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Vegetation geography of western part of Elmacik mountain, Turkey

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Abstract

The study examines the western part of Elmacik mountain from the perspective of vegetation geography. Research area is within the phytogeographical region of Euro-Siberian that is among the flora and phytogeographical region of Turkey. According to Turkey's grid square system, the research area is located in the A3 square. The main elements of forest formation consist of *Fagus orientalis*, *Abies nordmanniana* subspp. *bornmuelleriana*, *Pinus nigra* subsp. *pallasiana*, *Pinus sylvestris*, *Quercus* spp., *Platanus orientalis* and *Tilia argentea*. Humid forests are dominant and the main elements of shrub formation consist of *Buxus sempervirens*, *Rubus sanctus* and especially *Rhododendron ponticum* subsp. *ponticum*. The main herbaceous formation area consists of *Digitalis ferruginea* subsp. *ferruginea*, *Fragaria vesca*, *Euphorbia falcata*, *Crocus colchicum kotschyi* and *Verbascum* sp. Distribution of natural vegetation varies due to climate, soils and morphologic character and of the research area. This situation was examined and defined by applying field surveys and geographical information systems.

Key words

Elmacik mountain, Keremali hill, Vegetation formation

Introduction

The western part of Elmacik is mountainous, and encompassed by the active North Anatolian Fault (NAF) from west and south. Different rock types such as sandstone, shale, conglomerate, tuff, andesite, basalt, schist, fillite metasandstone, metamudstone, and marble occur on the northern slopes of the Elmacik mountain (Abdusselamoglu, 1959; Gedik *et al.*, 2002).

The lowest part of the area is 31 m in Adapazari plain and 175 m in Duzce. Depressions are surrounded by mountains. The highest part is on the Elmacik mountain is 1830 m. The other hills of this east - west directional mountainous area are Erenler hill (1830 m), Dikmen hill (1729 m) and Keremali hill (1549 m). The main geomorphological units in the study area are high plateaus and deep valleys, namely; Mudurnu river, Aksu creek, Goksu creek and their tributaries.

Humid climate, where is winters are cold and summers are cool and humid prevails in the area. This climate is classified as humid subtropical type by Koppen and it is known as "Western Black Sea Climate type" (Erinc, 1984). But, climate features differ depending on altitude, topography and other geographical features. For instance, while the average temperature is 23 °C at Adapazari in July, it decreases down to 16 °C due to high altitude in Keremali mountain.

Generally mollisols occur in the area, but entisols are found in lower parts. In Mollisols; A, B, C horizons are well developed and the rate of $CaCO_3$ is low (Atalay, 2006).

The effect of climate and geomorphology is very prominent on the distribution of vegetation communities. In fact, vegetation consists of forest formation (Humid - Mild Deciduous and Humid - Sub Humid Cold Coniferous Forests). Furthermore, there are also shrub (maquis, pseudomaquis) and herbaceous plants in patches.

Natural plant species collected in the field are found to be in accordance with the species lying in the A3 square of Davis (1965-1985) for Turkey's flora. These plants also exist in Euxine sector of Euro-Siberian phytogeographical region. Broad-leaved and mesophyll species are dominant in Euxine sector. Needle-leaved species got mixed in this forest in addition to *Fagus orientalis* forest that represents climax plant community.

Agricultural areas were emerged by destroying the forests in patches. Destruction of forests accelerated with population increase. Agricultural land attract people liveing in northern part of Turkey. Many people migrated from Eastern Black Sea region to environs of Adapazari after 1950s. The climate and soil conditions in the study area are suitable for hazelnut cultivation. As a consequence of this, hazelnut gardens were established on the north slopes. This study aims to determine ecological conditions that affect the growth and distribution of vegetation communities in Elmacik mountain.

Materials and Methods

Study area is located in the west of Black Sea Region of Turkey, between 30° 36´ - 31° 00´ the E longitude and 40° 34´ - 40 ° 45´ N latitude (Fig 1). Topographic, geologic, soil and forest arrangement maps have been used to determine the distribution of vegetation. Plant samples were collected during the field surveys performed in June, July and August, 2009. Plant samples were identified and classified in Herbarium of Sakarya University. Plant list was created according to Flora of Turkey and East Aegean Islands (Davis 1965 - 1985, Davis et al. 1988, Guner et al. 2000) (Table 1). This plant list was classified according to vegetation formation and phytogeographical region. Vegetation maps were created by using Arc GIS 9.2 software. This map layer was integrated to forest management map and data. The relationship between vegetation maps and management maps showing the distribution of vegetation formations and the other digital map layers (elevation, relief, geology, soil, climate and use of land), produced in Arc GIS 9.2 software, was searched with overlaying. The relations between the data belonging to ecological conditions (climate, soil, geologic, geomorphologic, and biotic) of study area and its vegetation were also determined. In this analytical approach, observations were carried out in the field surveys and records of the interviews were used. Distribution of vegetation formations on the western part of Elmacik Mountain and ecological conditions were explained according to the findings.

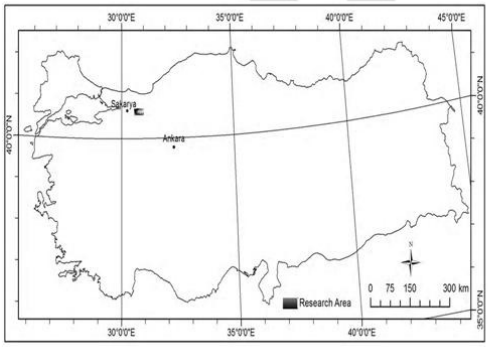

Fig 1: Location map of the research area

Results and Discussion

Local ecological conditions such as climate, soil, geologic and geomorphologic and biotic, features determine the distribution of vegetation.

The relations between vegetation and climate conditions: The research area has humid climatic conditions that dominate Western Black sea coasts and its hinterland, where winters are cold; summers are not very hot and humid and is known as "Western Black Sea Climate Type" (Erinc, 1984). These climatic features vary with the effects of geographical conditions.

Climate data (1975-2005) obtained from Sakarya and Duzce meteololrolgical statinos were analyzed in order to determine the ecological conditions of the area. Climate features of research area and its map with interpolation were created. According to results obtained from the data, annual average temperature is 14.3 °C (Sakarya) and 13.0 °C (Duzce). Annual temperature amplitude is 17.2 °C and 18.5°C. According to these values, it could be said that "Maritime Climate Type" can be seen in the area (Sezer, 1990). However, due to difference of local geographic factors between meteorology stations whose data were used, climate features have more maritime and colder character.

Temperature in Adapazari plain changes between 12 and 14 °C. It decreases with the altitude in the slopes of Elmacik mountain. So in Keremali, Erenler and Dikmen mountains, where elevations are above 1400 m, the temperature decreases to 4 and 7 °C (Fig. 2). Depending on topography, decreasing temperature in vertical direction affects distribution of vegetation formations. For instance, in slopes of Elmacik mountain deciduous trees such as *Fagus orientalis, Quercus robur* subspp. *robur, Tilia argentea, Populus* sp. can be seen whereas in high part of the area, these trees are replaced by *Abies nordmanniana* subspp. *bornmuelleriana, Pinus sylvestris* at higher elevations.

