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Biodiversity and land degradation in the lower Euphrates subregion of Turkey

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Abstract

A total of 107 plant taxa were determined in this study, 24 being new records for the area. Out of 813 plant taxa reported from the study area 100 species couldn't be verified. The number of endemics in the study area is around 46. The major families and genera are *Asteraceae, Fabaceae*, and *Poaceae* and *Astragalus, Euphorbia, Allium* and *Trigonella*. The area shows a relatively rich and highly diverse fauna. For terrestrial vertebrate species peculiarly showing marginal distribution, this area forms their northernmost distributional limits. Avifauna along the Euphrates valley is quite rich with 207 species. Globally threatened species, *Geronticus eremita* (Waldrapp), has been observed locally in the area. Many macromammal species once common have gone extinct. Out of 18 lizard species, 3 lizards are known only from the study area. There are 20 species of snakes, one being exclusively endemic to the study area. Nearly 30 fish species are found in Euphrates system. Very scanty information is available for the invertebrate fauna except for some groups of Mollusca and Arthropoda. The biodiversity of the area is under threat from recent developments and abiotic interferences.

Key words

Biodiversity, Lower Euphrates, Land degradation, Turkey

Introduction

Nearly 28.5% of the Turkey's water potential is provided by Tigris-Euphrates system. To utilize this potential in electric power production and conversion of vast dryland areas of Southeast Anatolia to irrigated farming, the megaproject GAP (The Southeastern Anatolian Project) was initiated in 1961. It is the biggest project of modern Turkey and was planned to cover 22 dams, 19 hydroelectric plants and a canal network for irrigation of 1.7 million ha, corresponding to 20% of the arable lands in Turkey (Karadogan and Atasoy, 2010). During the initial phase, loss of archaeological and cultural values acquired great publicity. Following the disappearence of 25 historical sites beneath Ataturk dam (Karadogan and Atasoy, 2010), gradual drowning of antic city Zeugma under the waters of Birecik dam has brought worldwide interest to the region.

The Fertile crescent is an ancient region stretching in an arc from the Tigris-Euphrates in the east to the Mediterranean sea in the west. Lower Euphrates which covers our study area is situated at the heart of this so-called 'cradle of civilizations' being home to earliest examples of domestication and first cities during the Neolithic (Zohary and Hopf, 1993). The Euphrates, bringing life and wealth to the land throughout the history, supports a remarkably rich biodiversity along its valley. The valley acts as a natural corridor for dispersalists and wetlands formed within the basin and serves as an important resting area for migratory Palearctic birds.

Through the long history of land use and habitat destruction, vegetation structure has extensively been degraded. Therefore, populations of many endemic animal and plant taxa show restricted distribution. Current projects involving construction of dams and irrigation systems put in further disturbance to the natural environment (Balos and Akan, 2008). In the lower Euphrates part 3 successive dams have been constructed namely; Ataturk dam-largest dam in Turkey, Birecik dam and Karkamis dam. No collective work has been presented towards a better understanding of disappearing wildlife and biological diversity. Such studies are needed for environmental impact assessment studies and management plans.

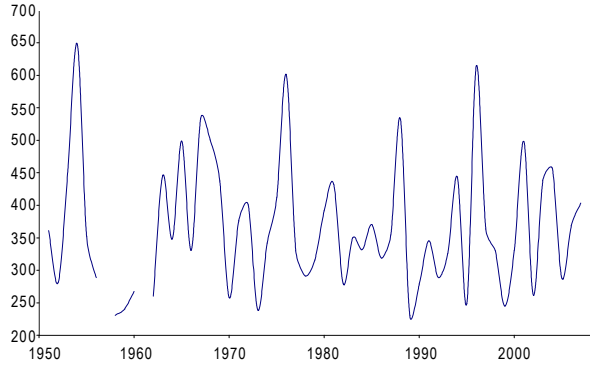

Fig. 1: Total annual precipitation in Birecik (Birecik station, 1951-2007)

This paper aims to enlighten the present status of the biological potential and degradation in lower Euphrates area.

Study area: The study area lies in the Southeast Anatolia region of Turkey between the provinces of Gaziantep (Nizip and Karkamis districts) and Sanliurfa (Halfeti and Birecik districts) and Euphrates forms the provincial borderline in this area. The Euphrates flows locally in a meandering pattern through a deep and confined gorge entrenched in a low plateau composed of Eocene to Miocene limestone and calcareous mudstone levels. The plateau is not densely settled despite the availability of arable deep soil because of insufficient surface flow and deep water table. Quaternary terraces and high floodplain steps flanking the river are covered by pistachio trees and other dryland as well as irrigated crops (Algaze *et al.*, 1994).

The climate of the study area is typical arid Mediterranean. According to Emberger, the precipitation-temperature coefficient is 42.94 (Akman, 1990), annual mean temperature being 17.6°C, maximum mean temperature 46.8°C (in July) and minimum mean temperature -6.8°C (in February) (Atamov *et al.*, 2007). Annual rainfall is about 366.57 mm and the seasonal precipitation regime is winter, spring, autumn and summer. This is the first variant of the East Mediterranean precipitation regime. Average relative humidity is 56%, but decreases below 30% in summer, during the hottest days even below 1%, due to excessive amount of evapotranspiration (Atalay and Efe, 2010).

Topography in the area is generally even except for undulated hills split by valleys mostly dry during summer, but near the Syrian border there are several north to south directed mountains having average heights allowing pistachio and olive cultivation in the foothills and on the sides. Highest peak of the area, Mt Arat at 920, is situated at 15 km east of Birecik. Vertisols, commonly seen in plains along Euphrates, are characterized by pebbles under the soil and around Birecik the soil is highly pebbly. In these areas, soils buried under pebble layers are typical examples of palaeosoils. Grey-coloured soils on clayish-lime areas between Gaziantep-Sanliurfa reflect the character of the main ground. These soils do not present a normal profile due to erosion. In Birecik, buried palaeosoils are found at an altitude of 450 m on the west bank of the Euphrates (Atalay and Mortan, 1997).

Floristic diversity: The study area is located in the Irano-Turanian phytogeographical region, in the C7 grid square (Davis, 1965). Geographically unseparable from Syrian plateau, this area represents the Mesopotamian subregion (Atalay and Efe, 2010). Considering plain topography, arid climate and closeness to Turkish-Syrian borderline, considerable level of endemism and species richness can be seen among the plant taxa as compared to the surrounding areas. This is mainly due to microclimatic effect of Euphrates valley in combination with uneven topography around Halfeti and Birecik, with most interesting distributional records.

