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LAND DEGRADATION AND HALOPHYTIC PLANT DIVERSITY OF MILLEYHA WETLAND ECOSYSTEM (SAMANDAĞ-HATAY), TURKEY

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Abstract

Investigations were undertaken during 2010-2011 to study effect of human induced land degradation on structure of some halophytic plant communities. Over all 183 taxa of vascular plant were recorded. Out of these 76 were of typical halophytes. The dominant plant taxa were; *Phragmites australis, Halimione portulacoides* and *Bolboschoenus maritimus*. The threatened categories of these taxa were identified from the Red Data Book of Turkey together with their distribution. The impact of degradation on the habitats due to land use for agriculture, organic and inorganic waste disposal and housing for tourisitc purposes were identified and conservation measures were outlined in this study.

Introduction

Aquatic ecosystems are the most productive ecosystems and provide a resource of food and raw materials with a very high economical value to the national and regional economy (Mitsch & Gosselink, 2000; Zahoor *et al.*, 2012). They are important for economical activities such as; fishery, transportation, wildlife, hunting, recreation, bird-watching, surfing, camping besides providing a natural equilibrium (Gallego-Fernandes, 1999; Korkmaz & Gurbuz, 2008). A large number of these were drained in Turkey up to 1960's, because these were regarded as worthless and unnecessary. After mid 1960's their functionality and importance was realized and it was understood that these areas are important for the local cultures and drainage was prohibited in Turkey (Korkmaz, 2008). These fragile ecosystems include different biotopes like; sand-dune, marshes, lakes and rivers. Much work has been carried out on the floristic, phytosociology and pollution aspects of these ecosystems in different regions of Turkey notable among these being; Uslu (1977), Ozturk & Secmen (1986), Kumerloeve (1988), Gehu and Uslu (1989), Uslu and Gehu (1990), Kilinc & Ozen (1990), Secmen & Leblebici (1991, 1996, 1997), Yucel *et al.,* (1995), Karaer *et al.,* (1997), Kilinc & Ozdemir (1998), Cetin *et al.,* (2000), Ozturk & Guvensen (2002), Kavgacı (2007), Sakcali *et al.,* (2009) and Ozturk *et al.,* (1994, 1995, 1996, 2005, 2006, 2010, 2011a).

Some work has been done on the floristics, ecology and biotope mapping of the Milleyha (Samandag-Hatay) aquatic ecosystem (Kayikci, 2006; Gumusboga, 2006; Fidan, 2006), however no work has been undertaken on the halophytes of this area. In view of this present study was undertaken to present the floristic account and ecological features of halophytes distributed in this area. Negative effects of anthropogenic activities in the area were recorded and precautions to be taken discussed.

Materials and Methods

Study area: Milleyha aquatic ecosystem lies within the borders of Asi Delta in East Mediterranean Region. It is 16 km long and 500-600 m wide including second largest sand beache in Turkey situated alongside the Samandağ coastline in Hatay province. The study area was the Milleyha wetland that covers approximately 100 hectar (Fig. 1). The area experiences a typical Mediterranean climate, annual average temperature being 19^{o}C and average annual rainfall about 895.0 mm, most of which falls in winter months (Table 1).

Table 1. Precipitation and temperature values of the study area (Kayikci, 2006).

Months	1	2	3	4	5	6	7	8	9	10	11	12	Yearly
Temperature (^{o}C)	9.9	11.0	13.9	17.6	21.1	24.5	27.1	27.8	26.2	21.7	15.7	11.3	19.0
Precipitation (mm)	137.9	118.6	107.9	63.7	43.2	14.5	7.6	7.0	45.0	101.0	110.4	138.2	895.0

The area and its environs belong to the upper cretaceous ophiolites and miocene formation. The youngest units are alluviums, slope debris, and debris cones from quaternary period (Erol, 1963; Kuscu & Tonbul, 2005). Geomorphologically Milleyha aquatic ecosystem together with the Asi River Delta possess the lowest elevations from its surrounding. The altitude varies from sea level to 10 meter (Korkmaz *et al.,* 2010).

This study was conducted during 2010-2011. The vascular plants collected from the area were identified using Flora of Turkey and the East Aegean Islands (Davis, 1965-1985; Davis *et al.,* 1988; Güner *et al.,* 2000). The plants distributed on saline habitats were listed, and their life forms given according to Raunkiaer (1934). The categories and criteria of rare and endangered species were recorded according to Ekim *et al*., (2000), Yurdakulol (2008) and Ozturk *et al.,* (2011 b). Other ecological features of halophytes feature were recorded following the data published by Ozturk *et al.,* (2006, 2008, 2011 b), Guvensen *et al.,* (2006) and Gucel *et al.,* (2009).