Monthly average temperature is lowest in January and February. It increases from March and reaches highest

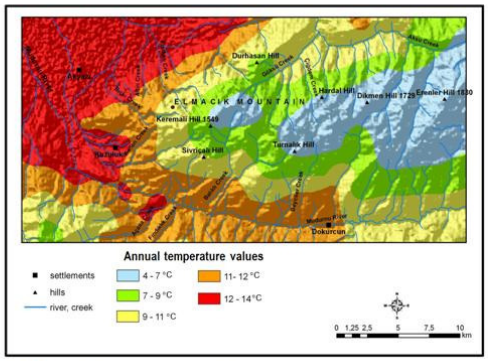

Fig 2: Distribution of mean annual temperature map

Table - 1: Floristic list of research area

Family	Genus (sp. - subspp.)	Plant	Location (UTM Wgs 1984)	Elevation (m.)	Dated d.m.y	Phytgeographic regions
	Herbaceous formation					
APIACEAE	*Anthriscus caucalis* Bieb.	Camlica v.	308856.046-4505022.588	700	08.09.09	
	Daucus carota L.	Guney v.	318594.481-4509771.987	425	15.08.09	
		Camlica v.	308856.046-4505022.588	700	08.09.09	
		Guney v.	322939.505-4509353.689	750	15.08.09	
		Sariyer v.	307297.948-4510669.381	42	08.09.09	
	***Heracleum pastinacifolium* C.Koch subspp. *incanum* (Boiss. et Huet) Davis.**	Dikmen v.	324062.252-4504966.186	1350	15.08.09	
	Malabaila secacul Banks *et* Sol.	Dikmen v.	324062.252-4504966.186	1350	15.08.09	
	Tordylium apulum L.	Dikmen v.	324062.252-4504966.186	1350	15.08.09	Med.
	Torilis arvensis (Huds.) Link subspp. *arvensis* (Huds.) Link.	Guney v.	322939.505-4509353.689	750	15.08.09	
	Scandix stellata Banks *et* Sol.	Guney v.	322939.505-4509353.689	750	15.08.09	
	Hedera helix L.	Sumbullu v.	318594.481-4509771.987	425	15.08.09	
BORAGINACEAE	*Anchusa pusilla* Gusul	Sumbullu	319184.019-4509901.088	600	15.08.09	
	Cerinthe minor L. *subsp.aauriculata* (Ten.) Domac	Dikmen u.	323665.835-4504315.862	1360	15.08.09	
	Echium vulgare L.	Dikmen v.	324062.252-4504966.186	1350	15.08.09	Euro-Sib.
	Heliotropium europaeum L.	Sariyer v.	307297.948-4510669.381	42	08.09.09	Med.
	***Myosotis alpestris* F. W. Schmidt. subspp. *alpestris* F. W. Schmidt**	Golyaka v.	311205.397-4504709.031	1150	08.09.09	
	***Onosma mutabile* Boiss.**	Dikmen v.	323.549.142-4507960.226	900	15.08.09	Euro-Sib.
CAMPANULACEAE	*Campanula latifolia* L.	Dikmen v.	323.549.142-4507960.226	900	15.08.09	Euro-Sib.
CAPRIFOLIACEAE	*Sambucus ebulus* L.	Sariyer v.	311205.397-4504709.031	1150	08.09.09	Euro-Sib.
COMPOSITAE (ASTERACEAE)	*Anthemis cretica* L.subspp. *pontica* (Willd.) Grierson	Sariyer v.	311205.397-4504709.031	1150	08.09.09	
	Aster tripolium L.	Golyaka v.	311229.541-4505473.848	1050	08.09.09	Euro-Sib.
	Bellis perennis L.	Camlica v.	308856.046-4505022.588	700	08.09.09	Euro-Sib.
	Cichorium intybus L.	Golyaka v.	311229.541-4505473.848	1050	08.09.09	
	Cirsium vulgare (Savi) Ten.	Sariyer v.	311229.541-4505473.848	1050	08.09.09	
	Conyza canadensis (L.) Cronquist	Dikmen u.	323665.835-4504315.862	1360	15.08.09	
	Crepis foetida L. subspp. *rhoeadifolia* (Bieb.) Celak.	Dikmen u.	323665.835-4504315.862	1360	15.08.09	
	Doronicum orientale Hoffm.	Camlica v.	308856.046-4505022.588	700	08.09.09	
	Echinops microcephalus Sm.	Camlica v.	308856.046-4505022.588	700	08.09.09	Med.
	Taraxacum minimum (Briganti Ex Guss.) Terrac.	Camlica v.	308856.046-4505022.588	700	08.09.09	
	Tussilago farfara L.	Camlica v.	308856.046-4505022.588	700	08.09.09	Euro-Sib.
CRUCIFERACEAE (BRASSICACEAE)	*Alyssum minutum* Schlecht. Ex Dc.	Dokurcun t.	324036.016-4499649.509	1375	15.08.09	
	Capsella bursa-pastoris (L.) Medik.	Dikmen u.	323665.835-4504315.862	1350	15.08.09	
	Cardaria draba (L.) Desv. *subspp. draba* (L.) Desv.	Dikmen u.	324036.016-4499649.509	1375	15.08.09	
	Erysimum repandum L.	Guney v.	319184.019-4509901.088	600	15.08.09	
CYPERACEAE	*Carex riparia* Curtis	Sariyer v.	307297.948-4510669.381	42	08.09.09	Euro-Sib.
DIPSACACEAE	*Dipsacus laciniatus* L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	
EUPHORBIACEAE	*Euphorbia barrelieri Savi* var. thessala (Form.) K. Maly	Dikmen v.	323.549.142-4507960.226	900	15.08.09	Med.
	Euphorbia falcata L. subspp. *falcata* L. var. falcata L.	Dikmen v.	323.549.142-4507960.226	900	15.08.09	
	Euphorbia seguieriana Necker subspp.*niciciana* (Borbas Ex Novak) *Rech. Fil.*	Dikmen v.	323.549.142-4507960.226	900	15.08.09	

