RESEARCH OF THE VEGETATION COVER OF SEYHAN RIVER BASIN IN FLORISTIC AND VEGETATION VIEWPOIN

Türker Altan [1], Mustafa Atmaca[2], Ekrem Aktoklu[2], Kayhan Kaplan[2], Meryem Atik[3], Mustafa Artar[4], Aysel Güzelmansur[1], Aylin Çinçinoğlu[1], Yelda Büyükaşık[2]

[1]*University of Çukurova, Adana-Turkey*
[2]*University of Mustafa Kemal, Hatay-Turkey*
[3]*University of Akdeniz Faculty, Antalya-Turkey*
[4]*University of Karaelmas Bartın -Turkey*

1. Introduction

The impacts of climate change have became a greater concern to scientific era and have been studied on different scales, whereas Vilalta (2002) examined the change in water resources in the Mediterranean Region, Reid et al (2000) assessed relationship the impacts of climate and land use change on the vegetation where DeLuis et al., (2001) investigated climate trends and vegetation dynamics in case of a Mediterranean scrublands.

Land use change has been a phenomenon that nature has been facing for centuries. Mediterranean Basin presents the best example for the human impact on natural structure particularly natural vegetation where the oldest civilizations had taken place (Atmaca et al, 2005). But recently climate change is another environmental phenomenon as Tamai et al., (2005) indicated that climate changes, especially precipitation and air temperature in semi-arid areas will likely effect the quality and the quantity of the vegetation.

As rainfall, humidity, temperature, wind are most indicative climatic components Tamai et al (2005) describes that standing plant structure and the plant growth involve two factors; anthropozoic and environmental pressure. By this recent research, natural vegetation of Seyhan River Basin were analysed and different scenario were evaluated in respect to likely climate change as well as anthropozioc pressures based on socio-economic studies on the location of upper basin where human impacts on natural vegetation were evident.

2. Material and Method

Seyhan River Basin was chosen as the material of the research regarding to RIHN-TÜBITAK agreement (Figure 1). Seyhan River is the longest and biggest river flowing to Mediterranean. Basin starts with Çukurova delta an important coastal ecosystem on ecological bases extends to the Çukurova plan flats with 150 meters in the middle parts goes up to transition areas in the Taurus.

2.1. Methods

2.1.1. Indication of Constant Monitoring Parcels

Prior to vegetation analysis three transects that reflecting natural structure of the Seyhan River Basin were designated according to evaluation of satellite images and plant formation maps. As a result of field examination only one transect among three that best representing all vegetation forms in the basin was selected (Figure 1). Vegetation analysis were conducted as well as analysis on topography, soil, aspect and anthropozoic pressures whereas 23 (20x20m) and 18 (100x100m) Constant Monitoring Parcels were set up. Using Braun-Blanquet (1964) detailed analyses were held on 20x20m plots and only dominated species were determined on 100x100m plots.

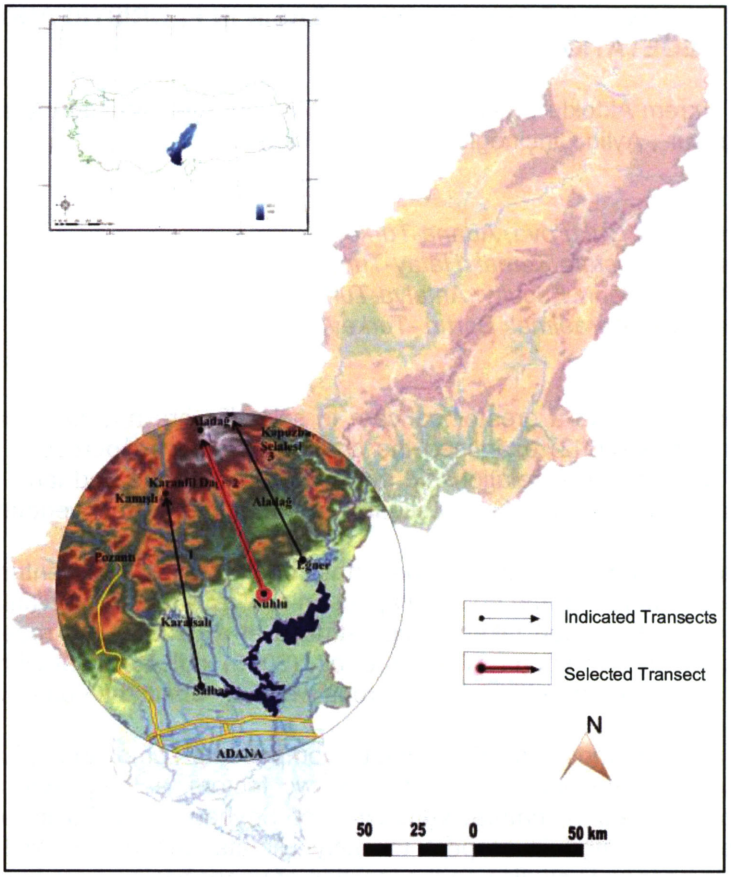


Figure 1. Situation of Seyhan River Basin and selected transects

2.1.2. Studies on Vegetation

Vegetation analyses on selected constant monitoring parcels were carried out three times a year. Braun-Blanquet (1964) method was used where layering in vegetation ranked was in five steps;

Moss layer	< 10 cm
Herbaceous layer	10–50 cm
Bush layer	51–150 cm
Shrub layer	151–400 cm,
Tree layer	> 400 cm

2.1.3. Socio-Economic Studies

In order to indicate anthropozoic pressures on vegetation on the locations and closer settlements socio-economic studies were carried out where constant monitoring parcels located. The aim of these studies was to obtain data on the relation between human land use patterns and natural resources, present impacts on vegetation and likely tendencies in the future. Twofold socio-economic studies were based on face to face interviews on site with both local villagers and authorities (Atik, et al., 2006). Interviews were analysed using SPSS Software

2.1.4. Method on Scenario for Possible Vegetation Change in Future

Beyond ICCAP Project on climate change, there were more than one probability on vegetation change due to diversity of factors influencing vegetation and lasting pressures of human use. For scenario for possible vegetation change, scenario (temperature and precipitation) adopted by climate sub-project group were taken into consideration. Relatively three scenario were formulated on possible vegetation change according to scenario as 1,87 °C temperature increase and 322,72 mm precipitation decrease by 2070's that produced by climate group which were integrated with anthropozoic pressures based on results of socio-economic studies. Three scenario were discussed particularly on vertical distribution of vegetation which are no vegetation change, change on vegetation driven only by climate and change on vegetation driven by climate and anthropozoic pressures by 2070s.

3. Results

3.1. Results on Vegetation Analysis

Characterised by Irano-Turanean on upper and Mediterranean phtogeographic region on lower parts Vegetation of Seyhan River Basin was determined as;

- South Anatolian Mediterranean Plant communities
- South Anatolian Cedar-Fir Mountainous Forests
- Sub-alpine and alpine plant communities (in Altan, 2000; Louis,1939 and Walter,1956).

Vegetation analysis was carried out by using Braun-Blanquet Method (Braun-Blanquet, 1964) whereas important life forms was based on Davis (1965-1985); Davis et al.,(1988); Güner et al., (2000). Studies on vegetation in terms of climate change were on forest, however all life forms of woody and hebacous were included in analysis. Main tree forms are *Pinus brutia*, *Pinus nigra* subsp. *pallasiana*, *Abies cilicica* subsp. *cilicica*, *Cedrus libani, Juniperus excelsa*, *Juniperus oxycedrus* subsp. *oxycedrus*, *Juniperus foetidissima*, *Quercus cerris*, *Quercus pubescens.*

Elaborate studies on the selected transect and constant monitoring parcels during three years derived that there are 241 plants species and sub-species, 149 genus belonging to 52 families of which 3 of them are Pteridophyta, 10 are Gymnospermae, 228 are Angiospermae.

Total number of vascular plants is 241, whereas 33 are endemic in 13,7 %. Almost all the endemics that already been identified are the element of Mediterranean flora (Table 1). According to Red Data Book of Turkish Plants 1 species is endemic (EN) and 7 species are vulnerable (VU) (Ekim et al., 2000) (Table 2). Relatively Selected Monitoring Parcels reflects the diversity in the upper Seyhan River Basin in terms of floristic and vegetation point of view where forest vegetation was major concern.

Four main localities on the selected transect were Kaledağ, Eğni Gözü, Katran Çukuru and Küküt Havzası.

Kaledağ

Constant monitoring parcels in Kaledağ starts at 950 meters with *Pinus brutia* formation. Other dominant species are *Cedrus libani* and *Styrax officinalis.* Moving up to 1100-1250 meters *Quercus pubescens, Quercus cerris* and *Ostrya carpinifolia* reveal with absolute formations of *Abies cilicica* up to 1200 meters (Figure 2).