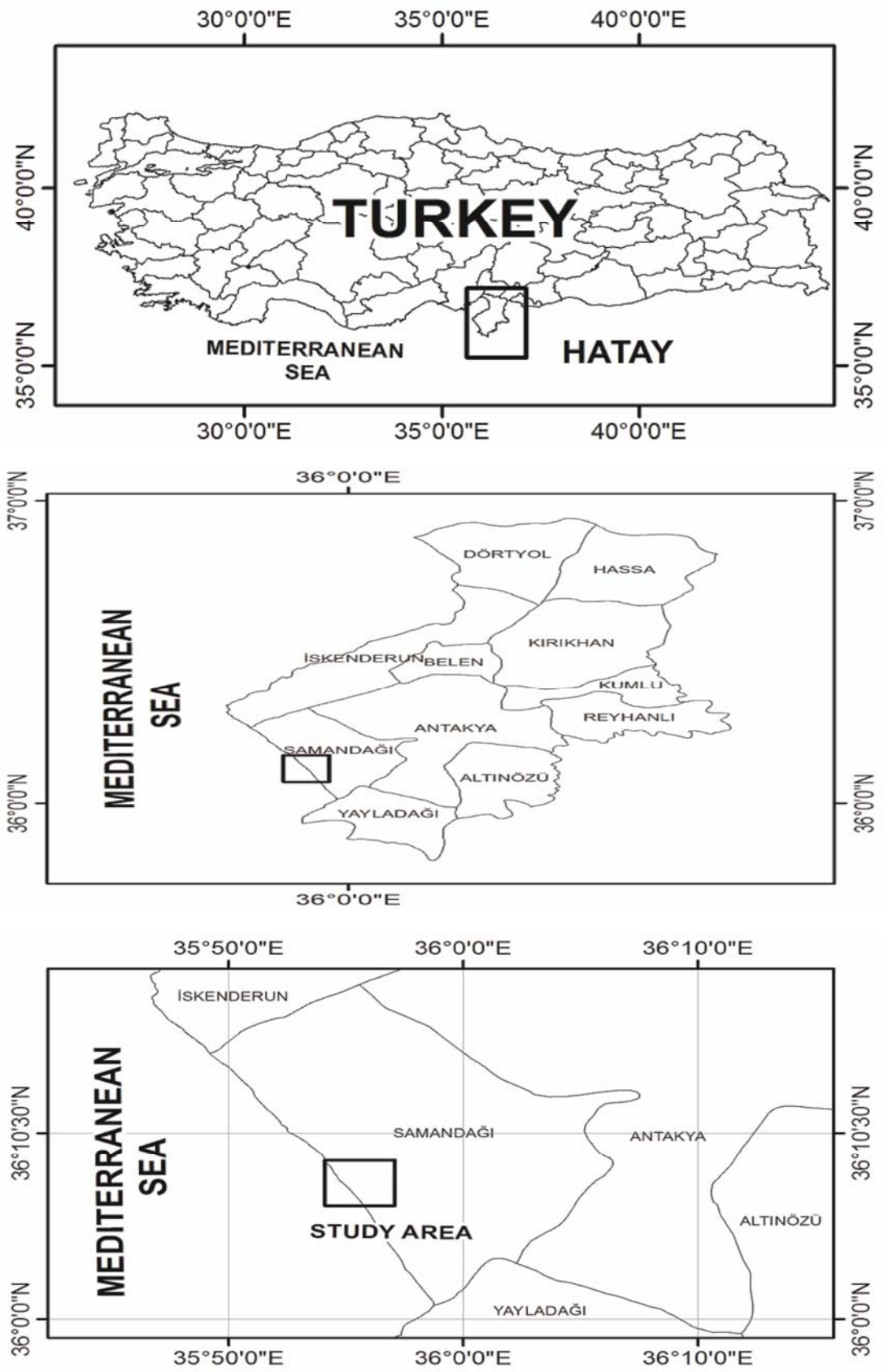

Fig. 1. A map showing location of the study area.

Results

Nearly 4.3 million ha of agricultural land in Turkey are degraded, out of which 1.5 million ha are arid and 2.8 million ha saline-alkaline.The saline areas in Turkey are smaller in size than in neighboring countries like Iran (27,085,000 ha) and Iraq (6,726,000 ha), but larger than in Syria (532,000 ha) and Bulgaria (25,000 ha) (Guvensen *et al.,* 2006). The area of degraded soils in the Mediterranean region of Turkey lies around 635.197 ha and saline soils are 209,510 ha. Some of the factors responsible for the salinity-alkalinity problems are accumulation of salts in plains due to heavy rains, a long standing high water table, and the impact of sea water on the coastal alluvial plains. These areas are the true habitats for halophytic plant communities (Breckle, 1986).

The number of halophytic taxa distributed in the world lies around 3000 (Guvensen *et al.,* 2006). Nearly 700 species are distributed in the Mediterranean climatic zone (Choukr-Allah, 1991; Ozturk & Guvensen, 2002; Ozturk *et al.,* 2011b). Our study area lies in the Mediterranean climatic zone. Very few papers have been published on the halophytes from this area, notable among them being Gehu and Uslu (1989), Yurdakulol and Ercoskun (1990), Guvensen *et al*., (2006), Ozturk *et al.,* (2006, 2008).

A total of 183 taxa (49 monocotyledons and 134 dicotyledons) belonging to 48 families and 136 genera were identified from the area. These are given in Table 2.

Table 2. The diversity of vascular plant taxa in the Milleyha wetland area.

No.	Family	Taxa
1.	Amaranthaceae	*Amaranthus retroflexus* L.
2.	Amaryllıdaceae	*Narcissus tazetta* L. ssp. *tazetta*
3.		*Pancratium maritimum* L.
4.	Apıaceae	*Crithmum maritimum* L.
5.		*Eryngium maritimum* L.
6.		*Falcaria vulgaris* Bernh.
7.		*Scandix pecten-veneris* L.
8.		*Torilis nodosa* (L.) Gaertner
9.	Apocynaceae	*Nerium oleander* L.
10.	Araceae	*Arisarum vulgare* Targ.-Tozz. ssp. *vulgare*
11.		*Arum dioscoridis* Sm.
12.	Asteraceae	*Anthemis cotula* L.
13.		*Anthemis palestina* Reuter
14.		*Calendula arvensis* L.
15.		*Cichorium intybus* L.
16.		*Conyza bonariensis* (L.) Cronquist
17.		*Conyza canadensis* (L.) Cronquist
18.		*Crepis foetida* L. ssp. *rhoeadifolia* (Bieb.) Celak.
19.		*Crepis sancta* (L.) Babcock
20.		*Echinops viscosus* DC. ssp. *bithnicus* (Boiss.) Rech.
21.		*Filago pyramidata* L.
22.		*Inula crithmoides* L.
23.		*Inula viscosa* (L.) Aiton
24.		*Leucanthemum myconis* (L.) Giraud
25.		*Otanhus maritimus* (L.) Hoffmans et Link.
26.		*Reichardia picroides* (L.) Roth
27.		*Scolymus hispanicus* L.
28.		*Senecio vernalis* Waldst. et Kit.
29.		*Tragopogon longirostris* Bisch. ex Schultz Bip. var. *longirostris*
30.		*Urospermum picroides* (L.) F. W. Schmidt
31.		*Xanthium strumarium* L. ssp. *cavanillesii* (Schouw) D. Löve et P. Dansereau
32.	Boragınaceae	*Anchusa aggregata* Lehm.
33.		*Echium angustifolium* Miller
34.		*Echium glomeratum* Poiret
35.		*Heliotropium hirsutissimum* Grauer

Table 2. (Cont'd.).

