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وزارة التعليم العالي
والبحث العلمي

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رقم الايداع في دار الكتب والوثائق - بغداد (٧٦٤ لسنة ٢٠٠٣)

تعليمات النشر

1- تقبل المجلة البحوث العلمية والأنسانية الرصينة في مختلف الأختصاصات .

2- تخضع البحوث المقدمة للتقويم العلمي من قبل اختصاصيين من داخل القطر وخارجه.

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5- يرتب البحث كما يأتي: الخلاصة، الخلاصة باللغة الاخرى، المقدمة، طريقة العمل، النتائج، المناقشة، والمصادر.

6- يتم ذكر المصادر في البحث باتباع اسلوب الترقيم حسب اسبقية ذكر المصدر وتذكر المصادر في النهاية على الوجه الاتي: اسم الباحث (او الباحثين)، اسم المجلة، السنة، المجلد، العدد، رقم الصفحة الاولى.

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المؤتمر الدولي الأول للبيئة

بعنوان

التلوث البيئي والتصحر من مخاطر العصر

للفترة من

22-24/10/2011

Effects of low water quantity and quality on submerged aquatic plant species diversity in Saffia natural reserve /Basrah-IRAQ

تأثير قلة كمية ونوعية المياه على تنوع النباتات المائية الغاطسة في محمية الصافية الطبيعية/البصرة- العراق

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Abstract

Saffia natural reserve (named SNR) wetland is one of restored marshes in Basrah-south of Iraq. This SNR is undergoing rapid water chemical and physical changes. The SNR was visited monthly during study period carried out from December 2008 to November 2009. The present study was assessed the disturbance by water loss that affect on water quality, sediment and submerged aquatic plant communities. Study sites were classified into two stations depending on water sources in SNR. Dramatically changes were recorded during water loss from SNR led to severe reduction to submerged aquatic plant species. The mean of values 14%, 8, 10.6% of species abundance, diversity and vegetation cover of submerged aquatic plants were extremely reduced. It can be concluded that SNR is exposed to mass mortality and desertification unless governmental role to bring back water again to SNR.

الملخص

تعد محمية الصافية الطبيعية إحدى الأراضي الرطبة المستعادة من الأهوار في البصرة- جنوب العراق. تعاني المحمية من التغييرات السريعة في خصائص المياه الكيميائية والفيزيائية. تم زيارة محمية الصافية الطبيعية شهريا خلال فترة الدراسة من كانون الأول 2008 الى تشرين الثاني 2009. قيمت الدراسة الاضطرابات الناتجة عن فقدان الماء التي تؤثر على نوعية المياه والتربة و المجتمعات المحلية للنباتات المائية الغاطسة. صنف موقع الدراسة إلى محطتين اعتمادا على المصادر المائية الداخلة في المحمية. أدى فقدان الماء في المحمية إلى اختزال وفرة وتنوع النبات و الغطاء النباتي الغاطس بمعدل 14% و 8 و 10,6% على التوالي بشكل حاد. يستنتج من الدراسة الحالية أن المحمية معرضة إلى فناء للمجتمعات النباتية وحدوث التصحر ما لم يكن هناك دور حكومي لإعادة المياه إليها مرة أخرى.

INTRODUCTION

Wetland ecosystems provide important ecological services by supporting biotic diversity, nutrient retention and flood protection (Mitsch and Gosselink, 2000; Sonal *et al*, 2010). The protection of the aquatic habitats before they can be degraded is likely to be more beneficial to the health of the ecosystems and, ultimately, may prove to be more cost effective than habitat restoration.

Dynamics of wetlands are associated to autogenic as well as allogenic factors (Mitsch and Gosselink, 2000). The first type can be related to soil development, competition for light, mineral depletion or accumulation. The latter can be related to flooding, drought, fire, wind, and anthropogenic influences (Niering, 1994). Both floods and draughts can destroy habitat patches and create new ones that are then colonized and inhabited by biota with the return of stable flow conditions (Lake, 2000). Disturbance by human changes have caused impairment of water quantity and quality and the absolute loss of wetland habitat (Smith *et al.*, 1991; Chow-Fraser *et al.*, 1998). According to Pickett and White (1985), a disturbance means any relatively discrete event in time that disrupts an ecosystem, its community and population structure, and changes substrate availability or the physical environment.

Degradation of wetlands via degraded water quality causes a variety of changes in the biotic communities, where the altered macrophyte community results in impacted zooplankton and fish communities (Lougheed and Chow-Fraser, 2002). The relationship between wetland biotic communities and water quality can be recognized and then the biotic community alone can be used to quantify the condition of a wetland using while still reflecting the water quality aspects. One of these aspects is nutrient status of wetland by considering water, vegetation and soil conditions. Biogeochemical cycling of nutrient like nitrogen and phosphorus in wetlands is governed by physical, chemical and biological process in the soil and water column (Mustapha *et al*, 2008). The hydroperiod of wetland systems significantly affects nutrient transformations, availability, transport and loss of gaseous forms to the atmosphere (Mitsch and Gosselink, 2000).

