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The Comparison of The Natural Stands Quantitative Characteristics in Managed and Non-Managed Areas in Caspian Sea Coastal Forests

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ABSTRACT

In this consideration the natural forest stands in managed and non-managed areas in Iran's North forest were studied from the view point of quantitative characteristics. Inventory was done by random systematic method and with a net of 112×112 meters dimensions with sample pieces of 500 square meters. In each sample piece the quantitative characteristics of breast height sections Basal Area (B.A) and the number of trees in a hectare were considered. ANOVA was used for testing the significant difference among parameters of quantitative means in the two areas the results of this study showed that from the view point of quantitative characteristics among Basal Area in hectare and the number in hectare in the two managed and non-managed areas a significant difference exists.

Keywords: Quantitative characteristics, Coastal, Natural forest.

INTRODUCTION

From the view point of precedence Caspian Sea coastal forests, Iran's North, are exception in the world and in fact they are the natural heritance of world. These days factors such as inaccurate planning and incorrect execution along with other factors caused the destruction of the forests (Namiranian, 1999). Therefore the executions of the protection plans for these forests in order to prevent more destructions and torestore these forests is necessary and essential. According to this it should become clear that how has the forest evolutional process been in non-protected stands and in protected stands that weren't managed how has the forest reached its climax and how it is stability guarantied. The betterment of the quantitative forest situation after a execution of a management period. In a study a part of forest stands in protected and non-protected areas in Iran's Arasbaran forests were compared from the viewpoint of quantitative characteristics and it was known that the number in hectare and section surface in hectare in protected stands are significantly more than non-protected areas

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(Alijanpour et al., 2003). In another study the consideration of forest quantitative situation in protected and non-protected areas in Iran's west forests showed that generally the quantitative and qualitative situations in protected areas is better Them non-protected areas (Pourreza, 2004). Also the study of wooden species diversity in protected and non-protected areas of Iran's Arasbaran forests showed that there is a significant difference between the Richness index and Evenness index in the natural protected stands in comparison with non-protected forest stands (Alijanpour et al., 2009).The managed and natural stands biodiversity and regeneration structure of Shorea robusta species also Terai area in Nepal was also studied. The results showed that regeneration and plant diversity in the managed forest of the above species regeneration during natural forests management has had a comparatively good increase (Webb and Sah., 2003). Also other researchers have admitted in their studies that the combination of prevailing tree species in exploited stand in comparison with natural and protected stands have had some changes so that most of unwanted species have replaced the area's original and prevailing species. So before interfering in a stand the ecologic and habitation should be considered (Angers et al., 2005; Pat, 2007).

MATERIALS AND METHODS

The Under Study Area

The execution location of this study was Tonekabons forest in North of Iran. This areas forests are located in 36° 47′ 40″longitude and 50° 41′ 45″ latitude and it is least altitude from sealevel is 230 m and its most altitude form sea level is 2350 m (Figure.1). Pedologicaly the soil type is forest brown and its mean annual shower is 1250 mm and the under study area's mean annual heat degree is 12.5°C and it has humid weather. The main species that exist in the under study sites are Fagus orientalis along with Carpinus betulus, Alnus subcordata, Acer velutinum, Quercus castaneifolia, Ulmus glabra and Diospyrus lotus, and shrubs such as Mespilus germanica, Ilex hyrcana and Crataegus sp. are observed in the trial sites.

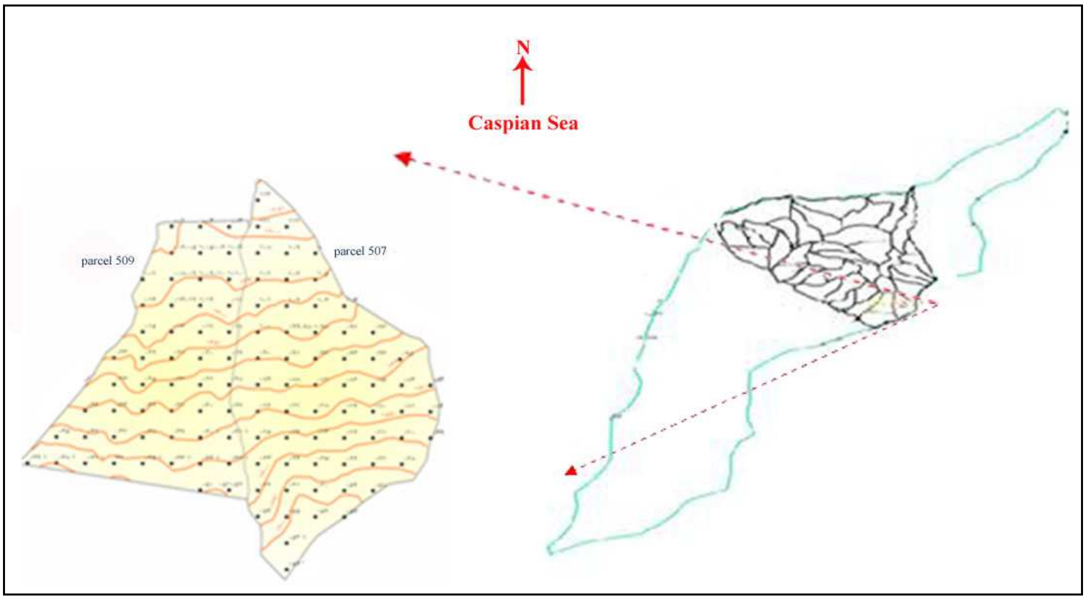

Figure 1. The research area.

Study Method

In order to do this study two parcels with numbers of 509 (non-managed) with a measurement of 65 hectares and 507 (managed) with a measurement of 81 hectares were selected. In this area because the under study forest stands are congenial the inventory was done by a random-systematic method and with a net of 112×112 meters dimensions with 500 square meters circle shape sample pieces. In the non-managed parcel 51 sample plots and in the managed parcel 63 sample pieces were selected and in each sample piece quantitative characteristics such as diameter and the number of trees were measured.

RESULTS

The results of the obtained means in the two managed and non-managed stands according ANOVA are shown in the following Table1.

Table1. The comparison of the quantitative characteristics of managed and non-managed parcels.

Characteristic	Non-managed Area	Managed Area	F Value
Mean of the number in hectare	149.6	182.35	14.2***
Mean of Basal Area in hectare(m^2)	26.94	43.54	12.29***

*** Significante in 0.001 level

According to the obtained results the quantity of number in hectare and also basal area in hectare in the managed and non-managed stands hove had considerable difference (Figure 2 and 3) and this difference is significant at 1% level.

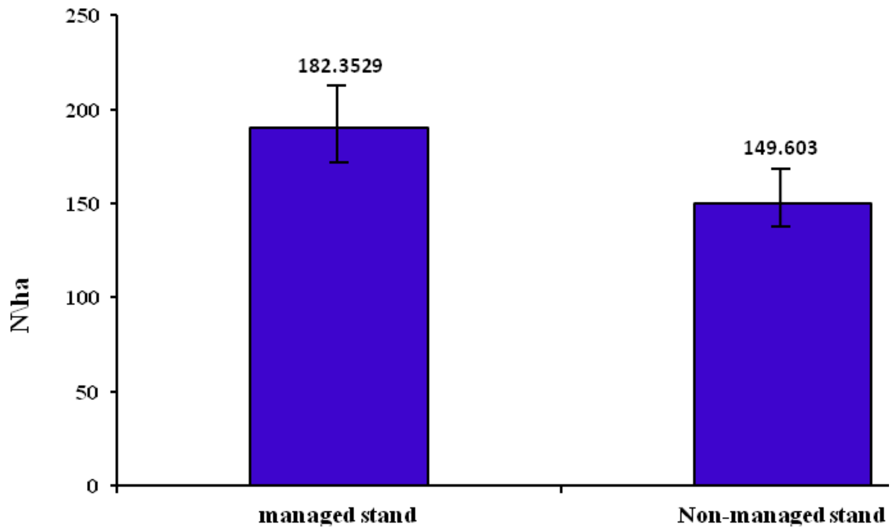

Figure 2. The statistical comparison of the number in hectare in managed and non-managed stands.

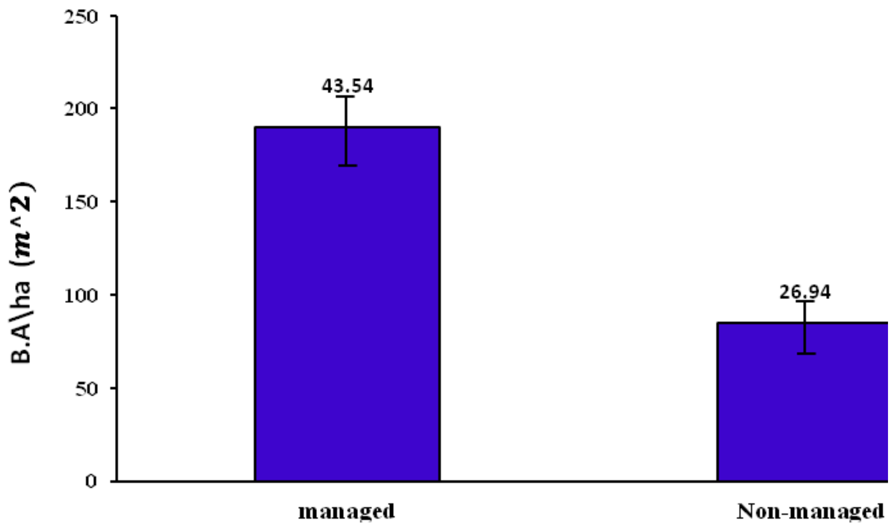

Figure 3. The statistical comparison of the Basal Area hectare in managed and non-managed stands

The consideration of the number of distribution in different diameter classes in managed stands shows the most gathering of trees in young and middle aged stages with low diameter classes (Figure.4). The same situation is observed in non-managed stands the shows the considerable decrease in number in hectare in middle aged trees with high diameter classes (Figure 5).

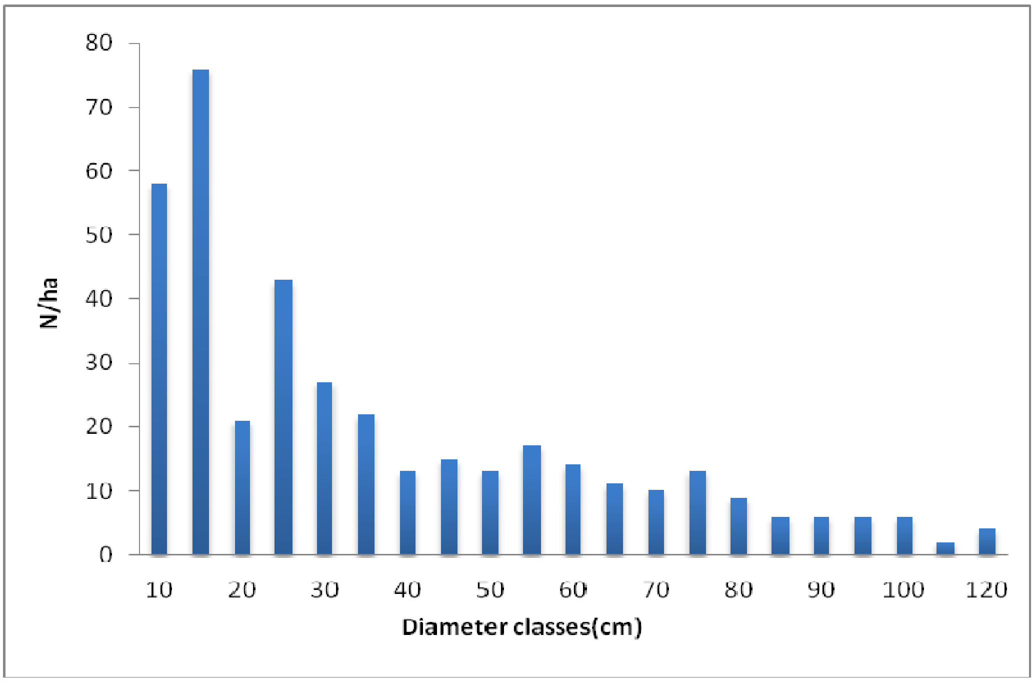

Figure 4. The distribution of numbers in different diameter classes in managed stand.

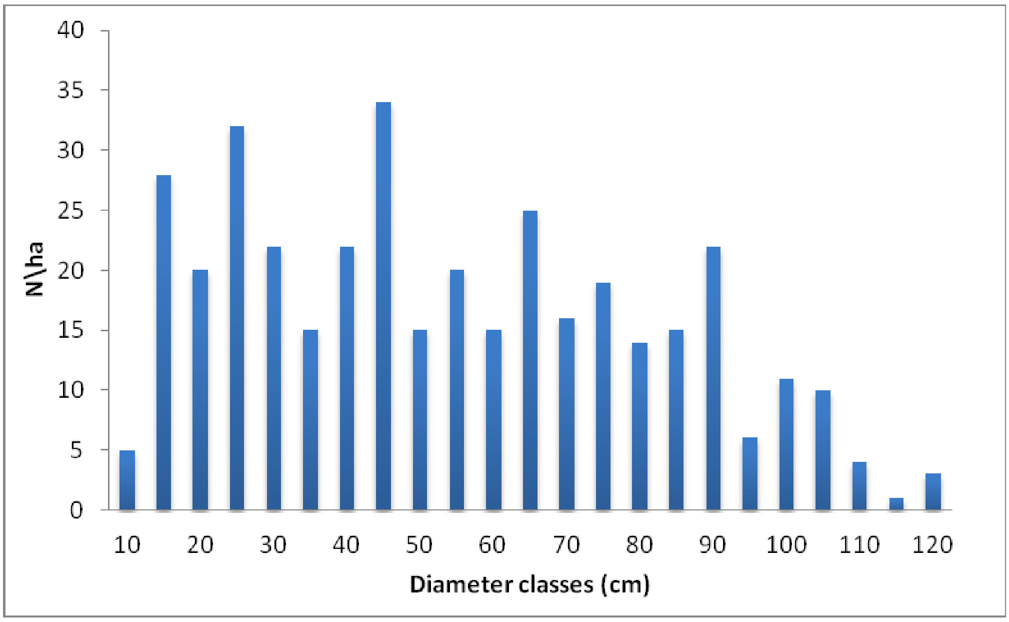

Figure 5. The distribution of numbers in different diameter classes in non-managed stand.

The survey of correlation curve between diameter breast height and the trees height in managed stand shows that there relationship is almost as a linear model (Figure 6). The correlation intensity (r) between these two parameters equals 83.8% which ANOVA insists on its significance at one percent level (Table 2).

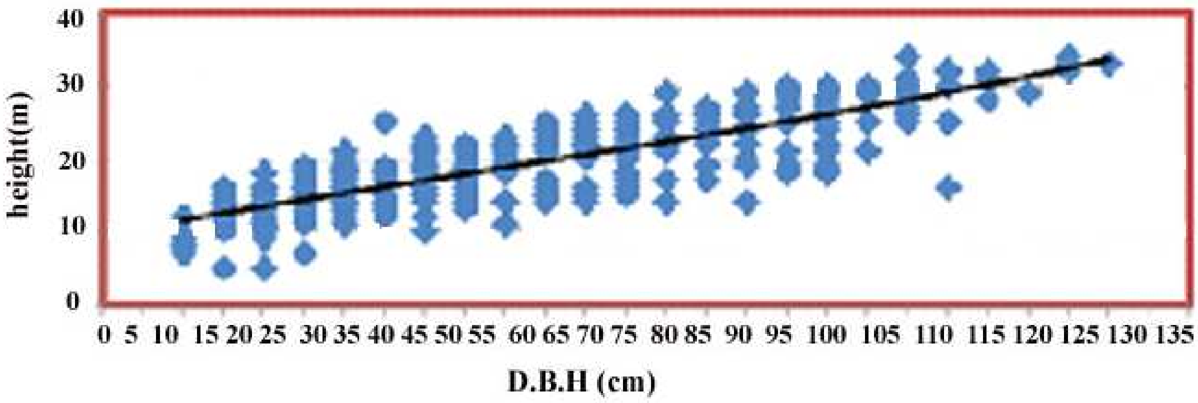

Figure 6. The diameter and height in managed stand

Table 2. Height and diameter correlation equation in managed stand.

Model	B	Std. Deviation	F Value
Constant	9.825	0.371	26.455
D	0.838	0.006	29.693**

** Significant in 0.01 level

Correlation curve between the trees diameter and height in non-managed stands shows a non-linear model (Figure 7). The correlation intensity (r) between these two parameters in non-managed stands equals 79.4% (Table 3).

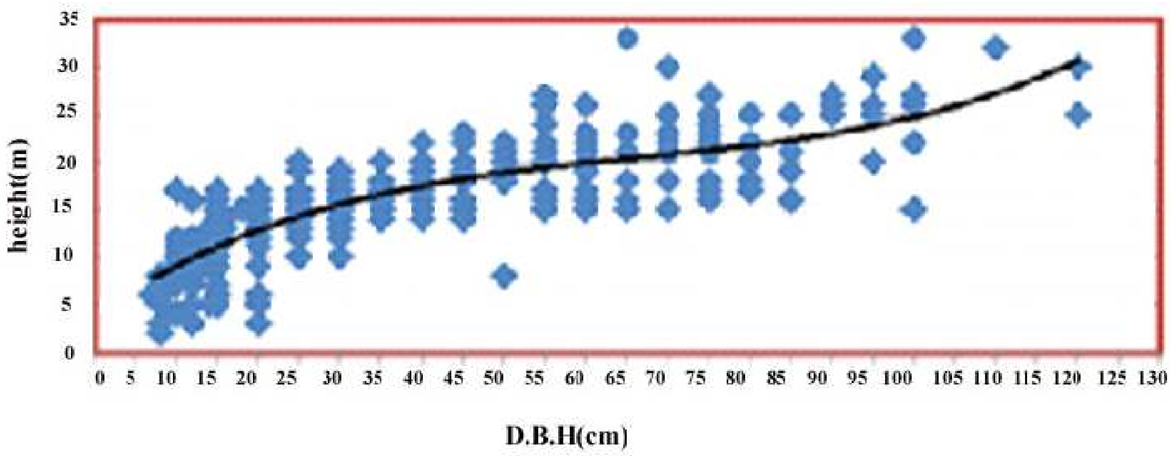

Figure 7. Diameter and height curve in non-managed stand.

Table 3. Diameter and height correlation equation in non-managed stand

Model	Std. Deviation	B	F Value
Constant	0.306	-	29.098
D	0.007	0.794	25.151**

** Significant in 0.01 level.

Discussion and Conclusion

The results of this study showed that in the managed stand the stand quantitative parameters such as number in hectare and Basal Area in hectare have more desirable situation in comparison with non-managed protected stand. This result shows that essential management of forest stands in many cases has caused positive changes in forest stands in this area. The considerations show that the most quantitative characteristics in managed stand have a better situation in comparison with non-managed stands (Pourreza, 2004; Alijanpour, 2003). The distribution of the trees number in hectare in different diameter classes in managed stands have a more congenial and regular state in comparison with non-managed stand. In other words because of structure diversity the managed stand has a more stable situation. The distribution of the trees number in hectare in non-managed stand is mostly related to less and young diameter classes. The inaccurate and essential silviculture management can have intense destructive effects in the forest and the main goals of afforestation plans that are making various and stable forest structure can be questioned. Because in many mentioned studies essential an accurate forest management can end to the increasing of biologic diversity (Halpern and Spies, 1995; Larsen, 1995; Attiwill, 1994). Therefore applying stable and essential management is not only non detrimental for forest stands but also in many cases in can cause structure improvement and biodiversity that ends to forest stand survival.

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DETERMINING ERGONOMIC FACTORS OF LOADING MACHINES USING IN FORESTRY OPERATIONS IN TURKEY

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ABSTRACT

Loading machines in various types are generally used in forest depots in Turkey for loading and stacking the forest products. However, the risks accompanying this development threaten the health of the operators working in loading machines. The aim of this study is to examine the working conditions of the operators of loading machines being used in forest operations in Turkey in terms of ergonomics. This study was applied on machines and operators 45 each, working in loading and stacking operations in forest depots within the borders of Western Black Sea Region. Physiological workload and ergonomic factors influencing the workload were evaluated with principal component analysis. The average physiological workload was calculated as 49% and it was in the category of "medium heavy work". It was also determined that the most important factors influencing the physiological workload during the operations were; body weight, machine technology and noise, anthropometric lengths, vibration, work technique, the length of the operator's arm, climate factors, social position, the surface of the terrain, the duration of the use of machine and the seat, motivation, smoking and proceeding speed of the machine.

Keywords: Ergonomics, Forestry, Loading machine, Physiological workload.

INTRODUCTION

Loading operations are quite important in terms of time and cost and regular flow of transportation operations in the production phases of raw materials obtained from wood. Using machines in loading operations has been increasing continuously in Turkey for the past 10-15 years due to high productivity in machine operations and difficulty in finding workers. However, ergonomic principles such as noise, vibration, anthropometric dimensions and physiological workload aren't assigned required importance in loading operations with tractors.

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In recent years, mechanization and automation in workplaces have developed and as a result, workload has increased considerably (Hirai 2006). In order to ease working conditions and facilitate the use of machines, operators are considered with the machine they operate. Work physiology studies the relation between human body and work. The aims of work physiology are; to study the relation between worker and working conditions, set rules regarding these relations, ensure that labor force is protected, increase productivity and to research the appropriate working style for the work in question (Yıldırım 1989).

Heart rate is used to determine and describe the state of health (Astrand et al. 2003). Moreover, physiological measurements including heart rate are reliable means to ascertain workload (Roja 2005). The relation between heart rate and physiological parameters has been studied in lots of scientific research (Lass et al. 1997). There are a limited number of ergonomic researches on loading-unloading machines in Turkey (Acar and Topalak 2001; Tunay et al. 2006). Most researches are usually concerned with the comparison of loading by hand and loading by machines in terms of cost and productivity. No serious research has been carried out on operators' health, safety and education although loading with machines is frequently applied currently. Furthermore, even though general ergonomic studies have been carried out on forestry machines in world countries (Gellerstedt 1999, Shemwetta et al. 2002, Neitzel and Yost 2002), no ergonomic study has been found specifically on loading machines.

The aim of this study is to examine the working conditions of the operators of loading machines used in forestry operations in Turkey in terms of ergonomics. In the study, ergonomic factors affecting the physiological workload of operators during the operations with loading machines were evaluated. During the operations with loading machines, factor analysis was applied using on site measurements regarding the ergonomic factors such as physiological workload, anthropometric dimensions, noise and vibration. As a result, ergonomic precautions that must be taken to protect the operators while working with loading machines used in forestry operations in Turkey were presented.

MATERIALS AND METHODS

This study was carried out in forest depots in Western Black Sea Region, which is rich in forest resources in Turkey. Ergonomic measurements on site were made during the operations with loading machines in September, October, November 2007 and in March, April, May 2008. The measurements used in the study were made during the operations of International, Ford and Massey Ferguson tractors on which loading equipment is mounted and original loading machines such as Komatsu and Hidromek.

Heartbeats of operators at work and at rest were measured so as to determine the physiological workload. Physiological workload was determined using heartbeat per minute (pulse) telemeter method. Polar S610i pulse meter and polar belt were used to have information about pulse and workload. Operators' pulse values in every 5 seconds at rest and at work were saved in the memory of the pulse meter. And then, the pulse values were transferred into computer using a software program. With the help of the pulse values while working with machines and at rest, the rate of physiological workload can be calculated (Shemwetta et al. 2002, Vitalis 1987, Kirk and Sullman 2001). As a result of the calculations, it was determined the loading operations under which work group are evaluated in terms of physiological workload.

Statistical analyses were made so as to determine the factors which affect the physiological workload of operators while working with machines used in forestry. Firstly, all the factors that may have an effect on workload were put forth after being discussed among experts. In log loading and stacking operations, in order to find out the factors that affect workload; operators, loading machines, working areas, anthropometric dimensions and noise and vibration etc. characteristics in different regions were determined.

Operator characteristics; age of the operator, total years worked, daily working time, occupational educational status (1: no training, 2: trained slightly, 3: trained), monthly wage of operator, working time within a day, smoking status (0: not smoking, 1: occasionally, 2: pack a day, 3: more than one pack), alcohol consumption (0: not drinking, 1: rarely, 2: one a week, 3: a little daily, 4: excessively a day), sports activity of operator (1: slightly, 2: moderately, 3: permanently), working situation of operator (1: civil servant, 2: worker of private enterprise, 3: own work), social requirement situation (according to Maslow; 1: no fulfillment, 2: intermediate, 3: satisfactory), improvement need situation (according to Maslow; 1: no fulfillment, 2: intermediate, 3: satisfactory), situation of realization oneself (according to Maslow; 1: no fulfillment, 2: intermediate, 3: satisfactory).

Machine characteristics; machine type (1: mounted agricultural tractor, 2: original), Loader type (1: back shovel, 2: front loader), age of the machine, Cabin status (1: no cabin, 2: only roofed, 3: original completely closed cab), situation of air conditioner (1: without air conditioner, 2: only fan, 3: air conditioned), front wheel pressure, rear wheel pressure, proceeding speed of the machine, seat use duration, seat suspension system (1: useless, 2: middling quality, 3: effective).

Working area characteristics; Altitude, pressure, temperature, relative humidity, wind velocity, slope, clothing insulation value (clo; 0.4: summery clothes, 0.6: light working clothes, 1.0: normal working clothes, 1.2: light outdoor clothes, 1.4: normal clothes, 1.7: wintery clothes), ground type (1: soil, 2: stabilized), ground hindrance (1: low hindrance, 2: middle hindered, 3: high hindrance), ground soil status (1: wet peat lands, 2: soft soil on a wet land, 3: soft soil on a dry land, 4: hard mineral soil, 5: sandy-graveled soil).

Anthropometric characteristics; stature, sitting height, knee height, shoulder breadth, hip breadth, chest depth, abdominal depth, shoulder-elbow length, elbow-fingertip length, upper limb length, hand length, vertical grip reach-standing, vertical grip reach-sitting, triceps skinfold, supraspinale skinfold, subscapular skinfold, upper arm girth, calf girth, body weight, operator’s arm force.

Noise and vibration characteristics; x-axes weighted acceleration (Rms-x), y-axes weighted acceleration (Rms-y), z-axes weighted acceleration (Rms-z), total vibration magnitude (Rms- sum), Total vibration dose value (VDV), noise, maximum noise.

Correlation analysis was made to ascertain the relations among all the variables that may affect physiological workload. Then, factor analysis (Principal Component Analysis) that categorizes a number of variables which affect physiological workload under certain factor groups was made. In loading operations, it is quite difficult to determine the workload in accordance with each of the 59 variables. Therefore, in forestry, workload is brought about by a number of factors among which there are complicated interactions. Moreover, more than one variable may be found affecting the workload at the same rate. Hence, it is intended to measure the workload taking the most significant variable into consideration instead of focusing on too many variables. Determination of the most significant variables and interpretation of factors were realized according to varimax transformed factor matrix which was obtained as a result of rotation and had higher practical value.

RESULTS

In this part, first of all, a general outline of the physiological workload such as pulse values and maximum heart rate belonging to operators of loading machines was formed. And then, statistical analyses were made so as to determine the most effective factors on physiological workload. Average and standard deviation values belonging to some variables obtained as a result of measurements and examinations carried out during the operations with loading machines are determined. Correlation analysis was applied among 59 variables which were considered to have an effect on the operator in terms of ergonomics in the operations with loading machines. When the mutual interactions were studied, the highest positive correlations were found between the machine type and air conditioning($r=0.937$), skinfold between the stomach and rib and below the omoplate ($r=0.859$), stature and sitting height ($r=0.835$), weight and omoplate skinfold ($r=0.714$) and operator age and experience ($r=0.681$). On the other hand, the highest negative correlations were found between state of the cabin and noise transmitted to operator ($r=-0.796$), temperature and humidity ($r=-0.679$), machine type and operator's monthly income ($r=-0.667$) and lastly machine type and machine proceeding speed ($r=-0.495$).

Factor analysis was applied in order to ascertain the factor groups affecting the physiological workload of operators in loading operations in forestry (Table 1). Following the analysis of all the measurable variables (59 variables) 13 factor groups were formed. As a result of the rotation using varimax method, 89.51 % of the total variance could be explained with 13 factors cumulatively. In other words, nearly 90 % of workload can be measured with these 13 basic factors. The rest 10 % depends on other factors which can't be measured or considered to be fixed.

Table 1 Rotation sums of squared factor loadings*.

Factor No	Total	Variance (%)	Cumulative (%)
1	7.308	13.050	13.050
2	7.138	12.747	25.797
3	5.687	10.156	35.952
4	5.387	9.620	45.572
5	3.436	6.135	51.707
6	3.249	5.801	57.509
7	2.939	5.248	62.756
8	2.874	5.132	67.888
9	2.813	5.023	72.911
10	2.742	4.897	77.807
11	2.540	4.536	82.343
12	2.204	3.936	86.279
13	1.808	3.228	89.508

* Extraction Method: Principal Component Analysis.

In the interpretation of the factors, factor loads higher than 0.50 as the absolute value were taken into account. As the basis of interpretations, variables having the highest factor load were chosen for a true representation of the common feature of the factor. Thus, each of the chosen variables represented a different dimension of workload. As a result of the factor analysis, each of the factor groups was given a name using the values of the most significant variable.

Factor 1: Bodyweight; This factor is named “bodyweight” due to the fact that it consists of variables regarding the bodyweight among which significant correlations were found. The increase in weight, diameter and perimeter dimensions has a positive on the factor. Variables having the highest values are bodyweight (0.911), skinfold between the stomach and the rib (amount of fat) (0.857) and the skinfold under the omoplate (0.839).

Factor 2: Machine Technology and Noise; Since the group is composed of variables the majority of which are concerned with the development level of loading machines, it is named as above. That the machine has a cabin and air conditioning affects the factor positively, however, using tractors on which loading equipment is mounted instead of original loading machines and the noise level transmitted to operator affects the factor negatively. The highest variable values are noise level (-0.917), original machine and having a cabin (0.909).

Factor 3: Anthropometric lengths; It is given this name since it is mainly concerned with the values of the anthropometric dimensions of the body. Operator seat-body compatibility and stature, sitting height, hip width, knee height, the values of gripping level while sitting, which are all important for the posture in the tractor have a positive effect on the factor. Variables having the highest values are stature (0.912), sitting height (0.862) and hip width (0.751).

Factor 4: Vibration; This group is called “vibration” due to the fact that the majority of the variables consist of the ones regarding the whole body vibration transmitted to the operator from loading machines. Total rms acceleration values in the direction of z-axis, y-axis and x-axis have a positive effect on the factor. The highest variable values are total (0.965) and in the direction of z-axis (0.904) rms acceleration values of whole body vibration.

The other factors are named respectively; Factor 5: Work technique, Factor 6: The length of the operator’s arm, Factor 7: Climate factors, Factor 8: Social position, Factor 9: The surface of the terrain, Factor 10: Machine use duration, Factor 11: Motivation, Factor 12: Smoking and Factor 13: Machine Proceeding Speed.

The factors affecting the physiological workload of the loading machine operators while they are working are given in Figure 1.

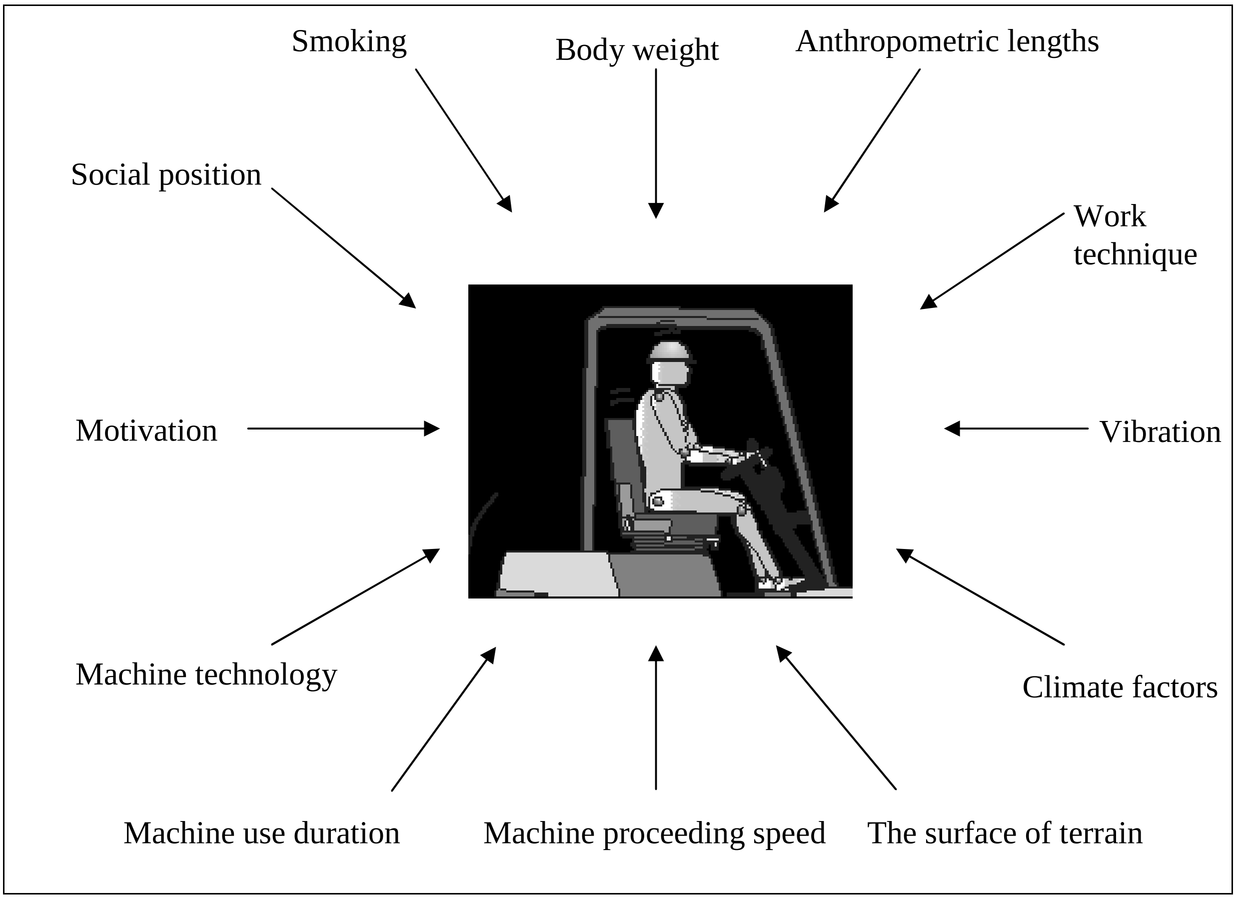

Figure 1 Factors effective on physiological workload of operators.

DISCUSSION

It was determined that the average physiological workload value (HRR %) of the operators while working with loading machines was 49 % and it was classified under the “medium difficult work” category the percentages of which were between 38-78 %. The characteristics of “medium difficult work” group are that energy consumption is between 2.5-5 kcal and heartbeat per minute is between 90-100. Although forest harvesting operations are usually considered “very difficult work” by ILO, it was found out in this study that loading operations with machines could be classified under “medium difficult work” group. When previous studies on physiological workload are evaluated (Abeli and Malisa, 1994; Kirk and Sullman, 2001); Shemwetta et al., 2002), it is understood that physiological workload value varies depending on the type of the work first and the difficulty level of it.

As a result of the correlation analysis carried out among all the variables affecting physiological workload, high correlations were found between anthropometric dimensions such as stature and sitting height; values regarding the machine such as machine type and cabin condition and values concerning the body fat ratio such as bodyweight and skinfold.