36.		*Nonea obtusifolia* (Willd.) DC.
37.	Brassıcaceae	*Cakile maritima* Scop.
38.		*Cardaria draba* (L.) Desv. ssp. *draba*
39.		*Diplotaxis erucoides* (L.) DC.
40.		*Maresia nana* (DC.) Batt.
41.		*Raphanus raphanistrum* L.
42.		*Sinapis alba* L.
43.	Cactaceae	*Opuntia ficus-indicata* (L.) Miller
44.	Campanulaceae	*Legousia falcata* (Ten.) Fritsch
45.	Caryophyllaceae	*Agrostemma githago* L.
46.		*Polycarpon tetraphyllum* (L.) L.
47.		*Silene aegyptiaca* (L.) L. fil. ssp. *aegyptiaca*
48.		*Silene colorata* Poiret.
49.		*Silene vulgaris* (Moench) Garcke. var. *vulgaris*
50.		*Spergularia marina* (L.) Gris.
51.	Chenopodıaceae	*Arthrocnemum macrostachyum* (Moric.) K.Koch
52.		*Halimione portulacoides* (L.) Aellen
53.		*Salicornia palasiana* Yaprak & Yurdakulol ssp. *palasiana*
54.		*Salsola kali* L.
55.		*Salsola soda* L.
56.	Cucurbıtaceae	*Ecbalium elaterium* (L.) A. Rich.
57.	Cuscutaceae	*Cuscuta campestris* Yuncker
58.	Convolvulaceae	*Convolvulus arvensis* L.
59.		*Cressa cretica* L.
60.		*Ipomoea stolonifera* (Cry.) J. F. Gmelin
61.	Cyperaceae	*Bolboschoenus maritimus* (L.) Palla var. *maritimus*
62.		*Carex divisa* Hudson
63.		*Cyperus capitatus* Vandelli
64.		*Cyperus rotundus* L.
65.		*Schoenus nigricans* L.
66.	Euphorbıaceae	*Euphorbia falcata* L. ssp. *falcata*
67.		*Euphorbia helioscopia* L.
68.		*Euphorbia paralias* L.
69.		*Euphorbia peplis* L.
70.		*Euphorbia peplus* L. var. *minima* DC.
71.		*Euphorbia terracina* L.
72.		*Mercularis annua* L.
73.	Fabaceae	*Acacia karroo* Hayne
74.		*Alhagi mannifera* Desv.
75.		*Glycyrrhiza echinata* L.
76.		*Glycyrrhiza glabra* L. var. *glandulifera* (Waldst. et Kit.) Boiss.
77.		*Hymenocarpus circinnatus* (L.) Savi.
78.		*Lathyrus annuus* L.
79.		*Lathyrus aphaca* L. var. *modestus* P.H. Davis
80.		*Lathyrus gorgoni* Parl. var. *gorgoni*
81.		*Lotus corniculatus* L. var. *tenuifolius* L.
82.		*Medicago intertexta* (L.) Miller. var. *ciliaris* (L.) Heyn
83.		*Medicago littoralis* Rohde ex Lois. var. *littoralis*
84.		*Medicago marina* L.

Table 2. (Cont'd.).

85.		*Melilotus alba* Desr.
86.		*Melilotus indica* (L.) All.
87.		*Melilotus messanensis* (L.) All.
88.		*Onobrychis caput-galli* (L.) Lam.
89.		*Ononis mitissima* L.
90.		*Scorpiurus muricatus* L. var. *subvillosus* (L.) Fiori
91.		*Trifolium angustifolium* L. var. *intermedium* (Guss) Gib. et Belli.
92.		*Trifolium campestre* Schreb.
93.		*Trifolium lappeceum* L.
94.		*Trifolium spumosum* L.
95.		*Vicia lutea* L. var. *hirta* (Balbis) Lois.
96.		*Vicia narbonensis* L. var. *serratifolia* (Jacq.) Ser.
97.		*Vicia sativa* L. ssp. *incisa* (Bieb.) Arc. var. *cordata* (Wulfen ex Hoppe) Arc.
98.	Gentıanaceae	*Blackstonia perfoliata* (L.) Hudson ssp. *perfoliata*
99.		*Centaurium erythraea* Rafn ssp. *erythraea*
100.	Geranıaceae	*Erodium malacoides* (L.) L'herit.
101.		*Geranium dissectum* L.
102.		*Geranium molle* L. ssp. *molle*
103.		*Geranium rotundifolium* L.
104.		*Geraniumtuberosum* L. ssp. *tuberosum*
105.	Illecebraceae	*Paronychia argentea* Lam. var. *scariosissima* Post.
106.	Irıdaceae	*Gladiolus italicus* Miller
107.		*Gynandiris sisyrinchium* (L.) Parl
108.		*Romulea ramiflora* Ten. ssp. *ramiflora*
109.	Juncaceae	*Juncus littoralis* C. A. Meyer
110.		*Juncus rigidus* Desf.
111.	Lamıaceae	*Lamium amplexicaule* L.
112.		*Salvia viridis* L.
113.	Lemnaceae	*Lemna gibba* L.
114.	Lılıaceae	*Allium ampeloprasum* L.
115.		*Allium neapolitanum* Cyr.
116.		*Allium porrum* L.
117.		*Bellevallia trifoliata* (Ten.) Kunth
118.		*Muscari comosum* (L.) Miller
119.		*Muscari parviflorum* Desf.
120.		*Ornithogallum umbellatum* L.
121.		*Urginea maritima* (L.) Baker
122.	Lınaceae	*Linum bienne* Miller.
123.	Lythraceae	*Lythrum hyssopifolia* L.
124.	Malvaceae	*Lavatera cretica* L.
125.		*Malva parviflora* L.
126.	Orobanchaceae	*Orobanche minor* Sm.
127.		*Orobanche nana* Noe ex G. Beck
128.	Oxalıdaceae	*Oxalis corniculata* L.
129.		*Oxalis pes-caprae* L.
130.	Papaveraceae	*Fumaria capreolata* L.
131.		*Fumaria densiflora* DC.
132.		*Papaver syriacum* Boiss.
133.	Plantagınaceae	*Plantago coronopus* L. ssp. *commutata* (Guss.) Pilger