The steppe vegetation is severely degraded by agricultural practices and grazing pressure, therefore identification of vegetation structure is often difficult (Balos and Akan, 2008). It is mainly composed of perennial chaemephytes and hemicryptophytes. Typical examples of plant taxa from these steppes are *Artemisia herba-alba, Prosopis farcta, Teucrium polium, Thymbra spicata* var. spicata, *Centaurea virgata, Papaver syriacum, Hordeum spontaneum* and *Poa bulbosa*. The sparsely distributed trees among these steppes are *Amygdalus arabica, Ficus carica, Crataeagus aronia* var. aronia, *Celtis tournefortii* and *Pistacia khinjuk* (Davis 1965-1985). Within the valley and to the west of Euphrates, Mediterranean elements become more prominent in proportion and at steep slopes *Crataegus monogyna.* subsp. *monogyna, Capparis ovata* var. palaestina, *Celtis australis* and *Rhus coriaria* are observed in the area. Limestone plateaus along Euphrates are covered with olive and pistachio plantations in general. The forest vegetation occurs only at higher altitudes (above 700 m) in Nizip, to the west of our study area, as fragmentary deciduous oak woodlands. In addition, gallery forests formed by *Populus euphratica, Salix alba, S. acmophylla* and *S. triandra* are also present along the Euphrates.

Wetland vegetation; encountered only at the banks of the Euphrates; is most affected from dam constructions and consequent rise in water levels. *Arundo donax, Cyperus rotundus, Mentha pulegium, Tamarix smymensis, Nasturtium officinale, Phragmites australis, Typha domingensis, Juncus articulatus* are the typical representatives from this vegetation.

A total of 813 plant taxa have been recorded uptill now from the lower Euphrates subregion (Davis, 1965-1985; Davis, 1988; Turkmen *et al.*, 2005; Atamov *et al.*, 2007; Balos and Akan, 2008). Out of these, the families with highest number of taxa are *Asteraceae, Fabaceae* and *Poaceae*, while the major genera are *Astragalus, Euphorbia, Allium* and *Trigonella.* During our field studies, a total of 107 plant taxa were collected from Nizip, Halfeti, Zeugma, and Birecik. Out of these 24 are new records for the area. The endemism rate is relatively higher (5.94%) than surrounding areas of similar size, like Ceylanpinar State Farm (2.4%) and even comparable to

Table - 1: Endangered plant taxa of higher threat categories

	CR[1]	EN[1]	VU[1]	DD[1]	Total	%[2]
Gaziantep-Sanliurfa						
All	7	10	85	26	128	-[3]
Endemics	5	6	20	10	41	37.61
Study area						
All	3	3	38	13	57	-[3]
Endemics	2	1	7	6	16	34.78

[1] CR= Critically endangered, EN=Endangered, VU=Vulnerable, DD= Data deficient, [2] Percentage of CR, EN, VU, and DD totals to all endangered taxa
[3] Non-endemics in lower risk categories were not listed in Ekim et al (2000)

that of Karacadag mountain (5.79%), which is one of the major plant endemism centers in the region (Ertekin, 2002).

It is worth noting here that out this huge plant diversity, 100 plant taxa have not been verified during the investigations carried out in last 25 years. This information includes 9 of the 46 endemic taxa encountered in the area.

Currently, populations of endemic and rare plants in the study area are highly endangered due to habitat destruction. A total of 109 endemic plant taxa recorded from the provinces of Sanliurfa and Gaziantep are endangered according to IUCN criteria and Red Data book of Turkish plants (Ekim *et al*., 2000). Out of these, 46 taxa (42.20%) are known from our study area. As seen in the table showing the distribution of taxa in higher threat categories (Table 1), the vulnerable (especially in non-endemics) and data deficient taxa prevail. Relative proportions of the categories between Sanliurfa-Gaziantep and our study area are similar, but the extinction risk is obviously higher especially among DD ranked taxa from study area. *Astragalus balkisensis* is known from the Balkis (Zeugma), for instance, has not been recovered since 1907. *Cousinia birecikensis* and *Scilla mesopotamica*, both known from single collections in 1888, were recently rediscovered after a century from two sites near Birecik and Halfeti (Ekim *et al*., 2000). Due to extensively fragmented structure of natural habitats, especially in the Euphrates plain, determination of exact ranges and protection measures needs detailed field studies.

Single spot endemics, confined to isolated segments of Euphrates valley, are quite susceptible to anthropogenic interferences like road or dam constructions. For instance, the surveys since the establishment of Keban dam; situated within the Euphrates basin; show that 4 species (*Onosma affine, O. descedens, Teucrium leucophyllum* and *Astragalus pseudocylindraceus*) are now extinct from the dam area (Ekim *et al*., 2000). For such endemic species, *ex situ* protection programs need be initiated immediately to prevent further tragedies in the region. Two previously unrecorded endemic taxa, *Achillea aleppica* subsp. *zederbaueri* and *Alcea calvertii*, were determined during our field study. *A. aleppica* subsp. *zederbaueri* is used as a folk medicine in Gaziantep (Surmeli *et al*., 2001). Medicinal use of plants is common in the Birecik area and 17 taxa, corresponding to 10% of all taxa having ethnobotanical importance, are of therapeutic use (Akan *et al*., 2008). Currently, whether harvesting of these medicinal plants endangers local populations is unknown.

Many cultivated plants like common wheat, einkorn, macaroni wheat, barley, oat, rye, pea, olive, hackberry, pistachio, common vetch, faba bean, chickpea, lentil, carrot, safflower, leek, lettuce, flax, sorghum originated from Near East gene center, where their wild progenitors, relatives and landraces can still be found. According to recent molecular and archaeobotanical data, the area played the primary role in the domestication process of barley, einkorn and emmer wheat. Barley and wheat are the two staple crops, on which 30% of the world's population depends (Zohary and Hopf, 1993; Ozkan *et al*., 2005). Some wild relatives of crops occurring in the area, principally of legumes and cereals, are endemic to and/or endangered in Turkey. *Triticum dicoccoides* (wild emmer), wild progenitor of emmer whear, is an endangered species in Turkey and categorized as VU (Ekim *et al*., 2000). The wild ancestor of the chickpea (*Cicer reticulatum*) is restricted to the Southeastern Anatolia and it is recorded as endangered while another endemic *C. echinospermum* is vulnerable according to IUCN criteria (Ekim *et al*., 2000). The area is also the microcenter of diversity of genus *Lens* (lentils) (Harlan, 1951). *Lens tomentosus* endemic to Southeast Anatolia is endangered, while *L. montbretii* found also in northern Iraq is vulnerable. In the view of changing environmental conditions, preserving genetic stocks of wild relatives and ancient cultivars crops has acquired great conservational importance. The genetic diversity within populations of economically important species can only be maintained *in situ*, to assure greater genetic diversity and keep the germplasm in tune with changing environment (Shands, 1991).