In this study, it was found that the factors such as bodyweight, machine technology and noise, anthropometric dimensions, vibration, work technique, operator's arm length, climate factors, social situation, ground surface, seat use duration, motivation, smoking and machine proceeding speed had an effect on physiological workload. Bridger (1995) classified the factors generally affecting the physiological workload under two groups; *personal factors* (age, bodyweight, sex, alcohol and cigarette consumption, active lifestyle, training diet and motivation) and *environmental factors* (atmosphere pollution, quality of the air, ventilation, altitude, noise, and extreme temperature). Kroemer et al. (1999) suggested that the factors affecting the physiological workload were age, sex, body dimensions, health training, being active, character, motivation, climate and altitude. Factors affecting the physiological workload such as bodyweight, anthropometric dimensions, climate factors and motivation that were put forward in past studies are consistent with the factors found in this study. Moreover, in addition to the general factors, variables such as machine proceeding speed and ground surface which are directly related with loading operations were found to have affected physiological workload.

CONCLUSIONS

Ergonomic criteria should be taken into consideration so that loading operations with machines can be performed more healthily, safely and productively in terms of operators. Machines used in loading and stacking operations and having static and dynamic defects should be renewed and using original loading machines instead of tractors on which loading equipment is mounted should be encouraged and supported. While choosing the loading machines, it should be paid attention whether the operator control area in the machine complies with the anthropometric dimensions of operators or not. In order to minimize the noise transmitted to the operator, the use of tractors having an original cabin should be ensured. While choosing the location of the forest depots, terrains which are flat and having a slope should be avoided and the roughness of the ground should be reduced by covering the ground of existing depots with stabilized materials. Anthropometric features and important ergonomic factors like noise and vibration which affect the physiological workload of operators should be evaluated constantly and regularly and loading operations should be performed productively.

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Effects of Soil Properties and Botanic Composition on Arbuscular Mycorrhizal Fungus (AMF) from *Gramineae* Family Plants

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ABSTRACT

Mycorrhizae is the term used to describe the mutualistic associations between specizalized fungi and roots of higher plant. Numerous plants strongly depend upon mycorrhizae for optimal growth. Studies of mycorrhizae are unsufficient in rangeland in Turkey. The aim of the present study is to establish interrelationships between AM colonization status with the physico-chemical properties of the soil and botanic composition.To achieve these objectives, rhizosphere soil samples from *Gramineae* family plants were collected in June and July 2010. Soil samples were taken for determination of several soil characteristics. In addition, vegetation analyses were carried out. AMF was determined that 64% plants colonized by variable range (7.14%-41.38%) of arbuscular-mycorhizal fungi and established symbiotic relationship. *Glomus* genus was determined as fungal symbiont of all root samples. The rangeland soils were characterized by high organic matter, high total nitrogen, low electrical conductivity and low lime content. At the present day arbuscular mycorrhizal inoculation must use in range rehabilitation. However, information on the AMF potential in our rangeland is still lacking. Therefore, this study would provide fundemental information on range rehabilitation studies in degraded rangeland ecosystems of Western Black Sea region. Also, this study contributed to the AMF map of Turkey for Bartın.
Keywords: Bartın, Uluyayla, Arbuscul, Mycorrhizae

INTRODUCTION

AMF encourages plant development in marginal soil condition that has low plant nutrient. This encouragement supply phosphorus, macro and micro soil nutrient to root which has symbiosis with AMF. Fungi take some organic matter and carbonhidrates from plant. In these smybiosis associations form both partners benefit from each other under certain conditions (Demir, 1998; Rhodes, 1980; Bolan et al., 1987; Li et al., 1991). AMF increase plant hormones such as arginin, isoflavanoides (Caron, 1989), cytokines and gibberellins (Muchovej, 2001). AMF effect root development, taking nutrient-water, cell regeneration in root by root absorption capacity enlargement. AMF supply nutrients such as phosphorus, nitrogen (N), calcium (Ca), copper (Cu), manganese (Mn), sulphur (S) and zinc (Zn) (Sieverding, 1991; Ortaş, 2002). AMF increase resistance host plant against soil fungi and nemathods. Better nourishment plant with mycorrhizae can better resistant from unsufficient nourishment plant without mycorrhizae against obligate phatogens (Demir and Onoğur, 1999).

AMF increase resistance plants against salty-dry soil condition, heavy metal toxicity and temperature stress. Furthermore some AMF hyphae bind soil aggregation together and contribute to soil structure. Thus soil loss resulting from soil erosion is prevented by AMF hyphae (Tisdall, 1994).

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There was 44 million ha rangeland area in 1940 in Turkey but at present day there is 13 million ha area. Collective using of this rangeland flora is inadequate in villages 70% (Erkun, 1999).

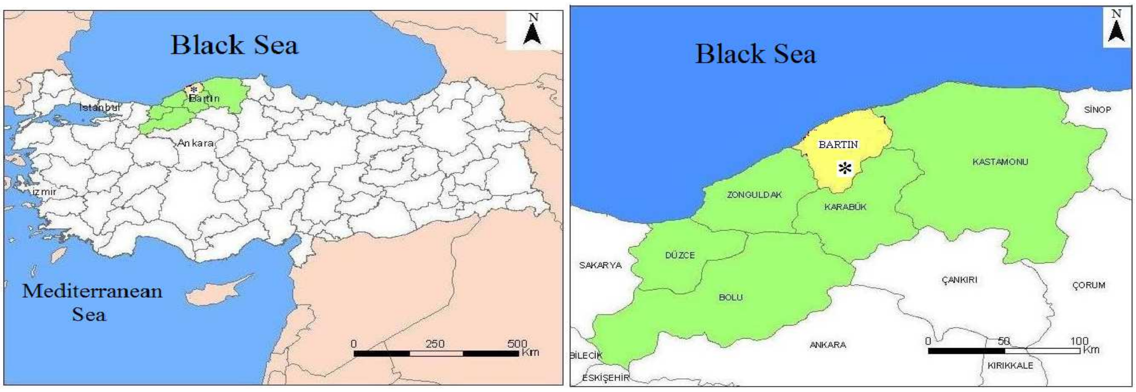
Studies about mycorrhizae are unsufficient in rangeland in Turkey. The aim of this study is to establish interrelationships between AM colonization status with the physico-chemical properties of the soil and botanic composition. Therefore, this study would provide fundemental information on range rehabilitation studies in degraded rangeland ecosystems of Western Black Sea region. Also, map of AMF in Bartın were contributed by this study.

MATERIALS AND METHODS

This study was collected from *Gramineae* family species on the rangeland of Uluyayla district of Bartın province in Turkey. Plant and soil samples were taken from study area for AMF isolation and soil analysis during June and July 2010. Soil samples were taken from plant rhizospheres. 10 sample plots were randomly selected and 5 soil samples were taken from each plot. 50 soil samples were taken from the study area for AMF isolation and soil analysis. Furthermore vegetation analysis was done for each sample area in this study. Range plants were collected for identification. Soil physical and chemical properties such as texture, actual pH, organic matter, $CaCO_3$ content, electrical conductivity, bulk density, partical density, pore space, soil aggregation stability, total nitrogen were analysed.

1.General İnformation About The Materials

Rangeland of Uluyayla district is located at Bartın province in West Black Sea region in Turkey. Bartın is about 12 km away from sea and has 2143 km² area. Geographic coordinates of Bartın lie at latitude 41° 37' north and longitude 32° 22' east (Figure 1-2). Altitude of study area is about 1000 m. Study area has about 150 ha area.



(a) (b)

Figure1. Study area in Turkey (a) and Western Black Sea region (b).*Study area

Figure 2. A view from Uluyayla (Palta, 2010).

Geologic structure of study area is formed in mesozoic time. Bedrock is contained sand rock, gre and conglomera (Anonymous, 1994).

Abies bornmülleriana Mattf., *Pinus sylvestris* L., *Fagus orientalis* Lipsky, *Populus tremula* L., *Taxus baccata* L., *Quercus* sp., *Acer* sp., *Prunus* sp., a lot of herbaceous vegetation-shrubs-geophyt species are present in study area (Figure 2).

Relative humudity of study area ranges from 66.8% to 71.4% (Topay, 2003). According to Thonthwaite method, climate of the study area is humid, mesothermal ($B2B_1rb4'$). Climatological data gathered (1997-2006) shows that the annual mean temperature in this province is 8.0 °C. The mean temperatures of the hottest months, July and August, are 18.0 and 17.5 °C, respectively. Annual mean precipitation in the region is 1534.1 mm (Şengönül et al. 2009).

2.Methods

2.1 Isolation and identification of AMF

During June- July 2010, in order to isolate arbuscular microorganisms, soil samples were taken from 30 cm depth of rhizosphere of plants from *Gramineae* family species. Soil samples' coordinates were recorded by GPS. Soil samples were sieved by 2 mm sieve and put in polyethylene bag and stored at +4 °C. *Zea Mays* was used as trap plant for AMF isolation. *Zea Mays* seeds were kept in procholaraz solution for 30 minutes (Leopold, 1990) and washed by sterile distilled water. Furthermore, flower pots were disinfected by water with %10 formaline before seeds were planted. Soil samples were mixed with sterile stream sand in the ratio of 1:1 and put into the flower pots. *Zea Mays* seeds were planted in flower pots on the following day. Plants were kept in greenhouse conditions (23.5/18 °C night/day, 4000-6000 light lux) and irrigated with sterile distilled water for 10 weeks. Plant roots were fixed and painted (lactaphenol blue solution) at the end of 10 weeks (Phillips and Hayman, 1970). AMF genera were identified by classical methods with using identification keys. AMF propagules (internal-external hyphae, vesicul, arbuscul, spor) were observed by microscope for AMF genus identification (Walker and Trappe, 1993). AMF colonization rates (%) were determined by Grid-Line Intersect method (Giovanetti and Mosseae, 1980).

2.2 Vegetation analysis

Vegetation analysis of rangeland plants were determined by line intercept method (25 m) (Canfield, 1941; Bonham, 1989; Gökbulak, 2006). Botanic composition and canopy coverage were also identified by this method. Rangeland plants were collected and identified by classical methods with using identification keys.

2.3 Physical and chemical properties of soils

Physical and chemical properties of soils were determined by standard methods: soil particle size distribution by the hydrometer method (Bouyoucos 1962), pH in 1:2.5 soil/water suspension by pH-meter (Rowell, 1994), EC in 1:5 soil/water suspension by an electrical conductivity meter (Rhoades, 1982), soil organic matter by the Walkley-Black wet oxidation method (Walkley and Black, 1934), total nitrogen by the Kjeldahl method (Bremner and Mulvaney, 1982), and $CaCO_3$ content by the Scheibler calcimeter method (Allison and Moodie, 1965). The bulk density of soils (g cm^{-3}) was calculated by using mass and volume (Blake, 1965). The particle density of soils (g cm^{-3}) was measured by using the Pycnometer method and pore space was calculated by using the bulk and particle densities (Brady, 1990). The soil aggregate stabilitiy was determined by wet sieving method (Kemper and Koch, 1969).

2.4 Statistical analysis

Pearson correlation analysis was used to examine the relationships among AM fungi colonization and soil properties, and botanic composition. Statistical analysis were carried out by using the Statistical Package for the Social Sciences version 16.0.

RESULTS

Isolation and identification of AMF

22 different taxons and a total number of 50 soil samples from the rhizosphere area of plants from *Graminae* family were taken from the study area. AMF existence was determined in 64% of these plants colonized by variable range (7.14%-41.38%) of arbuscular-mycorhizal fungi and established symbiotic relationship (Table 1).

Table 1. AMF existence and colonization percentage of plants from *Gramineae* family Uluyayla district in Bartın province.

Plant No	Plant name	AMF existence	Properties Hyphae, spore, arbuscul, vesicul	Colonization percentage (%)	GPS (latitude, longitude)
1	*Dactylis glomerata* L.	+	In-ext cel. Hyp., spore, ves exist.	17.24	36T0485934 4600282
2	*Lolium perene* L.	-	-	-	36T0485934 4600282
3	*Brachypodium sylvaticum* (Huds.) Beuv.S	+	In-ext cel. Hyp., spore, ves exist.	7.41	36T0485934 4600282
4	*Poa pratensis* L.	+	In-ext cel. Hyp., spore, ves exist.	12.50	36T0485934 4600282
5	*Cynosorus cristatus* L.	+	In-ext cel. Hyp., spore, ves exist.	11.54	36T0485934 4600282
6	*Hordeum violaceum* Boiss. & Huet	+	In-ext cel. Hyp., spore, ves exist.	7.14	36T0486074 4600234
7	*Bromus hordeaceus* L.	-	-	-	36T0486074 4600234
8	*Danthonia decumbens* (L.) DC.	+	In-ext cel. Hyp., spore, ves-arb exist.	41.38	36T0486074 4600234
9	*Anthoxanthum odoratum subsp. Odoratum* L.	+	In-ext cel. Hyp., spore, ves exist.	9.68	36T0486074 4600234
10	*Anthoxanthum odoratum subsp. odoratum* L.	+	In-ext cel. Hyp., spore, ves-arb exist.	11.11	36T0486074 4600234
11	*Gaudiniopsis macra* (Bieb) Eig *subsp. macra*	-	-	-	36T0485966 4600014
12	*Hordeum bulbosum* L.	+	In-ext cel. Hyp., spore, ves exist.	17.39	36T0485966 4600014
13	*Brachypodium pinnatum* L.	-	-	-	36T0485966 4600014
14	*Descampsia caespitosa* L.	+	In-ext cel. Hyp., spore, ves exist.	24.24	36T0485966 4600014
15	*Lolium perene* L.	+	In-ext cel. Hyp., spore, ves exist.	11.58	36T0485966 4600014
16	*Cynosorus echinatus* L.	-	-	-	36T0486022 4600151
17	*Festuca sp.*	+	In-ext cel. Hyp., spore, ves exist.	8.70	36T0486022 4600151
18	*Cynosorus cristatus* L.	-	-	-	36T0486022 4600151
19	*Poa bulbosa* L.	-	-	-	36T0486022 4600151

20	*Anthoxanthum odoratum subsp. odoratum* L.	+	In-ext cel. Hyp., spore, ves exist.	14.81	36T0486022 4600151
21	*Poa pratensis* L.	-	-	-	36T0485806 4599806
22	*Danthonia decumbens* (L.) DC.	-	-	-	36T0485806 4599806
23	*Cynosorus echinatus* L.	+	In-ext cel. Hyp., spore, ves exist.	17.21	36T0485806 4599806
24	*Dactylis glomerata* L.	+	In-ext cel. Hyp., spore, ves exist.	33.33	36T0485806 4599806
25	*Briza media* L.	+	In-ext cel. Hyp., spore, ves-arb exist.	38.24	36T0485806 4599806
26	*Brachypodium pinnatum* L.	+	In-ext cel. Hyp., spore, ves-arb exist.	29.63	36T0485264 4598864
27	*Danthonia decumbens* (L.) DC.	+	In-ext cel. Hyp., spore, ves exist.	30.77	36T0485264 4598864
28	*Hordeum violaceum* Boiss. & Huet	-	-	-	36T0485264 4598864
29	*Lolium perene* L.	+	In-ext cel. Hyp., spore, ves exist.	25.93	36T0485264 4598864
30	*Anthoxanthum odoratum subsp. odoratum* L.	+	In-ext cel. Hyp., spore, ves exist.	14.29	36T0485264 4598864
31	*Cynosorus cristatus* L.	+	In-ext cel. Hyp., spore, ves-arb exist.	20.69	36T0485832 4599824
32	*Descampsia caespitosa* L.	+	In-ext cel. Hyp., spore, ves exist.	20.59	36T0485832 4599824
33	*Lolium perene* L.	+	In-ext cel. Hyp., spore, ves exist.	9.52	36T0485832 4599824
34	*Elymus repens*	+	In-ext cel. Hyp., spore, ves exist.	17.28	36T0485832 4599824
35	*Descampsia caespitosa* L.	+	In-ext cel. Hyp., spore, ves-arb exist.	16.67	36T0485832 4599824
36	*Poa bulbosa* L.	+	In-ext cel. Hyp., spore, ves exist.	22.22	36T0485817 4599904
37	*Brachypodium pinnatum* L.	-	-	-	36T0485817 4599904
38	*Danthonia decumbens* (L.) DC.	+	In-ext cel. Hyp., spore, ves exist.	11.51	36T0485817 4599904
39	*Briza media* L.	-	-	-	36T0485817 4599904
40	*Phelum pratense* L.	+	In-ext cel. Hyp., spore, ves exist.	12.59	36T0485817 4599904
41	*Arrhenatherum elatius* (L.) J. Presl & C. Presl subsp. *elatius*	+	In-ext cel. Hyp., spore, ves exist.	14.85	36T0485794 4599685
42	*Arrhenatherum elatius* (L.) J. Presl & C. Presl subsp. *elatius*	+	In-ext cel. Hyp., spore, ves-arb exist.	13.04	36T0485794 4599685
43	*Descampsia caespitosa* L.	-	-	-	36T0485794 4599685
44	*Elymus repens* L.	+	In-ext cel. Hyp., spore, ves exist.	9.55	36T0485794 4599685
45	*Descampsia caespitosa* L.	-	-		36T0485794 4599685
46	*Phelum pratense* L.	-	-	-	36T0485503 4598946
47	*Phelum pratense* L.	-	-	-	36T0485503

					4598946
48	*Briza maxima* L.	+	In-ext cel. Hyp., spore, ves-arb exist.	19.05	36T0485503 4598946
49	*Brachypodium pinnatum* L.	-	-	-	36T0485503 4598946
50	*Avena fatua* L.	-	-	-	36T0485503 4598946

In-ext cel. Hyp.: Internal-external hyphae ves-arb- exist.: vesicul-arbuscul existence

Fungal structures (internal-external hyphae, vesicul, arbuscul, spore) were observed for identification of AMF genus and colonization percentage. As a result of observation, all of AMF propagules were seen by microscope (4x10 and 10x10) (Figure 3-6).

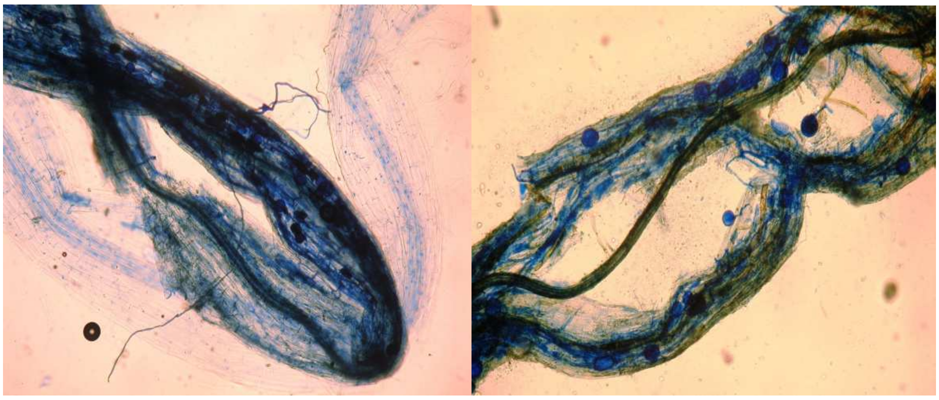


Figure 3. AMF propagules in root (clamidosporas, vesiculas, Internal-external hyphae)

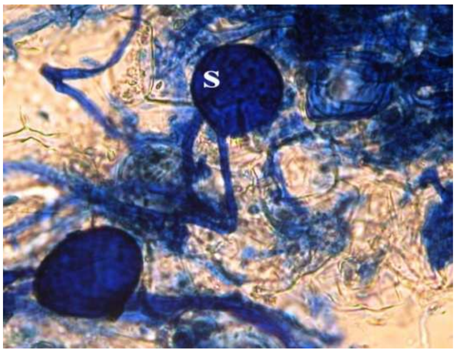


Figure 4. Clamidosporas in root (s)

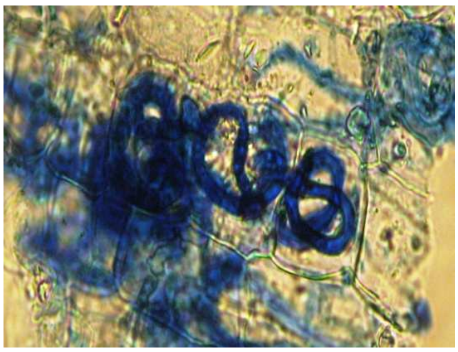


Figure 5. Intracellular coils

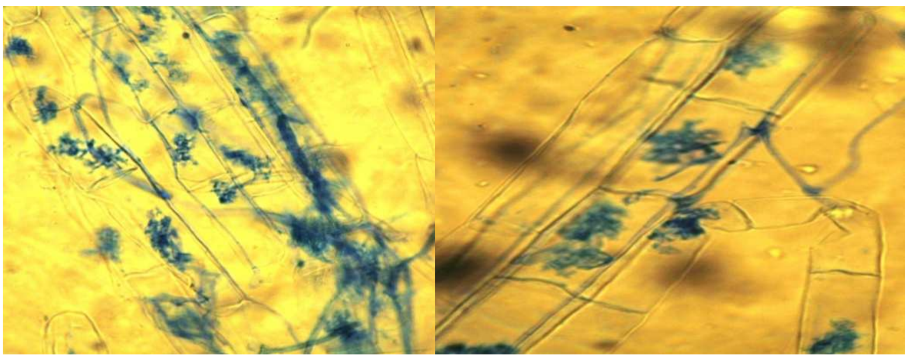


Figure 6. Arbuscul existences in cortical cells

At the end of the surveys in study area. *Danthonia decumbens* was the most intensive species with its colonization percentage of 41.38% and *Hordeum violaceum* was the least intensive species with its colonization percentage of 7.14% (average %17.86). *Bromus hordeceus, Gaudiniopsis macra subsp. macra, Briza media* and *Avena fatua* were non AMF. AMF genera were also identified by classical methods using identification keys. AMF propagules (internal-external hyphae, vesicul, arbuscul, spore) were observed by microscope for AMF genus identification. As result of identification, *Glomus* genus was determined as fungal symbiont in all root samples.

Vegetation analysis

A total number of 98 plant taxons belonging to 31 different families were recorded in the study (22 grasses, 10 legumes, 66 other plant families). Canopy coverage was 98.56% in Uluyayla district. Canopy covarege for grasses was 37.88%, for legumes 19.71%, for other plant families 40.96% and for open space 1.44%. Botanic composition for grasses was 38.44%, for legumes 20.02%, for other plant families 41.53%.

Physical and chemical properties of soils

Soil samples were taken from a depth of 0-10 cm of plant rhizosphere. A total number of 50 soil samples were taken and analysed in the study area. Data presented in Table 2 showed that soil of Uluyayla district is sandy loam, clay loam, loam sandy, sandy-clay loam and loam clay with sand values ranged from 32.43% to 78.23% (average 58.42%), clay values ranged from 4.84% to 31.47% (average 17.73%), silt values ranged from 14.82% to 37.68% (average 23.85%), bulk density values ranged from 0.48 g cm^{-3} to 1.1 g cm^{-3} (average 0.77 g cm^{-3}), partical density values ranged from 2.21 g cm^{-3} to 2.93 g cm^{-3} (average 2.59 g cm^{-3}), pore space values ranged from 57.99% to 81.16% (average 70.36%), actual pH values ranged from 5.11 to 6.38 (average 5.45), organic carbon values ranged from 3.06% to 7.50% (average 3.88%), electrical conductivity values ranged from 0.06 dS m^{-1} to 0.36 dS m^{-1} (average 0.20 dS m^{-1}), lime content values ranged from 0% to 2%, soil aggregate stability values ranged from 82.32% to 95.90% (average 93.67%) and total nitrogen values ranged from 0.33% to 0.96% (average % 0.76).

Table 2. Physical and chemical properties of soils

	BD (g cm^{-3})	PD (g cm^{-3})	PS (%)	Sand (%)	Silt (%)	Clay (%)	pH (H_2O)	EC (dS m^{-1})	$CaCO_3$ (%)	SAS (%)	TN (%)	$C_{Org.}$ (%)
Min.	0.48	2.21	57.99	32.43	14.82	4.84	5.11	0.06	0.16	82.32	0.33	3.06
Max.	1.10	2.93	81.16	78.23	37.68	31.47	6.38	0.36	0.57	95.90	0.96	7.50
Avrg.	0.77	2.59	70.36	58.42	23.85	17.73	5.45	0.20	0.34	93.67	0.76	5.88

BD: Bulk density (g cm^{-3}) PD: Partical density (g cm^{-3}) PS: Pore space (%) EC:Electrical conductivity (dS m^{-1}) Corg: Organic carbon (%) TN : Total Nitrogen (%) SAS = Soil aggregate stability (%) Min.: Minimum Max.: Maximum Avrg.: Average

Statistical analysis

Within site, soil's physical and chemical data, botanic composition and AM fungi colonization values were analysed to determine whether relationship among them using Pearson correlation analysis and SPSS 16.0. As a result of analysis, a negative relationship was found only between botanic composition of legumes and AMF colonization (α=0.025).

DISCUSSION

The mycorrhizal status of *Gramineae* family plants of Uluyayla district of Bartın province is reported for first time in this study. It is found that arbuscular mycorrhizas are present in study area. AMF was determined that

64% plants colonized by variable range (7.4%-41.38%) of arbuscular-mycorhizal fungi and established symbiotic relationship. *Danthonia decumbens* was the most intensively found species with its 41.38% percentage colonization and *Hordeum violaceum* was the least intensive species with its 7.14% percentage colonization (average %17.86). Least intensive colonization percentage in *Hordeum violaceum* was also noted with same plant (%1.21 percentage colonization) by Demir et al. (2008). However, some plant taxons weren't colonized, these taxons are *Bromus hordeceus, Gaudiniopsis macra subsp. macra, Briza media* and *Avena fatua.*

AMF genera were identified by classical methods using identification keys. AMF propagules (internal-external hyphae, vesicul, arbuscul, spore) were observed by microscope for AMF genus identification (Walker and Trappe, 1993). As result of identification, *Glomus* genus was determined as fungal symbiont all of root samples. Demir et al. (2007) identified *G. intraradices* and *G. mosseae* from plant roots from *Gramineae* family by Nested PCR method in Van province in Turkey. Schenck and Smith (1982) and Morton and Bentivenga (1994) emphasized that *Glomus* species are the most pervasive genus (especially *G. mosseae*, *G. intraradices* and *G. occultum*) of AMF all around the world.

As a result of statistical analysis a negative relationship was only found between botanic composition of legumes and AMF colonization (α=0.025). There was no significant relationship between soil properties and AMF colonization. This may be caused by similarity in soil properties. It is tought that, if similar study is done in different study areas (with different soil properties), significant relationship may be found among soil properties and AMF colonization. Escudero and Mendoza (2005) emphasized that to difficult to separate the influences of host plant species and soil charecteristics on spore density or any other measure of AM fungi. However, it was emphasized that host plant factors are more important than soil factors (Koomen et al. 1987; Mendoza et al. 2002).

Today arbuscular mycorrhizal inoculation must use in range rehabilitation. However, information on the AMF potential is still lacking rangeland in Turkey. Therefore, this study may provide fundemental information on range rehabilitation studies in degraded rangeland ecosystems of Western Black Sea or other regions. Also, this study were contributed to map of AMF in Bartın.

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SOME IMPORTANT SHOOT AND STEM FUNGI IN PINE (*Pinus* spp.) AND FIRS (*Abies* sp.) IN WESTERN BLACKSEA REGION, TURKEY

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ABSTRACT

This study was carried out to determine fungal diseases of pines and firs observed on the shoots and the stems in the Western Blacksea Region (Karabük, Ulus and Bartın State Forest Enterprises) between the years of 2001–2004. Five different fungi were determined on pines (*Pinus* sp.) and firs (*Abies* sp.) by this study. *Melampsora pinitorqua* and *Cronartium flaccidum* which cause rust diseases were determined only on pines. *Sphaeropsis sapinea* and *Gremmeniella abietina* were determined on pines and firs, while *Sirococcus strobilinus* was only found on firs. In this study, description of the disease agents, their symptoms, damages and distribution of the diseases are presented.

Keywords: Shoot, stem, fungi, pine, fire, western blacksea,

INTRODUCTION

Besides being raw material, wood is one of the most important materials which human race needs, since its sustainable characteristic is very important. Additionally, trees and forests which are sources of wood are valuable wealths for recreation. But shoot and stem fungi have great impact on trees growth like other diseases and pests, therefore valuable and effective output of wood decreased.

Vural and Tunçtaner (1971) determinated that *Melampsora pinitorqua* caused different deformations on 2–5 years age pine shoots.

Nicholls and Robinson (1984) reported that *Sirococcus strobilinus* affected conifers in the Nothen United States and Southern Canada, and the fungus infected the new shoots; diseased seedlings and saplings were especially affected.

Vural et. al. (1985) fist time identified *Cronartium flaccidum* on pines in Turkey in 1969. The fungus caused drying, degeneration and death of saplings.

Peterson and Johson (1986) determinated that *Sphaeropsis sapinea* was a caker causing fungus killing new shoots, and causing sever infections that may lead to death of trees in all sizes.

Haugen (1997) said that *Gremmeniella abietina* was the most often observed in red and jack pine plantations in Michigan and Northen Wisconsin. According to Haugen there were two recognized strains of fungi. The North American strain usually causes damage primarily below six feet above ground. The European strain can cause damage throughout the crown of tree, and thus has the potential to be much more damaging.

Özkazanç (2007) observed that *Melampsora pinitorqua* was more dangerous for 1–10 yers old pines.

The study aims at describing the disease agents, their symptoms, damages and distribution of the diseases.

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Introduction of The Fungus Species Identified

Five different fungi species causing disease on the shoots and stems of the pines and firs were identified by field and laboratory studies.

Melampsora pinitorqua Rostr.; At first it appears with aecidiums that can be seen among the pine shoots' barks turning into yellow (Butin, 1995). spiring yellow blotchs of 3 cm height occur on the pine shoots. The fungus is diagnosed with orange-coloured urediums in poplar leaves and at the end of the growth period brown teliums appearing on the same poplar leaves in alternative host *Populus termula* (Apsen). The fungus causes C and S shaped twists on pine shoots (Hansen and Lewis 1997). The damage on poplars is limited by the decreased chlorophyll assimilation (Fig. 1) (Vural and Tunçtaner 1971, Özkazanç 2007).

Cronartium flaccidum (Alb. Ve Schw.) Winter; First appearing symptoms are pink coloured aecidiums, which have orange coloured aecidiospores, on pine shoots and stem (Vural at. al.1985; Hansen and Lewis 1997). Infections of pine and developing of aecidiums continue 3-4 years or more (Cummis and Hiratsuka 1983). Aecidiums of the fungus were determined as pink coloured, pyramidal shaped and of 2-3 mm height in area of the study. Aecidiospores are yelow-orange coloured, elipsoidal or oval shape. The fungus caused dieback, crown to die, hypertroppies, open injuries and exudation of resin on pine shoots and stem (Fig. 2) (Vural et. al. 1985; Butin, 1995; Hansen and Lewis 1997).

Sphaeropsis sapinea (Fr.) Dylco&Juston; After the first symptomps that are sprout blight, shoots can't grow and their colors turn to yellow-brown and dwarf, needles turn to brown. Needles on the infected shoots change colour before budding. Exudation of resin occurs on infected shoots (Peterson and Johnson, 1986; Tisserat 2003). Dead grey-yellow-brown needles and twisted shoot sprouts, dwarfing and drying occur because of shoot infections (Hansen and Lewis 1997). While pcynidiums in fir needles, are oval shape and appear at the bottom surface of fir needles, They are long-spindle shaped and appear on the whole surface of pine needles. Conidiums are elipsoidal and 1 or 2 celled. The fungus causes cancer injuries on shoots and stem (Fig. 3)

Gremmeniella abietina (Largerberg) Morelet; ; The disease have strarted by drying of needles from bottom to top and after needles have casted, green spots have been seen under the barks of shoot (Haugen, 1997). The fungus has two different races of Europe and North America (Hansen and Lewis, 1997; Haugen, 1997). It causes death of seedlings and saplings, losses of growth, cancer of stem, death of crown, deformations and losses of wood quality (Sinclair at. al. 1996). The top parts of the apotheciums on top side of fir needles are bored and blistered shaped at the beginning stages. Apothecium dehiscences like a goblet in future periods. The fungus causes drying and diebacks of shoots (Fig. 4).

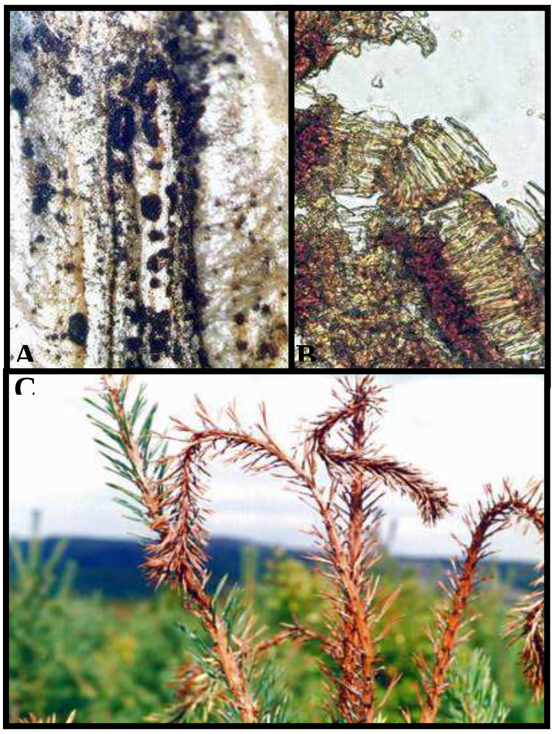

Figure 1. *Melampsora pinitorqua* A) Aecidiums on pine sooht B) Teliums in poplar leave (x10) C) Damage on pine shoots.

Figure 2. *Cronartium* flaccidum A) Aecidium on pine shoot B) Aecidiospores (x20) C) Damage on pine shoots and stem

Figure 3. *Sphaeropsis sapinea* A) Pycnidiums un fir needles B) Pycnidiums un pine needles C) Conidiums (X 20) D) Damage on pine

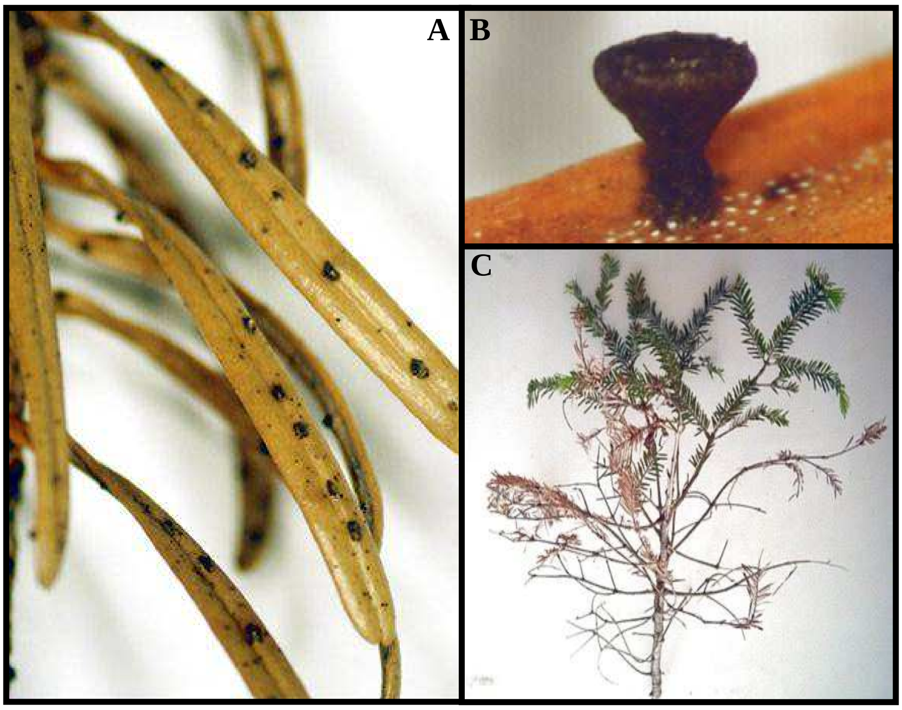

Figure 4. *Gremmeniella abietina* A) Apothecium of fir needles B) Mature apothecium (x7,5) C) Damage on fir

Sirococcus strobilinus (Preuss); The fungus causes exudation of resin, brown base of needles, chlorosis, twisted and dead shoots. Diebacks occur on shoots, cancer occurs on last year's shoots and the sprout parts of the shoots twist as cane (Nicholls ve Robinson, 1984; Butin, 1995). Pcynidiums which are of 0,5–1 mm diameter and blister shape occure on fir needles. The fungus causes twisted and dead shoots in area of the study (Fig. 5).

