

**An Interim Report on the Effects of Global Warming on the Species
Composition and Vegetation Productivity in the Eastern Mediterranean
Region of Turkey**

**- Species composition and environmental factors along
the vertical distribution of trees in Cukurova Plain -**

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1. Introduction

There are various vegetation types along the climatic and topographic gradient in Turkey (Altan, 2000). Especially in the eastern Mediterranean region of Turkey, they contain grassland above the timber line, evergreen and deciduous forests, scrubland, river beds, lagoons, coastal saltmarshes, coastal woodland, and sand dunes (Yilmaz, 1998).

The most commonly encountered types of vegetation in Turkey are shrubs, needle-leaf or deciduous forest trees, and steppe-type vegetation. Less frequent formation also exist owing to the extent of the ecological differentiation (Turkish Ministry of Tourism, 2003).

Turkey's forest land is found on the mountains bordering the Black Sea, Marmara, the Aegean and the Mediterranean, and is located in an altitude belt of 0 to 2000 meters. Central and eastern parts of the country are much less heavily forested. Small concentrations of needle-leaf forests (*Pinus nigra* and *P. sylvestris*) are found in some protected locales of Central Anatolia. In both regions, however, the most common forest trees are species of *Quercus*. Genus *Quercus*

include many evergreen and deciduous species in the Mediterranean region (Roda et al. 1999).

There is a great variety of forests ranging from evergreen coniferous forests to forests dominated by deciduous broad-leaved trees. There are also gallery-type forests along rivers in Central and Eastern Anatolia. There are single-species forests of both evergreens and deciduous trees, and also mixed forest formations. The most frequently occurring evergreen forests consist of *Pinus brutia*. Other needle-leaf forest trees are *Pinus halepensis* in the coastal regions, and *Abies cilicia* and *Cedrus libani* in the higher part of mountains. The most commonly occurring deciduous forest trees are various *Quercus* species such as *Q. coccifera*, *Q. infectoria*, *Q. cerris*, which are widespread in this region. These trees are more often found in single-species forests, but may also be seen in mixed formations. Other common trees, mostly seen in mid-altitude mixed forests, are *Carpinus*, *Fraxinus*, *Styrax*, and some maquis species (Maki) such as *Arbutus andrachne* and *Quercus coccifera* (Sano et al. 2003).

Steppe-type vegetation is more common in the Central and Eastern Anatolian regions. If

steppe-type vegetation and Alpine or high-mountainous vegetation, which show a physiognomic resemblance, are grouped together, this type of formation is also found in the mountains of southern and northern Anatolia, in altitude ranges above 2000 meters. It is widespread in the dry and cold climatic zone, although anthropogenic, or man-made destruction is clearly visible as well as the lowlands of Central and Western Europe (Vera 2000).

The purpose of this study is to describe the present condition of vegetation of Cukurova plain in Anatolia and to estimate the effects of global warming on the species composition and vegetation productivity in the Eastern Mediterranean Region of Turkey.

2. Study area

Species composition, stand structure and environmental measurements were researched at relatively good conditions left from the Mediterranean coast to the mountain region (ca. 0-1500 m a. s. l.). We set up seven plots in the following regions (1) Yumurtalik (2) Catalan (3) Karatepe (4) Aladag (Table 1). Yumurtalik is the lowest part of this region facing the Mediterranean Sea, and Catalan and Karatepe 1 are relatively lower. Aladag 1 and 3 were the highest parts among these research sites over 1200 m a.s.l. The other sites, Aladag 2 and Karatepe 2, were the mid-altitude sites in this region.

Table 1 Research sites with GPS data

Site	Yumurtalik	Catalan	Karatepe 1	Karatepe 2	Aladag 2	Aladag 3	Aladag 1
Date	20030823	20030829	20030827	20030828	20030825	20030825	20030824
Dominant species	<i>Pinus halepensis</i>	<i>Pinus brutia</i> and Maki	<i>Pinus brutia</i> and Maki	<i>Arbutus andrachne</i> and Maki	<i>Pinus brutia</i>	<i>Abies cilicica</i>	<i>Cedrus, Abies</i>
Plot size (m*m)	50*40	20*20	30*20	15*6	50*30	40*40	30*20
Slope	2	10	21	21	10	26	12
Direction	N50W	N40W	N45E	N30W	N65W	N60W	S35E
GPS: N	36°44'49.2	37°12'04.4	37°17'45.4	37°15'48.4	37°33'32.9	37°28'06.4	37°36'20.8
GPS: E	35°37'40.4	35°15'22.4	36°15'02.7	36°13'35.5	35°23'31.7	35°19'10.1	35°29'17.3
Altitude	3	151	253	559	793	1223	1532

3. Species composition

Tree species composition with relative basal area (BA%) in each plot is shown as Table 2. There were sixteen species occurred in our research plots. Dominant tree species were *Pinus halepensis*, *Pinus brutia*, *Arbutus andrachne* and *Abies cilicica* in the coastal region, lowland, maquis, and highland, respectively. *Pinus brutia* and *Quercus coccifera* were found relatively large area

from lowland to highland. *Arbutus andrachne*, *Quercus infectoria* and *Styrax officinalis* were limited to mid-altitude regions. Maquis shrubs (Maki) include *Arbutus andrachne* and *Quercus coccifera*. *Carpinus betulus*, *Carpinus orientalis* and *Quercus cerris* were found only at the lower part of high altitude region. While *Cedrus libani* and *Pinus nigra* were found only at the higher part of the high latitude region.