Table 2. (Cont'd.).

134.		*Plantago lagopus* L.
135.		*Plantago maritima* L.
136.		*Plantago scabra* Moench
137.	Plumbagınaceae	*Limonium angustifolium* (Tausch) Turrill
138.	Poaceae	*Aegilops triuncialis* L. ssp. *triuncialis*
139.		*Aeluropus littoralis* (Gouan) Parl.
140.		*Alopecurus myosuroides* Hudson var. *tonsus* (Blanche ex Boiss) R. Mill
141.		*Arundo donax* L.
142.		*Avena barbata* Pott ex Link ssp. *barbata*
143.		*Catapodium marinum* (L.) C. E. Hubbard
144.		*Catapodium rigidum* (L.) C. E. Hubbard ex Dony ssp. *rigidum* var. *majus* (C. Presl) Lainz
145.		*Cynodon dactylon* (L.) Pers. var. *dactylon*
146.		*Elymus elongatus* (Host) Runemark ssp. *elongatus*
147.		*Elymus farctus* (Viv.) Runemark ex Melderis ssp. *farctus* var. *farctus*
148.		*Hordeum murinum* L. ssp. *glaucum* (Steudel) Tzvelev
149.		*Lagurus ovatus* L.
150.		*Lolium rigidum* Gaudin var. *rigidum*
151.		*Paspalum paspalodes* (Michx.) Scribner.
152.		*Phalaris paradoxa* L.
153.		*Phragmites australis* (Cav.) Trin. ex Steudel
154.		*Polypogon maritimus* Willd. ssp. *maritimus*
155.		*Polypogon monspeliensis* (L.) Desf.
156.		*Polypogon viridis* (Gouan) Breistr.
157.		*Rostraria cristata* (L.) Tzevelev var. *cristata*
158.		*Rostraria cristata* (L.) Tzvelev var. *glabriflora* (Trautv.) M. Doğan
159.		*Saccharum ravennae* (L.) Murray
160.		*Sporobulus virginicus* (L.) Kunth.
161.		*Trachynia distachya* (L.) Link.
162.		*Tragus racemosus* (L.) All.
163.	Polygonaceae	*Polygonum equisetiforme* Sibth & Sm.
164.		*Polygonum maritimum* L.
165.		*Rumex crispus* L.
166.	Portulacaceae	*Portulaca oleracea* L.
167.	Prımulaceae	*Anagallis arvensis* L. var. *arvensis*
168.	Ranunculaceae	*Ranunculus chius* DC.
169.		*Ranunculus marginatus* d'Urv. var. *trachycarpus* (Fisch. et Mey.) Azn.
170.		*Ranunculus sphaerospermus* Boiss. et Balanche
171.	Rosaceae	*Rubus sanctus* Schreber
172.		*Sarcopoterium spinosum* (L.) Spach
173.	Scrophularıaceae	*Verbascum sinuatum* L. var. *adenosepalum* Murb.
174.		*Veronica cymbalaria* Bodard
175.	Solanaceae	*Solanum nigrum* L. ssp. *nigrum*
176.	Tamarıcaceae	*Tamarix smyrnensis* Bunge.
177.	Thymelaeaceae	*Thymelaea hirsuta* (L.) Endl.
178.	Thyphaceae	*Typha domingensis* Pers.
179.	Urtıcaceae	*Urtica urens* L.
180.	Verbenaceae	*Phyla nodiflora* (L.) Greene
181.		*Vitex angus-castus* L.
182.	Zygophyllaceae	*Tribulus terrestris* L.
183.		*Zygophyllum album* L.

The families with highest number of taxa are; Fabaceae (25 taxa-13.26%), Poaceae (25 taxa-13.26%) and Asteraceae (20 taxa-10.92%). These three families constitute 38.24% of total flora in terms of number of taxa. The families together with the number of taxa are; Fabaceae (25), Poaceae (25), Asteraceae (20), Liliaceae (8), Euphorbiaceae (7), Brassicaceae and Caryophyllaceae (6 each), Chenopodiaceae, Geraniaceae, Apiaceae, Boraginaceae, Cyperaceae (5 each), Plantaginaceae (4), Ranunculaceae, Papaveraceae, Polygonaceae, Convolvulaceae, Iridaceae (3 each), Malvaceae, Oxalidaceae, Zygophyllaceae, Rosaceae, Gentianaceae, Scrophulariaceae, Orobanchaceae, Verbenaceae, Lamiaceae, Araceae, Amaryllidaceae, and Juncaceae (2 each), Portulacaceae, Illecebraceae, Amaranthaceae, Tamaricaceae, Linaceae, Lythraceae, Cucurbitaceae, Cactaceae, Campanulaceae, Primulaceae, Apocynaceae, Cuscutaceae, Solanaceae, Plumbaginaceae, Thymelaeaceae, Urticaceae, Lemnaceae, and Thyphaceae (1 each). The dominant genera are *Euphorbia* (6), *Trifolium* (4), *Geranium* (4) and *Plantago* (4).

