

Wetland vegetation as affected by water regime of two coastal marshes

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Abstract

Among the very few wetlands remaining in Halkidiki, Northern Greece, are the natural coastal marshes known as Gerani and Stavronikita in Nea Fokaia. In order to drain these wetlands a drainage system was established in 1971. The system operated for 20 years in Gerani and 28 years in Stavronikita. The most important changes in the wetland vegetation were studied in both marshes during the period 1997 to 2000. In Gerani marsh as the water regime did not change drastically during the studied period, no marked vegetation changes were observed. In Stavronikita marked changes in the wetland flora distribution were observed from 1997 until 2000. The most significant changes were: a) The halophyte area was decreased, b) The *Hordeum maritimum* was translocated to the marsh periphery and c) The *Typha* sp. vegetation area increased at the expense of *Scirpus lacustris*, *Vallisneria spirallis* and *Chara* sp.

1 Introduction

At the beginning of the twentieth century Greece had threefold wetland area than today. Wetlands were drained in order to confront problems such as malaria, flood damage to property and to acquire new farmland (Tsiouris [1], Gerakis [2]). The highest wetland losses took place in Macedonia from 1930 to 1990: the 73.2% of fresh water wetlands area was lost, while the new artificial wetlands which were created represent only the 5.5% of the area (Psalovikos [3]). The

annual percentage loss for Thessaloniki plain varies from 3% in the 1930s to 1% in the 1980s (Athanasidou [4]).

The marshes almost disappeared since only 5.7% remained. Halkidiki stands as a typical example. Till 1980, it was reported that three wetlands had been drained (Zalidis [5]). The actual number must be higher considering that Halkidiki's coastal areas were subjected to profound alterations by tourism development during the period 1960-1980. Over the following years, up to 1994, eleven more wetlands were drained (Dorikos [6], Zalidis [5]). Most of the remaining wetlands, are degraded as a result of the anthropogenic pressure they receive. According to Tsiouris [1] the primary degradation factors were: water overpumping, illegal hunting, overfishing, woodcutting and drainage. The water quality is degraded by urban, industrial and agricultural pollutants (Tsiouris [7]) and the loss of wetland areas is due to urban and tourism development.

The wetland vegetation is an important constituent in any wetland and largely determines the habitat of other wetland organisms, particularly the invertebrate and vertebrate fauna (Verhoeven [8]). The aquatic vegetation affects wetland functions such as flood attenuation, sediments entrapment, food web support and determines wetland values such as biodiversity, forage for farm animals, protection from erosion and floods, water quality improvement, scientific research and education. The aquatic vegetation also constitutes a criterion for wetland delineation (Mantzavelas [9]).

The wetland plant communities existing in a given site are determined by the topographical and hydrological patterns of that site (Tallis [10]). The main factors determining the species composition of plant communities in the wetlands of the Mediterranean region are: hydroperiod, depth and periodicity of flooding, water and soil salinity, grazing intensity, strength of water currents, water quality, soil or sediment type and annual temperature range (Papastergiadou [11]). Although nutrient availability and vegetation management play an important role, hydrology is the governing factor that determines vegetation composition, species richness and vegetation extent. Water level, duration and seasonality of flooding, and substrate saturation has a strong influence on the composition, stability, distribution, and performance of wetland vegetation (Wierda [12]). Wetland flora always respond to small changes in hydrological conditions with consequences in biodiversity and productivity (Mitsch [13]). In cases where a wetland has remained dry for a few years the reflooding of the wetland may re-establish hydrophytes since many seeds and other plant propagules will have survived. This is especially true in wetlands which showed a non-permanently flooded type of hydroperiod (Papastergiadou [11]).

The coastal marshes Gerani and Savronikita in Halkidiki, received severe anthropogenic pressure over the last forty years, with the aim to be completely drained. In early 1970's, a drainage system was established in both these wetlands. Drainage ditches collected the surface water to pumping stations, which diverted it to the sea. After few years the system became ineffective, due to lack of any maintenance work. The pumping stations in Gerani ceased in early 1990's, while the one in Stavronikita in 1998. The wetlands did not dry up, and were reflooded after the pumping ceased.

The aim of this study was to inventory the major changes which occurred to the vegetation of the wetlands from 1997 until 2000, as a result of the cessation of the drainage system operation.

2 Materials and methods

2.1 Study area

Gerani (89.9 ha) and Stavronikita (133.3 ha) marshes are located in the northwest of Kassandra peninsula, 5 km west of Nea Fokaia in Halkidiki, Greece (Figure 1), at a longitude of $23^{\circ} 32'$ and at a latitude of $40^{\circ} 10'$ (Zalidis [5]).