Table 1. Distribution of Plant Species İnto Floral Regions

Floral Region	Number of Taxons	%
Mediterranean	81	33.6
Irano-Turanean	35	14.5
Euro-Siberian	6	2.5
Cosmopolitan on Unknown	119	49.4
TOTAL	**241**	**100**

Table 2. List of Endemic Species According to IUCN Red Data Book

PLANT SPECIES	**IUCN**
Apiaceae (Umbelliferae)	
Ferula drudeana Korovin	VU
Aristolochiaceae	
Aristolochia cilicica Davis & Khan	LR (cd)
Asteraceae (Compositae)	
Achillea cappadocica Hausskn. & Bornm.	LR (lc)
Centaurea haradjianii Wagenitz	VU
Centaurea ptosimopappoides Wagenitz	VU
Brassicaceae (Cruciferae)	
Alyssum masmenaeum Boiss.	LR (lc)
Alyssum peltarioides Boiss. subsp. *virgatiforme* (Nyár) Dudley	LR (lc)
Cochlearia sempervivum Boiss.	LR (nt)

PLANT SPECIES	IUCN
Campanulaceae	
Asyneuma limonifolium (L.) Janchen subsp. *pestalozzae* (Boiss.) Damboldt	LR (lc)
Cistaceae	
Helianthemum antitauricum Davis & Coode	LR (cd)
Dipsacaceae	
Cephalaria cilicica Boiss. & Kotschy	LR (lc)
Fabaceae (Leguminosae)	
Astragalus schottianus Boiss.	LR (nt)
Melilotus bicolor Boiss. & Bal.	LR (cd)
Trifolium pannonicum Jacq. subsp. *elongatum* (Willd.) Zoh.	LR (lc)
Hypericaceae	
Hypericum aviculariifolium Jaub & Spach subsp. *depilatum* (Freyn & Bornm.) Robson var. *leprosum* (Boiss.) Robson	LR (lc)
Lamiaceae (Labiatae)	
Lamium garganicum L. subsp. *nepetifolium* (Boiss.)R. Mill	LR (lc)
Origanum micranthum Vogel	VU
Phlomis capitata Boiss.	LR (lc)
Phlomis linearis Boiss. & Bal.	LR (lc)
Scutellaria salviifolia Bentham	LR (lc)
Stachys annua (L.) L. subsp. cilicica (Boiss) Bhaft.	LR (lc)
Teucrium chamaedrys L. subsp. tauricolum Rech. fil.	LR (lc)
Oleaceae	
Fraxinus ornus L. subsp. *cilicica* (Lingelsh.) Yalt.	LR (lc)
Primulaceae	
Cyclamen pseudo-ibericum Hildebr.	EN
Rubiaceae	
Asperula stricta Boiss. subsp. *elmaliensis*	LR (nt)
Galium sieheanum Ehrend.	VU
Scrophulariaceae	
Linaria genistifolia (L.) Miller subsp. *prealta* (Boiss.) Davis	LR (nt)
Verbascum pinetorum (Boiss.) O. Kuntze	VU
Veronica balansae Stroh	LR (lc)
Liliaceae	
Asphodeline damascena (Boiss.) Baker subsp. *rugosa* E.Tuzlacı	LR (lc)
Muscari muscarimi Medik.	VU
Orchidaceae	
Dactylorhiza osmanica (Kl.) Soó var. *osmanica*	LR (lc)
Poaceae (Gramineae)	
Festuca anatolica Markgr.-Dannenb. subsp. anatolica	LR (lc)

EN: Endangered, VU: Vulnerable, LR: Lower Risk ,LR (cd): Conservation Dependent, LR (lc): Near Threatened, LR (nt): Least Concern

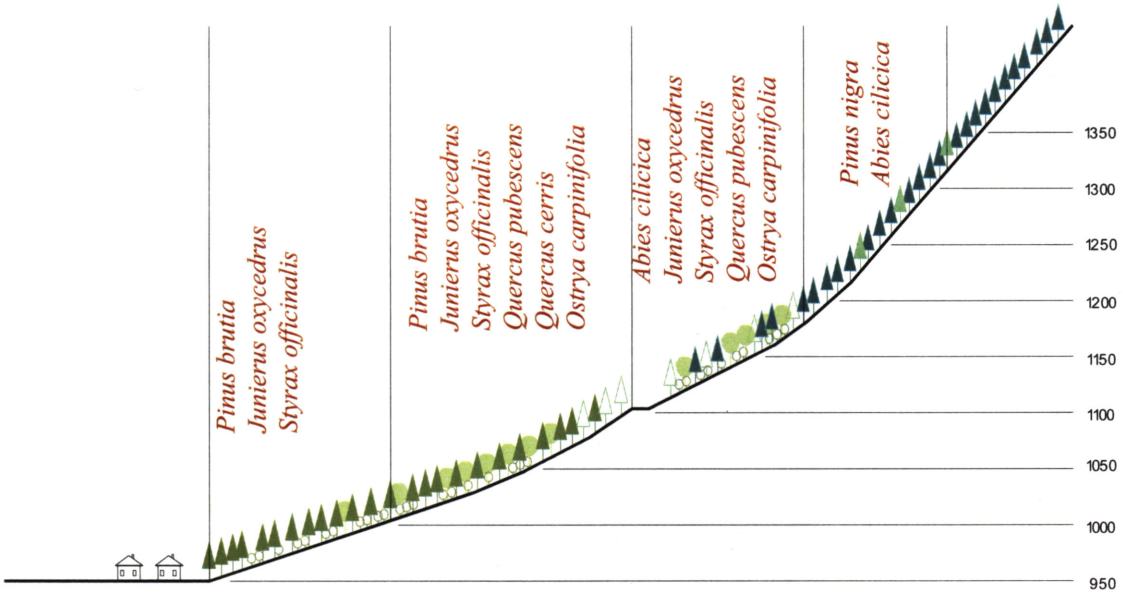


Figure 2. Vertical Transect of Natural Vegetation in Kaledağ Locality

Eğni Gözü

Constant monitoring plots that set up in Eğni Gözü start nearly at 1200 meters with formations of *Pinus nigra, Juniperus exelsa* and deciduous oaks. Dominant species are *Juniperus oxycedrus, Juniperus excelsa, Quercus pubescens, Quercus cerris, Fraxinus angustifolia* and *Styrax officinalis*. and continue up to absolute *Pinus nigra* formation at 1500 meters and on upper bound stand at 1500 meters on the *Cedrus libani- Astragalus* formations and end up at 1800 meters (Figure 3).

Katran Çukuru

Plots start in Katran Çukuru around at 1150 meters from *Pinus brutia* and passing through mix pine forest formations of *Pinus brutia*, *Pinus nigra* where dominant species are *Juniperus oxycedrus*, *Juniperus excelsa* and *Daphne oleoides.* Around 1400 meters *Pinus nigra, Juniperus excelsa* and *Quercus cerris* and up to 1500 meters solid *Pinus nigra* formation (Figure 4).