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EQUISETACEAE	*Equisetum arvense* L.	Guney v.	319184.019-4509901.088	600	15.08.09		
GERANIACEAE	*Geranium tuberosum* L. subspp. *tuberosum* L.	Dokurcun t.	323923.723-4499434.046	1350	15.08.09		
IRIDACEAE	*Crocus colchicum* kotschyi Boiss.	Dikmen u.	324036.016-4499649.509	1375	15.08.09		
	Ilris purpureobractea B. Mathew et T. Baytop	Sariyer v.	307297.948-4510669.381	42	08.09.09	Med.	
LABIATAE (LAMIACEAE)	*Mentha aquatica* L.	Sumbullu v.	318594.481-4509771.987	425	15.08.09		
	Mentha longifolia (L.) Hudson subspp. *longifolia* (L.) Hudson	Dikmen v.	324062.252-4504966.186	1350	15.08.09		
LABIATAE (LAMIACEAE)	***Salvia cadmica* Boiss.**	Guney v.	318594.481-4509771.987	425	15.08.09		
	Salvia tomentosa Miller	Dikmen v.	324062.252-4504966.186	1350		Med.	
LEGUMINOSAE (FABACEAE)	*Anthyllis vulneraria* L. subspp. *boisseri* (Sag.) Bornm.	Dikmen v.	324062.252-4504966.186	1350	15.08.09		
	Melilotus officinalis (L.) Desr.	Guney v.	318594.481-4509771.987	425	15.08.09		
	Trifolium repens L. var. repens L.	Dikmen u.	323665.835-4504315.862	1360	15.08.09		
LILIACEAE	*Muscari comosum* (L.) Miller	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Med.	
	Smilax excelsa L.	Guney v.	319184.019-4509901.088	600	15.08.09	Med.	
MALVACEAE	*Alcea pallida* Waldst. et Kit	Guney v.	322939.505-4509353.689	750	15.08.09		
ONAGRACEAE	*Epilobium anagallidifolium* Lam.	Sumbullu v.	319184.019-4509901.088	600	15.08.09		
ORCHIDACEAE	*Ophrys apifera Hudson*	Sumbullu v.	319184.019-4509901.088	600	15.08.09		
	Orchis morio L. subspp. morio L.	Dikmen u.	323665.835-4504315.862	1360	15.08.09		
PAPAVERACEAE	*Glaucium flavum* Crantz	Dikmen v.	322871.815-4509237.341	750	15.08.09		
	***Papaver apokrinomenon* Fedde**	Guney v.	322871.815-4509237.341	750	15.08.09		
PLANTAGINACEAE	*Plantago major* L. subspp. *major* L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09		
POACEAE	*Aegilops triuncialis* L.subspp. *triuncialis* L.	Dikmen v.	322871.815-4509237.341	750	15.08.09		
	Alopecurus arundinaceus Poiret	Guney v.	322871.815-4509237.341	750	15.08.09	Euro-Sib.	
	Alopecurus vaginatus (Willd.) Boiss.	Sariyer v.	307297.948-4510669.381	42	08.09.09		
	Avena barbata Pott Ex Link subspp. *barbata* Pott Ex Link	Dokurcun t.	324036.016-4499649.509	1375	15.08.09	Med.	
	Briza maxima L.	Sariyer v.	307297.948-4510669.381	42	08.09.09		
	Bromus madritensis L.	Dikmen u.	324036.016-4499649.509	1375	15.08.09		
	Dactylis glomerata L. subspp. *hispanica* (Roth) Nyman	Dikmen v.	322871.815-4509237.341	750	15.08.09		
	Hordeum vulgare L.	Dokurcun t.	324036.016-4499649.509	1375	15.08.09		
	Lolium perenne L.	Guney v.	322939.505-4509353.689	750	15.08.09	Euro-Sib.	
	Phleum subulatum Aschers. *et* Graebn.subspp. *subulatum* Aschers. *et* Braebn.	Guney v.	322939.505-4509353.689	750	15.08.09		
	Secale cereale L. var. cerale L.	Dokurcun t.	324036.016-4499649.509	1375	15.08.09		
	Triticum aestivum L.	Sariyer v.	307297.948-4510669.381	42	08.09.09		
	Vulpia fasciculata (Forsskal) Fritsch	Dikmen v.	322871.815-4509237.341	750	15.08.09	Med.	
POLYGONACEAE	*Polygonum lapathifolium* L.	Guney v.	322939.505-4509353.689	750	15.08.09		
PRIMULACEAE	*Primula vulgaris* Huds. subsp. *vulgaris* Huds.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.	
RANUNCULACEAE	*Helleborus orientalis* Lam.	Dikmen u.	323665.835-4504315.862	1360	15.08.09	Euro-Sib.	
	Ranunculus brutius Ten.	Dikmen u.	324036.016-4499649.509	1375	15.08.09	Euro-Sib.	
RESEDACEAE	*Reseda lutea* L. var. lutea L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09		
ROSACEAE	*Alchemilla pseudocartalinica* Juz.	Guney v.	318594.481-4509771.987	425	15.08.09		
	Fragaria vesca L.	Dikmen v.	324062.252-4504966.186	1350	15.08.09		
	Potentilla astracanica Jacq.	Golyaka v.	311205.397-4504709.031	1150	08.09.09	Euro-Sib.	
	Sanguisorba minor Scop. subspp. *minor* Scop.	Camlica v.	308856.046-4505022.588	700	08.09.09		
RUBUIACEAE	***Asperula lilaciflora* Boiss. *subsp. phrygia* (Bornm.) Schonb.- Tem.**	Guney v.	322871.815-4509237.341	750	15.08.09		
	Cruciata taurica(Pallas Ex Willd.) Ehrend.	Camlica v.	308856.046-4505022.588	700	08.09.09	Ir.-Tur.	
	Galium odoratum (L.) Scop.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.	
SCROPHUL-	*Digitalis ferruginea* L.	Sumbullu v.	318594.481-4509771.987	425	15.08.09	Euro-Sib.	

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ARIACEAE	subspp. *ferruginea* L.					
	***Linaria corifolia* Desf.** (Dinay, 1994)	**Guzlek v.**			**12.08.92**	**Ir.-Tur.**
	***Verbascum bithynicum* Boiss.**	Dikmen v.	322871.815-4509237.341	750	15.08.09	Euro-Sib.
	Verbascum blattaria L.	Guney v.	322871.815-4509237.341	750	15.08.09	
	Veronica arvensis L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.
URTICACEAE	*Urtica dioica* L.	Cigdem u.	317855.455-4501374.413	1450	19.08.09	Euro-Sib.
	Shrub formation					
APIACEAE	*Oenanthe pimpinelloides* L.	Guney v.	322939.505-4509353.689	750	15.08.09	
	Pimpinella peregrina L.	Guney v.	322939.505-4509353.689	750	15.08.09	
APOCYNACEAE	*Vinca major* L. subspp. *major* L.	Sariyer v.	307297.948-4510669.381	42	08.09.09	Med.
BUXACEAE	*Buxus sempervirens L.*	Tumalik u.	317855.455-4501374.413	1450	19.08.09	Euro-Sib.
CELASTRACEAE	*Euonymus europeaus* L.	Guney v.	322939.505-4509353.689	750	15.08.09	
CONVOLVULACEAE	*Convolvulus cantabrica* L.	Camlica v.	322260.461-4507656.345	700	08.09.09	
		Dikmen u.	323665.835-4504315.862	1360	15.08.09	
CORNACEAE	*Cornus mas* L.	Sumbullu v.	318594.481-4509771.987	425	15.08.09	Euro-Sib.
CORYLACEAE	*Corylus avellana* L. var. avellana L.	Guney v.	318594.481-4509771.987	425	15.08.09	Euro-Sib.
		Dikmen u.	324036.016-4499649.509	1375	15.08.09	Euro-Sib.
CUPRESSACEAE	*Juniperus communis L.* var. communis	Erenler h.			15.08.09	
EPHEDRACEAE	*Ephedra major* Host	Dikmen v.	322871.815-4509237.341	750	15.08.09	
ERICAEAE	*Arbutus andrachne* L.	Dikmen v.	322871.815-4509237.341	750	15.08.09	
	Rhododendron ponticum L.					
	subspp. *ponticum* L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.
		Golyaka v.	311205.397-4504797.031	1150	08.09.09	Euro-Sib.
		Camlica v.				
		Dokurcun t.	324036.016-4499649.509	1375	15.08.09	
		Keremali h.	311020.090-4505488.737	1050	08.09.09	
	Vaccinium myrtillus L.	Guney v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.
GUTTIFERAE	*Hypericum calycinum* L.	Sumbullu v.	318594.481-4509771.987	425	15.08.09	Euro-Sib.
LEGUMINOSAE						
(FABACEAE)	*Genista tinctoria* L.	Dikmen u.	323665.835-4504315.862	1360	15.08.09	Euro-Sib.
LILIACEAE	*Ruscus aculeatus* L. var. aculeatus L.	Sariyer v.	307297.948-4510669.381	42	08.09.09	
ROSACEA	*Crataegus monogyna* Jacq.					
	subspp. *monogyna* Jacq.	Dikmen h.	324849.155-4503471.313	1400	15.08.09	
	Laurocerasus officinalis Roemer	Erenler h.	324849.155-4503471.313	1400	15.08.09	
	Mespilus germanica L.					Euro-Sib.
	Persica vulgaris Miller	Golyaka v.	313088.629-4507578.601	750	15.08.09	
	Rosa sempervirens L.	Sumbullu v.	313088.629-4507578.601	750	15.08.09	Med.
	Rubus sanctus Schreber	Dokurcun t.	323923.723-4499434.046	1350	15.08.09	
	Sorbus umbellata (Desf.) Fritsch					
	var. *umbellata* (Desf.) Fritsch	Dikmen u.	323923.723-4499434.046	1350	15.08.09	Ir.-Tur.
SANTALACEAE	*Osyris alba* L.	Guney v.	322939.505-4509353.689	750	15.08.09	Med.
		Golyaka v.		1150	15.08.09	
STYRACACEAE	*Styrax officinalis* L.	Sariyer v.	307297.948-4510669.381	42	08.09.09	
THYMELAEACEAE	*Daphne pontica* L.	Dikmen h.	324919.594-4504648.653	1250	15.08.09	Euro-Sib.
	Forest formation					
ACERACEAE	*Acer platanoides L.*	Guney v.	322871.815-4509237.341	750	15.08.09	Euro-Sib.
BETULACEAE	*Alnus glutinosa* (L.) Gaertner					
	subspp. *glutinosa* (L.) Gaertner	Madenler v.	315421.135-4495830.201	590	19.08.09	Euro-Sib.
CORYLACEAE	*Carpinus betulus* L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.
	Ostrya carpinifolia Scop.	Camlica v.	308856.046-4505022.588	700	08.09.09	Med.
CUPRESSACEAE	*Juniperus oxycedrus* L.					
	subspp. *oxycedrus* L.	Dedeler v.	315421.135-4495830.201	590	19.08.09	
FAGACEAE	*Castanea sativa* Miller	Guney v.	318594.481-4509771.987	425	15.08.09	Euro-Sib.
		Keremali h.	309750069-4502371.371	1350	08.09.09	
		Bakacak v.	313246.727-4507885.134	775	08.09.09	
	Fagus orientalis Lipsky	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.
		Dikmen v.	323.549.142-4507960.226	900	15.08.09	
		Dokurcun t.	324036.016-4499649.509	1375	15.08.09	