Marshes of submerged aquatic macropytes, comprising diverse species of chlorophyte (Characeae), and other species responsible for much of the primary production of marshes, intervene in a great number of physic-chemical in the water column and determinant elements in nutrient cycles in wetlands (van Vierssen, 1982; Carpenter & Lodge, 1986; Golterman, 1995). Te first importance of macrophytes is dedicated to the biological diversity at a global scale as they represent a natural and stable habitat of great ecological importance (Denny,2001).

Different studies have demonstrated the importance of water quantity and quality on aquatic plants, Blindow (1993) had studied the influence of water level fluctuations on biomass, growth, production, and distribution of aquatic macrophytes. The studies of Alwan (2006), Al-Kenzawi(20007) and Al-Abbawy and Al-Mayah (2010) explained the success of southern Iraqi marshes to restore diverse species of aquatic macrophytes after inundation by large quantities of water in 2003.

Indicators of ecological change are important tools for allowing how wetland condition changes as degraded sites and as a means to measure and define endpoints for restoration success. SNR wetland have had an average loss of water quantity came from its Iranian source. The extent of degradation among SNR wetland should be measured so that an objective system may be used to identify wetlands that would benefit from restorative efforts. Nutrient conditions in water, soil and aquatic plants can reflect the role of disturbance in determining SNR wetland status during study period.

This is the first time to study the effects of low water quantity and quality changes in SNR, so the purposes of this study were to assess SNR wetland after five years of restoration and the effects of water loss on submerged aquatic macrophytes.

MATERIALS AND METHOD

Study area

Saffia natural reserve wetland (named SNR) is one of the restored wetlands in Basra Governorate south of Iraq near Iraqi-Iranian borders south of Huwaiza marsh. It is located in N 31 10,887 and E47 40,41. SNR Wetland was chosen by Ministry of Agriculture in 2006 as protected area from human activities. Emerged plants like *Phragmites australis* and *Typha domingensis* were covered SNR and gave its landscape. The main water sources of the wetland were: 1) Iranian side (Sabla steam) 2) Iraqi side (Huwaiza marsh). Iranian side was closed by Iranian government with dike, while no more water comes to SNR from Huwaiza marsh. Two main stations of SNR were chosen to give the picture of status and continuous changes in water of the wetland.

Methodology

The SNR was visited monthly during study period carried out from December 2008 to November 2009. During each visit, water samples were collected from different substations of the main two Stations. The water temperature (WT), Water depth (WD), pH, Electrical conductivity (EC), Dissolved Oxygen (DO), Nitrates (NO_3^{-2}) and Phosphates (PO_4^{-3}) were estimated according to the standard methods described by APHA (2005). In comparison, data were grouped in to two periods: first period (Water presence) and Second period (Water absence).

Sediment samples

Sediment samples were air dried, pulverized, thoroughly mixed and passed through a 2 mm sieve. The fractions of sediment were determined with a hydrometer method using sodium hexametaphosphate after soluble salts were removed by washing and organic matter was removed (Bouyoucos, 1962). Total organic Carbon was determined using chromic acid with conc. H_2SO_4 and titrating against ferrous ammonium sulphate with diphenylamine indicator (Jackson, 1960) as described by

Al-Hilli *et al.*, (2009). Total nitrogen (TN) and total phosphorus (TP) were determined according to Knight *et al.* (1993)

