinosa*	Pınarönü Mahallesi Terzioğlu Dağı Yamaçları	38.43917-037.16347	1577	21.07.2015	37492
374	POLYGONACEAE	*Atrophaxis billardieri* Jaub.& Spach var. *billardieri* **(Ir-Tur.)**	Suçatı Kalaycık Mevki	38.51333-094.47.941	1436	20.05.2015	37726
375		*Polygonum aviculare* L. **(Kozmopolit)**	Karayar Mahallesi Konut Alanları	38.72799-037.24837	1282	15.05.2013	37673
376		*Polygonum cognatum* Meissn.	Pınarönü Mahallesi Tarihi Kilise Çevresi	38.72964-037.25433	1277	14.05.2013	37673
377		*Rumex angustifolius* Campd. ssp. *macranthus* (Boiss.) Rech. **(Ir-Tur.)**	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37853
378		*Rumex crispus* L.	Gürün Anadolu Lisesi Bahçesi	38.72012-037.27412	1301	17.08.2015	37674
379		*Rumex scutatus* L.	Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	22.08.2015	37426
380	PRIMULACEAE	*Anagallis arvensis* L. var. *caerulea*	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	Foto30
381		*Androsace maxima* L.	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	17.05.2013	37527
382		*Lysimachia vulgaris* L.	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37528
383	RANUNCULACEAE	*Adonis aestivalis* L. ssp. *aestivalis*	Hacılar Mahallesi Bahçe Alanları	38.39729-037.18200	1305	21.07.2015	37425
384		*Ceratocephalus falcatus* (L.) Pers	Işıtan Mahallesi Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	37748
385		*Consolida orientalis* (Gay) Schröd	Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	21.07.2015	37775
386		*Nigella arvensis* L. var. *glauca* Boiss.	Şuğul Mahallesi Yoncalık Mevki Tarım Alanları	38.42859-037.12061	1484	19.05.2015	37776
387		*Ranunculus constantinopolitanus* (DC.) d'Urv.	Ketençayır Mahallesi Konut Alanları	38.72369-037.24885	1304	14.06.2013	37778
388		*Ranunculus kotschyi* Boiss.	Burçevi Mahallesi Dere Yatağı	38.43560-037.14447	1319	18.05.2015	37777
389		*Ranunculus repens* L. **(Ir-Tur.)**	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37424
390		*Thalictrum minus* var. *majus*	Burçevi Mahallesi Bahçe Alanları	38.43443-037.13935	1461	21.07.2015	Foto31
391	RESEDACEAE	*Reseda lutea* L. var. *lutea*	Gürün Telekom Lisesi Bahçesi	38.72515-037.29095	1315	11.05.2013	37484
392	RHAMNACEAE	*Frangula alnus* Miller ssp. *alnus* **(Av-Sib.)**	Çörten Mahallesi Çalılık Alanlar	38.43420-037.19936	1337	21.07.2015	37860
393		*Rhamnus oleoides* L. ssp. *graecus* (Boiss. & Reyt.) Holmboe	Suçatı Kalaycık Mevki	38.51333-094.47.941	1436	20.07.2015	37551
394	ROSACEAE	*Agrimonia eupatoria* L.	Çayboyu Mahallesi Tohma Çayı Kenarı	38.43277-037.17757	1304	21.05.2015	37559
395		*Amygdalus orientalis* Mill. **(Ir-Tur.)**	Karatepe-Işıtam Mahallesi Arası Ağaçlandırma Alanı	38.42828-03716219	1417	11.08.2015	37550
396		*Cerasus incana* Spach var. *incana* **(Ir-Tur.)**	Şuğul Mahallesi Çalı Toplulukları	38.44534-037.14248	1306	19.05.2015	37567
397		*Cerasus mahaleb* Mill. var. *mahaleb*	Şuğul Mahallesi Bahçe Alanları	38.73803-037.23645	1368	09.08.2015	37503
398		*Cotoneaster integerrimus* Medik.	Gökpınar Yolu Çalılık Alanlar	38.43764-037.15268	1549	21.07.2015	37502
399		*Crataegus microphylla* C.Koch.	Kemal Özalper İ.Ö.O. Bahçesi	38.72910-037.24722	1291	12.05.2013	37506

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
400	ROSACEAE	*Crataegus pontica* C.Koch.	Burçevi Mahallesi Kuru Tarım Alanları	38.42404-037.12223	1588	21.07.2015	37507
401		*Fragaria vesca* L.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1440	21.07.2015	37568
402		*Geum urbanum* L. **(Av-Sib.)**	Şuğul Mahallesi Balık Çiftliği Yanı Dere Kenarı	38.44786-037.14354	1282	19.05.2015	37549
403		*Potentilla recta* L.	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	14.05.2014	37504
404		*Potentilla reptans* L.	Kurultay Mahallesi Konut Alanları	38.43983-037.16748	1346	21.05.2015	37508
405		*Potentilla speciosa* Willd.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1439	09.05.2014	37500
406		*Prunus divaricata* Ledeb. ssp. *divaricata*	Işıtan Mahallesi Konut Alanları	38.42801-037.16619	1348	21.05.2015	37501
407		*Pyrus elaeagnifolia* Pall. ssp. *elaeagnifolia*	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.08.2014	37557
408		*Rosa canina* L.	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.05.2014	37570
409		*Rosa foetida* L. **(Av-Sib.)**	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	37697
410		*Rubus caesius* L.	Şuğul Mahallesi Balık Çiftliği Yanı Dere Kenarı	38.44786-037.14354	1282	19.05.2015	37505
411		*Sanguisorba minor* Scop. ssp. *lasiocarpa* (Boiss. & Hausskn.) Nordb.	Gürün Meslek Yüksek Okulu Bahçesi	38.71906-037.33609	1286	22.08.2015	37558
412	RUBIACEAE	*Asperula glomerata* (Bieb.) ssp. *eriantha* Ehrend.	Gürün-Sivas Yolu Ağaçlandırma Alanı	38.73405-037.27943	1376	25.06.2013	37440
413		*Asperula capitellata* Hausskn. & Bornm.	Gölpınar Dinlenme Tesisi Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37439
414		*Asperula stricta* Boiss. ssp. *latibracteata* (Boiss.) Ehrend. **(EN, Ir-Tur.)**	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37444
415		*Cruciata taurica* Ehrend. **(Ir-Tur.)**	Gürün Telekom Lisesi Bahçesi	38.72515-037.29095	1315	22.08.2015	Foto32
416		*Galium humifusum* Bieb.	Pınarönü Mahallesi Terzioğlu Dağı Yamaçları	38.43917-037.16347	1577	21.07.2015	37437
417		*Galium verum* L. ssp. *verum* **(Ir-Tur.)**	Karayar Mahallesi Su Bendi Çevresi	38.72480-037.25629	1329	14.06.2013	37442
418		*Rubia tinctorium* L. ssp. *spurium* **(Ir-Tur.)**	Aksu Mahallesi Konut Alanları	38.42922-037.16599	1363	21.05.2015	37790
419	RUTACEAE	*Haplophyllum myrtifolium* Boiss. **(EN, Ir-Tur.)**	Şuğul Mahallesi Dağlık Yamaçlar	38.44231-037.13644	1427	21.07.2015	37461
420		*Haplophyllum telephioides* Boiss.**(EN, Ir-Tur.)**	Burçevi Mahallesi Kuru Tarım Alanları	38.41927-037.12580	1705	21.07.2015	37526
421	SALICACEAE	*Populus alba* L. **(Av-Sib.)**	Gürün Tarım İlçe Müdürlüğü Bahçesi	38.73255-037.24297	1276	14.06.2014	37680
422		*Populus nigra* L.	Gürün Postanesi Bahçesi	38.72158-037.27244	1279	12.08.2015	37691
423		*Salix alba* L. **(Av-Sib.)**	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1440	21.07.2015	37745
424		*Salix excelsa* J.F. Gmelin **(Ir-Tur.)**	Gürün Kurultay İ.Ö.O. Bahçesi	38.71701-037.27638	1334	17.08.2015	37675
425	SCROPHULARIACEAE	*Anarrhinum orientale* Bentham **(Ir-Tur.)**	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37553
426		*Antirrhinum majus* L.ssp. *majus* **(Akd.)**	Yassıcatepe Mah. Konut Alanları	38.73810-037.23635	1293	17.05.2013	37701
427		*Bungea trifida* (Vahl) C.A.Meyer **(Ir-Tur.)**	Karatepe-Işıtam Mah. Arası Ağaçlandırma Alanı	38.42828-03716219	1417	20.05.2014	37703
428		*Linaria corifolia* Desf. **(EN, Ir-Tur.)**	Burçevi Mahallesi Çalılık Alanlar	38.43176-037.11612	1277	18.05.2015	37702
429		*Linaria genistifolia* (L.) Miller ssp. *genistifolia* **(Av-Sib.)**	Şuğul Mahallesi Terzioğlu Dağı Güney Yamaçları	38.44524-037.14431	1277	19.05.2015	37700
430		*Linaria kurdica* Boiss. & Hohen. ssp. *kurdica* **(Ir-Tur.)**	Suçatı Kalaycık Mevki	38.51333-094.47.941	1436	20.05.2015	37707
431		*Melampyrum arvense* L. **(Av-Sib.)**	Şuğul Mahallesi Yoncalık mevki Tarım Alanları	38.42640-037.12160	1560	19.05.2015	37652

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
432	SCROPHULARIACEAE	*Odontites aucheri* Boiss. **(Ir-Tur.)**	Işıtan Mahallesi Kavak Yolu Kenarı Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	37644
433		*Pedicularis comosa* var. *sibthorpii* (Boiss.) Boiss.	Suçatı Mevki Boğaziçi Mahallesi Konut Alanları	38.44195-037.21326	1281	21.07.2015	37704
434		*Scrophularia libanotica* Boiss. var. *cappadocica* R.Mill **(EN, Ir-Tur.)**	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37651
435		*Scrouphularia scopolii* Pers. var. *scopolii* **(D. Akd.)**	Karayar Mah. Tohma Çayı Yanı Konut Alanları	38.72799-037.24837	1282	20.08.2015	37699
436		*Scrophularia xanthoglossa* Boiss. **(Ir-Tur.)**	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37705
437		*Verbascum lasianthum* Boiss. ex Bentham	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	21.06.2014	37647
438		*Verbascum natolicum* (Fisch & Mey) Hub.-Mor. **(EN, Ir-Tur.)**	Şuğul Mah. Yoncalık Mevki Yamaçları	38.72586-037.15085	1451	11.06.2013	37698
439		*Verbascum speciosum* Schrader	Çayboyu Mahallesi Kavak Plantasyonları	38.43349-037.17744	1313	21.05.2015	37650
440		*Veronica anagalis-aquatica* L.	Suçatı Boğaziçi Mah. Kavak Plantasyonları	38.43874-037.21408	1219	20.05.2015	37706
441		*Veronica cinerea* Boiss.&Bal. **(EN, D. Akd.)**	Terzioğlu Dağı Yamaçları	38.43784-037.15119	1368	22.05.2015	37646
442		*Veronica jacquinii* Bornm. **(Av-Sib.)**	Suçatı Boğaziçi Mahallesi Çalılık Alanlar	38.44010-037.21528	1266	20.05.2015	37648
443		*Veronica macrostachya* Vahl ssp. *macrostachya* **(D. Akd.)**	Karşıyaka Mahallesi Kenan Evren Ormanı	38.72067-037.34941	1356	20.05.2015	37649
444		*Veronica orientalis* Miller ssp. *orientalis*	Gürün-Sivas Karayolu Dağlık Alanlar	38.44808 037.17060	1543	21.05.2015	37645
445		*Veronica polita* Fries	Gürün Hükümet Konağı ve Öğretmenevi Bahçesi	38.72141-037.27056	1269	09.05.2013	Foto33
446	SOLANACEAE	*Hyoscyamus niger* L.	Şuğul Mahallesi D-300 Karayolu Yol Kenarı	38.43838-037.13628	1353	21.07.2015	37370
447		*Hyoscyamus reticulatus* L. **(Ir-Tur.)**	Karayar Mahallesi D-300 Karayolu Yol Kenarları	38.72441-037.25153	1315	15.05.2013	37371
448	SOLANACEAE	*Solanum dulcamara* L. **(Av-Sib.)**	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37369
449	SIMAROUBACEAE	*Ailanthus altissima* (Mill.) Swingle	Yassıcatepe Mahallesi Konut Alanları	38.73810-037.23635	1293	17.05.2013	Foto34
450	TILIACEAE	*Tilia argentea* Desf.	Yassıcatepe Mahallesi Konut Alanları	38.73810-037.23635	1293	17.05.2013	37635
451		*Tilia plathyphyllos* Scop.	Nuri Açıkalın Parkı	38.42653-037.16455	1315	01.08.2013	37634
452	THYMELAEACEAE	*Daphne oleoides* Schreber ssp. *oleoides*	Burçevi Mahallesi Kuru Tarım Alanları	38.41927-037.12580	1705	21.07.2015	37725
453	ULMACEAE	*Celtis glabrata* Steven ex Planchon	Hacılar Mahallesi Dağlık Alanlar	38.39729-037.18200	1338	21.07.2015	37682
454		*Ulmus minor* Mill. ssp. *minor*	Gürün Hükümet Konağı ve Öğretmenevi Bahçesi	38.72141-037.27056	1269	09.05.2013	37666
455	UMBELLIFERAE/ APIACEAE	*Bupleurum heldreichii* Boiss. & Bal. **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37662
456		*Bifora radians* Bieb.	Şuğul Mahallesi D-300 Karayolu Yol Kenarları	38.72441-037.25153	1291	15.05.2013	37413
457		*Bunium microcarpum* (Boiss.) ssp. *microcarpum* **(D. Akd.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37416
458		*Angelica sylvestris* L. var. *sylvestris* **(Av-Sib.)**	Çayboyu Mah. Tohma Çayı Kenarı	38.43277-037.17757	1304	21.05.2015	37858

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
459	UMBELLIFERAE/ APIACEAE	*Caucalis platycarpos* L.	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37881
460		*Daucus carota* L.	Gürün Anadolu Lisesi Bahçesi	38.72012-037.27412	1301	17.08.2015	37410
461		*Eryngium billardieri* Delar.	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	17.05.2013	37412
462		*Falcaria vulgaris* Bernh.	Şuğul Mahallesi Çalı Toplulukları	38.44534-037.14248	1306	19.05.2015	37411
463		*Foeniculum vulgare* Miller.	Yassıcatepe Mahallesi Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	Foto35
464		*Grammosciadium daucoides* DC.	Karatepe Dağlık Yamaçlar	38.42959-037.15938	1389	21.07.2015	37417
465		*Heracleum platytaenium* Boiss.	Karşıyaka Mahallesi Tohma Çayı Kenarı	38.42704-037.21489	1259	21.07.2015	37415
466		*Laserpitium hispidum* M.Bieb. **(Av-Sib.)**	Pınarönü Mezarlığı	38.73394-037.27933	1299	25.06.2013	37657
467		*Malabaila secacul* Banks. & Sol.	Şuğul Mah. D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	37660
468		*Oenanthe pimpinelloides* L.	Şuğul Mahallesi D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	37409
469		*Pastinaca sativa* ssp. *urens*	Karşıyaka Mahallesi Tohma Çayı Kenarı	38.42704-037.21489	1259	21.07.2015	37859
470		*Prangos ferulacea* (L.) Lindl.	Gökpınar Gölü Doğal Yaşam Parkı	38.65696-037.30169	1440	21.07.2015	37659
471		*Scandix stellata* Bank. & Sol.	Gökpınar Yolu Dağlık Yamaçlar	38.39730-037.18197	1502	21.07.2015	37418
472		*Turgenia latifolia* Hoffm.	Yeni Mahalle Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	25.06.2013	37658
473		*Zosima absinthifolia* (Vent.) Link	Şuğul Mahallesi D-300 Karayolu Yol Kenarları	38.72441-037.25153	1291	15.05.2013	37414
474	URTICACEAE	*Parieteria judaica* L.	Gürün Eski Yoncalık İ.Ö.O. Bahçesi	38.73141-037.22683	1361	12.05.2013	37632
475		*Urtica dioica* L. **(Av-Sib.)**	Gürün Kurultay İ.Ö.O. Bahçesi	38.71701-037.27638	1334	17.08.2015	37552
476	VALERIANACEAE	*Centranthus longiflorus* Step. ssp. *longiflorus* **(Ir-Tur.)**	Çayboyu Mahallesi Konut Alanları	38.42715-037.20118	1457	01.08.2013	37816
477		*Valerianella pumila* (L.) DC.	Işıtan Mahallesi Kuru Tarım Alanları	38.42363-037.16677	1450	21.05.2015	37791
478		*Valerianella carinata* Loisel.	Küçük Yassıcatepe Mezarlığı	38.73199-037.24833	1287	10.05.2014	Foto36
479	VERBENACEAE	*Verbena officinalis* L.	Çayboyu Mahallesi Toki Evleri Bahçesi	38.71907, 037.29096	1323	25.06.2013	37488
	VIOLACEAE	*Viola odarata* L.	Işıtan Mahallesi Konut Alanları	38.42801-037.16619	1348	21.05.2015	37677
480	ZYGOPHYLLACEAE	*Peganum harmala* L.	Pınarönü Mezarlığı	38.73394-037.27933	1299	25.06.2013	Foto37
481		*Zygophyllum fabago* L. **(Ir-Tur.)**	Pınarönü Mahallesi Tarihi Kilise Çevresi	38.72964-037.25433	1277	21.07.2015	37719
482		*Tribulus terrestris* L.	Büyük Yassıcatepe Mezarlığı	38.73198-037.24834	1284	21.07.2014	37587
483	CYPERACEAE	*Carex nigra* (L.) Reichard ssp. *dacica* (Heuffel)	Gürün Özel İdare Müdürlüğü Bahçesi	38.71704-037.27657	1299	14.06.2014	37763
484		*Carex otrubae* L.	Karayar Mahallesi Su Bendi Çevresi	38.72480-037.25629	1329	14.06.2013	37762
485		*Schoenoplectus lacustris* (L.) Palla	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37761
486		*Scirpoides holoschoenus* (L.) Sojak	Çayboyu Mahallesi Tohma Çayı Kenarı	38.43277-037.17757	1304	21.05.2015	37438
487	GRAMINEAE /POACEAE	*Aegilops biuncialis* Vis.	Yeni Mahalle Konut Alanları	38.43430-037.16949	1342	21.05.2015	37773
488		*Aegilops cylindrica* Host. **(Ir-Tur.)**	Şuğul Mahallesi D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	37830

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489	GRAMINEAE /POACEAE	*Agrostis stolonifera* L.	Şuğul Mahallesi D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	37844
490		*Arhenatherum elatius* (L.) P.Beauv. **(Av-Sib.)**	Gürün Özel İdare Müdürlüğü Bahçesi	38.71704-037.27657	1299	09.05.2013	37829
491		*Avena eriantha* Drueu	Işıtan Mahallesi Kuru Tarım Alanları	38.42363-037.16677	1450	21.05.2015	37834
492		*Bromus erectus* Hudson	Gürün Özel İdare Müdürlüğü Bahçesi	38.71704-037.27657	1299	12.08.2015	37817
493		*Bromus hordeaceus* L. ssp. *hordeaceus*	Gürün Endüstri Meslek Lisesi Bahçesi	38.74157-037.23380	1365	20.08.2015	37818
494		*Bromus intermedius* Guss.	Gökpınar Yolu Badem Toplulukları	38.43764-037.15368	1459	21.07.2015	37877
495		*Bromus japonicus* Thunb. ssp. *japonicus*	Şuğul Mahallesi Terzioğlu Dağı Yamaçları	38.44524-037.14431	1277	20.08.2015	37819
496		*Bromus scoparius* L.	Gökpınar Yolu Ağaçlandırma Projesi	38.42897-037.17593	1391	21.05.2015	37836
497		*Cynodon dactylon* (L.) Pers. var. *villosus* Regel	Şuğul Mahallesi D-300 Karayolu Yol Kenarları	38.43838-037.13628	1353	21.07.2015	37820
498		*Dactylis glomerata* L. ssp. *glomerata* **(Av-Sib.)**	Şuğul Mahallesi Bahçe Alanları	38.44071-037.13681	1404	21.07.2015	37822
499		*Deschampsia caespitosa* L.	Karşıyaka Mahallesi Tohma Çayı Kenarı	38.42704-037.21489	1259	21.07.2015	37839
500		*Elymus erosiglumis* Melderis **(EN, Ir-Tur.)**	Gökpınar Yolu Dağlık Yamaçlar	38.39729-037.18200	1599	21.07.2015	37843
501		*Elymus elongatus* ssp. *elongatus* (Host) Runemark	Gürün Kurultay İ.Ö.O. Bahçesi	38.71701-037.27638	1334	17.08.2015	37865
502		*Erogrostis minor* Host.	Tarihi Burçevi Kalesi ve Çevresi	38.43197-037.13879	1550	21.07.2015	37840
503		*Festuca anatolica* Markgr.-Dannenb. ssp. *anatolica* **(EN)**	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	37864
504		*Hordeum spontaneum* C.Koch. **(Ir-Tur.)**	Gürün Sanayi Sitesi Bahçesi	38.72492-037.28040	1312	25.06.2013	37823
505		*Hordeum bulbosum* L.	Aksu Mahallesi Konut Alanları	38.42922-037.16599	1363	21.05.2015	37832
506		*Hordeum geniculatum* L.**(Av-Sib.)**	Gürün Kurultay İ.Ö.O. Bahçesi	38.71701-037.27638	1334	11.05.2013	37833
507		*Hordeum vulgare* L.	Gölpınar Dinlenme Tesisleri Yol Kenarları	38.72348-037.26027	1277	14.05.2013	37871
508		*Koeleria cristata* (L.) Pers.	Karşıyaka Mahallesi Kuru Tarım Alanları	38.41882-037.21183	1548	20.05.2015	37826
509		*Lolium persicum* Boiss. & Hohen. **(Ir-Tur.)**	Karşıyaka Mahallesi Üzüm bağları	38.51333-094.47.941	1329	01.08.2013	37878
510		*Pennisetum orientale* Rich. **(Ir-Tur.)**	Karşıyaka Mahallesi Tohma Çayı Kenarı	38.42704-037.21489	1259	21.07.2015	37841
511		*Phleum pratense* L. **(Av-Sib.)**	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	09.08.2015	37785
512		*Phragmites australis* (Cav.) Trin. **(Av-Sib.)**	Şuğul Mahallesi Kavak Plantasyonları	38.43675-037.14525	1266	09.08.2015	37785
513		*Poa alpina* L.ssp. *fallax* F.Hermann	Burçevi Mahallesi Bahçe Tarımı Alanları	38.42160-037.13403	1698	21.07.2015	Foto38
514		*Poa angustifolia* L.	Gürün Endüstri Meslek Lisesi Bahçesi	38.74157-037.23380	1365	20.08.2015	37842
515		*Poa pratensis* L.	Gürün Sağlık Ocağı Bahçesi	38.72141-037.27056	1269	14.06.2014	37824
516		*Polypogon monspeliensis* (L.) Desf.	Şuğul Mahallesi Yoncalık Mevki Tarım Alanları	38.42859-037.12061	1484	19.05.2015	37821
517		*Psathyrostachys fragilis* Nevski. **(Ir-Tur.)**	Işıtan Mahallesi Kuru Tarım Alanları	38.42363-037.16677	1450	21.05.2015	37837
518		*Sclerochloa dura* (L.) P.Beauv. **(Av-Sib.)**	Yassıcatepe Mahallesi Terzioğlu Dağı Yamaçları	38.43764-037.15219	1385	22.05.2015	Foto39
519		*Secale cereale* (L.)	Burçevi Mahallesi Dağlık Yamaçları	38.42776-037.13717	1611	21.07.2015	37873
520		*Setaria viridis* (L.) P.Beauv.	Gürün Telekom Lisesi Bahçesi	38.72515-037.29095	1315	22.08.2015	37774
521		*Stipa ehrenbergiana* Trin. & Rupr. **(Ir-Tur.)**	Pınarönü Mezarlığı	38.73394-037.27933	1299	25.06.2013	37835

No	Familya	Tür	Lokalite-Habitat	Enlem-Boylam	Yükseklik (m)	Toplanma Tarihi	ISTO No
522		*Stipa holosericea* Trin.	Yeni Mahalle Gürünsoy Bakliyat Fabrikası Bahçesi	38.75886-037.28363	1551	22.08.2015	37825
523		*Stipa pontica* P. Smirnov in Feddes Rep.	Karşıyaka Mahallesi Su Kanalı Çevresi	38.42449-037.21438	1421	01.08.2014	37838
524		*Taeniatherum caput-medusae* (L.) Nevski **(Ir-Tur.)**	Şuğul Mahallesi Milli Eğitim Ormanı	38.44459-037.14058	1345	19.05.2015	Foto40
525		*Trachynia distachya* L.	Karşıyaka Mahallesi Su Kanalı Çevresi	38.42449-037.21438	1421	01.08.2014	37831
526		*Triticum aestivum* L.	Burçevi Mahallesi Su Kanalı Çevresi	38.43595-037.14360	1323	18.05.2015	37815
527		*Vulpia ciliata* Dumort.	Işıtan Mahallesi Dağlık Yamaçlar	38.42569-037.16751	1403	21.05.2015	37827
528		*Zingeria biebersteiniana* (Claus) ssp. *trichopoda* (Boiss.)	Şuğul Kanyonu Kayalık Alanlar	38.45600-037.13718	1311	27.06.2013	37772
529	IRIDACEAE	*Gladiolus kotschyanus* Boiss. **(Ir-Tur.)**	Şuğul Mahallesi D-300 Karayolu Yol Kenarı	38.43838-037.13628	1353	20.05.2014	37694
530		*Iris sari* Schott ex Baker **(EN, Ir-Tur.)**	Gürün-Sivas Karayolu Ağaçlandırma Alanı	38.44120-037.16872	1453	21.05.2015	37683
531		*Iris schachtii* Markgr **(EN, Ir-Tur.)**	Gürün-Sivas Karayolu Ağaçlandırma Alanı	38.44120-037.16872	1453	21.05.2015	37684
532	JUNCACEAE	*Juncus inflexus* L.	Yassıcatepe Mahallesi Tohma Çayı Kenarı	38.43764-037.15268	1326	21.05.2015	37483
533	LILIACEAE	*Allium scorodoprasum* L. ssp. *rotundum* (L.) Stearn **(Akd.)**	Şuğul Mahallesi Konut Alanları	38.44205-037.13.984	1398	19.05.2015	37421
534		*Asparagus officinalis* L.	Boğaziçi Mahallesi Suluçayır Deresi Kenarı	38.44981-037.21208	1290	20.05.2015	37431
535		*Asphodeline damascena* (Boiss.) Baker. ssp. *damascena* **(Ir-Tur.)**	Şuğul Mahallesi Kuru Tarım Alanları	38.41619-037.12490	1827	21.07.2015	37685
536	LILIACEAE	*Asphodeline tenuior* (Fischer) Ledeb. var. *tenuiflora* **(Ir-Tur.)**	Karayar Mahallesi Karatepe Dağlık Yamaçlar	38.71556-037.29370	1394	14.06.2013	37491
537		*Eremurus spectabilis* Bieb. **(Ir-Tur.)**	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	27.06.2013	37866
538		*Muscari comosum* (L.) Mill.	Burçevi Mahallesi Bahçe Tarımı Alanları	38.43443-037.13935	1461	21.07.2015	37419
539		*Muscari neglectum* Guss.	Gürün-Sivas Karayolu Ağaçlandırma Alanı	38.44120-037.16872	1453	21.05.2015	Foto41
540		*Muscari tenuiflorum* Tausch	Gürün Katı Çöp Atık Alanı	38.73254-037.24414	1580	25.06.2013	Foto42
541		*Ornithogalium sphaerocarpum* Kerner	Şuğul Kanyonu ve Çevresi	38.74524-037.23543	1371	14.05.2014	37852
542	POTAMOGETONACEAE	*Potamogeton pectinatus* L.	Karayar Mahallesi Tohma Çayı Kenarı	38.43700-037.14967	1328	22.05.2015	37481
543		*Groenlandia densa* (L.) Fourr.	Çayboyu Mahallesi Tohma Çayı Kenarı	38.43277-037.17757	1304	21.05.2015	37482
544	TYPHACEAE	*Typha minima* Funck ssp. *minima*	Şuğul Mahallesi Karacaören Suyu Kenarı	38.73465-037.23855	1321	17.06.2013	37499
545		*Typha shutleworthi* W.Koch	Karşıyaka Mahallesi Tohma Çayı Kenarı	38.42704-037.21489	1259	21.07.2015	37498

- EN: Endemik,
- Ir-Tur: İran-Turan Elementi,
- Av-Sib: Avrupa-Sibirya Elementi,
- Akd: Akdeniz Elementi,
- D. Akd: Doğu Akdeniz Elementi,
- B6: Sivas-Gürün
- YK: Yeni kayıt

1-*Cotinus coggyra* Scop.