Out of 183 plant taxa 76 are typical halophytes; 52 (68.42%) being dicots and 24 (31.58 %) monocots (Table 3).

Table 3. Halophytes distributed in the Milleyha Aquatic Ecosystem and their ecological features.

Family	Taxa	Life forms	Ecological types	Choro-types
Amaryllıdaceae	*Pancratium maritimum* L.	C	PH	M
Apıaceae	*Crithmum maritimum* L.	CH	X	IN
	Eryngium maritimum L.	H	PH	IN
Asteraceae	*Crepis foetida* L. ssp. *rhoeadifolia* (Bieb.) Celak.	T	PH	IN
	Crepis sancta (L.) Babcock	T	XH	IN
	Inula viscosa (L.) Aiton	CH	X	M
	Inula crithmoides L.	CH	HG	IN
	Otanthus maritimus (L.) Hoffmans et Link.	CH	PH	M
	Reichardia picroides (L.) Roth	H	X	M
Boragınaceae	*Anchusa aggregata* Lehm.	T	PH	M
	Echium angustifolium Miller	CH	PH	IN
Brassıcaceae	*Cakile maritima* Scop.	T	PH	IN
	Maresia nana (DC.) Batt.	T	PH	IN
	Raphanus raphanistrum L.	T	X	IN
Caryophyllaceae	*Spergularia marina* (L.) Gris.	T	XH	CM
Chenopodıaceae	*Halimione portulacoides* (L.) Aellen	CH	HA	IN
	Salicornia palasiana Yaprak & Yurdakulol ssp. *palasiana*	T	HA	EN
	Salsola kali L.	T	PH	IN
	Salsola soda L.	T	PH	IN
Convolvulaceae	*Cressa cretica* L.	H	XH	IN
	Ipomoea stolonifera (Cry.) J. F. Gmelin	T	PH	M
Cuscutaceae	*Cuscuta campestris* Yuncker	T	X	IN
Cyperaceae	*Bolboschoenus maritimus* (L.) Palla var. *maritimus*	C	HG	CM
	Carex divisa Hudson	C	HG	ES
	Cyperus capitatus Vandelli	C	HG	IN
	Schoenus nigricans L.	H	HG	IN
Euphorbıaceae	*Euphorbia falcata* L. ssp. *falcata*	T	XH	CM
	Euphorbia paralias L.	H	PH	M
	Euphorbia peplis L.	T	PH	M
	Euphorbia terracina L.	CH	PH	M
Fabaceae	*Alhagi mannifera* Desv	CH	X	IN
	Glycyrrhiza glabra L. var. *glandulifera* (Waldst. et Kit.) Boiss.	H	PH	IN
	Lotus corniculatus L. var. *tenuifolius* L.	H	HA	CM
	Medicago littoralis Rohde ex Lois. var. *littoralis*	T	X	IN

Table 3. (Cont'd.).

Family	Taxa	Life forms	Ecological types	Choro-types
	Medicago marina L.	H	PH	IN
	Melilotus indica (L.) All.	T	HA	IN
	Melilotus messanensis (L.) All.	T	PH	M
	Trifolium campestre Schreb.	T	X	CM
Gentıanaceae	*Blackstonia perfoliata* (L.) Hudson ssp. *perfoliata*	T	HG	IN
	Centaurium erythraea Rafn ssp. *erythraea*	T	HG	ES
Geranıaceae	*Geranium dissectum* L.	T	X	IN
Juncaceae	*Juncus littoralis* C. A. Meyer	C	HG	M
	Juncus rigidus Desf.	C	HG	IN
Lamıaceae	*Salvia viridis* L.	T	X	M
Lılıaceae	*Urginea maritima* (L.) Baker	C	PH	M
Lınaceae	*Linum bienne* Miller.	H	HG	M
Orobanchaceae	*Orobanche minor* Sm.	T	X	IN
Plantagınaceae	*Plantago coronopus* L. ssp. *commutata* (Guss.) Pilger	T	PH	EM
	Plantago lagopus L.	H	HG	M
	Plantago maritima L.	T	PH	IN
	Plantago scabra Moench	T	X	IN
Plumbagınaceae	*Limonium angustifolium* (Tausch) Turrill	H	HA	M
Poaceae	*Aeluropus littoralis* (Gouan) Parl.	C	PH	IN
	Arundo donax L.	C	HG	IN
	Catapodium marinum (L.) C. E. Hubbard	T	PH	M
	Cynodon dactylon (L.) Pers. var. *dactylon*	C	PH	IN
	Elymus elongatus (Host) Runemark ssp. *elongatus*	C	PH	IN
	Elymus farctus (Viv.) Runemark ex Melderis subsp. *farctus* var. *farctus*	C	PH	M
	Hordeum murinum L. ssp. *glaucum* (Steudel) Tzvelev	T	X	IN
	Imperata cylindrica (L.) Raeuschel.	C	PH	IN
	Lagurus ovatus L.	T	PH	M
	Lolium rigidum Gaudin var. *rigidum*	T	XH	IN
	Phragmites australis (Cav.) Trin. ex Steudel	H	HG	ES
	Polypogon maritimus Willd. ssp. *maritimus*	T	PH	ES
	Polypogon monspeliensis (L.) Desf.	T	XH	ES
	Rostraria cristata (L.) Tzevelev var. *cristata*	T	PH	IN
	Sporobulus virginicus (L.) Kunth.	C	PH	IN
	Trachynia distachya (L.) Link.	T	PH	M
Polygonaceae	*Polygonum equisetiforme* Sibth & Sm.	H	X	IN
	Polygonum maritimum L.	H	PH	IN
Prımulaceae	*Anagallis arvensis* L. var. *arvensis*	T	PH	IN
Rosaceae	*Rubus sanctus* Schreber	CH	X	IN
Scrophularıaceae	*Verbascum sinuatum* L. var. *adenosepalum* Murb.	H	PH	M
Tamarıcaceae	*Tamarix smyrnensis* Bunge.	P	HA	IN
Thymelaeaceae	*Thymelaea hirsuta* (L.) Endl.	CH	X	M
Verbenaceae	*Phyla nodiflora* (L.) Greene	CH	PH	IN