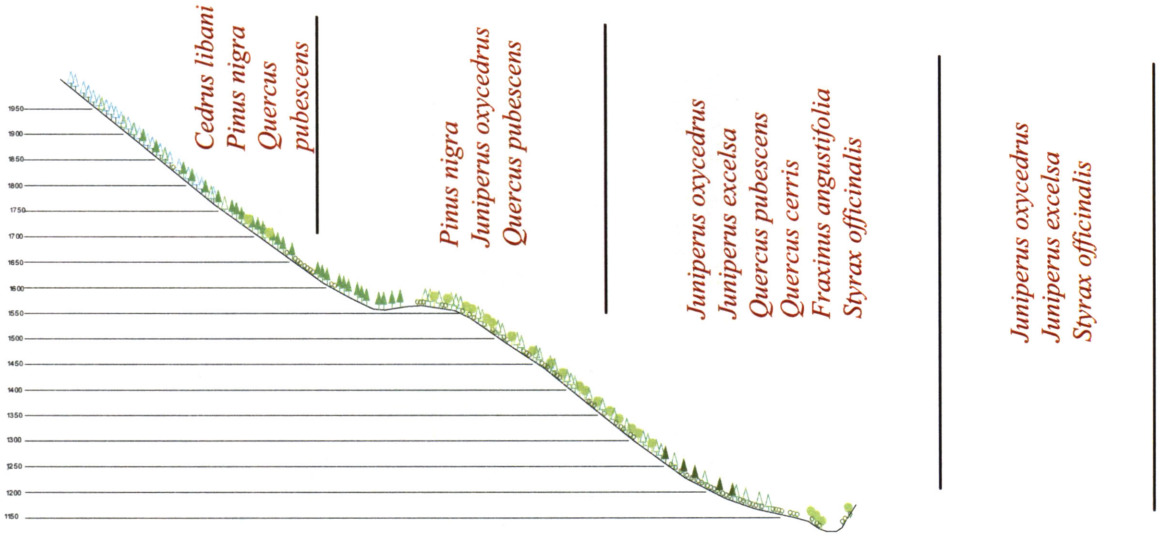


Figure 3. Vertical Transect of Natural Vegetation in Eğni Gözü Locality

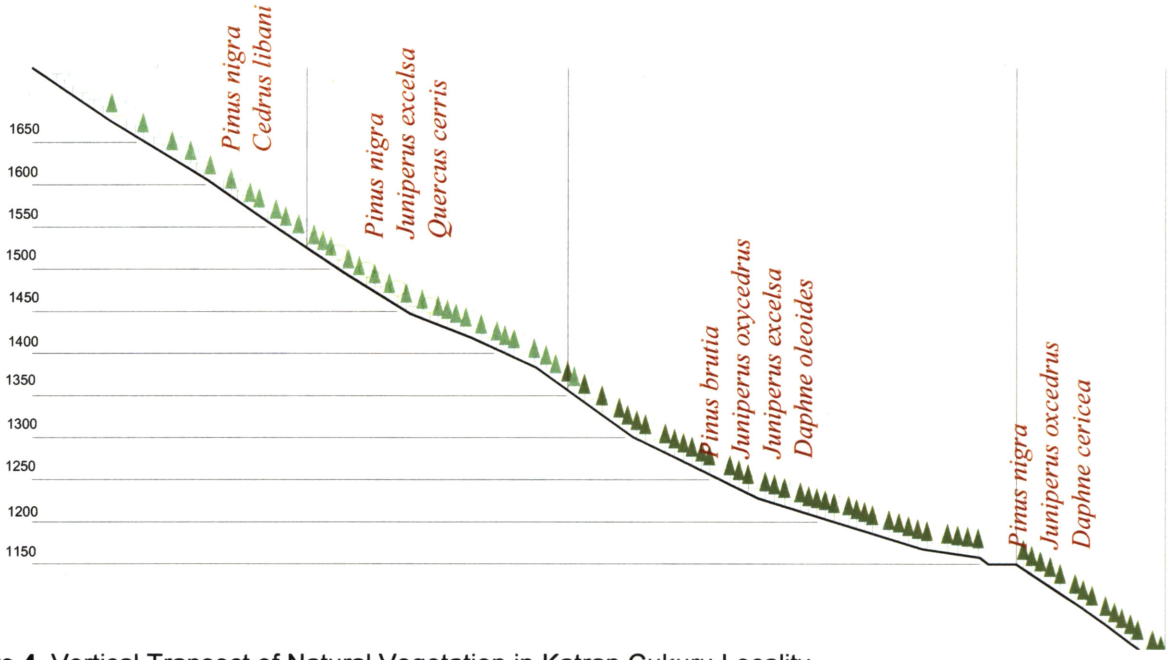


Figure 4. Vertical Transect of Natural Vegetation in Katran Çukuru Locality

Köküt Havzası

Representing upper basin Köküt location situates between 1400 and 2100 meters. It starts at 1400 meters from *Pinus nigra* formation, but *Pinus nigra* mix with *Juniperus oxycedrus* on lower parts and *Cedrus libani* on upper parts. Here *Juniperus oxycedrus* stands more in bush form. Up to nearly 2600 meters on far rocky sites sub-alpine *Astragalus* is formation typical.

3.2. Land Use Patterns in Seyhan River Basin

Vegetation in the eastern Mediterranean severely disturbed by anthropozoic pressure and it is very hard to estimate vegetation in the past (Tamai et al, 2005). But learning from the past, land use pattern will keep its critical role in long term change of the vegetation. Occupation of the area traces back as earlier as to neolitic periods and Hittites in 1000s BC. And also the use of natural forest goes back as earlier as antic times to Phoenician, Egyptians, and Romans used Pos (*Pinus nigra*) forest to build ships and houses. During Seljuks and Ottoman occupation the area was used as settlement by nomadic Turkish tribes, and nomadic and semi-nomadic lifestyle has still continuing on the upper basin today.

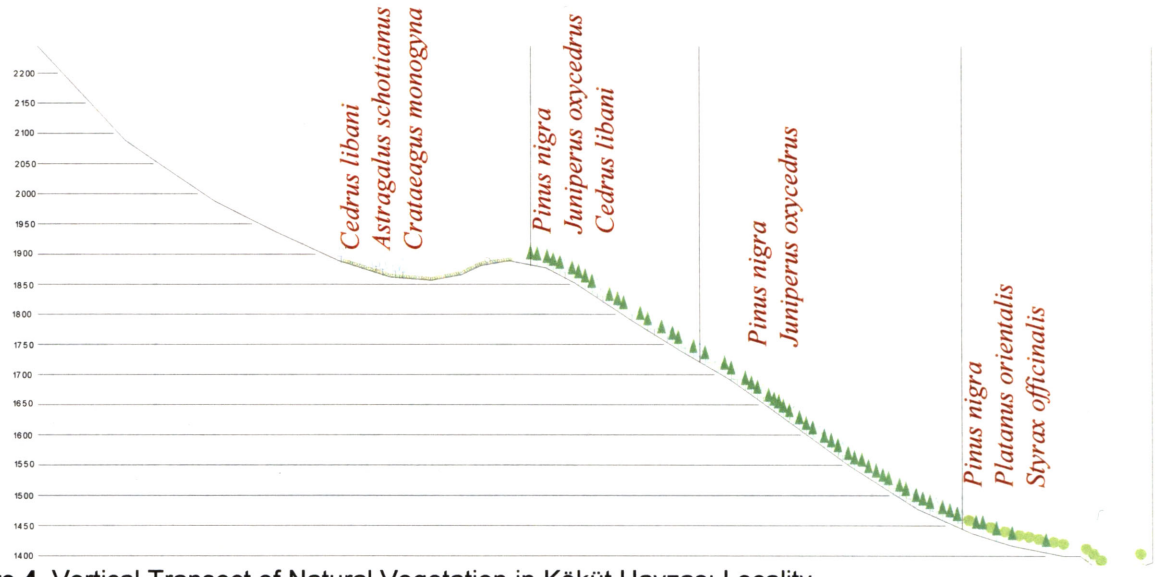
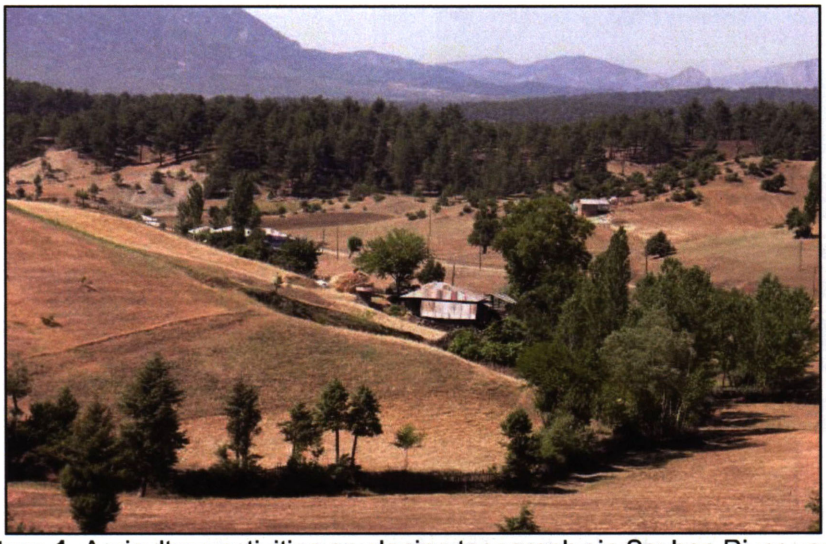


Figure 4. Vertical Transect of Natural Vegetation in Köküt Havzası Locality

3.2.1. Agriculture

Most of the agricultural fields in the area stand on the slope lands. They are usually stony and have boulder surfaces and poor therefore local people do not use modern techniques relying on old agricultural forms that they used to do 50 years ago. Availability of the flat field for agriculture is quite limited which could likely lead to surface erosion.

Impact of agriculture on the natural environment becomes more apparent by the use of slope lands and consequent erosion. Another issue is the conversion of forests into agricultural field (Picture 1).

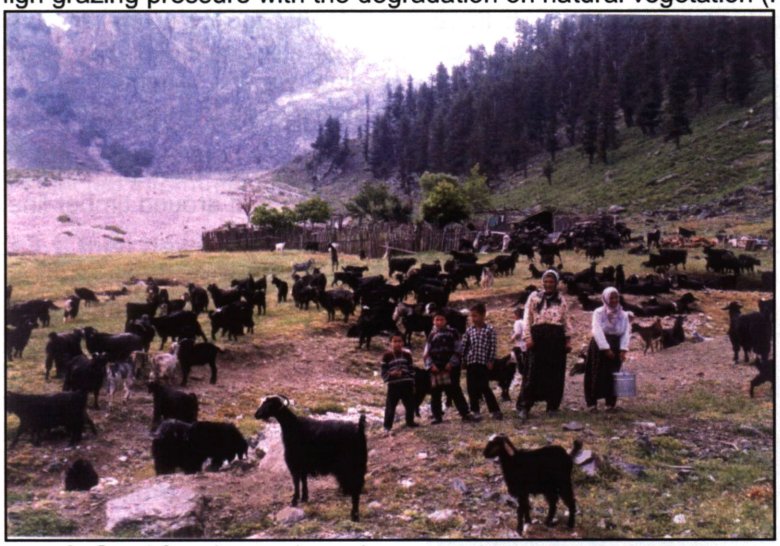


Picture 1. Agriculture activities on sloping topography in Seyhan River upper basin

3.2.2. Stock farming

Stock farming is carried out in the area in two terms; nomadic way of stock farming and sedentary stockfarming. Nomadic way has been the oldest traditional type that people take their animals to Taurus Mountains for grazing for at least one season starting from very early spring to late autumn. Moving from one location to another nomadic life style of the tribes influences and shapes the land use patterns (Picture 2).