Cont.....

		Dikmen v.	323.549.142-4507960.226	900	15.08.09	
		Sariyer v.	307297.948-4510669.381	42	08.09.09	
		Golyaka v.	311205.397-4504797.031	1150	08.09.09	
		Camlica v.	308856.046-4505022.588	700	08.09.09	
		Golyaka v.	311020.090-4505488.737	1050	08.09.09	
	Quercus petraea (Mattuschka) Liebl.					
	subspp. petraea (Mattuschka) Liebl	Dokurcun t.	324036.016-4499649.509	1375	15.08.09	
	Quercus robur L. subspp. *robur L.*	Sumbullu v.	315221.143-4512526.035	300	15.08.09	Euro-Sib.
		Dokurcun t.	324036.016-4499649.509	1375	15.08.09	
JUGLANDACEAE	*Juglans regia* L.	Camlica v.	308856.046-4505022.588	700	08.09.09	
	Pterocarya fraxinifolia (Poiret) Spach	Camlica v.	308856.046-4505022.588	700	08.09.09	Euro-Sib.
LAURACEAE	*Laurus nobilis* L.	Guney v.	322939.505-4509353.689	750	15.08.09	Med.
MORACEAE	*Ficus carica* L. subspp. *carica* (All.) Schinz et Thell.	Guney v.	322939.505-4509353.689	750	15.08.09	
	Morus alba L.	Guney v.	322939.505-4509353.689	750	15.08.09	
	Morus nigra L.	Dikmen v.	323.549.142-4507960.226	900	15.08.09	
PINACEAE	****Abies nordmanniana* (Stev.) Spach subsp.*bornmuelleriana* (Mattf.) Coode *et* Cullen**	Guney v.	322939.505-4509353.689	750	15.08.09	
		Dikmen v.	324062.252-4504966.186	1350	15.08.09	
		Dikmen v.	323.549.142-4507960.226	900	15.08.09	
		Dokurcun t.	324036.016-4499649.509	1375	15.08.09	Euro-Sib.
		Madenler v.	315421.135-4495830.201	590		
		Keremali h.	309191.056-4502813.029	1100	08.09.09	
		Tumalik u.	315891.871-4498280.829	1070		
	Pinus nigra Arn. subspp.					
	pallasiana (Lamb.) Holmboe	Golyaka v.	309191.056-4502813.029	1100	08.09.09	
	Pinus brutia Ten.	Dikmen v.	324062.252-4504966.186	1350	15.08.09	Med.
	Pinus sylvestris L.	Cigdem u.	317855.455-4501374.413	1450		Euro-Sib.
PLATANACEAE	*Platanus orientalis* L.	Guney v.	319184.019-4509901.088	600	15.08.09	
		Dedeler v.	316004.427-4495120.157	330	19.08.09	
ROSACEA	*Cerasus avium* (L.) Moench	Camlica v.	308856.046-4505022.588	700	08.09.09	
SALICACEAE	*Populus nigra* L. subspp. *nigra* L	Guney v.	319184.019-4509901.088	600	15.08.09	
	Populus tremula L.	Sumbullu v.	319184.019-4509901.088	600	15.08.09	Euro-Sib.
	Salix triandra L. subspp. *bornmuelleri* (Hausskn.) A. Skv.	Camlica v.	308856.046-4505022.588	700	08.09.09	Ir.-Tur.
TILIACEAE	*Tilia argentea* Desf. Ex Dc.	Guney v.	318594.481-4509771.987	425	15.08.09	Euro-Sib.
ULMACEAE	*Celtis australis* L.	Dikmen u.	324036.016-4499649.509	1375	15.08.09	Med.

* Endemic species, Euro-Sib: Euro-Siberian, Ir.-Tur: Irano-Turanian, Med: Mediterranean

temperature in July and August and then it begins to decrease again after September (Fig. 3). Average temperature of January varies between 3.9 (Duzce) and 6 ºC (Sakarya) in the study area.

The daily average temperatures show parallelism with monthly average temperatures. The lowest value is seen in January (Adapazari 4.9 ºC, Duzce 2.9 ºC). After February, the daily average temperature increases in Sakarya and it reaches up to 23.9 ºC, in Duzce to 23.1 ºC in July. From August onwards, it begins to decrease again until January. According to average period of 1975 - 2006, daily average temperature doesn't go down below 2.9 ºC. Absolute minimum temperature is -10ºC (February) in Sakarya and -17.3ºC (February) in Duzce. Annual average number of frost days differs between 21.2 days (Sakarya) and 45.3 days (Duzce). Amount of frost days increases at the higher parts of the research area.

Daily average temperature is important to determine the vegetation period. Vegetation period is accepted to be the days for which the average daily temperature is over +5°C (Erinc, 1984) or +8°C (Atalay, 1994). Vegetation period changes in Sakarya for an average of 265 days (19 March - 8 December) and in Duzce about 247 days (22 March -23 November). These values decrease with altitude, exposure and orography. Depending on this situation, broad - leaved forest species can be seen in lower parts. Needle leaved forest vegetation occur on the higher parts with increasing altitude. On the other hand, because of orographic direction of Elmacik mountain (east-west), higher temperatures occur in southern slopes. So, trees such as *Quercus robur* subspp. *robur, Fagus orientalis, Castanea sativa, Tilia argentea, Pinus sylvestris* that require medium temperatures are found on lower parts.