2-*Buxus sempervirens* L.

3-*Sambucus nigra* L.

4- *Silene latifolia* Poir.

5- *Centaurea triumfettii* All.

6- *Centaurea urvillei* DC. subsp. *stepposa* Wagenitz

7- *Lactuca serriola* L.

8- *Logfia arvensis* (L.) Holub.

9- *Scariola viminea* (L.) F.W.Schmidt

10- *Sedum hispanicum* L. var. *hispanicum*

11- *Brassica elongata* Ehrh.

12- *Thlaspi perfoliatum* L.

13- *Scleranthus uncinatus* Schur.

14- *Lamium amplexicaule* L.

15- *Salvia ceratophylla* L.

16- *Salvia verticillata* L. subsp. *amasiaca*

17- *Stachys annua* L. subsp. *annua* L.

18- *Teucrium multicaule* Montbret & Auch. ex Benth.

19- *Astragalus campylosema* Boiss. subsp. *campylosema*

20-*Astragalus condensatus* Ledeb.

21-*Astragalus lagurus* Willd.

22- *Hedysarum elagans* Boiss. & Huet

23- *Medicago minima* L.

24- *Tetragonolobus maritimus* (L.) Roth.

25-*Vicia cracca* L. subsp. *cracca*

26-*Alcea hohenackeri* Boiss. Huet

27- *Alcea rosea* L.

28-*Papaver triniifolium* Boiss.

29-*Plumbago europaea* L.

30-*Anagallis arvensis* L. var. *caerulea*

31-*Thalictrum minus* var. *majus*

32-*Cruciata taurica* (Pallas ex Willd.)Ehrend.

33-*Veronica polita* Fries

34-*Ailanthus altissima* (Mill.) Swingle

35-*Foeniculum vulgare* Miller.

36-*Valerianella carinata* Loisel.

37-*Peganum harmala* L.

38-*Poa alpina* L.subsp. *fallax* F.Hermann

39-*Sclerochloa dura* (L.) P.Beauv.

40-*Taeniatherum caput-medusae* (L.) Nevski

41-*Muscari neglectum* Guss.

42-*Muscari tenuiflorum* Tausch

Ek 2: Araştırma alanında tespit edilen ve fotoğraf üzerinden teşhis edilen veya herbaryum örneği özelliğini yitirmiş olan doğal türlerin görünümleri.

Appendix 2: Appearances of natural species identified in the research area and identified by photo or lost the characteristic of a herbarium sample.

Nonea stenosolen Boiss.

Matthiola anchoniifolia Hub.-Mor.

Thymus pectinatus Fisch.&Mey. var. *pectinatus*

Marrubium globosum Montbret & Auch.

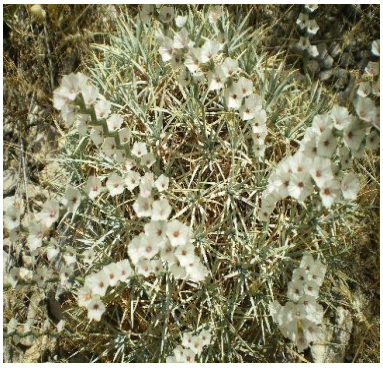
Astragalus brachypterus Fisch.

Tchihatchewia isatidea Boiss.

Astragalus hirsitus Vahl.

Scutellaria orientalis ssp.*bicolor*

Convolvulus galaticus Rot. ex Cho.



Acantholimon acerosum (Willd) Boiss. ssp. *parvifolium* Bokhari

Paronychia cataonica Chaudhri

Hypericum thymopsis Boiss.

Şekil 5: Araştırma alanında tespit edilen bazı endemik türler (2012-2015).
Figure 5: Some endemic species identified in the research area (2012-2015).

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Climate change impacts on the potential distribution of *Taxus baccata* L. in the Eastern Mediterranean and the Bolkar Mountains (Turkey) from last glacial maximum to the future

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Abstract

The Pleistocene is an important period for assessing the effects of climate change on biological diversity. In the beginning of this period, many tree species disappeared in the flora of Europe, with ongoing, but smaller losses later, and many tree species exhibiting repeated strong range shifts mostly at the end of the period. It is thought that some areas will be more affected from possible climate change. The Mediterranean Basin is the most important among the mentioned sensitive areas. Species with scattered, relict populations in the region would be more affected by future climate change. One such species is *Taxus baccata*. *Taxus baccata*, which is distributed throughout the temperate zones of Northern hemisphere, is the only species of *Taxus* to be naturally distributed in Turkey. Apart from its general dispersal area in the north of Turkey, *Taxus baccata* is seen in small groups in protected local areas in southern Anatolia.

The aim of this study is to determine the potential effects of past and future climate change on the distribution of *Taxus baccata* in Bolkar Mountains, using species distribution modelling. We studied how the potential distribution has been affected by the Last Glacial Maximum (LGM) climate and the subsequent climate shift to the present, and it can be expected to be affected by future climate change, as represented by a range of future climate change scenarios. For this purpose, Maxent is used for determining the distribution of *Taxus baccata*. Our Maxent model results show that the AUC values are calculated as 0,85 and 0,80 in sequence.

Our results show that the *Taxus baccata* would have found suitable conditions in the Bolkar Mountains area even during the LGM, pointing to this as an important refuge area. With also find that the potential distribution in Kadincik Valley (on the southern slope of Bolkar Mountains) of *Taxus baccata* has been reduced with the shift to a Holocene climate, and the distribution in Taurus Mountains is likely diminish even further under future climate change.

Our results show that *Taxus baccata* is a cool-climate relict in southern Turkey and that its distribution is likely to come under further pressure from future climate change. This situation is likely shared with many other temperate plant species persisting with small populations in mountain areas in the region.

Key words: Climate change, Species Distribution Model, *Taxus baccata***,** Bolkar Mountains, Central Taurus Mountains, Turkey

Introduction

The distribution of plant species is sensitive to climate change. Paleobotanical and genetic studies show that there is a close relationship between climate change and changes in the physiological, genetic, spatial properties of plant populations and the species composition of plant communities (Medail and Diadema, 2009). When the climate conditions change, plants either migrate or adapt to the changing conditions, or, else, go extinct (Aitken et al., 2008; Ackerly et al., 2010; EEA, 2004). Mediterranean basin, our research area, is also included among these hotspots. Mediterranean basin is one of the significant centers in terms of plant diversity and endemism. This area is one of the refuges in Pleistocene for the pre-Quaternary flora of Europe (Biltekin et. al., 2017; Hewitt, 1996; Magri et al., 2017; Medail and Diadema, 2009; Martinetto et al., 2017). Therefore, these refuges will be most affected from possible climate changes in the future.

It can be stated that the ongoing climate changes have an effect on today's vegetation distribution. Glacial and interglacial periods in Pleistocene led to significant changes in the distribution of plant communities (Avcı, 2014). Glacial period in Pleistocene caused the extinction of the species that were intolerant to low temperatures (Eiserhardt et al., 2015; Svenning, 2003). Most of these extinctions happened in the beginning of Pleistocene (Biltekin et.al, 2015; Magri et. al, 2013; Martinetto, 2017). Some species in European tree flora migrated in the last period of Pleistocene (Mayol et al., 2015; Svenning et al., 2008). In this period, many nemoral tree species (*Fagus*, *Carpinus*, some *Quercus* species, *Tilia* and *Taxus baccata* etc.) which required relatively higher temperature was affected by the climate changes and they survived in refuges on the mountainsides stretching out east-west direction on The Pyrenees, The Alps, Iberian Peninsula and in Caucasus, Turkey, Italy (Svenning, et al., 2008; Hewitt, 1999). This condition was also been supported by the phylogeographic studies (i.e. genetic differentiation of population of nemoral species around Mediterranean and different genetic variability of the communities in the refuges of Last Glacial Maximum (LGM) within Mediterranean Basin). It became a refuge for plants in the areas of middle height in Mediterranean, which needed warmth in the Last Glacial Maximum (Svenning, et al., 2008). With temperature rise and retreat of glaciers with the transition to the Holocene, plant and animal species extended their areas to the north (Hewitt, 1999). In this period, some species which came out of refuges either hybridized or differentiated genetically (Avcı, 2011; Parker and Markwith, 2007).

The climate changes in the Quaternary led to significant changes in the sea levels, glaciers, fluvial systems in Turkey (Doğan, 2012; Kayan, 2012; Sarıkaya, 2012). All these changes also affected the dispersal area of some plants. They extended the dispersal areas of some plants while they narrowed the areas of some others. With the topographical conditions, the higher parts of the mountains, glacial valleys and depressions in Anatolia acted as a refuge for the species which were affected by the climate changes in the Pleistocene (Avcı, 2005-2011-2014). Glaciers in the Eastern Black Sea, the Central and Southeastern Taurus stretched out to a larger area especially during the Last Glacial Maximum (Turoğlu, 2011). The glaciers in the Bolkar Mountains reached their maximum size at 18.9 ± 3.3 ka. In this situation the length of the glaciers from the cirque is estimated to have reached 5.5 km. (Sarıkaya and Çiner, 2015).In this period, forest line levelled down more than today's forest line. Refuging on mountains, inner parts of valleys or around lakes, the species survived in isolated areas by varying during Last Glacial Maximum. The plants in the protected areas in Turkey which were on the migration corridor in Pleistocene constitute the significant amount of relict plants in Anatolia. The dispersal area of plant communities has changed with the changes in the climate after Last Glacial Maximum. In Holocene, the shrinking glaciers maintained its existence in the higher sections of the Bolkar Mountain. In the research area, current glaciers are gradually shrunk and covered with debris. (Sarıkaya and Çiner, 2015). While snowline was 2650 meters in Last Glacial Maximum, present snowline is 3450-3700 meters in Bolkar Mountains **(**Çiner and Sarıkaya, 2015). With the retreat of glaciers, forest line levelled up and plant communities extended their dispersal areas vertically (Avcı, 2005-2011-2014).

Many plant and animal species will be unable to adapt locally or move fast enough to track suitable climates. With the effect of climate change or other stress factors, many species will face the extinction in the future or during climate change (IPCC, 2014).

Some species *(e.g. Cedrus libani, Juniperus drupacea)* have limited, scattered distribution areas in Mediterranean Basin, one of the most sensitive areas in terms of possible climate change. Climate change causes changes in the frequency, intensity, area distribution and timing of extreme weather and climate events. The frequency of heavy precipitation events has increased over most areas. From 1900 to 2005, precipitation increased significantly in the Mediterranean (IPCC,2007).

The Bolkar Mountains in the Mediterranean Basin are rich in plant diversity and reflect the changing processes well. The investigative site, biodiversity conservation area, is an important part of the habitats of endangered species. The forests that are distributed outside the local climatic zones, which emerged as a result of topography in the Bolkar Mountains, are all dry forests. But the changes in the climate conditions between the northern and southern parts of the Bolkar Mountains have caused some changes in the main species in the dry forest areas. Inside the valley there are relatively more species of hygrophilous such as *Taxus baccata*.

Based on the mentioned reasons, by taking the different climate change scenarios into consideration, we have studied the state of temperate, relatively moisture-demanding European yew (*Taxus baccata)*, which survives in the protected places on the Bolkar Mountains, in the Last Glacial Maximum and its future distribution area in our research. In this context, we tried find answers to these following questions:

- How was the potential distribution of *Taxus baccata* on the Bolkar Mountains in the Last Glacial Maximum? Did this area have potential to act as a glacial refuge for the species?
- How is the potential distribution of *Taxus baccata* today? Can the species already today be considered a climate relict species in the region?
- How will be the distribution of *Taxus baccata* in the future? Notably, will the species come under future climate stress?

Study area

The southern slopes of Bolkar Mountains, stretching roughly in the line of NE-SW, are under the effect of Mediterranean climate. Precipitation and temperature properties change as the altitude changes on the mountains. In Mersin station in 7 m altitude, the mean annual temperature is 28.0 °C, mean annual precipitation is 589.1 mm while in 2000 m altitude, temperature is 18.0 °C, and precipitation is around 1627.5 mm. In Tarsus meteorology station in 12 m altitude, the temperature is 27.1 °C and precipitation is 610.8 mm. As the altitude increases, temperature lowers to around 17.0 °C in 2000 m, precipitation levels up to around 1675.5 mm. Northern slopes on Bolkar Mountains is different from southern slopes. Since these areas are open to the north, they are more under the effect of continental climate. The temperature and rainfall properties on Bolkar Mountains change within short distances.

The vegetation on Bolkar Mountains consists of 3 groups: forest, shrub and alpine formations. Dried forests constitute the forest formation in the research area. Dried forests in the southern part of the area generally consist of tree species like *Pinus brutia*, *P. nigra*, *Abies cilicica* subsp. *cilicica*, *Juniperus drupacea* and *Cedrus libani*, in the northern part they consist of *P. nigra, J. excelsa*, *Quercus pubescens* and *Q. ithaburensis* subsp. *macrolepis*. Shrub formation arising from forest destruction is usually represented by maquis. Alpine plants start approximately from 2100 m and they are also very rich in plant species such as *Astragalus sp.*, *Acantholimon sp.*, *Ononis sp.*, *Marrubium sp.*, *Onasma sp*., *Eryngium sp*..

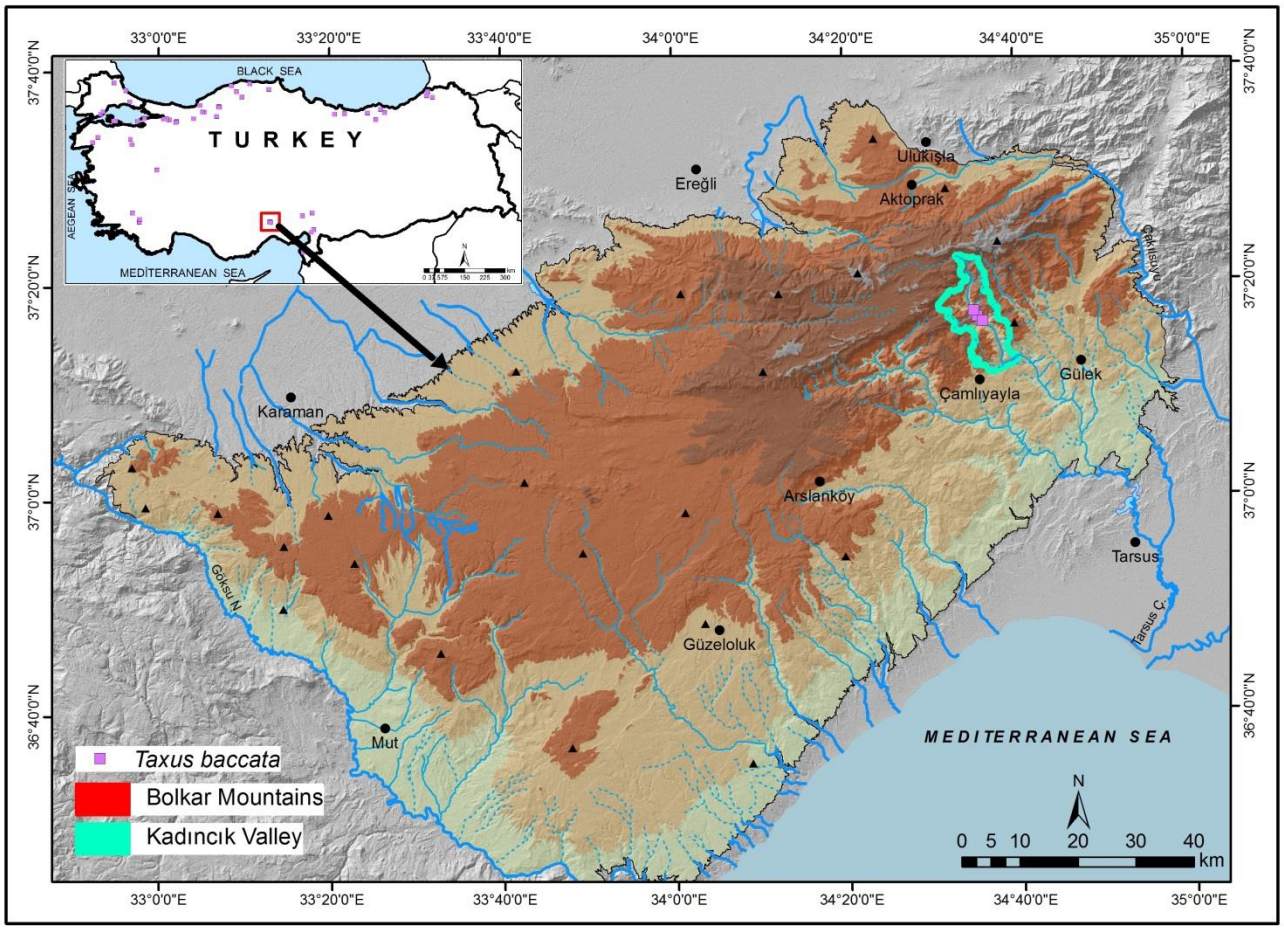

Figure 1. Location map of Bolkar Mountains

Apart from the general distribution, deep valleys in Bolkar Mountains are also rich in terms of flora and they are in contradiction with its environment. The existence of *Taxus baccata* in the deep Kadincik Valley on the southern slope of Bolkar Mountains is quite remarkable. Developing in a protected area because of topographic conditions, *Taxus baccata* which is a nemoral tree species due to the local climatic conditions had the opportunity to thrive. In this area, other main hygrophilous species that accompany *Taxus baccata* are *Carpinus orientalis*, *Salix alba*, *Salix caprea*, *Ostrya carpinifolia*, *Fraxinus ornus* subsp. *cilicica*, *Alnus glutinosa*, *Ulmus glabra* subsp. *montana* and *Juglans regia.*

2. Materials and Methods

2.1. Study species

Taxus L. is naturally represented by 10 species in the Eastern Asia, North Africa, Anatolia, Europe and North America. *Taxus baccata* is evergreen conifer species that is distributed in Central and Southern Europe, Northwestern Africa, Northern Iran and Southwest Asia. Distributed mostly in temperate zones of Northern hemisphere, *Taxus baccata* is the only species of *Taxus* to be naturally distributed in Turkey. Its largest distribution area in Turkey is Black Sea Region (Coode and Cullen, 1965; Farjon and Filer, 2013).

Older members of this species is usually found between 300-1500 m a.s.l of the forest areas in Northern Turkey. Found alone or in small groups in the mentioned areas, *Taxus baccata* is shade-adapted, sensitive to low temperatures and frost. Apart from its general distribution area in the North of Turkey,

Taxus baccata is seen in small groups on the Sultan Mountains, Denizli Bozdağ, the Amanos Mountains and the Bolkar Mountains (Coode and Cullen, 1965). Distributing sporadically in different regions besides these areas, *Taxus baccata* is seen occasionally in the protected areas in the upper course of Kadincik Stream Valley on the research area, Bolkar Mountains.

2.2. Species Distribution Data

In addition to the survey of the distribution data of *Taxus baccata* in Europe, their distribution areas in Turkey, surveys and *Flora of Turkey and the East Aegean Islands* (Davis, 1965-1985; Davis et al., 1988; Güner et al., 2008; Özhatay and Kültür, 2006; Özhatay et al., 1999-2009-2011) and herbarium samples (34 registries) are supplied by scanning from the database (729 registries) of Atlas Florae Europaeae (AFE), Global Biodiversity Information Facility (GBIF). AFE 50x50 km grid system based on Universal Transverse Mercator (UTM) and the Military Grid Reference (MGRS) is used for absolute data for distribution projections of *Taxus baccata* (Luomus, 2017) (Figure 2)

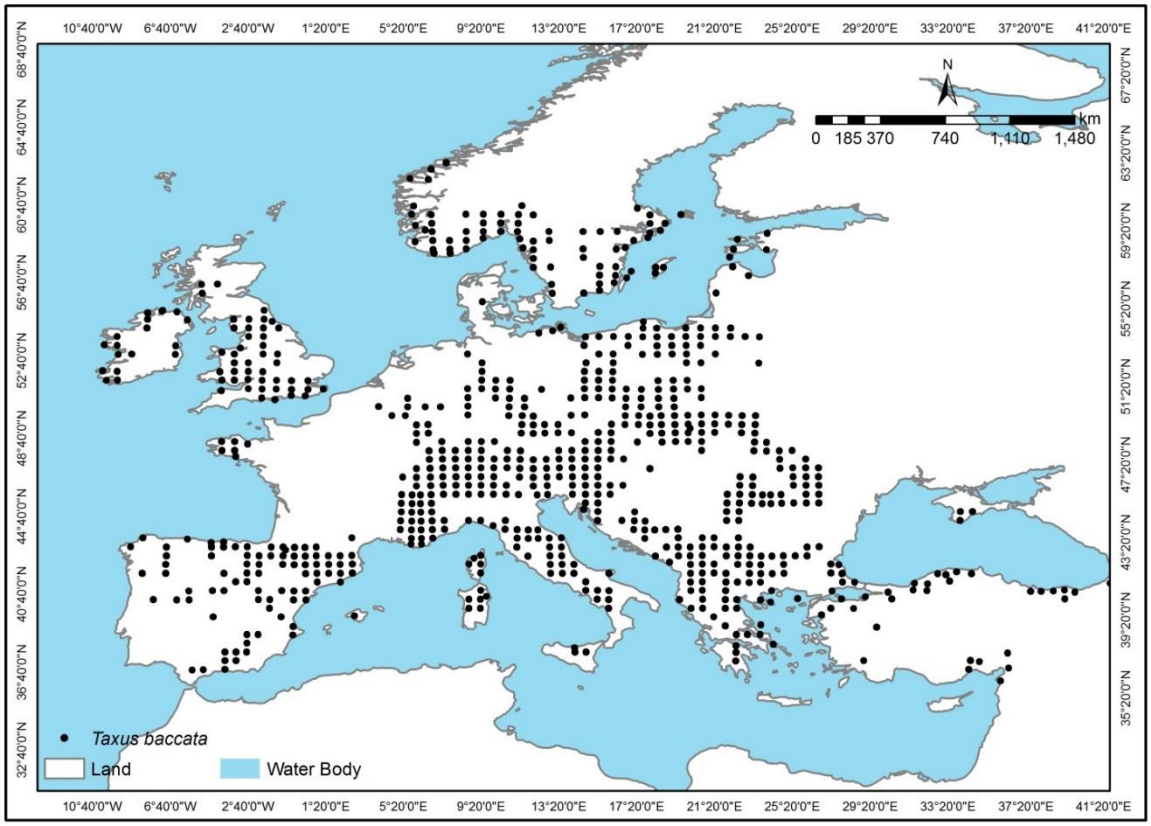

Figure 2. Occurrence data distribution map for *Taxus baccata*

In order to interpret the past and future distribution patterns of *Taxus baccata* in our research area, this species distribution around Bolkar Mountains in these periods should be examined. Therefore, smaller scaled distribution patterns that show Turkey and its surroundings are produced. However, only the distributions of it on Bolkar Mountains are crucial for this research.

