VARIATION OF SOME WATER QUALITY PARAMETERS OF HUWAIZA MARSH IN SOUTHERN IRAQ

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Abstract

Huwaiza marsh is considered the largest marsh in the southern part of Iraq. It is located between 31° and 31.75° latitude and extends over the Iraqi-Iranian border; but the largest part lies in Iraq. It is located to the east of Tigris River in Messan and Basra governorates.

In this research, the variation of some water quality parameters at different locations of Huwaiza marsh were studied to find out its efficacy in the treatment of the contamination coming from the wastewater outfall of Kahlaa brokendown sewage treatment plant which lies on the Kahlaa River. This rive is the main feeder of Huwaiza marsh. Ten water quality sampling locations were chosen in this marsh. The water samples were taken during 2009 for three months; January, April and August representing winter, spring and summer respectively. The results of water quality analyses showed that Kahlaa untreated sewage had a negative impact on the water quality of Huwazia marsh; especially in its upstream region. Analyses of water samples taken from the middle and downstream end of the marsh showed that the marsh water is safe for fishing and swimming in these regions.

الخلاصة

يعد هور الحويزة من اكبر الاهوار في جنوبي العراق. يقع الهور بين خطي طول 31° و31,75° حيث يمتد عبر الحدود العراقية الايرانية ; ولكن يقع الجزء الاكبر منه في العراق شرق نهر دجلة في محافظتي ميسان و البصرة.
في هذا البحث تم دراسة تغيرات بعض مؤشرات نوعية المياه في مواقع مختلفة من هور الحويزة لايجاد كفائته في معالجة التلوث القادم اليه نتيجة طرح مياه الصرف الصحي غير المعالجة من محطة الكحلاء العاطلة والواقعة على نهر الكحلاء . يعد نهر الكحلاء من اهم الانهر المغذية للهور. تم اختيار عشرة مواقع لاخذ عينات لتحديد نوعية المياه. اُخذت العينات خلال سنة 2009 ولثلاثة اشهر ; كانون الثاني، نيسان و أب ممثلة للشتاء والربيع والصيف على التوالي. بينت نتائج التحليل ان مياه الصرف الصحي غير المعالجة لها تأثير سلبي على نوعية مياه هور الحويزة وخاصة في مناطق مصب نهر الكحلاء. كما بينت النتائج المأخوذة من وسط ونهاية الهور امكانية استخدامه لصيد الاسماك والسباحة في هذه المناطق.

Keywords: Wetlands, Huwaiza marsh, Water quality parameters, Organic pollution, Faecal Coliform.

Introduction

Wetlands, as defined by the Ramsar convention on wetlands, include a wide variety of habitats such as marshes, peat lands, floodplains, rivers and lakes, as well as coastal areas such as salt marshes, mangroves, and sea grass beds. It also includes coral reefs and other marine areas no deeper than six meters at low tide, in addition to human-made wetlands such as wastewater treatment ponds and reservoirs (**Ramsar Convention Secretariat, 2004**).

The amount of water in wetlands varies depending on the weather and the time of year. Plants, such as reeds, grow in wetlands area. Wetlands also provide a home for a host of different wildlife ranging from migratory and local birds to fish, reptiles, amphibians and insects (**Chouhan Paridhi, 2008**).

Many studies were conducted by Iraqi ministries, organizations, and associations as well as UNEP teams which were related to the restoration of water quality and ecology of marshes.

The demise of the marshes in Iraq began during the Iraq-Iran war. As a result many dykes, embankments, and drainage canals were constructed by the two countries as they struggled to gain military advantage using water as a military tool. After 1991 many diversion canals were constructed in the marshes to reclaim land for agricultural purposes. Additionally, Turkey and Iran have constructed dams on the headwaters of the Euphrates, Tigris and Karkha Rivers, resulting in the reduction of the amount and quality of the water reaching southern Iraq (**Alwash Azzam et al.**, **2007**).