Table 2 Species composition and dominance (Basal area) of trees

	Yumurtalik	Catalan	Karatepe 1	Karatepe 2	Aladag 2	Aladag 3	Aladag 1
Altitude (m)	3	151	253	559	793	1223	1532
Species							
<i>Pinus halepensis</i>	100						
<i>Quercus coccifera</i>		0.45	2.09	20.33			
<i>Pinus brutia</i>		98.87	95.23		100		
<i>Fontanesia phillyrioides</i>		0.48					
<i>Olea europea</i>		0.20					
<i>Arbutus andrachne</i>			1.84	57.71			
<i>Quercus infectoria</i>			0.31	13.59			
<i>Styrax officinalis</i>			0.54	2.80			
<i>Fraxinus sp.</i>				5.57			
<i>Carpinus betulus</i>						3.26	
<i>Carpinus orientalis</i>						2.01	
<i>Quercus cerris</i>						1.92	
<i>Abies cilicica</i>						92.53	43.93
<i>Juniperus oxycedrus</i>						0.28	14.28
<i>Cedrus libani</i>							35.05
<i>Pinus nigra</i>							6.75
BA (m ² /ha)*	8.76	15.97	42.44	20.57	36.49	36.37	43.00

* Calculated for live stems of all species in each plot .

4. Environmental factors

We measured some environmental factors in the plots set at each altitude (Table 3). Temperature at 1.5 m high from the ground, soil temperature at 5 cm below the ground and soil humidity at 5 cm below the ground were measured as environmental factors in each plot. Soil temperatures were gradually decreased from lower to higher part of this region together with air temperatures. Soil temperatures were lower than air temperatures in every plot. Soil humidity was

relatively high at the sites of lower part, while relatively low at the sites of higher part of this region. The border of this difference of soil humidity was found at 600-700 m a.s.l. Canopy cover was measured using Nikon cool-pix 950 with Fisheye converter analysed by LIA32 for Windows (Yamamoto 2000). Canopy cover was extremely low at Yumurtalik because of scarce distribution of canopy trees (*Pinus halepensis*), and relatively low at the sites of lower to middle part, and relatively high at the sites of higher part of this region.

Table 3 Environmental factors in each plot

Plot	Yumurtalik	Catalan	Karatepe 1	Karatepe 2	Aladag 2	Aladag 3	Aladag 1
Date	20030823	20030829	20030827	20030828	20030825	20030825	20030824
Altitude	3	151	253	559	793	1223	1532
Air temperature (time) (°C)	NA	36.7 (14:00)	33.4 (16:05)	31.2 (14:40)	31.1 (12:27)	24.3 (18:10)	23.2 (19:05)
Soil temperature (°C)		(-5 cm)					
Mean	NA	30.20	27.67	26.13	28.10	23.09	21.11
SD	-	1.99	0.98	1.29	2.49	0.98	1.24
CV	-	6.61	3.55	4.95	8.84	4.23	5.85
Max	-	34.00	30.00	29.40	35.00	24.60	23.60
Min	-	26.80	26.10	23.60	24.60	20.80	18.70
Soil humidity (%)		(-5 cm)					
Mean	NA	41.45	43.31	42.47	27.06	28.74	29.46
SD	-	2.37	4.66	3.68	5.75	8.07	8.26
CV	-	5.71	10.76	8.66	21.26	28.09	28.04
Max	-	46.30	51.20	48.70	39.70	39.50	42.90
Min	-	38.40	29.70	36.00	14.30	12.60	12.60
Canopy cover (%)							
Mean	49.024	72.587	71.745	78.139	64.862	84.502	80.718
SD	12.111	2.642	3.638	4.957	3.593	3.082	3.870
CV	24.704	3.640	5.070	6.344	5.540	3.648	4.794
Max	62.190	76.021	76.735	86.375	71.074	88.626	87.878
Min	24.698	69.642	67.141	73.160	57.988	81.607	77.497

5. Vertical distribution of main tree species

We can define vertical distribution of flora in Cukurova Plain by several conifers (*Pinus*, *Abies*, *Cedrus*, and *Juniperus*) and *Quercus* species (Sano et al. 2003). The vertical distribution of main tree species is as follows (see also Table 2).

2000-3000 m in altitude: Alpine pastures

Astragalus spp. (Milk vetch). e.g. *A. angustifolius*

Acantholimon spp. (Prickly thrift) .e.g. *A. glumaceum*

600-2000 m in altitude: Aladag

Abies cilicica (Toros goknari)

Cedrus libani (Lubnen Sediri)

Juniperus oxycedrus (Katran Ardici. Prickly juniper)

Quercus cerris (Turk mesesi. Turkey oak, deciduous)

Pinus nigra (Karacam. Austrian black pine. European black pine)

Pinus brutia (Kizilcam)

Less than 600 m in altitude : Karatepe and Catalan

Pinus brutia (Kizilcam)

Quercus infectoria

Quercus coccifera (Maquis)
Arbutus andrachne (Maquis)

0 m in altitude: Yumurtalik

Pinus halepensis (Aleppo pine) and
maritime Maquis, halophyte communities

6. Further research

In order to estimate species response and vegetation productivity for the climate change, further researches on the biomass of trees by their weights after cutting, and their growth patterns using increment bores are required in the plots from the Mediterranean coast to the mountain region.

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