2.3. Climate Data

CMIP5 is used for past and future climate data in the species distribution models. (MIROC ESM Model for Interdisciplinary Research on Climate) which has been produced for RCP (Representative

Concentration Pathways) 8,5 scenario, and CCSM4 (Community Climate System Model is used in the model. The data produced by CCSM4 and MIROC ESM are compared and it has been decided that the models produced by CSSM4 is appropriate for this study.
In order to put forth the present situation, the data produced by interpolating the data of weather stations in different parts of the world (Hijmans et al. 2005).

The data related to the applied models are 2,5 arc-minute/~5 km resolution for Last Glacial Maximum, 30 arc-second/~1 km resolution for future. Data that involves today's conditions are 30 arc-second/~1 km resolution.
19 climate variables supplied from the WorldClim database are used for species distribution models (Table 1). Modeling is done for all the areas where *Taxus baccata* shows and clips our study area from inside. For this reason, we think it would be appropriate to use 19 variables. Relevant climate variables represent the climate conditions of today (between 1950-2000), Last Glacial Maximum (~22,000 year ago) and future (between ~2061-2080).

Table 1. Bioclimatic variables and their explanations

Bioclimatic Variable	Explanation
BIO1	Annual Mean Temperature
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO3	Isothermality (BIO2/BIO7) (* 100)
BIO4	Temperature Seasonality (standard deviation *100)
BIO5	Max Temperature of Warmest Month
BIO6	Min Temperature of Coldest Month
BIO7	Temperature Annual Range (BIO5-BIO6)
BIO8	Mean Temperature of Wettest Quarter
BIO9	Mean Temperature of Driest Quarter
BIO10	Mean Temperature of Warmest Quarter
BIO11	Mean Temperature of Coldest Quarter
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
BIO15	Precipitation Seasonality
BIO16	Precipitation of Wettest Quarter
BIO17	Precipitation of Driest Quarter
BIO18	Precipitation of Warmest Quarter
BIO19	Precipitation of Coldest Quarter

Species Distribution Modelling

Maxent 3,3,3 Maximum Entropy Modelling of Species has been used in order to predict how *Taxus baccata* distributed in the areas in the past and how it will be distributed in the future. Maxent has been designed to make predictions on incomplete data (Phillips et. al, 2006). The model was run more than once for species with its "replicate" feature and "cross-validation" is used in the produced species distribution model. It is stated that this cross validation method shows correct results in small data sets since it is used for data verification (Beton, 2011). Therefore, 15 replicates are used in this research, 500 iterations has been done for each replicate. In the study, the potential dispersal areas of *Taxus baccata*

in the past, future and at present are estimated and projected by Maxent model, using today's climate data.

The performance of the produced species distribution model was tested by ROC (Receiver Operating Characteristic) analyses, using the AUC (Area Under the ROC Curve) metric to describe the model's discriminatory capacity (Phillips et al., 2006). The closer AUC test value is to 1, the better the distinction is, model is sensitive and descriptive (Oliveria et al., 2010). The models with AUC test value between 0.75-1.00 can considered to have high predictive power. Values about 0.5 show that the model is not sensitive and it is not sufficient in descriptiveness better than a random draw (Elith, 2002; Phillips and Dudik, 2008).

One of the methods we use while investigating the contributions of variables in the model output is jack-knife. According to this method, each variable included in the model is left out in each repetition and remaining ones are evaluated. After that all variables are included in the analysis and the model is run and evaluations are carried out (Pearson et al., 2007). Therefore, the contribution of each variable to the model is defined. In other words, the lower the total gets when one variable is left out, the more significant the left-out variable is.

Results

Climatic forcing in the Species Distribution Model

Maxent models with adequate predictive power were applied to past, present, and future climate data to assess the potential distribution of *Taxus baccata* in these periods.

Predicted possible distribution map of the species distribution model which are carried out with Maxent for *Taxus baccata*, showed better results than random prediction. ROC curve charts show us that compatible models are produced (Figure 3).

ROC is formed to test the model and accordingly, for model test and training data, AUC values are calculated as 0,85 and 0,80 in sequence and standard deviation is calculated as 0.014. That AUC test values are close to 1 and standard deviation is low shows that both models are successful

The percentage contribution to dispersal pattern obtained from the model result of used 19 bioclimatic parameters is included in the model output. Accordingly, BIO4 has contributed %53,8, BIO 7 %13,9 BIO6 %7,7.

Among the contributions of 19 variables to the model, it is seen that BIO4, one of the most effective variables in the model output according to the jackknife analysis of the Maxent model, has contributed to the model the most when the variables evaluated relatively. When the jackknife analysis is evaluated alone, the contribution of the other variables (BIO7, BIO11, BIO6) that contribute to the model increase along with BIO4 (Figure 4).

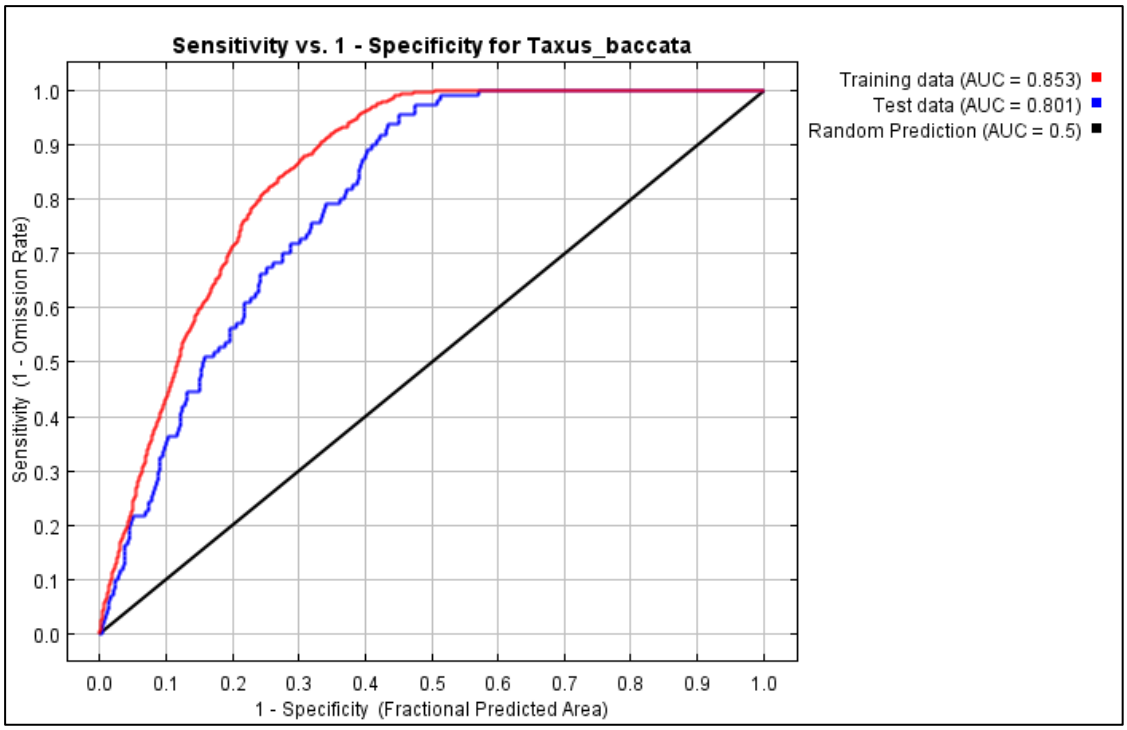

Figure 3. ROC curve and AUC values for Maxent model

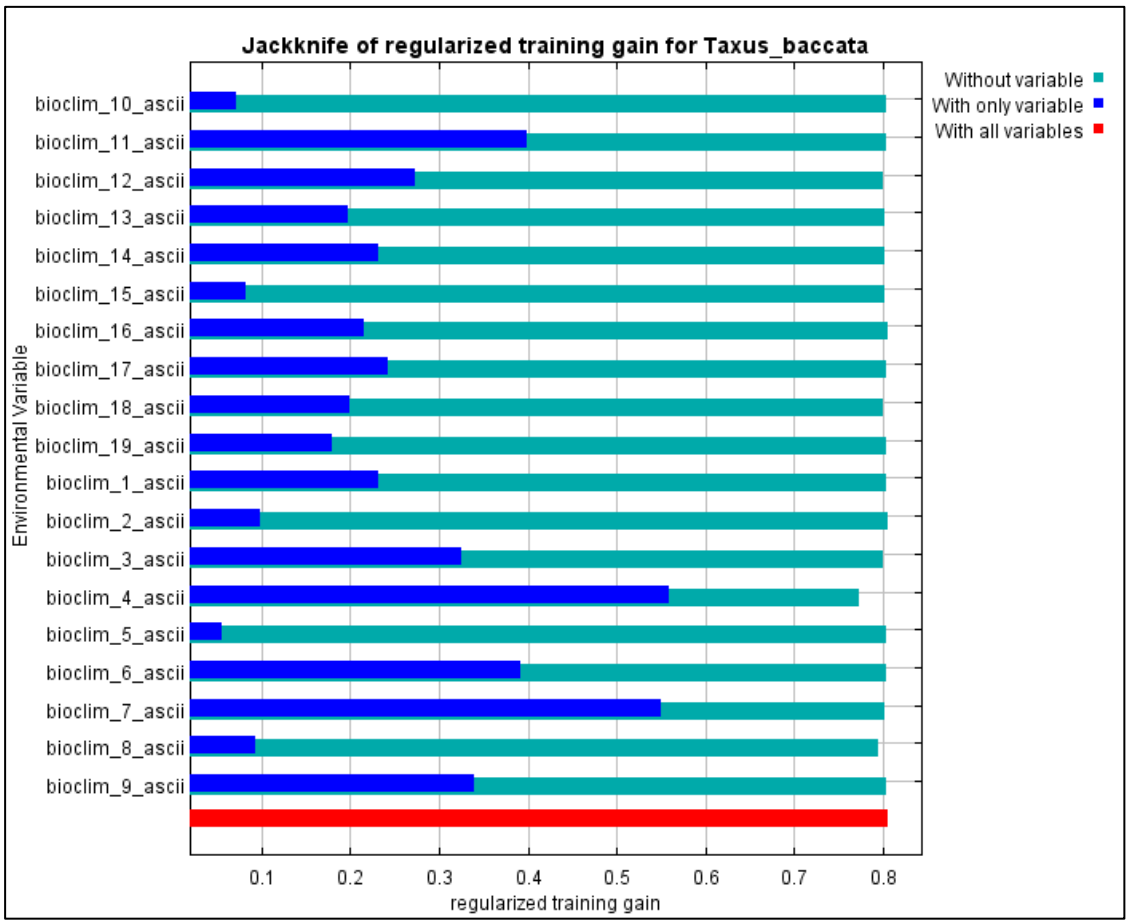

Figure 4. Jackknife test of variable importance of *Taxus baccata*

3.2 Potential Taxus baccata Distributions during the Last Glacial Maximum*, Current and Future*

Considering the potential distribution of *Taxus baccata* during the Last Glacial Maximum, especially the northern Anatolian coasts had the suitable conditions for *Taxus baccata* (Figure 5). These suitable areas stretch out to the east of Colchic area, and encircle the Marmara Sea from the coasts of Black Sea to the west. They further extend from the southern coasts of the Marmara Sea to the Kaz Mountains in the west. *Taxus baccata* range to the Taurus Mountains by the mountainside corridor in the inner parts of Anatolia. Inner parts of the protected valleys of the mountain areas in southern Anatolia also had suitable conditions for *Taxus baccata* during Last Glacial Maximum, including the Bolkar and Amanos Mountains (Figure 5), which hence may have functioned as glacial refuge regions.

Compared to the Last Glacial Maximum potential distribution in the area, the current potential distribution is increased in northern and western Turkey, but reduced in the south-eastern part (Figure 5), suggesting that populations here can be considered climatic relicts. However, current suitability in the Bolkar Mountains is much larger than during the LGM (Figure 6).

Under future climate change, as represented by the CCSM scenario, *Taxus baccata* will lose major part of its suitable distribution area in the south of Anatolia (Figure 5) as well as in the Bolkar Mountains specifically (Figure 6).

Discussion and Conclusions

The Quaternary is the period in which are of suitable climatic conditions for temperate vegetation was limited in Turkey and significant floristic changes happened vegetation zones moved down vertically a few hundred meters in glacial periods, it moved up a few hundreds in interglacial period. The last one of the mentioned climate changes happened in Last Glacial Maximum. Glaciers which cover larger areas in Last Glacial Maximum on the higher parts of Bolkar Mountains and permanent snowline which was lower than today's lowered the forest line. Changing conditions after this period caused changes in the dispersal area of plant communities. Vegetation zones moved up vertically due to the withdrawal of glaciers and the rise of permanent snowline. In sum, the species that need warmer temperatures can move away from any area or totally disappear in the cold climate following a warmer one after the possible climate change. Instead, plants that are more tolerant to cold climates take place. If the area is mountainous, heat-tolerant plants take shelter in inner parts of valleys and to the southern slopes.

Although dry forests are dominant in our research area, the species which needs respectively more humidity such as *Taxus baccata, Ostrya carpinifolia, Carpinus orientalis, Corylus avellena, Cornus sanguinea* are seen in the inner parts of Kadincik Valley which is a protected area. Both climate and morphological features of the land are quite effective on plant diversity on the area.

The questions need to be answered in our research are: What are the changes in the dispersal area of *Taxus baccata* in Last Glacial Maximum, today and in the future?

Applied ENM (Ecological Niche Modelling) Assessment: While assessing the obtained results of Maxent, it must not be ignored that the modelling is based on the prediction and it is not accurate. The statistical validity of results obtained by Maxent method is carried out by tests along with model analysis. Within the scope of statistical try-outs, modellings have given meaningful results.

Distribution of Taxus baccata: As the distribution pattern of Last Glacial Maximum is examined, it is necessary to mention the past possible distribution of *Taxus baccata*. When LGM model is analyzed; it is observed that there are suitable conditions for this species to disperse on Bolkar Mountains in this period. According to the species distribution models carried out for *Taxus baccata*, a tree species belonging to Europe-Siberia flora region, likely shifted to Mediterranean in Last Glacial Maximum and after with the temperature rise, it shifted to the northern latitudes. Also some modeling studies

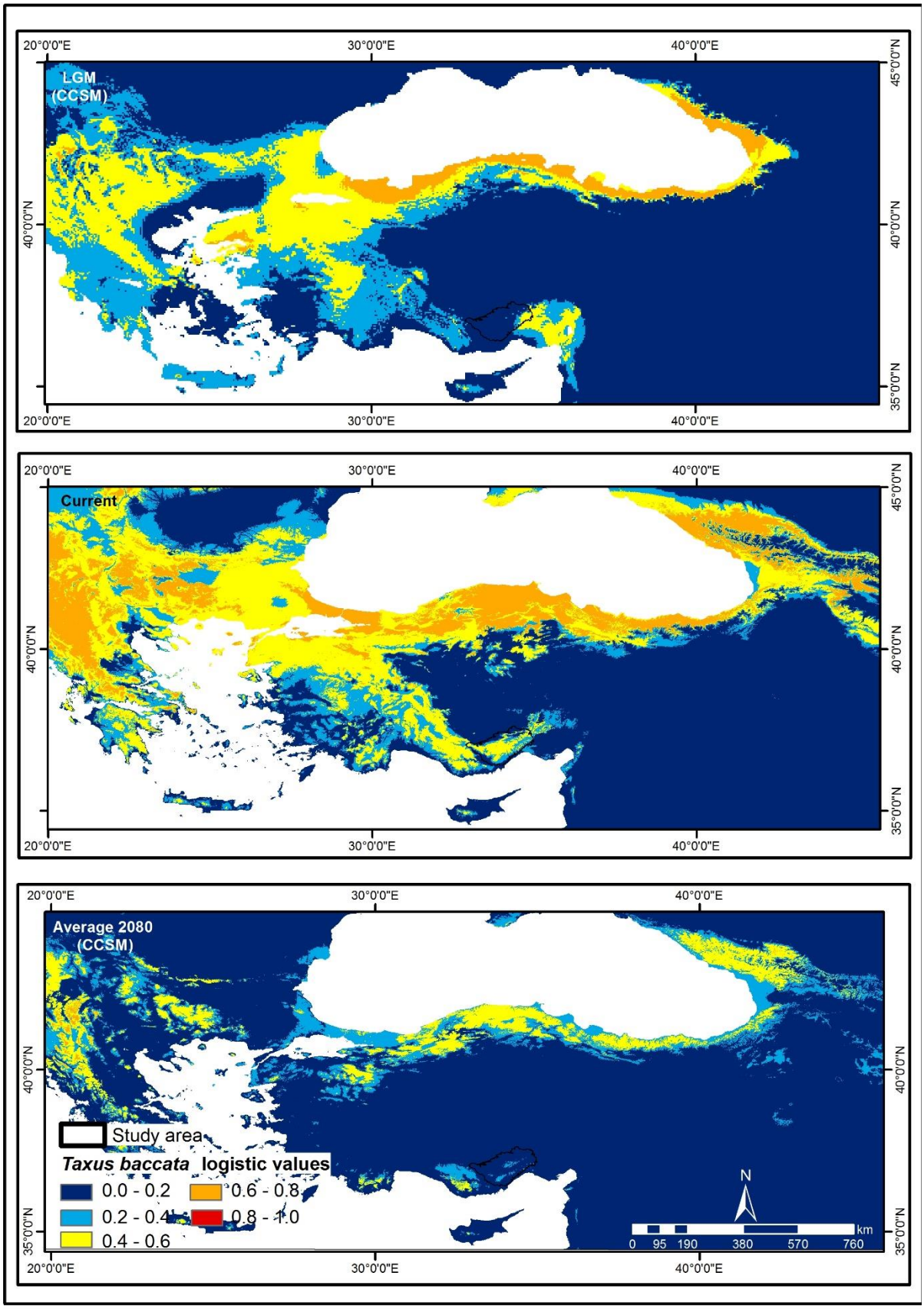

Figure 5. The Last Glacial Maximum, today and approximately 2080 distribution of *Taxus baccata* around Turkey and surroundings

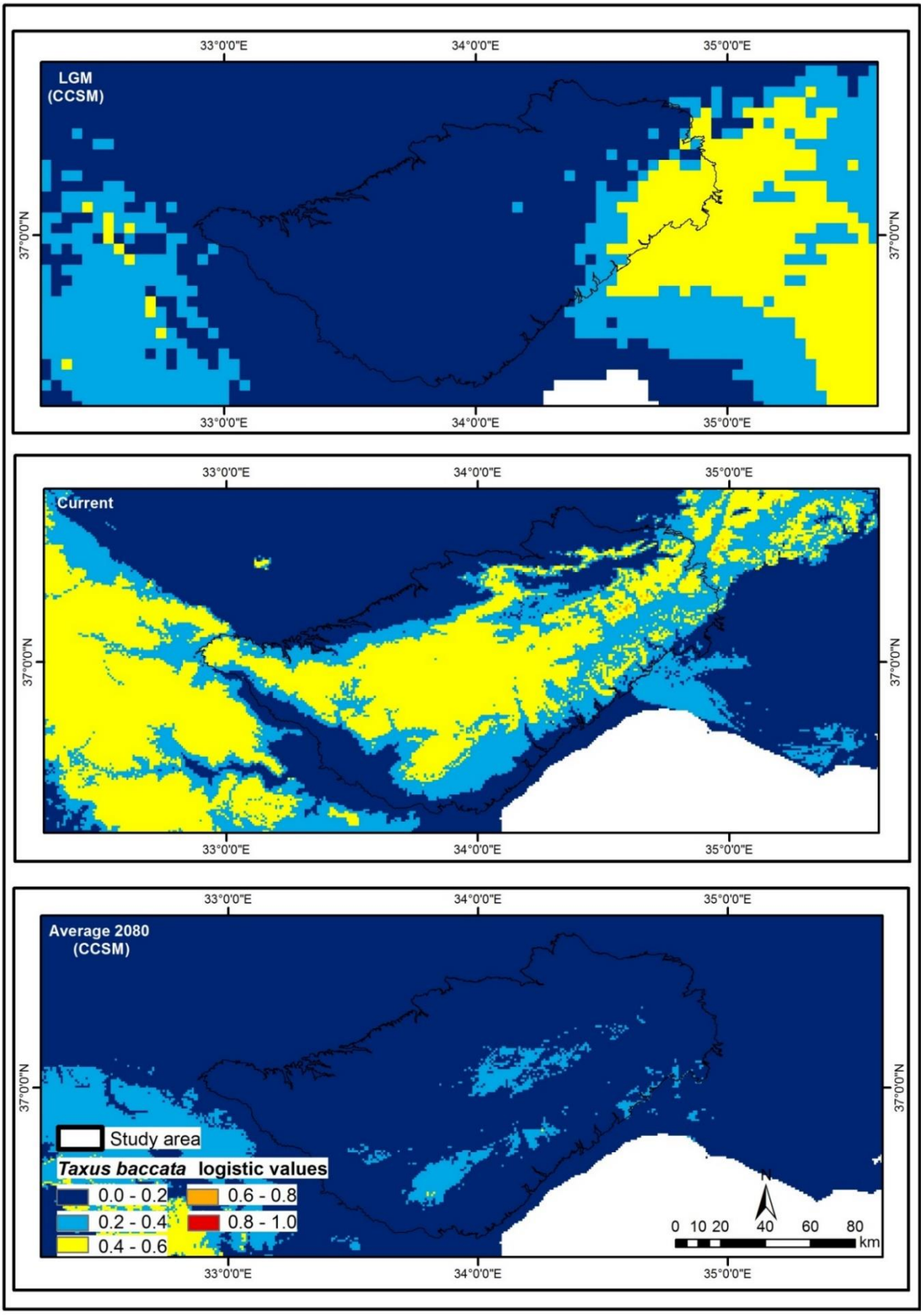

Figure 6. The Last Glacial Maximum, today and approximately 2080 distribution of *Taxus baccata* around Bolkar Mountains.

about hygrophilous species show similar results with *Taxus baccata* in Anatolia (Dyderski et al., 2017). Paleoecological research based on plant macrofossils and pollen fossils revealed the distribution of *Taxus baccata* in the Mediterranean basin with the rise in the rainfall in the Paleogene (Sadori et al., 2004; Drescher-Schneider et al., 2007) Paleogeographic studies support the idea that there were more refuge in the Mediterranean and Black sea regions for nemoral tree species in Last Glacial Maximum (Leroy & Arpe 2007). In the pollen analysis carried out in the marsh lands of Akgöl (in Ereğli-in the north of Bolkar Mountains), younger Dryas climate has been observed. In pollen diagrams, some sporadic species that are sensitive to relatively low temperatures like *Betula* has been seen today around the research area. In Late Quaternary, high pollen count pertaining to broad leaved tree species like *Fraxinus ornus* and *Quercus* are seen clearly in another pollen study done around Beyşehir Lake (in North West of Bolkar Mountains) close to our research area (Bottema & Woldring, 1984; van Zeist et al., 1975; Bottema & Woldring, 2001-2002). Considering today's distribution of *Taxus baccata* on Bolkar Mountains, it is thought that the distribution of this species is possible during LGM.

In our research area, *Taxus baccata* survives in microclimate areas that will constitute a refuge in the area. Taking the above mentioned conditions into consideration, it is considered that today's distribution of the species has taken its shape with the effect of last glacial period (Figure 5). As a conclusion, migration corridor in LGM is not constituted by the Anatolian Diagonal between Central and Eastern Anatolia for *Taxus baccata* dispersing on the mountainsides in the south of Anatolia. In other words, "migration corridor" for *Taxus baccata* in Anatolia is composed by the mountainsides in the inner parts of west Anatolia. Relatively high mountains on this corridor (such as Murat Mountain , Yirce Mountain, the Sultan Mountains and the mountainsides of lakes region) could make step stones in the migration of *Taxus baccata* to the south. Ranging to Taşeli Plateau, *Taxus baccata* could have found the opportunity to disperse to the Bolkars and Amanos Mountains in the east. The microclimatic factor of Kadıncık Valley and its topographical structure have affected the distribution of the species.

Under the climate changes expected, our results suggest that the Bolkar Mounatins will no longer be a suitable area for the distribution of *Taxus baccata*. *Taxus baccata* has already limited distribution in the research area and in the protected areas inside the valleys that can be a refuge for them. Hence, there is a high risk that they will become extinct in the region, although it is important to note that remnant populations or individuals may be able to survive for a long time, for example in microclimatically less stressful microsites. To limit this risk, it is important to ensure that current occurrences in the region are adequately protected and not subject to land use pressures, as well as to include the species in reforestation plans for sites locally or elsewhere in Turkey that are estimated to remain suitable under the expected future climate change.