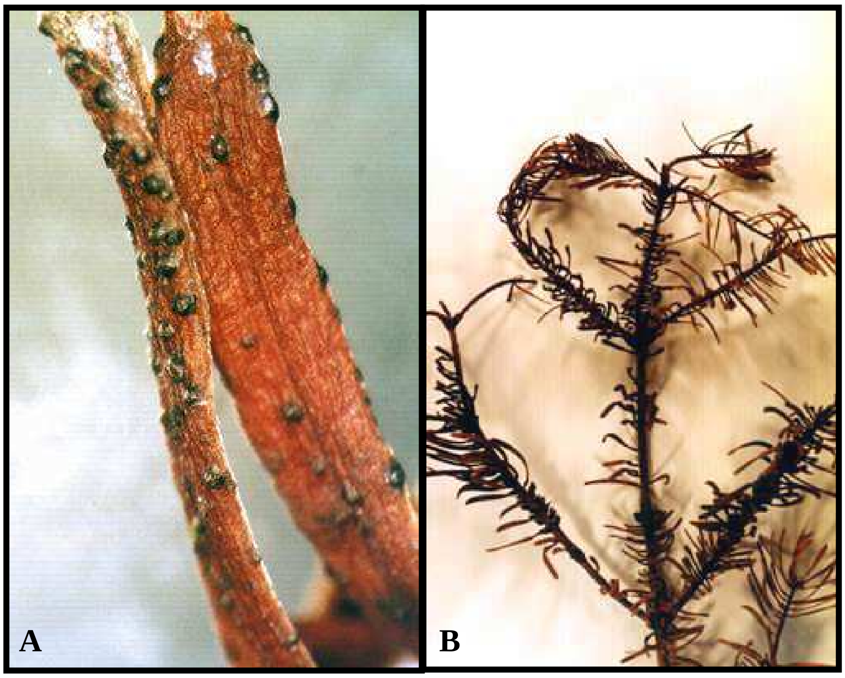

Figure 5. *Sirococcus strobilinus* A) Pycnidiums on fir needles B) Damage on fir

MATERIAL AND METHOD

Two different methods, field and laboratory studies were applied. The shoot, branch, needle and stem sections were collected from trees on which probable disease symptoms were observed through field studies. Specimens collected from land were classified in the laboratory and then preparats were prepared with curettage and section methods from parts of disease symptoms. The identification of the species was done by these preparats and land specimens were analysed by light and stereo microscope. To attain these aims in laboratory, Nikon ZMU stereo microscope and Nikon Ecllipse E 400 light microscope were used to indentify fungi existing on shoot and stem of pines and firs. The preparats were prepared with water or safffron gelatine and then were analysed by x10, x20 and x40 focused. Butin (1995), Cummis and Hiratsuka (1983), Hansen and Lewis (1997) and Sinclair et. al (1996) are some of who which used it for identifying the fungi.

RESULTS AND DISCUSSION

Pinus sylvestris L. (Scote pine), *Pinus nigra* Arnold (Austrian pine), *Pinus brutia* (Ten.) (Red pine), *Pinus pinea* L. (Stone pine), *Pinus pinaster* Ait. (Maritime pine), *Abies nordmanniana* supsp. *bornmülleriana* Mattf. (Caucasian fir) are the species have been observed in area of the study (Yaltırık, 1993).

The general imformation about determinated fungi by field and laboratory studies have been given at the Table 1.

Table 1. Identified fungi on pines and firs

Species	Host	Place	First Determination	Density
Melampsora pinitorqua	*Pinus sylvestris*	Karabük S.F.E. Dikmen F.S.H. number of 269,270,271 Forest division	1995	xxx
Cronartium flaccidum	*Pinus brutia*	Karabük S.F.E. Dikmen F.S.H. Kaplan plantation	02.05.2003	xx
Sphaeropsis sapinea	*Abies bornmülleriana* *Pinus sylvestris* *Pinus nigra*	Karabük S.F.E. Dikmen F.S.H. number of 269,270,271 Forest division	02.05.2003	xx
	Pinus brutia	Karabük S.F.E. Dikmen F.S.H. Kaplan plantation	09.04.2004	xx
Gremmeniella abietina	*Abies bornmülleriana* *Pinus sylvestris*	Ulus S.F.E. Uluyayla F.E.C. Location of Ahmet Usta	02.03.2003	xx
	Pinus nigra	Bartın F.E. Arıt F.S.H. Location of Cücübaşı	21.05.2004	x
Sirococcus strobilinus	*Abies bornmülleriana*	Ulus S.F.E. Merkez F.S.H Location of Güney Ören	18.10.2002	x

F.E.: State Forest Enterpris, F.E.C.: Forest Subdistric Headquarters xxx: hight xx: midium, x: low

Melampsora pinitorqua on *Pinus sylvestris, Cronartium flaccidum* on *Pinus brutia*, *Sphaeropsis sapinea* on *Abies bornmülleriana, Pinus sylvestis, Pinus nigra, P. brutia, Gremmeniella abietina* on *Abies bornmülleriana, Pinus sylvestris, Pinus nigra* and *Sirococcus strobilinus* on *Abies bornmülleriana* were identified as a result of the investigations.

Sphaeropsis sapinea, Gremmeniella abietina and *Sirococcus strobilinus* are known the first records up to date in Turkey.

Melampsora pinitorqua, Cronartium flaccidum, Sphaeropsis sapinea were found in Karabük Forest Enterpris, *Gremmeniella abietina* was found in Ulus ve Bartın State Forest Enterprises, and *Sirococcus strobilinus* was identified in Ulus State Forest Enterpris.

Considering damage severity and distribution, *Melampsora pinitorqua* has been observed more intensively than the other fungus species in area of the study. However *Sirococcus strobilinus* was the species that appears the least and damage of which is the lowest. While damage of *Melampsora pinitorqua* has occurred on only shoots, damages of other fungi occur on needles, shoots and stem. Finally, *Melampsora pinitorqua* on 1-10 years old pines, *Cronartium flaccidum* more than 5 years old pines, *Sphaeropsis sapinea* and *Gremmeniella abietina* on stake age young pines and firs and *Sirococcus strobilinus* on mature firs have caused diseases in area of the study.

The following precautions can be applied for preventing to damage and distrubition of these fungi.

- Infected saplings should not be in new plantations,
- The plantations must be established by native tree species,
- Alternative hosts of diseases can be eradicated in field,
- Dead and infected trees and pruning residues must be moved from area,

- Sanitation can be done to reduce the level of diseases available to infect new plantings on or adjacent to a site,
- Tree species which are resistant to diseases can be used for plantations,
- Effective fungicide programs must be developed for nurseries and plantations.

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MODELING OF VILLAGE CHARACTER USING LANDSCAPE CHARACTER ANALYSIS APROACH

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ABSTRACT

Landscape character analysis that has added to agenda of Turkey with European Landscape Convention in 2003 has important role determining interaction between protected areas and rural settlement areas. Despite protected area and rural settlement areas have affected as the social, economic and cultural aspects of each other, they have affected as spatial one another. In this study, the spatial interaction between the protected area and rural settlements is intended to identify with.landscape character analysis approach

In this study, context of landscape character analysis perspective, land survey and literature studies have been realized. Obtained data have been evaluated being used mapping and modeling programs (like Geographic Information System, AutoCAD, NetCAD, 3Dmax, Global Mapper, Lumion). As a result of modeling and analysis, settlement type analysis, interactions analysis between land use and forest area, landscape diversity analysis and population analysis, landscape character of villages which are on the periphery of Bartın-Kastamonu Küre Mountains National Park have been identified. Effect of identified landscape character type on natural area has been guestioned in the context of the landscape fragmentation.

Keywords: Landscape Character, Village Character, Bartın-Kastamonu Küre Mountains National Park, Kapısuyu Basin

1. Introduction

Landscape Character Assessment is a well-established tool for systematically, identifying, classifying and describing the landscape recognising it as a continuous system that does not adhere to administrative boundaries. By identifying, features and elements of the landscape (and their combination and expression), the essence or special character of a particular place can be revealed, explored and understood (Anonymous, 2007). Due to properties of landscape character analysis, landscape planning will be integrated to social and economic planning.

Importans effects of rural settlements areas on natural areas is landscape fragmentation. The rural feauture in Turkey has a quite complex structure with its socio-economic and cultural characteristics, therefore the outcoming of these identify current problems and setting goals for solution both in politics and in progress of these rural areas have a great importance. The unique feautures of these rural areas (to be away from urbanization, messy settlement, physical conditions) lead to many problems and prevent these areas to prosgress in terms of socio-economic way (Keleş, 2006a; Keleş 2006b).

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The legislation that the villages in Turkey are bound to is the Village Act (LAW NO. 442) issued on March 18th, 1924. According to this act, the village was defined as “a local government whose population does not more than 2000 and also has movable or immovable properties and takes decisions with its units about given duties, based on the Village Act. As the proposals related to spatial layout of these villages have not been applied by this law, there have been many problems about spatial layouts.

One of the most common problems in many developing countries and Turkey is chaotic spatial dispersions in numerical and functional terms of cities, towns and villages that make up the settlement system (Marin, 2010). The rural settlements are known to be dispersed in a large number and a wide range within the settlement system in Turkey (Marin, 2010). State Planning Organization (2000) states that there are a total of 75 631 rural settlements (35 014 villages and 40 617 units bound to these villages) in 2000.

Villages in Turkey have been classified according to their relationship with their spatial layout and the natural resource values. Classification that is done according to its spatial order are paid attention by considering Villages’ collective, dispersed or less dispersed settlements. As for the relationship between villages and natural resource values is a classification that is done according to their proximity to the forest areas. In this classification villages are regarded as off-forest, in-forest and edge-forest. Türkdoğan (2006) has classified the villages and defined each class number in Turkey according to their distribution and relationship with forests. (**Tab. 1** and **Tab. 2**)

The high rate of units in rural settlements and the presence of low-population and dispersed units (Marin 2010) leads landscape fragmentation and habitat loss as well as economic and social problems. One of the significant rural settlements that leads landscape and habitat fragmentation is in-forest and edge-forest villages. These villages constitute the poorest part of the rural areas. These villages take form according to their physical conditionals and natural environment and their unique way of life. The diffrences can be observed among the regions, even in the same region or from one village to another, in rich culture of Anatolia in Turkey. The settlements are shaped by the topographic structure, cultural and physical environmental conditions they take place (Eminağaoğlu and Çevik 2007). The villages that are shaped and got identity within principles of exprerienced construction and layout in generally, (Eminağaoğlu and Çevik 2007) are in interaction with surrounding forest areas, cultivated areas, roads and landscape around them.

Table 1Spatial arrangement of villages in Turkey

Type of Village	Number of village	Population
Cumulative village	25.453 (71.9%)	13.160.279
Sparse village	5.467 (5.5%)	3.339.917
Less sparse	4. 192 (11. 8%)	2.189.975

Table 2 Proximity of village to forest

Position	Number of village	Population
Off-forest	19.746 (55.8%)	11.118.111
In-forest	5.093 (14.4%)	2.355.067
Edge-forest	7.225 (20.4%)	3.828.227

Landscape character analysis is essential for planning of rural area and protected areas. As Turkey joined European Landscape Convention in 2003, landscape character analysis has become important to national planning laws and regulations. Therefore mapping and modeling instruments get more important for defining, monitoring and protecting landscape characteristics.

In this study, which based on the basis of the requirements of the European Landscape Convention’s biological diversity conservation, landscape management and landscape determination, the identity of villages, their effects over the forests and protected areas they are in or on the edge of are discussed within landscape character analysis technique. In this study it is thought that the classification defined as landscape character analysis in village-scale will be useful for rural development, rural landscape planning, forest management, landscape management and nature conservation policies and strategies.

2. Material and Method

Kastamonu-Bartın Küre Mountains National Park covering an area of 37.000 hectares is one of these nine hot spots. Ministry of Forest launched a project in 1998 titled “Management of National Parks and Preserved Areas: Conservation of Bio-diversity and Rural Development” with the financial support of UNDP (United Nations Development Program) and FAO (Food and Agriculture Organization). Thanks to the “Küre Mountains Draft Development Plan” prepared within the framework of the project, a “planning zone” around the national park was planned aiming at reducing the threats caused by the immediate surrounding so as to secure “Kastamonu-Bartın Küre Mountains National Park” covering an area of 37.000 hectares and biodiversity within the national park, for the first time in Turkey (National park conservation zone is 37.000 ha and planning zone is 80.000 ha, total area is 117.000 ha). The core area (national park) is delineated by a range of cliffs and canyons that include pristine and semi pristine natural mixed deciduous and coniferous forest. The global significance of the Küre Mountains’ biodiversity has been highlighted by its inclusion in the WWF’s list of European forest hotspots for conservation. The site is considered to represent the best remaining example of deciduous and and coniferous forest. The global significance of the Küre Mountains’ biodiversity has been highlighted by its inclusion in the WWF’s list of European forest hotspots for conservation. The site is considered to represent the best remaining example of deciduous and coniferous forest of the North Anatolia ecoregion as well as being the best remaining example of the highly endangered karstic mountain areas of the ‘Black Sea Humid Forests’ ecotype (WWF, 2001). The Küre mountains hosts 40 out of the 132 mammals in Turkey, including large mammal species, such as gray wolf, brown bear, Eurasian lynx, red deer, roe deer and wild boar. The park and its buffer zone have been identified as one of the 122 Important Plant Areas (IPA), and also one of the 305 Key Biodiversity Areas (KBA) in Turkey (Anonymous, 1999; WWF, 2001; UNDP, 2008; Bann 2010).

Kastamonu-Bartın Küre Mountains National Park (KMNP) consists of two zone: KMNP Conservation Zone and KMNP Planning Zone. KMNP Conservation Zone that doesnt include settlements and agricultural areas have protection statue”and has been admitted “natural area”. Rural areas that includes settlement and agricultural areas in KMNP Planning Zone doesnt have “protection statue”. Study area, Kapısuyu Basin, is composed of KMNP Conservation Zone and KMNP Planning Zone. Forests in Kapısuyu basin divide to two groups: production forests and natural forests. Because of these different features, transistion has been occured between natural and cultural landscapes in Kapısuyu basin.

Study has been realized in 13 villages which are forest village according to numbered 6831 Turkey Forest Law (Fig.1).

2.1 Obtaining land cover/Land use map

The data bases of working field (Rapideye satellite images, present layouts of village, Forest Management Plans, Land Use Map, Digital Elevation layouts) have been digitized by Remote Sensing (RS) and Geographic Information Systems (GIS) techniques. ERDAS 8.7 software has been utilised for the classification of Raster data (satellite imagery) and ArcGIS 9.2 software has been used for the vector data digitizing and analysis. The accuracy control of spatial data obtained from RS and GIS has been provided with GPS (The Global Positioning System) based on the projection of coordinates of with UTM (Universal Transverse Mercator) WGS84 (World Geodetic System) in the field.

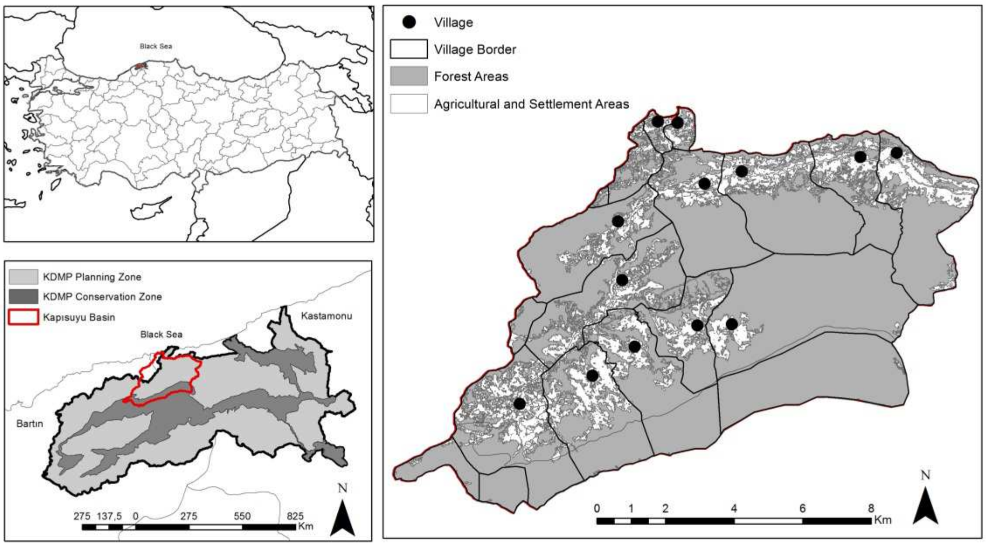

Fig.1 Location of study area

2.2 Identifying village landscape character variables

To determine the type of landscape character of each village a series of following analyses have been carried out: The settlement pattern analysis, analysis of interaction land use and forest areas, analysis of landscape diversity, population analysis (Fig. 2).

The settlement pattern analysis: Villages have been classified according to topographic position (Geray, 1985; Kurtkan Bilgiseven, 1988; Roberts, 2003; Türkdoğan, 2006), land arrengement (Kurtkan Bilgiseven, 1988; Türkdoğan, 2006; Roberts, 2003; Görmüş, 2012) and settlement patterns (Roberts, 2003; Görmüş 2012) (Tab. 3).

Analysis of the interaction land use and Forest areas: Land use map and patches and the edge density of these patches on the land cover have been determined by using landscape metrics (McGarigal, 2002). Weighted average of all values has been calculated. The forest-agricultural land interaction of the villages of which edge intensity is over the average value have been considered as negative; and those of which edge intensity is below the average value have been considered as positive (Tab. 3).

Analysis of landscape diversity: After borders of the villages have been assigned to the of land use and land cover maps, landscape diversity in each village has been obtained by the number of stains and Shannon Diversity Index (SDI) (McGarigal, 2002) calculations. Weighted average of values of all the villages have been calculated. The landscape diversity of he villages of which SDI value is over the average value have been considered as high; and those of which SDI value is below the average value have been considered as low (Table 3).

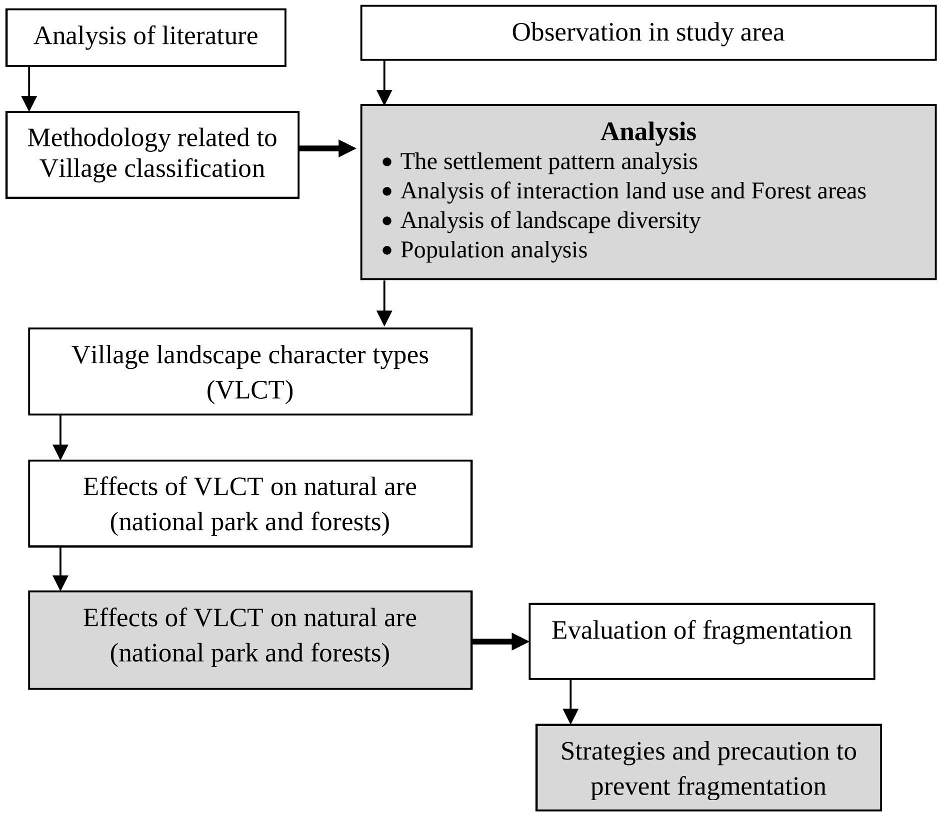

Fig. 2 A flowchart describing the process of identify of village landscape character

Population analysis: Main variables of the migration rate, the necessity of village-organization and the size of the village have been used in this analysis (Tab. 3).

Immigration rate: Migration rate has been determined according to the censuses between the years 1960-2010.

Necessity of local village-organization unit (According to the latest census): The necessity of village-organization is based on population data in the Village Act. According to the act, to establish and organization in a village, the population should not be less than 150 and more than 2,000.

Size of village: Village classification for Kapısuyu Basin has been expressed in line with classification method developed by Mitkovic et al. (2002) which is based on current population data. According to this classification, villages separate as very small villages (population: 0-100), small villages (population: 100-500), medium-sized villages (population: 500-2000) and the large village settlements (population greater than 2000).

Tab 3 Desription of the analysis of village landscape character

The Settlement pattern analysis	**Variables**	**Source**
Topographic position	Plain village (Pl)	Geray 1985, Kurtkan Bilgiseven, 1988; Türkdoğan, 2006; Roberts, 2003; Görmüş, 2012
	Valley foot village (Vf)	
	Valley slope village(Vs)	
	Mountain village(Mo)	
	Mountain slope village(Ms)	
Land arrangement	Nucleition village(N)	Türkdoğan, 2006; Roberts,2003; Görmüş, 2012
	Dispersion/scattered village(D)	
	Line village(L)	
Settlement patterns	Random (Rm)	Türkdoğan, 2006; Roberts, 2003; Görmüş, 2012
	Regular(Rr)	
	Clustered(Cd)	
	Mixed (linear random (Lr), clustered random (Cr), clustered (Cl) lineer)	
Analysis of interaction land use and Forest areas Using landscape metrics: Edge Density Patch Area,	Villages that have low pressure on forest areas (F+) Villages that have high pressure on forest areas (F-)	Görmüş, 2012
Landscape diversity analysis Using landscape metrics: Patch Number in village Landscape Richness in village Shannon Diversity Index in village	Villages that have low landscape diversity (Ld+) Villages that have high landscape diversity (Ld-)	Görmüş, 2012
Population Analysis Immigration rate	Immigration rate (1960-2010) Villages with a pozitive immigration rate (I+) Villages with a negative immigration rate (I-)	Görmüş, 2012
Necessary of local village goverment unit (Accordingin to lastest cencus)	Villages that can be established local village goverment unit (G+) Villages that can not be established local village goverment unit (G-)	Turkey Village Act (law no. 442); Görmüş, 2012
Size of village (Accordingin to lastest cencus)	Small village (Sv) Medium village(Mv Large village(Lv)	Mitkovic et al.,2002; Görmüş, 2012

2.3 Calculating and visualizing variables

By using mapping and modeling programs (like Geographic Information System, AutoCAD, NetCAD, 3Dmax, Global Mapper, Lumion) landscape character of villages which are on the periphery of Bartın-Kastamonu Küre Mountains National Park, is identified. Using cadastral, slope, elevation, topographic maps and social-cultural maps are realized analysis. Landscape character variables have been quantified and visualized by means of the programs mentioned below (Tab. 3, Fig. 3).

Tab. 3 variables and programs

Analysis		**The program used**
Settlement Analysis		Arc view/ Surface Analysis, Global Mapper Cadastral Data / AutoCAD/Netcad/3D Max
Analysis of interaction land use and Forest areas		Arc view/ Patch Analysis
Analysis of landscape diversity		Arc view/ Patch Analysis
Population analysis	Legal statistical data/ SPSS	

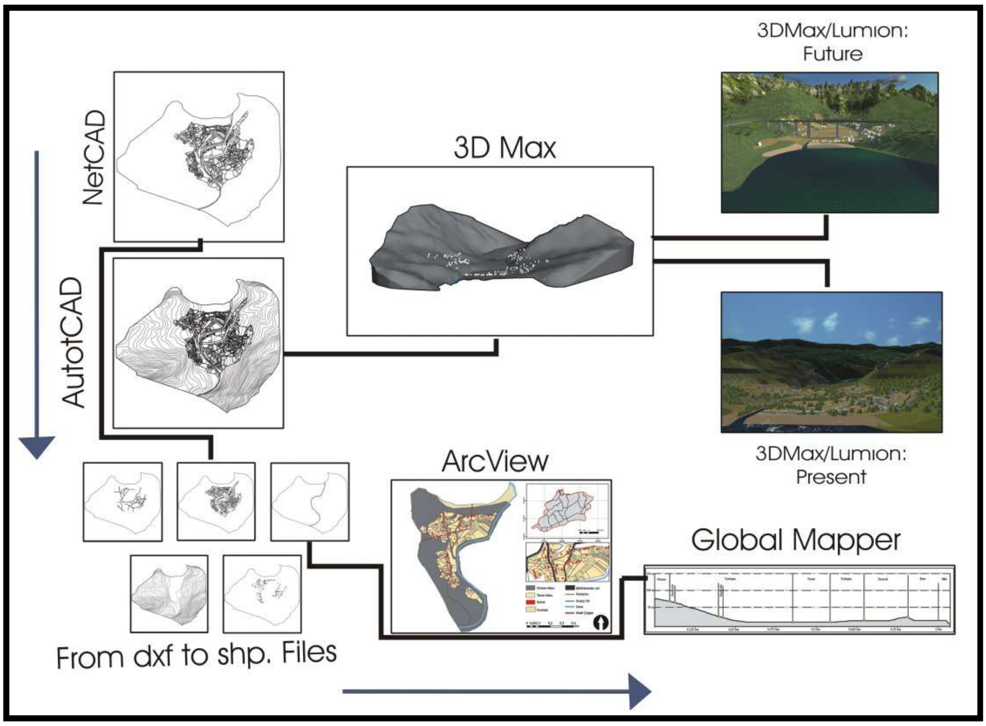

Fig. 3 Process of digital data

3. Results

Obtained data from analysis are classified in order to present landscape character of villages. To determine the type of landscape character of each village a series of following analyses have been carried out: the settlement pattern analysis, the interaction land use with forest areas analysis, analysis of landscape diversity and population analysis.

As a result of these analyzes, landscape character types that primarily cause fragmentation of the landscape have been obtained. Obtained some of village landscape character types are as follows:

•**Vf_ N_Cr_F$^-$_Ld$^+$_I$^+$_G$^+$Mv** (Başköy): Nucleation at the foot of valley, clustered in random order, highly repressive to the forest area, high landscape diversity, the sum of migration rate is positive, medium-sized village settlement (Fig. 4).

•**Ms_N_Cr_ F$^-$_Ld$^-$_I$^-$_G $^+$Sv** (Kaleköy): In a mountain slope, nucleation, random clustered, highly repressive to the forest area, low landscape diversity, the sum of migration rate is negative, a small village settlement where a local village goverment unit can be established (Fig. 4).

Vs_D_Lr_F$^-$_Ld$^-$_I$^-$_G$^-$SV (Nanepınarı): Scattered in the valley slope, linear random, highly repressive to the forest area, low landscape diversity, the sum of migration rate is negative, a very small village settlement where a local village goverment unit cannot be established (Fig. 4)

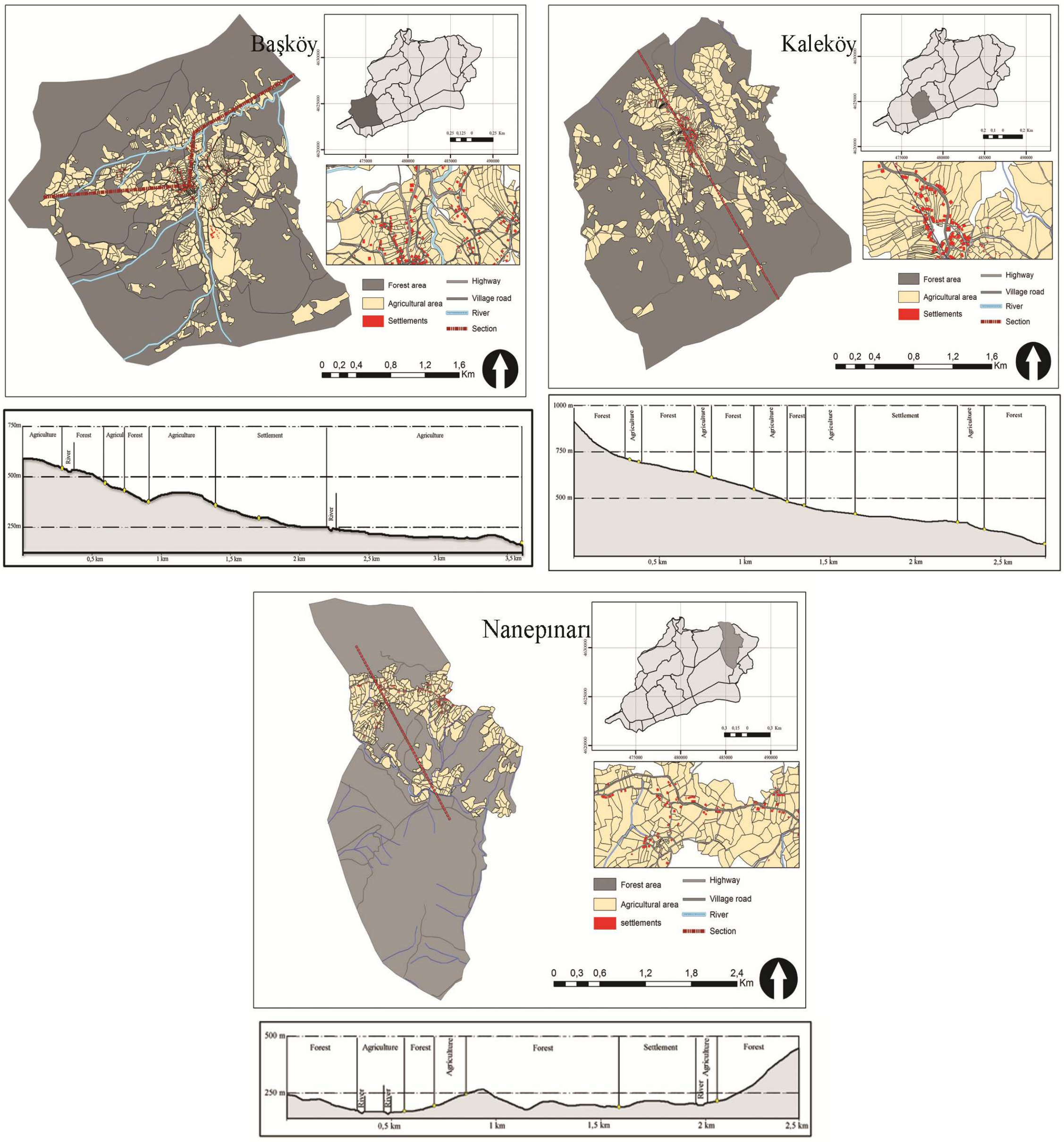

Fig. 4: Village maps

4. Conclusion

Landscape fragmentation affects biodiversity in spatial and temporal scales. The decrease of landscape types and species causes an increase in the rate of fragmentation in landscape. As increase of patchiness and decrease of connectivity restrict the movement of populations (Shukla, 2002). Landscape fragmentation affects the pattern-process relationship. By splitting large stains in the landscape into small ones, fragmentation leads to loss of original habitat, reduction of habitat stains and increase of isolation between habitat stains (Botequılha Leıtão and Ahern 2002).

That agricultural land parcels are irregular in shape and position may lead to an increase in edge habitat types. However, this causes a decrease in biodiversity. According to Odum and Barrett (2008), species richness between two different land cover is defined as the edge effect. Special arrangements have been advised in order to increase the number of species between the field and forest. As it causes reduction in species diversity, precise boundary or sudden and sharp edge between the two habitats is not desirable. On the other hand, more irregular edges means reduction of biological diversity.

There are direct and inverse proportions among landscape diversity of villages, migration rate and land use with its interaction with forest area. When these variables are compared to analysis of the settlement pattern, the following conclusions are reached.

The concept of diversity of landscape does not only include natural landscape features but also includes cultural landscape elements. For this reason, "landscape diversity" concept includes both positive and negative effects. While landscape diversity is high in the villages that are at slope of the valley, that of villages at the foot of the mountain is low. There is not a significant difference between landscape diversity and forest areas interaction in the villages that have "cluster-randomized" and "linear-randomized" layout. Landscape diversity of the villages of which field order is "line" type is higher and their negative impact to the forest areas is lower. "Messy" nature of villages’ landscape diversity is low but their impact to the forest area is the least.

In this study, the most important criterion that determines villages’ impact to the forest area and landscape diversity has been found to be location. Location of land and housing layout take shape according to topographic scheme. For this reason, the location of villages around the national park and their negative effects arising from the location should be especially evaluated.

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USING OPTIMIZATION TECHNIQUES IN DESIGNING FOREST ROADS AND ROAD NETWORKS

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ABSTRACT

There has been an increasing interest in using modern optimization techniques in forest road design due to advancements in computer hardware, optimization algorithms, and remote sensing technologies. These techniques allow one to automate many of the time consuming tasks involved in road design process and improve the efficiency of road design managers in identifying road alignment alternatives. This paper presents the main road design stages to indicate the possibilities of using optimization techniques in forest road design and provides background information on many of the optimization techniques used in road design and road network management problems. The current advances in forest road design and network optimization procedures are presented and recommendations are suggested for future studies.
Key words: Road engineering, forest road design, optimum route selection, road cost

1. Introduction

Forest roads provide access for timber harvests, recreation, fire protection, and other administrative needs (Weintraub *et al* 2000a). Designing forest roads and road networks is a complex engineering problem involving social, economic, and environmental considerations. Route location is critical in steep terrain, where ground slope, geology, and machine limitations (e.g., maximum road grade, minimum turning radius) affect road layout and design. On relatively flat terrain, soil properties and quality of the substratum may also influence the road location and seasonal road strength (O'Mahony *et al* 2000). Due to the inherent trade-offs involved, decisions regarding road building, maintenance, or decommissioning are very complex (Lugo and Gucinski 2000). Road managers often aim for the best path with the lowest total cost, while protecting soil and water resources. Therefore, they have to examine a sufficient number of alternatives to ensure that road networks are cost effective with minimum environmental damage.