Life forms: C = Cryptophytes, CH = Chamaephytes, H = Hemicryptophytes, P = Phanerophytes, T = Therophytes

Ecological types: HA = Halophytes, HG = Hygrohalophytes, PH = Psammohalophytes, X = Xerophytes , XH = Xerohalophytes

Chorotypes: CM = Common, EM: East Mediterranean, EN = Endemic, ES = Euro-Siberian, IN = Imperfectly Known, M = Mediterranean

Poaceae family (16 taxa-21.05%) contains the highest number of halophytic taxa. Others families in the descending order according to the number of taxa are; Fabaceae (8), Asteraceae (6), Chenopodiaceae (4), Cyperaceae (4), Euphorbiaceae (4) Plantaginaceae (4), Brassicaceae (3), Apiaceae (2), Boraginaceae (2), Convolvulaceae (2), Gentianaceae (2), Juncaceae (2), Polygonaceae (2), Amaryllidaceae (1), Caryophyllaceae (1), Cuscutaceae (1), Geraniaceae (1), Lamiaceae (1), Liliaceae (1), Linaceae (1), Orobanchaceae (1), Plumbaginaceae (1), Primulaceae (1), Rosaceae (1), Scrophulariaceae (1), Tamaricaceae (1), Thymelaeaceae (1), Verbenaceae (1).

The dominating phyto-geographical elements of the halo-phytes are Mediterranean (28.94%) when categorized according to chorotype data. Other phyto-geographical elements are European-Siberian (6.57%), East Mediterranean elements (1.32%) and 42 taxa unknown. *Salicornia palasiana* ssp. *palasiana* is an endemic (Table 4). The genera having the highest number of taxa are *Euphorbia* (4) and *Plantago* (4). Out of the life form spectrums therophytes (46.05%) and hemi-cryptophytes (19.74%) constitute the largest groups. The percentages of other life-forms are Crypto-phytes (18.42%), Chamaephytes (14.47%) and Phanerophytes (1.32%) (Table 5). Therophytes and Hemicryptophytes are common in the areas due to the Mediterranean climatic features (Akman & Ketenoglu, 1987; Altay *et al*., 2010a, 2010b; Osma *et al*., 2010). Typical halophytes detected in the study area can be grouped as psammohalophytes (35), xerophytes (16), hygrohalophytes (13), xerohalophytes (6), halophytes (6) (Table 6) and 6 taxa are rare.

According to the threatened categories based on RED DATA BOOK (Anon., 1994 and 2003), 5 taxa are in the threatened category (VU) and 2 taxa are in EN category (Table 7).

Table 4. Chorotypes of the halophytic plant cover.

Code	Chorotypes	The number of taxa	Percentage (%)
M	Mediterranean	22	28.94
EM	East Mediterranean	1	1.32
ES	Euro-Siberian	5	6.58
IN	Imperfectly Known	42	55.26
CM	Common	5	6.58
EN	Endemic	1	1.32
	Total	**76**	**100**

Table 5. Life form spectrum of halophytic taxa in the study area.

Life Form	Number of taxa	Percentage (%)
Therophytes	35	46.05
Hemicryptophytes	15	19.74
Cryptophytes	14	18.42
Chamaephytes	11	14.47
Phanerophytes	1	1.32
Total	**76**	**100**

Table 6. Ecological types of halophyte distributed in the study area.

Code	Halophyte type	Number of taxa	Percentage (%)
PH	Psammohalophyte	35	46.05
X	Xerophyte	16	21.05
HG	Hygrohalophyte	13	17.10
XH	Xerohalophyte	6	7.90
HA	Halophyte	6	7.90
Total		**76**	**100**

The halophytic plant communities distributed in the study area are; *Phragmites australis, Halimione portulacoides* and *Bolboschoenus maritimus*. These communities are substantially under the anthropogenic pressure and their habitats are seriously narrowing.

1. *Phragmites australis* community: *Phragmites australis* is the most common halophytic community in the area. *Phragmites australis* is the dominant species with companions like *Aeluropis littoralis*, *Bolboschoenus maritimus, Juncus rigidus* and *Polypogon monspeliensis*. The community generally covers up to 100% and it can vary from 160 to 350 cm. It is under pressue from anthropogenic fires.

2. *Halimione portulacoides* community: The major species found in the floristic composition of this halophytic community are *Halimione portulacoides, Limonium angustifolium, Polypogon monspeliensis, Arthrocnemum macrostachyum,Aeluropis littoralis, Juncus rigidus, Melilotus messanensis* and *Inula crithmoides*. The community covers 70-100%, varying between 30-60 cm.

3. *Bolboschoenus maritimus* community: *Bolboschoenus maritimus* is the dominant species with companions like *Aeluropis littoralis, Polypogon monspeliensis, Phragmites australis, Inula crithmoides* and *Typha domingensis*. It covers up to 100% and varies from 60 to 100 cm.