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Impact of spatial factors on climate variables and species distribution in forest ecosystems under sea influence of Eastern Black Sea Region, NE Turkey

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Abstract

The distribution and characteristics of forest ecosystems are largely under the influence of climate. Climate directly affects the growth, leaf area and form, fenology and plant life, from seed to seedling formation. Climate varies from global scale to regional and local scales. Climate also has feedback mechanisms that can revert the changing vegetation back to its original state, through the changes it can create on vegetation. In this study, it was aimed to investigate the relationships between the distribution of tree species in the highland which is under the influence of the sea in Canik-Giresun Mountains, Trabzon Mountains and Rize-Kaçkar Mountains sites in the Eastern Black Sea Region, and spatial factors (altitude, distance from sea and latitude) and climate variables. The climate data, such as precipitation, temperature (average, minimum and maximum) and number of foggy days, of meteorological stations at different altitudes in coastal and mountainous areas under the influence of the sea were used in the study. 100 m increase in altitude led to a decrease in 26.9 mm precipitation in the Canik-Giresun Mountains, a decrease in 87.0 mm precipitation in the Rize-Kaçkar Mountains, and an average temperature decrease of 0.4ºC in sites. The decrease in annual precipitations reaches 70 mm in Trabzon Mountains, 100 mm in Canik-Giresun Mountains and 290 mm in Rize-Kaçkar Mountains at a distance of 10 km away from the coast. Statistical increases were determined in the number of foggy days depending on the altitude and distance from the sea.

In the research area, at 3rd altitude step where the distance from the sea and altitude are extreme, Scots pine, Oriental Spruce and Fir are spread in Canik-Giresun Mountains, Oriental Spruce and Scots pine are spread in Trabzon Mountains, and Oriental Spruce, Oriental Beech and Fir are spread in Rize-Kaçkar Mountains. Despite the decreasing amount of precipitation along with the increase in altitude and distance from the sea, the fog cloud in high mountainous areas plays an important ecological role in the conservation and distribution of these species.

Key words: Sites, altitude, latitude, distance from the sea, precipitation, temperature

Özet

Orman ekosistemlerinin dağılımı ve özellikleri büyük ölçüde iklimin etkisi altındadır. İklim, tohumdan fidan teşekkülüne, büyümeyi, yaprak alanı ve formunu, fenolojiyi ve bitki hayatını doğrudan etkiler. İklim, küresel ölçekten bölgesel ve yerel ölçeğe farklılık gösterir. İklimin, vejetasyon üzerinde meydana getirebileceği değişiklikler yoluyla, değişen vejetasyonu tekrar orijinal haline döndürebilecek geri besleme mekanizmaları da vardır. Bu çalışmada, Doğu Karadeniz Bölümü'nde Canik-Giresun Dağları, Trabzon Dağları ve Rize-Kaçkar Dağları yetişme ortamlarında deniz etkisi altındaki dağlık arazide ağaç türlerinin yayılışı ile konum faktörleri (yükselti, denizden uzaklık, enlem) ve iklim değişkenleri arasındaki ilişkilerin araştırılması amaçlanmıştır. Çalışmada, deniz etkisi altında kıyı ve dağlık alanlarda farklı yükseltilerdeki meteoroloji istasyonlarının yağış, sıcaklık (ortalama, minimum ve maksimum) ve sisli günler sayısı gibi iklim verilerinden yararlanılmıştır.

Yükseltideki 100 m artış Canik-Giresun Dağları'nda 26.9 mm, Rize-Kaçkar Dağlarında 87.0 mm yağışta düşüşe; yetişme ortamlarında ortalama olarak 0.4 ºC ortalama sıcaklık düşüşüne sebep olmuştur. Yıllık yağışlardaki düşüş, sahilden 10 km uzaklaşıldığında, Trabzon Dağları'nda 70 mm, Canik-Giresun Dağlarında 100 mm ve Rize-Kaçkar Dağlarında 290 mm'ye ulaşmaktadır. Yükselti ve denizden uzaklığa bağlı olarak sisli gün sayısında istatistiksel olarak artışlar belirlenmiştir.
Araştırma alanında, denizden uzaklığın ve yükseltinin ekstrem olduğu III. yükselti basamağında, Canik-Giresun dağlarında Sarıçam, Doğu Ladini ve Göknar, Trabzon dağlarında Doğu Ladini ve Sarıçam, Rize-Kaçkar Dağlarında Doğu Ladini, Doğu Kayını ve Göknar yayılış göstermektedir. Yükselti ve denizden uzaklığın artması ile düşen yağış miktarına rağmen, yüksek dağlık alanlardaki sis bulutu bu türlerin korunmasında ve yayılışında önemli ekolojik bir rol üstlenmektedir.
Anahtar kelimeler: Yetişme ortamları, yükselti, enlem, denizden uzaklık, yağış, sıcaklık

Introduction

There are many different factors that affect the climate of a place in the world. The climate of a region is determined by the interaction of some important natural controls such as latitude (proximity to the equator), altitude, distance from the sea, aspect, slope, ocean currents, orographic effect, warming and cooling characteristics and air pressure. It has been recently accepted that human activity also affects the climate (Scott, 2004). The changes in altitude may cause big differences in temperature even at similar latitudes. For this reason, high mountain and plateau stations are much colder than the low-altitude stations at the same latitude (Apaydın et al., 2011). In many parts of the world, mountains are open to the effects of a rapidly changing climate and are interesting places for early detection and analysis of the signals of climate change and their effects on hydrological, ecological and social systems (Beniston, 2005). Although the mountains are very different from region to region, their common characteristic is the complexity of their topography. Orographic characteristics affect the rapid and systematic changes especially in temperature and precipitation conditions at very short distances in climate parameters (Becker and Bugmann, 1997; Arnbjerg-Nielsen et al., 2013), directly developing flow and erosion, the systematic change of other climate variables (e.g., radiation), and the environmental factors (such as the differences in soil types). Orographic effect is the lifting effect on winds passing over the mountain peaks or ranges. The air rises as it approaches a mountain barrier, and it typically generates clouds and precipitation usually on the windward side of the mountains. The wettest parts of the world are located on the windward side of high mountain ranges (Clarke and Wallace, 1999; Jackson, 2000; Scott, 2004; Espinoza et al., 2015). These factors are the spatial functions, and the accurate determination of spatial distribution of meteorological variables is as important as their measurements (Apaydın et al., 2004).

The climate factors, such as temperature, potential evapotranspiration, growing season length, moisture, air pressure, presence of nutrients, ultraviolet radiation and precipitation, vary depending on the altitude (Funnell & Parish, 2001). The range of change of tree species spreading in this change is determined directly or indirectly by the inappropriate extremes of these climate factors. The upper limit of the distribution of a species can be determined by a combination of climate and biotic factors (MacArthur, 1972; Ehrlén and Morris, 2015). For this reason, the distribution and characteristics of forest ecosystems are largely controlled by climate. At the individual level, climate directly affects the reproduction of seeds and seedling formation (Renard et al. 2016), the growth (Carrer & Urbinati, 2004, 2006), the leaf area and form (Fisher et al. 2007; Yang et al., 2015), the fenology (Petrotelli et al. 2005), and the lifespan of the plant as an individual (Goulden et al., 1998). The influence of climate in nature varies from global scale to regional and local scales. Climate also has feedback mechanisms that can revert the changing vegetation back to its original state, through the changes it can create on vegetation (Bonan et al. 1992; Lynch et al., 1999; Anderson-Teixeira et al. 2013).

In this study, it was aimed to reveal the relationships between the spatial factors affecting the distribution of forest-building tree species in the highland which is under the influence of the sea in the

sub-regional sites in the Eastern Black Sea Region and climate variables. For this purpose, the statistical relationships between spatial factors (altitude, latitude and distance from the sea) in the highland under the influence of the sea and the climate variables were investigated, the distribution of spreading tree types was evaluated according to spatial factors.

Methods

Study Area

This study was carried out in the ecological units which are under the influence of the sea of Ordu, Giresun, Trabzon, Rize and Artvin provinces that are geographically located in the Eastern Black Sea Region of the Black Sea Region. The sub-regional sites formed by Kantarcı (1995) in the "Site under the influence of the sea", based on the earth-climate relationship for the Eastern Black Sea Region were taken into account while determining the study area. These site regions are Canik-Giresun Mountains, Trabzon Mountains and Rize-Kaçkar Mountains (Figure 1).

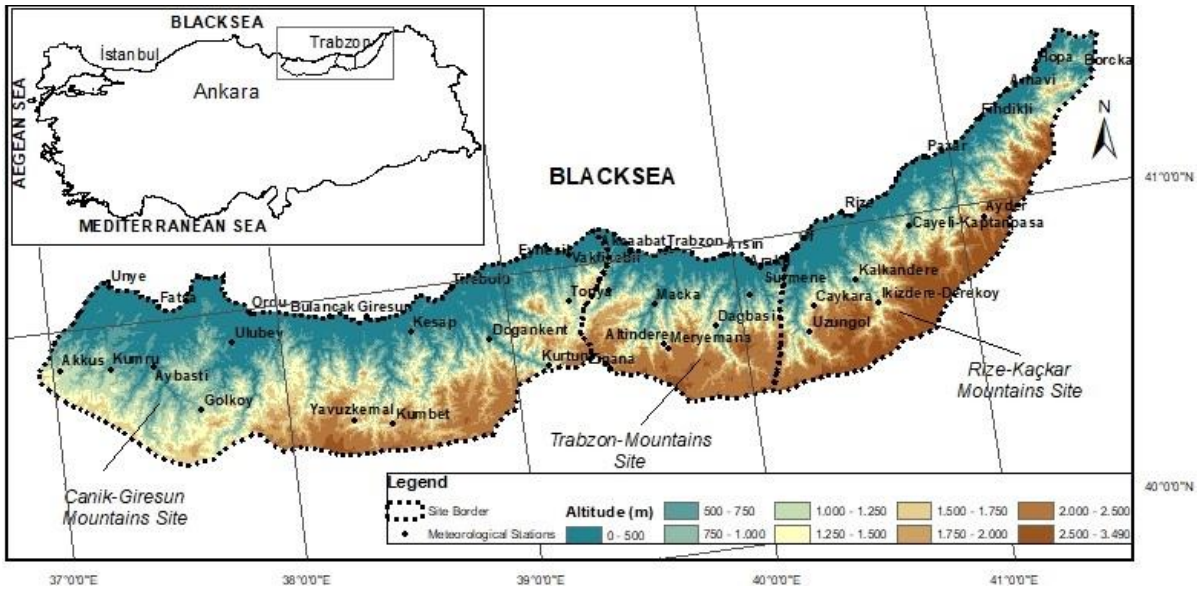

Figure 1. Location of the study area and DEM map

The study area is located between 40°30'42"N - 41°31'2"N latitudes and 36°56'11"E - 41°43'11"E longitudes. In the site which is under the influence of the sea, Canik-Giresun Mountains cover an area of 10149.54 km^2, Trabzon Mountains cover an area of 3362.49 km^2, and Rize-Kaçkar Mountains cover an area of 5869.24 km^2. The study area is a total of 19381,27 km^2.

The study area is located within A6-A8 squares of the Euro-Siberian floristic region among 3 floristic regions identified for Turkey. Euro-Siberian region is represented by Auxin province in Turkey. This site extends to the western part of the Caucasus, involving the whole northern Anatolia. A leafy forest formation merged with coniferous species at higher altitudes spreads in the Auxin province. In the auxin vegetation areas, there is no significant summer drought due to summer rains. The annual amount of precipitation exceeds 1000 mm in many places (Davis, 1971).

Climate Data

The data of meteorological stations (annual precipitation, average temperature, minimum temperature, maximum temperature and number of foggy days) at different altitudes in coastal and mountainous areas under the influence of the sea were used in the study (TSMS, 2018). The data of a total of 44

meteorological stations, including 19 meteorological stations in Canik-Giresun Mountains, 12 meteorological stations in Trabzon Mountains, and 13 meteorological stations in Rize-Kaçkar Mountains, were evaluated. The location information of meteorological stations (altitude, distance from the sea, latitude, longitude, years with data available) is presented in Table 1.

Table 1. Spatial features of the stations used in the study

Stations in Sites	Altitude (m)	Distance From Sea (km)	UTM		Years with data available
			Latitude	Longitude	
Canik-Giresun Mountains					
Akkuş	1190	38,305	346254	4573001	1989-1992
Aybastı	640	21,433	380413	4574322	1986-1994
Gölköy	925	44,948	398465	4558640	1986-1993
Kumru	600	30,738	364489	4573715	1986-1992
Ordu	5	0,050	416568	4594601	1961-2016
Ulubey	400	13,016	409743	4583550	1986-1993
Ünye	16	0,284	363973	4604414	1986-2016
Doğankent	550	26,690	505472	4584678	1983-1993
Giresun	38	0,030	459753	4593188	1950-2015
Kümbet Yaylası	1730	43,356	469512	4553302	2010-2017
Eynesil-Ören	10	0,384	515286	4614125	1989-1993
Tirebolu	10	0,409	490870	4603605	1986-2000
Yavuzkemal	1711	50,184	455439	4554880	2012-2017
Keşap-Yivdincik	680	7,973	476306	4587419	2014-2017
Kürtün	739	50,249	527504	4575167	1987-1993
Tonya	900	18,791	534633	4599003	1976-1995
Vakfıkebir	215	2,539	535044	4616071	1983-2010
Fatsa	2	0,144	382217	4596669	2010-2016
Bulancak	10	0,020	446371	4593314	1965-1997
Trabzon Mountains					
Akcaabat	3	0,991	557856	4617484	1963-2015
Altindere	1030	39,132	570275	4583113	2011-2015
Arsin	10	0,378	592503	4616168	1984-1995
Arakli	10	0,158	601364	4614415	1983-1996
Duzkoy	850	17,910	549864	4603020	1986-2003
Trabzon	25	1,343	570784	4617511	1950-2015
Zigana	2050	51,281	550001	4573740	2010-2016
Meryemana	1100	41,209	571674	4581544	1976-1986
Dagbasi	1450	29,195	589221	4589929	1989-1998
Macka	265	22,037	566457	4597873	1964-1997
Kucukdere	925	12,277	601969	4601252	1988-1993
Sürmene	50	1,602	606144	4611420	1989-1998
Rize-Kaçkar Mountains					
Of	10	0,566	619393	4619186	1964-1994
Uzungöl	1450	34,059	624271	4587560	1983-2015
Caykara	800	22,404	625690	4597284	1989-1998
Ayder	1354	33,173	689214	4630480	2010-2016
Ikizdere-Derekoy	800	39,811	650024	4598325	1970-1996
Findikli	190	1,004	687173	4666650	1989-2000
Kalkandere	400	26,854	641255	4606754	1986-1996
Cayeli-Kaptanpasa	525	16,703	661119	4626687	1965-1986
Pazar	78	0,472	667314	4652778	1963-2015
Rize	3	0,050	636236	4632061	1950-2015
Arhavi	10	0,071	697598	4677430	1983-1993
Borcka	120	21,893	728786	4684658	1987-2003
Hopa	33	0,267	707918	4685750	1962-2015

In the separation performed by Kantarcı (1995) to determine site regions for the Eastern Black Sea Region, the areas where there are Of, Çaykara and Uzungöl meteorological stations were shown in the Trabzon Mountains site. However, these areas were shifted to Rize-Kaçkar Mountains due to a transition climate between Trabzon Mountains and Rize-Kaçkar Mountains and high amount of annual precipitation (Table 1).

Determination of spatial factors and species distribution in forest sites

In the separation based on the relationship between earth shape and climate, Kantarcı (1995) separated a total of 6 sub-regional sites within two sites in the eastern black sea geography and stated that the

boundaries of regional classification complied with the boundaries of forest managements. In the study, the data of the General Directorate of Forestry were used for the distribution of forest trees spreading in the site under the influence of the sea (GDF, 2008; GDF, 2012; GDF, 2015). In the distribution of forest trees, the areas covered by dominant species in normal, degraded and very degraded forest sites were taken into account.

ArcGis/Arcmap software was used in determining the spatial features (slope, aspect, altitude, longitude, distance from the sea) of sites. SRTM 1 Version 3 (Shuttle Radar Topography Mission) satellite data at 30 m resolution with open access were used to obtain the digital elevation model (DEM), which is one of the inputs required for GIS analysis. By performing improvement and updating studies on SRTM data, they are presented with an increased sensitivity at 30 m resolution (Li et al. 2012, Mohd et al. 2014). The altitude, slope and aspect of site regions were generated using the SRTM data. According to the data obtained from the digital elevation model of the study area, the altitude was represented in 3 groups (0-1000 m, 1000 – 2000 m and 2000 – m) and % slope was represented in 5 groups (0-20, 20 – 40, 40 – 60, 60 – 80 and 80<). Furthermore, the systematic points on the study area (representing about 17 ha) were removed to determine the relationship between altitude and distance from the sea.

Statistical Analysis

In the study, the relationships between spatial factors (altitude, distance from sea and latitude) and climate parameters (precipitation, average temperature, minimum temperature, maximum temperature, number of foggy days) in forest ecosystemss were investigated. Regression analysis was used in the prediction of precipitation and average temperature in conjunction with the altitude and distance from the sea in forest ecosystemss. All statistical analyses were performed in the SPSS program.

Results

Relationships between climate parameters and spatial factors

The relationship between spatial factors of the selected meteorological stations and climate parameters was determined by correlation analysis. Significant and meaningful relationships were found between the spatial factors, like altitude, distance from the sea and latitude in sites, and meteorological parameters (Table 2).

Table 2. Correlation coefficients between climate parameters and spatial factors in the sites

Spatial Factors	Climate Parameters				
	Precipitation	Average Temp.	Min. Temp.	Max. Temp.	Foggy Days
Canik-Giresun Mountains					
Altitude	-,621**	-,930**	-,893**	-,917**	,871**
Distance from sea	-,666**	-,884**	-,908**	-,781**	,636**
Latitude	,562**	,861*	,874*	,782*	-,749*
Trabzon Mountains					
Altitude	-,521	-,767**	-,909**	-,705**	,805**
Distance from sea	-,622*	-,742*	-,970**	-,754*	,763**
Latitude	,642*	,897**	,871*	,782*	-,749*
Rize-Kaçkar Mountains					
Altitude	-,812**	-,951**	-,878**	-,896**	,852**
Distance from sea	-,798**	-,769**	-,724**	-,629*	,570
Latitude	,542*	,408	,357	,381	-,368

* Significance at 0.05 probability level.
** Significance at 0.01 probability level

In Canik-Giresun and Rize-Kaçkar Mountains, altitude showed a negative correlation on other climate parameters except for the numbers of foggy days (Table 2). In Trabzon Mountains, altitude once again showed a negative correlation on average minimum and maximum temperatures except for the numbers

of foggy days; however, no correlation was found between precipitation and altitude. This shows that the precipitation, average temperature, minimum and maximum temperature parameters decreased along with the increase in altitude in Canik-Giresun and Rize-Kaçkar Mountains, and the number of foggy days increased. In Trabzon Mountains, increase in altitude did not affect precipitation, decreased the average temperature, minimum and maximum temperatures but increased the number of foggy days. The degree of latitude had a similar effect in Canik-Giresun and Trabzon Mountains. The increase in latitude increased the precipitation, average temperature, minimum and maximum temperatures and decreased the numbers of foggy days (Table 2). The increase in the degree of latitude in Rize-Kaçkar Mountains led to an increase in precipitation and a decrease in the number of foggy days. Canik-Giresun Mountains are located between 41°6' N - 40°30'N latitudes, Trabzon Mountains are located between 41°6' N - 40°29' N latitudes and Rize-Kaçkar Mountains are located between 41°31' N - 40°29' N latitudes (Figure 1). Canik-Giresun and Trabzon Mountains are located between approximately same latitudes while Rize-Kaçkar Mountains are located in the further north.

The distance from the sea showed a similar effect to altitude in all sites except for the number of foggy days in Rize-Kaçkar Mountains. However, the distance from the sea in Trabzon Mountains showed a negative correlation on precipitation. Within the scope of the study, regression analysis was performed since a positive correlation was found between altitude and distance from the sea in sites (Table 3). The relationship between altitude and distance from the sea is presented in Figure 2.

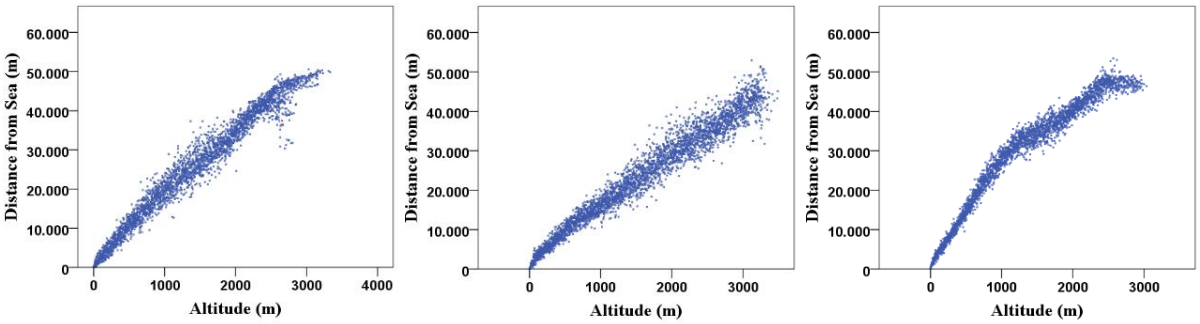

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Figure 2. Relationship between altitude and distance from the sea

As a result of the regression analysis performed for the estimation of altitude based on distance from the sea, equations were revealed for each of sites (Table 3). Accordingly, the increase in altitude due to distance from the sea is the highest in Rize-Kaçkar Mountains. For instance, at a distance of 50 km away from the coast, an altitude of 1957.55 m is reached in Canik-Giresun Mountains, an altitude of 2619.45 m is reached in Trabzon Mountains, and an altitude of 3182.17 m is reached in Rize-Kaçkar Mountains.

Table 3. Stepwise multiple regression models for altitude and distance from the sea in the sites

Forest Sites	Min	Max	Mean	Regression Equations	R^2	Adjusted R^2
Canik-Giresun Mountains						
Altitude	107.55	2191.22	1004.16	107.553+0.037*DFS (m)	0.688	0.668
Trabzon Mountains						
Altitude	119.48	2738.72	1370.67	119.451+0.050*DFS (m)	0.815	0.805
Rize-Kaçkar Mountains						
Altitude	82.18	3378.50	1352.25	82.168+0.062*DFS (m)	0.800	0.780

Regression analyses were performed for the estimation of precipitation and average temperature based on altitude and distance from the sea in site regions (Table 4).

Table 4. Stepwise multiple regression models for some spatial factors and climate parameters in the sites

Climate Parameters	Min	Max	Mean	Regression Equations	R^2	Adjusted R^2
Canik-Giresun Mountains						
Precipitation	606.60	1568.20	1041.62	1175.413-0.269*ALT (m) 1191.123-0.010*DFS (m)	0.386 0.444	0.352 0.413
Average Temperature	5.80	15.50	11.55	14.317-0.005*ALT (m)	0.866	0.858
Trabzon Mountains						
Precipitation	522.90	1226.50	785.88	909.505-0.007*DFS (m)	0.396	0.336
Average Temperature	4.40	14.90	12.17	14.543-0.003*ALT (m)	0.588	0.536
Rize-Kaçkar Mountains						
Precipitation	817.80	2327.40	1606.17	1981.34-0.870*ALT (m) 2007.66-0.033*DFS (m)	0.659 0.637	0.630 0.607
Average Temperature	8.30	14.60	12.33	14.020-0.004*ALT (m)	0.904	0.896

In the study, it was observed that precipitation decreased in Canik-Giresun and Rize-Kaçkar Mountains depending on the altitude in the site under the influence of the sea. The decrease in annual precipitation at an altitude of 100 m was 26.9 mm and 87.0 mm in Canik-Giresun Mountains and Rize-Kaçkar Mountains, respectively. The decrease in average temperatures due to altitude was found to be close in sites. The decrease in average temperature in sites was 0.3 – 0.5 ºC at an altitude of 100 m. Decreases were observed in annual precipitation due to distance from the sea. At a distance of 10 km away from the coast, the decrease in average annual total precipitation was 100 mm in Canik-Giresun Mountains, 70 mm in Trabzon Mountains and 330 mm in Rize-Kaçkar Mountains.

Relationships between spatial factors, climate and species distributions in forest sites

It was determined that the average slope was 23% in Canik-Giresun Mountains, 28% in Trabzon Mountains and 32% in Rize-Kaçkar Mountains. The average altitude is 994 m (max. 3037 m) in Canik-Giresun Mountains, 1319 m (max. 3002 m) in Trabzon Mountains and 1389 m (max. 3490 m) in Rize-Kaçkar Mountains (Figure 1). The slope and altitude increase as going from west to east in sites.

In the Eastern Black Sea region, the forest-building tree species in the sub-regional sites are Oriental Beech, Oriental Spruce, Scots pine, Alder, Chestnut, Hornbeam, Fir and Oak. The species involved in mixture with very low quantities were excluded from the study (Figure 3).