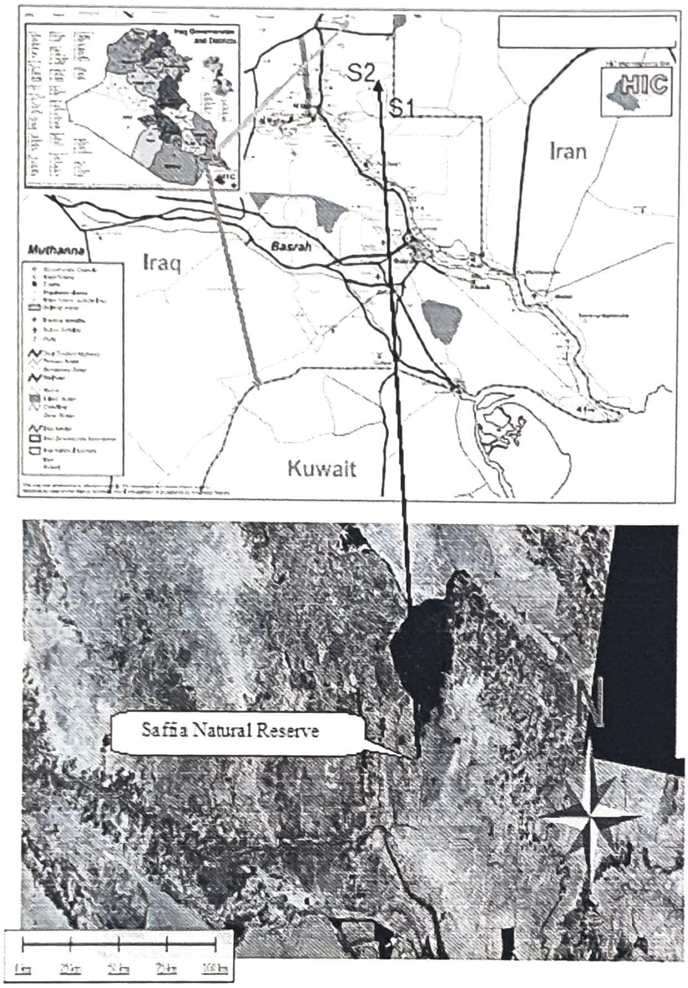


Fig. 1: Map of Saffia natural reserve wetland showed study area

Submerged aquatic plants

The Submerged aquatic plants were observed and listed within and by walking on boundaries of the SNR. The Submerged species were identified according to Al-Mayah and Al-Hameem (1991).

The diversity indices, species richness, Shannon wiener index (H') and Evenness (Pielou's index) (E) (Krebs 1985). To count the submerged aquatic plant cover, the transect method was used with an attempt to cover all the submerged aquatic plant in the SNR by estimate the vegetation cover (%) depended on method described by Kent and Coker (1992) .In the aim of comparison, all measurements were divided in to two periods depending on the status of water changes.

Data analysis

For the statistical analysis, the data for this study were done by SPSS software.

RESULTS

WATER QUALITY

During this study (Dec.2008.-June2009), continues changes were recorded in water quality measurements. The results were showed as two periods depending on presence and absence of water in SNR. Second period recorded full degradation in water quality happened simultaneously with water loss from SNR.

Temperature (°C) of water showed significant variations ($P < 0.05$) and was highest in the second period (summer). It was averaged with 20.5 ± 0.5°C in the first period and 26.6 ± 1.0°C in the last time. The water level of SNR was decreased continuously from 57-75 cm till near draught in the summer months in both two sites. The pH and EC values showed highly significant variations when the means over the months were compared ($P < 0.05$), their values were increased with time. Maximum pH was 9.6 ± 0.20 in the second period, while it was 7.7 ± 0.01 in the first period, and maximum values of conductivity was 17860± 20 µS/cm during second period (Fig.2).

The seasonal and spatial variations at SNR were clear in Table 1&2 and Figure 2. The Dissolved Oxygen showed maximum values during first five months and Station 2 recorded the highest mean (8.46 ± 0.5 mg/l), decreased during time with decreased water depth. The Nitrate concentrations also varied highly significantly throughout the year of study ($P < 0.05$). Nitrate concentration was 3.65 ± 0.3 mg/l and 5.78 ± 0.7 mg/l during first period in S1 and S2 respectively with but as the June 2009 approached it increased to maximum level at 7.25± 0.03 mg/l. PO_4 concentrations also showed highly significant variations ($P < 0.05$), It increased from 14.47 in first months to 18.23+ 0.01 mg/l in the last months in S2.

Table 1: Physical-chemical data of water in station 1 of Saffia natural reserve during Dec.2008-Nov.2009

Month	Water Temperature (C)	Depth (cm)	pH	EC (µS/cm)	NO_3 (mg/l)	PO_4 (mg/l)	DO (mg/l)
Dec.2008	10.3	57	6.9	6200	3.52	11.54	9.1
Jan.2009	15.2	44	6.9	8000	3.46	12.5	9.3
Feb.2009	17.2	32	7.4	8500	3.54	12.72	8.3
Mar.2009	21.0	18	7.6	9700	3.68	12.54	8.5
Apr.2009	26.3	12	7.6	10600	3.74	13.47	8.5
May.2009	27.0	9	7.8	12120	3.85	13.73	4.4
Jun.2009	27.2	5	8.4	15300	3.41	15.23	1.4
July.2009	-	-	-	-	-	-	-
Aug.2009	-	-	-	-	-	-	-
Sep.2009	-	-	-	-	-	-	-
Oct.2009	-	-	-	-	-	-	-
Nov.2009	-	-	-	-	-	-	-

- Water absence

Table 2: Physical-chemical data of water in station 2 Saffia natural reserve during Dec.2008-Nov.2009

Month	Water Temperature (C)	Depth (cm)	pH	EC (µS/cm)	NO_3 (mg/l)	PO_4 (mg/l)	DO (mg/l)
Dec.2008	10.3	75	7.5	4670	3.98	11.6	9.69
Jan.2009	16.1	73	7.9	6180	4.66	12.43	9.9
Feb.2009	18.4	61	7.8	7150	5.78	14.56	9.6
Mar.2009	22.2	53	7.7	9700	5.72	14.48	9.67
Apr.2009	27.5	49	7.6	11100	5.67	14.58	10.9
May.2009	27.9	40	7.8	11660	6.26	15.47	7.5
Jun.2009	28.3	33	7.8	15200	6.98	15.8	1.9
July.2009	29.0	27	8.6	16730	6.81	16.2	1.8
Aug.2009	29.3	15	9.6	17230	7.17	17.11	1.6
Sep.2009	26.0	9	9.8	17970	7.15	18.23	1.2
Oct.2009	18.0	5	10.4	19400	7.78	19.76	1.54
Nov.2009	-	-	-	-	-	-	-