Planning of road location and construction is an integral part of harvest planning. Barreto *et al* (1998) compared the economics of planned and unplanned harvesting units in Brazil. The results indicated that with proper road planning, the time spent on locating roads and landings was reduced by 37%, and the density of forest roads was reduced by 33%. Furthermore, Gullison and Hardner (1993) have reported that poor road planning and construction could cause excessive damage to residual stands, reduce the value of future harvests, and diminish the role that the residual stands may play in maintaining non-timber species. Thus, effective planning of forest roads is essential from both economic and environmental perspectives.

Road management problems have become too complex to be solved using traditional road location methods, which basically consist of aerial photograph interpretation and field reconnaissance. Bailenson *et al* (1998)

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indicated that selecting a route between two known points based on a designer experience may not necessarily provide the shortest or the most efficient road alignment. Computer-aided analysis of road location have become highly desirable since it could reduce the time spent on road planning and provide a designer with quick evaluation of alternatives, considering economic and environmental constraints.

Application of computer-aided road location methods dates back to the late 1960's when shortest path algorithms were first combined with Digital Elevation Models (DEMs) (Turner 1978). Currently, there are several computer-aided systems (e.g., Pegger&RoadView WA; Lumberjack WA; RoadEng OR) that have been widely used in forest road design. These systems automate some of the tasks in locating forest road alignment; however, they do not have capability of generating large number of alternative routes, minimizing the total road cost, or considering the least environmental impact. By means of using advanced microcomputer technology (i.e., speed and memory), modern optimization techniques, and advanced Geographical Information Systems (GIS), forest road design systems using mathematical optimization techniques can be utilized to solve complex road design problems. Optimization techniques systematically search for the desired or “best” solution among the acceptable solutions at reasonable computational cost (Beasley *et al* 1993).

The objective of this study is to present the progress and opportunities of using optimization techniques in designing forest roads and road networks. In order to achieve this objective, major road design stages are identified and many of the commonly used optimization techniques and their applications in forest road design and network optimization problems are presented. It is expected that this review article will draw attentions of researchers, transportation engineers, land managers, and other practitioners to the capabilities of using optimization techniques in designing forest roads and road networks. Readers will be provided with an assessment of the current state of road design and road network optimization in forestry applications, as well as associated efforts in road design provided by the transportation sciences. This work will add to the literature a synthesis of optimization techniques used across disciplines, yet focused on applications within forest land management.

2. Road Design Stages

In order to understand how optimization techniques can be used in forest road design, it is necessary to identify the major road design stages of a single forest road. Computer-aided analysis of route selection using optimization techniques generates a large number of alternatives, subject to road design constraints. Some of the route alternatives may be eliminated during the process as they do not satisfy one or more design constraints. Design constraints are generally divided into two groups; geometric specifications and environmental requirements. The geometric specifications may include maximum road grade for logging vehicles, minimum curve dimensions for both vertical and horizontal curves, and minimum safe stopping distance. The environmental requirements may include minimum road grade for drainage, optimal stream-crossing angle for stream protection, and maximum cut and fill slope ratio for slope stability. The average values for some of the design constraints used in North America are listed in Table 1 (AASHTO 1990; Kramer 1993; Kramer 2001). Optimization techniques require design constraints that can be represented quantitatively. And, the complexity of the optimization techniques increases as the number of constraints increases.

Table 1. The typical values for some of the road design constraints.

Constraints	Value
Max. adverse road grade on rock-surfaced roads	16 %
Max. favorable road grade on rock-surfaced roads	-12 %
Min. radius of a horizontal curve	18 m
Min. length of a vertical curve	15 m
Min. road grade	± 2 %
Min. safe stopping distance on gravel-surfaced roads	35 m
Optimal stream-crossing angle	90 °
Max. cut and fill slope ratios on common soil	1:1 and 1.5:1

2.1 Horizontal and Vertical Alignment of a Road

Determining the location of horizontal and vertical alignment is a time-consuming process (Erdas 1997). Computer-aided analysis of route location using optimization techniques may lead to considerable time savings by providing the designers with quick evaluation of alternative alignments, while satisfying the design constraints (Akay 2006). In the computer-aided road design optimization process, an initial horizontal alignment consisting of a set of tangents and circular curves is specified, and then the vertical alignment consisting of a set of straight lines and parabolic curves along the generated horizontal alignment is established (Figure 1). Once the horizontal alignment is fixed, vertical alignment alternatives can be generated by systematically altering the road elevations on intersection points using optimization techniques. The optimum solution for locating a single forest road can be also determined by simultaneously optimizing both horizontal and vertical alignments, at the expense of computer processing time. In a recent study, it was found that simultaneous optimization of horizontal and vertical alignments provided the best road alignment with minimum total cost, subject to specified road design constraints (*Aruga et al* 2004).

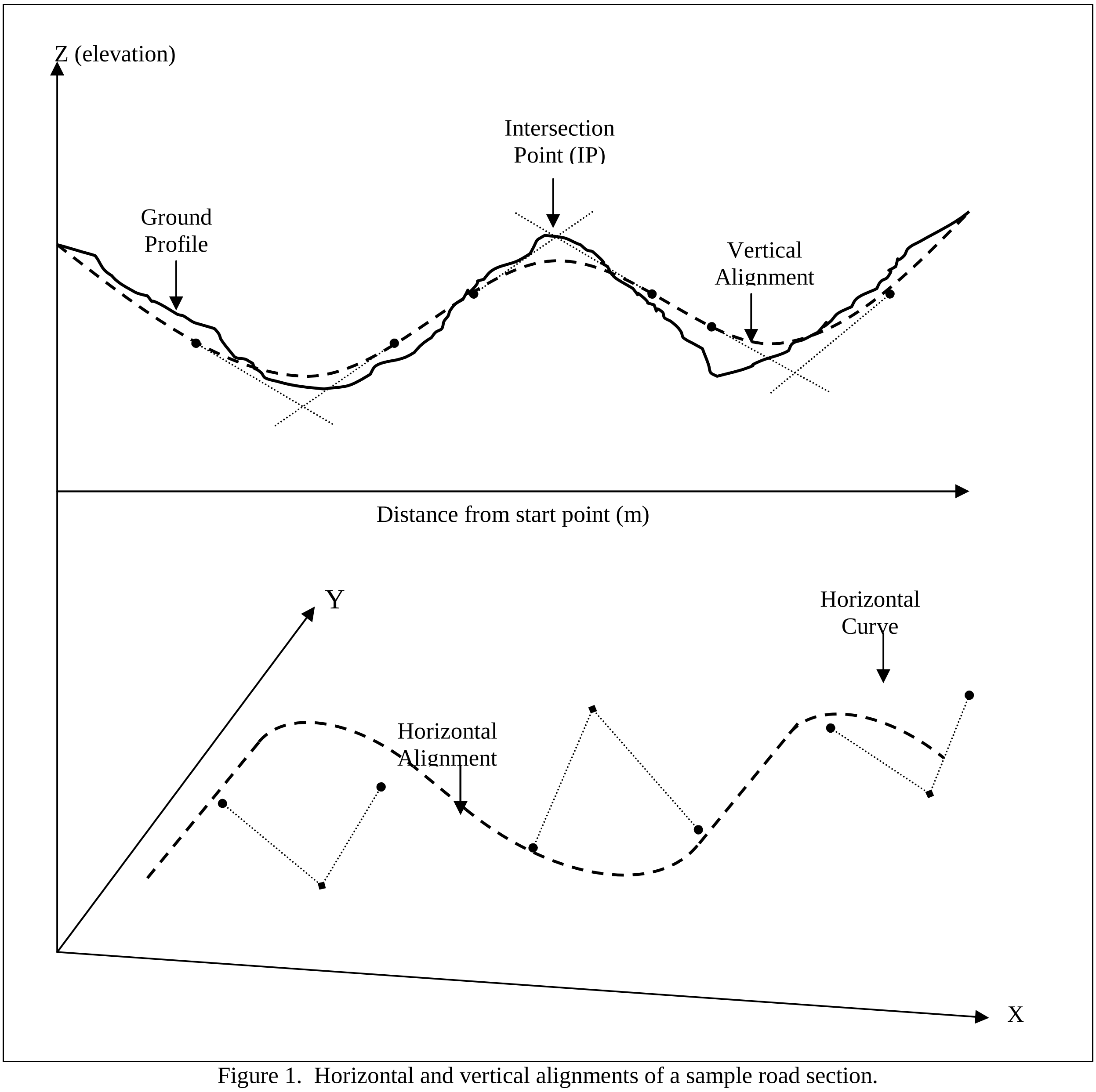

Figure 1. Horizontal and vertical alignments of a sample road section.

2.2 Earthwork Allocation of a Road

Earthwork allocation involves three major activities including excavation and loading, hauling and unloading, and compaction (Erdas 1997). This work may amount to a significant portion of the total cost of forest road construction. Determining the least-cost alternative for distribution of earthwork from cut sections and borrow areas to fill sections and landfill areas is an important design activity (Figure 2). Typically, a road designer estimates the amount of material required at each cut and fill section, soil characteristic along the roadway, location and capacities of borrow and fill areas, and the unit costs for excavation, haul, and fill and compaction activities. With this information, it is also possible to formulate earthwork allocation as an optimization problem.

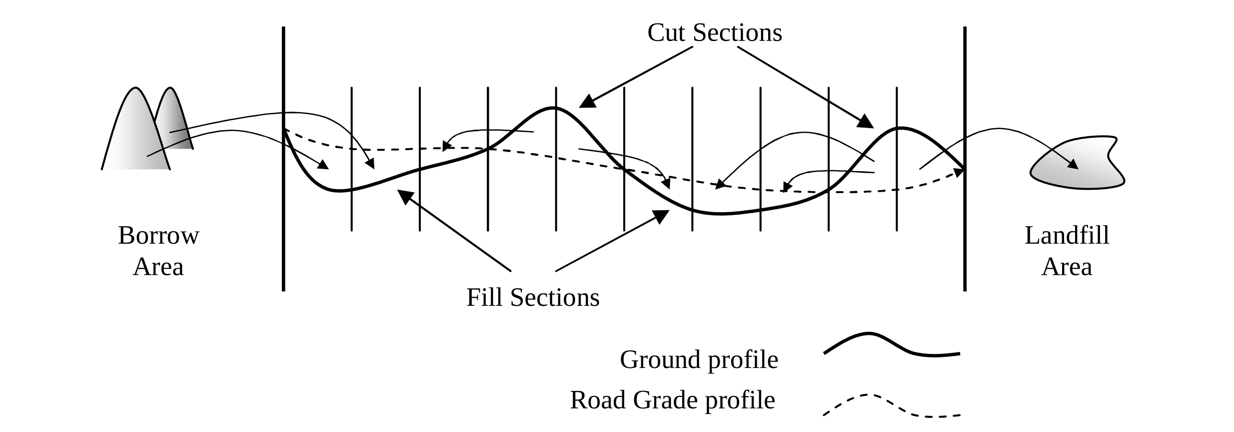

Figure 2. Sample solution for an earthwork allocation problem

In several current road design systems (Lumberjack WA and RoadEng OR), the mass diagram (Oglesby and Hicks 1982) has been used to balance the required quantities of cut and fill materials. However, the capability of the mass diagram is limited where soil characteristics vary along the roadway (Akay and Sessions 2005). Optimization techniques have been used to overcome the limitations of the mass diagram in earthwork allocation problems (Mayer and Stark 1981; Christian and Caldera 1988; Easa 1988).

2.3 Calculating Total Road Management Cost

The main cost factors involved in managing a road network include construction, maintenance, and transportation costs (Akay 2006). Cost components analyzed with optimization techniques should be represented with a mathematical problem formulation. The “unit cost approach”, where estimated unit costs are multiplied by the quantity of design parameters (e.g. m^3, m^2, m, etc.), is often used in computer-aided road design systems. For low volume forest roads in mountainous terrain, construction and maintenance costs are the largest cost components (Pearce 1974). The road construction activities may include the construction staking, clearing and grubbing, earthwork allocation, drainage, surfacing, and seeding and mulching. Road maintenance activities generally consist of replacing the aggregate to preserve structural integrity and travel quality, performing blade maintenance activities, maintaining culverts, and cleaning ditches. Removing brush from both cut and fill slopes is also considered to maintain visibility. Transportation costs, although a minor component of the total cost computation, will vary with vehicle performance, equipment costs, and gradient and curvature. It is easy to incorporate these factors into optimization techniques using mathematical functions.

The major cost components of a single-lane forest road section in mountainous terrain were investigated by Akay (2004). In this study, two road examples were presented, considering different specifications for the surfacing material (Kramer 2001). In Example A, good quality rock for base course and surface rock (finer surface rock if road grade is less than 16%) for traction surface were used. In Example B, good quality rock (pit run if road grade is less than 10%) for base course and surface rock (no surface rock if road grade is less than 10%) for traction surface were used. The relative weightings of cost components for both road examples were indicated in Table2.

Table 2. The relative weightings of cost components for a single-lane forest road section.

Cost Components	Relative Weightings (%)	
	Example A	Example B
Construction Costs	70.1	73.7
Earthwork allocation cost	12.5	25.7
Construction staking cost	0.8	1.3
Clearing and grubbing cost	4.5	7.7
Drainage cost	2.0	3.0
Seeding and mulching cost	2.3	4.0
Surfacing cost	48.0	32.0
Maintenance Costs	22.6	14.3
Rock replacement cost	15.9	3.5
Blade maintenance cost	0.5	0.8
Culvert, ditch, and brush costs	6.2	10.0
Transportation Costs	7.3	12.0

3. Optimization Techniques and Applications in Forest Road and Network Design

Road building, maintenance, and decommissioning problems are combinatorial in nature, and require integer decision variables. As a consequence, the resulting mathematical statements of these problems may be quite large and difficult to be solved (Church *et al* 1998). In order to find the best solution for any combinatorial optimization problem, one might first assume that complete enumeration of the feasible solutions can be generated, and their objective functions can be evaluated to determine the solution with the best result. However, this approach is not effective in practice when there are a large number of alternative solutions - either for a single road or for a network of roads. Therefore, optimization techniques are useful tools in finding the near-optimal solutions in an acceptable time frame. The following section briefly describes several optimization techniques, from exact algorithms (Linear Programming) to inexact algorithms (Dynamic Programming and Heuristics) and presents forest road design systems that utilize these techniques. The exact algorithms have an advantage of guaranteeing the optimal solutions for the problem being solved.

3.1 Linear Programming

Linear Programming (LP) is an optimization method that allows one to minimize or maximize a specified objective function while satisfying the various constraints (Bowman and Fetter 1967). In order to use LP, the objective function and the constraints need to be formulated as linear equations with non-negative variables. A general LP algorithm such as Simplex Method (Bowman and Fetter 1967) can be used to solve all LP problems. The decision variables are usually represented by continuous numbers, whereas some road design or network problems require a binary (yes/no) representation. LP has the capacity of generating the exact solution to a problem; however computer computation time can limit problem size. Some of the basic problems that can be solved by LP include production scheduling, transportation problem, and capacity allocation problems.

LP has been used in several forest road optimization models (Akay 2006; Aruga *et al* 2004 and 2005) to design roads and minimize the costs of the earthmoving activities. These models generated ground profile, intersection points, and cross sections using a high resolution DEM. The results indicated that LP overcame the limitations of the mass diagram by considering various soil characteristic and possible borrow and landfill locations along the roadway. In these models, an increase in the number of intersection points reduced the construction cost since the road profile became closer to the ground profile. However, increasing the number of intersection points significantly increases the computational time in solving earthwork allocation problem.

Mixed-integer formulations have been devised to develop road maintenance and network management plans where the locations of current and proposed roads are known. In these algorithms, the goal is not to assess the environment and determine where to place a road, but to assess the environment and decide what to do with planned or current roads (i.e., road locations are not defined *a priori*). Conservation of flow constraints between nodes (end points of road sections) are common in these mixed LP formulations as well as integer decision variables since some choices (i.e., whether to build a road) are binary (yes/no). Kirby et al. (1986) were among the first to describe a mixed integer formulation for forest road management, creating the IRPM model. Olsson and Lohmander (2005a) and Olsson (2005b) described road investment scenarios in Sweden where mixed integer formulations are used to assist decision-makers in developing tactical plans. In these cases, the road system has been defined *a priori*, and the task is to decide which route logging trucks should travel.

3.2 Dynamic Programming

Road design and road network problems can be solved by using Dynamic Programming (DP) in which optimum solution is reached in a multistage process (Beasley *et al* 1993). DP applies recursion to solve all possible small problems and then combine them to obtain solutions for larger problems. In this process, size of the optimum solution set is reduced into smaller subsets which are much easier to solve. Therefore, the optimal solution to the problem contains the optimal solution of the subsets. The subset space (stages and states) should be sufficiently small so that the same solution can be applied a number of times to obtain the solution for the main problem. Unlike LP, there is no specific DP algorithm that can be used to solve all DP problems. However, it has the ability to solve non-linear problems. DP is often used in practice for solving problems in transportation, harvest scheduling, and manufacturing. Teasley (2002) found dynamic programming to be an effective tool for developing a road removal plan, yet noted several areas of improvement necessary for the algorithm to perform as well as a heuristic.

Tan (2000) developed a procedure where DP was used to help road managers in determining the optimum location for a forest road section. Costing and routing of road construction, extraction, and transportation were predetermined in a separate module using microcomputer-based spatial database and heuristic procedure using shortest path (Tan 1999). In this DP procedure, the road planning area was divided into zones (stages) of equal width. Zone boundaries were assumed to be parallel to the existing road. Therefore, the nodes on a specific boundary of a zone have the same distance to the existing road. The DP algorithm searches for the best route between two boundaries for every node, while considering minimum construction costs. The best route between boundary nodes of adjacent zones was located by minimizing the construction costs of a road starting with the boundary nearest to the road and ending with the boundary farthest from the road.

3.3 Heuristics

The heuristic techniques are repetitive search procedure where an improved solution relative to the current one is determined based on experience and empirical rules (Tan 1999). There are numerous heuristic techniques that can be used to provide an optimization (or pseudo-optimization) approach to the design of forest roads or road networks. Many of these techniques come from fields outside of forestry. For example, Pérez de la Cruz *et al* (1995) describe an artificial intelligence approach to the design of highways, which takes into account environmental variables and other complexities.

Richard *et al* (2004) described the use of the Hooke and Jeeves search method for optimizing vector-network techniques in the design of mechanical systems. Elnagar and Hussein (2000) indicated the use of matrix methods for smooth paths in three dimensions (3D) given assumptions on machine velocity. And, Gipps *et al* (2001) presented the Quantum model, a heuristic for generating sets of low-cost alternatives for proposed highways, using databases describing the environment and economic assumptions.

In the field of forestry, Gullison and Hardner (1993) described a rule-based simulation model designed to examine options for reducing the total length of forest roads. Tan (1999) used a heuristic procedure to select road development choices from a set of network links where the shortest paths were first determined using Dijkstra'a algorithm. Peters (1978) provided a description of a direct method for determining optimal in-woods harvest system road spacing (i.e., primary transportation) and landing options, which could be extended to unroaded areas for determining low-cost secondary transportation options.

Clark et al. (2000) also used a heuristic for access road development where roads are not defined *a priori*. Finally, Weintraub *et al* (2000b) described two models: OPTIMED, which used an LP-based heuristic to decide amongst road building options that are stated *a priori*, and PLANEX, which used raster GIS databases and other information along with a heuristic to locate access roads for timber harvesting operations. Early development of this work can be found in Weintraub et al. (1994 and 1995).

In the following section, commonly used modern heuristic techniques (Simulated Annealing, Genetic Algorithm, Tabu Search, and Shortest Path Algorithm) are briefly described and their usefulness in forest road or network design have been investigated. The algorithms for these techniques are fairly easy to program and one general code can be used to solve many different optimization problem.

3.3.1 Simulated Annealing

Simulated Annealing (SA) as a solution strategy for combinatorial optimization problems dates back to the early 1980's (Beasley *et al* 1993). SA relies on a metallurgical concept, where a heated raw material is cooled back slowly-while being reheated occasionally- to produce the best material (Kirkpatrick *et al* 1983). The basis for SA was first published by Metropolis *et al* (1953), and the approach uses a local search in which a subset of solutions is explored by moving from one solution to a neighboring solution. To avoid converging and becoming stuck in local optima, the procedure allows the occasional acceptance of an inferior solution. SA has been applied in a wide variety of disciplines to solve optimization problems due to its simplicity.

In a study conducted by Akay (2004), SA was used to guide the search for the best vertical alignment that minimizes the total costs of construction, transportation, and maintenance costs for a single forest road. An initial road path is generated by establishing intersection points on the 3D image of the terrain, considering road design constraints. During the search process, 182 feasible solutions were evaluated out of 1200 automatically generated vertical alignment alternatives. For each change in the vertical alignment, the model minimized the costs of the earthmoving activities using LP. The results indicated that total road cost was reduced about 25% by using optimization techniques. The most of the computer computation time was spent on calculating earthwork allocation using LP.

3.3.2 Genetic Algorithm

To solve optimization problems, the Genetic Algorithm (GA) approach was developed by Holland (1975) and his colleagues at the University of Michigan. GA is based on biological processes of inheritance, mutation, natural selection, and the genetic crossover (Beasley *et al* 1993). First, a set of feasible solutions is randomly generated, where each solution corresponds to a chromosome. Second, two parent chromosomes are chosen based on their objective function values (fitness) to reproduce two new child chromosomes, which is called cross-over operation. In an attempt to improve the solutions over time, GA allows a random mutation when producing child chromosomes. This search process is repeated until a stopping condition (desired number of generations or improvement of the best solution) is satisfied. GA has been mostly applied to problems involving sequencing and scheduling.

In applications outside of the forestry field, Liatsis and Tawfik (1999) presented a GA approach to optimize the shape of roads in two dimensions. Jong and Schonfield (2003) developed a GA approach for optimizing highway alignment in 3D. Jha and Schonfled (2004) also developed a GA approach for optimizing highway alignment, yet within GIS, and investigated the effectiveness of the algorithm in steep terrain conditions. In each of these approaches, road locations were not specified *a priori*; the resulting road locations were a function of environmental conditions and other information.

In the field of forestry, Ichihara *et al* (1996) proposed a GA model integrating two optimization techniques to optimize forest road profiles. Once a horizontal alignment is fixed, the model identifies the optimum combinations of intersection points. Within the model, the optimum longitudinal slope with minimum construction cost was designed by using a DP method (Kanzaki 1973). The model was applied to a road section that had been previously designed using traditional methods. It was assumed that this original road profile was optimum from an economic perspective since it was designed by professionals. Then, the original profile was compared with the profile designed by GA. The results indicated that the volume of earth cutting by GA was less than that of the original profile, while the volume of earth waste by GA was larger than that of the original profile. It was assumed that the difference is due to objective function of DP where driver comfort and safety were not considered. In the model, 420 feasible profiles were evaluated in approximately 10 minutes in which one profile was calculated approximately 1.43 sec. The optimum combinations of intersection points determined by GA indicated close correspondence to those of a road profile determined using traditional methods, yet the computer computation time was significantly reduced when using GA.

3.3.3 Tabu Search

Tabu Search (TS) was first developed by Glover (1989) as a neighborhood search technique to solve discrete optimization problems. TS produces solutions by making iterative choices, considering certain choices as taboo (i.e. Tabu). In general, during the solution process, if a decision choice has been recently selected, it is rejected (Tabu). If a choise is not Tabu, or is Tabu yet its objective function value is better than the previous best solution, the choice is selected. If the solution is not better than the previous best solution, the algorithm accepts the candidate which gives the highest increase above the current the objective function value. If it is not possible to generate a candidate with increased value, the algorithm moves forward with the candidate, which provides the least decline in the objective function value. TS has been successfully applied to a number of optimization problems.

In a road design study conducted by Aruga *et al* (2005), GA and TS were compared to a manually designed forest road profile. Once the horizontal alignment was fixed, optimization techniques were used to generate alternative vertical alignments by adjusting the heights and the location of the intersection points. The vertical alignment was optimized considering construction and maintenance costs. LP was used to determine earthwork allocation. Both heuristic techniques found near optimum solutions within a reasonable time. TS could not find a better solution than GA, but it usually found a good solution in less time. One year later, Aruga *et al* (2004) proposed an improved road design model in which TS was used to optimize the horizontal and vertical alignment of a forest road. The model was applied to design 827-meter road section in Capitol Forest, Washington State, USA. In the model, the vertical alignment was first optimized, and then horizontal and vertical alignments were optimized simultaneously. The best road alignment found by the simultaneous optimization of both alignments reduced the total cost by 29%, compared to the case where only vertical alignment was optimized.

3.3.4 Shortest Path Algorithms

Shortest path problems are among the most fundamental problems studied in computational geography (Lanthier *et al,* 2003). In general, the shortest path is the problem of finding a series of road links connecting two nodes such that the sum of the weights on those edges is minimized. Dijkstra's algorithm is one of the most efficient algorithms for solving the shortest path problem in which all the weights are non-negative (Dijkstra, 1959). Zhan (1997) provides a discussion of the performance of several shortest path algorithms.

In the algorithm, road links are connected in the order of their weighted lengths, from the shortest to the longest paths. The weights of the links can be represented by distances, costs, or times. The algorithm stores the weighted value for each path. The essential feature of Dijkstra's algorithm is road link relaxation (Cormen *et al* 1990). When there is an edge from node A to node B, the shortest path from node C to node A can be extended to a path from node C to node B by adding link (A, B) at the end. If the weight of this path is less than the previous weight, the current best weight is replaced with the new weight. In the algorithm, each road link (A, B) can be relaxed only once, when the weight of the path has reached its final value.

In the field of forestry, shortest path algorithms have been used to develop near-optimal transportation networks. Sessions and Sessions (1991) implement a shortest path algorithm for secondary harvest transport in forest operations. Bettinger *et al* (1998) integrated road maintenance and obliteration choices with a harvest scheduling model (TS) in an effort to develop forest plans where sediment concerns were important. Dijkstra's algorithm was used to determine the shortest paths from each management unit to a mill given the roads available.

Anderson and Nelson (2004) developed a computer algorithm that quickly generated road networks for strategic road planning. In this study, Dijkstra's shortest path algorithm was used to project a road link that minimized the distance between a landing and the current road network, considering specified road design constraints. In order to present the capabilities of the model, it was applied to a forest on Hardwicke Island, Canada. A sensitivity analysis was conducted to provide road managers with extra information on long-term effects of various variables (total length of road network, percentage of landings connected, and road gradient). The order in which the landings were connected to the road network was also tested. The results indicated that reducing the maximum road gradient constraint increased the total length of the road network and decreased the percentage of landings connected. That produced longer roads in gentler grounds and fewer roads in steep and broken grounds. The number of landings connected and total length of the road network decreased as the landing spacing increased. The network generated using closest landings first resulted in a longer network, steeper road gradient, sharper curves, more landings, and shorter processing time than that of using farthest landings first.

Dijkstra's algorithm was a practical tool for quickly projecting road networks in strategic planning. However, it caused a considerable variation due to landing order in which the landings were connected. To improve the landing order, Tan (1999) suggested a heuristic procedure where each possible landing was connected by using a shortest path algorithm. In this procedure, each road link between two nodes was associated with the cost which was equal to road length times the average cost per unit distance. To reduce processing time, the shortest route of extraction, transport, and road construction between every two nodes were predetermined by the procedure. This procedure integrated spatial database and shortest path algorithm to assist road managers for quickly generating and assessing road network alternatives.

Since the processing involved with shortest path algorithms is computationally intensive, Lanthier *et al* (2003) suggested using a parallel processing approach to the implementation of shortest paths through a triangular irregular network, one form of a DEM. This currently requires, however, a number of personal computers to be interconnected, creating a cluster, as well as shared-memory architecture. This type of computer network design is atypical of most natural resource management organizations.

4. Results and Discussion

Computer-aided processes for optimizing the design of single roads or road networks improve the efficiency of managing both budgets and natural resources. When road design algorithms are integrated with optimization techniques, guidance can be provided to natural resource managers to help them wisely use the limited resources at their disposal. Forest road design systems using mathematical optimization techniques automate many of the time consuming road design tasks while implementing a decision support framework. For the design of a single road, the systems developed by Akay (2006), Aruga *et al* (2005), and others allow one to optimize the vertical alignment for a given horizontal alignment. These systems can be improved by including joint optimization of the horizontal and vertical alignments (Aruga *at al* 2004) into the optimization process.

For the design of road networks, Sessions and Sessions (1991), Weintraub *et al* (1994 and 1995), and Bettinger *et al* (1998) provide a diverse set of options. In this forest network case, current and potential road locations and specifications must be pre-defined. In the former case (optimizing the location of a single forest road), the specifications and location are not pre-defined - the optimization algorithm defines them.

There are several key researchable questions may arise from this discussion. First, the shortest path algorithm is useful in locating optimal solutions for individual forest roads. Although shortest path algorithms are designed to find paths through a pre-defined network, one could utilize them to locate the optimal solution to a single forest road design problem, if the design problem is formulated as a network of choices for the road. LP, DP, SA, GA, and TS have been used to assist with the design of single forest roads, but the possibility for using them to optimize forest road networks also presents an area of future research. Within the forest planning studies, these techniques have been used for timber management options, while shortest path algorithms have been used to optimize road networks.

The second researchable question relates to the design of optimal road networks in roadless areas. While many current "roadless areas" in North America may never be developed, areas can be found where the road network is not very dense, and the in-fill of roads is possible for timber production purposes. Here, one might apply the SA approach by Akay (2004) to an entire proposed network, where the initial road paths are generated, and vertical alignment is then optimized. Single road optimization processes could also be developed to utilize GIS techniques without any proposal of new roads, to identify the best transportation network of a given road density for a landscape. These methods could be used in conjunction with shortest path or other techniques to reduce the proposed roads to a network that is appropriate given the timber production or recreation activities proposed, or so that other environmental impacts measured at larger scales (i.e., sediment production, wildlife habitat) are minimized.

The third researchable topic is to design a smaller, more effective forest transportation network in areas where roads exist, yet new road construction will not be considered. A management goal may be to reduce the density of roads for wildlife, aquatic resource, or visual quality reasons. Bettinger *et al* (1998) provided a method to reduce the network given sediment concerns. However, a more in-depth analysis of road profiles and landscape conditions (as used in the individual road design problem) may help in the assessment of road network alternatives. Combining these processes with a forest road network optimization process would allow one to evaluate contemporary land management options.

Most of the recent advances in optimization models for single forest roads rely highly on DEMs and other GIS databases (soils, streams, etc.). The fourth researchable question relates to resolution of DEM and accuracy of the attribute data that directly affect the performance of the optimization process. Tan (1999) notes that cell sizes that are too small bog down the processing associated with network nodes, and cell sizes that are too large result in accuracy levels that may be unacceptable. Thus, the trade-offs related to the input databases require some thought. Available attribute data in forested areas may also not represent the actual conditions well; however, the quality of GIS data keeps improving as GIS technologies advance. These advances include improved data sources for generating high-resolution and accurate DEMs using the latest technology (LIDAR), highly developed GIS techniques to store, analyze, and display spatial data, and advanced features of sophisticated computer software languages to display and render high-resolution 3D images on personal computers.

The fifth researchable topic is the verification of the optimal road design systems. To improve their performances in the future, the solution obtained from these optimization systems should be further tested by comparing them with current forest road design systems for the same area. Finally, office and field road design can be better linked. Although, the optimization systems do not provide a designer with a decision tool that locates the final route alignment, they can be enhanced by integrating it with Global Positioning Systems (GPS) extensions to help the designer evaluate the model solutions on the ground.

5. Conclusions

Computer-aided road design systems, using optimization techniques, provide land managers with a decision support tool that quickly evaluate alternatives. A number of approaches have been used to optimize the placement (vertical and horizontal) of individual forest roads. Enabling the optimization of entire networks of roads across a landscape, while considering broader-scale issues such as sedimentation and wildlife habitat, remains an issue to be addressed. In addition, assessing the design of optimal transportation networks from the suite of roads currently available seems to be a fruitful area of research, particularly if the algorithms used to delineate single forest roads can be used to assess which current roads should be eliminated from the network. Optimization of entire road networks with shortest path algorithms has received considerable attention in the forestry literature. Whether heuristics or exact algorithms can improve on the efficiency of shortest path algorithms remains to be seen. However, advances in computer-aided optimal road design and road network management have provided land managers, researchers, and others the ability to make more informed management decisions.

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DETERMINATION OF THE PRODUCT CONDITIONS OF PULP AND PAPER FROM WHITE MULBERRY (Morus *alba* L.) BY KRAFT METHOD

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ABSTRACT

In this study, 3 different cooking were performed from white mulberry by kraft process, under the conditions such as; Active Alkali / Sülfidite rates, 16/20, 18/20 and 20/22, the temperature at 180ºC for 170 minutes. Physical and mechanical properties of the papers, produced at 20SRº, 35SRº and 50SRº were carried out. Physical properties were improved when the beating degree was increased at the same cooking conditions. Bursting and tearing resistance were increased. Paper pulp yield decreased with increasing the amount of total alkali.

Keywords: White mulberry (Morus *alba* L.), kraft method, pulp production

1. INTRODUCTION

White mulberry wood is native to China. It is distributed in Japan, Korea, Manchuria, India, Pakistan, Iran, North Europe and the Mediterranean countries. Capable of up to 15 m length, thick branches of a large tree that canopy. It is easy grown in deep soils, as well as in dry, sandy and chalky soils, endurance salt and cold weather conditions as a fast-growing species and usually likes warmer climate zones (Gökmen, 1973). It exists mostly in Erzincan followed by Elazığ, Ankara, Malatya and Tunceli, even can grow in every region. (Anon., 2002). Mulberry wood involves the colors from light brown to greenish brown, dark brown, brown or black and violet-colored, and has heartwood with (Merev, 1988). Chocolate Brown color yellowish-brown. The other properties are known that the annual ring limits are apparent, air-dry weight is 0.65 g/cm^3 (Bozkurt and Erdin, 1995), contents thyll formation as the same in other ring pored trees (Örs and Keskin, 2001).

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When wood treated with cold and dilute alkali solution only a small amount lignin can be dissolved however, for the solubility of the lignin in wood significantly, if the wood chips are heated with NaOH solution under pressure, to 160-180 °C, most of the lignin is removed. This process is the base of the general commercial soda method (Browning, 1967). Alkali used in the methods alkali is consumed in lignin reactions, the solubilization of carbohydrates, naturally found in wood and neutralize organic acids formed during cooking, resinous substances and tannin reactions. (Tank, 1980). Mulberry tree has an important role in the history of the paper. The Chinese produced the paper from mulberry tree by peeling the inner bark, and by using lime and ash having alkaline property dissolved in water producing pulp which was beated in a mortar (Eroğlu, 1990).

Fiber length shows correlation with the properties of sound paper. For this reason, the first that comes to mind for the production of pulp of wood of coniferous trees. However, the strength of the paper is decreased after a certain point since the fiber length deform the paper formation. Therefore, short and thin-leaved wood fibers are preferred for many types of paper (Eroğlu, 2003). White mulberry belongs to ring pored trees in terms of sequence of trahe (Berkel, 1970). The average fiber width and lumen diameter of White Mulberry trunk wood was averages 15.33 µm, 52 µm (Şirin, 2006). Based on these results;

Runkel ratio = (Fibre wall thickness x 2) / lumen diameter (Kırcı, 2003), the formula
Runkel ratio = (8.81 x 2) / 6.52 = 2.702> 1
It was included in coarse fibers group

Some chemical properties of White Mulberry wood were investigated (Şirin, 2006) and the values determined were given in Table 1.