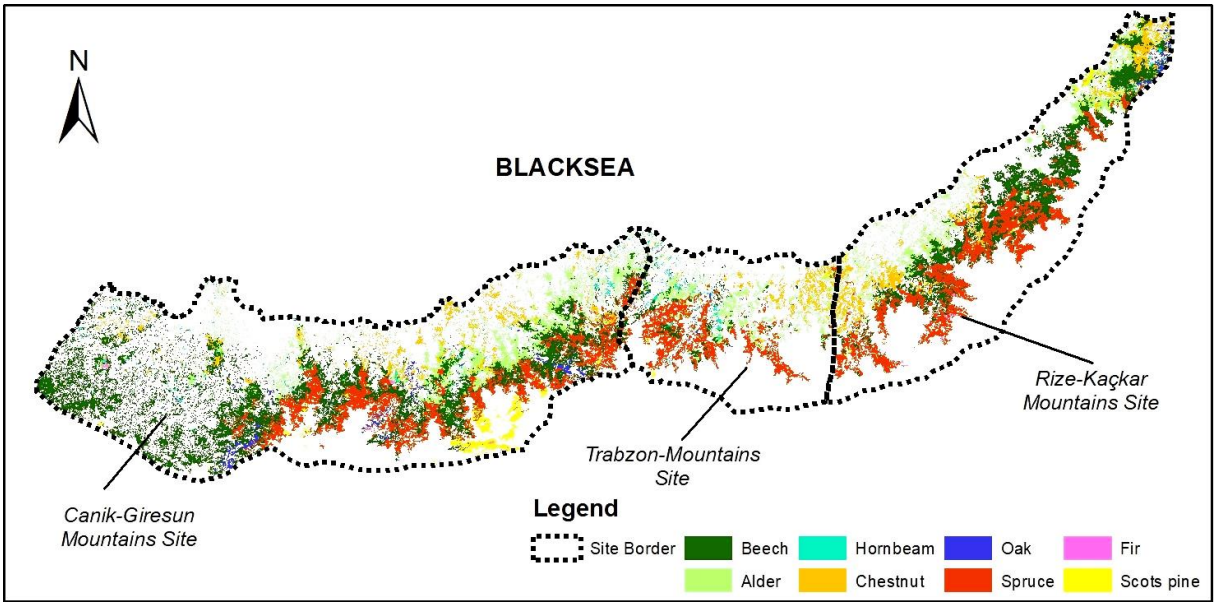

Figure 3. Distribution map of the dominant tree species in Eastern Black Sea region

The areal (%) distributions of forest-building tree species in the forest sites according to altitude steps and aspect groups are given below (Figure 4-6). Oriental Beech is the dominant species in both aspect groups at 0-1000 m (1st altitude step) and 1000 – 2000 m (2nd altitude step) altitude steps in the Canik-Giresun Mountains site. Oriental Beech is followed by Alder at 1st altitude step and Oriental Spruce at 2nd altitude step. At 3rd altitude step, Scots pine is the dominant species in both aspects. Scots pine is followed by Oriental Spruce (Figure 4).

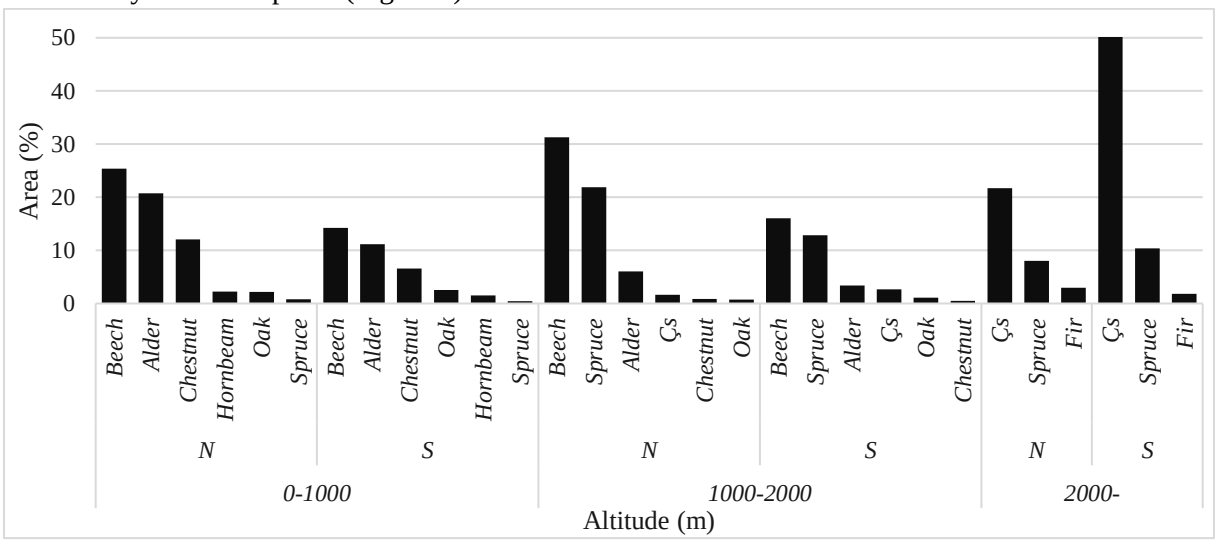

Figure 4. Distribution of dominant tree species in Canik-Giresun Mountains by altitude and aspect

In Trabzon Mountains site, Alder is dominant at 1st altitude step and Oriental Spruce is dominant at 2nd altitude step in both aspect groups. Alder and Oriental Spruce are followed by Chestnut and Alder, respectively. At 3rd altitude step, Oriental Spruce is the dominant species in both aspects. Oriental Spruce is followed by Scots pine (Figure 5).

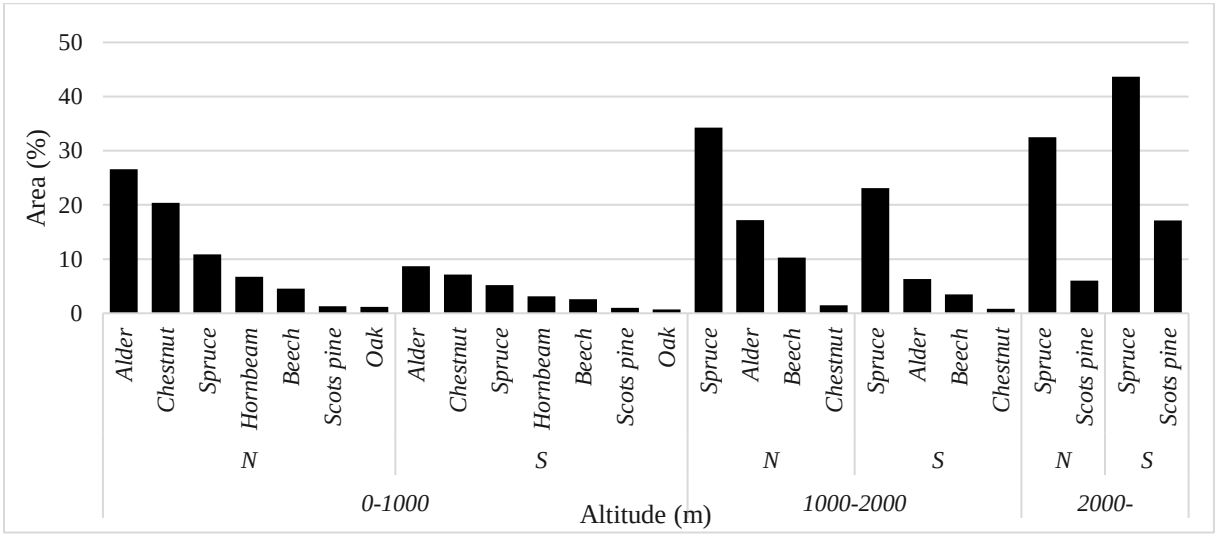

Figure 5. Distribution of dominant tree species in Trabzon Mountains by altitude and aspect

In Rize-Kaçkar Mountains site, Alder is the dominant species at 1st altitude step in both aspect groups. Alder is followed by Oriental Beech. At 2nd and 3rd altitude steps, Oriental Spruce is the dominant species in both aspect groups. Oriental Spruce is followed by Alder at 2nd altitude step and Scots pine at 3rd altitude step (Figure 6).

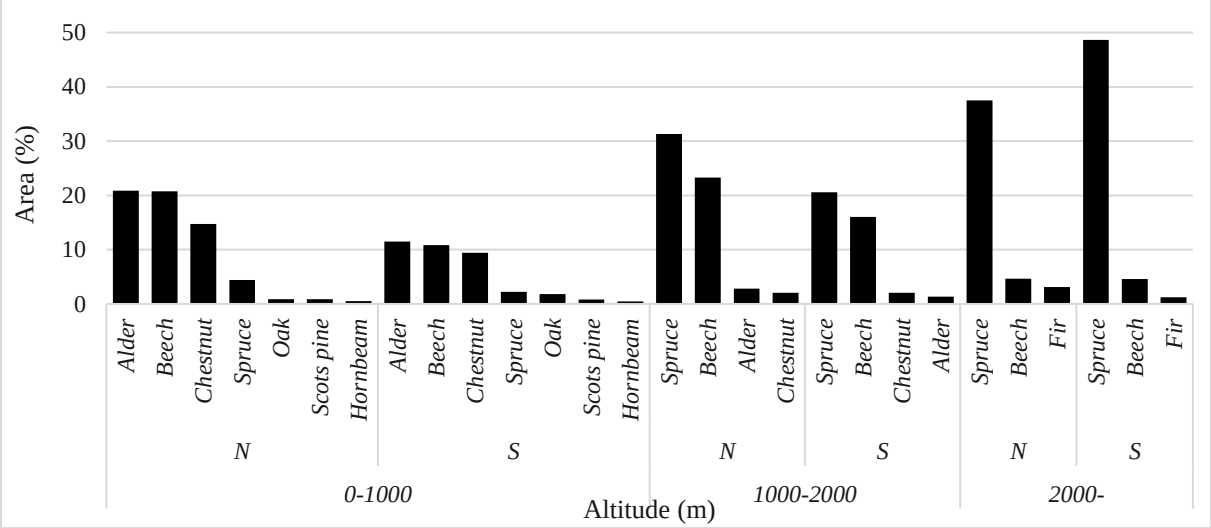

Figure 6. Distribution of dominant tree species in Rize-Kaçkar Mountains by altitude and aspect

When all site regions are evaluated, it is seen that the forest-building tree species at 1st and 2nd altitude steps are mainly present in the North aspect by area (%). However, the South aspect group gets this superiority at 3rd altitude step. Scots pine is the dominant species in Canik-Giresun Mountains and Oriental Spruce is the dominant species in Trabzon and Rize-Kaçkar Mountains. Scots pine is followed by Oriental Spruce in Canik-Giresun Mountains, Oriental Spruce is followed by Scots pine in Trabzon Mountains, and Oriental Spruce is followed by Oriental Beech in Rize-Kaçkar Mountains. At 3rd altitude step in Rize-Kaçkar Mountains, Oriental Spruce is apparently dominant while Oriental Beech is at much lower rates. While the distribution of species in the north aspect is more dominant at 1st and 2nd altitude steps, it is interesting that the south aspect group gets the dominance at 3rd altitude step. When it is noted, Scots pine and Oriental Spruce are more dominant in the south aspect group. It would not be wrong to say that the light demands of tree species come to the forefront at this altitude (2000 m <) where the vegetation period is quite shortened. Indeed, the light demands of Scots pine and Oriental Sprucen are higher compared to Oriental Beech and Fir.

Discussion

Relationships between climate parameters and spatial factors

The Eastern Black Sea Mountains constitute the highest part of the mountain range that surrounds our country from the north. The mountain range starts to rise as going from Central Black Sea Region to the east and reaches the highest level in Kaçkar Mountains. The mountain range with an extension in the east-west direction in Central Black Sea Region changes the direction as going towards the east and has an extension in the southwest–northeast direction. In this section, Eastern Black Sea Mountains rise suddenly at the backshore and exceed 3000 meters at a distance of about 20-30 km (Çiçek et al. 2003).
The effects of topographic factors such as altitude, slope status, orographic mountain ranges and continentality play the most significant role in the classification of habitats and ecosystems. For instance, local climate changes, and the distribution of vegetation cover both at vertical and horizontal distances are controlled by topographic factors (Atalay, İ. et al. 1985).
In this study, in contrast to the studies in which precipitation in mountainous areas is stated to increase typically with altitude (Daly et al., 1994; Park and Singh, 1996; Sevruk, 1997; Marquinez et al., 2003; Naoum and Tsanis, 2004), precipitation decreased along with the increase in altitude in Canik-Giresun and Rize-Kaçkar Mountains sites, except for Trabzon Mountains (Table 2). This decrease corresponds

to a decrease of 538 mm in Canik-Giresun Mountains and a decrease of 1740 mm in Rize-Kaçkar Mountains in the areas above 2000 m. There is no statistically significant and meaningful relationship between altitude and precipitation in Trabzon Mountains (Table 2). The accumulation of humid air masses coming over the Black Sea in front of the high highland leads to a huge amount of precipitation on the coastline. The air with decreasing humidity that rises on mountain slopes and also becomes cold as it rises also enables the formation of precipitation in these parts (Kantarcı 1995). The accumulation of humid air in front of a barrier, its rise, cooling and condensation, and the formation of precipitation are more apparent in Taurus Mountains in the Mediterranean Region (Kantarcı 1982). Warm and humid air masses coming from the Mediterranean need to rise by 600-800 m on the slopes of the Taurus Mountains for their cooling and the condensation of the moisture they contain. Since the winds coming from the Black Sea are cooler, they can be cooled at lower altitudes and cause high precipitations (Kantarcı 1995). The headland (Yoroz) between the Canik-Giresun Mountains and Trabzon Mountains sites decreases the precipitation falling to the Trabzon Mountains site. This topography is a natural barrier to the moisture-bearing dominant west and north winds. Since the headlands located in the coastal region block the west winds, the eastern part of the headlands receives less precipitation than western part. It is reported that the coastline angles are an effective factor in the precipitation of the eastern and western parts of headlands (Eriş, 2011). The choice of western direction at the coastline angle is based on the dominant wind direction in the study area. If the coastline angle is less than 90 degrees, the measurement point is blocked from the west and north winds and receives less precipitation than the areas with an angle greater than 90 degrees (Eriş, 2011). Accordingly, among the measurement stations on the coast of Trabzon, the coastline angles of Vakfıkebir and Of were determined to be above 90^{o} while the coastline angles of Akçaabat, Trabzon, Arsin, Araklı and Sürmene were determined to be below 90^{o}. Even in this study, Vakfıkebir region was evaluated within the boundaries of Canik-Giresun Mountains sites while Of and Çaykara and Uzungöl regions at the same vertical position were evaluated in Rize-Kaçkar Mountains site.

Orographic precipitations are mostly observed in these sites that receive the influence of the sea. Orographic precipitation takes place in a mountain range at middle latitudes the axis of which is perpendicular to the wind direction. In the climatological average, the windward side of the mountain range receives more precipitation from the non-windward side reflected by sharp transitions in climate, flora and fauna, known as rain shadow (Roe, 2005). Orographic precipitation is at the center of the interaction between the field surface and the atmosphere. It is not only important for the management of natural ecosystems and drinking water resources but also has important subcomponents for the other physical components of the world system. For instance, on short time scales, natural hazards such as sudden floods, landslides and avalanches are affected by precipitation in mountainous regions (e.g., Caracena et al. 1979, Caine 1980, Conway & Raymond 1993). Finally, for millions of years, orographic precipitation models control the surfacing of rocks moving to finalize erosion and ultimately mountain ranges (e.g., Beaumont et al. 1992, Willett 1999, Montgomery et al. 2001, Reiners et al. 2003, Anders et al. 2004a, Roe et al. 2004).

Relationships between spatial factors, climate and species distributions in forest sites

The Eastern Black Sea region is a geographical area where there are very significant ecological differences between its slopes facing the sea by the effect of steep highland. The forests of the Eastern Black Sea are the forests that strictly reflect the effects of precipitation, one of climate factors, and the altitude and aspect, physiographic factors. This section includes the areas with the highest precipitation values (Rize 2441 mm) of Turkey (Ardel et al. 1969, Erinç 1969). While the maximum level of diversity was reached in the vegetation stages, high slope and aspect differences increased the ecotype richness of Eastern Black Sea forests (Efe and Sönmez, 2006). The location of the mountains against the winds coming over the sea causes significant precipitation differences while altitude causes significant

temperature differences. The change of precipitation and temperature according to the earth's shape has enabled the emergence of significant ecological differences. The presence of a high mountain or mountain ranges located in the climate region enables the formation of one or more separate environments in the vertical direction. The altitude, direction of extension of mountains, direction of the slope, ruggedness and slope conditions that constitute the properties of the earth surface, and some surface features affect the distribution of climate elements such as temperature, precipitation, fog and wind, which plays a significant role on the spread of plants and the biomass efficiency (Atalay, 2014).
In the correlation analyses, it was stated that the precipitation decreased in site regions due to the altitude and distance from the sea in the site under the influence of the sea, but the number of foggy days increased. When altitude and distance from the sea factors are evaluated together, the increase in the number of foggy days against the decrease in precipitation gives us information about the moisture that can maintain the life of high mountain forests despite being far away from the coast.
Fog is considered as an important ecological factor in mountain cloud forests in the world (Cavelier and Goldstein 1989, Schemenauer and Cereceda 1994, Walmsley et al. 1996, Bruijnzeel 2001). The fog droplets on the vegetation cover can serve as an additional water source supplementing the amount of precipitation (Bruijnzeel and Proctor 1995, Hutley et al. 1997, Chang et al. 2002, Gutierrez et al. 2008); however, its contribution to groundwater is limited (Eugster 2007, Ritter et al. 2008). In several previous studies, complete tree transpiration was measured in the cloud forests (Hafkenscheid 1994, Santiago et al. 2000, Motzer et al. 2005). Hutley et al. (1997) reported a 40% decrease in the tree transpiration rate of foggy conditions on a single tree in a small forest land in the southeastern Queensland. Johnson and Smith (2008), when Rhododendron catawbiense Michx and Abies fraser (Pursh) Poiret seedlings were compared with open days, reported an estimated reduction in the leaf transpiration of 83-95% in a 6-day study in the southern Appalachian Mountains.
It has been reported that altitude plays an important role in determining the amount of fog. Provided that there is sufficient moisture support (Zangvil, 1996), it has been reported that altitude may lead to an increase in fog precipitation as a result of low temperatures in higher fields (Levi, 1967; Oke, 1978). The distance from the sea factor was also considered to be a critical factor for dew and fog precipitations. Precipitation is expected to decrease as going away from the sea (Zangvil, 1996). Thus, as going away from the sea, both factors, altitude and distance, may contribute to increasing or decreasing the dew and fog amounts by their geographical locations. The size, shape and structure of the trees that prevent the fog droplets and wind velocity are effective on the amount of fog water that contributes to the ecological system (Parsons, 1960). Furthermore, Went (1955) determined that the leaf surfaces of coniferous species were much more effective on the interception of fog water.

Conclusion

In this study, the relationships between the spatial factors affecting the distribution of tree species in the sub-regional sites which are under the influence of the sea in the Eastern Black Sea Region and climate variables were revealed.
In many parts of the world, mountains are open to the effects of a rapidly changing climate and are extreme places for early detection and analysis of the signals of climate change and their effects on hydrological, ecological and social systems. Furthermore, probably the most significant effect of climate change in mountain ecosystems will be seen in the spatial size of forest ecosystems and in upper forest boundaries. Therefore, when tree species at 3rd altitude step (above 2000 m) where the distance from the sea and altitude are extreme are taken into account, Scots pine, Oriental Spruce and Fir are spread in Canik-Giresun Mountains, Oriental Spruce and Scots pine are spread in Trabzon Mountains, and Oriental Spruce, Oriental Beech and Fir are spread in Rize-Kaçkar Mountains. Despite the decreasing amount of precipitation along with the increase in altitude and distance from the sea, the

fog cloud in high mountainous areas plays an important ecological role in the conservation and distribution of these species.

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The effects of liquidity on inventory: Evidence form forestry products subsector in Turkey

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Abstract
As a part of Agriculture sector, forestry subsector is the main provider for the forestry products industry which has been neglected in terms of short-term liabilities and liquidity analysis. Liquidity is a function of the liabilities of the businesses in the short-run and it is expected to consist much of trade credit rather than bank credit. This study tries to reveal the long-term dependence of the short-term inventories on cash and cash equivalents, short-term bank credit used, and short-term accounts receivable as a percentage of short-term liabilities in the forestry products subsector in Turkey. We analyze the sectoral three years averages of aggregate balance sheet data in the long-term (1998 - 2016) and we depict that inventories have correlations with cash and cash equivalents, short-term bank credit and short-term accounts receivable and we also reveal that the sector's short-term liabilities have had a diminishing trend in the very long-run. After introducing the model, we have run the linear regression of the model and we share the robust results of the tests. The findings give evidence that inventories, which are in fact the most illiquid part of the current assets, have bank credit dependency as much as accounts receivable though decreasing liabilities in the short-term. We therefore offer suggestions on the results for the forestry products subsector so as to hedge against the potentially adverse liquidity conditions in the near future. Each precaution held for a subsector will therefore help the sustainability of the forestry and the agriculture sector as a whole and it will also contribute as an example therein integrated especially with the marketing strategies.

Key words: Forestry products subsector, financial analysis, liquidity, inventory, bank credit.

Introduction

Forestry products industry is related to the manufacturing sector. In the literature, there is a lack of short-term liabilities and liquidity analysis on the forestry products subsector. As a function of the liabilities in the short-run for the businesses, liquidity mostly consists of cash and equivalents, accounts receivable, and inventories. Trade credit and bank credit, on the other hand, increase short-term liabilities, and furthermore they could be a source at the same time. This study tries to reveal the dependence of the short-term inventories on especially short-term bank credit used in the forestry products subsector in Turkey along with the relations to accounts receivable and cash. We analyze the sectoral data in the long-term and we depict

that inventories have low degrees of correlations with cash and cash equivalents, accounts receivable, and short-term bank credit, though the sector's short-term liabilities have had a diminishing trend in the very long-run.

We have run the linear regression of the model presented and we offer the robust results of the tests. The findings give evidence on the bank credit dependency of the inventories, which are in fact the most illiquid part of the current assets, as much as accounts receivable. Cash, however, is the most significant independent variable.

The study offers suggestions on the results for the forestry products subsector so as to hedge against the potentially negative liquidity conditions which are potentially ahead in the future with a profound uprising wave of short-term bank credit. Any precaution held for a subsector will therefore help the sustainability of the main providing sectors and such precautions will contribute as a good example to improve the integration of liquidity with the marketing strategies of the firms in these sectors.

Materials and Method

The study uses real sector statistics of the Central Bank of Turkey from 1996 to 2017 as three years aggregate balance sheet averages available from 1998 to 2016 (CBRT, 2018). The data consists of 57 observations for each variable and note that the average data in 1998 is the average of last three years 1996, 1997, and 1998; in 1999 is the average of last three years 1997, 1998, and 1999; and so up to 2016. CBRT data is a set of NACE Rev. II classification including the forestry products subsector. We have analyzed the data of forestry products subsector which informs on a total of 1,749 businesses of all scales for 19 years and an average of 78 businesses for each year within the time span (1998-2016) as series of three years aggregate balance sheet averages to normalize the data. The study uses the data of forestry products industry for the years 1998 to 2009 and from 2010 to 2016 uses three years averages of the aggregate sectoral data of the sector's subtitles (Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; Manufacture of paper and paper products; Manufacture of pulp, paper and paperboard; Manufacture of products of wood, cork, straw and plaiting materials). The idea beyond the study is the Acid-Test Ratio which has only recently reached the ideal minimum of 1.00 by 2011 after a long cruise of below from 1998 in the subsector. However, this ratio is omitted in the predictors since the independent variable is selected as the short –term inventories. Thereafter, we design and run a linear regression model and related statistical tests using contemporary statistical software. The ***nomenclature*** used in the study is given below:

STL (Short-Term Liabilities)
STI (Short-Term Inventories)
C&CER (Cash and Cash Equivalents Ratio: Cash and cash equivalents as a percentage of STL)
STBC (Short-Term Bank Credit)
STAR (Short-Term Accounts Receivable)
STL/TL (STL as a percentage of Total Liabilities)
ATR (Acid Test Ratio; calculated as (Current Assets – STI) / STL))

Net Working Capital (**NWC**) is the excess part of Current Assets (**CA**) over Current Liabilities (**CL**) in the firms or it can be given as the equation below:

NWC = (CA – CL)
CA = (C&CE + SEC + STAR + STI + OCA)
CL or STL = (STTC + STBC + OCL)
TL = (STL + LTL + EQU)

CL is also called STL (Short-Term Liabilities) and with LTL (Long-Term Liabilities) they form the Total Liabilities or TL of the firms.
C&CE or (Cash and Cash Equivalents) refer to the cash available in the firm and in its bank accounts. The study omits or excludes the SEC (Securities) which are very rare and/or limited in quantity. STAR stands for the Short-Term Accounts Receivable and STI for the Short-Term Inventories available. The liabilities of one year ahead are named as the Short-Term Liabilities (STL). STL consist of STTC (Short-Term Trade Credit) and STBC (Short-Term Bank Credit). Similarly, LTL (Long-Term Liabilities) are the sum of LTTC (Long-Term Trade Credit) and LTBC (Long-Term Bank Credit). EQU refers to the shareholders' Equity. The omitted OCA and OCL stand for Other Current Assets and Other Current Liabilities respectively. The study focuses on the variables of C&CER, STBC, and STAR with their effects on STI for the assumption of the risky and solid nature of the latter variable with a novel model among the net working capital components.