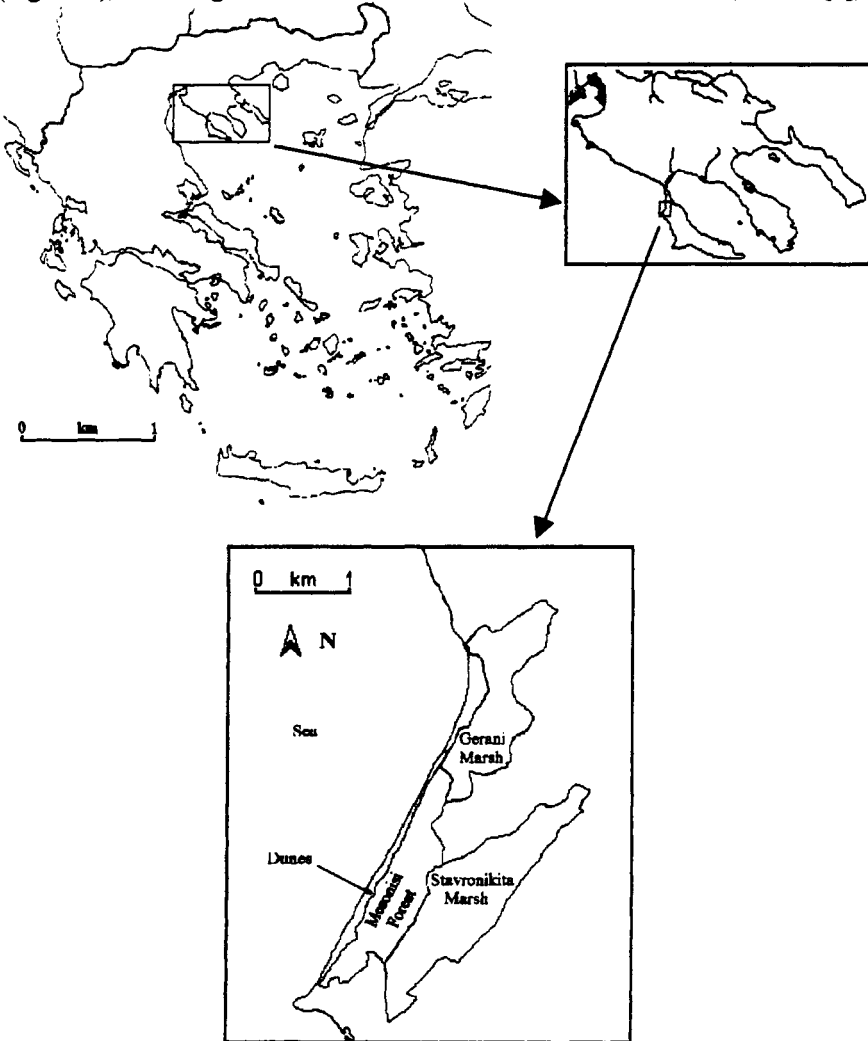


Figure 1: Map of Greece with the two studied marshes

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On the west part of the Stavronikita marsh there are dunes along the seacoast and a coniferous woodland known as Mesonisi forest. The watershed of the marshes are mainly on the eastern part, where agriculture is practiced. The type of wetlands vegetation is azonic, not dependent on climate, but on local ruling aquatic and edaphic factors such as humidity and salinity (Galani [14]).

2.2 Wetland vegetation data

The fieldwork was conducted from July 1999 until August 2000. The flora species and vegetation changes in the wetlands were recorded. Thirteen plant sampling locations were selected for Stavronikita marsh and 10 locations for Gerani marsh (Figure 2).