The precipitation and atmospheric moisture constitute the source of water which is a vital necessity for plants. The total annual rainfall in Elmacik mountain vary between 851 (Sakarya) and 836.4 mm (Duzce). By the effect of the relief and altitude, the total annual and monthly precipitation show significant changes. For instance, the total annual rainfall around the Elmacik mountain

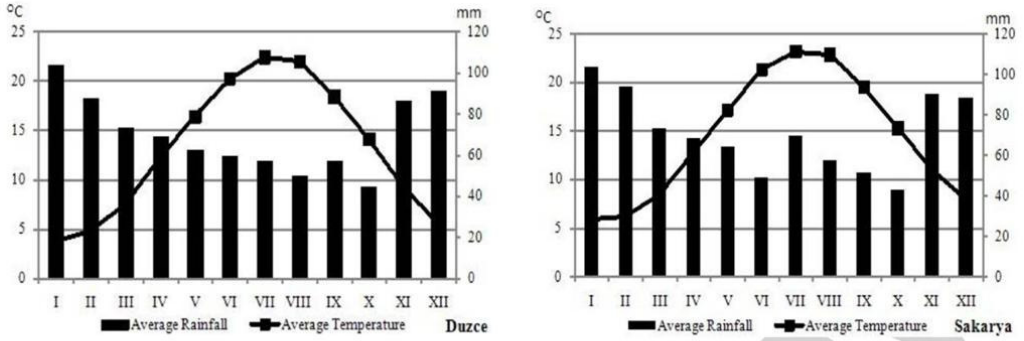

Fig. 3a,b: Mean monthly rainfall and temperature graphic of Duzce and Sakarya meteorology stations (1975-2005)

is 850 - 900 mm. However, it reaches up to 1400 - 1550 mm around the Keremali, Erenler and Dikmen hills (Fig. 4). Depending on the rise of the precipitation rate, the vegetation density also increases.

The research area receives rain every season throughout the year. There is a slight difference in the seasonal distribution of the total average annual precipitation. Its proportion is between 31.7 and 31.44 % in winter, 21.7 and 22.8 % in spring, 20.9 and 19.4 % in summer and 26 and 26.3 % in autumn.

The area receives the highest amount of rainfall in December and January (103 - 87 mm). As in February, it starts decreasing and it gets to the lowest level in the months of May (42 - 49 mm) and September (42 - 44 mm). As of October, it starts increasing again (Fig. 3). With this distribution, the research area is "Marmara Rainfall Regime" according to Temucin (1990) and the B3 type of "Black Sea Rainfall Regime" (Ikiel, 2005). So in the research area, although the monthly precipitations change, it is observed that each month receives rainfall. This issue is related with the fact that moisture increase of the air masses coming upon the Black Sea causes precipitation due to the orography and altitude, depending on the general atmosphere circulation in the summer months when the frontal activities slow down.

Rainfalls are vital for plants in vegetation period (Efe, 1998, 2010). The total amount of the precipitation in the vegetation period is 561.8 mm (65.9 %) in Sakarya and 499.1 mm (59.7 %) in Duzce. These figures increase depending on the altitude and orography. Along with this issue, it is observed that the plant species change in the vertical direction. The plants that need much precipitation like *Abies nordmanniana* subspp. *bornmuelleriana, Pinus sylvestris* are seen to be the prevailing species in the higher areas where the precipitation increases. Due to the orographic direction of the mountains, the undergrowth vegetation becomes sparse in the southern slopes that receive rainfall less than the northern slopes.

The relative humidity rate, which is a key factor for plants during vegetation, is over 68 % throughout the year. As well as the number of the cloudy days change according to the seasons, it is over 180 days. Average daily sunshine duration is minimum of 2 hrs in winter months and a maximum of 8 hrs in summer months. During the vegetation period, the high rate of the humidity removes the adverse effects by diminishing the drought in the summer months. This situation enables the growing of plants that need humid and foggy environment in the higher parts of the area. *Pinus sylvestris* requires high solar radiation (light) and constitutes communities on high levels. This situation has an influence on the increase in the intensity of *Quercus* sp. on the southern slopes.

The wind is important on the sea coasts, high mountains and high levels. Bringing the moisture, the winds have a positive impact on the vegetation. When the annual wind frequencies were analyzed, it was observed that prevailing wind direction is north. The frequencies of north-south directional winds increases in the winter months. In spring and summer months, north directional winds are prevalent in both the stations of Adapazari and Duzce, whereas in autumn north directional winds dominates Adapazari and south-north directional winds are seen in Duzce. In the south of the area, southeast and southwest winds decrease the relative humidity and increase the temperature (Inandik, 1955). In winter, however, the winds that blow from southwest are the prevailing winds and they have higher influence on temperature on the south slopes than on the northern ones. Therefore, it is one of the highly effective factors that *Quercus* sp. is dominant on the south slopes of Elmacik mountain.

The relations between the vegetation and soil features: Generally, one type of zonal soils; mollisol (brown forest soils and non-calcareous brown forest soils) and one type of non-zonal soils; entisols (alluvial and colluvial soils) are seen in the research area (Anonymous, 1972; Atalay, 2006; Efe, 2010). While the entisol are found in the plains, the mollisols are prevalent in the places where Elmacik mountain constitutes high and forested land.

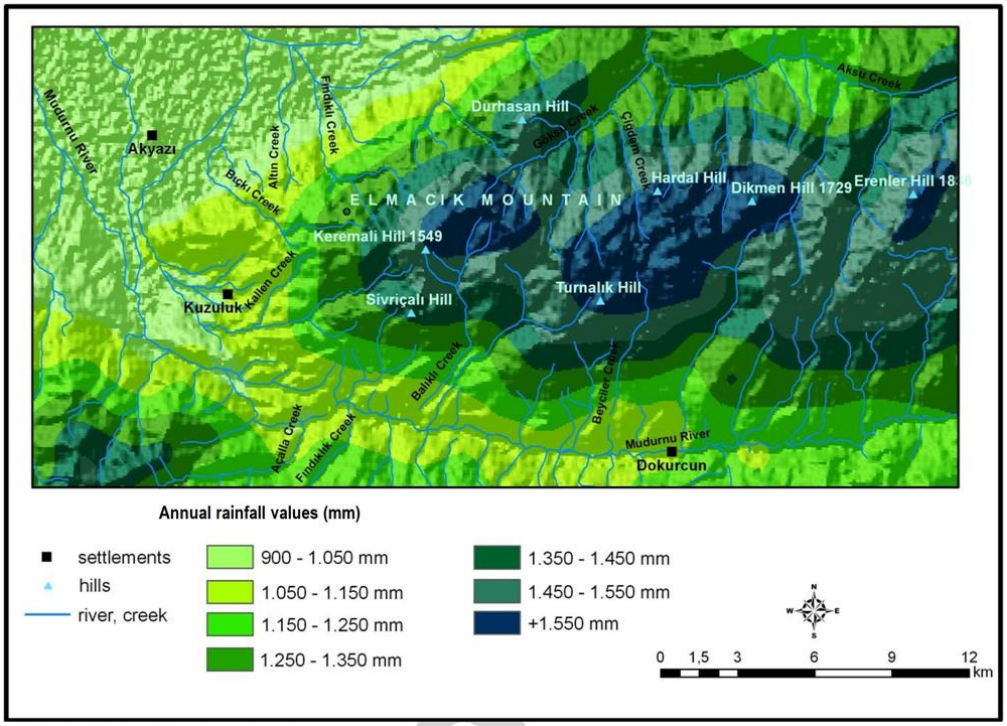

Fig 4: Distribution of mean annual rainfall map

The non-calcareous brown forest soils are prevalent in the research area. Mollisols are well developed and have the horizons A, B and C. These soils are slightly alkali and have good drainage conditions (Anonymous, 1995). These soils have reasonable amount of organic substances, and thus create a convenient environment for the vegetation (Donmez, 1979).