The designed model given below has a Bartlett's test of sphericity significance where the most significant results of 0.000 significance for the regression and sphericity were taken from the model, 81.215 per cent of the cumulative percentage of variance is at the second component level of initial Eigenvalues (Bartlett, 1950). Reliability statistics of all variables included in the test reports 0.60 Cronbach's Alpha and 0.70 Cronbach's Alpha based on standardized items (Cronbach, 1951; Cronbach, 2004) with 0.000 significance between items and 0.001 between residuals for Friedman's Test and Tukey's Test for nonadditivity (Friedman, 1937; Friedman 1939; Tukey, 1949). Then, from the contemporary software (SPSS 22 and Eviews 9) along with other tests, Pearson correlations, inter-item covariance matrix, model summaries and ANOVA results are obtained and reported (Pearson, 1920; Fisher, 1925; Fisher, 1932; Durbin and Watson, 1950; Durbin, 1970; Durbin and Watson, 1971; Kutner et al., 2005). The tests confirming the assumptions of the regression model are Breusch-Godfrey Serial Correlation LM Test for serial correlation (Breusch, 1978; Godfrey, 1978a), Breusch-Pagan-Godfrey heteroscedasticity test for the presence of heteroscedasticity (Breusch and Pagan, 1979; Godfrey, 1978b), and Jarque Bera Test for normality (Jarque and Bera, 1980; Jarque and Bera, 1987). Along with the fundamental analysis, the study then uses post statistical methodology which includes inquiries for spurious regression, unit root and stationary series, co-integration in unrestricted VAR, and causality (Granger, 1969; Granger and Newbold, 1974; Sims, 1980; Engle and Granger, 1987; Johansen, 1988; Johansen, 1995; Levin et al., 2002; Im et al., 2003; Dickey and Fuller, 1979; Fisher, 1932; Phillips and Perron, 1988; Pesaran and Shin, 1998). Further analysis would be forming an error correction model in vectors (Pesaran et al., 2000), however, the study recesses at the causality level. Therefore, the study also reports the results of lag length, group unit root tests at the level of first differences, Johansen cointegration test by an unrestricted cointegration rank test with both trace and maximum Eigenvalues for p values of MacKinnon-Haug-Michelis (1999), and pairwise Granger causality results (Akaike, 1973; Akaike, 1974; Akaike 1979; Schwarz, 1978; Lutkepohl, 1991; Lutkepohl, 2004). The tests report that the series are stationary at the first differences. Using variables as a percentage of STL normalizes the data and increases the comparability among businesses of different scales. The equation refers to the model of the study where STI is taken into consideration as the dependent variable with the

independent variables which are C&CER, STBC, and STAR. The constant is $\boldsymbol{\beta_0}$ and the error terms are $\boldsymbol{\varepsilon_{it}}$. All variables are assessed as a percentage of STL. The equation of the linear regression run is given below:

$$\boldsymbol{Y_{STI\,it} = \beta_0 + \beta_1 x_{C\&CER\,it} + \beta_2 x_{STBC\,it} + \beta_3 x_{STAR\,it} + \varepsilon_{it}}$$

Results and Discussion

The forest industry is among sectors of global importance (Dieter and Englert, 2007), and it has also attractive economic impact and contribution along with the effects on employment in the world (Kupcak and Smida, 2015; Henderson et al., 2017). Being export oriented and innovative are seen as assets (Valimaki et al., 2004) so the circumstances have always been challenging for this sector. In a specific country, the sector could be vulnerable under the negative effects of both local and global economic conditions (Koulelis, 2016) as well. The sector also faces challenges to change for and adopt into new circumstances (Maksymets and Lonnstedt, 2015) for which firm level financial stability is required.

In Turkey, the sector has difficulties within its subsectors, not only with decreasing domestic production which is much dependent on imports (Bayram et al., 2015), but also in terms of the prices of imported raw materials and high cost in its own subsectors (Istek et al., 2017). Thus, we think that a strong liquidity would add much at this point. Liquidity has been assessed by the use of financial ratios in the relevant literature and it has been among the failure indicators for businesses (Beaver, 1966; Altman, 1968; Altman and Narayan, 1997).

The forestry products subsector reflects most of the long-term liquidity characteristics and dimensions of the agriculture sector in Turkey (Acikgoz et al., 2016; Acikgoz et al., 2018). Short-term liabilities and current assets with their components are the main indicators of liquidity for every business.

The flexible part of short-term liabilities is trade credit whereas bank credit is not. The most illiquid part of current assets is inventories on the other hand. Any increase in the scale of the businesses may negatively affect liquidity (Ponikvar et al., 2009).

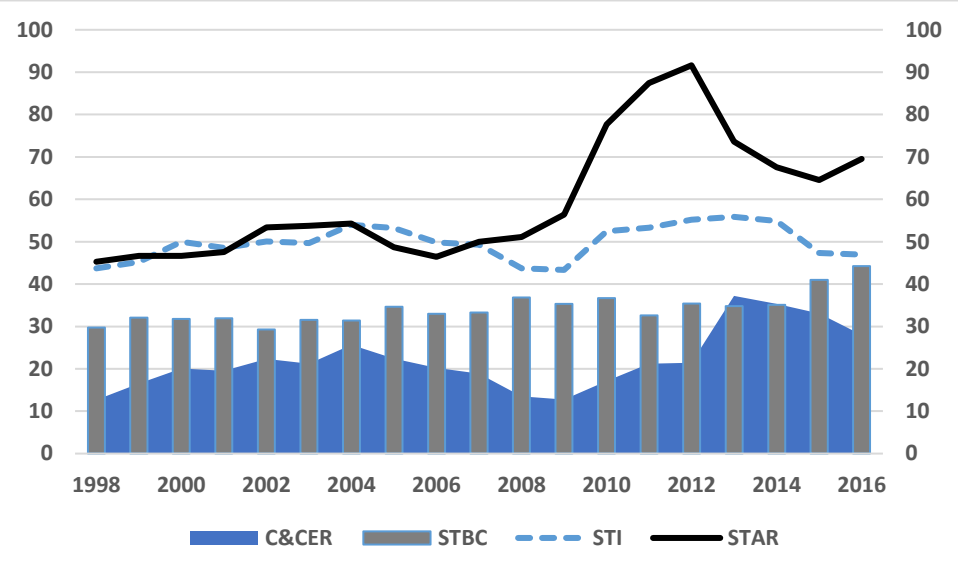
Liquidity in terms of cash is required in the easy provision of financial credit (Sohn and Kim, 2013; Apak et al., 2016). Businesses will comfort their own payment and collection policies (Michalski, 2008) and accounts receivable will also generate cash. Businesses may also look for additional short-term loans if they have volatility in cash generation (Keefe and Yaghoubi, 2016). Bank credit has permanently been an alternative for trade credit (Burkart and Ellingsen, 2004; Chong and Yi, 2011; Psillaki and Eleftheriou, 2015).

There have been new challenges in the forestry sector in marketing (Hansen and Juslin, 2005) with which business finance and liquidity has correlations in terms of collection of accounts receivable and sales policies on cash or credit.

Nonetheless, financial difficulties may force businesses to increase incompetent liquidity from inventories (Dasgupta et al., 2014).

Figure 1 reports the independent variables of the study versus the dependent STI which has had become more dependent on accounts receivable by 2010, and on cash and short-term bank credit by 2014. The liquidity from inventories and accounts receivable are also a result of the marketing strategies and circumstances in which the forestry products sector in Turkey may live difficulties. The leading title among the most serious marketing-related difficulties reported as the condition of the stagnation in domestic markets (Aksu et al., 2011). Supply agreements and/or contracts may create difference with the forestry subsector (Li and Zhang, 2014).

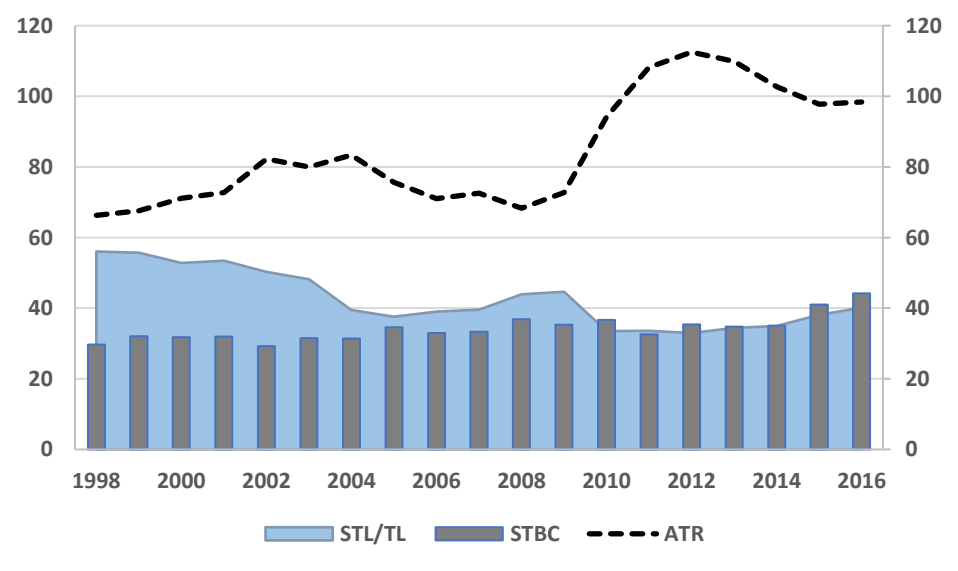
Figure 1. C&CER, STBC, and STAR vs. STI as percentage of STL in forestry products sector-Turkey (1998 – 2016)



Source: Calculations on CBRT data.

A wide use of those agreements or contracts may help in balancing the levels of inventories and accounts receivable and create additional motives of sustainability in cash flow and accumulation for the firms in the subsector. Therefore, inventory level and its relative contribution to the liquidity deserves further analysis in micro scale and under sector specific circumstances. The study reveals that the forestry products subsector has an accounts receivable driven trend on liquidity in the long-run.

Figure 2. STL/TL and ATR vs. STBC as percentage of STL in forestry products sector-Turkey (1998 – 2016)



Source: Calculations on CBRT data.

Figure 2 depicts the increasing trend in short-term bank credit of this subsector, even though the short-term liabilities decrease as a percentage of the total liabilities in the time span.

Table 1 reveals the descriptive statistics on the selected variables. Table 2 reports the relatively low degrees of Pearson correlations of the research data. The inter-item covariance matrix, the summaries of the model, the ANOVA results, coefficients, and residual statistics are given in Tables 3, 4, 5, 6, and 7 respectively.

Table 1. Descriptive characteristics of the selected data in forestry products sector-Turkey (1998 – 2016)

As a percentage of STL	**Minimum**	**Year**	**Maximum**	**Year**	**Average**
STI/STL	43.34	2009	55.86	2013	49.8212
C&CER	12.69	1998	37.21	2013	22.0623
STBC/STL	29.27	2002	**44.22**	**2016**	34.2461
STAR/STL	45.27	1998	91.62	2012	59.5813
ATR	66.28	1998	112.49	2012	84.5839

Source: Calculations of the authors on CBRT data. Note that STBC/STL is at the maximum in 2016.

Table 2. Pearson correlations of the variables

Variables	STI/STL	C&CER	STAR/STL
C&CER	**0.604****		
	0.006		
STBC/STL	-0.091	0.364	
	0.711	0.125	
STAR/STL	**0.552***	0.379	0.411
	0.014	0.110	0.080

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed). Note that N =19 for each variable from 57 observations as three years averages (19 x 3).

Table 3. Inter-item covariance matrix

Variables	STI/STL	C&CER	STBC/STL	STAR/STL
STI/STL	16.321	17.312	-1.354	32.240
C&CER	17.312	50.278	9.502	38.827
STBC/STL	-1.354	9.502	13.519	21.873
STAR/STL	32.240	38.827	21.873	209.173

Note that N =19 for each variable from 57 observations as three years averages (19 x 3).

Table 4. Model summaries

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
0.841[a]	0.707	0.649	2.39481	1.497

[a]. Predictors: (Constant), C&CER, STBC/STL, and STAR/STL. STI/STL is the dependent variable and the independent variables are C&CER, STBC/STL, and STAR/STL for the model.

Table 5. ANOVA results of the model

Models	Sum of Squares	df	Mean Square	F	Sig.
Regression	207.760	3	69.253	12.075	0.000[a]**
Residual	86.026	15	5.735		
Total	293.786	18			

[a]. Predictors: (Constant), C&CER, STBC/STL, and STAR/STL. STI/STL is the dependent variable and the independent variables are C&CER, STBC/STL, and STAR/STL for the model. **. Significant at the 0.01 level.

Table 6. Coefficients of the model

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	*t*	Sig.	Tolerance	VIF
(Constant)	53.288	5.294		10.066	0.000		
C&CER	0.337	0.089	0.591	3.794	0.002	0.804	1.243
STBC/STL	-0.584	0.174	-0.531	-3.359	0.004	0.780	1.282
STAR/STL	0.153	0.044	0.547	3.434	0.004	0.771	1.298

Note that N =19 for each variable from 57 observations as three years averages (19 x 3). STI/STL is the dependent variable for the model, the independent variables are C&CER, STBC/STL, and STAR/STL for the model. VIFs and tolerances are very close to 1.

Table 7. Residuals statistics

	Minimum	Maximum	Mean	Std. Deviation
Predicted Value	44.1261	56.7429	49.8212	3.39738
Residual	-3.41689	5.14784	0.00000	2.18615
Std. Predicted Value	-1.676	2.037	0.000	1.000
Std. Residual	-1.427	2.150	0.000	0.913

STI/STL is the dependent variable for the model. The independent variables are C&CER, STBC/STL, and STAR/STL for the model.

ANOVA results are significant at 0.01 per cent in the estimation of STI with the independent variables of C&CER, STBC/STL, and STAR/STL. Along with collinearity diagnostics of the model for each variable from 57 observations as three years averages (Table 8), we have also tested the assumptions of the regression on serial correlation, heteroscedasticity, and normality (Table 9). Afterwards, we have further analyzed the data to reveal the appropriate lag length as lag 1 according to Akaike information criterion which is the smallest, nevertheless all criteria reflect lag 1 as well (Table 10).

Table 8. Collinearity diagnostics of the model

			Variance Proportions			
Dimension	Eigenvalue	Condition Index	(Constant)	C&CER	STBC/STL	STAR/STL
1	3.908	1.000	0.00	0.00	0.00	0.00
2	0.056	8.325	0.03	0.95	0.01	0.03
3	0.031	11.262	0.07	0.02	0.03	0.94
4	0.005	27.927	0.91	0.03	0.96	0.03

Note that N=19 for each variable from 57 observations as three years averages (19 x 3). Condition index for the model are below 20 up to the third dimension. STI/STL is the dependent variable and the independent variables are C&CER, STBC/STL, and STAR/STL for the model.

Table 9. Test confirming assumptions of the regression

Test	Prob. *
Breusch-Godfrey Serial Correlation LM Test: Obs*R-squared Prob. Chi-Square (10)	0.2808
Breusch-Pagan-Godfrey Heteroscedasticity Test: Obs*R-squared Prob. Chi-Square (3)	0.7973
Jarque Bera Test: Prob.	0.6706

All tests confirm no serial correlation, no heteroscedasticity, and normality for the model as p values > 0.05 (Breusch, 1978; Godfrey, 1978a; Breusch and Pagan, 1979; Godfrey, 1978b; Jarque and Bera, 1980; Jarque and Bera, 1987). STI/STL is the dependent variable and the independent variables are C&CER, STBC/STL, and STAR/STL for the model.

Table 10. VAR Lag order selection

Lag	LogL	LR	FPE	AIC	SC
0	-216.3371	NA	504262.7	24.48190	24.67976
1	-173.0616	62.50907*	25841.56*	21.45129*	22.44059*

* indicates lag order selected by the criterion at VAR (Akaike, 1973; Akaike, 1974; Akaike 1979; Schwarz, 1978; Lutkepohl, 1991; Lutkepohl, 2004). Exogenous variables: C. Sample: 1998-2016. Included observations: 18. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion.

Table 11. Group unit root tests at level of first differences.

Group of the series	Method	Statistic	Prob.**	Cross-sections	Obs
STI, C&CER, STBC, and STAR	Null: Unit root (assumes common unit root process)				
	Levin, Lin and Chu t	-4.45014	0.0000	4	68
	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-4.63592	0.0000	4	68
	ADF - Fisher Chi-square	34.2823	0.0000	4	68
	PP - Fisher Chi-square	34.2394	0.0000	4	68

** Probabilities for Fisher tests are using an asymptotic Chi-square distribution. All other tests assume asymptotic normality (Levin et al., 2002; Im et al., 2003; Dickey and Fuller, 1979; Fisher, 1932; Phillips and Perron, 1988). Sample: 1998-2016. Exogenous variables: Individual effects. Automatic selection of maximum lags. Automatic lag length selection based on SIC: 0. Newey-West automatic bandwidth selection and Bartlett kernel. Balanced observations for each test.

To eliminate the probability of the presence for a spurious regression, group unit root test is also conducted, and significant results are given (Table 11).

Table 12. Unrestricted cointegration rank tests for the group of the series

Hyp. No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.886129	88.01883	47.85613	0.0000
At most 1 *	0.836981	51.08305	29.79707	0.0001
At most 2 *	0.556811	20.24696	15.49471	0.0089
At most 3 *	0.314247	6.413047	3.841466	0.0113
Hyp. No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.886129	36.93578	27.58434	0.0024
At most 1 *	0.836981	30.83609	21.13162	0.0016
At most 2	0.556811	13.83392	14.26460	0.0584
At most 3 *	0.314247	6.413047	3.841466	0.0113

Group: STI, C&CER, STBC, and STAR. Unrestricted Cointegration Rank Test: Trace and Maximum Eigenvalue (Johansen, 1988; Johansen, 1995; Pesaran and Shin, 1998). Sample (adjusted): 2000 2016. Included observations: 17 after adjustments. Trend assumption: Linear deterministic trend. Lags interval (in first differences): 1 to 1. * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values. Trace test indicates 4 cointegrating eqn(s) at the 0.05 level. Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level.

Table 13. Significant results of pairwise Granger causality tests for the group of series.

Lag	Null Hypothesis:	Obs	F-Statistic	Prob.
1	STI does not Granger Cause STAR	18	7.98634	0.0128
1	STAR does not Granger Cause C&CER	18	9.38310	0.0079
2	C&CER does not Granger Cause STBC	17	5.53551	0.0198
2	STAR does not Granger Cause C&CER	17	4.90193	0.0278
2	STBC does not Granger Cause STAR	17	11.8486	0.0014
3	C&CER does not Granger Cause STBC	16	4.54038	0.0335
3	STBC does not Granger Cause STAR	16	7.31097	0.0087
4	C&CER does not Granger Cause STBC	15	5.32004	0.0355

Reports only the significant results at the 0.05 level for Pairwise Granger Causality Tests on the group of the series for Lag 1–4. Sample 1998–2016.

Then, cointegration has been analyzed and at least 2 cointegrating equations are reported by the Johansen cointegration test (Table 12). Finally, causalities among the series of the group are revealed as well. The results depict granger causality between the variables of the study from first up to fourth lag (Table 13).

Short-term inventories have granger causality relation with short-term accounts receivable at the first lag and the latter does granger cause cash and cash equivalents in the forestry products subsector. Finally, we conclude that the presence of stationary series and the cointegration equations confirm the model in both the time span studied or short and the long run.

Conclusion

The subsector of forestry products in Turkey has a liquidity which could be explained in terms of cash, accounts receivable, and inventories in the long-run as expected in many sectors and subsectors. The inventories have had a steady cruise with a changing dependency. Nevertheless, along with the relations with accounts receivable and cash, the results of the study reveal the dependence of the short-term inventories on short-term bank credit used with a relatively negative coefficient though the decreasing level of short-term liabilities in the long-run.

After analyzing the sub-sectoral selected data on liquidity in the long-term, we may conclude that the inventories in the forestry products subsector has relatively low degrees of correlations with cash and cash equivalents, accounts receivable, and short-term bank credit; though the diminishing trend of short-term liabilities from 1998 to 2016 as three years aggregate balance sheet averages in the very long-run. However, the model designed in the study has the regression with significant and robust results of the tests. The findings depict the evidence of cash and cash equivalents dependency of the inventories with higher significance and a deuce in significance of short-term accounts receivable and short-term bank credit for the subsector. The results also confirm the existence of stationary series and cointegrating equations for the variables in the model of the study in which the series have significant Granger causalities as well.

Inventories of a business consisting of the most illiquid part in the current assets are funded by short-term bank credits which are seen as an inflexible source of finance tying up the collateral potential or credit limits. We therefore emphasize the recently squeezing condition of liquidity in the subsector analyzed and offer suggestions on the results in order to hedge against the potentially negative liquidity conditions of the future. Since a profound uprising wave of short-term bank credit has been revealed, the below given precautions will much help the subsector and ensure the sustainability in the forestry products subsector. Therefore, the businesses operating in this explicit subsector would better:

1. Try to readapt marketing strategies which will assess the significance of cash and accounts receivable on their liquidity.
2. Provide an upper limit for their inventories in order to limit the short-term bank credit financing on this most illiquid component of their current assets.
3. Redesign receivables to payables due times so as to favor the diminishing trend of their short-term liabilities.
4. Supply agreements and/or contracts will help in balancing the levels of inventories and accounts receivable and add on sustainability in cash flows.
5. Concentrate on the leading significance of cash and cash equivalents over their inventories.

The study is expected to offer favorable clues on the concealing aspects of liquidity for the forestry products subsector and businesses. A set of limitations is also present for the study; such as the use of ratio analysis and aggregate local data which may not reflect the whole forestry products industry in Turkey with the constraints and assumptions of the CBRT methodology. However, the results of the study might be a milestone for the future research in enlightening the other titles of financial analysis for the subsector which has been studied only in terms of liquidity herein.

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A methodical approach to the mapping of biotope types by using GIS based remote sensing techniques (Köprülü Kanyon National Park Case / Turkey)

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Abstract

The objectives of nature conservation focused on the protection of selected animal and plant species and individual ecosystems through conservation. The basic components of nature conservation are flora and fauna including their habitats, biodiversity, performance and functionality of the natural environment. These can be directly linked to the goals for ecosystem, species and biotope protection. The main objective of this study is the development of an efficient nation-wide procedure for biotope type mapping. This requires the methodical development of a systematic biotope type mapping. In preparation an exemplary region was chosen the Köprülü Canyon National Park, which covers an area of 35,672.72 ha, The biotope types in the area were recorded, classified and mapped using GIS-supported remote sensed technology. Methods of digital classification were utilized in determining forest types and maquis. The remotely acquired information and the classes had to be combined with other information in order to be processed via GIS. The analysis and evaluation using GIS was the basis for establishing the biotope types. The GIS analysis served to place the polygon and object classes which were classified by visual or digital image evaluation on the biotope type layer. Thus the biotope type layer is a final layer for all biotope-forming shape files that serves the transferring of adjoining polygon classes. The biotopes were classified by coding the homogenous biotope surfaces according to their characteristics. This made it possible to address the biotope types via their properties in various hierarchical levels. The typification and description of biotopes achieved through hierarchic classification. Thereafter, the biotope types were presented as a list together with their descriptions, which contained information used during classification. The characteristics for classification are distinguished by hierarchical level which entails a discreet description of the particularities and characteristics. The biotope types were mapped for each layer in a hierarchical level.