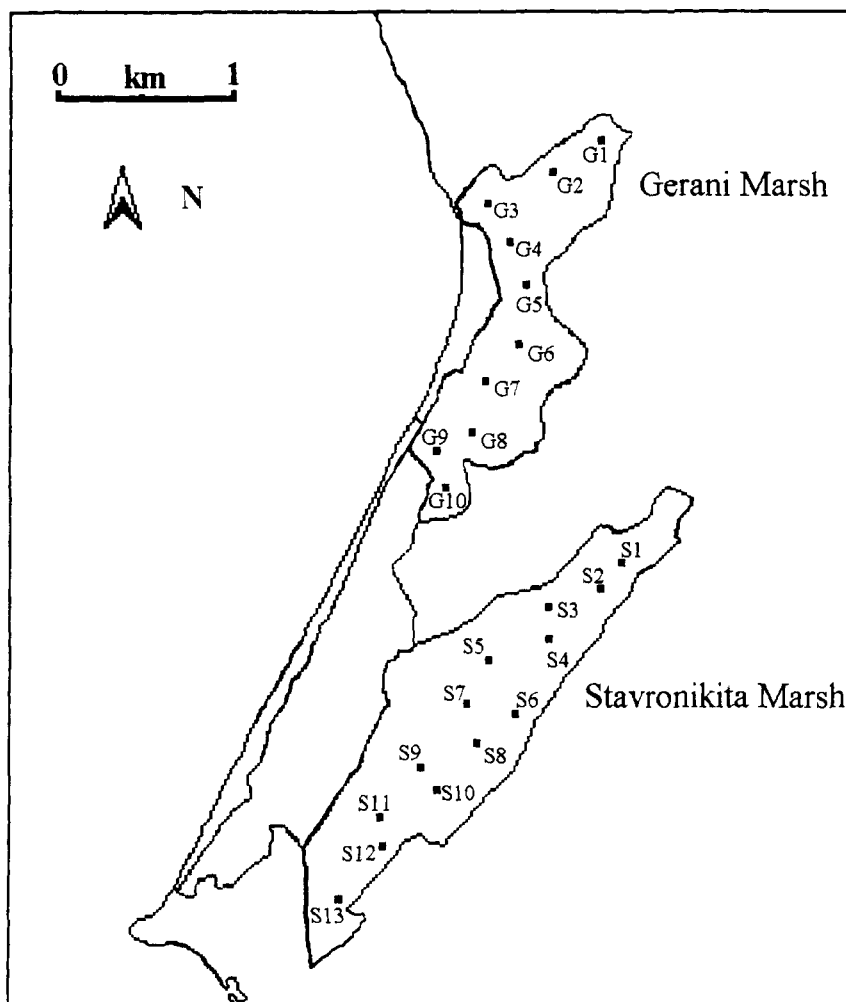


Figure 2: Aquatic macrophyte and halophyte sampling locations

Plant determination and collection of dominant species was always done from these specific sampling positions. Six visits took place in the following dates: 15/7/1999, 17/8/1999, 13/5/2000, 18/6/2000, 20/7/2000 and 12/8/2000. The collected samples were dried and classified at genus and species level. The used nomenclature was according to Tutin [15], Fasset [16] and Correll [17].

In order to identify the changes occurred to the wetlands vegetation during the study period, there were used the vegetation map (Figure 3) by Galani [14] and the wetland vegetation data collected during the present study.