Alien introductions pose a major threat for plant diversity of Mediterranean and arid ecosystems. In GAP area, the adventive taxa benefit from the recent developments like extension of irrigated land and climatic changes. Alien taxa are often rapidly establishing weeds competing with crop species for the nutrients, moisture, light and space (Bukun, 2005). Irrigation and salinization stimulate local and adventive weeds like *Echinocloa crus-galli, Physalis angulata, Physalis philadelphica, Portulaca oleracea, Setaria verticillata, Sorghum halepense* and *Xanthium strumarium*. Rapid establishment of casually

Table - 2: Plants collected from the area during the field study

	Plant name	Family	Site collected
1	*Equisetum arvense*	Equisetaceae	Ayran Village
2	*Ephedra campylopoda*	Ephedraceae	Nizip
3	**Clematis cirrhosa*	Ranunculaceae	Northern Birecik
4	*Ranunculus ficaria* ssp. *ficariiformis*	Ranunculaceae	Ayran Village
5	*Cardaria draba*	Brassicaceae	Northern Birecik
6	*Nasturtium officinale*	Brassicaceae	Birecik (along Euphrates)
7	*Capparis ovata* var. palaestina	Capparaceae	Nizip
8	*Capparis spinosa* var. spinosa	Capparaceae	Northern Birecik
9	*Reseda lutea*	Resedaceae	Nizip
10	*Rumex sp.*	Polygonaceae	Ayran Village
11	*Rumex crispus*	Polygonaceae	Ayran Village
12	*Chenopodium album* ssp. *album*	Chenopodiaceae	Nizip
13	**Chenopodium foliosum*	Chenopodiaceae	Northern Birecik
14	**Noaea mucronata* ssp. *mucronata*	Chenopodiaceae	Zeugma
15	*Tamarix smyrnensis*	Tamaricaceae	Northern Birecik
16	*Hypericum retusum*	Hypericaceae	Ayran Village
17	**Alcea calvertii*	Malvaceae	Northern Birecik
18	*Malva neglecta*	Malvaceae	Northern Birecik
19	*Oxalis corniculata*	Oxalidaceae	Northern Birecik
20	*Peganum harmala*	Zygophyllaceae	Southern Birecik
21	*Tribulus terrestris*	Zygophyllaceae	Nizip
22	**Haplophyllum telephioides*	Rutaceae	Zeugma
23	*Vitis vinifera*	Vitaceae	Northern Birecik
24	**Paliurus spina-christi*	Rhamnaceae	Ayran Village
25	*Pistacia khinjuk*	Anacardiaceae	Nizip
26	**Pistacia terebinthus*	Anacardiaceae	Zeugma
27	*Pistacia vera*	Anacardiaceae	Nizip
28	*Rhus coriaria*	Anacardiaceae	Zeugma
29	*Prosopis farcta*	Fabaceae	Nizip
30	*Amygdalus communis*	Rosaceae	Northern Birecik
31	**Amygdalus orientalis*	Rosaceae	Northern Birecik
32	*Crataegus aronia* var. aronia	Rosaceae	Zeugma
33	**Crataegus curvisepala*	Rosaceae	Northern Birecik
34	*Potentilla reptans*	Rosaceae	Catalsu Village
35	**Rubus discolor*	Rosaceae	Northern Birecik
36	*Rubus sanctus*	Rosaceae	Ayran Village
37	*Sanguisorba minor* ssp. *lasiocarpa*	Rosaceae	Zeugma
38	*Sanguisorba minor* ssp. *magnolii*	Rosaceae	Ayran Village
39	**Sarcopoterium spinosum*	Rosaceae	Zeugma
40	*Punica granatum*	Punicaceae	Northern Birecik
41	*Bryonia multiflora*	Cucurbitaceae	Ayran Village
42	*Echinophora tenuifolia* ssp *sibthorpiana*	Apiaceae	Zeugma
43	*Eryngium campestre* var. virens	Apiaceae	Zeugma
44	*Eryngium glomeratum*	Apiaceae	Zeugma
45	**Cephalaria aristata*	Dipsaceae	Northern Birecik
46	**Scabiosa rotata*	Dipsacaceae	Northern Birecik
47	**Achillea aleppica* ssp. *zederbaueri*	Asteraceae	Zeugma
48	*Artemisia herba-alba*	Asteraceae	Zeugma
49	*Artemisia scoparia*	Asteraceae	Northern Birecik
50	*Bellis perennis*	Asteraceae	Ayran Village
51	*Calendula arvensis*	Asteraceae	Ayran Village
52	*Cirsium* L.sp.	Asteraceae	Nizip
53	*Conyza bonariensis*	Asteraceae	Northern Birecik
54	*Picnomon acarna*	Asteraceae	Nizip
55	*Picris strigosa* ssp. *strigosa*	Asteraceae	Zeugma
56	*Pulicaria dysenterica*	Asteraceae	Northern Birecik
57	*Senecio vernalis*	Asteraceae	Northern Birecik

58	*Sonchus oleraceus*	Asteraceae	Ayran Village
59	*Taraxacum aleppicum*	Asteraceae	Northern Birecik
60	*Xanthium spinosum*	Asteraceae	Zeugma
61	*Xanthium strumarium*	Asteraceae	Ayran Village
62	*Ligustrum vulgare*	Oleaceae	Northern Birecik
63	*Olea europaea* var. europaea	Oleaceae	Nizip
64	*Nerium oleander*	Apocynaceae	Nizip
65	*Vinca herbacea*	Apocynaceae	Ayran Village
66	*Convolvulus arvensis*	Convolvulaceae	Ayran Village
67	*Myosotis refracta* ssp *refracta*	Boraginaceae	Northern Birecik
68	*Borago officinalis*	Boraginaceae	Ayran Village
69	**Echium italicum*	Boraginaceae	Nizip
70	*Heliotropium europaeum*	Boraginaceae	Ayran Village
71	*Onosma sericeum*	Boraginaceae	Nizip
72	*Cuscuta campestris*	Cuscutaceae	Nizip
73	*Solanum nigrum*	Solanaceae	Nizip
74	*Linaria* sp.	Scrophulariaceae	Zeugma
75	*Scrophularia xanthoglossa* var. decipiens	Scrophulariaceae	Northern Birecik
76	*Verbascum kotschyi*	Scrophulariaceae	CatalsuVillage
77	*Orobanche aegyptiaca*	Orobranchaceae	Nizip
78	*Verbena officinalis*	Verbenaceae	Northern Birecik
79	**Lycopus europaeus*	Lamiaceae	Northern Birecik
80	**Melissa officinalis* ssp. *inodora*	Lamiaceae	Ayran Village
81	*Mentha longifolia* ssp. *typhoides* var. typhoides	Lamiaceae	Northern Birecik
82	**Mentha* x *piperita*	Lamiaceae	Nizip
83	**Mentha spicata*	Lamiaceae	Northern Birecik
84	*Sideritis libanotica* ssp *microchlamys*	Lamiaceae	Zeugma
85	*Teucrium polium*	Lamiaceae	Northern Birecik
86	*Thymbra spicata* var. spicata	Lamiaceae	Zeugma
87	**Plumbago europaea*	Plumbaginaceae	Northern Birecik
88	*Plantago lanceolata*	Plantaginaceae	Ayran VillageNorthern Birecik
89	*Elaeagnus angustifolia*	Elaeagnaceae	Northern Birecik
90	**Euphorbia peplis*	Euphorbiaceae	Ayran Village
91	*Chrozophora tinctoria*	Euphorbiaceae	Northern Birecik
92	*Euphorbia haussknechtii*	Euphorbiaceae	Nizip
93	*Parietaria judaica*	Urticaceae	Ayran Village
94	*Celtis australis*	Ulmaceae	Northern Birecik
95	*Platanus orientalis*	Platanaceae	Ayran Village
96	*Populus euphratica*	Salicaceae	Southern Birecik
97	**Populus tremula*	Salicaceae	Nizip
98	*Salix alba*	Salicaceae	Southern Birecik
99	**Salix pedicellata*	Salicaceae	Halfeti
100	**Sagittaria sagittifolia*	Alismataceae	Nizip
101	*Arum dioscoridis* var. luschanii	Araceae	CatalsuVillage
102	*Crocus cancellatus* ssp. *damascenus*	Iridaceae	CatalsuVillage
103	*Iris persica*	Iridaceae	Birecik
104	*Typha domingensis*	Typhaceae	Southern Birecik
105	*Juncus articulatus*	Juncaceae	Northern Birecik
106	*Phragmites australis*	Poaceae	Northern Birecik
107	*Sorghum halepense* var. muticum	Poaceae	Nizip