Alluvial soils occur found in the west of the research area, in Akova and along the Mudurnu river valley, the soils are agglomerated and carried by the rivers upon the young sediments at the bottom of the valleys or in the spheres of their influence. These soils have the horizons A and C and are rich in organic substances. Although they create a convenient environment for the plant life; most of them are in housing or agricultural areas.

Colluvial soils are seen in a narrow location in the west of the research area. They usually develop under different climatic regimes and great variety of vegetation. Carried from short distances or by runoff and land slip, the materials are agglomerated in the places where the slope decreases. These young soils have A and B horizons. In a narrow, non-agricultural area of these soils *Quercus* sp., *Populus tremula* becomes widespread.

The soil is thin in the summit of the hills due to the steep slopes. Therefore, no communities of trees were seen there. Instead of this, shrub and herbaceous formations *like Rhododendron ponticum* subspp. *ponticum, Ilex aquifolium, Digitalis ferruginea* subsp. *ferruginea, Hypericum calycinum* were seen distinctively in the Dikmen, Erenler and Mezarlikkasi hills.

The relations between the vegetation and geologic - geomorphologic features: The basis of Elmacik mountain comprises the various facets of the formations belonging to crystalline series. In this area from the bottom, there are formations of the crystalline series, Devonian, Perm Carboniferous, Jurassic, Lower-Upper Cretaceous, Paleocene, Eocene, Pliocene and Quaternary (Abdusselamoglu, 1959).

In the east of the research area, the Almacik ophiolites occur tectonically on the Akcay metamorphic rocks. Permo-Triassic metamorphic rocks are prevalent in the southern and western parts of the mountainous area. Metamorphic rocks outcrop best around Turnalik, Hardal and Mezarlikkasi hill. Yiglica formations can be seen around Keremali and Dikmen hill. Metamorphic and volcanic rocks are also prevalent (Gedik *et al.*, 2002).

North Anatolian fault is limited to Mudurnu river and Akyazi - Golyaka - Duzce segments and it lies in east-west direction. The main morphological units consist of high plateaus, ridges that lie in northwest - southeast and northeast - southwest directions and

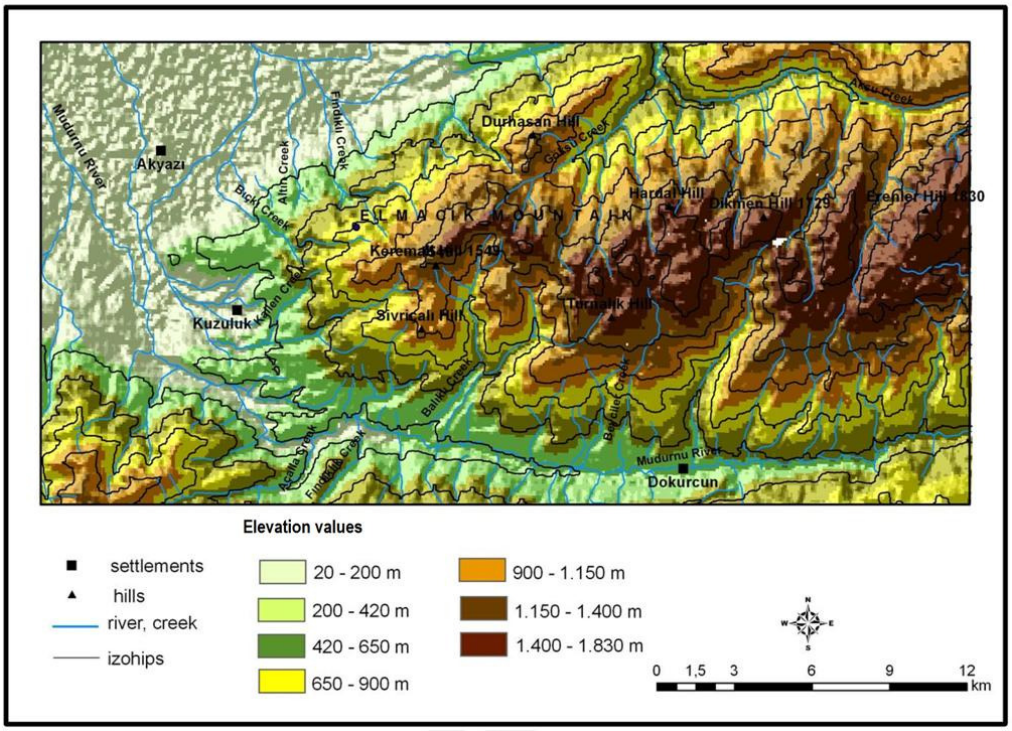

Fig. 5: Digital elevation map

canyons (Tari and Tuysuz, 2008). The depressions surrounding the Elmacik mountain from north and south (Adapazari 31 m, Duzce 146 m) are the flat areas filled with quaternary deposits in the south. They exist in Mudurnu river valley as well. In the mass of Elmacik mountain rising out with the steep slopes from this valley and depressions, the altitude reaches 1830 m at the Erenler hill. Elmacik mountain rising out suddenly with young fault line steeps from Adapazari and Duzce lowland is fractured by Aksu, Goksu and other small creeks. The southern slopes of the area are drained by Mudurnu river and its tributaries (Fig. 5). Difference in altitude resulting from the geomorphologic characteristics of the area, the orographic direction, exposure and slope affect the climate, soil and human activities. It also affects the type and distribution of vegetation.

The relations between the vegetation and the biotic factors: The research area has the convenient ecological conditions for the humid forest vegetation to grow. The agricultural activities of the rural population who have settled down in this region have caused degradable progression on the natural vegetation.

Although the areas that are under human influence were covered with the plant associations like *Fagus orientalis, Abies nordmanniana* subspp. *bornmuelleriana* in 1950's, and these communities of trees disappeared in 1990's. This vegetation left its place to non-qualified *Fagus orientalis, Abies nordmanniana* subspp. *bornmuelleriana* and in some places totally disappeared; it left its places to agricultural areas and hazelnut gardens. The cereal agriculture is practiced up to 770 m around the Dokurcun and Okuzoba regions. Hazelnut farming is also practiced in Madenler village up to 850 m and around Cigdem upland up to 1100 m. This situation is quite widespread in the villages of the settlers who came from Black sea region. Annual average temperature is 13-16 °C in areas where hazelnuts are grown (Ustaoglu and Karaca, 2010). But we have seen hazalnut growing upto 1100 m, where the annual average temperature is around 10-11 °C in the research area.

Also, the livestock activity has an adverse effect on the natural vegetation, the sheep and goat breeding has been forbidden in the last few years. For instance, the reason why there are old *Fagus orientalis* trees but not *Fagus orientalis* seedling around the Turnalik highland in Madenler village is that both wild and domestic animals are bred by the people living around and some animals in the region feed on the *Fagus orientalis* seedlings. In this context, the destroyed areas of the communities of *Fagus orientalis* are covered *with Rhododendron ponticum* subsp. *ponticum*. There

are also communities of *Fagus orientalis* in 900 -1000 m around the Golkaya. These communities of *Fagus orientalis* were comprised with the forestation of the area that was destroyed in a fire 25 years ago.

On the other hand, around the villages, the forest vegetation is sparse. It is because of the cutting down the trees for the fuel wood, building materials etc. For instance, it is the reason why the communities of *Carpinus betulus* are much scarcer around the Madenler village.

Due to the fact that the people living in immediate surroundings cut down the trees illegally, the forest vegetation is damaged, such as the forest in the area between Golyaka and Keremali hill. The traditional transhumance activity in Elmacik mountain declined nowadays, however it becomes the transhumance for the tourism and recreational purposes.