Table 1. Chemical analysis of trunk wood and branches of White mulberry (Morus *alba* L.) (Şirin, 2006).

The analysis	**Results (%)**
Cold water solubility	6,04
Hot water resolution	14,83
Resolution 1% NaOH	14,83
Alcohol resolution	11,13
Holocellulose rate	85,98
Cellulose ratio	53,08
Lignin ratio	21,30

It is suitable for the pulp production in terms of the cellulose ratio the same as it was in many broadleaved species.

2. MATERIALS AND METHODS

The test specimen was obtained from Inozu district of Ankara (Beypazarı) region located at 1000 m altitude, and the North-West direction. White mulberry wood first was chipped, and moisture content was determined, then weigh to 700 gas oven dry, afterwards stored in polyethylene bags. It is a fact that there is no available literature in relation to pulp production with mulberry wood previously. Since the kraft method is suitable for all types of wood it was chosen in this study. Pulp production was performed in a cylindrical boiler which is working with heating and resistant to pressure, rotating 2 cycles for per minute. Literature findings were based on the determination of the cooking conditions as well as temperature was maintained at 170 ° C. Cooking conditions are given in Table 2.

Table 2: Cooking conditions used in the study.

Active Alkali / Sulfite (%)	16/20(I)	18/20 (II)	20/22 (III)
Solids (%)	20.88	23.87	27.27
Solid content (g)	271	256.15	242.76
Moisture ratio (%)	12	12	12

The unbeaten paper was produced with 35 SRº and 50 SRº from the pulp, then, the paper thickness, surface smoothness, air permeability, tear resistance, and burst resistance properties were determined.
Test papers were conditioned under the temperature at 23±1 and relative humidity with 65 % according to TAPPI T402 om-88 standard for 24 hours in the room, followed by subjected to the tests given below. TAPPI T402 om-88 standard test papers obtained by the temperature and relative humidity of 23 ± 65% of the air in the first 24 hours after conditioning were subjected to the following tests,

1 .According to TAPPI 410 om-88 standard weight,
2. According to TAPPI 411 om-89 standard, thickness, density and volume,
3. Moisture according to TAPPI 412 om-90,
4. According to TAPPI 220 om-88 standard test paper cutting,
5. According to TAPPI 410 om-88, expressed in grams of 4-fold paper with founding tear resistance,
Tear resistance index = x (16/4) x 9.81 / weight,
Formula $mN.m^2$ / g calculated,
6. TAPPI 403 om-91 standards, determined by the bursting strength in kg/cm^2,
Index = 1000 x 0.0981 x Bursting resistance / Weight formula $kPa.m^2$ / g, respectively.

3. RESULTS AND DISCUSSIONS

Cook the paper pulp screened yield values obtained is given in Table 3.

Table 3: White mulberry wood screened pulp produced in yields.

Active Alkali / Sulfite (%)	16/20 (I)	18/20 (II)	20/22 (III)
Elimination yield (%)	38.44	36.60	34.68
Screen surplus (%)	2.00	0.61	0.70
Total yield (%)	40.44	37.20	35.38

In the first cooking, active alkali and sulfidity were chosen 16 % and 20 % respectively, the eliminated yield was determined to be 38.44 %. The eliminated yield values were given in Table 3.

The eliminated yield was determined to be 36.60 %. Active alkali was increased to 18 % and sulfidity to 22 % because of the decline in yield, and eliminated yield was calculated to be 34.70 %. Because the decline in the yield was taken in to account, active alkali and sulfidity were not increased, therefore recooking was not done. Table 4 shows some of the features white mulberry wood manufactured hand made sheets.

Table 4: White mulberry wood essay papers produced some of the features.

Cooking	SRº	Surface Smoothness (ml/min)	Air Permeability (ml/min.)	Thickness (µm)	Tear index (nM. m^2/g)	Burst index (kPa.m^2 / g)
I (16/20)	20	781	>5000	176	102	0.53
	35	580	1925	131	281	1.77
	50	492	420	126	229	2.32
II (18/20)	18	829	>5000	180	121	0.52
	35	506	2443	142	255	1.76
	50	340	470	125	227	2.28
III (20/22)	20	717	>5000	176	125	0.54
	35	521	1757	140	280	2.06
	50	395	499	125	234	2.42

The paper testing is done based on the produced paper beating 50 SRº When the paper produced 50 SRº was examined for surface smoothness it was seen that decreased when NaOH ratio increased from 16 % to 18 % and air permeability increased at constant sulfidity 20 %. It may be caused by weakening of the fibers with burning affect of NaOH. Tear and burst resistance decreased at fixed sulfidity 20 %, when NaOH ratio increased from 16 % to 18 % However, it increased when the sulfidity was increased to 22 % at the same conditions. The decline in the yield indicates that it is not possible to produce paper without giving loss in the part of carbohydrate with sulphate cooking solution. Hemicelluloses fractions having low molecular weight and labile to alkali merge in to cooking solution at the beginning of the cooking. Although cellulose component is the most durable polymer against alkali attack, 5 % of cellulose is dissolved during kraft cooking and merge in to cooking solution (Kırcı, 2003).

The loss in the yield caused from increased total alkali quantity might be resulted from cellulose degradation by alkali attack. Therefore, viscosity should be monitored in cooking by using lover alkali in the further experiments.

5. CONCLUSIONS

White mulberry has a high potential resource since it is distributed in a broad area in Turkey. It has sound wood, as well as can be used in the production of pulp and paper because of the high celluse content. Although kraft method is used in this study, further studies based on chemical, semi-chemical and mechanical methods are needed to get precise finding whether white mulberry suitable for pulp and paper.

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IMPACTS OF FOREST HARVESTING OPERATIONS ON SOIL COMPACTION IN SCOTCH PINE-FIR MIXED STANDS (ÇANKIRI SAMPLE)

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ABSTRACT

This study investigated soil compaction, caused by tree felling and ground based forest harvesting operations, in sandy loamy brown forest soil, located in mixed forest stand harvesting units. In the study area, conventional forest harvesting is still practiced and this resulted in considerable soil compaction. As the forests are on the mountainous landscape, ground skidding is carried out by human, animal or tractor power. The impacts of harvesting operations in felling and skidding areas on soil compaction were assessed in this study. Thirty nine sample areas were taken for two soil depths (0-5 cm and 5-10 cm) before and after tree felling and ground skidding activities measuring 7 samples for each, in four different stands. Soil compactions at logged areas were nearly two times greater than the unlogged areas, except tree felling values at 5-10 cm depth.

Keywords: Soil compaction, brown forest soil, tree felling, ground skidding, penetrometer

INTRODUCTION

Forest harvesting operations (FHO) can cause considerable soil disturbances as removal and mixing of topsoil, compaction of soil layers (Jurgensen et al., 1997; Kozlowski, 1999; Agherkakli et. al., 2010). Disturbance can negatively affect soil physical properties via increased soil compaction (Tan et. al., 2005; Naghdi, et. al., 2007; Gebauer et al 2012). Soil compaction increases bulk density (Van Rees et al 2001; Ares et al. 2005; Demir et al. 2007; Makineci et al. 2007; Lotfalian and Bahmani, 2011), decreases porosity, infiltration capacity (Kozlowski, 1999; Grigal 2000; Startsev and McNabb 2000; Özgöz and Okursoy 2001; Rohand et al. 2004; Ares et al. 2005; Ampoorter et al. 2007; Demir et al. 2007), saturated hydraulic conductivity (Wood et al. 2003; Grace et al. 2006; Ampoorter et al. 2007) and microbial activities (Jordan et al 2003; Ares et al. 2005; Tan et al. 2008). The soil compaction can reduce tree root volume by increasing soil resistance to root growth or decreasing oxygen and water supply to plant roots (Murphy et al., 2004). These characteristics have potential to mitigate plant and tree growth (Corns 1998; Murphy et al 2004; Lotfalian and Bahmani, 2011; Gebauer et al 2012). Besides soil compaction, soil mixing, puddling, and rutting are important types of soil disturbances that can cause a disruption of matter flow of disturbance (Agherkakli et. al., 2010). In addition, degree of hazard caused by FHO depends on several factors such as soil moisture content (Ampoorter 2011; Ares et al 2005; Eliasson 2005; Korb 2011; Naghdi et al 2007), topography, operation method (clear-cut, single-tree selection, group selection), harvesting method (ground based logging, skyline or even helicopter systems) (Lister 1999; Donagh et al 2010; Ampoorter 2011), type of machinery used and the number of machinery passes (Donagh et al 2010; Eliasson 2005; Gebauer 2012; Hutchings 2002; Junior et al 2007). When all adverse effects on forest soil and environment were considered, the timber harvesting may be considered as an disturbance activity all over the world (Najafi et. al., 2009).

The objective of this study was to assess the soil disturbance and compaction caused by FHO in Ilgaz Forests, located in north central of Turkey. For this purpose, we measured soil compaction before and after tree felling and ground skidding with rubber-tyred tractors in highly productive Scotch Pine-Fir Stands.

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MATERIALS AND METHODS

Study area

This study was carried out in Scotch Pine-Fir Stands located in Yenice Forest District, Ilgaz Forest Management Directorate, approximately 100 km northeast of Çankırı Province (41° 02' 20"-41° 02' 10"N latitudes and 33° 46' 24"-33° 47' 45"E longitudes) in north central Turkey (Figure 1).

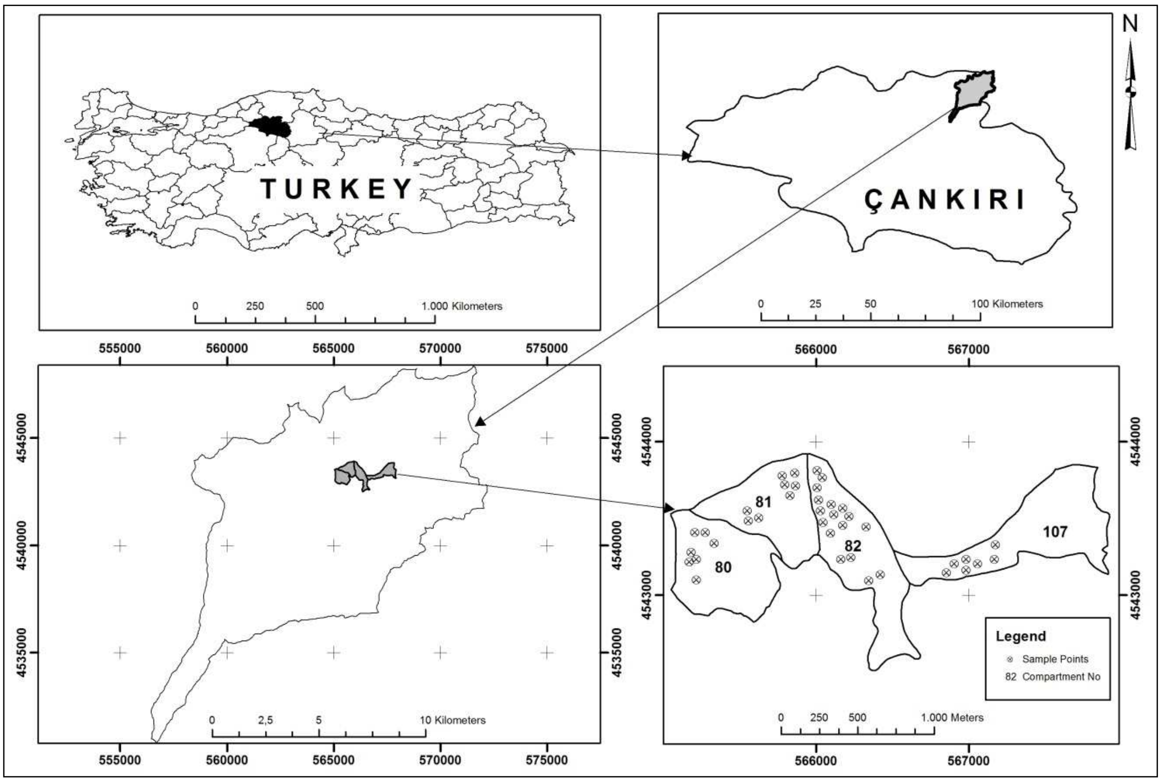

Figure 1. Location of the samples in the study area in Çankırı-Turkey

The elevation in the study area ranges from 1380 m to 1620 m with average of 1460 m (Figure 2) and average slope is 30-35% according to the IUFRO slope classification (Figure 3).

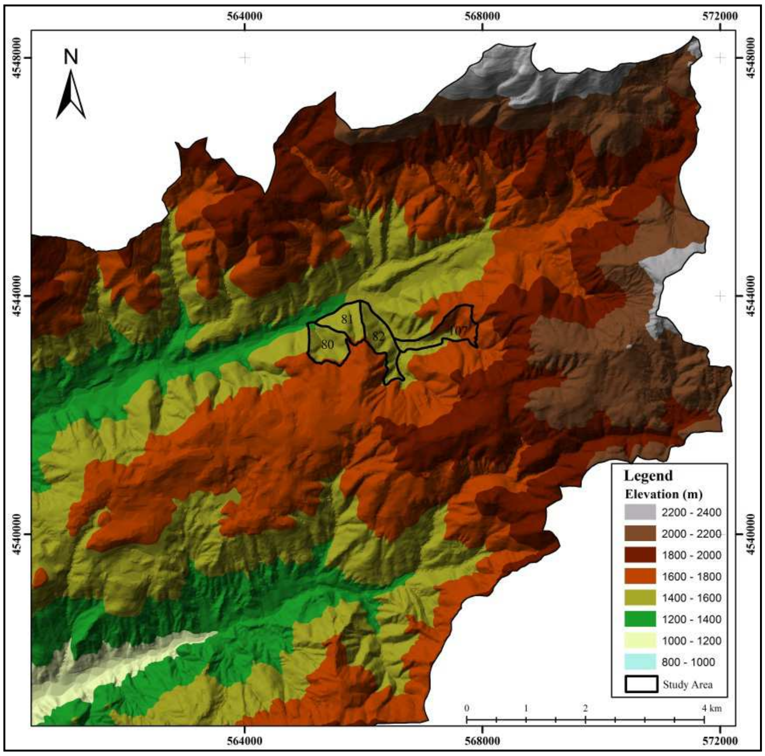

Figure 2. Elevation map of the study area

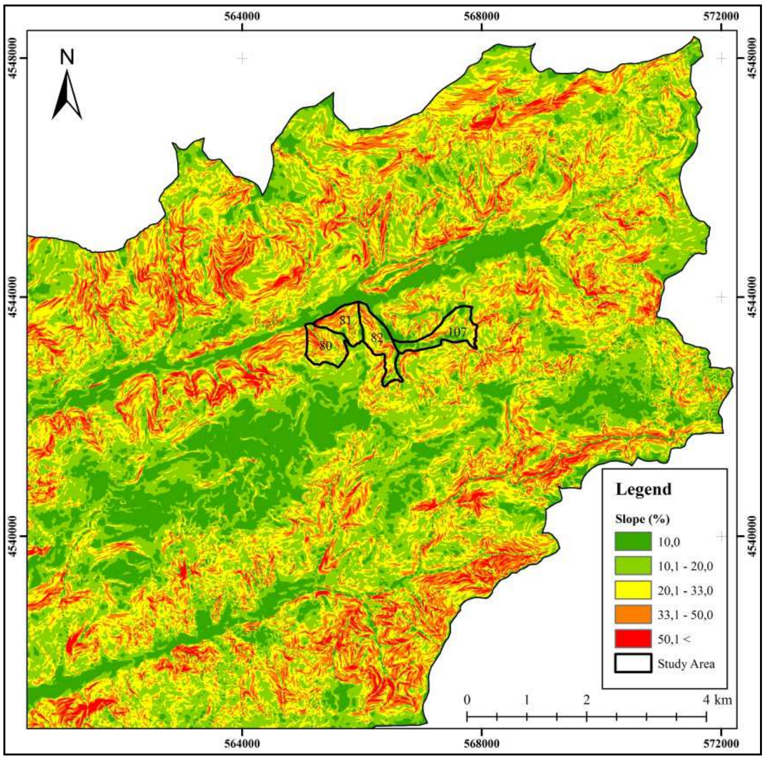

Figure 3. Slope map of the study area

The climate in the study area is continental-coastal type, with the mean annual temperature of 8.2 °C. Mean annual precipitation is 410 mm, approximately half of which occurs as snow, and the rest as of rainfall occurs in the growing season between May and October (Anonymous, 2008). Prior to harvest, the forest stand was dominated by Scotch Pine (*Pinus sylvestris* L.) and Fir trees (*ağabeyes nordmanniana* subsp. *Bornmulleriana* Mattf.), and some Austrian-pine (*Pinus nigra* Arnold). Brown forest soil is the main soil type (sandy loam and and sand) in the study area (Göl et al. 2010). Single-tree selection harvesting system is implemented, individual trees that are ready for harvest are removed in the study area. The total volume of production at the studied compartments (80, 81, 82 and 107) was 3320 m^3 and extraction of logs from the stump area to roadside landing was achieved by a ground-based skidding system. The use of the farm tractor is widespread throughout Turkey with the advantages of assembling appropriate technical equipment for the terrain conditions and several items of forestry equipment (loading, skidding and road surface smoothing equipment) (Melemez et al 2013). Rubber-tyred farm tractor was used in the study area to skid logs to a landing point for loading onto trucks is conventionally carried out in the areas where slope was less than 30% and this method is known as the worst method causing soil disturbance.

Data preparation

We studied the impact of FHO on soil compaction in four different compartments (Figure 1). Soil compaction was measured before and after tree felling and ground skidding activities at different sample points. Trees were felled and branches were cut by using power saw. Hand-held cone (30˚) penetrometer was used to examine the impact of tree felling and ground skidding activities on soil compaction. Herbaceous, litters and debris at measurement points were cleaned and measurements were taken by placing the cone on the soil surface with the shaft upright. The cone was pressed into the soil until the soil is level with the base of the cone to minimize variability in starting depth (Figure 2). Soil compaction was measured at 39 sample areas, measuring 7 different points for each on felling direction for two soil depths (down to 0-5 cm and 5-10 cm depth). To examine the impact of skidding on the skid road, soil compaction was also measured on skid roads, before and after ground skidding at the same sample areas, measuring 7 different points for each for the same soil depths.

Figure 2. Hand-held cone (30˚) penetrometer

Data Analysis

Soil compaction values measured in two different depths and areas were compared to determine the effect of tree felling and ground skidding activities in soil compaction by using analysis of student's t test. The student's t test was performed by using SPSS version 15.0 (SPSS Institute Inc., 2008) to evaluate whether there is enough evidence that the means of soil compaction measurements differ at 95% significance levels for before and after tree felling and ground skidding activities.

RESULTS AND DISCUSSION

In Table 1, some descriptive statistics were presented for soil compactions measured for different logging activities and soil depths. The logged and unlogged areas have statistically significant different soil compaction values at 95% significant levels (Table 2). The mean soil compactions measured, before and after tree felling are; 2.1464 kgf/cm^2 and 3.9040 kgf/cm^2 for 0-5 cm depth (t-value=-33.913, df=544, $p<0.05$), 7.3833 kgf/cm^2 and 8.6583 kgf/cm^2 for 5-10 cm depth (t-value=-26.095, df=544, $p<0.05$) respectively. The mean soil compactions measured, before and after ground skidding are; 6.9813 kgf/cm^2 and 10.2884 kgf/cm^2 for 0-5 cm depth (t-value= -36.444, df=544, $p<0.05$), 13.4926 kgf/cm^2 and 24.5825 kgf/cm^2 for 5-10 cm depth (t-value=-72.604, df=544, $p<0.05$) respectively. Soil compactions at logged areas were nearly two times greater than the unlogged areas, except tree felling values at 5-10 cm depth (Table 1). The results of FHO effects on soil compaction obtained in this study are similar to some studies; e.g. Ares et al. (2005); Donagh et al. (2010); Ampoorter et al. (2007); Horn et al. (2004); Makineci et al. (2007) and Demir (2007).

Table 1. The soil compaction content at the unlogged and logged areas

	Felling				Skidding			
Depths (cm)	**0-5**		**5-10**		**0-5**		**5-10**	
Statistics	**Pre-Felling**	**Post-Felling**	**Pre-Felling**	**Post-Felling**	**Pre-Logging**	**Post-Logging**	**Pre-Logging**	**Post-Logging**
Minimum	1.09	2.17	6.36	6.67	5.58	11.28	11.78	12.09
Maximum	2.95	5.43	8.22	10.08	8.61	12.71	15.19	29.30
Mean	2.1464	3.9040	7.3833	8.6583	6.9813	10.2884	13.4926	24.5825
Std. Error	0.02972	0.04246	0.02594	0.04140	0.04430	0.07919	0.05982	0.14054
Std. Deviation	0.49098	0.70160	0.42857	0.68411	0.73199	1.30851	0.98847	2.32213
Variance	0.241	0.492	0.184	0.468	0.536	1.712	0.977	5.392

Table 2. Student's t test results at 95% significant levels for soil compaction comparisons in different logged activities and soil depth

Logging activities and soil depth	df	t-value	p
Soil compactions measured in 5 cm soil depth for felling activities	544	-33.913	<0.05
Soil compactions measured in 10 cm soil depth for felling activities	544	-26.095	<0.05
Soil compactions measured in 5 cm soil depth for skidding activities	544	-36.444	<0.05
Soil compactions measured in 10 cm soil depth for skidding activities	544	-72.604	<0.05

CONCLUSIONS

Forest harvesting activities, carried out in Yenice Forest District, increased compaction of soil layers; 82% for 0-5 cm depth and 17% for 5-10 cm depth at tree felling, 47% for 0-5 cm depth and 82% for 5-10 cm depth at ground skidding. Tree felling activities caused higher soil compaction effect at topsoil layer (0-5 cm) than lower ones. However, ground skidding activities engendered lower soil compaction effect at topsoil layer (0-5 cm) than lower ones. These relationships can be explained by tree felling direct impact on topsoil, and by splitting of the upper soil layer at ground skidding. Placement of harvesting waste in places of forwarders' and harvesters' passages might be a good solution to minimise soil compaction (Gebauer et al. 2012).

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RELATIONSHIPS BETWEEN EASTERN BEECH FORESTS STAND PARAMETERS AND LANDSAT ETM SPECTRAL RESPONSES IN TURKEY

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ABSTRACT

This paper explores relationships between forest stand parameters and Landsat Enhancement Thematic Mapper (ETM), atmospheric correction applied, spectral responses thorough analyses of study area in Mugada, Bartin and its vicinity where natural beech (*Fagus orientalis* L.) stands. ETM bands and many vegetation indices were examined thorough integration of spectral responses and field vegetation inventory data. Pearson's correlation coefficients were used to interpret relationships between forest stand parameters and TM data. Besides, regression analysis method for the development of multi linear regression models was used. This study concludes that vegetation indices such as KT2 (greenness of the tasselled transform), Leaf Area Index (LAI), Fraction of Photosynthetically Active Radiation (FPAR), Soil Adjusted Vegetation Index (SAVI) and PC1 (the first component in a principal components analysis) were significantly correlated with forest stand parameters. Some vegetation indices, such as Normalized Difference Vegetation Index (NDVI) and KT3 (Wetness of the tasselled transform), were not significantly with selected forest stand parameters. To estimate the stand parameters by making use of the relations between stand parameters and remote sensing data multiple linear regression models were formed using stepwise regression analysis method. As the resulting product, thematic maps were produced concerning basal area, tree height and volume.

Key words: Atmospheric correction, Fagus *orientalis* L., forest stand parameters, spectral response, vegetation indices

INTRODUCTION

It is important to determine the existing potential of natural and cultural resources. In order to determine this potential, it is necessary to reveal the natural values of the area. Thus, the fact of utilizing areas will be able to be assessed by the demands of the society and with sustainable approaches. Nowadays a total 17.5% of a forest eco-system of 20.7 million hectare, of which nearly half is fertile, is evaluated as protected area, whereby biological diversity constitutes 1.8% of it (Konukçu, 2001; İnan, 2004). Natural resources rapidly decrease as a result of the increase of consumption in relation to economical development. Forest stand parameters, such as volume, diameter and height are important data needed to assess forest resources. In this context, in projects regarding the determination of forest stands and the actual presence and potential of related resources, the usage of purpose conforming remote sensing data will ensure the acquisition of fast and low-cost data/information (Kachhwala, 1985).

Stand diameter and volume are the characteristics of a forest have most commonly been estimated using computational remote sensing methods. The correctness of the performed image processing methods is very important in the determination of the relation between the features of a stand by the aid of satellite image data. As a method, it is targeted to achieve the desired results by the models, established by using the statistical relations between satellite image data and ground methods. Using segmentation 3 × 3 pixel windows, Hall et al., (2006) image height model had an adjusted R^2 of 0.65 and in parallel with the stand volume was within 4 m^3/ha of field plot values and Lu et al., (2004) found strongly correlated between forest stand parameters and six Thematic Mapper (TM) bands, many vegetation indices such as Principal Component Analysis, Tasselled Cap Transform, Albedo etc. In another study (Freitas et al.,, 2005), three vegetation indices (Normalized Difference

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Vegetation Index (NDVI), Moisture Vegetation Index (MVI) were correlated with measurements of forest structure (tree diameter, tree height and basal area). The vegetation indices are most often used in many applications relevant to analysis of forest stand parameters, however depending on the use of specific biophysical parameters and the characteristics of the study area (Gong et al.,, 1995; Roy and Ravan, 1996; Eklund et al., 2001)

By the increase of the geometric resolutions of satellite image data, more accurate and effective information containing satellite images are concentrated in particularly biomass mapping and the determination of bio-physical parameters of stands. The results of the specifications of the stand, obtained by ground methods, acquired by statistical associations, using different satellite images and corrections, have opened the way for remote sensing techniques and calculations of forest stand parameters in particular. Aboveground biomass (AGB) was strongly related to near-infrared reflectance and NDVI using Landsat 7 Enhancement Thematic Mapper (ETM) data through multiple regression analyses to produce an initial biomass map (Zheng et al., 2004). Fazakas et al., (1999) was used Landsat TM to estimate tree biomass and volume. This estimation method is *k*NN method (Reese et al., 2002; Makale and Pekkarinen, 2004; McRoberts and Tomppo, 2007). Using high spatial resolution images, Astola et al., 2003 found relationship of belonging to stem volume, average stem diameter, stem number and tree species proportions. Besides, using lidar and radar systems, it was predicted forest stand parameters and constructed regression models (Holmgren et al., 2003; Lefsky et al., 2005; Holström and Fransson 2003)

In this study, a geometric correction process is applied to the ETM satellite image of July 4th 2000 and converted into the related projection system. In the work, an atmospheric correction process was applied regarding all areas, in which remote sensing data was used, which could also eliminate the negative effects due to the atmosphere on the image data and negative effects of the topography due to the inclination and aspects. For the work area, a basin with a weighted natural beech (*Fagus orientalis* L.) stand was selected. In this study, the relationships between forest stand parameters and Landsat ETM spectral responses thorough analyses of study area was explored and the results were evaluated

MATERIALS AND METHODS

The study area comprises 1750 hectares in the north of the Western Black-Sea Region and 13 km northwest of Bartın province centre located at 41° 37′ 44″ northern latitude and 32° 11′ 59″ eastern longitude. (Figure 1).The summers are calm and the winters are snowy and rainy in the region. The vegetation term (the warm period, during which the average temperature is +10 °C and above according to Rubner (1960)) lasts seven months (April-October). The relative humidity of the study area, which has a rather humid climate, is about 80%.

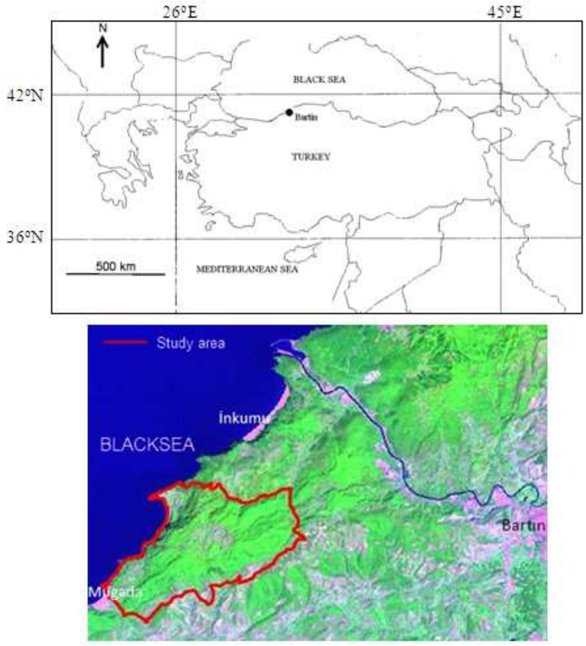

Figure 1. Study area and Thematic Mapper images.

The average altitude of the study area is 200 m. Examining the elevation distribution of the study area according to Özhan (1991), 40% of the area is sloped, 33% is steep and 19% is very steep. Respecting the aspect groups, it is seen that the area has nearly equal areal distribution regarding each aspect. Nearly 85% of the study area is covered with forests, constituted by the dominant Beech (*Fagus orientalis* L.), followed by, depending particularly on the aspect, horn beech, sporadic chestnut and lime trees along with pseudo-maquis (Table 1).

Table 1. Biophysical and land use characteristic in study area.

Soil types	Principal geological formations of research area consist of limestone and andesite rock. These parent materials are quickly dissociated and rich in Ca. the soil of the area is fine-texture and soil type is clay.
Landscape characteristics	Due to take place in the Black Sea coastal region, study area and close district extensive deforestation occurred in past 30-40 years. Mature *Fagus orientalis* L. forests are distributed along rugged terrain
Main tree species	*Fagus orientalis*, *Castanea sativa* (individual case), *Tilia tomentosa* (individual case), *Quercus sp*. (southern aspect)
Average vegetation age	Most successional vegatations are between 35 and 50 years.
Vegetation stand structure	Relatively simple
Average periodic increment (10 years)	About 24.30 m^3/ha
Climate conditions	Rainfall: 1023.6 mm Rainy Season: September-February
Topographic variability	Rugged terrains. The elevation bands from 50 to 400 m.

***Reference data and analysis*:** In the study, two topographic maps of the scale 1:25000 (Zonguldak E28-d2, E28-d3) and stand type maps of the Central Forestry Department of the Bartın Forestry Directorate were used. The maps were used at the control of the ground method data and the geometric correction of satellite images. Landsat ETM+ satellite data (WRS: Path 178 and Row 31) was acquired for July 4, 2000, georeferenced to UTM zone 36 projection based on the ED50 datum. Atmospheric correction procedure was applied to all Landsat ETM+ bands except the thermal. In order to generate the numeric terrain model of the study area, the contour lines at each 10 m on the topographic map were digitized. The altitude values of the contour lines were entered into a computer environment. By utilizing the contour lines the Digital Terrain Model (DTM) was generated for atmospheric correction (Figure 2).

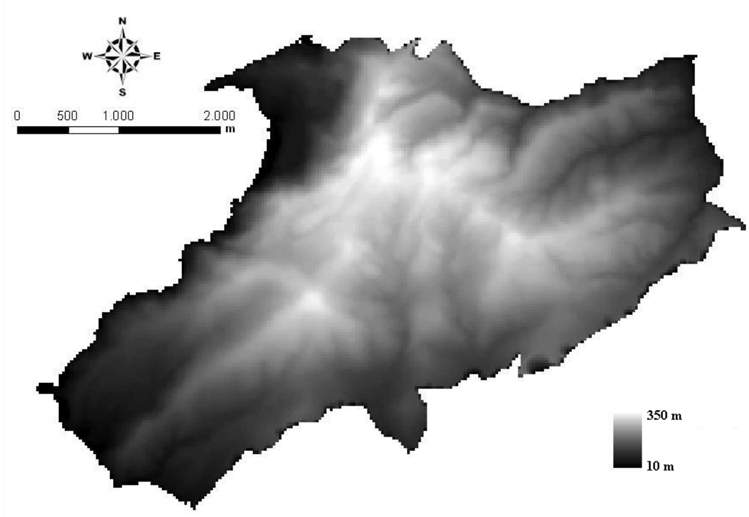

Figure 2. Digital terrain model.

In order to collect ground inventory data, the systematic sampling method was used and in distances of 300 × 300 m at a size of total 400 m^2, it was planned to take 64 samples in total. However, during the field studies, performed in July-August 2007, a total of 23 sample areas were cancelled due to the topography and the disturbance of the present homogeneity (as a result of illegal cuts) at some of the selected trial areas, and the measurement of a total of 1600 trees at 41 sample areas was performed (Figure 3). The centre coordinates of each sample area were recorded in the respective coordinate system and datum by the aid of GPS (Global Positioning System). The correctness of each coordinate value obtained from the terrain was controlled on topographic maps of 1:25000, a stand map of the same scale and geometric corrected satellite image data. Since the study to be performed will be realized based on spectral reflection values with a 3 × 3 window size (surrounding the field plot), care was taken that the close proximity regarding each sample area has similar features, meaning on the homogeneity of the vegetation structure.

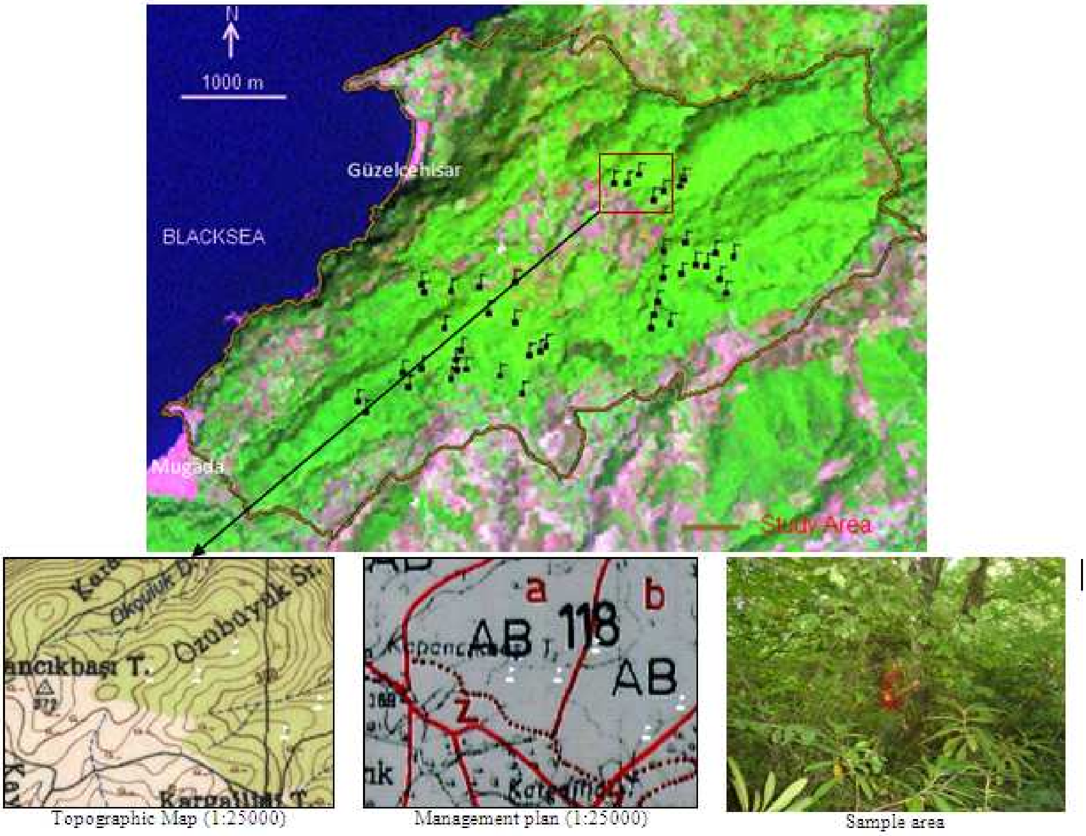

Figure 3. Positions of the sample areas.