* Plants newly observed in the area

introduced *Physalis philadelphica* var. *immaculata* in cotton fields of Harran plain indicates that the sensivity to expanding xenophytes such as *Solanum elaeagnifolium* or *Ludwigia peploides* is high. Increasing international transportation network seems to be effective, as indicated by recent recording of expanding roadside adventive *Onopordum canum* native to Iraq and Iran and commonly distributed alongwith grain transports from the region (Greuter and Raab-Straube, 2005).

Faunal diversity: In Turkey, Southeast Anatolian region has an even topography and low altitude (on average below 600 m), therefore many eremial elements are restricted to this area due to semiarid climate as well as high mountain ranges, but some have crossed these barriers along the Euphrates valley. Ongoing Holocene expansion of thermophilous migrants into the region, rapid and long-term effects of

Table - 3: Rare mammals encountered in the study area and its environs.

Latin name	English name	Occurrence	Threat status (IUCN)
H. auritus	Long-eared desert hedgehog	Urfa	LC
O. hemprichi	Hemprich's long-eared bat	Urfa	LC
T. nudiventris	Naked-rumped tomb bat	Nizip	LC
M. auratus	Golden hamster	SE Anatolia	EN
M. irani	Persian vole	SE Anatolia	LC
M. guentheri	Guenther's vole	Kilis	NT
G. dasyurus	Wagner's dipodil	Kilis	LC
M. tristrami kilisensis	Tristram's jird	Nizip, Kilis	LC
M. vinogradovi	Vinogradov's jird	SE Anatolia	LC
M. crassus charon	Sundevall jird	Urfa	LC
T. indica taeniura	Indian gerbil	Birecik	LC
E. melanurus	Asian garden dormouse	Harran	LC
A. s. mystacinus	Broad-toothed field mouse	Kilis	LC
N. indica	Short-tailed bandicoot rat	Urfa	LC
A. euphratica	Euphrates Jerboa	Urfa	NT
H. hyaena syriaca	Striped hyaena	Urfa	NT
P. pardus tulliana	Anatolian leopard	?	CR
G. dorcas	Dorcas gazelle	?	VU
G. subgutturosa	Goitered gazelle	Ceylanpinar	NT

recent habitat changes necessitate detailed faunal surveys around the region.

Mammalian fauna is recognizable with its lost species once common in the area. Before modern age some large mammals had already disappeared. It is known that until the early 1st century BC the Asian elephant (*Elephas maximus asurus*) lived near the lakes and wetlands of Kahramanmaras and in the valleys of the Euphrates and Tigris rivers. Likewise, in the same era the wild ox (*Bos primigenius boganus*) lived in different regions of Anatolia, and the wild ass (*Equus hemionus anatoliensis*) lived near the Euphrates and Karasu until the end of the 12th century. Possibly bear (*Ursus arctos syriacus*) and Mesopotamian fallow deer (*Dama mesopotamica*) also existed in the same period. Last individual of Asiatic lion (*Panthera leo persica*) was last shot in the second half of the 19th century near Birecik in the Euphrates valley. The cheetah (*Acinonyx jubatus*) lived in our study area till last century and last observation of a captive individual was from 1879. Reports concerning some other large mammals are uncertain at the same period. According to distributional reports, Anatolian leopard (*Panthera pardus tulliana*) may have existed in the area. There is some evidence about the presence of beaver (*Castor fiber*) and otter (*Lutra lutra*) (TCV, 1990). Although Kumerloeve (1975) reports red deer (*Cervus elaphus*) from Halfeti, no recent record is available. Presence of *Gazella dorcas* has always been questionable (Kumerloeve, 1975; Kasparek, 1986), but goitered gazelle (*G. subgutttturosa*) occur in low numbers near Syrian border. From the carnivores, jackal (*Canis aureus syriacus*), striped hyena (*Hyaena hyaena syriaca*), and Egyptian mongoose (*Herpestes ichneumon*) can still be encountered in valleys along Euphrates, while wolf (*Canis lupus pallipes*) is probably extinct from the area. The study area is among the last few quarters for striped hyaena in Turkey. Other rare mammal species in and around the area include *Hemiechinus auritus*, *Hystrix indica, Otonycteris hemprichi*, *Caracal caracal*, *Eliomys melanurus*, *Apodemus mystacinus*, *Meriones tristrami kilisensis, Microtus irani, Nesokia indica, Mesocricetus auratus, Gerbillus dasyurus, Meriones crassus, M. vinogradovi*, *Allactaga euphratica* and *Tatera indica taeniura* (Kumerloeve, 1975; Sachanowicz *et al.*, 1999; Yigit and Colak, 1998, 2002).

As in other wetlands in neigbouring countries like Syria and Iraq, the wetland ecosystem formed along Euphrates shows a rich avifauna.This diverse fauna is equally vulnerable in three hotspots in the study area, Halfeti, Birecik, and Karkamis, which are thoroughly under the influence of Birecik and Karkamis dam lakes. The avifauna consists of 207 species, but actual number should be expected higher as passage migrants, particularly raptors, in the area are not known exactly. Of globally threatened species *Phalacrocorax pygmaeus, Geronticus eremita* (locally extinct in the wild), *Pandion haliaetus, Circus macrourus, Falco naumanni* and *Aythya nyroca* have been observed in the area. The Birecik population of *Geronticus eremita* (Waldrapp) has been accepted as extinct in the wild by 1992. A total of 60 captive bred birds live in a station north of Birecik. These birds, as with many other species, are under the threat of DDT and other insecticides, while withdrawal of river water due to dam construction is dangerous for aquatic life and consequently to aquatic birds. Historically bred also in Central Europe till 1600s, waldrapp has declined to the brink of extinction. Untill recently, two genetically distinct populations at its extreme margins of the former range: in Morocco and Birecik in Turkey were known (Pegoraro *et al*., 2001). Turkish population of waldrapp numbered 1000 pairs in 1911, which declined to 530 pairs in 1953 but increased slightly to 600-800 pairs in 1954. In 1967 only 50 pairs nested, in 1970 36 pairs, in 1972 only 26 pairs, and the total population of the colony had declined to some 60 birds that year. In 2002, however a

Table - 4: Rare birds encountered in the study area

Latin name	English name	Threat level			National scale	
		IUCN	BERN		Category	Protection (Annex I)
			Annex II	Annex III		
Aythya nyroca	Ferruginous Duck	NT		+	A.4	+
Circus macrourus	Pallid Harrier	NT		+	A.3	+
Crex crex	Corncrake	NT	+		A.4	+
Emberiza cineracea	Cinereous Bunting	NT	+		-	+
Falco cherrug	Saker Falcon	EN	+		A.1.2	+
Falco naumanni	Lesser Kestrel	VU	+		A.3	+
Otis tarda	Great Bustard	VU	+		A.1.2	+
Phalacrocorax pygmeus	Pygmy Cormorant	NT	+		A.3	+
Vanellus gregarius	Sociable Lapwing	CR		+	A.3 »	+

small population was discovered at Palmyra in Syria, where the species was assumed extinct since 1916 (Serra *et al.*, 2003).