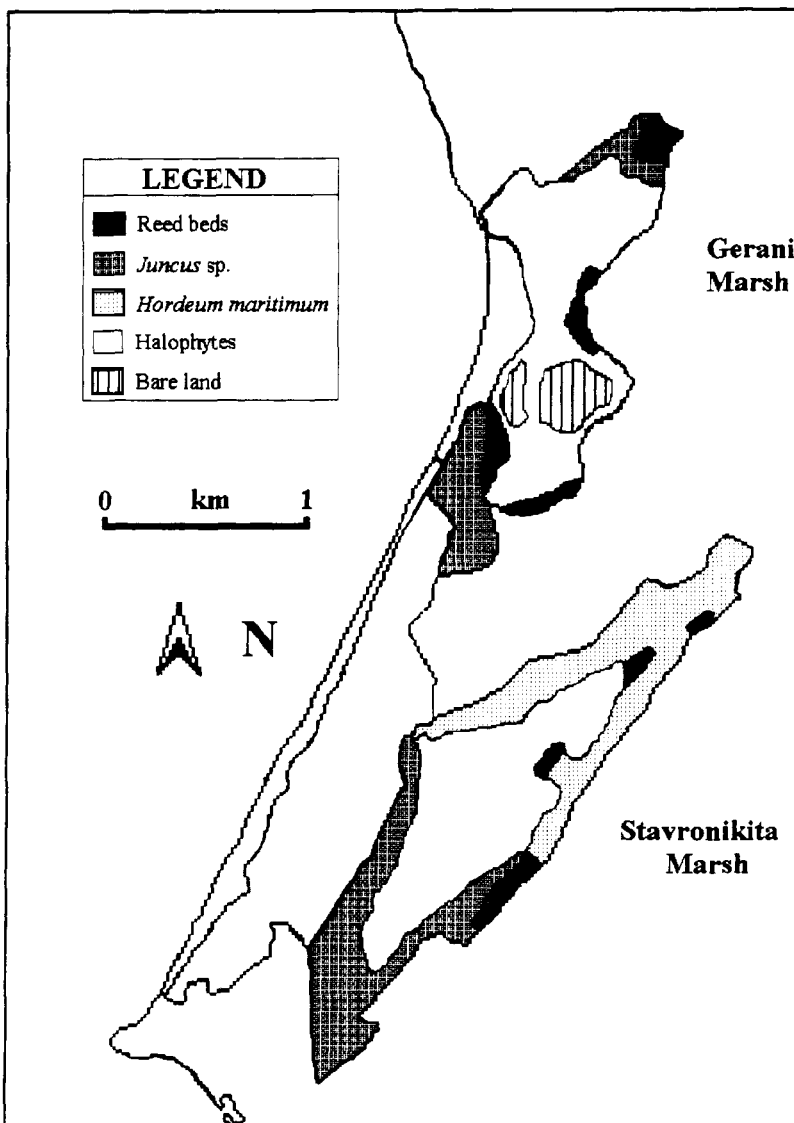


Figure 3: Vegetation map of the two marshes in 1997

3 Results and discussion

The present field survey of the marshes flora and vegetation, which was conducted during the growing season and the Galani [14] data led to the identification of the following vegetation units (Cowardin [18]): (a) aquatic bed vegetation and (b) emergent vegetation. Aquatic bed vegetation consists of species growing principally on or below the surface of the water. Species of this unit recorded as dominant in both marshes are: *Chara* sp., *Lemna* sp., *Potamogeton trichoides*, *Ranunculus trichophyllus*, *Valisneria spiralis* and *Zannichelia palustris*. Emergent vegetation consist of erect and rooted species. Species of this unit recorded as dominant in both marshes are: *Halocnemum strobilaceum*, *Juncus maritimus* *Salicornia europaea*, *Salsola soda*, *Phragmites australis*, *Scirpus maritimus* and *Typha* sp. The first four species are halophytes and the last three are reeds.

3.1 Stavronikita Marsh

Aquatic bed vegetation, which was absent in 1997 was established after two years of re-flooding (Figure 3, Table 1).

Table 1: Dominant species of wetland flora at the sampling locations of Stavronikita marsh.

Sampling locations	Dominant species at two sampling dates	
	August 1999	July 2000
S.1	<i>Typha</i> sp., <i>Lemna</i> sp.	<i>Typha</i> sp., <i>Lemna</i> sp.
S.2	<i>Typha</i> sp., <i>Lemna</i> sp.	<i>Typha</i> sp., <i>Lemna</i> sp.
S.3	<i>Scirpus maritimus</i> <i>Valisneria spiralis</i>	<i>Typha angustifolia</i>
S.4	<i>Scirpus lacustris</i> , <i>Chara</i> sp.	<i>Typha</i> sp.
S.5	<i>Scirpus lacustris</i> , <i>Chara</i> sp.	<i>Scirpus lacustris</i> , <i>Chara</i> sp.
S.6	<i>Scirpus</i> sp. <i>Zannichelia palustris</i>	<i>Scirpus</i> sp. <i>Zannichelia palustris</i>
S.7	<i>Zannichelia palustris</i> <i>Potamogeton trichoides</i> <i>Ranunculus trichophilus</i>	<i>Zannichelia palustris</i> <i>Potamogeton trichoides</i> <i>Ranunculus trichophilus</i>
S.8	<i>Zannichelia palustris</i> <i>Chara</i> sp. <i>Potamogeton trichoides</i>	<i>Zannichelia palustris</i> <i>Chara</i> sp. <i>Potamogeton trichoides</i>
S.9	<i>Zannichelia palustris</i> , <i>Chara</i> sp.	<i>Zannichelia palustris</i> <i>Chara</i> sp.
S.10	<i>Chara</i> sp., <i>Scirpus lacustris</i> <i>Potamogeton trichoides</i> ,	<i>Chara</i> sp., <i>Scirpus lacustris</i> <i>Potamogeton trichoides</i>
S.11	<i>Chara</i> sp.	<i>Chara</i> sp.
S.12	<i>Phragmites australis</i>	<i>Phragmites australis</i>
S.13	<i>Typha</i> sp.	<i>Typha</i> sp.