In the measurement of stands, the stand or stand type at a definite location is deemed to be a population. The units of the population are constituted by trees. Forest stand is determined by features like the number of trees and their distribution, basal area, tree volume, mean diameter etc. (Kalıpsız, 1993). The trees within each sample were identified. Diameter at Breast Height (DBH) of all trees in the sample areas a diameter higher than 8 cm (DBH >= 8 cm) were measured. DBH was measured with a tree calliper bilaterally and averaged. Besides, the height of the trees in the trial area was determined by utilizing the “Blume Leiss” height gauge. Tree heights at each diameter step were attempted to be measured at as equal a number as possible. Five forest stand parameters were calculated using following formulas.

Number of trees (NUM): $Number\ of\ trees = \Sigma Number\ of\ trees \times A$ (N/ha) (1)

Average Stand Diameter (ASD): $\bar{d} = \frac{\sum d_i}{n}$ (cm) (2)

Basal Area (BA): $G_{1.30} = \sum \frac{\Pi}{4} d_{1.30}^2$ (m²/ha) (3)

Average Stand Height (ASH): $\bar{h} = \frac{\sum h_i}{n}$ (m) (4)

Stand Volume (VOL): $V = \sum V_i$ (m^3/ha) (5)

Image pre-processing and advance of vegetation indices: Geometrical rectifications, radiometric and atmospheric correction of remotely sensed data are often required for many applications (Lu et al., 2002). The satellite images used in the study were received with only the failures due to the sensor being corrected, but the environmental caused failures due to the atmosphere and topography and due to the object were not corrected. For this purpose, geometric correction process was performed in order to establish the balancing model of the relation between the image coordinate system and earth coordinate system (Lillesand and Kiefer, 2004). In this research, ETM image were geometrically rectified into UTM projection using control points taken from topographic maps at 1:25000 scale. The nearest neighbourhood method was used and a root-mean square error of less than 0.8 pixel was obtained for ETM image. Due to the fact that as the sampling method the pixels obtained from the original image were associated to the nearest pixel location on the numerical corrected image, nearest neighbourhood resampling technique affecting the original pixels the least was applied.

The Atmospheric Correction was applied to ETM image data (Chaves, 1996; Ouaidrari et al., 1999; Zhang et al., 1999; Song et al., 2000; Liang et al., 2001) which method is suitable for a specific project depends on the objective of the study and atmospheric data available. The most valuable data to be obtained from remote sensing sensors is sun radiation within a definite band, reflected from any object on the Earth's surface or the emitted thermal radiation (Sarıkaya, 2006). Atmospheric correction is an application in order to obtain data regarding the real reflection values of surface temperatures and objects on satellite images. The atmospheric correction software (ATCOR), used in the study, has been developed by Dr. R. Richter from the German Aerospace Centre (Richter 1996; Richter 1998; Richter 2008). The terrains in this study area are dominantly rugged, hence, the ATCOR-3 module of the PCI Geomatica 9.1® was used (PCI Guide, 2005). The gain and offset, and sun elevation angle were obtained from the ETM image header file. Looking at the configuration of the atmospheric correction parameters (ATCOR-3) used in the study, the parameters; aerosol types, atmospheric definition, solar zenith and azimuth, visibility, adjacency and calibration (Table 2).

Table 2. Used to study the technical characteristics of Landsat ETM+ and parameters of atmospheric correction procedures.

Acquisition Date	2000-07-04
Sensor	Landsat-7 ETM+
Band Combination	1,2,3,4,5,7
Location	Ul Lat = 42.7243004 Ul Lon = 31.1021290 Ur Lat = 42.3644676 Ur Lon = 33.5827637 Ll Lat = 41.1399345 Ll Lon = 30.7223053 Lr Lat = 40.7881851 Lr Lon = 33.1447487
Sun_Azimuth Sun_Elevation	127.7101082 63.1439777
DTM	10 m
Aerosol Type	Rural
Atmospherical Condition	Humid
Calibration File	Geomatica_V91\Atcor\Cal\Landsat7\ Etm_Std1
Visibility	25 km

After geometric rectification and atmospheric correction, a variety of vegetation indices were calculated for study area. These vegetation indices are summarized in Table 3. These included, SAVI, NDVI, LAI, FPAR (Baret and Guyot, 1991; Choudury, 1994), Surface Albedo, PCA and KT (Crist and Kauth, 1986) were applied (Table 3).

Merging of field data end ETM spectral responses: The sample data can be linked to ETM individual bands or the vegetation indices derived from ETM image to extract the spectral responses for each field plot. A plot size from the field was about 0.45 times image pixel size. In calculations in this study, the arithmetic means of radiance values within 3 × 3 pixel window surrounding the target pixel were used for each Landsat ETM+ band and vegetation indices. It is provided that the mean pixel value for each image band and vegetation indices was computed from these homogeneous pixels. The Pearson's correlation coefficient analysis was utilized in the analysis of the relations between the forest stand parameters and ETM+ spectral response relationships. In order to be able to establish a model of the stand parameters, determined with measurements on the terrain, and independent variables, which were spectral reflection values of satellite image data, a multiple linear regression modelling was performed with the package statistics software SPSS 15.0. ® The models producing the highest adjusted R^2 were determined as the best function to model stand structure.

Table 3. Selected remote sensing vegetation used in research

Vegetation Indices	Formula
NDVI	NIR-RED / NIR+RED
SAVI	(NIR-RED)/(NIR+RED+L)(1+L), L=0.5
PCA	-
KT Brightness (KT1) Grenness (KT2) Wetness (KT3)	 0.3037ETM1+0.2793ETM2+0.4743ETM3+0.5585ETM4+0.5082ETM5+0.1863ETM7 -0.2848ETM1+-0.2435ETM2+-0.5436ETM3+0.7243ETM4+0.0840ETM5+-0.1800ETM7 0.1509ETM1+0.1973ETM2+0.3279ETM3+0.3406ETM4+-0.7112ETM5+-0.4572ETM7
LAI FPAR	$- 1/a_{2*}\ln(a_0\text{-VI}/a_1)$, (VI=SAVI), a_0=0.5, a_1=0.65, a_2=0.60 C[1-A exp(-B LAI)] A=1, B=0.4, C=1
ALBEDO	ETM1+ETM2+ETM3+ETM4+ETM5+ETM7

RESULTS

The correlation between the reflection values in the visible spectrum of ETM+ satellite was higher. Therefore, the red band, important for the vegetation indices, and infrared bands reflection values were used in the statistical analysis. Selected forest stand parameters were significantly related to some vegetation indices but no related ETM bands depending on the characteristics of the study areas. All of the data contained in the six bands ETM, except the thermal band, was squeezed into the three band component for PCA (Lillesand and Kiefer, 2004). Due to the fact that the information content of the first band resulted in 84% after the conversion of the PCA, the first band was used in this study. Selected forest stand parameters have correlations with ETM and vegetation indices reflectance values (for the full 3 × 3 window) depending on the characteristics of the study area. Table 4 summaries the correlation coefficients between the selected stand parameters and ETM bands, vegetation indices in the study area.

Table 4. Correlation coefficients between forest stand parameters and ETM band, vegetation indices in the study area

	ETM 3	ETM 4	ETM 5	ETM 7	SAVI	NDVI	PCA
ASD	-.091	.067	-.040	-.058	.424(**)	.123	.355(*)
BA	-.029	.290	.183	.138	.693(**)	.116	.669(**)
ASH	.003	.189	.048	-.035	.570(**)	.074	.499(**)
CRC	.018	.207	.244	.191	.134	.006	.251
NUM	.080	.281	.244	.217	.497(**)	-.029	.505(**)
VOL	-.040	.243	.161	.123	.643(**)	.123	.590(**)

	KT1	KT2	KT3	ALBEDO	LAI	FPAR
ASD	.457(**)	.487(**)	-.020	.411(**)	.392(*)	.380(*)
BA	.590(**)	.792(**)	-.223	.708(**)	.761(**)	.755(**)
ASH	.498(**)	.690(**)	-.066	.549(**)	.670(**)	.652(**)
CRC	.087	.080	-.240	.220	.264	.276
NUM	.359(*)	.513(**)	-.217	.500(**)	.570(**)	.569(**)
VOL	.541(**)	.720(**)	-.220	.651(**)	.696(**)	.690(**)

*: P <0 .05, **: p < 0.01

The visible, near and middle infrared wavelengths were not significantly correlated with forest stand parameters; however, vegetation indices most and strong correlations correlation with selected stand parameters. Vegetation indices were most correlated with BA, ASH, VOL and NUM, but NDVI and KT3 were not significantly correlated with forest stand parameters. NDVI and KT3 have weak correlation with forest stand parameters due to homogeneity vegetation structure, land-use and canopy homogeneities in the study area. SAVI was significantly correlated with ASD and NUM and strongly correlated BA, ASH and VOL. PCA was significantly correlated with ASD and NUM and strongly correlated BA, ASH and VOL. KT1, KT2 and ALBEDO was significantly and strongly correlated ASD, BA, ASH, NUM and VOL. Since the NDVI have weak statistical relationship with forest stand parameters at the performed study, the SAVI was used for the generation of the LAI. LAI and FPAR, LAI used in the calculation of, was significantly correlated with ASD and strongly correlated BA, ASH, NUM and VOL.

The forest stand parameters have high correlations with vegetation indices in study area, marking the impacts of different characteristics. The stand structure in study area may be an important factor significantly relationships between vegetation indices spectral signatures BA, VOL and height because these parameters related to forest stand density and species. The optical sensors mainly canopy information and the canopy density regular in study area for this reason NUM had weaker correlations with vegetation indices than did the others. This results in better relationships of vegetation indices with BA, ASH and VOL than ASD and NUM in study area.

Regarding each stand parameter of the ETM+ bands and vegetation indices, in order, simple linear or multiple linear regression models were established. Based on the variable addition and elimination method (Stepwise Selection), KT2 was selected for ASD; KT2, ETM4, ALBEDO, NDVI for BA; KT2, ETM7, LAI, ETM3 for ASH; LAI for NUM and KT2 for VOL (Table 5).

Table 5. Model summaries

Model summary (BA)			
Adjusted R^2	Std.Dt..	F	D.W.
0.617(a)	6.048	65.574	1.652
0.650(b)	5.787	38.207	
0.701(c)	5.350	32.207	
0.753(d)	4.860	31.487	

a. KT2
b. KT2, ETM4
c. KT2, ETM4, ALBEDO
d. KT2, ETM4, ALBEDO, NDVI
Dependent variable: **BA**

Model summary (ASH)			
Adjusted R^2	Std.Dt..	F	D.W.
0.462(a)	2.638	35.384	1.996
0.538(b)	2.445	24.291	
0.582(c)	2.327	19.548	
0.581(d)	2.328	28.764	
0.625(e)	2.204	23.205	

a. KT2
b. KT2, ETM7
c. KT2, ETM7, LAI
d. ETM7, LAI
e. ETM7, LAI, ETM3
Dependent variable: **ASH**

Model summary (ASD)			
Adjusted R^2	Std.Dt.	F	D.W.
0.217(a)	3.383	12.110	1.904

a. KT2
Dependent variable: **ASD**

Model summary (NUM)			
Adjusted R^2	Std.Dt.	F	D.W.
0.307(a)	313.126	18.741	2.242

a. LAI
Dependent variable: **NUM**

Model summary (VOL)			
Adjusted R^2	Std.Dt.	F	D.W.
0.506 (a)	53.279	41.934	1.630

a. KT2
Dependent variable: **VOL**

The multivariate exponential regression function resulted in the best model performance for prediction BA, ASH and VOL. Using Landsat ETM+ band 4 and vegetation indices KT2, ALBEDO and NDVI as forecaster variables of basal area, the adjusted R^2 was 0.753 with a standard devotion (Std. Dt.) of 4.86. For the exponential model of height using Landsat ETM+ band 3,7 and vegetation indices LAI, the adjusted R^2 was 0.625 with a standard devotion (Std. Dt.) of 2.20. For volume using vegetation indices KT2, the adjusted R^2 was 0.506 with a standard devotion (Std. Dt.) of 53.28 (Table 6). The models ($R^2 \geq 50.00$) presented in Table 6 were used to generate basal area, stand height and stand volume image output (Figure 4).

Table 6. Regression models for estimation stand parameters

	Regression Parameters ($Y = B_0 + B_1X_1 + ... B_nX_n$)				
	B_0	B_1X_1	B_2X_2	B_3X_3	B_4X_4
ASD	-8.260	0.127(KT2)			
BA	-78.677	0.53(KT2)			
	-77.638	0.623(KT2)	-0.112(ETM4)		
	-67.067	0.467(KT2)	-0.152(ETM4)	0.168(ALBEDO)	
	-82.592	0.376(KT2)	-0.154(ETM4)	0.252(ALBEDO)	0.116(NDVI)
ASH	-18.781	0.170(KT2)			
	-17.718	0.196(KT2)	-0.051(ETM7)		
	-11.274	0.066(KT2)	-0.068(ETM7)	0.118(LAI)	
	-6.805	0.073(ETM7)	0.167(LAI)		
	-9.373	-0.115(ETM7)	0.179(LAI)	0.058(ETM3)	
NUM	-976.183	11.394(LAI)			
VOL	-576.479	3.73(KT2)			

DISCUSSION

While BA, ASH and VOL of natural beech (*Fagus orientalis* L.) stands were significantly correlated to Landsat ETM+ band 3, 4, 7 and vegetation indices KT2, LAI, ALBEDO and NDVI (Table 5). Some vegetation indices, such as NDVI and KT3, were not significantly with selected forest stand parameters. Lu et al., (2004) concluded that linear transformed indices such as PC1, KT1 and ALBEDO were most strongly correlated with forest stand parameters (BA, ASD and ASH). In parallel to this work, NDVI and KT3 were weakly and not significantly correlated with selected forest stand parameters. Also, Lu et al., (2004) concluded that SAVI was not significantly correlated except with selected forest stand parameters (ASD and ASH) in Bragantina study area. But, SAVI was significantly correlated with selected forest stand parameters in this study. So, the SAVI was used for the generation of the LAI. For mapping of aboveground biomass and stand volume the pixel values within the 3 × 3 pixel window surrounding the centre pixel of the field plot were averaged for each Landsat ETM+ band (Hall et al., 2006). The image height model had an adjusted R^2 of 0.65 from ETM+ bands 3, 4 and 5. Also, correlation coefficients generated from tassel cap brightness, greenness and wetness were respectively *R*-values of -0.52, -0.53 and 0.45 (Statistically significant at p=0.05). In this study, image height model had an adjusted R^2 of 0.653 from ETM+ bands 3, 7 and vegetation indices LAI and correlation coefficients generated from tassel cap brightness, greenness and wetness were respectively *R*-values of 0.498, 0.69 and -0.066 (Statistically significant at p=0.05). Hall et al., (2006) concluded that the study focused on method development to estimate stand parameters for conifer component due to the obvious dominance of conifer species. This study focused on method development to estimate select forest stand parameters for the deciduous component (dominance of deciduous species, mostly *Fagus orientalis* L.). The ratio and aspect of *R* values regarding tassel cap culminated in different due to the fact that site conditions and tree species.

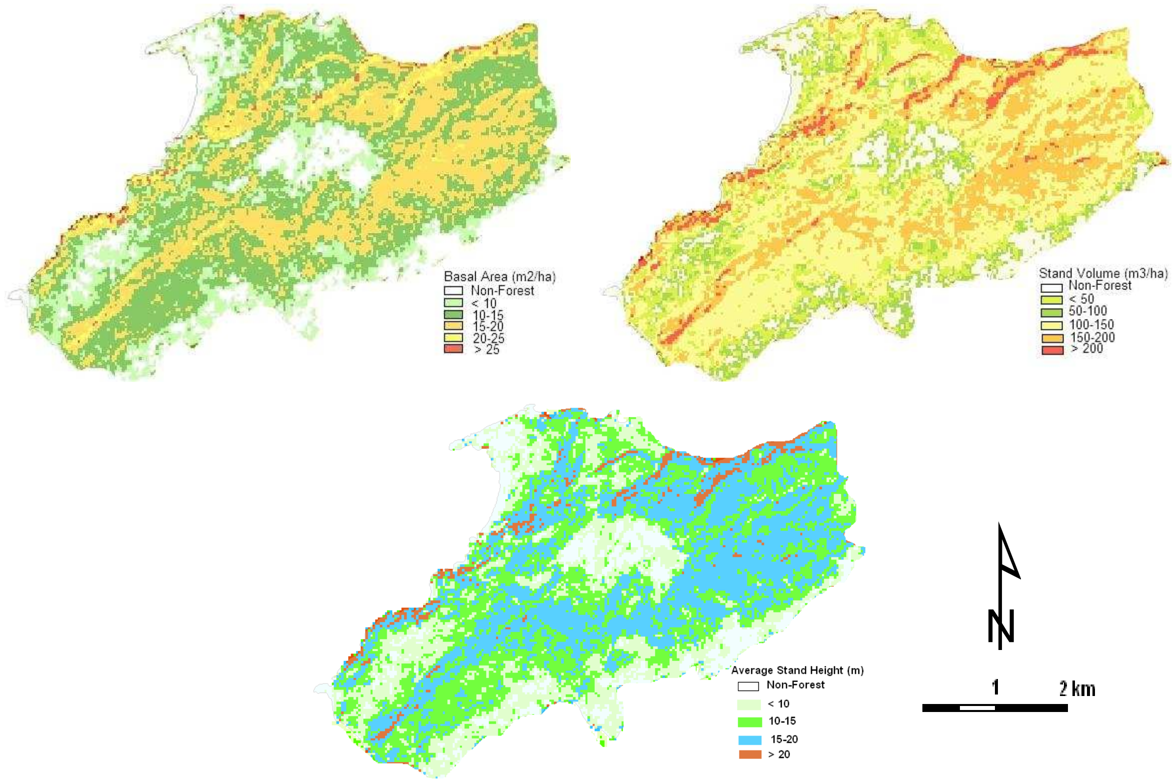

Figure 4. Modelled Basal Area, Stand Volume and Height estimates for the study area.

Freitas et al., (2005) concluded that three vegetation indices (normalized difference vegetation index (NDVI), moisture vegetation index using Landsat's band 5 (MVI5) and moisture vegetation index using Landsat's band 7 (MVI7)) were correlated with measurements of forest structure and models were also developed. At the same time, NDVI was not significantly with selected forest stand parameters for humid and dry seasons. In this study, despite its weak statistical relationships with forest stand parameters, NDVI contributed the established model. The accuracy of elevation and aspect analysis (Carter, 1992) used for atmospheric correction procedure depends on the DTM. In general, DTM resolution 0.25 times the geometric resolution of the satellite image data is enough (Goodenough et al., 1990). In this study, DTM resolution was ~0.35 times the geometric resolution of the Landsat ETM+. The desired DTM resolution ratio increases the accuracy of the results.

CONCLUSION

By the utilization of the Landsat 7 ETM+ image data, vegetation indices KT2 (greenness of the tasselled transform), Leaf Area Index (LAI), Fraction of Photosynthetically Active Radiation (FPAR), ALBEDO, Soil Adjusted Vegetation Index (SAVI) and PC1 (the first component in a principal components analysis) were significantly correlated with forest stand parameters (especially as Basal Area, Average Stand Height and Stand Volume). In order to be able to make definitions regarding the forest stand based on the relations between remote sensing data and the stand parameters, spectral based regression models were developed. Multiple linear regression models were generated by using the staged regression analysis (Stepwise Selection) method regarding the estimation of stand parameters by the utilization of the relations between the stand parameters and remote sensing data. Models developed for small sampling land plots were applied on the whole of the study area. In future, the study for beech (*Fagus orientalis* L.) stands is going to set an example in ways: providing faster and less expensive observation or measurement, providing inventory estimates, and producing forest thematic maps. The accuracy and practicability of the study depends to different biophysical environment of study area. Also, the deficiencies of available data –especially DEM data used as template in atmospheric correction- were factor in the accuracy study. It is a fact that forest inventory studies at regional and global scales will be valuable by this method regarding time and costs.

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THE FACTORS AFFECTING THE SUCCESS OF NATURAL REGENERATION EFFORTS IN KASTAMONU-ARAÇ REGION'S BLACK PINE (*Pinus nigra* Arnold. subsp. *pallasiana* (Lamb.) Holmboe) STANDS

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ABSTRACT

In this study, where the habitat and the factors affecting the success of natural regeneration efforts performed in different years in Araç region have been investigated has been completed in year 2012.

Within the scope of research, in order to determine the most important factors affecting the success of the black pine natural regeneration efforts, the factor analysis was utilized. As a result of factor analysis, it has been found that physiographic conditions, physical soil properties, organic matter, climate, and outer soil status factors affect the success of regeneration efforts.

Keywords: Black pine, natural regeneration, regeneration success

1. INTRODUCTION

Because of increasing population and the industrialization, the decrease of natural forest resources still continue in 21st century. Especially for satisfying the high amount of demand increase especially for wood raw material, 180 million hectare of natural forests and plantation forests of developing countries have been destroyed between 1980 and 1995 as a result of excessive usage from forest resources. This amount has reached 200 million hectare nowadays (İlter and Ok 2004).

Because of various habitat conditions depending on existence of various climate and physiographic conditions, our country has biologically and economically rich pure and mixed natural forest resources in terms of both of tree species and stand establishments. According to data of year 2004, total forest surface area of our country is 21,188,747 ha. This equals 27.2% of total surface area of our country and is a very important amount. From the qualitative aspect; 50% of our forest resources (10,621,221 ha) is normal bosket and normal coppice forest, and 50% (10,567,526 ha) ruined bosket and coppice forest (Anon. 2006). As can be understood from those data, most of our forest resources have been spoiled as a result of biotic and abiotic factors such as excessive usage, wrong technical interventions, fires, snow, and disaster damages. So their productivity has been decreased. Depending on that decrease in productivity of our natural forest resources, the amount of product obtained from them has gradually decreased year by year. According to recent data, 15-15 million m^3 products can be obtained from forests of our country. This value means an increase of 0.750-0.800 m^3/ha per year. When comparing that value with that of countries such as Romania (2.6 m^3/ha), Greece (2.1 m^3/ha) and old Yugoslavia (2.7 m^3/ha), it is very low (Ürgenç 1998). The significant increase of this rate and consequently the ability to increase the share of forestry industry in our national income can only be possible through successful regeneration (natural and artificial) efforts on our ruined natural forest resources of which the productivity has been decreased, their rehabilitation in terms of quality and quantity, and making unproductive forest areas more productive via forestation efforts. This point takes place in definition of silviculture which is adopted by many scientists as

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"planned establishment of new forests and sustainment of (keeping) them with ones existing in nature, and regenerating them and sustaining their existence in best form" (Saatçioğlu 1969; Ata 1995; Odabaşı et al. 2004).

The existence of wide range of species diversity and stand establishments in Turkey depending on various habitat conditions play direct role in determination of techniques to be used in regeneration and keeping efforts to be made, and also in their success. That's why; it is very important to determine the regional habitat conditions (climatic, edaphic, and physiographic conditions) and stand properties (stand type, closure, density, layeredness, mixture rate, and etc.) in details in forest area where the silvicultural intervention will be performed (Çepel 1966; Daşdemir 1987; Oliver and Larson 1996; Çolak and Odabaşı 2004). In order to provide that information, the habitat researches and stand structure analyses should be done (Saatçioğlu 1969; Smith et al. 1997; Bachofen and Zingg 2001; Wehrli et al. 2005). Even though the information about habitat conditions and stand properties are very important, they are not enough for the success of regeneration and keeping efforts by themselves. Besides the information obtained from performed researches and stand analyses, also the species to be intervened and the silvicultural requirements of those species should be known (Özel 2007).

The black b-pine populations in our country includes some important criteria such as volume productivity, height increase, diameter increase, wood quality, and seed productivity, and they sustain their existence by adopting themselves to their habitat as a result of natural selection which nature has sustained for hundreds of years. The black pine is one of the leading species spreading all over the world. Besides being the specie objected to many researches in different countries, black pine is also a specie which has engaged botanists' attention for many years, and there are some debates about its systematic. According to the recently used and valid classification, black pine is distributed into 5 sub-classes (Alptekin 1986; Yaltırık 1988; Ertekin 2006). Those sub-classes and their habitats are given below.

- **a.** *Pinus nigra* Arnold. Subsp. *nigra*: Austrian black pine, (Syn: *Pinus nigra* Arnold var. a*ustriaca* (Hoess.) Badaux.), from Austria to middle Italy, naturally develops in Greece and Yugoslavia.
- **b.** *Pinus nigra* Arnold. Subsp. *larico* (Poiret) Maire: Corsica black pine, (Syn: *Pinus nigra* Arnold var. *corsicana* Suring), exists in Southern Italy, Corsica and Sicilia.
- **c.** *Pinus nigra* Arnold. Subsp. *dalmatica* (Vis.) Franco: Dalmatian black pine, spreads over northwestern coasts and islands of Yugoslavia.
- **d.** *Pinus nigra* Arnold. Subsp. *salzmannii* (Dunal) Franco: Pyrene black pine, (Syn: *Pinus nigra* Arnold var. *cabennensis*), seen in middle and southern Spain and over Pyrene mountains.
- **e.** *Pinus nigra* Arnold. Subsp. *pallasiana* (Lamb.) Holmboe: Anatolian black pine, (Syn: *Pinus nigra* Arnold var. *caramanica*, *Pinus nigra* Arnold var. *pallasiana* Schneid.), spreads over Balkans, Southern Carpathians, Crimean, Turkey, Cyprus, and Syria.

About 30-35 m height, Anatolian black pine is among first class forest trees. They have thick peels, and their old bodies have deep cracks. They have thicker branches than Scotch pine. The resinous gemmas are cylindirical, their tips become sharp suddenly. 8–15 cm length needle-leaves are dark green and hard. As they head through gemma at sucker tips, they create a gap like a pot, and that property of them differs from Scotch pine (Anşin 1994; Ertekin 2006).

Being in second place after Turkish pine in our needle-leaved tree species, black pine is resistant against both drought and winter colds, and its habitat spreads over 3,328,730 ha in our country. The habitat of black pine are Thrace, Northern, Western, Southern and Central Anatolia. They don't exist in marine climate regions of eastern Black Sea region only. This situation is very important from the aspect of evaluation of habitat requirements of this specie. Black pines create pure forests at 400-1400 m altitudes in Black Sea region, except eastern part. They exist at 1400–1700 m altitudes together with Scotch pines and in smaller surface areas. They create mixed stands in western parts of Black Sea region, especially with abies and oaks. Being leading specie in western Anatolia with its large and pure forests, it dominates in higher altitudes. They spread over valleys through shoulders facing the sea. The specie spreading into the steps at most in Anatolia is black pine. It creates its most valuable stands in Kütahya-Tavşanlı, Dursunbey-Alaçam, Adana-Pos, Kastamonu-Boyabat-Elekdağ, Çorum-Kargı, Tosya and Karabük-Yenice. The most typical property of black pine is to prefer the locations facing against the sea such as south parts in northern and central Anatolia, northern shoulders and narrow valleys in Toros mounts; black pine prefers extreme climate conditions. On the other hand, black pine has wide variation in Anatolia. Despite it grows in hot and dry climates, it is also specie which can resist against winter colds. Black pine is a half-light tree. This property of them continues to half-shadow tree property under optimum regional conditions. The black pine is very abstinent in terms of soil requirements, and creates taproot. Because of its resistance against drought and frost, rapid growth, valuable wood, and being the specie closest to step, the black pine is the first tree coming to the mind during forestation efforts in our country (Saatçioğlu 1976; Yaltırık 1988; Anşin and Özkan 1993; Ertekin 2006).

In this study, by using the Large Field Cover Method (LFCM), it was aimed to determine the success level of black pine regeneration efforts in Kastamonu-Araç region. Within this context, 5 parts of fields where 1st Forest Sub-District Directorate (affiliated with Araç Forest District Directorates) has conducted natural regeneration efforts in different years (2004, 2005, and 2007) have been chosen as research site. In order to achieve the goal of this research, the determinations and evaluations specified below have been made during 2 years in experiment sites from black pine regeneration fields:

- **a.** The habitat conditions (climatic, edaphic, and physiographic factors) of stands where natural regeneration efforts have been made have been determined,
- **b.** During 2 years of study (2011-2012), the changes in numbers of youth beeches in unit of area (m^2) in regeneration fields and the changes in their development (length and thee root neck diameter (the status of tip and the color of leaves) have been investigated,
- **c.** The effect levels of many factors affecting the success of regeneration effort have been determined via multi-dimensional statistical analyses, and the most important factors affecting the success of regeneration have been stated.

2. MATERIAL - METHOD

2.1 Material

2.1.1 General Introduction of Research Sites

Located within the borders of Araç district of Kastamonu and administratively affiliated with Araç Forest District Directorate, Araç (Central) Forest Sub-District Directorate is located in the E26-a3, E26-a4, F28-b3 and F28-b4 sections of 1/25000 scaled topographic Kastamonu map. Having a rough terrain in general, the Araç Forest Sub-District Directorate's mean altitude is 1150 m, while the lowest point is Brook Aydın and the highest point is Çandarlı hill (Anon. 2011).

From the forest populations, the research site is located in *northwestern euxin* sub-zone of *euxin* forest zone (Mayer and Aksoy 1998). In Araç planning unit, according to the inventory studies completed in 2011, there are totally 12,143 ha forest field. Of this field; 62.6% is normal, and the rest has the characteristic of ruined forest. According to the forestry being implemented, the forest sub-district directorate has been separated into 3 process units. In harmony with that, the distribution of forests in planning unit in terms of area, tree wealth, and increase is shown in Table 1 (Anon. 2011).

Table 1. The status of forests of Araç Forest Sub-District Directorate in terms of area and tree wealth by process units

Process Units	Area (ha)	Total Wealth (m^3)
AA-Process unit of bad habitat fields	2,465.6	458,976
AB-Black pine process unit	8,473.4	2,796,165
AC-Rehabilitation sites process unit	1,204.6	1,345,897
General Total	**12,143.6**	**4,601,038**

Evaluating the forests in Araç region in terms of stand organization, most of forests of sub-district directorate (56.6%) are in mixed-stand organization. In mixed forests in planning unit, the bipartite and tripartite mixed stand types such as black pine+Scotch pine, black pine+Scotch pine+abies, black pine+oak, black pine+beech, black pine+beech+abies, and abies+black pine dominate the region. The pure forests of region consist of pure beech stands (Anon. 2011).

According to the micro-climate types classification, Araç region is under the effect of Western Black Sea sub-climate type (IIc) (Saatçioğlu 1969; Özyuvacı 1999). There isn't any meteorology station in research site. For having general information about climate of a region having no meteorology station but having known altitude, Çepel (1995) and Özyuvacı (1999) suggest the interpolation of precipitation and temperature values of a meteorology station of which the altitude is known via using Schreiber and Lapse-Rate formulas. That's why, for drawing the climate diagram of the site according to the Walter method, the long-term (73 years) mean values of Kastamonu Meteorology Station (which is the closest one) have been utilized. For this purpose, the precipitation and temperature values obtained from Kastamonu Meteorology Station have been interpolated for Araç region via Schreiber and Lapse-Rate formulas. The climate diagram of Araç region prepared according to Walter method is given in Figure 1.

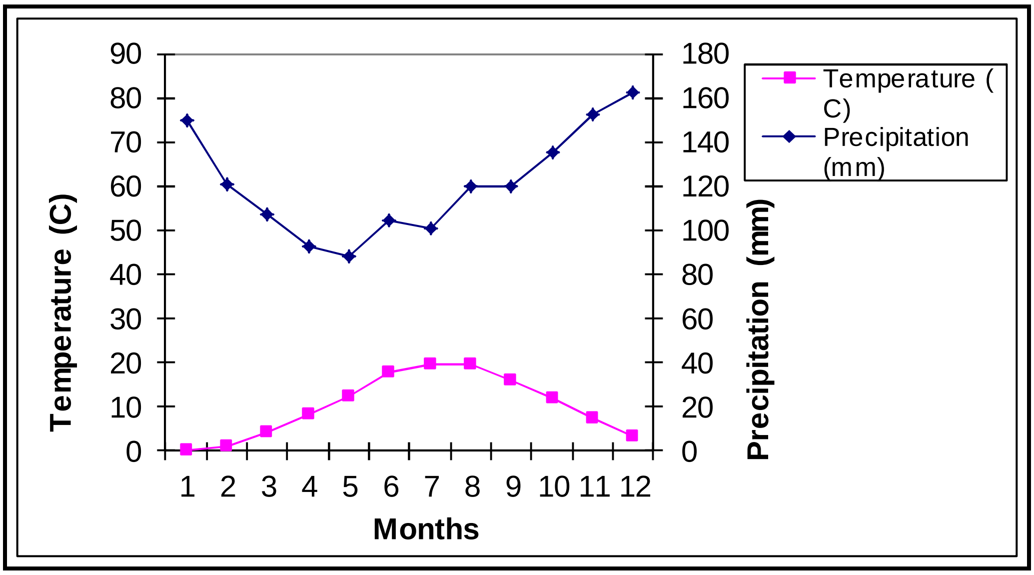

Figure 1. Araç region's climate diagram prepared with Walter Method

2.1.2 The Implementations in Experiment Sites

According to the actual forestry plan, 54b, 63c and 76a parts of Araç are within III. bonitet class, and the actual stand type is showed to be Çkcd$_2$ (Anon. 2011). The parts located in AB-Black Pine process unit are northward and northeastward in general, and their altitudes are 935m, 943m and 910m while the land grade varies between 20% and 35%. The natural regeneration efforts have been made in those segments in 2003, 2005 and 2007 over 10ha, 13,5ha and 8,7ha areas via LFCM method, respectively. For this purpose, seeding-cutting has been performed in Septembers of related years (Figure 2). In that operation, finally 675,356 m^3 revenue etas have been obtained from black pines in all segments. After seeding-cutting, a land preparation consisting of living cover removal and soil processing has been performed on field. During living cover removal process, the pasture brake and blackberry existing densely in field have been removed by cutting in whole surface, and the obtained cutting residuals have been massed in 1-m diameter field. In all segments, because young black pines got their independencies, the removal cutting has been done in November 2010, and totally 788,649 m^3 final revenue etas have been obtained (Anon. 2010).

Figure 2. A general view from research site after seeding-cutting in 2003

2.2 METHOD

2.2.1 Conditions of Experiment Sites

In this study, where various measurement and determinations have been performed about the young black pines, the research sites have been derived in various sizes from total 5 natural regeneration segments of Araç Forest Sub-District Directorate in 2011 within the context of implemented model forestry plans.

The determination of sampling size plays an important role on reliability of the results of a scientific research. In our country, scientists working on similar objects have taken various sampling sizes as bases for determining the stand organizations and youth biology. For example; Pamay (1962, 1967) has worked on 4x16 m, 10x50 m and 20x100 m of experiment site sized depending on the situation to be determined in stand. Saatçioğlu (1971), in his study on natural regeneration of beech in Forest Belgrad, has worked on experiment site sizes varying between 2116 m^2 and 3625 m^2. Odabaşı (1976), in his research on coppice forest and copse forests, has taken various sizes varying between 10x20 m and 20x50 m. Ata (1975), Aksoy (1978), Bozkuş (1987) and Özalp (1989), have generally worked on 10x50 m of experiment site sizes. Suner (1978), in his pure oriental beech study in Düzce, Cide and Akkuş regions, has worked on 90x90 m experiment area size. In this study conducted in Araç Forest Sub-District Directorate, considering the duration and object of study, work resources, and land conditions, the size of experiment sites has been determined as 25x40 m (1000 m^2).