On the other hand, some rare species of Western Palearctic are breeders or passage migrants in or around the wetlands. These include *Gyps fulvus, Circaetus gallicus, Hieraaetus fasciatus* (bred in Halfeti)*, Aquila nipalensis, Falco concolor, F. cherrug, F. pelegrinoides, Ammoperdix griseogularis, Francolinus francolinus* (recorded from Karkamis)*, Burhinus oedicnemus, Cursorius cursor, Charadrius leschenaultii, Vanellus spinosus, V. gregarious, V. leucura, Larus genei, L. armenicus, Pterocles orientalis, P. alchata, Bubo bubo, Otus brucei, Phalaropus lobatus, Porphyrio porphyrio seistanicus, Crex crex, Otis tarda, Apus affinis, Halcyon smyrnensis* (recorded from Karkamis)*, Ceryle rudis, Merops persicus, Ammomanes deserti, Oenanthe pleschanka, O. finschii, O. xanthoprymma, Turdoides altirostris*, *Hippolais languida, Sylvia mystacea, Sitta tephronota, Lanius isabellinus, Passer moabiticus, Carpospiza brachydactyla, Gymnoris xanthocollis, Emberiza cineracea semenowi* and *E. buchanani.*

Pandion haliaetus, Circaetus gallicus, Hieraetus fasciatus, Francolinus francolinus, Porphyrio porphyrio, Bubo bubo, Strix aluco, Ceryle rudis, Halcyon smyrnensis are species occurring in the area and listed in A.1.2 rarity category in the National Red Book. According to a recent assessment (Kilic and Eken, 2004), this number has gone up to 18 species. Among these, *Hieraetus fasciatus* should be considered as the most endangered as one of the two breeding sites in Turkey, Rumkale, is threatened by Birecik dam and the survival of the species is therefore doubtful. Turkey holds greatest part of the world population of *Emberiza cineracea*, categorized as near threatened in IUCN. Currently the species is not under threat and it is legally protected. However, this is not the case for many wetland species experiencing general declines due to habitat destruction. Mainly acting as wintering grounds for such species, changes related to construction of dams will certainly affect their populations.

The study area forms the northern distributional boundary for many eremophilous species in Western Palearctic region, housing several isolated minor breeding populations of species like, *Ammomanes deserti, Otus brucei, Apus affinis,* and most recently recorded *Turdoides altirostris*. There are also a number of recently recorded vagrants from the middle east like *Oenanthe deserti* (Roselaar, 1995), *Pterocles senegallus* (Kirwan, 2000), *Oena capensis* (Balmer and Betton, 2005) found here and *Cercomela melanura* (Cofta *et al.*, 2005) has been recorded from Diyarbakir as well. These findings can be evaluated as a sign of global climatic change in the region.

Amphibian diversity, as expected, is moderate with 5 species. Presence of *Ommatotriton vittatus* (banded newt) is of zoogeographical importance. On the other hand, reptiles are represented by high number of species; a characteristic of eremial vertebrate faunas; and the prominence of Syroeremic elements are clearly seen. 18 lizard species are present in the area with the highest number of gecko species and the only known distributions of *Eublepharis angramainyu, Asaccus elisae*, and *Acanthodactylus boskianus euphraticus* in Turkey. Other species of zoogeographical importance are *Cyrtopodion scabrum*, *Varanus griseus griseus*, *Blanus strauchi aporus,* endemic *Apathya cappadocica muhtari* and recently recorded *Mesalina brevirostris* (Gocmen *et al.*, 2002; Kumlutas *et al.*, 2002; Ilgaz *et al.*, 2005; Yildiz *et al.*, 2007; Ugurtas *et al.*, 2007; Yildiz *et al.*, 2009). *Acanthodactylus harranensis*, recently described from Harran to the east of the area, is one of the most endangered lizards of Turkey (Baran *et al.,* 2006). Twenty snakes species are present in the study area, and from these *Letheobia episcopus* is exclusively endemic to the study area (Franzen and Wallach, 2002). Other species of zoogeographical importance, most having their northernmost limits within the area

Table - 5: Rare reptiles encountered in the study area and its environs

Latin name	Occurrence	Threat status (IUCN)
Acanthodactylus harranensis	Harran	CR
Eublepharis angramainyu	Birecik	DD
Letheobia episcopus	Halfeti	DD

Table - 6: Threatened endemic fishes of Euphrates system in Turkey

Family	Scientific name	Distribution	IUCN status
Balitoridae	*Cobitis elazigensis*	Euphrates system	VU
	Barbatula euphraticus	Euphrates basin	LC
	Turcinoemacheilus kosswigi	Tigris and Euphrates systems	DD
Cyprinidae	*Kosswigobarbus kosswigi*	Tigris-Euphrates basin	LC

are: *Leptotyphlops macrorhynchus, Eryx jaculus jaculus, Platyceps ventromaculatus, Pseudocyclophis persicus*, *Rhynchocalamus melanocephalus satunini, Spalerosophis diadema cliffordi*. Among these, there are also 2 venomous species of medicinal importance, *Walterinnesia morgani* and *Macrovipera lebetina euphratica* (Gocmen *et al*., 2009). Recent reports on previously unrecorded species of lizards and snakes, namely *M. brevirostris, E. angramainyu, W. morgani*, and *T. nigriceps*, and on range extensions can be interpreted as signs of a combination of climate change, aridification, and corridor effect of highways. It is notable that, in their marginal distributions, many eremial species are somewhat sporadic and rare as their habitats are generally enclosed by extensive agricultural lands. Moreover, some corpulent species like *Spalerosophis diadema cliffordi* and *Varanus griseus griseus* often fall victim to misconceptions. Among the 4 turtle and tortoise species, *Rafetus euphraticus* (Euphrates softshell turtle) is a globally threatened species indigenous to Euphrates and Tigris rivers. It is currently listed as endangered and considered to be among most affected species from ongoing dam construction projects (Taskavak and Atatur, 1998). It is said to be abundant once by local people, but is scarce nowadays around Birecik. Loss of shallow water habitats and decrease in water temperatures in reservoirs are major threats for the species. Gloablly threatened reptile species encountered in and around the study area and their risk categories (excluding least concern and near threatened) are presented in Table 5.