- Water absence

Sediment

The fraction of sediment in SNR were dominated by clay consisted 48% in S1 and 51% in S2, While silt was 45% in S1 and 41% in S2 (fig. 3). Total organic Carbon in SNR sediments ranged between 0.23-0.56 g/kg in S2. Highest mean value was during second period (fig. 4). The one way ANOVA test showed significant difference in TOC between two periods. The results showed that the concentration of total nitrogen (TN) in SNR sediments ranged between 2.6-6.49 mg/l in S2 . The concentration of total phosphorus (TP) in the SNR sediment ranged between 18.68 and 23.56 mg/l in S2. Higher values were recorded during second period (fig. 5).

Submerged aquatic plants

Eight species of submerged aquatic plants were observed in SNR wetland in the first period, while it were absent in the last months. Biological indices of Shannon- Wiener species diversity index (H') for submerged aquatic plant species were higher in S2 (1.24 ± 0.18) than S1 (0.67± 0. 08). The species richness was maximum in S2 (1.57 ± 0.14) and lower in S1 (0.31 ±.06). At SNR the submerged aquatic plants of S1 were most evenly distributed all throughout the year with 0.97 ± 0.06, while it was 0.60 ± 0.03 in S2. Significant variations ($p< 0.05$) were noted for the diversity index (H') and evenness (E) between the two Stations.

Decrease in number of submerges aquatic plants species was clear from June 2009 to the end of November 2009 compared with first five months (Dec.2008-May 2009) for both Stations (Table 3 and figure 6). The results of species richness, Diversity and richness index were decreased to zero in both Stations in the last months due to absence of all submerged aquatic plant species.

The results from figures 7 and 8, the total vegetation cover was maximum during March 2009, the average value in S1 was 7.2±0.6 % while it was 10.62± 0.73 % in S2 .

Hydrilla verticillata was exotic species recorded in S2 only not exceed 5% of vegetation cover. *Ceratophyllum demersum* was the most abundant species consisted 40% and 87% in Stations 1 and 2 respectively. *Chara vulgaris* was the most abundant species in S1 consisted 60% of submerged community.