Halophytes, that covered most of the wetland area before 1998, they are absent from its centre, which has been covered by aquatic macrophytes. *Hordeum maritimum* which was the dominant species in the northern and eastern part of the wetland before 1998 was not found in any of the 13 sampling sites. There is a notable expansion of all reed species after 1998. They are dominant in nine out of the 13 sampling positions.

Comparing the dominant species at the sampling positions during the years 1999 and 2000 (Table 1), the only notable change is the further expansion of *Typha* sp. *Typha* occupied the ground of *Scirpus lacustris*, *Scirpus maritimus*, *Valisneria spiralis* and *Chara* sp. at the sampling locations S.3 and S.4 covering up almost all the northern part of the wetland.

From the entire aquatic flora recorded in the marsh it was evident that the halophytes have been restricted in a small area at the northern places of the marsh, which are covered with water for shorter period or they are not covered with water at all. The *Hordeum maritimum*, has now been translocated on the marsh periphery and *Typha* sp. occupied gradually the *Hordeum maritimum* former places.

These changes should mainly be due to the alteration of marsh water regime. After almost 30 years of continuing water pumping, the wetland was flooded and a major part of its area held surface water all year along. The halophytes and *Hordeum maritimum*, which are common in semidry soils (Mantzavelas [9]), were concentrated in higher parts of the marsh after the flooding, where the surface water was present for a shorter period. Species of aquatic bed vegetation which were absent and reeds that were present but they were covering a small part of the marsh grew and occupied the newly created flooded habitats. *Typha* sp. continued its expansion over the year 2000.

3.2 Gerani Marsh

Comparing the vegetation map of 1997 (Figure 3) and studying also the dominant flora species of the years 1999 and 2000 (Table 2), we have not found any marked differences.

It is evident from table 2 that only in three locations in 1999 and in four locations in 2000 aquatic bed vegetation species were recorded as dominant. These species were absent from Gerani marsh in 1997 (Figure 3).

Halophytes which occupied great part of the wetland in 1997 (Figure 3), they found to be dominant in most of the sampling locations in 1999 and 2000 (Table 2).

Comparing the dominant species in both marshes it is evident that appearance of the aquatic bed vegetation species and reeds is much more marked in Stavronikita than in Gerani marsh. This is attributed to less drastic changes on the water regime in the Gerani marsh.

Table 2: Dominant species of wetland flora at the sampling positions of Gerani marsh.

Sampling locations	Dominant species at two sampling dates	
	August 1999	July 2000
G.1	<i>Scirpus maritimus</i>	<i>Scirpus maritimus</i>
G.2	<i>Halocnemum strobilaceum</i>	<i>Halocnemum strobilaceum</i> .
G.3	<i>Salicornia europaea</i>	<i>Salicornia europaea</i>
G.4	<i>Salicornia europaea</i> <i>Salsola soda</i>	<i>Salicornia europaea</i> <i>Salsola soda</i>
G.5	<i>Salicornia europaea</i> <i>Salsola soda</i>	<i>Salicornia europaea</i> <i>Salsola soda</i>
G.6	<i>Zannichelia palustris</i>	<i>Zannichelia palustris</i>
G.7	<i>Salicornia europaea</i>	<i>Zannichelia palustris</i>
G.8	<i>Zannichelia palustris</i> <i>Potamogeton trichoides</i> <i>Scirpus maritimus</i>	<i>Zannichelia palustri</i> , <i>Potamogeton trichoides</i> <i>Scirpus maritimus</i>
G.9	<i>Juncus maritimus</i> , <i>Salsola soda</i>	<i>Juncus maritimus</i> <i>Salsola soda</i>
G.10	<i>Zannichelia palustris</i> <i>Potamogeton trichoides</i> <i>Vallisneria spiralis</i>	<i>Zannichelia palustris</i> <i>Potamogeton trichoides</i> <i>Vallisneria spiralis</i>

4 Conclusions

The vegetation units in both studied marshes are aquatic bed vegetation and emergent vegetation.

The water regime changes, by reflooding of the Stavronikita marsh during the recent years, affected the aquatic vegetation of this wetland. The halophyte area was decreased and together with the *Hordeum maritimum* were concentrated to higher wetland places which are at the marsh periphery. On the centre of this wetland where the water was present permanently, various species of aquatic bed vegetation and reeds were favorite recently. *Typha* in particular increased at the expense of *Scirpus lacustris*, *Vallisneria spirallis* and *Chara* sp.

In Gerani marsh the observed wetland vegetation changes were not as pronounced as in Stavronikita marsh.

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