Tigris-Euphrates system is an endemism center for fishes (Heller, 2007). In Tigris-Euphrates basin of Turkey, 46 fish species and subspecies are found. These belong to 10 families. Many are non-migratory species, but land-locked anadromous and catadromous taxa due to numerous dams in Syria and Iraq are also present. Nearly half of over 30 fish species present in the Euphrates river (Kuru, 1996, 2004) are economically important. *Chalchalburnus mossulensis*, *Capoeta trutta*, *C. capoeta umbla, Barbus subquincunciatus*, *Carasobarbus luteus*, *Cyprinus carpio, Chondostoma regium*, *Liza abu, Tor grypus*, *Silurus triostegus, Luciobarbus mystaceus*, and *Aspius vorax* are the most caught fish species in Ataturk dam lake (Karakas, 2005). *Leuciscus lepidus, L. cephalus orientalis, Barbus xanthopterus, B. lacerta* were also recorded in the reservoir. Although rare, fairly large individuals (2.4 m) of *Barbus esocinus* have been caught in Birecik. Smaller lotic species *Acanthobrama marmid*, *Cyprinion kais*, *Cyprinion macrostomus*, *Garra variabilis, G. rufa*, *Cobitis elazigensis, Mystus pelusius,* and *Mastacembelus mastacembelus* are other common fish species in Euphrates (Coad, 1991). Fish fauna resembles to that of upper Euphrates and Tigris rivers (Kuru, 1996), with lack of species migrating montane streams for breeding.

With water potential about one third to that of Marmara sea, fisheries potential of Southeastern Anatolia project area is assumed to be remarkably high (22000 tons yr^{-1}). Annual yield of 21.29-65.08 kg ha^{-1} from Bozova region of Ataturk dam lake, biggest reservoir in GAP region, is relatively low and the situation is similar in other dam reservoirs (Karakas, 2005). Current problems of productivity are considered related more to reduction of fish stocks than environmental changes (Unlu, 2000). Reservoirs are complex and dynamic ecosystems, differing from rivers primarily by presence of thermal stratification and changes in water quality parameters and sedimentation. But it is known that fewer species will occur in reservoirs than in rivers due to loss of habitat diversity and homogenization. The loss of spawning grounds is the main reason mainly for proportional decrease of lotic species such as *Barbus subquincuncinatus* and *Tor grypus*, which have high oxygen requirement and need clean shallow gravel beds. The lentic species like *Aspius vorax* and *Silurus triostegus* are expected to decrease due to loss of aquatic vegetation. Other long-term effects, such as splitting of populations with dams and fluctuations in water levels and nutritive composition, will also affect populations negatively. A '5 phase process' of succession of dam lakes and their fish fauna after the impoundment should be surveyed carefully (Unlu, 2000). Pollution is a problem of concern in the Tigris river but it may also start building up in the Euphrates due to emerging industrialization.

Exotic and transplanted fishes endanger local populations in the region due to competition, predatory habits, transmission of diseases and parasites, habitat destruction, aggressive behaviors, genetic swamping, and venomous capability (Coad, 1991). Fewer exotic taxa were recorded from Turkish section of Tigris-Euphrates system. The introductions may either be accidental or purposeful (for fish farming as controlling agents). *Cyprinus carpio* (carp) is the most transplanted fish species in dam systems in Turkey. It is known to compete with native *Barbus* species, being highly tolerant to environmental changes, fluctuations in salinity, decreased levels of oxygen due to increased BOD, and increased temperature. Escaped fries of various alien exotic species have also been recorded in Iraqi sector of the Euphrates (Coad, 1996). *Heteropneustes fossilis* (introduced for eradication of *Bulinus truncatus*) and *Gambusia holbrooki* (introduced for controlling mosquitos) are now established and widespread in the neighbouring countries. *Pseudorasbora parva* (a byproduct of fish stocking studies) and

Pterygoplichthys disjunctivus (common species of aquaria introduced recently into Asi river) are accidentally introduced fish taxa near the study area (Coad, 1991, 1996; Yalcin-Ozdilek, 2007). Competition with present and future introduced taxa may be an important risk for populations of native species.

Invertebrate fauna of the area, yet mostly unknown except for some groups of Arthropoda and Mollusca, is unique in particular for Turkey in having close ties with the fauna of Syrian plateau. An example is the land snail fauna, recognized by presence of species like *Calaxis hierosolymarum* and *Cecilioides minuta* which are largely restricted to Birecik or Urfa in Turkey. Although close to Syrian border, interestingly, unneglectable amount (4 out of 23) of this relatively poor fauna are endemics: *Orculella mesopotamica mesopotamica, Pene kotschyi naegelei, P. sidoniensis edessanus* and *Pseudochondrula arctespira* (Schutt, 2005).

Aquatic molluscs are quite responsive to major habitat changes like damming and they are among the key groups to monitor the environmental effects of dams. In lower Euphrates, 6 gastropods and 3 bivalves are present (Unlu, 2000). Among aquatic gastropods, ubiquitous *Galba truncatula* is parasitologically important. *Dreissena polymorpha* (zebra mussel), a species known to cause fouling problems in dam systems, has already become a noxious species in Birecik and Karkamis dams since 2000 (Bobat *et al.*, 2004). *Dreissena siouffi,* an endemic species of Euphrates river has also been found in Birecik dam area near Halfeti (Ekin *et al.*, 2008).

Spiders (Araneae), most specious group of Arachnida, are only partially known in the area. In a faunistic study carried out in Nizip and Karkamis, a total of 56 species belonging to 29 genera and 7 families have been reported (Ozdemir *et al.*, 2006). The most common families are Lycosidae and Gnaphosidae, mainly including ground-active spiders. Scorpions (Scorpionida) are common in the area reflected with highest species density (with 7 species) in Turkey. The species list includes *Scorpio maurus fuscus*, *Androctonus crassicauda*, *Compsobuthus matthiesseni*, *Mesobuthus nigrocinctus Mesobuthus eupeus,* along with newly discovered endemics *Leiurus abdullahbayrami* and *Calchas birulai* (Karatas and Colak, 2005; Fet *et al.*, 2009; Yagmur *et al.*, 2008; Yagmur *et al.*, 2009).

Only some orders of insects have been studied in detail in the study area. 86 species and subspecies from Orthoptera, belonging to 50 genera and 7 families have been reported from Sanliurfa province and the research area (Sevgili and Ciplak, 2000). From Neuroptera following species of mainly Irano-eremial character have been reported from the study area: *Dielocroce baudii, Dielocroce ephemera, Dielocroce modesta, Nemoptera sinuata, Lertha ledereri, Lertha extensa, Lertha palmonii, Lertha schmidti, Lertha schmidti* (Dobosz and Abraham, 2009). *Gegenes nostrodamus, Euchloe belemia, Gonepteryx cleopatra taurica, Danaus chrysippus, Melanargia titea standfussi, Pseudochazara thelephassa,Tomares callimachus, Zerynthia deyrollei, Cigaritis acamas, Zizeeria karsandra* and endemic *Melanargia grumi* are among 38 Lepidopteran species determined from the study area. Generally insect fauna is characterized by Syrio-eremial and Irano-eremial elements. But, as in Orthoptera, some inclusion of Anatolian endemites and Mediterranean taxa can be seen. Entomofauna is expected to change significantly with more additions of hydrocole species replacing with local xerocole elements (Akkaya, 1997).