In terms of environmental effects of goat herding is the major concern in stock farming. Although nomadic stock farming activities is decreasing, but still local people take their animals to the plateaus for grazing or use forest sites around the villages. Therefore forests around the villages are subjected to high grazing pressure with the degradation on natural vegetation (Picture 2).



Picture 2. Stockfarming and grazing

3.2.3. Forestry

Natural forest in the area called "Pos" that origin comes from the local identification of Black Pine (*Pinus nigra*). Old documents indicate that the area was covered by dense forest of Red pine (*Pinus brutia*), Black pine (*Pinus nigra*), Juniper (*Juniperus oxycedrus, J. exelsa*) and Oaks (Yalgın, 1950).

Forest classification made is based on the timber productivity and wood quality rather than diversity. On the other hand afforestation works carried out by the forestry service have been rather based on certain species; *Pinus brutia* in lower areas and *Pinus brutia, Pinus nigra* and *Cedrus libani* in upper parts of the Seyhan River Basin which is rather monoculture and would restrain the species diversity in the vegetation.

Following agriculture and animal farming, working in forestry work of plantation, regeneration, seed planting, fire control and forest guard is the most common way of local living (Picture 3)..

Picture 3. Forestry work in the area

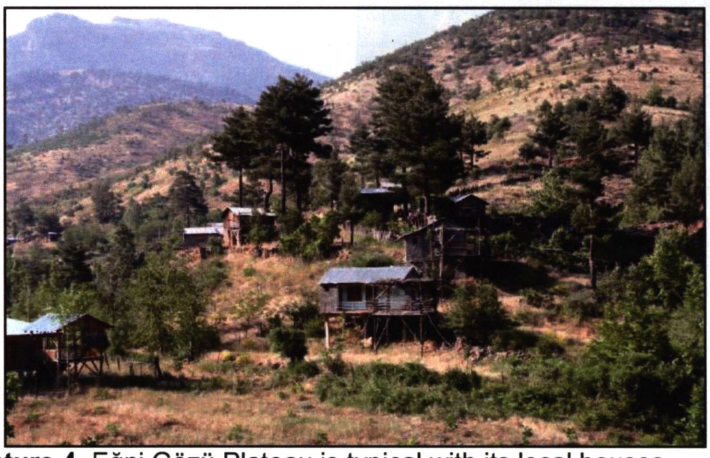
3.2.4. Mining

Some minerals of economic value such Chromiy, Galenite,Antimon, Malachite and Azorite is found in Seyhan River Basin particularly in Aladağlar location. Therefore mining activity has a long history in the basin. There are very old mine spots where people took the material out and basically used the natural forest and timber to work on mines for useful production. The wood from the natural forest was the basic source to produce items from the mines. In recent years, being an important income source in the area, the mining activity is based on chrome, plumbic (lead) and iron. According to items 16, 17, 18 of Forestry Act, authority for opening, licensing and management of these mines was given to Forestry Service as all mines are situating within the forest sites (Deneri, 2006).

3.2.5. Recreation

Recreation and tourism is another important activity in the basin. Having very cool and desirable climate conditions in summer on high elevation, the area attracts many people from the lower parts of Çukurova Region. Major points that domestic tourist and local inhabitants prefer are Meydan, Kükürt, Acıman, Trak, Eğni Gözü, Bürücek plateaus. Although there is no tourist facility in the area, visits related to local costume based on the staying in tents from the past still continues. For example Acıman plateau has been regarded by the locals with its healing waters. Attendance to the recreational activities continues during the summer season but accommodation in tents lasts only 1-2 weeks.

Recent years on the contrary of local housing (Picture 4) second house developments have become a threatening concern with the exploitation of forests particularly on and around timber line.



Picture 4. Eğni Gözü Plateau is typical with its local houses

3.2.6. Rural Settlements and Use of Plateaus

Some settlements are characteristic forest villages with its nomadic semi-nomadic life style where majority of local people live on stockfarming. Families move from lower parts of the basin to high plateaus in early spring with huge number of animal stocks. Main plateuas are Acısu, Tırak, Tahtalı, Karanfildağı, Kaledağı and Deliktaş that used for summer housing and grazing.

Direction of roads that used by semi-nomadic people to get main plateaus in Seyhan River Basin is given in Figure 5 whereby anthropozic pressures are concern on the natural vegetation along those roads and heavy grazing and recenlty risk of second house developments.

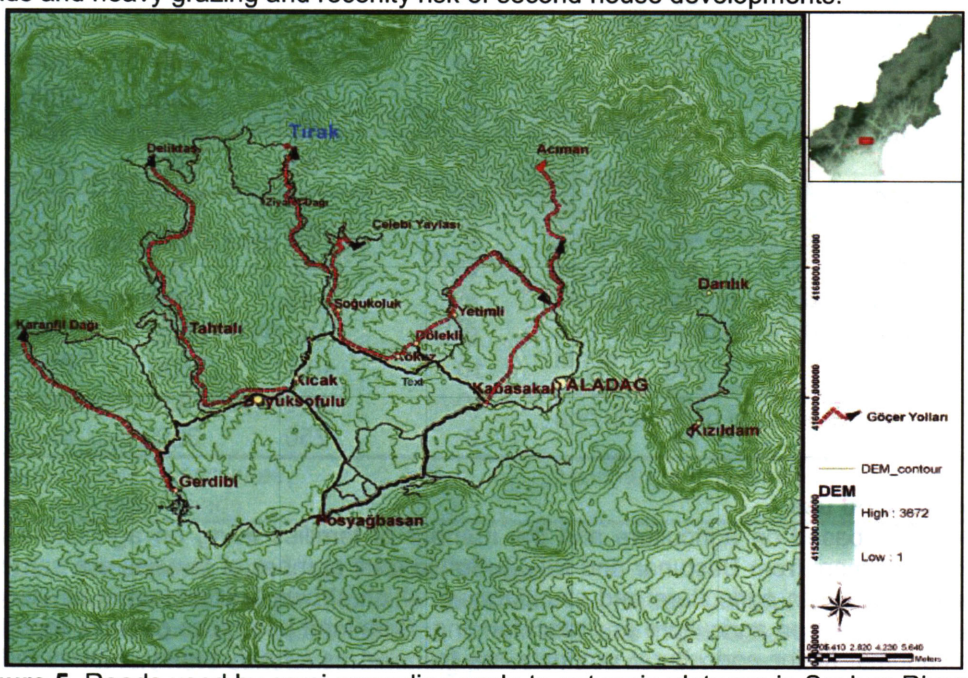


Figure 5. Roads used by semi-nomadic people to get main plateaus in Seyhan River Basin

3.3. Socio-Economic Studies

Socio-economic studies in the upper Seyhan River Basin Area was intended to analyze the living conditions in the area and land use patterns which are expected to be continuing in the coming years. Lower of the Seyhan River Basin is more disturbed having urban settlements and large scale of agricultural fields; therefore we concentrated on the upper river. In terms of vegetation change, forests representing the whole basin have widest distribution in the upper river basin.

Socio-economic studies were twofold; interviews with the local aouthorities (village headmen) and interviews with the villagers. The aim of first approach was to have an overall overview from the local authorities. The second approach was directly based on the local people, villagers themselves. Both interview results gave us valuable insight about the relation between local inhabitants and present and likley future impacts on natural environment particularly on natural vegetation. Being qiute elaborated, only selected information from socio-economic studies were given here.

3.3.1. Interviews with local Authorities

By the interviews with local authorities who are the village headmen more emphasis were put on the stockfarming and stockfarming related activities which have direct physical impact on the vegetation. Particularly grazing and the impact of grazing on the understory forest vegetation. There were 19 interview in total, but only 14 of them covering Başpınar, Büyük Sofulu, Darılık, Dölekli, Eğnel, Ebrişim, Gendibi, Gireği, Kabasakal, Kıcak, Kızıldam, Kökez, Posyağbasan and Yetimli villages were evaluated.

Stockfarming and stockfarming based land uses

Stockfarming and agriculture activities along with stockfarming are the most crucial way of living in the area. More than 100 families in Dölekli, Gendibi, Kıcak, Kızıldam and Kökez villages have been living on the stockfarming and agriculture alone (Table 3) which indicates that both land use have been carried out at the same time.

Main types of stocks are cattle, goat and sheep (Table 3). In mountainous parts stockfarming by goat and sheep are more intensive. Considering that majority of the rural settlements use forest

around the villages for grazing with the number of stocks more than 1000, changes driven by Anthropozoic pressures on the vegetation is likely expected.