Discussion

The area of salinity affected soils in Asia is approximately 320 million ha and 51 million in Europe (Szabolcs, 1989). More and more agricultural lands are subject to increasing salinity levels. During the last twenty years a lot of work has been done on halophytes throughout the world, in particular on biosaline agriculture (Ozturk *et al.,* 2008). These studies will probably lead to new approaches for more effective solutions to problems of inland saline-alkaline areas. There is great potential in halophytic plant cover for consumption as well as amelioration of degraded lands. Some work has already begun (Avci *et al.,* 2004; Dogan *et al.,* 2004; Gidirisli *et al.,* 2004; Guven *et al.,* 2001; Ozturk *et al.,* 1998), but many more studies need to be carried out (Ozturk *et al.,* 2008).

Sand-dunes and wetlands are very sensitivity ecosystems. These habitats are important areas that must be protected because of their richness in biodiversity (Kavak, 2006; Naz *et al.*, 2010; Hameed *et al.*, 2011). Asi River Delta which includes Milleyha Aquatic Ecosystem and its surrondings are under a great pressure from anthropogenic factors. Major anthropogenic impact is due to urbanisation (Odemis & Bozkurt, 2007). The touristic facilities in the area have increased approximatelly 3 times during the last 2 decades (Yener & Wilkinson, 2001; Ozsahin, 2010). Other factors effecting the area are; sand digging, fires for creation of cultivated area, dumping of organic and inorganic wastes, construction of summer houses, hotels and restaurants, and establishmment of entertainment areas (Kavak, 2006; Fidan, 2006; Kayikci, 2006; Caliskan, 2008).The agricultural areas have decreased because of uncontrolled development of touristic facilities. This has pushed the residents to create agricultural areas on bare areas (Korkmaz *et al.,* 2010) (Fig. 2).

Nearly 300 halophytic taxa, belonging to 150 genera and 40 families are reported to show distribution in Turkey (Guvensen *et al.,* 2006). The dominant families are Poaceae, Chenopodiaceae, Asteraceae, and Fabaceae, while the dominant genera with highest number of taxa are *Limonium, Juncus, Salsola, Plantago* and *Trifolium.* Phytogeographically, only 8 percent of these are Mediterranean elements and 3.33 percent East Mediterranean.

Out of these 40 percent are therophytes, 28.33 percent hemicryptophytes, and 23 percent cryptophytes, with the majority being hygrohalophytes followed by xerophytes and psammohalophytes. The number of endemic taxa is about 39, the highest in Asteraceae (8 taxa), and Plumbaginaceae (6 taxa). The red data book of Turkish plants shows that 33 endemic and 11 non-endemic halophytes are in danger of extinction.

A general evaluation of the halophytic taxa distributed in the study area reveals that in all 76 halophytic taxa belonging to 61 genera and 29 families are found in the area (Table 3). A comparison of these results with the general situation in Turkey depicts the area is rich in halophytes. Some of the families with highest number of taxa are Poaceae, Fabaceae, Asteraceae and Chenopodiaceae. Same families include the maximum number of taxa in Turkey as well (Guvensen *et al.,* 2006). The genera with maximum number of taxa in the study area are *Euphorbia* and *Plantago*. *Plantago* genus is one of the maximum represented genus in the Turkish halophytic flora. However, *Euphorbia* shows highest distribution in the study area among the halophytic taxa. Looking at the phytogeographical origin of plant taxa in the study area, ditribution of Mediterranean and East Mediterranean elements is 28.94 and 1.32 percent respectively (Table 4). These ratios in the overall Turkish halophytic flora lie around 8 and 3.33 percent respectively. The reason for a very high percentage of Mediterranean elements in the study area can be attributed to the location of the area within the Mediterranean climatic region. The life form spectrum data is as follows; therophytes 46.05 %, hemicryptophytes 19.74 % and Cryptophytes 18.42 % (Table 5). A comparison of this situation with Turkish halophytic plant diversity shows that percentage values are in full agreement with these (Guvensen *et al.,* 2006). Major ecological types found in the study area are psammohalophytes, xerophytes and hygrohalophytes which coincides with the general sitution in Turkey (Table 6). The study area has 1 endemic and 6 rare halophytic taxa, this number is much lower that the general situation in Turkey (Table 7). The reason for this is continuous anthropogenic pressures on the area.

Halocnemum strobilaceum, *Aeluropus littoralis* and *Arthrocnemum* sp., are grazed by cattle, and species of *Juncus* are used for basket making. A large number of people in the Aegean region have started using *Salicornia europaea* as salad. In some markets *Arthrocnemum fruticosum* is sold in place of *Salicornia europaea* for this purpose, and one has to be careful in this connection because consumption of the former in place of the latter may create health problems related to the digestive system.