Land degradation: The Euphrates has witnessed many civilizations, as a trade route and a barrier at the same time it played an important role in the history of Mesopotamia. Rich raw material and biological resources of Taurus mountains and flood plains along Upper Euphrates provided development of Paleolithic cultures in an independent manner. First human settlements in Birecik area could be traced to Epi-Paleolithic age (Kartal, 2003). The role of northern part of Fertile Crescent in the Neolithization process, as a nuclear zone, has become neglected based on the findings from Proto-Neolithic sites in Southern Levant indicating that food producing

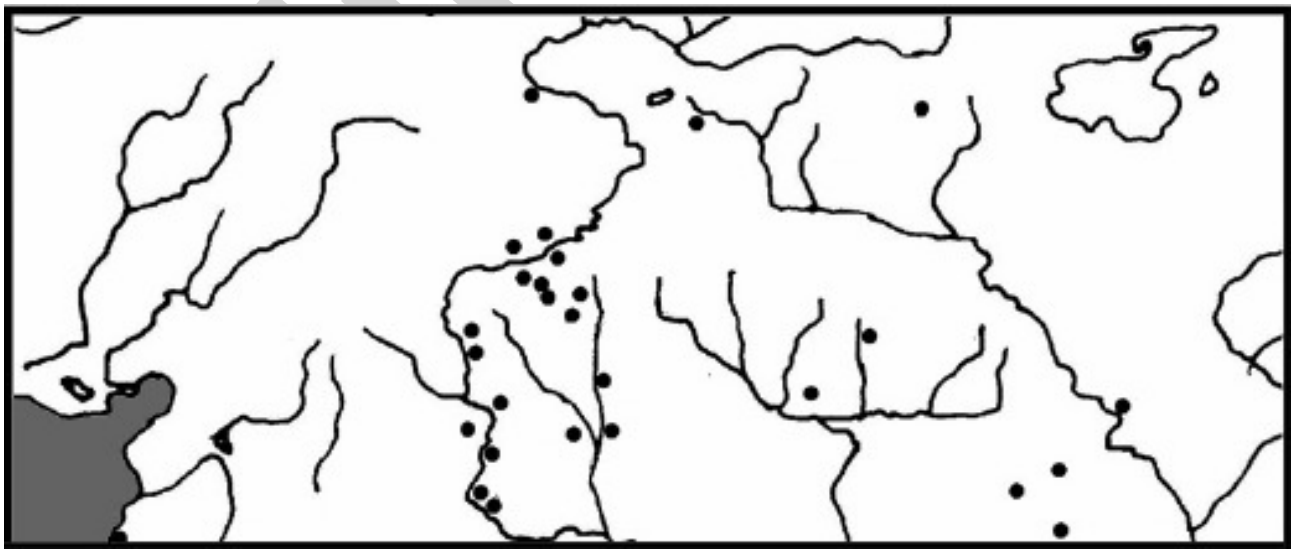

Fig. 2: Neolithic sites (full circles) in Northern Mesopotamia

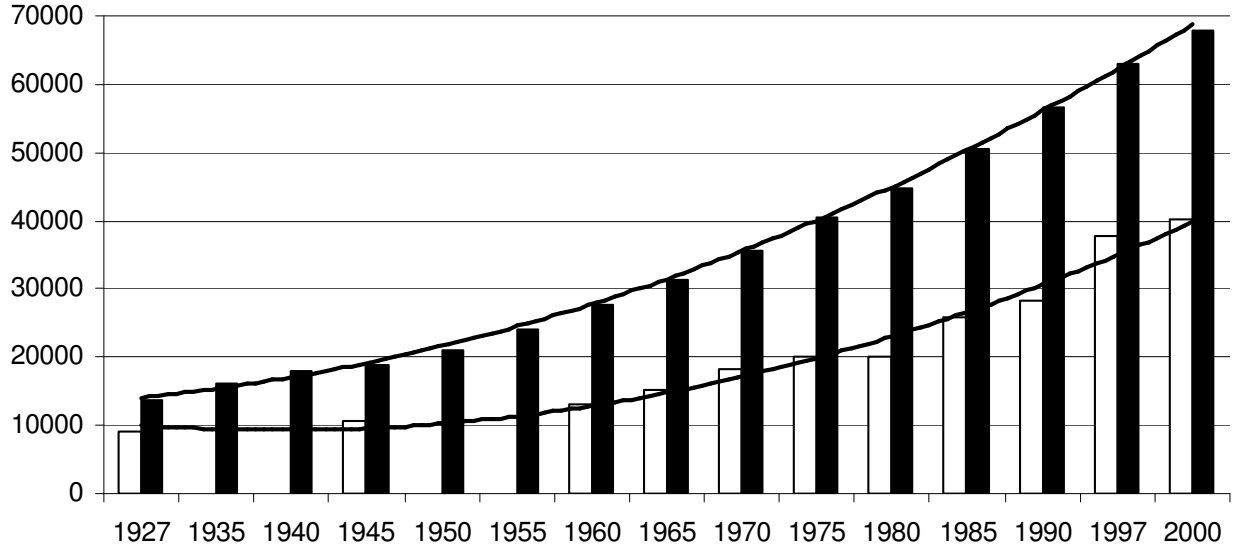

Fig. 3: Demographic developments in Birecik (1927-2000) (white columns) and Turkey (X 1000 black columns)

began in this region and spread later (around 9.500 BP) to Syria and Southeastern Anatolia. However, recent findings on early domestication from Anatolia and Iran show that simultaneous developments took place in northern areas. In addition, demography has changed with the beginning of aridification process and Euphrates region gained importance due to shifting of populations northwards. The concentration of Neolithic settlements along the Euphrates (Fig. 2), yet most still not studied in detail, support this argument.

During Chalcolithic and Bronze Ages, relative importance increased due to need for control over the ore transportation routes and trade route to Egypt. In 1600 BC, the area was conquered by Hittites who established cities like Hahhum (later capital of Commagene as Samosata, drowned under Ataturk dam in 1989), Birthe (Birecik) and Carchemish (Karkamis). After 840 BC, Assyrians ruled the area and during this period Birecik castle and Rumkale were established. Following shorter periods under rules of various empires, Roman Empire conquered the area and established a series of cities along Euphrates. Among these, Zeugma brought worldwide interest after activation of Birecik dam project by 1996. The city is situated at one of the two places providing shortest distances to cross Euphrates, which thus may also correspond to biblical Thapsacus (Comfort *et al.*, 2000). It was established as Seleuceia Euphrates together with Apamea on the opposite (eastern) bank of the river in 300 BC by a general of Alexander the Great. After conquered by Roman Empire in 31 BC, the city owned a high status as a frontier city trading with Persia, a crossing point on the Silk Road, and the base of Legio IV Scythica. Soon after reaching its golden age around 200 AD, with a population of approximately 80000, city was destroyed eternally by a Sasanid invasion in ca. 252 AD leaving only ruins of the polis (Basgelen, 2005). Thenafter, city never recovered back and was named as "the second Pompei" by some. Naming of the ruin area after Belkis (Queen of Sheba) under Turkish occupancy is reportedly due to direct linkage to legendary ruins of prosperous Sheba.