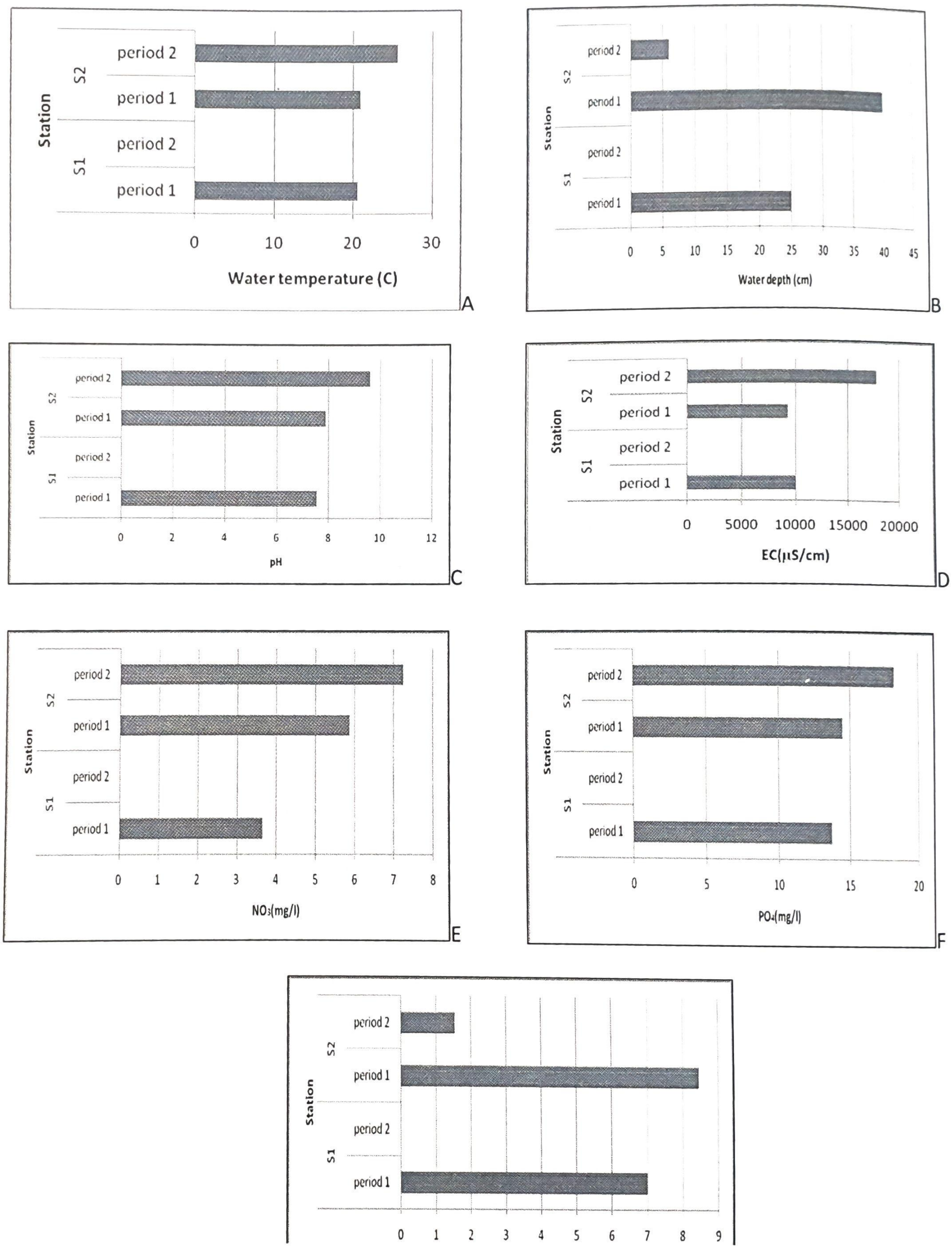


Fig 2 (A-G): Changes of water quality between stations and periods in Saffia natural reserve during Dec.2008-Nov.2009