Table 3. Stockfarming and Stockfarming Based Land Uses In Interviewed Villages (%)

Villages	Families live on Stockfarming	Families live on Stockfarming+ Agriculture	Families live on Mining	Number of Stocks		
				Cattle	Goat	Sheep
Başpınar	80	80	25	200	1000	1000
Büyük Sofulu	18	18	5	200	4000	2200
Darılık	35	35	20	25	600	200
Dölekli	140	192	0	450	2000	4000
Eğnel	50	50	0	30	200	100
Ebrişim	50	50	0	60	300	450
Gendibi	250	250	40	700	5000	400
Gireği	50	60	0	100	1500	600
Kabasakal	50	50	0	92	0	600
Kıcak	200	250	5	210	1000	4000
Kızıldam	125	125	0	60	5000	2500
Kökez	176	160	10	1000	1500	1500
Posyağbasan	100	100	10	254	2830	400
Yetimli	94	94	0	250	300	1500

Agriculture based land use

Comparing livelihood based on agriculture and the number of families living on agriculture and stockfarming (Table 4) except from Başpınar and Büyük Sofulu total number of families are same as the number of families living on agriculture and stockfarming which shows that almost in all villages people are heavily dependent on agriculture and stockfarming. Both land use types play an important role in the local economy. Major agricultural products are followed as wheat, barley, maize, fodder plants, yards and garden plants. Only few families grow sun-flowers. Almost in all villages traditional way of yards and gardening, growing vegetable and fruits in piece of land next to the houses remains substantial. But wheat cultivation is the major agricultural activity in the area, covering as large fields as 4000 acres in some villages. Impacts relating to the environment, land reclamation for agricultural fields, conversion from forests and in most cases agricultural areas in slope surfaces can cause such problems like changing vegetation cover and erosion.

Table 4. Agriculture and Agriculture Based Land Uses Interviewed Villages (%)

Villages	Total Houses (Number)	Agriculture and Stockfarming (Number)	Type and area of the Agriculture Product(acre)				
			Wheat	Barley	Maize	Fodder Plants	Yards and Gardens
Başpınar	160	80	100	0	0	100	50
Büyük Sofulu	435	18	1500	800	0	800	40
Darılık	35	35	100	10	0	11	10
Dölekli	192	192	3000	500	0	1500	30
Eğnel	85	50	300	0	0	0	0
Ebrişim	50	50	600	200	100	500	10
Gendibi	262	250	4000	400	70	1400	10
Gireği	150	60	600	200	0	50	10
Kabasakal	50	50	800	0	0	374	0
Kıcak	270	250	1700	0	100	100	10
Kızıldam	153	125	1500	1500	0	0	0
Kökez	220	160	2000	0	200	2000	100
Posyağbasan	115	100	4000	1000	0	1500	8
Yetimli	94	94	60	500	0	1000	0

Grazing in the villages

Grazing is the one of the most critical impact after land reclamation for agriculture and land loss in the region. Relating to grazing local people use village sites and closer forests for grazing cattle

stocks. Hereby to indicate the grazing density each village is shown with the total number of stocks. However it is not known exactly which type of grazing is preferred for animal stocks. Local people go to higher plateaus for the grazing, while Değirmencik, Kaledağ, Tahtalı, Acıman, Başpınar, Karanfildağ, Kızıldağ, Acısu, Deliktaş, Kızıldam, Trak-Karaisalı are the most visited ones (Figure 5, in *Section 3.2.6.).*

Almost 85 % of the grazing is taken place in closer village sites and forests besides other types of grazing (Table 5). Notwithstanding problems in grazing are summarised as decreasing size of pastures in 64.3 % alone, decreasing size of pastures and afforestation of grazed lands in 14.3 %, afforestation of grazed lands and change in plant cover in 7.1 %. Hereby quality of afforestation activities is not known.

Table 5. Type Of Grazing and the Its Problems In Villages

Type of Grazing	Rate in Villages (%)	Problems in Grazing	Rate in Villages (%)
Barns	14.3	Decreasing size of pastures	64.3
Barns+closer village sites an forest	14.3	Afforestation of grazed lands	7.1
Barns+inside the village+closer village sites and forest	50.0	Decreasing size of pastures and afforestation of grazed lands	14.3
Barns +inside the village	14.3	Decreasing size of pastures and change in plant cover	7.1
Barns+inside the village+closer village sites, forest and fallow lands	7.1	No change in pastures	7.1

3.3..2. Interviews with local People; Villagers

Areas for the local people interview was chosen as Katran Çukuru, Eğni Gözü Kalesi, Kaledağ and Köküt locations and their closer settings where land use impacts have direct pressure on the natural vegetation and where constant monitoring parcels have already been selected.

The interviews with local people; villagers intended more on local living facilities, problems, main livelihood types, state of stockfarming, change of pastures, grazing activities and lastly opinions about the forestry and forest. There were 130 interviews in total, but only 100 of them were evaluated covering Darılık, İbrişim, Kabasakal, Kıcak, Kızıldam, Kökez ve Posyağbasan villages that observed to be having direct impact on the natural vegetation as well as Köküt and Eğni Gözü.

People living in the villages

Majority of the people are living in the village (82 %) and only 17 % is coming for other locations for working, recreation and particularly grazing (Table 6). This shows us that grazing between villages is somehow common activity. Peoplecoming from other locations are working in mining and forestry.

Table 6. State of Living in The Village, People Coming from Other Locations and Their Coming Purposes

Village people	Rate (%)	State of living in the village	Rate (%)	Purpose of people coming from other locations	Rate (%)
Village people	82.0	Permanently living in the village	66.0		
		Living in the village in only summer	3.0		
		Living in the village in only winter	13.0		
People from other locations	17.0	Not living in the village	17.0	Working	12.0
				Recreation	2.0
				Grazing	3.0
No response	1.0	No response	1.0	No response	1.0

Main problems of the villages

One of the main problems that villages face is the drinking water, lack of good transport roads and bridges in 40 %. Flowingly in addition to infrastructure problems lack of social services (lack of school, health unites as well as doctors and teachers) is the secondary local problem (Table 7). Another local problem is the lack of infrastructure and social services and unemployment in 18.1 %.

Livelihood of the villagers depends on the stockfarming alone in 10 %, stockfarming with agriculture, orchads, fruit growing in 49 % (Table 7). This shows us that nearly 59-60 % of the inhabitants live on agriculture and stockfarming. Besides stockfarming 3 % is doing forestry work, 22 % is occupied with stockfarming, agriculture, orchards, fruit growing, working in forestry or mining. Most of the people in rural areas are living on stockfarming and other additional livelihoods, thus is clue that stockfarming and the grazing impact on the forest will likely continue.

Table 7. Main Problems of the Villages and Their Source Of Living

Promlems of the villages	Rate (%)	Source of living	Rate (%)
Infrastructure problems (drinking water, roads, bridges,...)	40.0	Stockfarming	10.0
Social services (lack of school, health unite as well as doctors and teachers)	2.0	Agriculture	10.0
Unemployment	1.0	Stockfarming, agriculture, orchards, fruit growing	49.0
Lack of enough place for settlement and stockfarming and lack of pastures for grazing	4.0	Retired, tradesman	6.0
Infrastructure problems and deficiency in social services	29.0	Stockfarming, working in forestry or mining	3.0
infrastructure problems, deficiency in social services and lack of grazing areas	2.0	Stockfarming, agriculture, orchards, fruit growing, working	22.0
No problem exists	3.0	In forestry or mining	
Lack of infrastructure and social services and unemployment	18.0		

Stockfarming and grazing

According to livelihood that greatly depends on the stockfarming, the villagers informed in 51 % that there is a decrease in the number of people living on stockfarming which relatively reflected as decrease in the number of stocks in 6 % (Table 8). The substitutional support from the government quite low (1 %), while some local people think that there is no change in stockfarming (3 %). Although a number of people that did not respond in 29 %, the reason that great majority of people living on stockfarming is that this has been an integral part of their nomadic and semi-nomadic life.

Pastures are crucial stockfarming, but recently there are some changes in these areas, which are expressed as the loss of pastures in 9 %, loss of pastures and reducing number of plants in 12 %, loss of pastures, reducing number of plants and change in forest cover in 12 % (Table 8). 23 % confirmed that there is no change in the pastures.

On the other hand change in forest cover in 9 %, reducing number of plants and change in forest cover in 4 % is the indicator of stockfarming impact on the forest around rural settlements in other words changes in forests (Table 8).

The type of grazing gives us some clues about the understanding either nomadic or sedentary way of stockfarming in the area. Most of the winter grazing is carried out in barns with dried grass and straw in 45 % (Table 9). The grazing in winter with dried bush and trees taken from the forest is based on the dense cutting of young buds and shoots of such species as cedar (*Cedrus libani*) and junipers (*Juniperus exelsa, J. oxycedrus*). 7 % of the winter grazing is held in plateaus while winter grazing within the villages and their closer surroundings in 28 % is the main cause in forest degradation around the rural settlements.