Demography has largely been shaped by the role of the Euphrates in trade, as can be exemplified by the case of Birecik. Established at an ideal location presenting small scale transporting opportunity with boats, the city became populated with the trade between Northerm Syria and Mesopotamia. After the control gained over by Ottoman Empire in 16th century, economical developments crowned by a shipyard for military and commercial ships led to a population increase from 2800 to 3850 (1536-1570). Commercial buoyancy continued till 19th century when the role was taken over by the railway passing south to town and as middle Eastern countries became independent states by World War I it faded for a long time.

The town regained its importance with the establishment of Birecik bridge, longest bridge of Turkey at its time, completed in 1956 with the awakening of land transport. Population of the town increased accordingly during 1960-1985 by almost 100%. Lack of property, unemployment, and other problems resulted in a significant immigration in Sanliurfa province during 80s' (Aksit *et al.*, 1996), which has got reversed by 1995. However, a moderate population growth in Birecik town since the initialization of GAP can be observed (Fig. 3) (Akis and Akkus, 2003). Approximately 76000 people were influenced by the Ataturk and Birecik dams, but demographic profile did not change as movement to close areas was involved in general.

Agricultural lands cover most of the surface area, 71.6% in Birecik district, and currently agriculture is the base of economy. Mainly cereals are grown by dry farming outside the valley, along with olive, pistachio and legumes in certain areas, to which cotton, corn, sunflower, hemp and vegetables can be added in irrigated fields along Euphrates.

Unreliable flow of Euphrates has always been a serious issue of flood protection and irrigation. From the time of Sumerians and Babylonians, canal network systems have been used and intensified in Euphrates basin till the Mongol invasions in 13th century, which largely impaired irrigated faming (Altinbilek, 2002). In Ottoman period there have been attempts to initiate the agriculture in the region. After the breakup of the empire, transboundary basins corresponding to 90% of the water resources in the region were formed. Independent policies involving water storage were followed on these basins especially after the expansion of irrigation by mid-1960s'. Although 92% of the water in the Euphrates originates in Turkey, with a share of only 28% of the basin, Turkey was the last country to initialize dam projects to satisfy increasing needs for hydropower and irrigation water. Construction of 14 dams (6 in operation) in the Euphrates basin will have a surface area of 125.175 ha in total (Demir, 2003). Transformation to irrigated farming in an area equal to 20% of total irrigable land of Turkey is the main goal of megaproject GAP (Altinbilek 2002). Established expansion of irrigated lands in the GAP area from 2.9 to 22.8% will dramatically improve the agricultural productivity in the region by 4.5 times and cultivation of irrigated crops, by 983% for cotton and 556% for tomato (Karadogan and Atasoy, 2010).

Land degradation is a natural consequence of irrigated systems, bringing about increased erosion and relevant problems. Despite lack of effective surface flow outside the Euphrates valley, erosion has already been a significant problem resulting in the irreversible loss of top soil, filling of the dams and damaging of other structures (Darama *et al*., 2004). Soil degradation is one of the most serious problems related to agriculture in GAP region (Ozturk *et al*., 2004). In irrigated areas, due to excessive surface flooding, sediment transport and soil erosion increased to critical levels (Darama *et al*., 2004): 74.3% of the area is facing moderate to intensive soil erosion, while in 54% bedrock exposure is observed (Sahan *et al*., 2001). In our study area, erosion problem is common occurring in 97.5% of Birecik district and 86.8 of Halfeti district (Anonymous, 2007). New developments in the area necessitates erosion control to sustain agricultural productivity, biodiversity, and to prolong the lifetime of irrigation systems. A lack of vegetation cover in the area is an important factor in soil erosion problem. Phanerophytic vegetation is scantily found throughout the area and natural vegetation cover is largely cleared. Ground covering plant species from such genera as *Capparis, Acantholimon, Astragalus, Euphorbia* and *Onobrychis* (Yilmaz *et al*., 2002), can be used for biorestoration and soil erosion control. Tree species, like carob *Ceratonia siliqua* and oaks *Quercus* spp, can be suggested for high terraces and hills. Pasture lands are among the most sensitive areas to water erosion. Due to overgrazing and insufficient vegetation cover, 95.6% of pasture lands covering ca. 10% of the region is considered at risk (Cevheri and Polat, 2009). The Poaceae members in pasture lands, like species of *Bromus, Aegilops, Koeleria, Poa, Stipa* and *Festuca,* are crucially important for erosion control as they densely cover the ground and protect soil with their diffuse root systems (Kaya, 1999).

In the recent years, various concerns over the conservation of agroecosystems of Mediterranean and middle East regions have been presented. Effect of the grazing and afforestation in particular are questioned. Due to limited resources, a humbacked relationship between species richness and patchily distributed primary production in Mediterranean grazing land vegetation has been shown (Alhamad, 2006). Furthermore, resilience against grazing is seen in native flora. Thus, under the circumstances of high degradation by overgrazing, a mosaic model for conservation planning involving biorestoration, grazing rotation and complete protection can be suggested to sustain spatial heterogeneity (Alrababah *et al*., 2007).

Afforestation is traditionally addressed as the method to prevent the deterioration of ecosystems and land degradation (Ozturk, 1995). However, this option is not practical in semi-arid eroded lands due to insufficient water content and nutrition for the seedlings. Secondarily, due to factors involving allelopathy and shading, afforestation is likely to decrease herbaceous plant diversity (Ozturk *et al*., 2007).

Salinization, sodicity and waterlogging, occurring already in Harran plain near study area (Kendirli *et al*., 2005), are the other irrigation related problems. Salinity, led often in irrigated areas of semiarid climates by the combination of high evaporation rates and improper drainage systems, is an important problem affecting not only the yield but also soil, surface and ground water quality (Feng *et al*., 2003). According to recent studies, the salinity problem existed even before the irrigation scheme in GAP area, but it has been intensified since then (Ozer and Demirel, 2004).

The GAP area is situated within mega-diversity area of food, pasture, and medicinal species. Habitat degradation due to agricultural activities and microclimatic effects of implemented dams on most eremial plant taxa, including old cultivars, wild ancestors and relatives of modern crops, can be expected. Competition with new crops and increasing number of introduced taxa will also threaten the genetic diversity, an important key to future improvement researches. Heavy use of pesticides on cotton and other irrigated crops is already an important problem in the GAP region. It is necessary to utilize water-saving technologies, adequate drainage systems with mole drains in suitable places, and grow salt-tolerant crops (Kendirli et al. 2005). Climatic changes in the GAP area have also been observed, with increase in winter temperatures due to reservoirs. As the root of economical growth, sustaining of biological resources should be considered a priority.

Only recently, studies regarding biodiversity and its conservative importance in GAP area have been initiated and two key biodiversity areas (KBAs) covering almost whole study area were established (Welch, 2004; Eken et al. 2006). However, 2.3 ha reserved as natural site for Euphrates poplar stand in Birecik and Birecik Waldrapp Breeding Station 3 km north of Birecik are currently the only official nature protection areas. In view of changing environmental conditions and still insufficient data for many

taxonomic groups, further detailed studies are needed to understand biodiversity and changes affecting it.

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