Keywords: Biotop types, mapping, GIS, Remote Sensing, Turkey

Introduction

The basic components of nature conservation are "flora and fauna including their habitats and habitats in the aspect of biodiversity" and "performance and functionality of the natural environment". These can be directly linked to the goals for ecosystem, species and biotope protection. Initially, the tasks and objectives of nature conservation focused on the protection of selected animal and plant species and individual ecosystems through conservation and conservation strategies (Erz 1980, Plachter 1991). The tasks of nature conservation in new approaches were no longer described as merely conventional, conservative and protective, but also as preservative and planned-formative. Such approaches have been

published in terms of country level (Deixler 1982) and forest biotope mapping (Ammer and Utschik 1982). This required a broader definition of nature conservation. It was from Plachter (1991) formulated as follows: "All measures for the conservation and aid of plants and animals of wild species, their communities and natural livelihoods as well as for protecting landscapes and landscape parts under natural conditions". According to Plachter (1991), with biotope mapping has been provided for the first time a thorough overview of the existence and condition of certain biotope types in Germany. This initial biotope mapping indicated the status and distribution of the most valuable and vulnerable habitats, and as a result, a regionalized evaluation was carried out to derive differentiated protection and development objectives. In recent years, biotope mapping has no longer concentrated solely on natural or semi-natural habitats, but also on the systematic inventory of semi-natural or land-use cultural landscapes serving a purpose-based integrated nature conservation. The mapping of the biotope types allows a nature conservation evaluation of the Wildlife habitats as a planning basis for habitat protection. The protection of biotopes is a central task of nature conservation, which results from the synthesis between the two fields of species and site protection (Erz 1980), Thereafter, the preservation and development of life opportunities for the flora and fauna throughout the landscape (from the natural to the urban and industrial landscape) must be ensured. The term of biotope in this definition is usually not strictly used in the sense of ecology as "habitat of a biocenosis of a certain minimum size and uniformly distinguishable from its environment", but according to Erz (1980) more or less in the sense of the location term as "the totality of the environmental factors acting on the place of residence of an organism". By mapping the biotopes, a sufficiently flexible database can be provided for the needs of the specific conservation plans relevant to nature conservation in order to fulfill legal mandates (Hmuelv 1995). The fields of application of biotope maps are distinguished on the basis of the methodological procedures for mapping the biotopes from a nature conservation point of view. It is important to mention three practical procedures for detecting biotope types:

a) The selective biotope mapping, which includes a targeted collection of protected or legally protected biotopes and forms the basis for (Lanuv 1982, Drachenfels 1993, Ssymank et al. 1993, Hmuelv 1995, Knickrehm and Rommel 1995, Lua 2002):

- the collection of the protected or legally protected biotopes of the countries

- the designation of valuable nature conservation areas

- the preparation of decisions on protected area designations and the Development of protected area systems and their monitoring in the context of the implementation of the Habitats Directive

b) Representative biotope mapping is based on a selective or area-wide biotope mapping and provides a more detailed picture of this through studies on the flora, vegetation or fauna and on site and habitat qualities on selected test areas in a random sampling theory (Hondong, 2002). Representative biotope mapping is used in urban biotope mapping, conservation and development planning for protected areas, landscape and landscape planning, conservation projects and in the context of EIA and Environmental Impact Assessment projects (Hondong 2002, Wächter 2003).

c) In the comprehensive biotope mapping all landscape components of a study area are completely assigned to a specific biotope type (Knickrehm and Rommel 1995), without first determining what is to be regarded as protection required (Lanuv 1982). The comprehensive biotope type maps are a complete survey of all biotope types in a processing area and are mostly used as the basis for the creation of ecological contributions to landscape- and site development plans, the development and implementation of a comprehensive conservation area system of graded intensity (as an inventory system with regard to the conservation and monitoring of biological diversity), the assessment of interventions in the context

of environmental impact studies and the regional and national red list of endangered biotope types (Drachenfels 1993, Ssymank et al. 1993, Knickrehm and Rommel 1995, Hondong 2002, Lua 2002):

According to Bastian (1997), nationwide biotope mapping provides the value-determining criteria for the assessment of landscape functions with regard to their habitat functions. The comprehensive biotope mapping, which is realized through a uniform survey and assessment of all natural and cultural habitats, has a great importance for the creation and implementation of regional and national species and biotope protection programs (Plachter 1989, Erz 1994), the Red List biotopes (Ssymank et al. 1993, Riecken et al. 1994, Drachenfels 1993), the biotope network (Jedicke 1990) and the integrated protected area system (German Councıl for Landespflege 1983), landscape and intervention planning (Knickrehm and Rommel 1995, Brinkmann 1997, Ott 1997). An another requirement placed on biotope mapping is the consideration of the hierarchical arrangement of the organizational levels of living beings. This results in a gradation of differently complex habitats, which must correspond to the respective organizational levels of life. When typing biotopes it is therefore important to consider this hierarchy (Haeupler 2002). Finally, biotope type indexes or mapping keys that are created nationwide or used for large-scale planning of the landscape units must be available as a standardized type formation in a hierarchically uniform structure (Ssymank et al. 1993, BfN 1995, Knickrehm and Rommel 1995, Lua Brandenburg 2004), while a distinction or treatment of regionally and locally important biotopes is to be respected.

Although the mapping of the biotopes in Turkey as a planning tool for nature conservation-oriented tasks finds no place, it was carried out as part of scientific research and externally funded projects exemplified. It can be differentiated in urban and rural areas. The first biotope mapping in the urban area was carried out in the city of İzmir (Köseoğlu 1981 and 1983, Yılmaz 1986). The first biotope maps, which were created in the rural area, are from Uzun et al. (1995) and Altan et al. (2001) in the Çukurova region. There are need new strategies, working methods and instruments based on nature conservation according to Turkey's species-specific and habitat-typical richness. They should primarily enable the planning and management of protected areas based on the biological, geo-ecological and socio-economic conditions of the country. The main objective of this study is the conception of a nationwide efficient procedure for biotope mapping. The main content of the study consists in the development of a nationwide systematic inventory and exemplary mapping of the biotopes in a protected area.

Material and Methods

Site Properties

The study area covers 35,672.72 ha. The area belongs to the counties of Manavgat (about 30,000 ha) with the provincial town of Antalya and Sütcüler (about 5,000 ha) with the provincial town of Isparta. It was declared to the National Park "Köprülü Kanyon" in 1973. The area is located about 90 km northeast of the city of Antalya in the western part of the Taurian mountain range in southern Anatolia, where the Köprü Çayı (river) forms a basin from north to south into the Mediterranean Sea. The study area is located in the central area of Köprü Irmağı Valley (Fig. 1).

Methods

Procedures for data collection and analysis

The determination of biotope properties is an important step in the identification of biotope types. The characteristic values for the identification of the biotope and land use types in the study area were determined by the analogue and digital processing of the data sources (Fig. 2) The analogue data was divided into printed maps, bibliographical references and authorities. The characteristic values for the identification of the biotope and land use types in the study area were determined by the analog and

digital processing of the data sources. A procedure has been developed to develop data collection and processing methods for the comprehensive mapping of biotopes (Fig. 3)

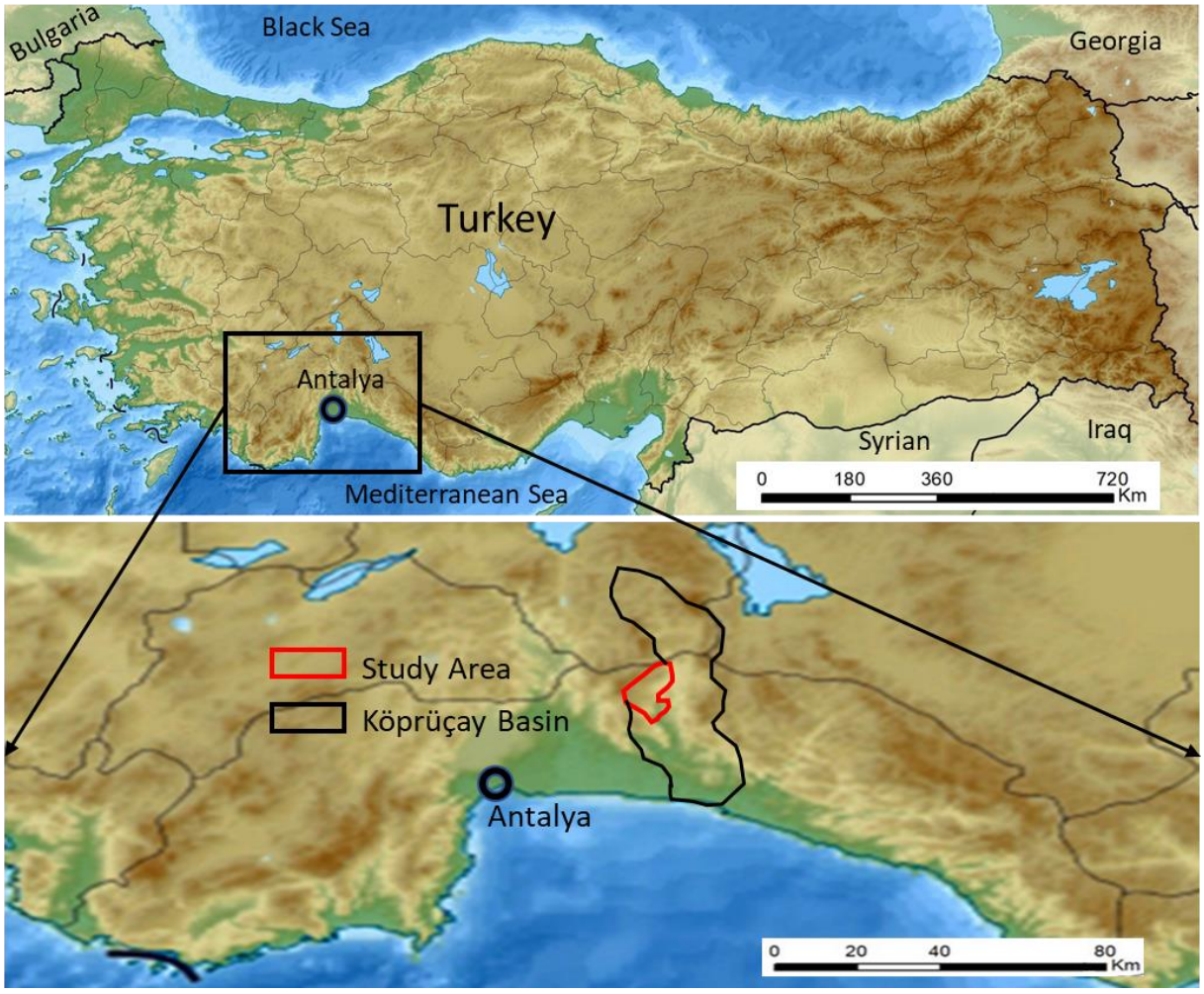

Figure 1. Location of study area

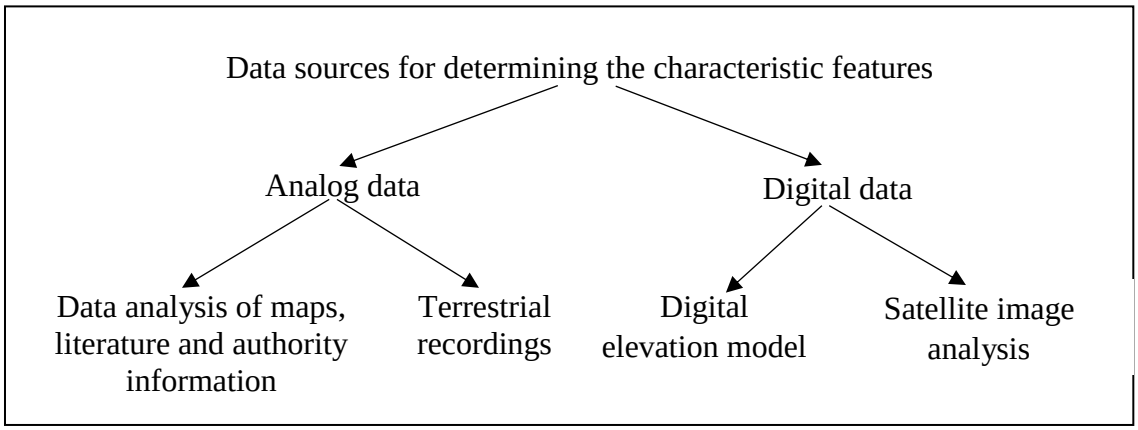

Figure 2. Data collection for the characteristics of the biotopes

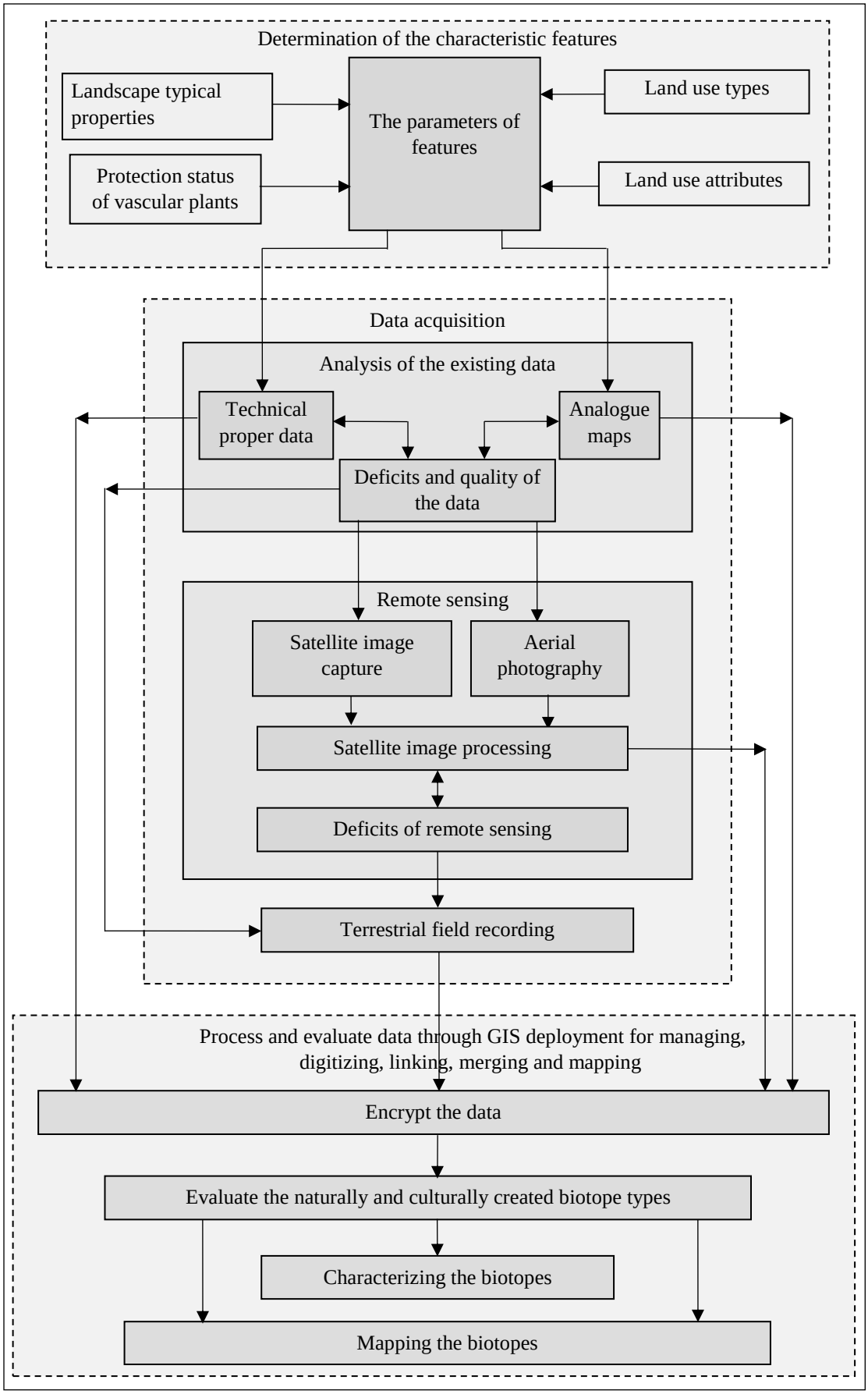

Figure 3. Procedure for recording biotope types

Assessment of the vegetation and land use properties

The vegetation characteristics for ecology and vegetation distribution, phytosociological and physiognomic characteristics and human influence provided the data for the characterization of biotope characteristics with regard to vegetation expression and land use. In addition, the vegetation types described in vegetation tables and their species were used to identify the biotopes (as a sample class of vegetation). Ayaşlıgil (1987) 's vegetation survey was used to obtain this information. The data on stratification, species-specificity and sociability of individual species were compared with location of characteristics such as slope, exposure and altitude as well as the bedrock and degree of vegetation in order to determine the spatial differentiation of characteristic plant species in the biotopes. The studies published by Kantarcı (1982 and 1990) on the relationship between the distribution of natural tree and shrub species and the regional site characteristics of the Turkish Mediterranean provided important information for the site identification of the biotopes. From the forest inventory maps, the data on the tree species composition, the degree of cover, the layering and stock development phase as well as the distribution of the tree species for the characterization of the forest biotopes are obtained. From these data, especially the tree species composition, the degree of cover and the distribution of the tree species were used as additional data in the evaluation of the satellite imagery. The rock types were digitized from the geological map (MTA 1995) to be used as a layer for classification. The significance of determining the types of land use for this study lies in distinguishing the natural given from the man-made structures of the landscape (Walz et al. 2001) and spatially delineating and typifying the land uses that occur. Only then can the naturally and culturally created structure of the landscape be comprehensively recorded on the basis of the biotope type mapping and the human influence with its consequences on the landscape elements and the structuring of the landscapes recognized. For the impact of human impact on the landscape, land use attributes are used to identify land use types.

Encryption of the homogeneous feature classes

The coding of the biotope types follows the hierarchical classification system and translates this into a numerical code. This gives the properties relevant to the biotope type at the various hierarchy levels. The goal of encryption of the biotope types is to record the hierarchical assignment category of landscape units at the various levels. The biotopes are encoded by the plane-by-plane homogeneity of their specific properties, which is a characteristic that is clearly different from others. Each level has a special significance for the labeling of biotope types. It was planned to limit the level number, because otherwise the classification into the sublevels will make it too confusing. Encryption has only formed three levels so far, but the encryption concept provides four or five levels to allow further differentiation where needed (Fig. 4).

Data preparation and processing using remote sensing techniques

To collect and analyse of data was used remote sensing and GIS techniques. Remote sensing played an important role in the storing of extensive area information. The results of the satellite image analysis were used to address vegetation types. The topographical map sheets on a scale of 1:25000 standard topographic maps of Turkey, produced by the General Directorate of Mapping for Turkey and with the geodetic reference system (UTM 1950 ED) are georeferenced according to the geodetic projection of the IKONOS 2 (geometrically corrected one frame, Pan+MSI 4 channel image type, acquisition Date/Time: 2003-06-13 08:59 GMT, pixel resolution 1 m) satellite imagery (UTM WGS 1984). Subsequently, they were used as a basis for the map applications of vegetation, geology and forest stands as well as for the geocoding of the GCP (Ground Control Points) for referencing the objects from IKONOS satellite images. In addition to satellite imagery, the 1/15000 CIR aerial imagery available was

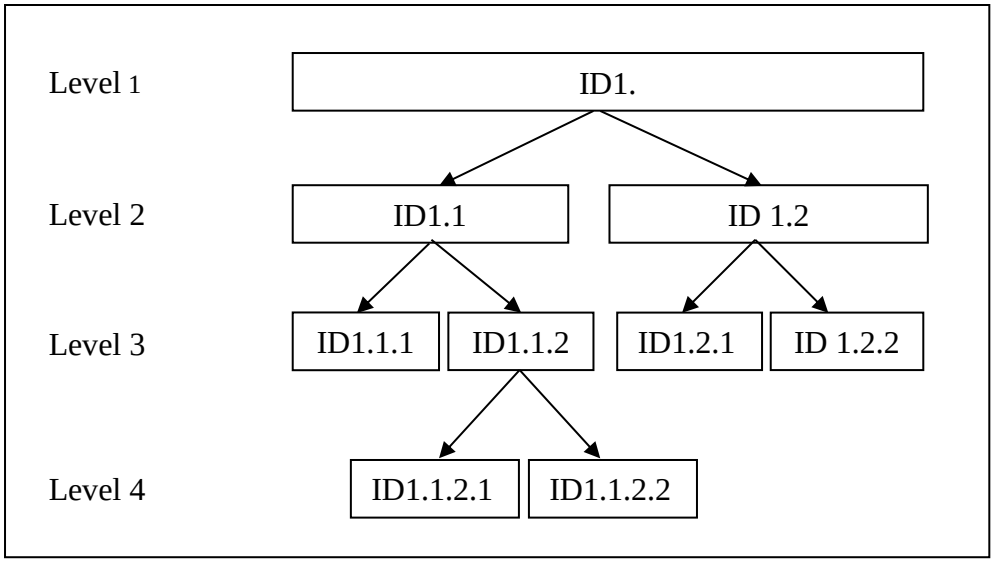

Figure 4. Encryption of biotope types in a hierarchical classification system

used for visual interpretation to identify forest tree species. The digital data was derived from the digital elevation map and the satellite image interpretation. The data basis for creating a digital elevation model were the files in e00. ARC/INFO coverage formats on a scale of 1/25000. Parameters such as slope, exposure, altitude classification and large-scale relief shapes were generated from the digital elevation model. The areas for the vegetation units and land use types were obtained by applying the digital image analysis methods. The terrestrial methods were mainly used to eliminate uncertainties or to increase the quality of remote sensing data. The content and methods of terrestrial recording are determined by the quality of the IKONOS images.

Using GIS in the hierarchical classification of the biotope types

The feature classes obtained by evaluating the image data were used in GIS together with other data for the characterization and classification of the biotope types. The role of GIS was very important in classifying the biotopes, using various software tools for operations or implementations such as converting, exporting, importing, storing, editing, querying, intersecting, georeferencing, selecting, extracting and mapping the data. A digital elevation model was created in grid cells. This was important for the site-morphology-related local features and further in the coding and typing of the biotope types. The advanced GIS analyses used to transfer of homogeneously characterized feature classes, encryption of homogeneous feature classes, hierarchical classification of encrypted biotope types. The determination of the biotope properties by using GIS serves both to distinguish homogeneous units which are characterized by certain features or feature groups, and to develop a classification system which follows a hierarchical arrangement of the homogeneous units at different levels. These features must be coded according to the GIS data foundation. The classification of the biotopes follows a hierarchical demarcation and classification of homogeneous spatial units with regard to different characteristic values of the respective biotope type (Fig. 5).

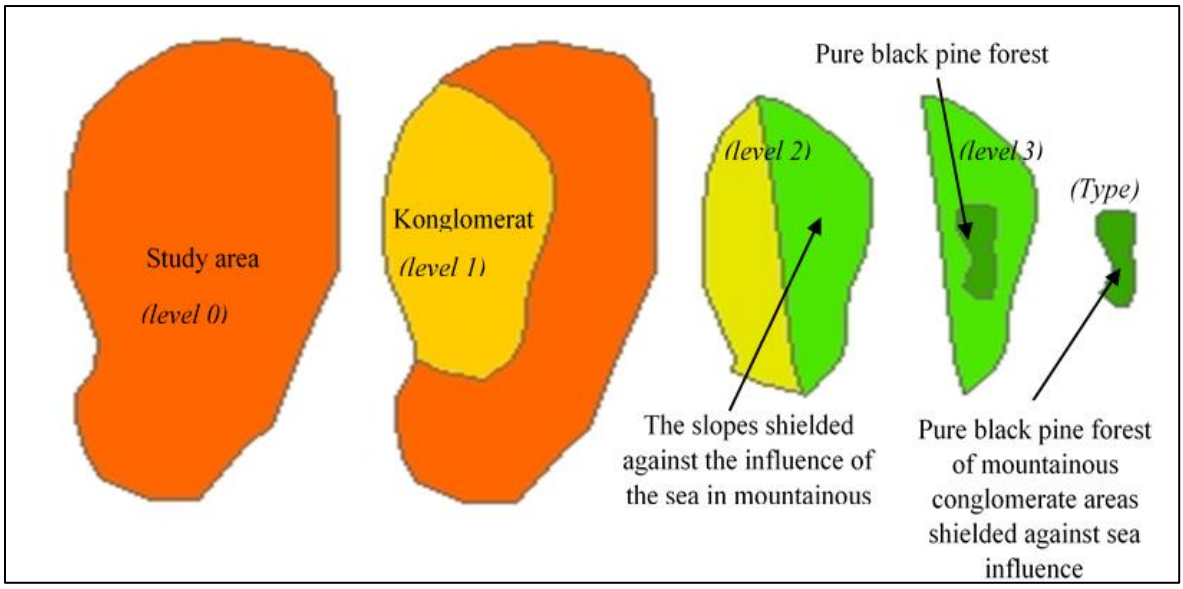

Figure 5. Exemplary representation for the GIS classification and typing of the biotopes in the study area

Data collection and analysis using remote sensing and GIS techniques

The topographical map sheets on a scale of 1 / 25000 and with the geodetic reference system (UTM 1950 ED) are geo-referenced according to the geodetic projection of the IKONOS satellite images into the geodetic projection UTM WGS 1984. Subsequently, they were used as a basis for the map applications of vegetation, geology and forest stands as well as for the geocoding of the GCP (Ground Control Points) for the referencing of objects from IKONOS satellite imagery. In addition to these satellite imagery, the 1/15000 CIR aerial imagery available was used for the visual interpretation of some objects taken for the identification of forest tree species. The digital data was derived from the digital elevation maps and the satellite image processing. Parameters such as slope, exposure, altitude and large-scale relief forms were generated from the digital elevation model. The areas for the vegetation units and land use types were obtained by applying the digital image analysis methods.

Results

The following biotope properties were determined by data collection and analysis method including satellite imagery analysis and GIS techniques (Table 1).

Vegetation units and their bioclimatic characteristics in relation to the altitude levels determined for the study area which was important to characterise the special features for individual vegetation types (Table 2).

Remote sensing techniques have been used intensively in the separation of forest types. One of the techniques applied for this is to distinguish the spectral reflectance values of tree species (Fig. 6). Supervised and unsupervised classification techniques are frequently used in forest areas where forest types cannot be visually classified (Fig. 7). ISODATA-Clusteranalyse was used for uncontrolled classification. Depending on the density of the vegetation, the areas were cut from the image. 15 classes and 20 iteration are used for each cutted image. A supervised classification was performed for all objects that could not be assigned to any class by ISODATA cluster analysis. Such classes have been classified used to the maximum likelihood classifier by spectral signature analysis. The visual interpretation was performed by the scale changes and band changes. Accuracy assesment procedures were applied to test the accuracy of these classifications (Fig. 8).