The shape of experiment sites is very important from the aspect of easy and appropriate implementation of borders to land. Taking experiment sites in circle form is an appropriate method because of minimization of the number of trees located on borders and leading to failures. But because of difficulty of implementation of 0.1 h and smaller experiment areas to land due to inclination, it is not used in order to avoid form increasing the suspected trees on border line. In those situations, it is recommended to use square- or rectangle-formed experiment sites (Kalıpsız 1993; Atıcı 1998; Carus 1998). In this study, considering the points such as detail measurements and countings in youth period, we have decided to take rectangular experiment sites.

The determination of the number of samples is very important during planning the research. Excessive amount of samples leads the waste of time and resources. On the other hand, the deficient amount of samples will lead people to estimate the population parameters within a very large range. That's why; the sampling size should be the optimum for representation of the population in best way (Kalıpsız 1976, 1994; Ercan 1997). In our country, various sampling sized have been utilized in studies about comparing the forest populations, determining the growth relationships and adaptation capabilities of various species and origins. For example; Saatçioğlu (1970), in his study on natural regeneration of beech, has established a 7 experiment sites (total area of 2.5 ha) within a beech area with total surface area of 7.6 ha. Within general habitat of Kazdağı abies over 512 ha, Ata (1975) has taken total of 30 experiment sites. And Bozkuş (1987), in his study about natural spread and silvicultural properties of Toros abies, have taken totally 48 experiment sites among the specie's natural habitat which he determined as 350,000 h. Daşdemir (1987), in his study where he has investigated the relationship between habitat factors and productivity of oriental beech, has used the data obtained from 66 experiment sites. Karadağ (1999), in his study on black pine, has carried out his investigation on 14 experiment sites. Çalışkan et al. (2004), in their study on regeneration of oak, have worked on 3 groups containing different amounts of oak seed trees. In this study, where various measurements and determination have been done, the surface areas of regeneration experiment sites have been taken as main criterion during determining the number of experiment sites in terms of segments. Within the scope of mentioned points, the numbers of experiment sites are given in Table 2.

Table 2.Introduction of experiment sites

Sub-district directorate	Segment	Experiment Site Nr.	Altitude (m)	Exposure	Slope (%)	Shoulder Status
Araç	54b	1	810	North	25	Top
		2	835	North	32	Middle
		3	846	Northwest	20	Bottom
		4	850	North	18	Bottom
		5	852	Northwest	23	Middle
		6	855	Northwest	27	Top
		7	861	North	20	Middle
		8	874	North	22	Bottom
		9	892	North	26	Middle
		10	896	North	17	Middle
	63c	1	910	Northeast	34	Bottom
		2	913	Northeast	30	Middle
		3	918	Northeast	33	Top
		4	924	North	35	Bottom
		5	930	North	30	Middle
		6	932	Northeast	32	Top
		7	944	Northeast	36	Top
		8	958	Northeast	31	Middle
		9	963	Northeast	32	Bottom
		10	968	Northeast	30	Bottom
	76a	1	910	North	28	Bottom
		2	912	North	24	Middle
		3	916	Northwest	26	Top
		4	910	North	25	Top
		5	918	Northeast	21	Middle
		6	915	Northeast	25	Bottom
		7	914	North	30	Middle
		8	910	North	27	Bottom
		9	914	North	26	Top
		10	910	Northeast	22	Middle

2.2.2 Determination of Habitat Conditions in Experiment Sites

Forests are living creatures, and have a very special ecosystem occurring as a result of under many factors. This life cooperation which is named “Forest Ecosystem” can show significant variation among regions and even in same region depending on changes in factor or factors forming the forests (Çepel 1966, 1995). That’s why; in order to be successful in silvicultural efforts (regeneration, keeping, and forestation) for ensuring the sustainability of the forests, it is very important to know the habitat conditions. For this purpose, we have performed some measurement and determinations on experiment sites about climatic, edaphic and physiographic properties being effective on development of black pine regeneration habitat condition. Those properties have been evaluated as a separated factor in analyses.

2.2.2.1 Determination of Climatic Factors

The climatic factors such as mean annual precipitation, mean annual temperature, and light intensity of experiment sites from natural regeneration areas have been determined. As there was no meteorology station in research sites, the mean annual precipitation and mean annual temperature values in research sites have been determined via interpolation from mean annual precipitation and mean annual temperature values measured in Kastamonu meteorology station. For interpolating the mean annual precipitation and mean annual temperature values to experiment sites, the Schreiber and Lapse-rate formulas have been utilized.

Within the scope of this study, in order to determine how much of full light in regeneration area penetrates into stand and to include it into analyses, the light intensity of research sites have been calculated. For this purpose, in noon hours when the sunlight reaches earth vertically, the light measurements have been carried out with 2 lux-meters with 240.000 lux capacity synchronously in stand and open area.

2.2.2.2 Determination of Edaphic Factors

In order to investigate the soil properties of regeneration fields, soil profiles have been opened. The numbers and locations of soil profiles vary depending on soil investigation aim and the sampling methods. When one wants to determine the soil properties of a segment, part or experiment site, according to randomized sampling method, it is enough to open profile in points where the physiographic conditions obviously change (exposure, altitude, slope, relief, and etc.) in parts or segments, and in middle point or near it in experiment sites (Irmak 1972; Çepel 1966; Kantarcı 2000; Scheffer and Schachtschabel 2001). The determination of the number of soil profiles has been performed differently by various researchers. For example, Çepel et al. (1977), in their study about Scotch pine in important habitats of Turkey, have opened soil profiled in all of 187 experiment sites with sizes varying from 150 m^2 and 870 m^2 and obtained from 14 forest district directorates. Eruz (1980), in his study in Forest Belgrad, has opened 46 soil profiles over 5441.7 h of research site. Akgül and Aksoy (1976), in their research in Bolu-Şerif Yüksel Research Forest, have carried out their research on totally 440 soil profiles opened in 1544 h of research area. Pamay (1962), in his research on natural regeneration of Scotch pine, considering the differences in exposure in altitude, has opened 12 soil profiles in total. Karadağ (1999), in his study on natural regeneration conditions of black pine, has opened 8 soil profiles on process segments with size of 5600 m^2 in total. As a result of performed assessments, it has been appropriate to open total of 9 soil profiles (3 in each segment) in order to determine the soil properties of natural regeneration area.

While opening the soil profiles, the rules stated by Çepel (1996) have been taken into account. In those profiles, the absolute and physiologic soil depths have been measured, and determinations have been made about root distribution and structure type. But, about the research topic, we focused on properties of top soil being effective on the number and development of young black pines, and the values about this property have been statistically analyzed.

For smooth penetration of roots and rain waters into the soil, improved aspiration in soil, and high nutrient exchange, the best structure type is clastic structure. Because, the plants can distribute their roots through a wider range in soils having clastic structure, and can profit the nutrient medium better. This situation significantly smooths the profiting of small rootlets from water and nutrients in early years of natural and artificial regeneration efforts (Çepel 1995). In this point, it has been found that the best developments of Scotch pine, black pine, Turkish pine, oak, Uludağ abies and Toros abies have occurred in clastic-structured soils having better aspiration and water-retention capabilities (Pamay 1962; Özdemir 1977; Çepel et al. 1977; Kantarcı 1978; Bozkuş 1987; Karadağ 1999). Under the light of those information, it has been determined that the structure type is important for development of young black pines, and the data about this variable has been included in analyses, as mentioned in Table 3.

Table 3 The numerical values of structure type in statistical analyses

Structure type	Numeric value
Granular structure	1
Clastic structure	2

There is no close relationship between the numbers of rootlets (< 2mm) in topsoil and soil productivity. The increase in number of rootlet creates positive effect on development of youth. That's why; the number of rootlets having diameter less than 2mm has been determined as mentioned in Table 4, and has been added into statistical analyses as a variable.

Table 4 The numerical value of rootlet status in statistical analyses

Definition of rootlet status	The number of thin rootlet per 1 dm^2 (Ǿ < 2 mm)	Numeric value
None	0	1
Very weak	1 – 2	2
Weak	2 – 5	3
Middle	5 – 10	4
Strong	10 – 20	5
Very strong	20 – 50	6
Root network	50 <	7

The soil samples taken from soil profiles according to the horizons have been analyzed in laboratories for determination of physical and chemical properties according to certain principles (Çepel 1996; Kacar 1996; Scheffer and Schachtschabel 2001), and soil properties such as soil reaction (pH), soil texture, organic matter, and macro plant nutrient elements (N, P, K) have been determined.

Soil texture is an important soil factor having important effect on nourishment of forest trees. From this aspect, sandy soils are poor in terms of water and nutrient matters. That’s why; the tree species having high organic matter requirements cannot show good development in sandy soils. On the other hand, the clayed soils retain more water and this leads to oxygen deficiency in tree roots. Also, despite the clayed soils retain high amount of water, the plants cannot profit from that water well. That’s why; the most appropriate soil types for plant development are sandy loam, loam, and sandy clayed loam where the water and air economy is optimum (Brady 1990; Çepel 1995; Scheffer and Schachtschabel 2001). Also, the soil type is an important factor affecting the regeneration success (Çepel 1982). That’s why; the determinations have been made in opened soil profiles about texture of top soil, which is important for the number and development of youth, the numerical values have been obtained and those values have been used in statistical analyses.

Table 5 Numeric values of soil texture (type) in statistical analyses

Soil type (Texture)	Numeric value
Clay	1
Clayed loam	2
Sandy clay	3
Sandy clayed loam	4
Sandy loam	5

Soil reaction (pH) is an important soil property in terms of plant’s nutrient intake. Hence, this situation has been proved in various researches of many researchers (Çepel et al. 1977; Kantarcı 1978; Eruz 1980; Kerr 1995). That’s why; it is thought that there may be a relationship between the number of youth and pH value of top soil. In parallel with that, the pH value of top soil determined under laboratory conditions are given in Table 6, and those numeric values have been used in statistical analyses.

Table 6 Numeric value of soil reaction (pH) in statistical analyses

pH	Soil reaction	Numeric value
< 3.5	Extremely acidic	1
3.5 – 4.5	Severely acidic	2
4.5 – 5.5	Mildly acidic	3
5.5 – 6.5	Weakly acidic	4
6.5 – 7.2	Neutral	5
7.2 – 8.5	Alkaline	6
> 8.5	Severely alkaline	7

Organic matters in soil play important role in disintegration of soil minerals and creation of clastic soil texture, so affect the soil development. Also, because they include the nutrients required for plants, they are important for mineral circulation. Besides them, they create the nutrient medium for soil micro-organisms, so it is an important factor affecting the soil biology (Çepel 1995; Kantarcı 2000).

About the amount of organic matter being effective on physical and chemical structure of soil, Çepel et al. (1977), in their research on Scotch forests, have found a relationship between organic matter in forests in Eastern Anatolia and increase. In another research conducted by Eruz (1980), it has been determined that the organic matter content in beech stands in Forest Belgrad varies significantly depending on soil type. In parallel with those explanations, it has been thought in this study about evaluation of natural black pine regeneration efforts that organic matter content in soil may be a factor on youth success, and that factor has been added into statistical analyses as stated in Table 7.

Table 7 The numeric values of organic matter content of soil in statistical analyses

Organic matter amount	Numeric value
%1 – 2 (Low)	1
%2 – 5 (Medium)	2
%5 – 10 (High)	3
%10 – 15 (Very high)	4

The macro nutrient elements of azote, phosphor and potassium are the most important elements required for normal development of the plants (Irmak 1972; Brady 1990; Çepel 1995; Smith et al. 1997; Türüdü 1997; Scheffer and Schachtschabel 2001).

Many researches investigating the relationship between azote, potassium and phosphor macro nutrient elements and plant development have been made, and very interesting results have been obtained in those researches. For example; Çepel et al. (1977), in their study on pure Scotch pine forests in important habitats, have significant relationships between reserve values of azote, phosphor and potassium elements and top heights of stands. Eruz (1980), in his research on beech and oak stands, has found that the diameters and heights of beech and oak trees increase in direct proportion to increase in amounts of especially azote and potassium in top soil. Uğurlu and Çevik (1990), in their study on coppice oak forests, have revealed that there is a linear relationship between potassium, magnesium and calcium elements in soil and sucker lengths. According those explanations, with thought of that the azote, phosphor and potassium content in top soil segment (Ah) may be effective on regeneration success in natural black pine regeneration efforts, including them into statistical analyses as stated in Table 8 has been considered to be suitable.

Table 8 Numeric values of azote, phosphor and potassium elements in statistical analyses

Nutrient matters	Limit values	Levels	Numeric value
Azote (%)	< 0.70	Low	1
	0.70 – 1.60	Medium	2
	> 1.60	High	3
Phosphor (ppm)	< 65	Low	1
	65 – 130	Medium	2
	> 130	High	3
Potassium (ppm)	< 80	Low	1
	80 – 160	Medium	2
	> 160	High	3

An increase in level of soil saltiness which has direct and indirect effects on creation of various physical properties of soils and plant nourishment affects the physical properties (structure, texture, and etc.) negatively, and the plants cannot obtain the nutrients required for their development from soil adequately as a result of that (Kacar 1996). Hence, Dündar (1973), in his study on relationship between dryness seen in black pine and Scotch pine stands and the concentration levels of nutrient matter in soil, has revealed that water-soluble total salt content was high in soils of experiment sites where black pine and Scotch pine stands exist. On the other hand, Eruz (1980), in his study in beech and oak stands' soils, has determined that there are high level of salt content, but in accumulation horizon where the saltiness is slightly higher than other soil horizons, the cation exchange capacity decreases and consequently the density of plant root density decreases in that horizon. Considering that saltiness level of top soil layer where the root development of youth occur may affect the number and development of youth, the level of saltiness in taken soil samples has been determined and the values about saltiness of top soil have been directly used in statistical analyses.

The main resource of macro and micro nutrient matters in soil is the litter. The litter generally consists of leaf, thin branch, peel, cone scale and organism residuals. The litter consists of 3 main layers of leaf, molds, and humus. That's why; for introducing the latter well, it is necessary to determine the changes in thickness of those 3 layers (Çepel 1995). In this study, in order to make detail measurements in youth and to count youth, the thicknesses of latter layers (leaf, mold, humus) have been measured in total of 20 sample sites with 5x5 m size (25 m^2) established in research site with dimensions of 25x40 m.

Besides establishing the most important nutrient resource of the soil, latter has important effects on temperature, moisture, aspiration, permeability, and acidity (reaction) of the soil (Saatçioğlu 1969; Irmak 1972, 1974; Çepel 1995, 1996).

It is possible to define the living cover (plant cover of soil) as a living layer consisting of annual and perennial plants existing over forest soil. From this aspect, the living cover, with latter, is a factor characterizing the status of outer soil (Çepel, 1995). Besides many physical and chemical properties of soil, the living cover layer has also direct and indirect effects on plant development. That's why; the interventions in forests during regeneration efforts to be made should be made by considering the density of living cover layer. In parallel with that information, the living cover density has been determined in sample areas with size of 25 m^2. The living cover density has been added into statistical analyses in accordance with determined numeric values.

2.2.2.3 Determination of Physiographic Factors

One of the important factors affecting the creation of habitat conditions is physiographic factors. Physiographic factors include various characteristics about geographic and geomorphologic properties. The presentation of physiographic characteristics of any region means specific local conditions belonging to that region. And the presentation of special location properties is carried out via altitude, exposure, land slope level, and land surface form (shoulder status) variables. So, the presentation of physiographic properties of a forest ecosystem can be possible only with variables used in presentation of specific location (Çepel 1966, 1995; Smith et al. 1997). In order to define the physiographic factors of stands where the experiment sites have been taken from, the measurements and determinations have been made for specific location conditions such as altitude, exposure, land slope and shoulder status.

The altitude (height from sea level) is an important factor affecting the climate, soil properties and vegetation structure. The low temperature and high moisture conditions in higher altitudes lead significant changes in soil properties. In parallel with those explanations, with the thought that the altitude may be a factor affecting the number and development of young black pines, the altitudes of experiment sites have been measured via altimeter and those values have been added into statistical analyses as variable.

The exposure of a land affects especially the temperature and precipitation climate of that place. In our country, the shadowed exposures (north, northeast, northwest, and east) are colder, sunny exposures (southeast, south, southwest, and west) are warmer. The reason is that the hours and strength of sunshine in sunny exposures are higher in north hemisphere. The shoulders facing the winds bringing the moisture get more precipitation. As their evapotranspiration is less because of coolness, the soil in shadowed exposures is moister than those in sunny exposures in same region. Because of excessive warming in days on one hand and excessive water loss in nights on the other hand, the frost danger in sunny exposures is more than that in shadowed exposures. The existence of snow cover in shadowed exposures more than in sunny exposures plays important role in this point. From this aspect, this characteristic must be considered in natural regeneration and forestation efforts (Çepel 1995). But Kapucu (1978) has reported that site quality is higher in shadowed exposures of spruce tree + Scotch pine + abies + beech stands than in sunny exposures. In a study of Daşdemir (1987) conducted in order to determine the factors affecting the productivity of fagus orientalis forests, it has been reported that there is no significant relationship between exposure and site quality index, but the shadowed exposures have more appropriate conditions for oriental beech stands' development than sunny exposures because of negative relationship between the variables. Bozkuş (1987), in his study on Toros abies, has reported that this specie creates its best stands in shadowed exposures. Çalışkan (1991) and Demirci (1991), in their researches on Scotch pine + abies + beech and spruce + beech mixed stands, have reported that the stand development is better in shadowed exposures than sunny exposures. That's why; the exposure of research sites has been determined via compass, and added into analyses as a variable after being given a numeric value.

The land slope has an important factor affecting the local climate and soil properties of any place and the styles of profiting the land. As land slope increases, the surficial flow and consequently the erosion severity increase and soil depth decreases. So, in sloped locations, shallow and droughty soil conditions having rich skeleton structure occurs. Bur in lowly sloped places, there are deep, moist and appropriate soil textures with low skeleton content. Also the land slope is an important factor affecting the nutrient economy of the soil. But biologic activity increased in lowly sloped lands with appropriate moisture and temperature conditions of soils, consequently the soil obtains high nutrient matter capacity as a result of better disintegration of organic matter (latter) (Çepel 1995; Kantarcı 2000; Scheffer and Schachtschabel 2001). According to the results obtained from various researches, the land slope is an important physiographic factor affecting the habitat productivity. That's why; with the thought that land slope can be factor affecting the natural regeneration efforts on black pine, this variable has been measured as percentage (%) via an abney level. Then the results have been added into statistical analyses.

Different land forms have various ecological properties. That's why; the land form (shoulder status) is an important physiographic factor affecting the local climate characteristics and soil conditions. Indeed, annual and daily temperature changes in parts of shoulder at and near the ridge are higher than those in flat lands at same altitude. Also, the damages of leaching and wind are more in ridge lands. The soil depth is higher in ridge and top shoulder lands are lower than that in middle ridge and bottom ridge lands (Çepel 1966; Brady 1990; Çepel 1995; Smith et al. 1997). In various researches on this topic, it has been determined that the ridge lands are the most unproductive sites for stand development, and the increase increases from upper parts of shoulders to lower parts, and then the most productive sites are the flat areas (Çepel et al. 1977; Kapucu 1978; Daşdemir 1987; Bozkuş 1987; Çalışkan 1991; Demirci 1991; Boydak et al. 2006). For this purpose, the land forms (shoulder status) of land where the experiment sites are located have been grouped into 3 groups, and those groups have been added into statistical analyses after being given a numeric value as stated in Table 9.

Table 9. The numeric values of land forms of experiment sites in statistical analyses

Land Form (Shoulder Status)	Numeric Value
Upper shoulder	1
Middle shoulder	2
Bottom shoulder	3

2.2.4 Counting, Measurement and Determinations about Juvenility
2.2.4.1 Juvenility Countings

The most important criterion used in determination of success of natural regeneration effort is the number of youth in square meter (Baker 1934; Smith 1962; Pamay 1962; Saatçioğlu 1979; Atay 1982; Smith et al. 1997; Nyland 2002; Odabaşı et al. 2004). Hence, in many researches conducted in order to determine the success of natural regeneration efforts performed on various species, the number of youth in square meter (pcs/m^2) has been considered to be a success criterion (Saatçioğlu 1970; Atay 1971; Sevimsoy 1984; Eyüboğlu et al. 1995; Umut et al. 1996; Karadağ 1999; Agestam et al. 2003; Pariona et al. 2003; Çalışkan et al. 2004). In practice, the number of youth in m^2 is considered while evaluating the success of natural regeneration efforts (Anon. 2006; Genç 2006). In this study, the number of youth in m^2 is considered to be a success criterion. For this purpose, the number of young black pines in square meter has been calculated.

Used in determination of the number of youth in square meter considered as an indicator of the success of natural regeneration efforts, the sampling method has great importance from the aspect of accuracy of the results. In practice, the method called “40 steps method” is used for determining the success of natural regeneration efforts. In this method, a rectangle (2 m2) or a circle (160 cm diameter) is placed after each 40 steps in parallel with leveling lines, and then the youth counting is performed. In sapling counting sheets prepared during those countings, the sampling sites where there is no young tree is given a value of 0, while the number of young trees is written besides the sampling sites where there are young trees. After those processes, while calculating the youth success, the total number of points where there are young trees is divided to total number of calculation sites, and the result is multiplied with 100 in order to determine the number of youth in percentage. In youth success calculations, the sites having at least 70% youth regeneration success are considered to be successful, while complementation is made in sites below 70% (Anon. 2006). But Kalıpsız (1988) has suggested to repeat the countings of cones, seeds and saplings in 1-4 m2 experiment sites for 30-100 times. Saatçioğlu (1970), in his study ın natural regeneration of beech, has carried out youth countings on experiment sites with varying areas from 1696 m2 to 3625 m2. Suner (1978), in his study on natural regeneration of beech, has carried out those countings on parcels with dimensions of 30x30m in 90x90m blocks. Umut et al. (1996), in their natural regeneration study ın Turkish pine, have conducted countings on 25x10 m sampling areas and repeated for 48 times. Kaymakçı et al. (2002), in their study ın regeneration of high-zone black pine forests, have carried out the countings on 10x25 m experiment sites and repeated for 9 times. In a study conducted between 2004 and 2006, the youth countings have been performed on 5x5m sized sites established in grid form on 25x40 m sized area. So, through the sampling method applied in research, the youth countings have been conducted on total of 20 experiment sites (500 m^2). Using the data obtained in countings in sampling sites on experiment areas, the number of youth per m^2 has been calculated via formulas below.

$$GS = \frac{\sum GSi}{\sum ÖB}$$

where;

GS : the number of youth per square meter (pcs/m^2),

$\sum GSi$: Total number of youth in sampling sites (pcs/500 m^2),

$\sum ÖB$: Total of sampling area (500 m^2).

2.2.4.2 Measurement of Juvenility Height

The height of youth is one of the most important criteria used for determination of growth of youth since first years (Saatçioğlu 1979; Atay 1982, 1987; Ata 1995; Oliver and Larson 1996; Smith et al. 1997; Nyland 2002; Odabaşı et al. 2004). That’s why; in many studies conducted on natural regeneration of various species, the height measurements have been carried out since first years in order to determine the changes (Sevimsoy 1984; Tosun and Gülcan 1985; Eyüboğlu et al. 1995; Umut et al. 1996; Karadağ 1996; Dündar et al. 2002; Kaymakçı et al. 2002; Çalışkan et al. 2004). For this purpose, the height values of young black pines during 2 years have been determined for each of experiment sites.

Figure 4. Measurement of youth height

As a result of height measurements carried out in black pine youths in sample sites during the study, the average of obtained results has been calculated via the formula below, and the mean annual growth values of black pine youths have been calculated. The mean height values of young black pines determined in each experiment site have been included in statistical analyses as individual variables.

$$\bar{h}g = \frac{\sum hgi}{n}$$

where;

$\bar{h}g$: mean height of young black pines in experiment site (cm),

$\sum hgi$: Total height of young black pines in experiment site (cm),

n : Total number of young black pines in experiment site (pcs).

2.2.4.3 Measurement of Root Collar Diameter of Juvenilities

Another variable used for determining the growth in youth in terms of years is the root collar diameter. The root collar diameter is also an important criterion for determination whether newly germinated seedlings could develop their root systems. Hence, it has been found as a result of researches on some species that there is an important relationship between root neck diameter and the opportunities of seedlings for profiting the water and nutrient elements in soil (Dündar et al. 2002). That's why; the determination of root neck diameters of young natural black pines has been considered to be important from the aspect of revealing the opportunities of seedlings for profiting the actual soil conditions.

$$\overline{KBÇ} = \frac{\sum KBÇi}{n}$$

where;

$\overline{KBÇ}$: The mean root collar diameter of young black pines in experiment site (mm),

$\sum KBÇi$: Total mean root collar diameter of young black pines in experiment site (mm),

n : Total number of young black pines in experiment site (pcs).

2.2.5 Statistical Analyses Used in Research

For statistical analysis of data obtained as a result of research, SPSS (Statistical Package for Social Science) 9.0 package software has been utilized. In order to determine whether data used in statistical analyses show normal distribution, the Kolmogoraf Simirnov test has been utilized (Kalıpsız 1994; Batu 1995; Ercan 1997; Özdamar 2004).

In natural regeneration implementations, there are individual and cooperative effects of many factors on regeneration success (the number of youth per square meter), development of youth (height increase and root neck diameter development) and some morphologic characteristics (the status of tip and leaf color) (Pamay 1962; Atay 1971; Saatçioğlu 1979; Çepel 1982). Especially the number of youth per square meter which is used for determining the success of regeneration efforts is significantly affected by environmental factors, genetic factors and implemented silvicultural techniques. So, it is recommended to utilize multi-dimensional statistical analyses for determining the factors affecting the quantitative character such as youth number (Oliver and Larson 1996; Madsen and Larsen 1997; Tegelmark 1998; Beck 2000; Elliott and Knoepp, 2005).

The multi-dimensional statistical analyses are techniques where many different variables being in relationship with each other are handled and evaluated (Daşdemir 1987, 1995). In this study, the multi-dimensional factor analysis and multiple regression analysis from statistical analyses have been utilized for assessment of factors affecting the success of youth.
Firstly, the correlation analysis has been utilized in order to determine the level and direction of mutual relationships between variables. As a result of analysis, it has been evaluated if the mutual linear correlation coefficients between variables are significant at confidence levels of, 0.05 and 0.01. The factor analysis has been utilized according to correlation coefficients between variables. After preparing the data table related with factor analysis, among widely used factor creation methods, Principal Components Analysis has been taken as base for determining the factors explaining the variance at best way. So, the variables having high correlation coefficients among each other have formed factors by gathering. For determining the number of factor to represent the relationship between variables at highest level, "Kaiser" and "Scree Test" criteria are used. In this study, the Kaiser method based on creation of factors having eigenvalue statistics higher than 1 has been utilized.

In order to name factors and smooth the interpretation, the factor matrix which has been obtained via Principal Component Analysis but not transformed must be rotated. For this purpose, by choosing the orthogonal rotation based on zero correlation between factors, *Varimax* technique has been implemented and the transformed factor matrix has been obtained.

The naming and interpretation of factors can be performed according to common feature of one or more variable having high factor load. Sometimes, the variable having highest factor load can be taken as factor standard (Kalıpsız 1994). Considering the aim of the study, common factors are named in 3 ways. Those are symbolic names, descriptive names, and causal names (Daşdemir 1987). In this study, the naming and interpretation of factors have been carried out generally based on variable with highest factor load. But in some situations, the common reasons lying behind the variables seeming to be in relationship with factor have been taken into account.

In this research, it has been thought to create an opinion about the variables (climatic, edaphic, and physiographic variables) determined during 3 years on the number of young trees. For this purpose, in order to determine the effects of all of the variables on the number of youth, the number of young black pines per square meter determined in 2006 has been taken as base in multiple regression analysis. As the independent variable in multiple regression analysis, the most important factor found as a result of factor analysis (eigenvalue higher than 1) was used. *Enter* method has been chosen for implementation of multiple regression analysis.

3. FINDINGS

3.1 FINDINGS ABOUT THE HABITAT CONDITIONS

3.1.1 Findings About the Climatic Factors

The mean annual precipitation and mean annual temperature values of experiment sites have been obtained via interpolation. During those interpolations in precipitation and temperature values, the annual increases and decreases in mean precipitation and temperature values in meteorology stations in same years with research have been taken into account (Table 10).

Table 10. Mean annual precipitation and mean annual temperature values of experiment sites

Sub-District Directorate	Parcel Nr	Experiment Site Nr	Year 2012	
			Mean Precipitation (mm)	Mean Temperature (°C)
Araç	54b	1	853.6	13.6
		2	862.5	14.2
		3	843.2	13.8
		4	875.9	13.5
		5	883.2	13.7
		6	887.5	13.2
		7	881.4	14.5
		8	886.3	14.8
		9	880.5	13.6
		10	883.6	13.4
	63c	1	945.2	12.4
		2	943.5	12.2
		3	937.8	12.0
		4	948.6	11.8
		5	952.5	12.3
		6	965.7	12.5
		7	973.8	12.8
		8	971.5	12.0
		9	955.3	11.7
		10	942.6	11.5
	76a	1	894.5	14.2
		2	892.6	14.5
		3	891.4	14.6
		4	890.2	14.3
		5	897.6	14.5
		6	898.3	14.2
		7	887.6	14.4
		8	890.1	14.6
		9	892.4	14.3
		10	898.7	13.6

Evaluating the mean annual precipitation and mean annual temperature values obtained via interpolation and showed in Table 10, it has been found that the mean annual precipitation value of year 2012 in Araç region where the research has been conducted has varied between 880.5 and 973.8mm, while the mean temperature value has varied between 11.5 and 14.8^{o}C.

Another factor taken into account within the climate conditions is the light intensity. For this purpose, in order to determine the light intensity, light measurements have been carried out simultaneously in an out of stand under open air (cloudless) conditions. As a result of conducted light measurements, the light intensity values obtained as a result of proportioning the light measurements in and out of the stand are stated in Table 11.

Table 11. Light intensities in experiment sites

Sub-District Directorate	Parcel Nr	Experiment Site Nr	Light Intensity (%)
Araç	54b	1	56
		2	58
		3	52
		4	63
		5	65
		6	62
		7	68
		8	67
		9	59
		10	61
	63c	1	68
		2	72
		3	75
		4	74
		5	73
		6	76
		7	75
		8	73
		9	71
		10	70
	76a	1	63
		2	62
		3	64
		4	65
		5	68
		6	63
		7	65
		8	66
		9	69
		10	71

3.1.2 Findings About The Edaphic Factors

The findings determined as a result of investigations conducted in 9 soil profiles opened in 3 parcels of regeneration implementation site are given in Table 12.

Table 12. The results of measurement and determinations in soil profiles.

Sub-District Directorate	Parcel Nr	Profile Nr	Physiologic Depth (cm)	Absolute Depth (cm)	Rootlet Status	Structure Type
Araç	54b	1	88	100	Medium	Granular
		2	86	75	Medium	Granular
		3	82	88	Medium	Granular
	63c	1	76	64	Medium	Clastic
		2	79	73	Frequent	Clastic
		3	75	53	Weak	Granular
	76a	1	81	38	Weak	Granular
		2	87	50	Frequent	Clastic
		3	84	87	Weak	Granular

The second phase of investigations of edaphic conditions consists of various physical and chemical analyses on soil samples taken from soil profiles in terms of horizons under laboratory conditions. In those analyses, important soil characteristics such as pH, organic matter content, total azote, phosphor, potassium and saltiness have been investigated. The minimum and maximum values of chemical analysis results determined in terms of trabeculas are given in Table 13.

Table 13. Maximum and minimum values of chemical analysis results of soil samples

Sub-District Directorate	Trabecula Nr	pH		Organic Matter (%)		Azote (N) (%)		Phosphor (P) (ppm)		Potassium (K) (ppm)		Saltiness (dS/m)	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Araç	54b	6.20	6.80	5.53	7.28	0.45	1.25	12.0	36.0	79.0	228.0	0.17	0.84
	63c	6.15	7.26	8.56	9.18	0.56	1.35	7.0	27.0	65.0	210.0	0.23	0.65
	76a	6.35	7.11	9.23	10.21	0.46	0.72	8.0	32.0	58.0	165.0	0.35	0.72

3.2 FINDINGS ABOUT JUVENILITY

3.2.1 Findings About the Number of Juvenilities

The most important criterion in determining the success of natural regeneration is the number of young trees per square meter. That’s why; the number of young trees per square meter in research site is given in Figure 5.

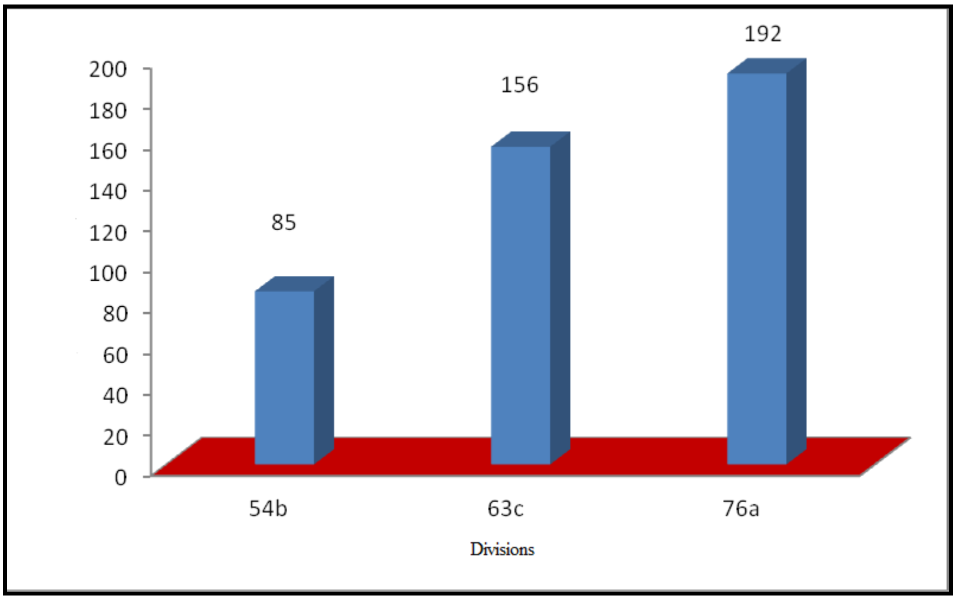

Figure 5. Mean number of young black pines by trabecula

3.2.2 Findings about the Height Growth of Young Black Pines

The most important criterion used in determining the growth of young trees in first years of regeneration studies is the youth height. That’s why; height measurements have been carried out on natural young black pines with different heights in 25 m^2 sample sites. The values of height measurements are given in Figure 6.