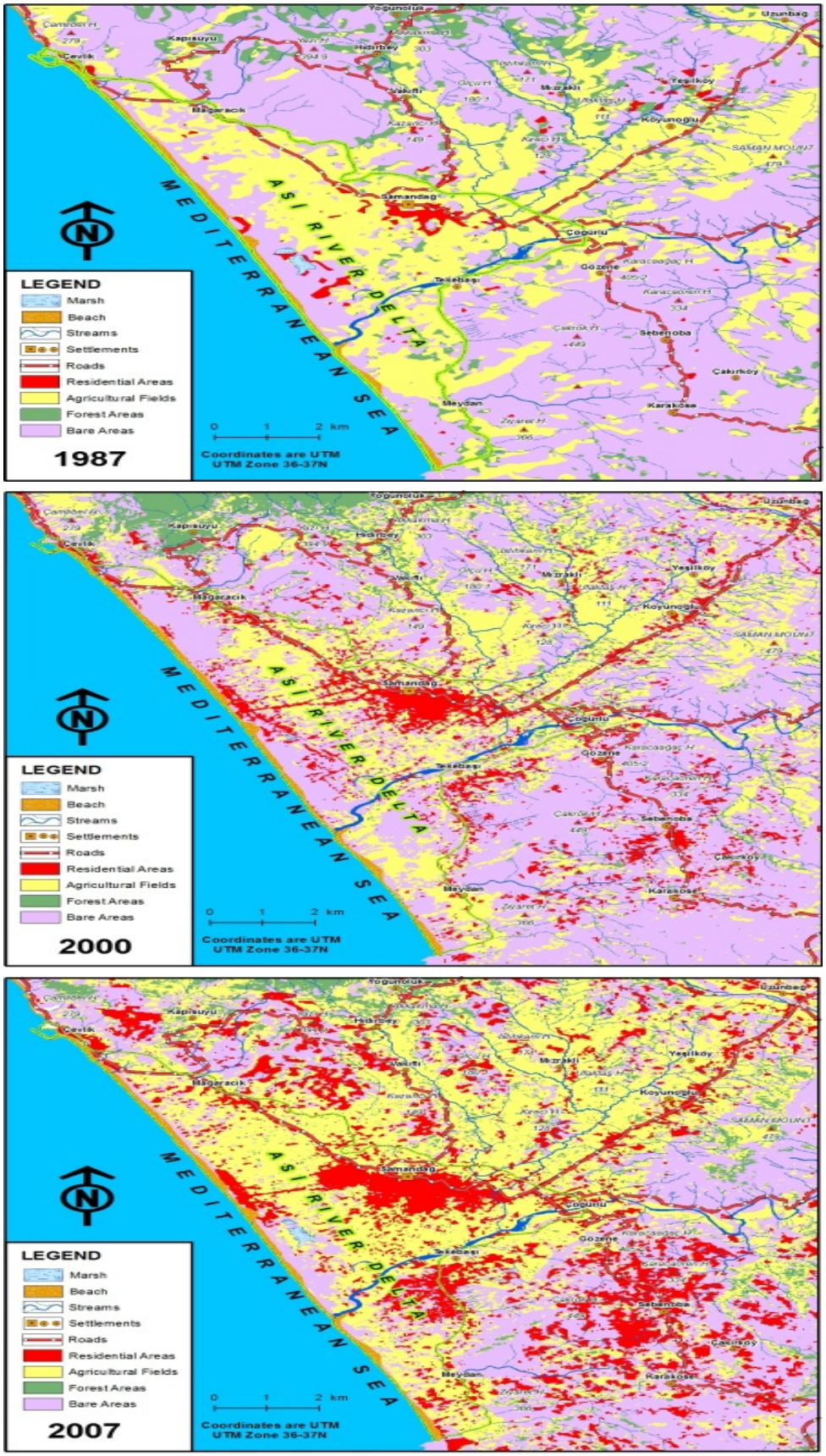

Fig. 2. Land use change over the years in the Asi River Delta (Korkmaz *et al.,* 2010).

Table 7. Conservation status of the Halophytes of Milleyha Wetland Ecosystem (*Endemic).

Latin name	Threatened category	Source
Alhagi mannifera	VU	Ekim *et al*., 2000
Euphorbia paralias	EN:A4ac	Ozturk *et al*., 2011b
Juncus littoralis	VU:D2	Ozturk *et al*., 2011b
Pancratium maritimum	EN	Ekim *et al*., 2000
Reichardia picroides	VU:D1+2	Ozturk *et al*., 2011b
**Salicornia palasiana* ssp. *palasiana*	VU	Yurdakulol, 2008
Salsola soda	VU:D1+2	Ozturk *et al*., 2011b

The littoral halophytic taxa, which occupy habitats immediately following the psammophytic plant communities, serve as a reclusive area for many animals and can serve as indicators of salinity-sodicity. There is great potential in the halophytic plant cover for consumption as well as amelioration of degraded lands in Turkey. Some work has already started in this direction but we have a long way to go.

The red data book of Turkish plants (Ekim *et al.,* 2000) reveals that 33 endemic and 11 non-endemic taxa from the halophytic plant cover are in danger of becoming extinct. The biotic pressures responsible for the destruction of over 10,000 ha along the 8,333 km long coastal sabkha ecosystem in Turkey are: city wastes, industrial effluents, marine traffic, sand extraction, summer houses and tourism (Erdem *et al.,* 1994). During the last few decades there has been a great population outburst along this coastal belt and large populations from east, south-east and central Anatolia have migrated to these parts of Turkey. The number of tourists visiting the area has increased eight fold.

These threats are affecting the biodiversity in this area in particular habitats supporting halophytic plant communities. The beach neighbouring the wetland is an important spawning area for turtles like *Caretta caretta* and *Chelonia mydas*, two out of eight sea turtle species. The area is one of the four ovulation coasts in Turkey for these animals because they lay eggs here but the area is seriously narrowing due to sand extraction in the area (Fidan, 2006). The area is also used by the soft-shell Nile turtle, *Trionyx triunguis*, (Uras, 2001; Fidan, 2006). The coasts in between Samandağ (Hatay-Turkey) and Syria are the areas on which Mediterranean monk seal struggle for existence in Turkey. Furthermore, there are many important plant and bird species restricted to these habitats in Turkey (Uras, 2001). Uncontrolled hunting activities are very high here because there is no strict control on the protection of wildlife in the study area. The number of waterfowls visiting this area especially during the winter months is decreasing. The number of migrating birds too has decreased (Fidan, 2006).

Conclusion

The Milleyha Aquatic Ecosystem and its environs (Asi River Delta) have no protection status at present. This unique habitat needs an urgent protection. There is a need for developing measures to protect this area from negative biotic and abiotic impacts, otherwise the damage can become irreversible. The effective and continuous protection measures should be identified and local community informed about the importance of the conservation of these fragile ecosystems.

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