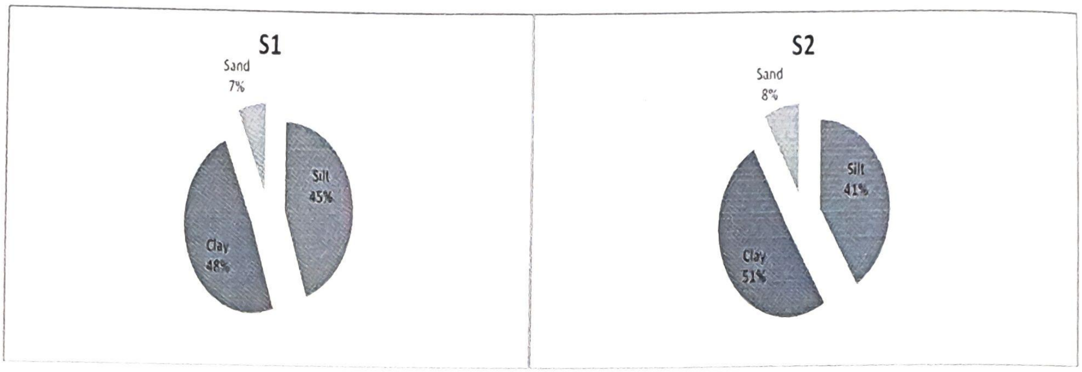


Fig.3: Component of sediment in the two Stations of Saffia natural reserve

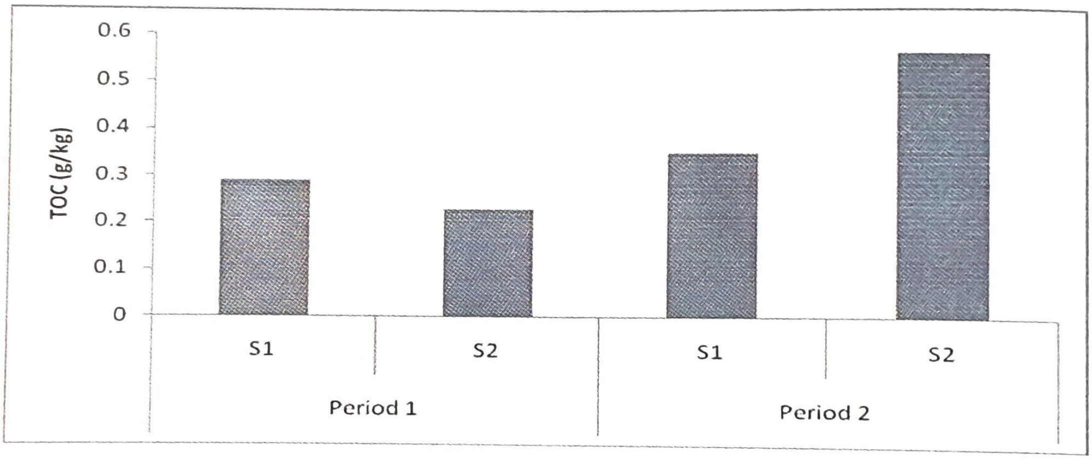


Fig.4: TOC of Saffia natural reserve sediment during two periods

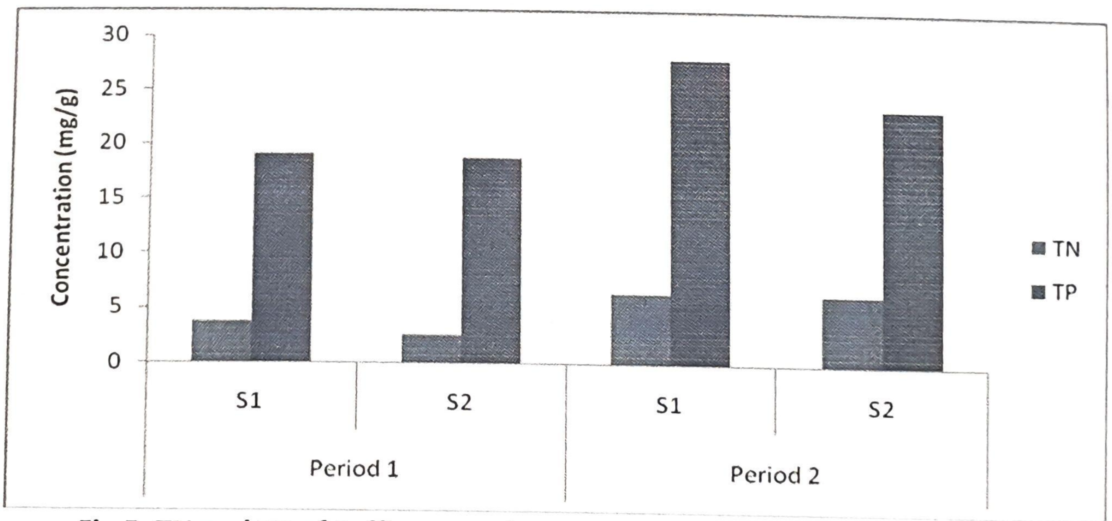


Fig.5: TN and TP of Saffia natural reserve sediment during study period

Table 3:Effect of water presence and absence on the occurrence and biological indices of submerged aquatic plants species in Saffia natural reserve during Dec.2008-Dec.2009

Species	First period		Second period	
	S1	S2	S!	S2
Ceratophyllum demersum	+	+	-	-
Myriphyllum spicatum	-	+	-	-
Potamogeton crispus	-	+	-	-
Potamogeton perfoliatus	-	+	-	-
Potamogeton pectinatus	-	+	-	-
Najas marina	-	+	-	-
Hydrilla verticillata	-	+	-	-
Vallisneria spiralis	-	+	-	-
Chara vulgaris	+	-	-	-
No. species	2	8	0	0
Shannon-Wiener Diversity index	0.67±0.08	1.24±0.18	0	0
Richness index	0.31±0.06	1.57±0.14	0	0
Evenness	0.97±0.06	0.6±0.03	0	0

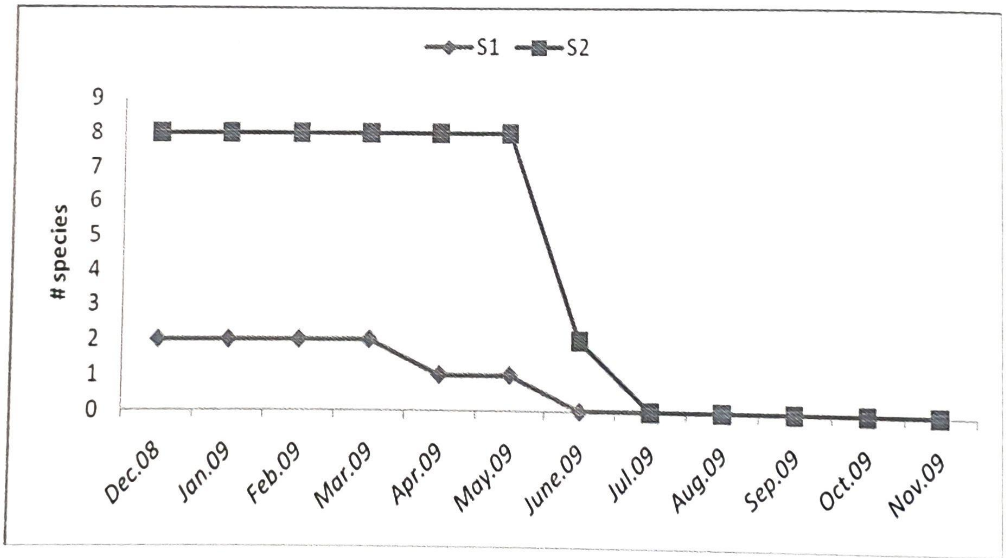


Fig. 6 : Number of submerged aquatic plant species in Saffia natural reserve during study period