The marshes of Iraq were once famous for their biodiversity and cultural richness. They were the permanent habitat for millions of birds and a migrating flyway between Siberia and Africa (**Maltby 1994, Evans 2002 qtd. by Richardson and Husssain, 2006**).

Partow (2001) studied the hydrology of the marshes of Iraq and mentioned that less than 10 % of their area remained as functioning marshland by the year 2000. The only remaining marsh was the northern portion of Huwaiza; the other two marshes, Hammar and Central were totally desiccated. This researcher also concluded that only 15 to 20 % of the dried marshes could be restored because of excessive salinity, environmental pollution, and lack of availability of fresh water. **Fig.1** shows the analysis of Landsat satellite imagery of marshlands area (**UNEP, 2001**).

After May 2003, water began to return to the marshlands. In 2004, up to 40% of the former marshlands were reflooded. Some of the reflooded areas experienced rapid regrowth of marshland vegetation, other areas are slowly recovering; while some reflooded areas remain barren. The marsh

dwellers are also coming back, with as many as 42,000 people returning to their traditional life styles within the reflooded areas. **Fig. 2** shows the Iraqi marshland in 2007.

The background image in Fig.2 is Landsat satellite image of Huwaiza marsh with resolution 250 m and was taken in September 2007.

Al-Musawi (2009) studied the water quality of Al-Hammar marsh in the south of Iraq. He mentioned that due to unavailability of Iraqi environmental regulations regarding marsh water on the one hand and the lacking of any actual water quality parameter values of such waters prior to desiccation on the other hand, his only recourse was to compare the recently obtained parameter values with the various water use categories; notably, irrigation, drinking and fishing.

Sometimes marshes are used for wastewater treatment. This kind of use has increased dramatically in the last decade, particularly for small scale applications such as individual homes and small villages (**Wallace and Knight, 2006**). Marshes are useful for nutrient recovery and cycling, releasing excess nitrogen, inactivating phosphates, removing toxins, chemicals and heavy metals through absorption by plants. Removal of suspended solids from flowing water occurs through flow reduction. Additionally retention of water for a long time whereby biological, physical and chemical processes occur periodically is beneficial. Huwaiza marsh can be considered as a natural free water surface (FWS) marsh; a large area of water with a combination of floating vegetation. The major processes that occur within FWS marshes are summarized in **Fig.3**.

Huwaiza marsh is considered the largest marsh in the southern part of Iraq. It is located between 31° and 31.75° latitude and extends over the Iraqi-Iranian border; but the largest part lies in Iraq. It is located to the east of Tigris River in Messan and Basra governorates. There is no definite area for the marsh due to seasonal and annual changes resulting from variations in the water amount reaching the marsh. According to the satellite image shown in **Fig.2** and by using geographic information system programs like ArcView GIS version 9.3, the net surface area of the marsh is approximately 2400 km^2 on the date of this image.

Huwaiza marsh is fed directly by three sources: the western source is the Tigris River through the Kahlaa, Musharah and Majar branches; the eastern source is from Iran through Karkha River. The marsh water returns to the Tigris River by many outlets, the most important ones are Swaib and Kassara outlets. Huwaiza marsh has been included in the Ramsar Convention on Wetlands since 17 February 2009.

In this research, the variation of some water quality parameters of Huwaiza marsh was studied to find out its efficacy to treat the contamination coming from the wastewater outfall of Kahlaa brokendown sewage treatment plant. Kahlaa River is the main feeder of Huwaiza marsh.

Field Work and Experimental Data

Sampling is a vital part of studying the quality of water. A major source of error in the whole process of obtaining water quality information often occurs during sampling. Poor management decisions based upon incorrect data may result if sampling is performed in a careless and thoughtless manner. Obtaining good results will depend on a great extent upon the following factors:

1. Ensuring that the sample taken is truly representative of the water under consideration.
2. Using proper sampling technique (e.g use of sterilized bottles for microbiological testing).
3. Protecting and preserving the samples until they are analyzed in laboratories.