Owing to the biotic factors, the forest vegetation is well preserved in the distant and steep lands which are difficult to access. In these areas, the communities of *Fagus orientalis and Abies nordmanniana* subspp. *bornmuelleriana*, which are seen as the climax species, are much more common. In the areas where humid forest vegetation is destroyed, the pseudomaquis species such as *Cornus mas, Arbutus andrachne, Corylus avellana* var. avellana, *Mespilus germanica, Rosa sempervirens, Rhododendron ponticum* subspp. *ponticum* are prevalent (Kaya and Aladag, 2009; Atalay, 1992, 1994, 2002, 2008).

The vegetation formations in Elmacik mountain*:* The vegetation and the flora of the Euro - Siberian region with its substantially tertiary origin was included in the research area. In this respect, there are relict plant species like *Castanea sativa, Fagus orientalis, Populus tremula, Buxus sempervirens* in the area. In the existence of various species belonging to different flora kingdom and especially in the Quaternary, the changes in the climate are very effective. In the interglacial period, the plants peculiar to Mediterranean flora region had the opportunity to move to the north.

As a result of the related literature and field works, 139 species of 53 families were identified. 43 of these species belong to Euro - Siberian phytogeographical region, 18 of them to Mediterranean region and 5 of them to Irano - Turanian phytogeographical region. 73 of them consist of the plant species that do not have a specific phytogeographical region. 9 of these plant species *(Abies nordmanniana* subspp. *bornmuelleriana, Asperula lilaciflora* subspp. *phrygia, Heracleum pastinacifolium* subspp. *incanum, Iris purpureobractea, Linaria corifolia, Myosotis alpestris*.subspp. *alpestris, Onosma mutabile, Papaver apokrinomenon, Salvia cadmica, Verbascum bithynicum)* are endemic to the region (Table 1).

Some plant species are involved in the Euxine province of Euro-Siberian phytogeographical region. These plant species are classified according to the vegetation formation (forest, shrub, herbaceous) in accordance with the principles of vegetation geography. The spatial distribution of this classified vegetation formations is given in Fig 6 and is explained below.

Forest formations: Most of the tree species such as *Acer campestre, Acer trautvetteri, Alnus glutinosa, Carpinus betulus, Carpinus orientalis, Castanea sativa, Fagus orientalis, Pinus sylvestris, Quercus petraea, Quercus robur and Tilia rubra* grow in the North Anatolia phytogeographical region and the majority of them are peculiar to lower Euxine province (Davis 1965-1985).

Plant species change when the altitude gets higher on the slopes of the Elmacik mountain. Tree species change along Aksu valley in the direction of Dikmen upland and hill on the north slopes of the mountain as of 150 - 200 m. In the valley, the communities of *Fagus orientalis* are common. *Populus* sp. *Carpinus betulus, Castanea sativa, Tilia argentea and Alnus glutinosa* subspp. *glutinosa, Juglans regia, Quercus* sp. mix with the communities of *Fagus orientalis* are species common in the area. There is also the intense understory vegetation of *Verbascum* sp., *Dipsacus laciniatus, Aster tripolium, Cichorium intybus, Salvia* sp., *Campanula latifolia, Alyssum minutum. Rhododendron ponticum* subspp. *ponticum, Daucus carota, Pimpinella peregrina* (Fig. 6). *Abies nordmanniana* subspp. *bornmuelleriana* mix with the humid forest vegetation of decidious tree species upto 1200 m. The communities of *Abies nordmanniana* subspp. *bornmuelleriana* start after 1300 m on the northern slopes of Elmacik mountain and extends up to 1450 m. Trees around the Dikmen upland become scarce and are replaced by herbaceous plants on Dikmen hill. The forests were cleared and replaced with hazelnut gardens in Aksu valley.

Pinus sylvestris is dominant on the southern slopes. Around the Okuzoba upland (1455 m), the communities of *Pinus sylvestris* are found. The forest in the area around the Okuzoba mountain had been destroyed. *Pinus sylvestris, Abies nordmanniana* subspp. *bornmuelleriana* comprise the mixed coniferous forest zone around Dokurcun. Understory of this mixed coniferous forests, the *Rubus sanctus* are dominant. Communities of pure *Fagus orientalis* are common around 1100 m. In the area between 900 and 1000 m, among the communities of *Fagus orientalis*, Quercus sp. *Abies nordmanniana* subspp. *bornmuelleriana* are observed. Communities of *Quercus* sp. trees become widespread in 700 and 800 m. Most of the forests were cleared and converted to agricultural land in Dokurcun valley.

Diversity in the forest vegetation and the vegetation zones are observed around Dokurcun valley, Dedeler, Madenler, Kurtulus village, Turnalik upland, Cigdem upland and Goksu creek. The area from the bottom of the valley to 900 m altitude has the features of Mediterranean ecosystem (Atalay, 1994; Yalcin, 1985). From the mountainside, the communities of *Quercus sp.* trees makeup the dominant forest vegetation. In the area up to 900 m height, the *Pinus sylvestris, Pinus brutia, Fagus orientalis, Tilia argentea and Alnus glutinosa* subspp. *glutinosa* at the least mix with the communities of *Quercus* sp. around Dedeler and Madenler village, the forest areas

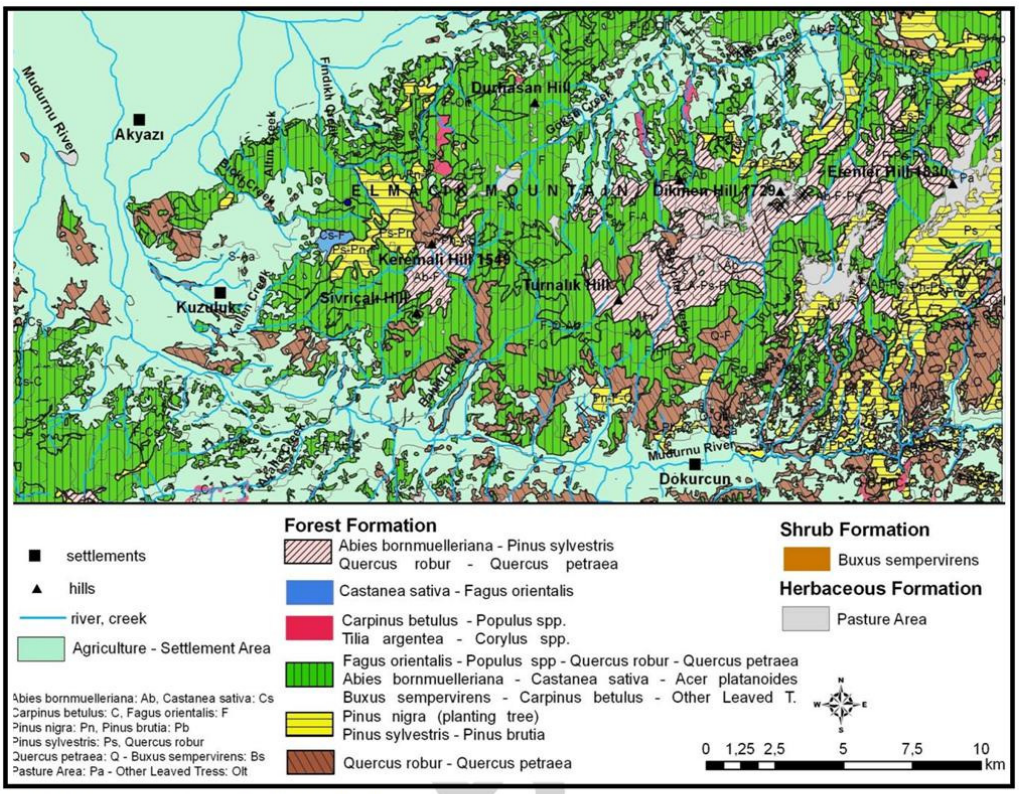

Fig 6: Distribution of the vegetation formations in Elmacik mountain (west part)

are transformed into agricultural areas. Saved from being cut down due to its worthless wood, *Alnus glutinosa* subspp. *glutinosa is* the most intense forest vegetation in this region. Above 1100 m altitude, *Fagus orientalis* forests become dominant. Around 1250 m, the trees of *Abies nordmanniana* subspp. *bornmuelleriana* are dominant species. This situation changes when sloping from Tumalik upland down Cigdem upland (1450 m) and it leaves its place to *Buxus sempervirens*. *Fagus orientalis, Quercus* sp. *and Abies nordmanniana* subspp. *bornmuelleriana* constitute a mixed humid forests on the northern slopes. Forestland is transformed into agricultural areas in some places around Kurtulus village, located on the northern slope of Elmacik mountain to Hendek town.