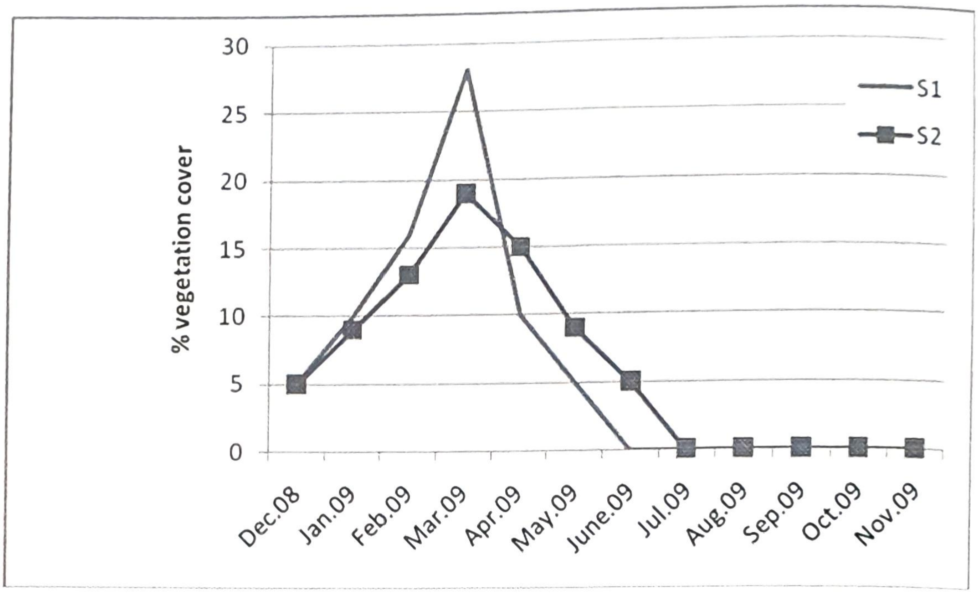


Fig. 7 : Monthly changes in submerged aquatic plant species vegetation in Saffia natural reserve during study period

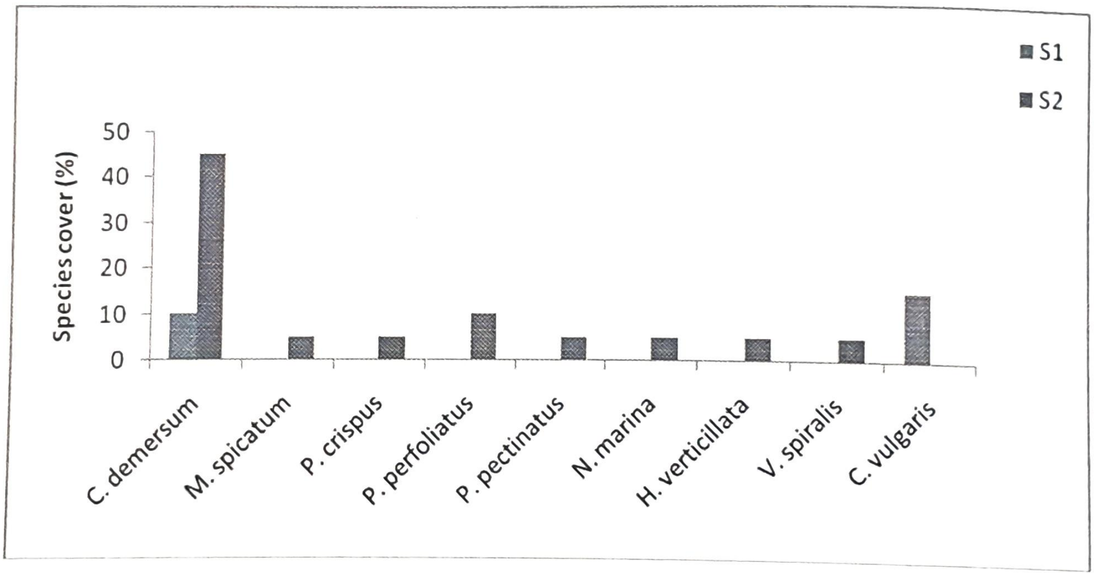
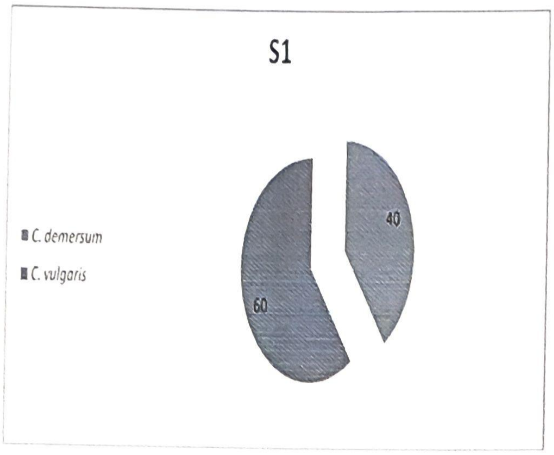


Fig. 8: Submerged aquatic plant vegetation cover (%) in both Stations of Saffia natural reserve



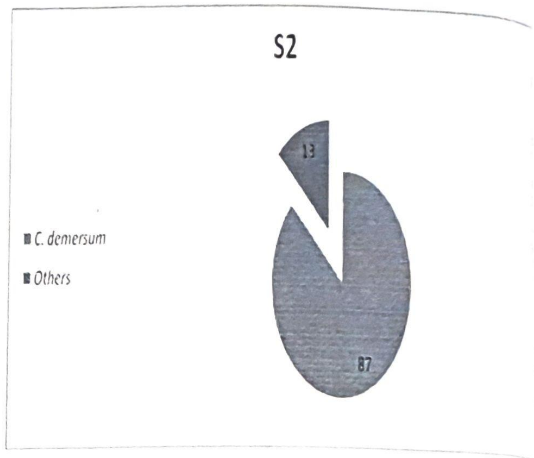


Fig. 9: Submerged aquatic plant abundance (%) in both Stations of Saffia natural reserve