Table 1. List of determined biotope properties

Characterized features	Classes
Land uses	afforestation, utilization of wood, grazing, forest fire, recreation, tourism, dry crop cultivation, irrigated field crops, fallow fields, traffic circulations, residential areas, others
Frequency of encroachments by land usages	regularly, irregularly, not any
Daily usage time	permanently, only by day, only in the evening/at night
Yearly usage time	permanently, seasonally
Accessibility	good, moderate, low, none
Special features for individual vegetation types	Forest (pure coniferous or deciduous, mixed coniferous or deciduous, mixed deciduous and coniferous forest, mixed coniferous and sclerophyllus shrubs, mixed deciduous and sclerophyllus shrubs, mixed deciduous and coniferous forest with sclerophyllus shrubs) Woody plants (shrubs and dwarf shrubs) Montane to subalpine xeromorphic open dwarf shrublands and grasslands in the mountains (montan and subalpin, moist or dry) Riparian vegetation (river, stream, siltation areas) Cleft vegetation (mediterranean, montane, high montane-subalpine), Areas degraded by rural uses (abandoned farmland, burnt areas, lands degraded by deforestation, by overgrazing degraded areas, strong to very strongly or little to moderately eutrophicated areas, intervened very strongly, strongly, moderately and little) Agricultural land (cereals, vegetable growing, fruit production, mixed cultivation, non-wood products, beekeeping, carob, thyme, sweet chestnut) Settlements and streets (village, hamlet, massive use, single or group use, continuous use, discontinued use, official use, two or one lanes and traffic-tight or low)
Characteristic plant species	Coding of the characteristic plant groups, for example: 182 *Pinus brutia* and *Glycyrrhiza asymmetrica* formation
Canopy closure degree	closed %70-100, half closed %40-70, light closed %10-40, open %0-10
Canopy closure degree of the shrub layer	closed %70-100, half closed %40-70, light closed %10-40, open %0-10
Layering of the vegetation	two or more, one, not layered
Other features of the vegetation	rich in lying and standing deadwood, rich in young growth, rich in herbs, rich in chasmophytes, geophytes, thermophytes, rich in anthropogenic plant species, rich in fire sensitive species, rich in shrub and herbaceous species, rich in tree and wood species.
Climate zone of plant society	*Oleo-Ceratonion* Zone: hot and rainy winters *Quercion calliprini* zone: mild and rainy winter *Querco-Cedretalia libani* zone: cold to very cold and moderately rainy winter *Astragalus Brometea* Zone: cool to frosty, winter with little rainfall
Stand development phase	Older, young, mixed
Structure of the surface	uncovered soils, soils and loose gravel and debris, mostly stones and gravel, partly soils, mostly loosened blocks, partly with gravel and soil, rough stones, Boulders and rock wall, rockfill
Rock formation	Holocene deposits in valleys and polders, sedimentary areas, Beşkonak Formation, Köprüçay Conglomerate, Mesozoic-Old Tertiary Formations, Radiolarites and Upper Triassic Sandstones
Geologically and geomorphologically important areas	Valleys (canyon- and deep-shaped, inliers), karst forms (poljen, sinkholes, barrow), half karst formations, cirques, snow erosion pans, firn patch)
Slope classes	plane, slightly inclined, moderately inclined, inclined, strongly inclined, steep, very steep
Slope exposure	plane, north, east, south and west exposed
Waters	perennial, periodic, standing, spring, gravel and sand banks in the flooded bank area

Table 2. Vegetation units of the study area and their bioclimatic characteristics in relation to the altitude levels

	Vegetation units	Altitude (m.)	Bioclimatic characteristics
	Astragalo-Brometea	2500 m	Mediterranean-subalpine / high-montane vegetation stage, with cool to frost-rich and rain-poor winter
	Querco-Cedretalia libani	2000/2100 m	Mediterranean-montane vegetation, with cold to very cold and rainy winter
Quercetalia ilicis	*Quercion calliprini*	1100/1250 m	Upper Mediterranean vegetation with temperate and rainy winter
	Quercion calliprini *Oleo-Ceratonion*	500/600 m	Meso-Mediterranean vegetation with warm / mild and rainy winter
	Oleo-Ceratonion	200/300 m 100/110 m	Thermo-mediterrane Vegetationsstufe mit warmem und regenreichem Winter

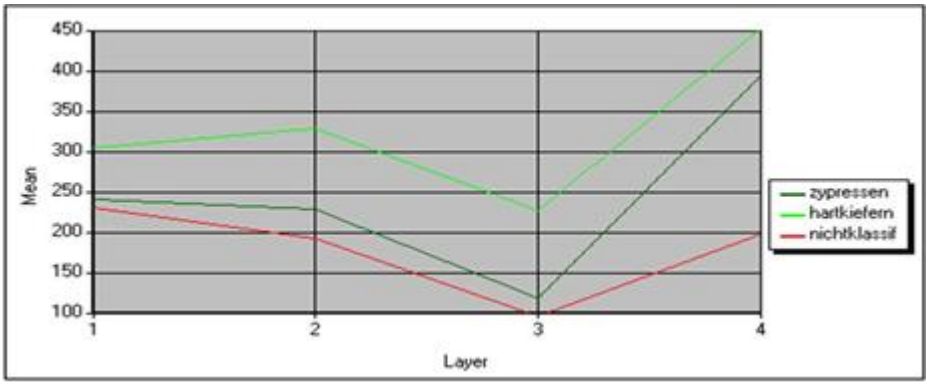

Figure 6. The distribution of spectral signatures of IKONOS images according to tree species (cypress: dark green, Turkish red pine: light green and unclassified: red)

For the coding of the biotope types, a hierarchical subdivision and classification of the biotope types initially classified in the first level was carried out. This required different GIS operations that required a different approach for each characteristic in terms of its raster or vector format. The class-related database attributes had to be prepared before, or after, entered, or transmitted according to the type of operation (→ overlay intersect). The following figures were used to illustrate the hierarchical classification under the level 1 (forests). Here, the layers of characteristics were selectively retrieved after the first-level biotope classes in a new layer and then categorized according to their unique feature classes. By intersecting two vector layers, the result classes were extracted to other new layers. Here in (Fig. 9), the rock types and forests (level 1) are combined in one layer to determine which rock types are important for the area-wide forest distribution. Then the rock types were selected and extracted with the forest types (special features for vegetation) by the clip operation. This marked the forest types that only exist on conglomerate, which is the first step in the classification for level 2.

Then the forest types (special features for vegetation) were selected on this layer. The different types of forest within conglomerate mountain forests have been specified. Therefore, a classification template for forest types still had to be designed. The forest types were selected by the main tree type via characteristic plant species and blended by overlay intersect with the previous layer. Then the pure mountain black pine forests occurring on conglomerate and dry and cold slopes were classified (Fig. 10).

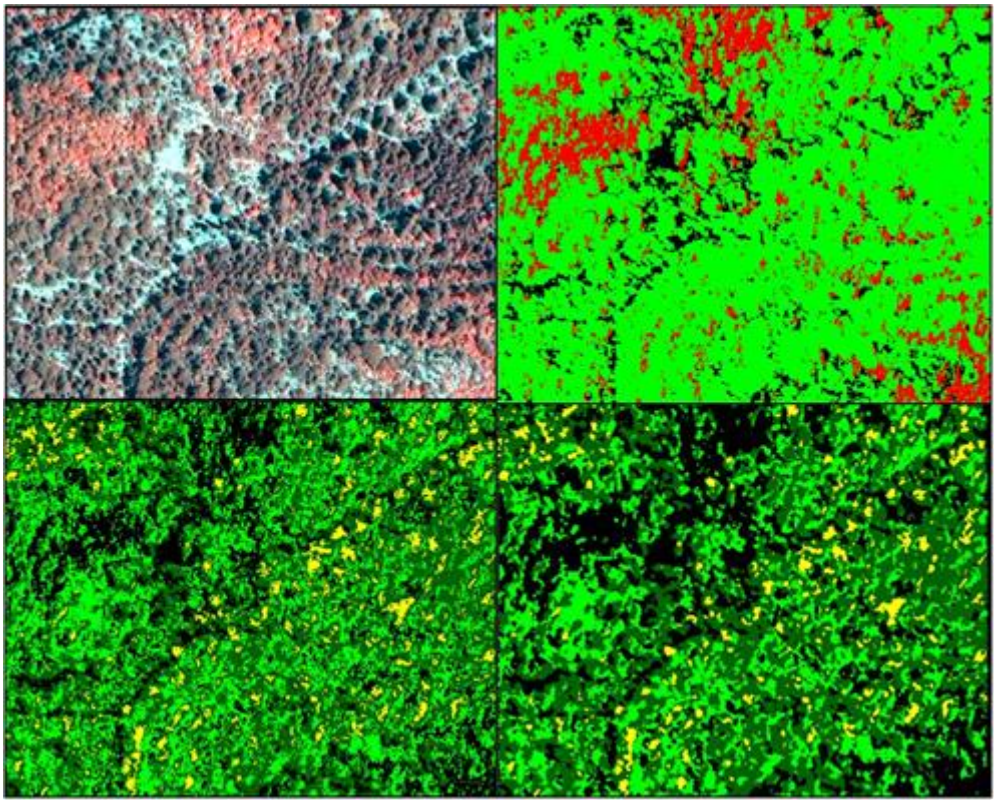

Figure 7. Top left, IKONOS image data in RGB true color representation; top right, the classes of ISODATA cluster analysis; bottom left, results of the Maksimum-Likelihood classification; bottom right, classes related to neighborhood relationships in block structures

CLASSIFICATION ACCURACY ASSESSMENT REPORT

Image File : d:/cumhur/rec101/101_alt/101alt/yeni/ne3recisobtk.img

ACCURACY TOTALS

	Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
1)	Hartkiefern	60	68	57	95.00%	83.82%
2)	HLGebüsche	66	54	50	75.76%	92.59%
3)	HLG-Laubb	21	25	20	95.24%	80.00%
4)	Laubbaum	3	3	3	100.00%	100.00%
	Totals	150	150	130		

Overall Classification Accuracy = 86.67%

----- End of Accuracy Totals -----

Figure 8. The accuracy assessment report for an unsupervised classification (1: Turkish red pine, 2: sclerophyllous bushes, 3: sclerophyllous bushes and deciduous forest, 4: deciduous forest)

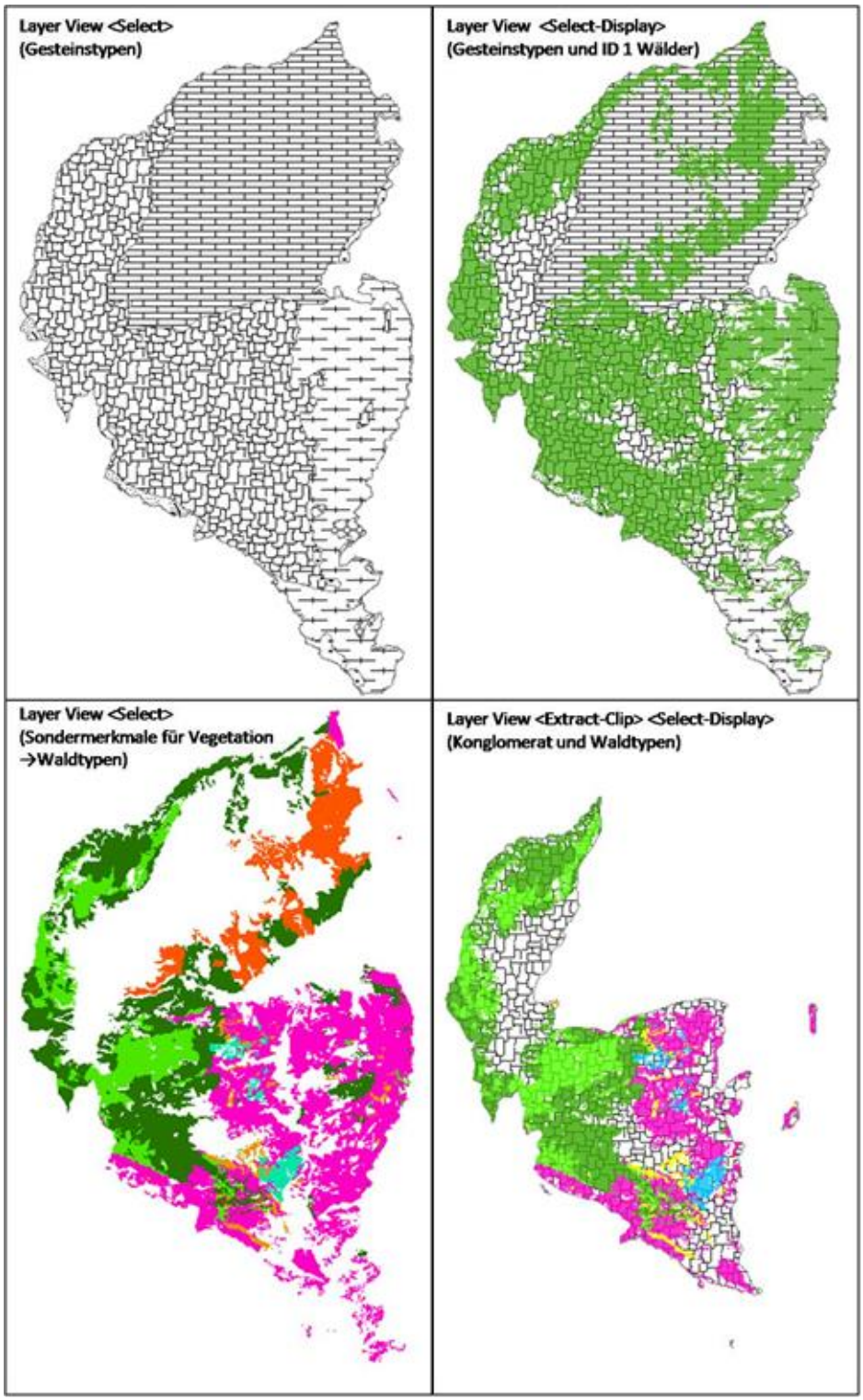

Figure 9. The steps for extracting the forest types of special features for vegetation with rock types

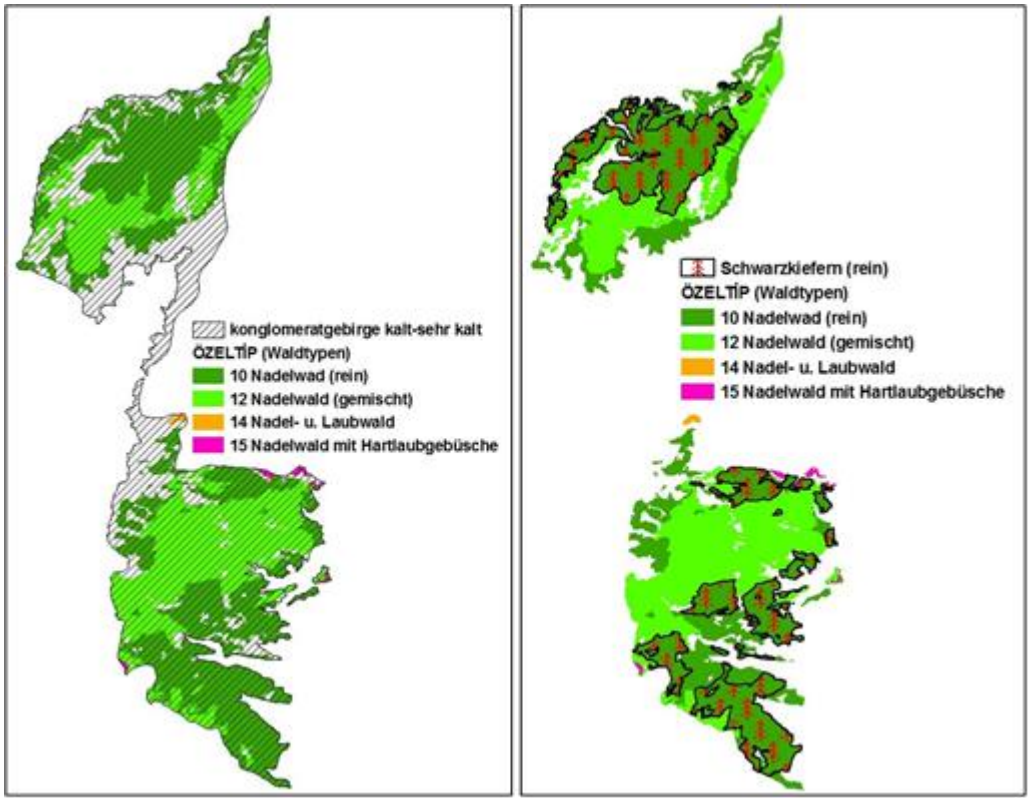

Figure 10. The intersection for the extraction of the conglomerate dry cold mountain forests, on slopes shielded against the influence of the sea (Level 2) and those of the black pine mountain forests (Level 3)

As a result of this study, maps were produced for each level. Eight biotope types were identified at the first level. The number of 3rd level biotop types in level 1 is also shown in (Fig. 11). The total area of the 1st level biotope types are given in (Fig. 12). Thirty-seven biotope types were identified at level 2. A total of 102 different biotope types in level 3 were distinguished in different surface areas. This map shows the all biotope types in the hierarchy at least. The forests were in the first place in terms of number of biotop types and total area size. The mapped all bitope types in level 3 shown in (Fig. 13).

Discussion

The biotope types were classified by coding the homogeneous biotope area based on their characteristic features. There are difficulties on compilation of data on vegetation, topographical land forms and land use becomes very complex. The available data and their informative value must be closely examined with regard to their quality for the determination of biotope properties. The biotope types are classified as the biotope type approach according to hierarchically arranged properties. All characteristic biotope features in the various hierarchical levels were determined in advance. This allows a clear classification and characterization of the biotope types at certain levels by coding the characteristics. The diversity of the characteristic values could be represented by numerous subdivisions of a biotope area into hierarchically classified types, which would otherwise have remained unstructured and unclear. Remote Sensing and GIS techniques are the most important tools for data capturing, analyzing and assessing biotopes. Due to their comprehensive coverage and rapid accessibility of the landscape elements and structures, and their linkability with other data layers by means of GIS are more favorable than field recordings, especially for area-wide biotope mapping. On the other hand it is possible, with the remote

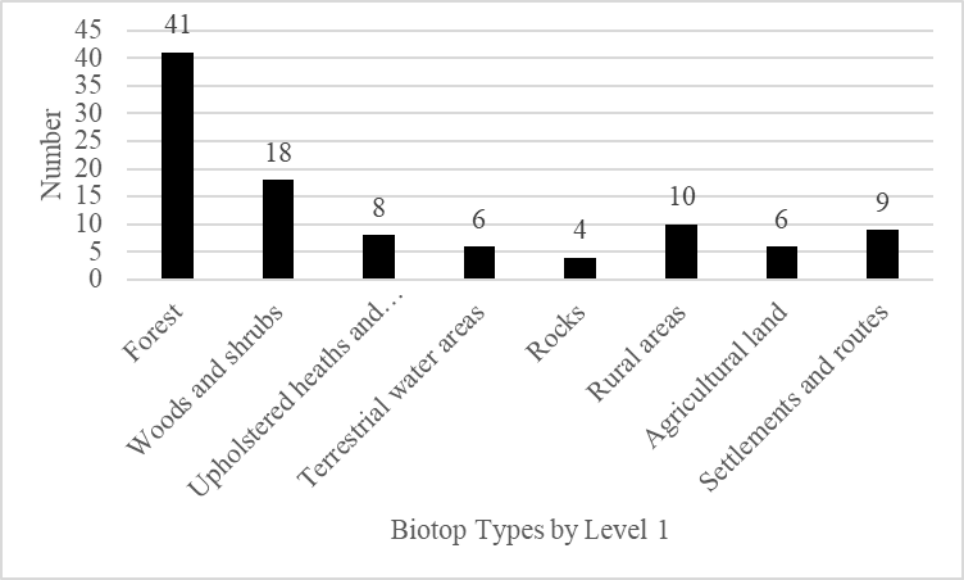

Figure 11. Number of biotope types by Level 1

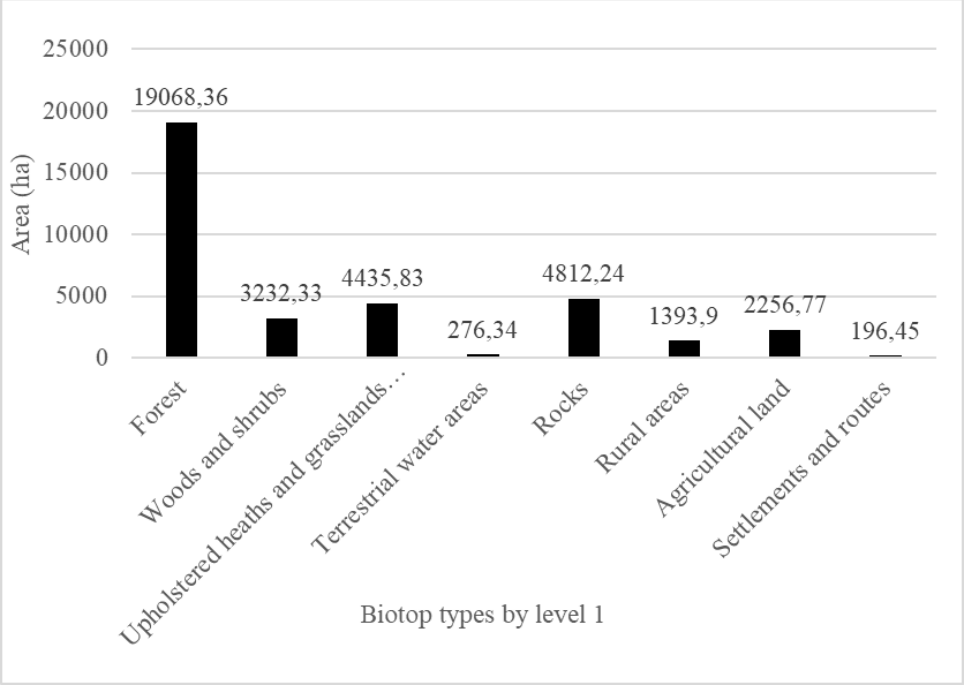

Figure 12. Areal distribution of biotope types by Level 1

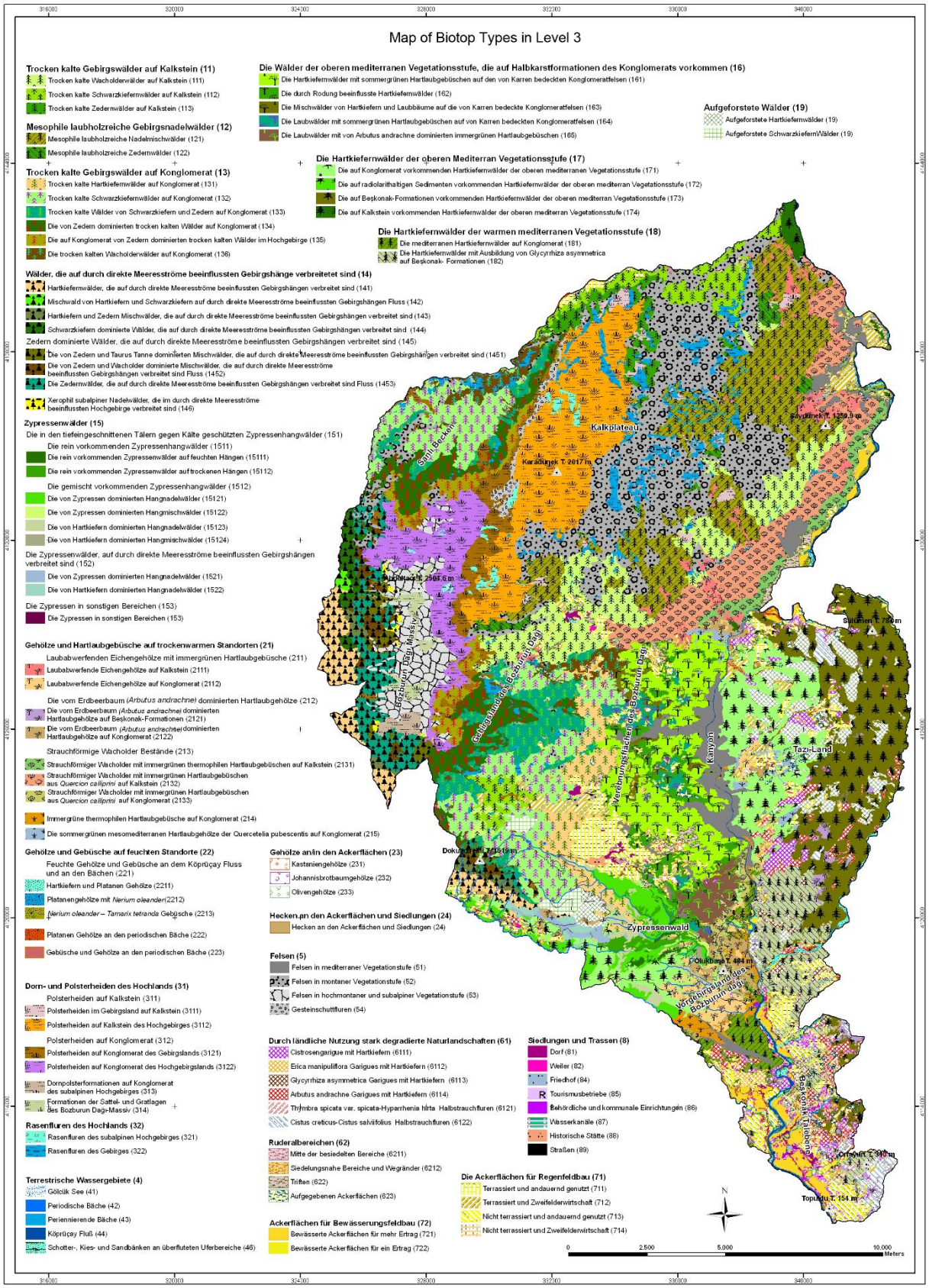

Figure 13. The bitope types of study area

data, to compile a complete collection or supplementation of the data that is essential for the biotope mapping, but in the existing data situation previously missing. The central importance of GIS analysis and assessment for this study lies in the spatial synthesis of properties and features to biotope types. In this study was given the important corner points of biotope mapping for Turkey. Turkey serves its membership negotiations with the EU since 2005. Those negotiations with Turkey are presented each year to the EU progress report. The requirements of biotope mapping in Turkey is reported since 2008. This study is expected to provide a significant contribution to biotope mapping work holds an important place for the protection of Turkey's nature. Mapping of biotope types is particularly important in the protected areas of Turkey.

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