Pinus sylvestris covers a large space among the forests of *Abies nordmanniana* subspp. *bornmuelleriana* while sloping down to 1400 m on the south slopes of Erenler hill. Sometimes *Fagus orientalis*, especially on the south slopes *Pinus sylvestris and Pinus nigra* subspp. *pallasiana* mix with the communities of *Abies nordmanniana* subspp. *bornmuelleriana* occur between 100 and 1100 m on the northern slopes of Erenler hill and 1400 m on the southern slopes. Because of the effect of the increasing inclination and altitude, thinning out of the soil by erosion, the Erenler hill is deprived of forest. *Crataegus and Juniperus communis* have been able to survive in this area (Yalcin, 1985).

The *Fagus orientalis,* the forest flourishes along with *Juglans regia, Tilia argentea, Acer platanoides and Carpinus betulus i*n the south of Akyazi, in the Findikli, Altin and Bicki creek valleys. Above 1250 m, the trees of *Abies nordmanniana* subspp. *bornmuelleriana* intensify. The communities of *Acer platanoides* are seen around Keremali hill (1450 m). The communities of *Quercus* sp. and *Fagus orientalis* trees are seen around the Kuzuluk town, located in the west of the area. Kuzuluk town and the forest vegetation around the hot springs are dramatically destroyed.

Shrub formation: Broad - leaved and coniferous humid forests comprise the natural vegetation of the research area. Besides, with advanced understory vegetation, the formation of shrub is also advanced in the destroyed areas of forest vegetation.

The majority of the plant species consists of the shrubs *Cornus australis, Corylus avellena, Crataegus microphylla, Daphne*

pontica, Fraxinus excelsior, Hedera colchica, Hypericum androsaemum, Mespilus germanica, Ostrya carpinifolia, Rhododendron ponticum, Smilax excelsa, Sorbus torminalis that belong to the Euxine province (Davis, 1965-1985). *Arbutus andrachne, Corylus* sp., *Cornus mas, Genista tinctoria, Prunus laurocerasus, Rhododendron ponticum* subspp. *ponticum, Rosa sempervirens, Vaccinium myrtillus, Buxus sempervirens, Rubus sanctus* are common species in the bush formation.

Predominant under the *Fagus orientalis* forests, the area is covered with *Rhododendron ponticum* subspp. *ponticum, Vaccinium myrtillus, Ilex aquifolium, Daphne pontica. Crataegus* and *Juniperus communis* are seen at the summit of Dikmen hill and Erenler hill which are deprived of forests. *Buxus sempervirens* is dominant among black pines in 1400 - 1500 m between the Turnalik upland and Cigdem upland. Saved from the fire that broke out in 1986, *Corylus* sp. are seen between the Golkaya and Keremali hills (around 950 m).

Rhododendron ponticum subspp. *ponticum* are much more widespread on the northern slopes than on the southern slopes. As *Rhododendron ponticum* subspp. *ponticum* covers the understory of the forest and create shadows, it prevents the seedlings of the trees which do not like shadows like *Alnus glutinosa* subspp. *glutinosa, Pinus nigra* subspp. *pallasiana, Carpinus betulus* to grow.

Herbaceous formations: The herbaceous vegetation area is prevalent in the lower level of the forest formation and in the area where the forests are destructed and on the hills.

Argyrolobium calycinum, Cardamine bulbifera, Circaea lutetiana, Epimedium pubigerum, Euphorbia amygdaloides, Galium odoratum, Helleborus orientalis, Lathyrus aureus, Ranunculus brutius, Salvia glutinosa, Trachystemon orientale are herbaceous species belong to the Euxine province (Davis, 1965-1985).

Digitalis ferruginea subspp. *ferruginea, Euphorbia* sp., *Fragaria vesca, Hedera helix, Pteridium agnilineum, Primula vulgaris* subspp. *vulgaris, Smilax excelsa, Veronica arvensis, Trifolium repens* var. repens, *Potentilla astracanica, Triticum aestivum, Verbascum blattaria* are also found in the research area.

Dikmen and Erenler hills are deprived of vegetation due to increasing inclination and altitude, the increasing wind force and thinning out of the top soil with the water erosion (Yalcin, 1985). The herbaceous vegetation is found on these hills. *Pteridium agnilineum* is dominant on Dikmen hill. However, *Verbascum blattaria, Euphorbia* sp., *Digitalis ferruginea* subspp. *ferruginea* are rare.

The herbaceous species in the forest vegetation in Elmacik mountain intensify in the humid areas and valleys. The plant species make up the herbaceous vegetation changes between the north and south slopes. The understory vegetation on the northern slopes are much intensive than on the southern slopes.

Table 2. The distribution of phytogeographical regions of plant species

Phytogeographical Regions	Genus (sp. - subspp.)	%
No specific region	73	52.5
Euro - Siberian	43	31.0
Mediterranean	18	12.9
Irano - Turanian	5	3.6
Total	139	100

Consequentially, among the natural vegetation determined in the research area, 31 % of them belong to Euro-Siberian, 12.9 % of them belong to Mediterranean, 3.6 % of them belong to Irano-Turanian phytogeographical region. About 52.5% of the vegetation does not belong to a specific phytogeographical region; they can grow in other regions as well (Table.2).

Elmacik mountain is located in the Western Black Sea subregion of forest of Black Sea Region. The forests in the Western Black Sea subregion support a much higher diversity of tree species (Atalay and Efe, 2010). Considering the tree species constituting the forest vegetation, 41 % of these tree species belong to Euro - Siberian, 13.6 % to Mediterranean, 4.5 % belong to Irano-Turanian phytogeographical region. About 40 % of the tree species do not belong to a specific phytogeographical region.

Many of the tree species that constitutes communities *(Fagus orientalis, Quercus robur* subspp. *robur, Abies nordmanniana* subspp. *bornmuelleriana, Alnus glutinosa* subspp. *glutinosa, Pinus sylvestris, Tilia argentea, Castanea sativa)* are included into the Euro-Siberian phytogeographical region. The similar situation is also observed in the understory vegetation.

The classification of these plant species according to vegetation formations and the vegetation communities, the research area includes the whole forest zone. These forests are deciduous forest, humid - temperate broad leaved and cold-humid, sub-humid conifer forests. Understory vegetation is well developed in the humid forests. However, some forests have been cleared and replaced by shrub and herbaceous formations. Vegetation formations change depending on the ecological conditions such as climate, soil type and topography. Vertical plant formations also occur on the slopes of mountains.

Hazelnut agriculture is generally practiced on the areas where forests were cleared. This is remarkable especially around the rural settlements in Aksu and Goksu creek valley and around Dedeler village, located on the northern slopes of Mudurnu river valley. Natural cycles and human activities should be carefully monitored for sustainable development in the research area.

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