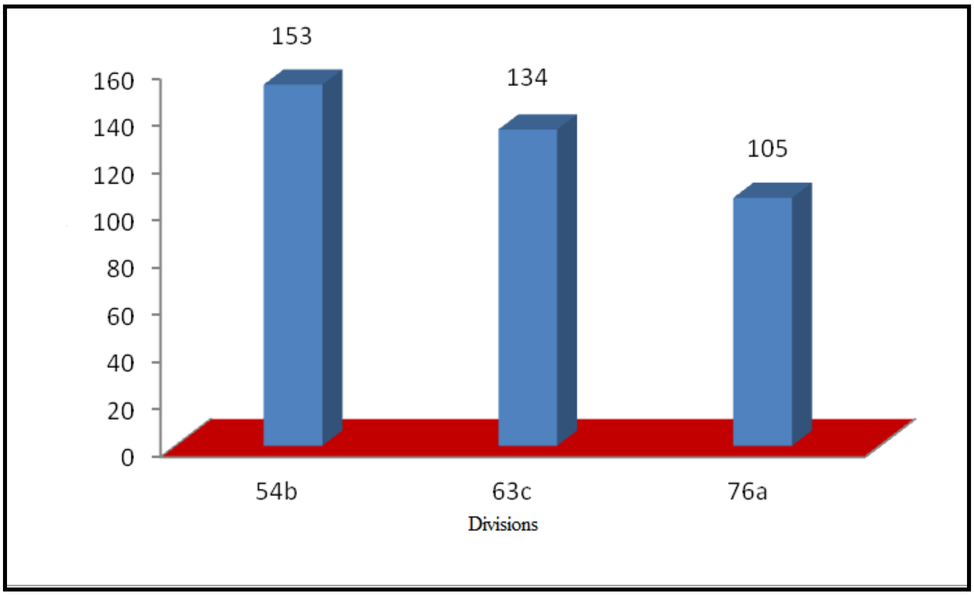

Figure 6. Mean heights of young black pines by trabeculas

3.2.3 Findings about the Root Collar Diameters of Young Black Pines

One of the variables used for tracking the growth in first years of young trees in regeneration studies is the root collar diameter growth of youth. That's why; the root collar diameter measurements have been carried out on young black pines in research site, and the results obtained are given in Figure 7.

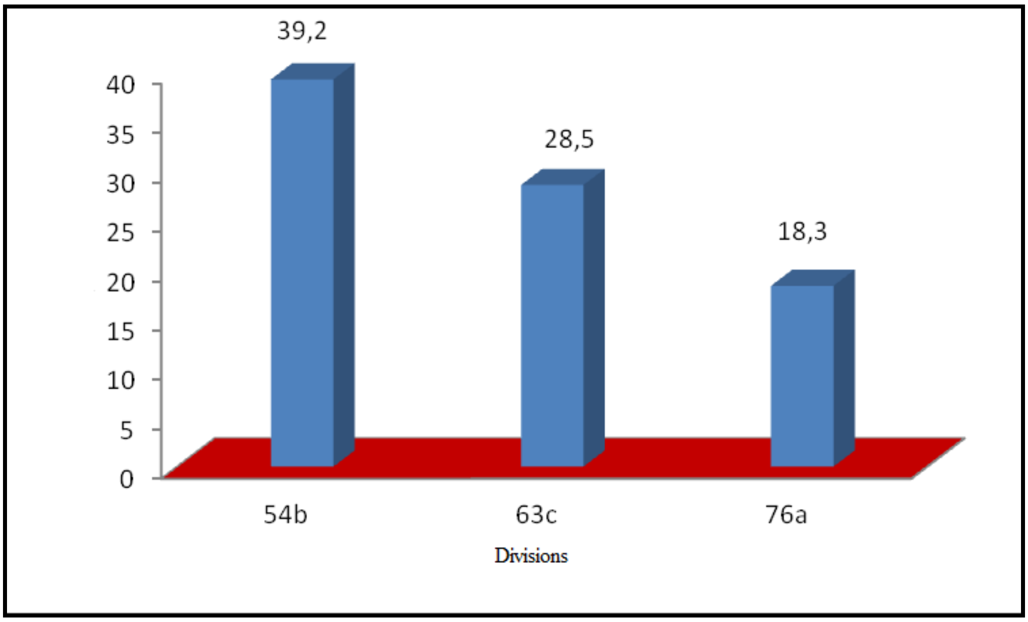

Figure 7. Mean root collar diameters of young black pines by trabeculas

3.3 FACTORS AFFECTING THE SUCCESS OF REGENERATION

In order to determine various factors which may be effective in regeneration success of natural black pine regeneration studies, the factor analysis has been utilized. For this purpose, the measurement units and analysis symbols of 19 variables investigated and taken into analyses are given in Table 14.

Table 14. Variables investigated within the scope of research

Nr	Variables	Unit	Symbol in analysis
1	Altitude of experiment sites	m	RAKIM
2	Exposure of experiment sites	---	BAKI
3	Slope of experiment sites	%	EGİM
4	Shoulder status of experiment sites	---	YD
5	Absolute soil depth	cm	MD
6	Physiographic soil depth	cm	FD
7	Rootlet status	---	KOKD
8	Structure type	---	STRT
9	Soil type	---	TOPT
10	Soil reaction in top soil layer (Ah)	---	PH
11	Organic matter content in top soil layer (Ah)	%	ORGM
12	Azote amount in top soil layer (Ah)	%	AZOT
13	Phosphor amount in top soil layer (Ah)	ppm	FSFR
14	Potassium amount in top soil layer (Ah)	ppm	PTSYM
15	Saltiness of top soil layer(Ah)	dS/m	TUZ
16	Precipitation of 2012	mm	YAG12
17	Mean temperature in 2012	˚C	SIC12
18	Thickness of latter in 2012	cm	OLUORT12
19	Living cover density in 2012	%	DORT12

As the measure of regeneration success, the number of young black pines per square meter in 2012 has been taken, and the factors affecting it have been investigated.

To explain the mutual relationship of variables mentioned above and affecting the number of young black pines is not enough for determining the combined effect on young black pines. That's why; the factor analysis has been utilized in order to group the variables having high correlation in that complex structure and to reveal variable groups transparently. The Principal Component Analysis model and Kaiser criteria have been taken as base, and 5 common (basic) factors have been derived (Table 15).

Table 15. The explanation of total variance according to factor analysis results

Factors	Initial eigenvalues			Square of Untransformed Factor Loads Before Rotation			Square of Transformed Factor Loads After Rotation		
	Total	**Variance (%)**	**Accumulated Variance (%)**	**Total**	**Variance (%)**	**Accumulated Variance (%)**	**Total**	**Variance (%)**	**Accumulated Variance (%)**
1	16.129	32.321	32.321	16.129	32.321	32.321	16.129	23.176	**39.40**
2	7.782	16.557	55.066	7.782	16.557	55.066	9.127	19.419	**41.56**
3	5.153	10.964	66.030	5.153	10.964	66.030	4.571	9.725	63.44
4	2.894	6.156	72.187	2.894	6.156	72.187	4.167	8.865	69.73
5	2.355	5.010	77.197	2.355	5.010	77.197	2.356	5.013	**72.96**
6	2.026	4.310	81.507						
7	1.208	2.570	84.077						
8	1.163	2.475	86.552						
9	1.086	2.310	88.862						
10	0.881	1.874	90.736						
11	0.657	1.398	92.134						
12	0.628	1.337	93.470						
13	0.573	1.220	94.690						
14	0.443	0.942	95.632						
15	0.370	0.788	96.420						
16	0.320	0.682	97.102						
17	0.251	0.534	97.636						
18	0.219	0.465	98.101						
19	0.179	0.380	98.480						
20	0.149	0.318	98.798						
21	0.146	0.310	99.108						
22	0.120	0.256	99.364						
23	8.325E-02	0.177	99.542						
24	6.480E-02	0.138	99.679						
25	4.231E-02	9.001E-02	99.769						
26	3.982E-02	8.472E-02	99.854						
27	2.971E-02	6.321E-02	99.917						
28	2.370E-02	5.042E-02	99.968						
29	8.818E-02	1.876E-02	99.987						
30	6.324E-02	1.346E-02	100.00						
31	1.694E-15	3.604E-15	100.00						
32	7.177E-16	1.527E-15	100.00						
33	4.005E-16	8.521E-16	100.00						
34	3.324E-16	7.072E-16	100.00						
35	3.001E-16	6.385E-16	100.00						
36	2.441E-16	5.194E-16	100.00						
37	1.048E-16	2.229E-16	100.00						
38	7.043E-18	1.498E-17	100.00						
39	-7.625E-17	-1.622E-16	100.00						
40	-1.007E-16	-2.143E-16	100.00						
41	-2.037E-16	-4.335E-16	100.00						
42	-3.172E-16	-6.748E-16	100.00						
43	-3.896E-16	-8.289E-16	100.00						
44	-5.771E-16	-1.228E-15	100.00						
45	-6.922E-16	-1.473E-15	100.00						
46	-8.352E-16	-1.777E-15	100.00						
47	-1.448E-15	-3.081E-15	100.00						

Extraction Method: Principal Component Analysis

As seen in Table 15, 5 factors having eigenvalue statistics higher than 1 have been derived. The 1st factor explains 39.40% of the variance. 1st and 2nd factor, together, explain 41.56% of variance. The 5 factors derived explain 72.96% of total variance.

In order to name the factors and smooth the interpretation, the transformed factor matrix has been taken as base (Table 16). In order to make interpretations and naming easier, the factor loads lower than 0.5 are not included in this chart.

Table 16. Transformed Factor Matrix

Variables	Factors				
	1	2	3	4	5
RAKIM	-0.975				
BAKI	0.963				
EGİM	0.958				
YD	-0.943				
MD		0.932			
FD		0.926			
KOKD		0.923			
STRT		0.921			
TOPT		0.917			
PH			0.883		
ORGM			-0.872		
AZOT			0.864		
FSFR			0.851		
PTSYM			0.842		
TUZ			-0.824		
YAG12				0.792	
SIC12				0.781	
OLUORT12					0.754
DORT12					0.743

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

As seen in transformed factor matrix; the correlations among 19 variables are represented with total of 5 factors. The variable having the highest correlation has taken the first rank in each of factors. So, the 1st factor's first variable is altitude (effective in negative direction), 2nd factor's first variable is absolute soil depth, 3rd factor's first variable is top soil reaction, 4th factor's first variable is mean precipitation of year 2012, and 5th factor's first variable is latter thickness.

As seen in chart 3.29; all of the 4 variables in 1st factor are related with physiographic conditions. Consequently, 1st factor has been named "**PHYSIOGRAPHIC CONDITIONS**". In order to represent this group in multiple regression analysis, **ALTITUDE** having the highest factor load (-0.975) has been chosen.

All of the 5 variables in 2nd factor are related with soil conditions. Consequently, 1st factor has been named "**PHYSICAL SOIL PROPERTIES**". In multiple regression analysis, **MD** having the highest factor load (0.932) has been chosen as representative of this factor.

In 3rd factor, there are 6 variables. All of those variables are related with organic matter content and macro nutrient elements. That's why; this factor is named "**ORGANIC MATTER"**. 3rd factor has been represented with **ORGM** in regression analyses.

There are 2 variables in 2nd factor. All of the variables are related with climate conditions of regeneration site. Within this context, 4th factor has been named "**CLIMATE**" and in order to represent this group in multiple regression analysis, **YAG12** having the highest factor load (0.792) has been chosen.

The variables in 5th factor are related with outer soil condition. That's why; 5th factor has been named "**OUTER SOIL CONDITION**" and in order to represent this group in multiple regression analysis, **OLUORT12** having the highest factor load (0.754) has been chosen.

In order to investigate the effects of 9 most important factors (independent variables) determined as a result of factor analyses on the number of young black pines, the multiple regression analysis has been carried out. As dependent variable in performed multiple regression analysis, the number of young black pines per square meter in 2012 (KGS06) has been used. The result of analysis performed via enter method are given in Table 17.

Table 17. Multiple regression analysis results

Independent Variables	Regression Coefficients	Standard Failure	F	R^2
(Fixed)	0.683	0.617	8.536***	0.78
RAKIM	-0.815*	0.105		
MD	0.00582	0.002		
PH	-0.00367	0.001		
YAG12	0.380*	0.005		
OLUORT12	0.0122	0.006		

Dependent Variable: KGS.12
(**): Significance level is P=0.01
(***):Significance level is P=0.001

According to the regression analysis results, 78% of the success of regeneration in research site originates in those 5 factors. But the most important ones of those factors are RAKIM and YAG12. The multiple regression model can be written as follows in parallel with obtained results;

$$\mathbf{Y}_{(KGS12)} = 0.683 - 0.815\mathbf{X}_{(RAKIM)} + 0.00582\mathbf{X}_{(MD)} - 0.00367\mathbf{X}_{(PH)} + 0.380\mathbf{X}_{(YAG12)} + 0.0122\mathbf{X}_{(OLUORT12)}$$

But these results obtained are not enough for making an absolute decision about the factors affecting the success of natural regeneration efforts on black pine. In order to obtain more reliable results in this topic, it is required to investigate the data covering much longer time (10-20 years). This analysis can give only a pre-understanding about the determination of the most effective factors on success of natural regeneration efforts.

4. DISCUSSION, RESULT AND SUGGESTIONS

4.1 The Quantitative Properties of Black Pines Juvenilities

Through the height and root neck diameter measurements in 6th, 8th and 10th years, the changes in growth of young black pines in research site have been determined. The mean height increase of young black pines determined at the end of 6th year is 105cm. On the other hand, the mean height increase determined at the end of 8th year is 134 cm and the value determined at the end of 10t year is 153 cm. These results indicate the accuracy of location choice for regeneration sites and that the plants could profit better from organic matter and other nutrient elements (N, P and K) which exist in top soil layer and are important for plant nourishment. Hence, according to the measurement and determinations made in soil profiles, the medium and frequent rootlet densities indicate that young trees profit better from water, organic matter and nutrient elements located especially in top soil layer. In this topic, Karadağ (1999) has revealed in his research on points to pay attention during black pine regeneration efforts in Bolu region that the organic matter content in top soil layer and soil moisture have direct effect on development of young black pines. In a study conducted in Kütahya and Muğla regions in order to determine the factors affecting the success level of natural regeneration studies in black pine forest of those regions, it has been found that the mean height value of young trees varies between 96 and 112 cm (Çelik et al. 2000). Tüfekçioğlu et al. (2002), have found that as biomass increases in black pine, it can profit more from water and nutrient content of soil, and it contributes to development significantly.

The root collar diameter development of young black pines at the end of 10th year was 39.2 mm, that determined at the end of 8th year was 28.5mm and the mean root collar diameter development at the end of 6th year was 18.3mm. As well as in height development, this result in root collar diameter development indicates the adequate profiting from water, organic matter content and other nutrient elements in top soil layer. Different results have been obtained in studies on this topic in our country. According to that, in a study on natural black pine youth in Forest Belgrad, the mean root neck diameter has been determined to be 15.6 mm at the end of 5th year (Atahan, 1986). In another study conducted on young black pines in Bolu region, it has been stated that the height and root neck diameter are important criteria for evaluating the adhesion of youth over the region (Karadağ 1999).

4.1.2 The Number of Juvenility

In this study, the number of young black pines per square meter (pcs/m^2) in regeneration site has been determined. During the countings in experiment sites, the mean number of 6 years-old young trees was 192 pcs/m^2, that of 8 years-old young trees was 156 pcs/m^2 and the same value of 10 years-old young trees was 85 pcs/m^2. In studies on this topic in our country, it has been determined that the number of 3 years-old young black pines varies between 182.000 and 225.000 pcs/ha (Karadağ 1999). In another study in Kütahya and Muğla regions, it has been determined that the number of 5 years-old black pines varies between 65.000 and 132.500

pcs/ha (Çelik et al. 2000). Comparing those results with the results of this study, it can be seen that the number of young trees in research site is low. Many factors have effect on this situation. The leading one of those factors is thought to be that it wasn't a productive year in terms of black pine seeds. Another reason of unsuccessfulness in natural regeneration efforts is the lowness of habitat productivity (site quality) of the region where the natural black pine regeneration efforts have been made via LFCM. Because, the regeneration sites are within 3rd site quality class in general. One of the important reasons of low number of young black pines in natural black pine regeneration site is that the living cover removal and soil processing implementations performed in 2003, 2005 and 2007 in those sites haven't been applied in appropriate density and in harmony with the right technique. As a result of determinations during 2 years, it has been determined that the thicknesses of latters in natural regeneration sites were excessive. These thickness values of latter layer indicate that the soil processing has not been applied in right density while opening the group sites. Hence, in natural and artificial regeneration efforts, it is known that the maintenances performed in right time and with right technique after youth is brought into region create positive effects on the number and development of young trees (Atay 1978; Ata 1995).

4.2 The Factors Affecting the Success of Regeneration

As a result of factor analysis applied to 19 variables in order to determine the factors affecting the regeneration success I natural black pine regeneration studies, 5 factors have been obtained.

As a result of analysis, the obtained factors affecting the regeneration success are Physiographic Conditions, Physical Soil Properties, Organic Matter, Climate, and Outer Soil Condition, respectively.

The first factor determined to be effective on regeneration success as a result of factor analysis is physiographic conditions. This factor is represented by variable "Altitude" having the highest factor load. Hence, as altitudes of natural black pine regeneration sites' altitude increased, the number of youth decreased. The altitude is an important physiographic variable affecting the local habitat conditions. Depending on changes in altitude, the micro-climatic and edaphic conditions significantly change (Çepel 1995). Within this context, the implementation of natural regeneration studies in stands at the optimal spreading altitude of black pine increases the success of regeneration (Karadağ 1999; Atalay and Efe 2010)

Second factor affecting the success of natural black pine regeneration efforts is physical soil properties. As absolute and physiologic soil depth and top soil type change from rough textured soils (clay, loam, clayed loam, loamed clay) to more shallow and thinner textured soils (sandy clay, sandy clayed loam), the number of young black pines decreases. Depending on depth and soil type (texture), the plants' capability of profiting from water and nutrient elements in soil through their roots varies. Hence, the thinner textured (sand, sandy clay, sandy clayed loam) soils having better aspiration and higher cation exchange capacity have better water and nutrient element conditions than rough textured soils (clay, clayed loam, loamed clay) (Çepel, 1966, 1996). Within this context, various researchers have stated that the most appropriate soil type for development of black pine is the soils with sandy clay or sandy clayed loam texture having clastic structure (Saatçioğlu 1969; Atalay and Efe 2010).

The third factor affecting the success of natural black pine regeneration efforts in this study is determined as organic matter level. Organic matter content plays important role in development of plants and their adaptation to field conditions. Although the black pine is a half-light tree, the organic matter content and soil moisture have great importance in adhesion of young black pines in first years (Karadağ 1999). The need for organic matter content in soil increases especially in advancing years. The most important reason of that is the seed production. In a study where the first results of origin experiments on Scotch pine in Turkey, it has been determined that the successful origins in terms of seed efficiency are the origins which have profited more from the soil moisture. Within this context, in a comprehensive research study on seed field of Yenice-Bakraz-origin black pine in Bartın region, it has been determined that the soil fertility and maintenance have significant importance on seed productivity of black pine clones (Ertekin 2006).

According to the results obtained from factor analysis implemented in study, the fourth factor affecting the success of natural black pine regeneration efforts is climate factor. The unexpected changes especially in precipitation and temperature parameters may lead to various effects on creation and development of youth. Although black pine is the specie which can penetrate into the anthropogenic step site at most, it is also a forest tree which can be affected negatively from climate changes as well as other tree species. Especially the excessive summer temperatures experiences in our country in summer 2012 and long drought period seen as a result of that have led an important portion of young black pines to move away from the site by drying out. In a study on ecology of black pine and its seed transfer regioning, it is stated that the long durations of drought period affect the black pine negatively even though it is abstinent specie (Atalay and Efe 2010).

The last factor affecting the success of natural black pine regeneration efforts has been determined to be outer soil conditions. The outer soil conditions consist of latter accumulation and living cover density. In experiment sites of natural black pine regeneration area, the adequate amount of young black pines couldn't develop as a result of inadequate contact with mineral soil in parts where the latter accumulation is relatively thicker. Also the dense and strong living cover layer has created negative effects on success of natural regeneration efforts. Especially in parts of stands where there are dense living cover consisting of sword fern and blackberry, the youth has choked and be selected from the site. Similar findings have been found by Karadağ (1999) and Çelik et al. (2000) too.

In this study where the habitat conditions, youth development and regeneration success in natural black pine regeneration efforts within the scope of implemented model forestry plans in Araç region have been investigated, the measurements and determinations have been carried out on the research site consisting of 30 parts and 3 parcels.

As a result of investigations about the habitat conditions, it has been determined that the habitat productivity in regeneration sites is low, and the stands where those sites are located are within 3rd site quality class.

Within the context of this study, it has been determined during the investigations about the latter cover thickness and living cover density that the latter cover thickness and living cover density have increased significantly by years and the regeneration sites has started to become wild.

The mean numbers of natural young black pines determined in experiment sites are 192 pcs/m^2 at 6th year, 156 pcs/m^2 at 8th year and 85 pcs/m^2 at 10th year. According to those results, it can be seen that the number of young black pines has significantly decreased in natural regeneration sites.

The mean height growth values of young black pines are 105 cm at 6th age, 134 cm at 8th age and 153 cm at 10th age. The root neck diameter growth values of youth are 18.3 mm at 6th age, 28.5 mm at 8th age and 39.2 mm at 10th age. According to those values, it has been determined that the height and root neck diameter values of young black pines are significantly low.

In order to improve the success of natural regeneration studies on black pine which is one of the important species of our country, following suggestions should be considered;

1. The fertile seed years in regeneration sites should be determined accurately.
2. The regeneration studies should be carried out on optimum spread sites of specie and in normal organization stands.
3. Before seeding in regeneration site, the living cover layer especially consisting of rhododendron should be removed completely by rooting away, and the latter cover layer should be adequately mixed with mineral soil via intensive soil processing.
4. After taking young black pines in research site, until those young trees will obtain their biological independencies, the youth caring measures, especially the struggle with living cover layer, must be taken at right time and in right density.

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LIPOPHILIC CONSTITUENTS OF SOME CONIFEROUS CONES

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ABSTRACT

The lipophilic constituents of cones, a renewable natural resource, from *Picea orientalis*, *Cedrus libani* L. and four different *Abies* species namely *A.equi-trojani*, *A.cilicica*, *A.nordmanniana* and *A.bornmülleriana*, were determined after n-hexane extraction. The amount of lipophilics, identified by GC and GC-MS from the cones of *A. cilicica* (154.6 mg g-1 g^{-1}) and *A. bornmülleriana* (131.8 mg g-1) was significantly different from others. The lowest value was obtained from the cones of *P.orientalis* (25.14 mg g-1). Abietic, neoabietic, sandaracopimaric and hydroxylated resin acids constituted the major compounds in the cones. Free fatty acids, resin aldehydes, resin hydrocarbons and sterols were the other chemical groups found in the composition.

Key words: Abies, *Cedrus libani* L, cone, lipophilics, *Picea orientalis.*

INTRODUCTION

Cone is the part protecting the seeds in the coniferous species till seeds are matured. The size and the shape of cone are changing from species to species. *Cedrus libani* L. (Lebanon cedar), the native species to south central Turkey, has 8-10 cm long and 4-6 cm wide cone with barrel shape. It matured in 24 months and the surface is resinous. More stable and smaller cone is belonging to *Picea orientalis* (oriental spruce) with 5-9 cm long and 1.5 cm broad size. It has smooth, stiff and dark brown rounded scales. Even after the maturation, scales are not disintegrated and keep attaching to axis. There is four different Abies species growing natively in Turkey; *A. equi-trojani* (Kazdagi fir), *A. cilicica* (Toros fir), *A. nordmanniana* (Silver fir) and *A. bornmülleriana* (Uludag fir). Fir has the biggest cone in between coniferous species. It is between 15-20 cm long and 4-6 cm wide. Matured fir cone is brown and has150-200 scales, each scale with two winged seeds. Like cedar, the surface of fir cones is resinous (Ansin and Ozkan 1993; Yaltırık 1993). Each year great amounts of cones are produced during conifer regeneration. Nonetheless this renewable natural product did find a limited industrial usage. The cones of *Pinus pinea* L. was tested in the production of medium density fiberboard with urea-formaldehyde and was proposed as an alternative biological formaldehyde catcher (Ayrilmis et al. 2009). Mainly the bioactivity of pine cone extracts and also its chemical composition are studied (Eberhard et al.1994; Eberhard et al.1996; Villagomez et al.2005; Barrero et al. 2005; Unaldi and Toroglu 2009. Kilic et al.2011).

Lipohilics, the non-polar compounds, are forming 1-3 % of wood extractives and can be in higher contents in tropical trees and some other parts of tree (e.g. in knots, heartwood). It composed mainly resin acids, some other diterpenoids, fats and steryl esters. The function of resin acids and other diterpeniods is to protect a tree against insect and fungal attacks. Fats and steryl esters are the energy sources and cell membrane components (Sunderberg and Holmbom 2005).

In the last decade there has been a big interest in the use of natural products not only in pharmacy but also in food industry. From this aspect could cones be a suitable natural source? The first step of the answer is to know the chemical composition of this natural resource. In the present paper, the chemical composition of lipophilic

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compounds from cones of *A. cilicica, A. bornmülleriana, A. nordmanniana, A. equi-trojani, C. libani and P. orientalis* which up to our knowledge has not been addressed before were studied.

MATERIAL AND METHODS

Plant material and Reagents

The study was carried out using the cones of *P. orientalis, C. libani* and four different *Abies* species (*A. equi-trojani, A. cilicica, A. nordmanniana, A. bornmülleriana*). Sampling data are listed in Table 1. For each species 5 kg of cones were collected from the trees just at the time of maturity and stored at -24 °C until analysis. After disintegrating into small pieces, the cones were freeze-dried and ground in a Wiley mill down to the size of 1 mm. n-Hexane, and pyridine were obtained in analytical grade purity from Merck (Turku, Finland). *N-O-*Bis(trimethysilytrifluoro-acetamide) (BSTFA), heneicosaic acid, heptadecanoic acid and trimethylchlorosilane (TMCS) were purchased from Fluka (Turku, Finland). Betulinol was obtained from a private paper factory in Finland.

Table 1. Species and sampling locations

Species	Sampling location (Turkey)
Abies bornmülleriana	Bartin
Abies cilicica	Adana
Abies equi-trojani	Edremit
Abies nordmanniana	Trabzon
Picea orientalis	Trabzon
Cedrus libani	Adana

Extraction

About 5 g of grounded cone samples were extracted with n-hexane in an accelerated solvent extractor (ASE; Dionex Inc.ASE 200) apparatus (solvent temperature 90^0C, pressure 13.8 MPa, 3x5 min. static cycles). 2 ml of internal standard (heneicosanic acid, heptadecanoic acid and betulinol) was added to aliquots of extracts and the mixtures were evaporated under nitrogen. 150 µl of pyridine:BSTFA:TMCS (1:5:1) mixture was added to the extracts and silylated at 70^0C for 35 min. Silylated samples were injected to GC and GC-MS for the determination of lipophilic constituent.

Chromatographic Conditions

Chromatographic analyses were performed with a PelkinElmer AutosystemXL gas chromatograph equipped with a long column of HP-1 (J&W) 25 m x 0.2 mm (0.11 µm film thickness); column and a flame ionization detector with H_2 as the carrier gas (0.8 ml min^{-1}). The temperature program was initiated at 120 °C min^{-1} with a ramp of 6 °C min^{-1} up to 320 °C, injector temperature was 260 °C and FID temperature 320 °C. 1 µl sample was injected (split ratio: 1 : 24). For Sterlyesters and triglycerides a short column (HP-1 (J&W) 5 m x 0.53 mm, 0.15 µm film thickness) was used with the temperature program of 80 °C (0.1 min), 110 °C (15 °C min^{-1}), 340 °C (7 min). The identification of the individual compounds was performed by HP 6890-5973 gas chromatograph/mass spectrometry instrument equipped also with an HP-1 capillary column. The temperature program was set to be the same as in the long column. Identification was based on both the mass spectra and the comparison of the samples to compounds present in the spectral library.

RESULTS

Silylated lipophilic extracts from oriental spruce, Lebanon cedar and four different fir species were analyzed by GC and GC-MS using short and long capillary columns. The composition of lipophilic extractives is presented in Table 2. The limit of quantification was 1/100 and precision of determination ± 5 %. The most predominant lipophilic compounds present in the cones were resin acids, followed by resin alcohols, resin aldehydes, fatty acids and sterols. Also, lower amounts of sterlyesters and triglycerides were determined with short column.

As mentioned before, resin acids are obtained mainly from coniferous species. The results of cone extractives in this study reveal this one more time. In the fir species 75 %, in Lebanon cedar 51 % and in spruce 23 % of total identified compounds was resin acids. The most abundant resin acid in all cones was the abietic acid (50.2-2.72 mg g^{-1}). Neoabietic acid was found to be more than 23 mg g^{-1} both in *A. cilicica* and *A. bornmülleriana* taking the place as the second important acid. However, in the cones of the other two fir species (*A. nordmanniana* and *A. equi-trojani*) and in the oriental spruce cone, hydroxylated resin acids, a group formed by crystalline resins, was the second dominant acid. The amount of this group was found to be very low in Lebanon cedar (0.18 mg g^{-1}). Sandaracopimaric, levopimaric and palustric acids were other detectable acids found in the cones. Isopimaric acid (1.80 mg g^{-1}) and cupressic acid (0.10 mg g^{-1}) was determined only in the Lebanon cedar. Abietol, the alcohol form of abietic acid, and abietal, the aldehyde form, were also important compounds in the lipophilic structure of cones especially in *A. cilicica* and *A. bornmülleriana*. Resin hydrocarbons e.g. abieta-8,11,13-triene and palustradiene, were detected abundantly in Lebanon cedar cones, while it was in trace amounts or even not detected in other species. Campestrol and sitosterol were the two sterols found in cones and campestrol was determined only in the cones of fir species.

The last group found in cones was free fatty acids and triglycerides. Generally, the structure of free fatty acids determined in the cones of fir species were the same despite various amounts. Triglycerides was determined by using a short column. A clear difference can be seen between fir species, Lebanon cedar and oriental spruce cones regarding to the total amount of triglycerides. The total amount of free fatty acids was found to be larger than the amount of triglycerides in fir cones. On the contrary, in oriental spruce and Lebanon cedar cones the amount of triglycerides was found to be higher (14.8 mg g^{-1} and 11.6 mg g^{-1}).

Table 2 Lipophilic constituents of cones (mg g $^{-1}$ in dry weight).

	A. equi-tro.	*A.cilicica*	*A.nordman.*	*A.bornmuller.*	*P. orientalis*	*C. libani*
Fatty acids						
16:0 +(Abieta-7,13-diene)*	0.32	2.09	0.33	0.98	0.24	2.34*
17:0	0.35	0.94	0.33	0.64	-	-
18:3	-	-	-	-	0.38	-
18:2	0.14	1.08	0.02	0.06	0.12	-
18:2 conj.	0.48	0.62	0.31	0.08	1.05	-
9-18:1	0.48	1.34	0.09	0.53	0.41	-
11-18:1	0.21	0.47	0.21	0.46	-	-
18:0	0.1	0.1	0.09	0.22	0.03	-
24:0	0.08	0.23	0.13	0.13	-	-
26:0	0.1	0.19	0.14	0.14	-	-
28:0	0.15	0.43	0.24	0.27	-	-
Resin aldehydes						
Palustral	-	-	-	-	-	0.25
Levopimaral	-	tr	-	0.84	-	-
Dehydroabietal	0.11	1.06	0.1	0.37	-	-
Abietal	0.96	8.49	0.99	5.17	0.49	0.44
Neoabietal	0.06	0.11	0.05	0.08	-	0.09
Resin hydrocarbons						
Abieta-7,13-diene	0.04	tr	tr	0.13	-	*
Abieta-8,11,13-triene	-	-	-	-	-	0.47
Palustradiene	-	-	-	-	-	0.54
Neoabietadiene	-	-	-	-	-	0.62
Resin alcohols						
Dehyroabietol	0.27	1.53	0.18	0.98	0.21	0.21
Abietol	1.29	12.5	1.43	8.15	0.83	-
Neoabietol	0.35	3.37	0.24	2.01	-	0.33
Resin acids						
Sandaracopimaric acid	2.21	2.51	0.52	2.42	0.45	5.83
Isopimaric acid	-	-	-	-	-	1.80
Palustric acid	0.13	6.69	0.18	1.20	-	0.54
Levopimaric acid	0.71	6.50	0.35	8.67	-	0.33
Dehydroabietic acid	2.46	9.23	1.71	7.76	-	-
Abietic acid	7.95	50.2	8.38	42.3	2.72	5.22
Neoabietic acid	3.73	23.5	5.0	24.6	0.18	4.12
Isomeric dehydroabietic acid	0.78	1.67	0.66	2.05	0.11	0.16
Hydroxylated resin acids	6.06	12.6	5.81	16.7	2.37	0.18
Abietatetraenoic acid	0.56	2.03	0.53	1.69	0.03	-
Secodehydroabietic acid	0.06	0.21	0.07	0.11	-	-
Cupressic acid	-	-	-	-	-	0.10
Sterols						
Campestrol	0.20	0.35	0.25	0.34	-	-
Sitosterol	0.81	1.81	0.91	1.08	0.20	0.25
Sterlyesters	0.22	0.91	0.34	0.49	0.52	0.62
Triglycerides	1.38	1.84	0.62	1.17	14.8	11.6
Total identified amount	**32.7**	**154.6**	**30.2**	**131.8**	**25.1**	**36.0**

- : Not detected; tr: trace amount;*:overlapped;

DISCUSSION

The knowledge of the chemical composition of lipophilic components of cones will assist for the utilization of this natural product. In general terms, remarkable differences were detected among the cones of fir species. While, *A. cilicica* (154.6 mg g^{-1}) and *A.nordmanniana* (131.8 mg g^{-1}) have the highest amount of lipophilic compounds the two other fir species (*A.bornmülleriana* (32.7 mg g^{-1}), *A.equi-trojani 30.2* (mg g^{-1})) had similar results with Lebanon cedar (36 mg g^{-1}) and oriental spruce (25.1 mg g-1) cones.

Abietane type resin acids was the dominant group in all cones within different amounts. Hafızoglu and Reunanen (1994) found similar results for the cone resin of *A. nordmanniana* and oriental spruce. In that study, abietic acid was determined approximately 20 % and neoabietic acid 10 % . Nevertheless, in the wood part of *A. nordmanniana* both of these acids were found to be in trace amounts while in oriental spruce dehydroabietic, palustric and levopimaric acids were dominant (Ucar 2005). In Lebanon cedar cone sandaracopimaric acid, a pimarane type, was found to in high amounts (5.83 mg g-1) with abietic acid (5.22 mg g-1). Similar data was obtained in the oleoresin of the cedrus cone (Hafızoglu and Holmbom, 1987). In the wood part, beside these two compounds isopimaric acid also indicated as an important acid in Lebanon cedar (Hafızoglu 1987).

Resin acids, has antimicrobial and antifungal activities. Micales *et al.*, (1994) indicated that while abietane-type compounds (levopimaric, dehydroabietic, abietic and neoabietic acids) inhibited the mycelia growth in various fungi, the pimaric, isopimaric and sandracopimaric acids of the pimarane-type resin acids displayed only limited activity. In another study (Smith et al.2005) the diterpene isopimaric acid from the extract of immature pine cone was assayed against multidrug resistant (MDR) and methicillin-resistant *Staphylococcus aureus* (MRSA). Kopper et al. (2005) also reported abietic and isopimaric acids as inhibitors for *Ophiostoma ips*, a conifer pathogenic fungus. A linear correlation between bioactivity against Gram-positive bacteria and lipophilicity degree was determined by San Feliciano et al. (1993). In the same study a reverse situation was observed for Gram-negative bacteria. Compared to common diterpen acids 7-oxo-dehydroabietic acid and 7-hydroxy-dehydroabietic acid, were found to be more active against inhibition of fungal growth (Savluchinke Feio et al.2006). From this point of view, extracts from the mature fresh cones especially from some fir species could be considered as a renewable resource for biological activities.

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