Table 8. State of the Stockfarming in the Villages and Change in Pastures

State of the stock farming	Rate (%)	Change in pastures	Rate (%)
Substitutions from government	1.0	Loss of pastures	9.0
Increase in number of people living on stockfarming	8.0	Reducing number of plants	12.0
Decrease in number of people living on stockfarming	51.0	Change in forest cover	9.0
Increase in the number of stocks	2.0	Loss of pastures and reducing number of plants	7.0
Decrease in the number of stocks	6.0	Reducing number of plants and change in forest cover	4.0
No change	3.0	Loss of pastures, reducing number of plants and change in forest cover	12.0
No response	29.0	No change	23.0
		No response	24.0

Table 9. Type of Grazing in Summer and Winter and Grazing Time

Grazing in winter	Rate (%)	Grazing in summer	Rate (%)	Grazing time	Rate (%)
In houses, barns, with dried grass and straw	45.0	In fallow fields	8.0	2-3 months (July-September)	5.0
Dried bush and trees taken from the forest	3.0	In forest sites with no young trees	1.0	5 to 7 months (December-May, April-September, May-October, April-October)	40.0
In plateaus	7.0	Around the villages, in their fields and pastures	35.0	8-9 Months (April-December, April-November)	9.0
Within the villages and their closer surroundings	28.0	In houses, barns, with dried grass and straw	9.0	No grazing	1.0
No response	17.0	In plateaus like Katran Çukuru	19.0	No response	45.0
		In forest sites	14.0		
		No response	14.0		

Summer grazing is carried out in fallow fields in 8 %, around the villages, in the fields and pastures in 35 % while 19 % is held in high plateaus like Katran Çukuru and 14 % is held directly in forest sites alone (Table 9). Almost 33 % of the summer grazing has an impact on forest and also on high plateaus covering timberline. Considering that 40 % of the grazing time last 5 to 7 months between April and October that is another likely impact that effects the vegetation period when the plant growth is active and relatively the plant formation.

Relation between forestry service in the area and the villagers involves education and information given by forestry service and efforestation works besides direct use of forests. 20 % of the villagers informed that they have information only on tree cutting, 25 % information about forests and their benefits given by leaflets, 5 % information about the prohibitions in the forest and 2 % information about the forest fires while 34 % is thinking that there is no information given by the forestry service (Table 10). On the other hand Afforestation works are described as new plantations in 41 % and some generation and cuttings in 33 % whereby 12 % of the villagers think that there is no afforestation work.

Opinion of the local people about the forests reveals the remarks about the relation between human-forest. 45 % of the local villagers confirmed that are have vital dependency on the forests maintaining their basic needs for building material, fuel, etc where 28 % believe that they have good relation and actually local people protect the forests (Table 10). But 18 % think that they have obligatory dependency on the forest forced by the local cooperative societies while 4 % stated that the forest areas are not in good condition due to afforestation work of the forestry service which damages the forest and 1 % believe that there is decrease in the size of the forests.

Table 10. Education Given by Forest Service in Villages, Afforestation Works and the Opinion of the Villagers About the Forests

Education, information given by forest service	Rate (%)	Afforestation works	Rate (%)	Opinions about the forests	Rate (%)
Information only on tree cutting	20.0	New plantations have been carried out	41.0	Forest sites are getting smaller	1.0
Information about forests and their benefits given by leaflets	25.0	Some generation and cuttings are exist	33.0	There is vital dependency on the forests, maintaining basic needs	45.0
Information only on tree planting	1.0	Afforestation works are profitable	2.0	Villagers protect the forests	28.0
Information about prohibitions in the forests	5.0	Village people make afforestation works difficult	1.0	There is obligatory dependency on forest by local cooperative societies	18.0
Information about the forest fires	2.0	There is no change in afforestation	6.0	Villagers damage the forest	3.0
No information is given	34.0	There is no afforestation work at all	12.0	Forests are not in good condition, cuttings by forest service damage the forest	4.0
Have no information	13.0	Have no information	5.0	No response	1.0

4. Scenario on Possible Vegetation Change in Future

Arid regions are expected to undergo significant changes under a scenario of climate warming, but there is considerable variability and uncertainty in these estimates between different scenarios (Lioubimtseva, 2004). Relatively THREE main Scenarios that were adapted by the Japanese and Turkish Vegetation Group within ICCAP Project (Atik et al., 2006).

The first scenario stands on that such differences as 1.87 °C increase in temperature by 2070s that predicted by ICCAP Climate Group would not cause substantial change on the vegetation. To have serious change on vegetation cover, vegetation distribution and plant productivity 100-150 years of time is needed. So the 1st scenario formulated on the prediction "No Climate Change" (Table 11).

Here still land use impacts need to be taken into consideration. Even though there is no change on the environmental conditions such climate, human pressure will remain in the river basin. Increasing population, difficulty on creating alternative income alternatives apart from agriculture would cause further pressures on natural resources particularly on the vegetation.

The second scenario is precise that expected change in climate conditions 1.87 °C temperature increase and –322.72 mm decrease in precipitation level will have impact particularly on the vertical distribution of the vegetation. Having different study approaches both Turkish and Japanese Vegetation Groups worked on the vegetation on 1000 meters and above. Considering Second scenario we expect that rainfall change around 900-1000mm together with temperature would be effective on the vegetation on the lower basin area. Altitude and precipitation info showed us that rainfall change is around 900-1000 meters. Accordingly from sea level (0) to around 1000 meters there will not be concrete change on the vegetation belts but change on some typical species.

However possible changes on the typical species and species combination that representing plant formations will be expected. A vertical distribution of present and expected future main vegetation types is given in Table 2. Main vegetation type will be *Pinus brutia* and macchia between 0-600 meters and *Pinus brutia* mixed forest between 600-1200 meters. Above Conifer forest mix with deciduous trees and after higher altitudes 1600 m and above conifer forest will remain (Table 12).

The third scenario will cover both impact on the climate change and impact of anthropozoic pressures and relevantly, scenario for disturbed vegetation in 2070s (Table 11). There are already existing rural land use types of agriculture, stockfarming, forestry, mining, recreation, settlements which will remain in the future. But in terms of severe drought on the lower parts of the river basin would force further land use demands on the upper river basin areas and drastic change on both landscape and the vegetation by the possible conversion from crop fields to pastures or conversion from forest sites to agricultural field.

We expect that ant pressures will be more exaggerated by human settlements and agricultural land use demands on the lower part of the basin and rural land use and stockfarming on the upper part, particularly grazing around the timberline which would pull down the forest cover.

Table 11. Three Scenarios Adopted by Vegetation Groups

1. Scenario	2. Scenario	3. Scenario
The first scenario is that there will be no change on Climate Conditions and relatively NO CHANGE on the Vegetation	The second scenario is that there will be change On the Climate Condition (1.87 °C degree increase in temperature and –322.72 mm decrease in precipitation level) and relatively CHANGE on the Vegetation	The third scenario is that there will be change On the Climate Condition (1.87 °C degree increase in temperature and – 322.72 mm decrease in precipitation level) TOGATHER with Human Impact and relatively CHANGE on the Vegetation
As a result Potential Vegetation that present today will be the ***Practical Vegetation in 2070s***	As a result Potential Vegetation that present today will be the ***Potential Vegetation in future*** by 2070s	Impact of the climate change on the Vegetation will be exaggerated by anthropozoic pressures and change on Vegetation will be further in 2070s
	In terms of Climate Conditions, Change in **Temperature and Change in **Precipitation** will be two main driving forces in Vegetation Change by 2070s and onwards	As a result Potential Vegetation that present today will be the ***Disturbed Vegetation in 2070s***

*Linear correlation between Plant Productivity and Temperature allows us to assess the Vegetation Change by the change in Average Temperature, which has already been expected to increase in 1.87 °C by the year 2070s.

**But relationship between Plant Productivity and Precipitation is rather complex. There is a linear correlation between Plant Productivity and Precipitation with around 400-600 mm, which turns out to be non-linear by 800-1000 mm of rainfall. And there is also a similar linear relationship between Vegetation Cover (%) and Precipitation in some degree of rainfall. Vegetation cover increases in parallel with the rainfall and stands still and does not change with non-linear correlation when the rainfall reaches up to some certain amount.

More precisely;

- Average rainfall will be 650-***322,72*** = 327,28 mm in the lower basin which would create considerable change on the vegetation. It is vague whether macchia and *Pinus brutia* will survive under this circumstance but there will be clear change on the species within the plant formations. For example it is imprecise if such species as *Oleae europea var. oleaster, Daphne sericea, Laurus nobilis, Cercis siliquastrum, Phillyrea latifolia, Quercus coccifera, Stryrax officinalis* would maintain their woody forms under such amount of rainfall.