DISCUSSION

The conservation of nature, management of such habitats irrespective of their sizes is necessary (Maltby *et al.*, 1999). To study any ecosystem the aquatic plants serve as important component as they are considered as important health indicators of the ecological conditions and productivity of an ecosystem. The program of ministry of agriculture was to preserve SNR wetland as a project of biodiversity. After 2003 the restoration of this wetland was successes through monitoring of progress in establishing new plant communities. During end of 2008 the quantity of water from sources that fed SNR was diminished and affected both water quality and plant communities.

Water quality was classified in to two groups, first from the beginning of the study till June 2009 and the other group was represented by July 2009 to the end of the study. The classification was done depending on the two status of water quantity and degree of water degradation as results of continues changes in different parameters. It was clear evidence from the results of present study that first period was better than the second one. This matter gave submerged aquatic plant species the chance to occurred and established in this environment.

Schneider (1994) examined the effects of water level fluctuations on some plant communities for two pond shores in Long Island, New York, affirming that "even small differences in hydroperiod may have major influence on wetland community structure. Lake (2000) suggested that there is a strong link between disturbance and biotic diversity of streams at the appropriate spatial scale, while Ellison (1994) and Burkert *et al.* (2004) were explained the effect of water chemistry and disturbance on the aquatic plant communities. The changes that happened and disturbed SNR wetland were acutely affected and threatened submerged macrophytes. The submerged aquatic plants in SNR were more affected than emerged plants because of degradation of its environment. Significant number of studies has been devoted to understanding the specific relationship between hydrology and the response of plant species and communities.

The sediment of SNR was also changed during the study that reflected on submerged aquatic plants species. Zahran et al.(1996) demonstrate the distribution of some aquatic species as best correlated along a gradient of soil variables, the most important being salinity, moisture content, soil texture, organic matter, and calcium carbonate. TOC in SNR sediment may have its origin either from organic matter from natural sources such as plant materials deposited on sediments. TOC content of sediments are predominantly associated with the fine fraction, through adsorption at clay surface (Greenland and Hays, 1981). Temporal variations in SNR had direct and indirect effects on factors influencing nutrient fluxes (Thayer, 1971). Nutrient concentrations and distributions have therefore seasonal patterns (Baird and Ulanowicz, 1989).

The presence of submerged aquatic plants in the first five period played a significant role in accumulation such of nutrient content, and act as nutrient sinks, most obvious way is nutrient incorporation in plant biomass. Submerged aquatic plants were enhanced sedimentation and counteract resuspension of sediment particles, thus restricting the return of nutrients already stored in bottom sediments. In the later after submerged aquatic plants had died it released nutrient that were available and taken by other plants. This matter can explain the addition of nutrient in the second period of the present study.

Aquatic plant habitats in both stations were characterized by spatial and temporal variations of physical and chemical parameters. The floristic composition of submerged aquatic plant species reflected the combination of environmental factors, hydrological and chemical factors. Less species were recorded In S1, probably it was more disturbed than S2. Submerged aquatic plant species richness decreased with time. With the exception of Evenness index for the wetland stations, the diversity indices indicated a decrease in submerged aquatic plant species diversity. The slightly greater Evenness index for the species in S1 indicated more evenness of abundance rankings.

Vegetation cover of submerged aquatic plants species were progressed in the first period due to the conditions of Nitrate and phosphate presence in wetland water continually.

The correlation between water level and the mean of plant cover ($r=0.86$, $p<0.05$) suggested that water level has an important role in determining the size of the vegetation cover. The conductivity values obtained in this SNR were higher that values which support the growth of macrophytes. Bini *et al* (1999) gave electrical conductivity value of 36-260 μS/cm as the range which support massive growth of aquatic macrophyte. In the second period water with higher conductivity inhibit the growth of submerged aquatic plant species as this matter was reported by Haller *et al.* (1974). The consequential effects of the submerged aquatic plant growth, abundance brought about changes in limnological conditions of the submerged aquatic plant as reflected in means values of physic-chemical factors of SNR. Low dissolved oxygen might occurred as a result of the water loss and also the decomposition of the macrophyte, since decomposition make use of oxygen.

The fact that frequent or prolonged presence of water at or near the sediment is the main factor determining the species composition of plant communities. Alteration of SNR hydrology changed the sediment chemistry and the plant community. Alteration which reduces the natural amount of water entering SNR or the period of saturation and inundation, in time, caused the ecosystem to change to an upland system. This alteration can be natural, such as stream impoundment from Iranian side.

These aquatic habitats represent disturbed environments, which are characterized by low water quantity and degradation of water quality and absence of submerged aquatic plant species. Unless sufficient quantity of water the SNR wetland will dry and be like a desert.

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