Table 12. Present and Expected Future Main Vegetation Types with Characteristic Species in Eastern Mediterranean

Elevation (meter)	Present Vegetation Characteristic species	Main Vegetation TYPE	Expected Change	Main Vegetation TYPE	Expected Future Vegetation Characteristic Species
0 – 100	Pinus halepensis (limited location in Çamlık) Pinus brutia, Quercus coccifera, Olea europea, Pistacia lentiscus, Phillyrea media, Myrtus communis, Cistus creticus and other macchia species	**Pinus halepensis P. brutia + Macchia**	*1.87 °C temperature **increase** + *–322.72 mm precipitation **decrease**	**Pinus halepensis P. brutia + Macchia**	Pinus halepensis, (limited) Pinus brutia, Quercus coccifera, Calycotome villosa, Paliurus spina-cristi, Olea europea var. oleaster, Phillyrea latifolia, Myrtus communis, Cistus creticus
100 – 400	Pinus brutia mixed Macchia species; Quercus coccifera, Olea europea, Pistacia lentiscus, Pistacia terebinhus, Laurus nobilis, Phillyrea latifolia, Daphne sericea, Myrtus communis Ceratonia siliqua, Cercis siliquastrum	**Pinus brutia + Macchia**		**Pinus brutia + Macchia**	Pinus brutia and macchia species; Quercus coccifera, Olea europea var. oleaster, Pistacia lentiscus, Pistacia terebinhus, Phillyrea latifolia, Ceratonia siliqua, Rhamnus alaternus, Calicotome villosa, Myrtus communis
400 – 700	Pinus brutia, Quercus coccifera, Quercus infectoria ssp. boisseri, Pistacia terebinhus, Laurus nobilis, Arbutus andrachne, Fontanesia phillyrioides, Ostrya carpinifolia, Styrax officinalis, Cotinus coggyria, Daphne gnidium, Cercis siliquastrum	**Pinus brutia + Macchia**		**Pinus brutia + Macchia**	Pinus brutia; Quercus coccifera, Quercus infectoria ssp. boisseri, Pistacia terebinhus, Phillyrea latifolia, Myrtus communis, Ostrya carpinifolia, Cotinus coggyria, Daphne gnidium
700 – 900	Pinus brutia, Pinus nigra, Juniperus oxycedrus, Quercus infectoria ssp. boisseri, Quercus cerris, Quercus pubescens, Pistacia terebinhus, Arbatus andrachne, Fontanesia phillyrioides, Ostrya carpinifolia, Styrax officinalis, Carpinus orientalis, Laurus nobilis, cercis siliquastrum	**Pinus brutia mixed forest**		**Pinus brutia mixed forest**	Pinus brutia, Quercus infectoria ssp. boisseri, Quercus cerris, Pistacia terebinthus, Myrtus coomunis, Phillyrea latifolia Arbatus andrachne, Fontanesia phillyrioides, Ostrya carpinifolia, Styrax officinalis
900 – 1200	Pinus brutia, Pinus nigra ssp. pallasiana, Juniperus oxycedrus, Juniperus exelsa, Ostrya carpinifolia, Quercus cerris, Quercus pubescens, Carpinus orientalis	**Pinus brutia mixed forest**		**Pinus brutia mixed forest**	Pinus brutia, Juniperus oxycedrus, Ostrya carpinifolia, Quercus cerris, Quercus infectoria ssp. boisseri
1200 – 1600 > 1600	Pinus brutia, Pinus nigra ssp. pallasiana, Cedrus libani, Abies cilicica, Juniperus oxycedrus, Juniperus exelsa, Juniperus durupacea. + Decidous trees; Ostrya carpinifolia, Carpinus orientalis, Quercus cerris, Quercus pubescens	**Conifer forest Mixed deciduous Trees** ↓ **Conifer Forests**		**Conifer forest Mixed deciduous Trees** ↓ **Conifer Forests**	Pinus brutia, Pinus nigra ssp. pallasiana, Cedrus libani, Abies cilicica, Juniperus oxycedrus, Juniperus exelsa, Juniperus durupacea; Ostrya carpinifolia, Quercus cerris, Quercus pubescens, Quercus infectoria ssp. boisseri (Likely escalation of timber line)

- Average rainfall will be 800-1000-***322,72*** = 477,28 - 677,28 mm in the upper basin. Under this circumstance its is unknown if submediterran deciduous species such *Fraxinus ornus, Ostrya* carpinifolia and deciduous oaks will survive

- Moreover one particular nature of Seyhan River Basin is the severe arid periods. Relatively number and the duration of the arid periods based on climate change for 2070 predicted by Climate Group of the project will be another factor on vegetation change. General expectation is that duration of the arid period will be longer with the sudden showery rains.

Plant growth and productivity are increasing when the amount of rainfall increases. But when the precipitation reaches at and above 1000 mm there will be no consequent change in either plant growth or productivity. Therefore draft estimation was carried out for the lower parts of the Seyhan River Basin based on both the prediction of ICCAP Climate Subproject Group, which has already been expected to be decreasing by – 322.72 mm. Considering that average amount of annual rainfall in the area is around 750 – 950 mm, such decrease by -322.72 mm will be a strong impact on the vegetation.

5. Conclusions

The impact of potential climate change on the geographic distributions of the vegetation is often assessed in terms of shifting precipitation or temperature in altitude. In case of Seyhan River Basin vertical distribution of the vegetation is evaluated on the bases of topography as well as spatial distribution of climatic data.

DelBarrio et al, (2006) indicated two general conclusions that despite the uncertainties; climate change involves the development of transient conditions and fragmentation within the core of species distributions; and climate change would favour the opening of gaps within the current vegetation zone, rather than a simple zonal shift of them. According to the scenarios on the vegetation change adapted by ICCAP Vegetation Groups main vegetation types along altitude is not expected to be changed by the change in climate conditions 1.87 °C increase in temperature and –322.72 mm decrease in precipitation level. But some characteristic species (core species) would move into higher elevations or would not appear.

According to the first scenario stands there will not be a substantial change on the climate and so on the vegetation. The potential vegetation that present today will be the Practical Vegetation in 2070s with a vertical distribution given in Figure 9. Hereby we have mainly typical Mediterranean Macchia cover from sea level and reaching up to 800 meters. On the area with no or low human impact macchia cover maintain a tall cover including large tree species as *Quercus infectoria, Quercus cerris, Arbutus andrachne, Ostrya carpinifolia* on the high elevations. It is possible to see *Pinus brutia* up to 1200 meters either in solid form or mixed forests. Coniferous forests have the distribution 1200 meter until timber line which was reduced to lower parts due to human use.

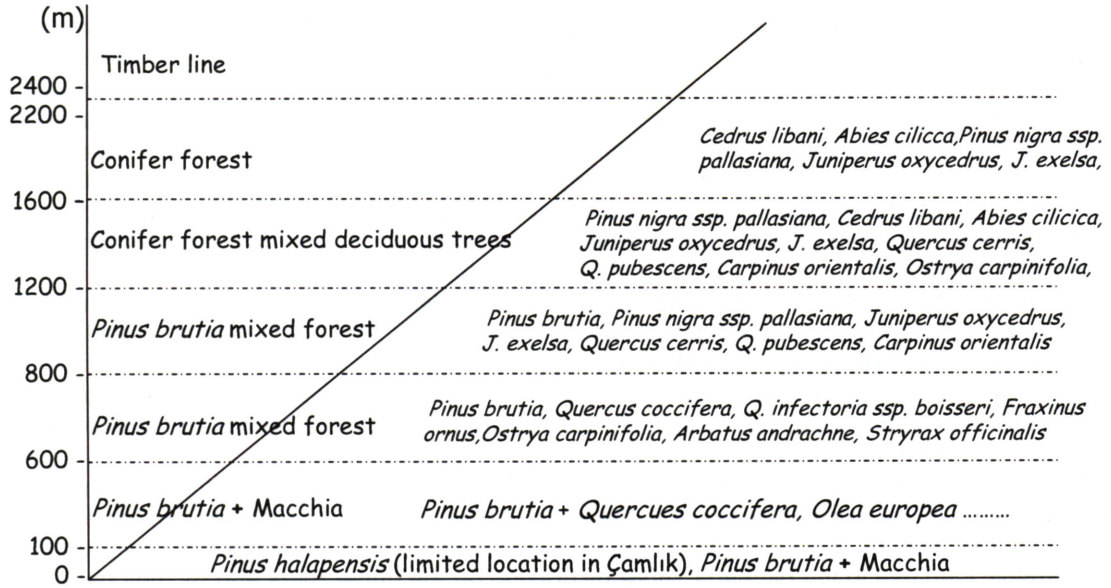


Figure 6. Expected change on vertical distribution of vegetation according to first scenario

According to the second scenario that expected change in climate conditions will be 1.87 °C increase in temperature and –322.72 mm decrease in precipitation level so we don not expect a substantial change on vertical distribution of the vegetation, but upwards movement in some vegetation belts such *Pinus brutia* mix forest, Conifer forest mixed deciduous trees as well as conifer forest by changing so the characteristic species (Figure 7).

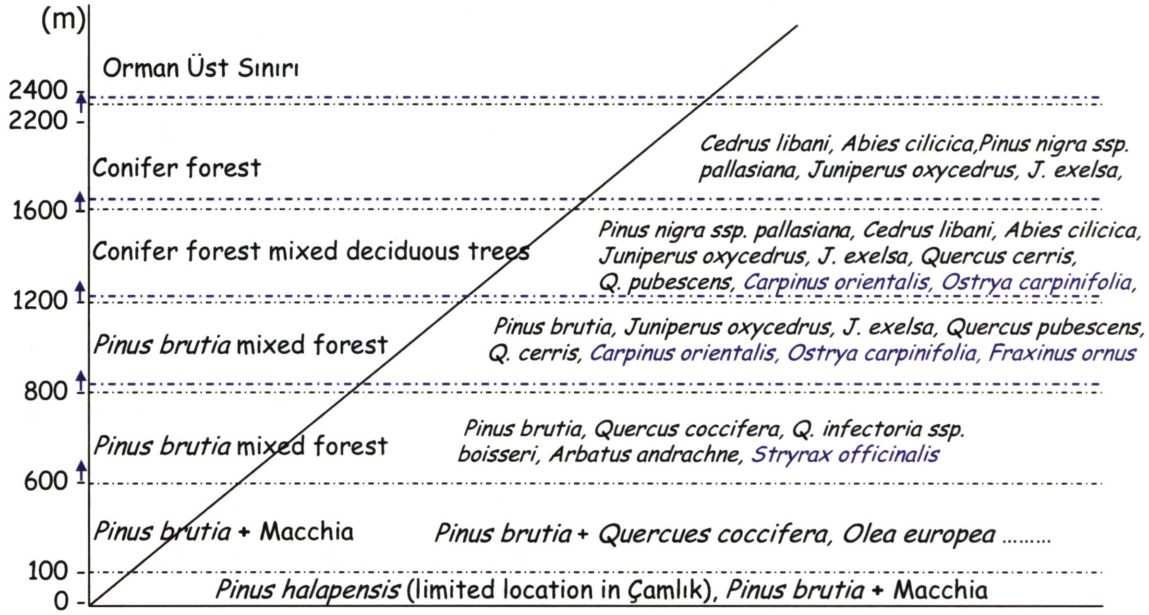


Figure 7. Expected change on vertical distribution of vegetation according to second scenario

Apart from climate based environmental conditions there will be continuing human land uses and anthropozoic pressure on the vegetation, which need to be taken into account along with the climate change. Altan (2000) informed that forest degradation in Turkey basically stands on forest fires, grazing in the in the forest sites, land reclamations for agricultural lands and over use of forest resources.

The third scenario of the vegetation group is the potential impact of the climate change and impact of anthropozoic pressures (human use) on the natural vegetation. We expect that existing rural land use types of agriculture, stockfarming, forestry, mining, recreation, settlement developments will remain in the future. In terms vegetation change Turkish vegetation group carried out socio-economic studies in upper Seyhan River Basin to get closer view on the existing land use patterns and the anthropozoic pressure, where such rural land use types have direct impact on the vegetation.

There is another project group; Güney et al (2006) worked on agricultural system involving livestock production. Although their work was covering the lower part of Seyhan River Basin, not intending to such location in terms of vegetation, there is still some common outcomes regarding to stockfarming. For example grazing time changes between March and December and depending on the altitude it moves on to most active growing period of the vegetation more on the mountainous sites. This directly relates the use of plateaus and the impact on forest finally plant formation

According to Güney et al (2006) bush and scrublands densely used in the mountainous areas with the rising numbers of sheep and particularly the goats which would cause overgrazing and consequently change on the vegetation types.

Conversion of grassland, woodland and forest into cropland or pastures has been continues human pressure in the area, but new legislative procedures put more control on such activities and some degraded forest sites are under afforestation work.

However in terms of severe aridity, it would be possible to see such land conversion from forests to agricultural fields or pastures in the basin. According to third scenario, we expect some changes with the main vegetation zones. For example timber line zone can be reduced by the nomadic land use in the plateaus, more by grazing on the upper parts and by the change in

air temperature on the lower parts. In some cases second house developments and recreation would be another driving force on the declining timber line (Figure 8).

Figure 8. Expected change on vertical distribution of vegetation according to third scenario

It is inevitable that climate change will affect natural ecosystems in Seyhan River Basin. Aiming at future vegetation change in the basin according to climate, studies on indication of actual natural vegetation and impacts of local people on the vegetation were concentrated in mid and upper basin still maintaining its natural assets.

- *Pinus brutia* forest on the lower part of Seyhan River Basin will survive. However there will be potential risk for the existence of *Pinus brutia* forest in case of unfavourable environmental condition such as thin layer of soil, poor water holding capacity and sloppy south aspects
- macchia vegetation generally will remain and move higher elevation by temperature increase and rainfall decrease.
- there will be a decrease on the deciduous species in the favour of *Pinus brutia* whereas transition from Mediterranean to sub-Mediterranean region will move up
- coniferous vegetation is expected to remain, but timber line zone can be reduced by the nomadic land use in the plateaus, more by grazing on the upper parts and by the change in air temperature on the lower parts. In some cases second house developments and recreation would be another driving force.

Considering main vegetation types and species diversity in Seyhan River Basin (Altan, 2000; Aktoklu et al, 2004; Atmaca; 2005; Atik et al, 2006; Altan et al, 2007) impact of climate on the vegetation of its own and, impact of anthropozoic pressures can be best monitor in used and un-used areas. Nevertheless long-term changes must to be monitored in detailed level, covering all plant forms in the vegetation. Turkish Vegetation Group set up a constant monitoring parcels' system so far and further researches can easily be integrated about the change on vegetation. Plant analysis that will be carried out on these regular monitoring on these parcels in the future and the comparative studies with project results will supply more precise picture about the future vegetation change by 2070s and onwards.. Hence constant monitoring parcels' system is an useful contribution and monitoring studies must be carried out with certain intervals in the future.

References

Altan, T., 2000. Doğal Bitki Örtüsü. Ç.Ü. Ziraat Fakültesi Genel Yayın No: 235. Ders Kitapları Yayın No: A – 28. Adana

Altan, T., Aktoklu, E., Atmaca, M., Kaplan, K., Atik, M., Artar, M., Güzelmansur, A., Çinçinoğlu Salıcı, A., Büyükaşık Güzel, Y., 2007. Seyhan Havzası Bitki Örtüsünün Floristik Ve Vejetasyon Açısından Araştırılması.TÜBİTAK Proje Raporu,TOVAG-JPN-07.

Aktoklu, E., M., Atmaca, K., Kaplan, M., Atik, M., Artar, A.Ç., Salıcı, A., Güzelmansur, Y., Büyükaşık, 2004. Natural Vegetation in Seyhan Watershed. Workshop for the Research Project on the Impact of Climatic Change on Agricultural System in Arid Areas (ICCAP) TÜBİTAK- Japon- RHIN (Research Institute for Humanity and Nature) November 21-23 2004 Cappadocia-Turkey.

Atmaca, M., Altan, T., Aktoklu, E., Kaplan, K., Atik, M., Artar, M., 2005. Constant Monitoring Parcels'System that Set Up in Seyhan River Basin and Vegetation Analyses. The Progress Report of ICCAP, Pages 25-35.

Atik, M., Tamai, S., Altan, T., Ando, M., Sano, J., Atmaca, M., Aktoklu, E., Kaplan, K., Artar, M., Güzelmansur, A., Çinçinoğlu, A., Büyükaşık, Y., 2006. Different Scenarios on the Impact of the Climate Change on the Vegetation in Seyhan River Basin and Role of Land Uses "Anthropozoic Pressures". A Joint Worksheet of Japanese and Turkish Vegetation Groups, Kyoto

Braun-Blanquet, J., 1964. Plant Sociology, London.

Davis, P.H., 1965-1985. Flora of Turkey and the East Aegean Islands, Vol. 1-9. Edinburgh Univ. Press. Edinburgh, UK.

Davis, P.H., Mill, R. ve Tan, K., 1988. Flora of Turkey and the East Aegean Islands, Vol. 10. Edinburgh Univ. Press. Edinburgh, UK.

Del Barrio, G., Harrison, PA., Berry, P.M., Butt, N., Sanjuan M.E., Pearson, R.G. Dawson , T., 2006. Environmental Science & Policy, No 9, Pages 129-147.

DeLuis, M., Garcisca-Cano, M.F., Cortina, J., Raventos, J., Gonzales-Hidalgo, Sanchez, J.R., 2001. Climatic trends, disturbances and short-term vegetation dynamics an a Mediterranean Schrubland. Forest Ecology and Management No 147, Pages 25-37.

Deneri, V., 2006. Aladağ İlçesi Pos Orman İşletmesi Alanında İnsan Orman İlişkilerinin Araştırılması. Çukurova Üniversitesi Fen Bilimleri Enstitüsü Peyzaj Mimarlığı Anabilim Dalı, Adana.

Ekim, T., M., Koyuncu, M., Vural, H., Duman, Z., Aytaç, N., Adıgüzel, 2000. Türkiye Bitkileri Kırmızı Kitabı. Türkiye Tabiatını Koruma Derneği ve Van 100. Yıl Üniversitesi, Ankara.

Güner, A., Özhatay, N., Ekim, T. ve Başer, K.H.C., 2000. Flora of Turkey and the East Aegean Islands, Vol. 11. Edinburgh Univ. Press. Edinburgh, UK.SFF.

Güney, O., Gül, A., Darcan, N., Çeliktaş, N., Güney, İ., Işık, H., 2006. Results of Agricultural System Involving Livestock Production in Lower Part of Seyhan River Basin (within ICCAP). Final Report.

Lioubimtseva, E., 2004. Climate change in arid environments: revisiting the past to understand the future. Progress in Physical Geography 28,4 (2004) pp. 502–530.

Reid, R.S., Kruska, R.L., Muthui, N., Taye, A., Wotton, S., Wilson, C.J., Mulatu, W., 2000. Land-use and land-cover change dynmamics in response to changes in climatic, biological and socio-political forces:the caseof southwestern Ethiopia.Landscape Ecology,15;339-355.

Vilalta, J.M., Pinol J. Beven, K., 2002.A hydraulic model to predict drought-induced mortality in woody plants: an application to climate change in the Mediterranean. Ecological Modelling 155; 127–147.

Yalgın, A.R., 1950. Toroslar'da Karatepeli Bölgesi, Yurt ve Etnoğrafya. Ulus Basım Evi, Ankara.