Samples were taken from locations that were considered representative of contamination sources or where contamination was suspected. Ten water quality sampling locations were chosen. All water samples were taken from 60 % of the water depth. The sample bottles were labeled with an identifying code (such as HZ 3, in which HZ refers to the Huwaiza marsh and 3 refers to sample location). The geographic coordinates of sample locations were fixed using GPS device (type: GARMIN,eTrex). The GPS measurements can be plotted on a map or used to return to the same site in the future. The following table shows the geographic coordinates of the ten water sample locations and their site description.

An important part of undertaking water quality studies is to know what parameters one should sample and analyze. There are a number of water quality parameters that could be measured and it is important to make a good judgment of what are likely to be the most important ones in a particular situation. Hence, an initial surveying was carried out to obtain information on any known activities that might affect water quality of Huwaiza marsh, e.g. sources of human and animal wastes, industrial activities and agricultural farms. Essential parameters to be measured would be those that indicate a risk to human health or the environment, those with potential to cause public complaints, and those which indicate a likelihood of causing operational problems in water treatment plants. Some chemical analyses are expensive and difficult to carry out, In addition it should be emphasized that laboratory facilities play an important role in the selection of water quality parameters that should be analyzed in an environmental assessment. **Mosley et al. (2004)** suggested the most important parameters to analyze in different water types. **Table 2** shows these parameters.

Initial surveying of Huwaiza marshland gave the following important information:

- Many organic waste sources are spreading near the feeder rivers of the marsh such as villages and small human settlements, so that biochemical oxygen demand (BOD) should be analyzed to find out the extent of organic pollution.

- Lack of industrial discharges containing metals so that there is no need to analyze metals.
- It is difficult and expensive to accurately analyze the following parameters: chemical oxygen demand (COD), ammonia, pesticides and radioactive constituents.
- Absence of oil fields/fuel spills in Huwaiza marsh area precludes oil and grease analyses.

Consequently, the following eleven surface water analyses became relevant: faecal coliform, turbidity, total dissolved solids (TDS), total suspended solids (TSS), nitrate (NO_3), phosphate (PO_4) and five-day biochemical oxygen demand (BOD_5), as well as direct measurements using portable devices for temperature, pH, dissolved oxygen (DO) and electrical conductivity (EC).

All the water samples were taken during 2009 for three months; January, April and August representing winter, spring and summer respectively. The water samples were submitted to analyses by "Standard Methods", (APHA, 1999). Fig.4 shows the locations of water samples taken from Huwazia marsh

Results and Discussion

The temperature of the natural water system depends mainly on the ambient temperature (temperature of the surrounding atmosphere). In general, as the temperature increases the saturation of dissolved oxygen in water decreases and vice versa. **Fig.5** shows the variation of water temperature in different location in Huwaiza marsh. It can be noticed that there is no or slightly change in water temperature along the marsh for three seasons, so that it can be conclude that the temperature of Huwaiza marsh depends on the ambient temperature to a great extend due to the large water surface area.

Many factors affect the concentrations of dissolved oxygen in a water body, among them organic pollution, temperature, light penetration, water movement, availability of plants and nutrients. **Fig.6** shows the results of dissolved oxygen concentrations of the ten samples. The lowest value of dissolved oxygen was obtained at location HZ 1, between 3 to 4 mg/l due to municipal wastewater pollution. At location HZ 2 it increases and reaches its maximum value at location HZ 7 (between 7 to 8.2 mg/l) in the middle of the marsh and then varies slightly at the end of the marsh. Therefore, the marsh improves the dissolved oxygen level due to the high rate of atmospheric aeration and photosynthetic process of aquatic plants abundant in the marsh.

pH is a measure of the hydrogen ion (H^+) concentration in water, it is an important parameter for describing the state of chemical processes. Water with pH greater than 8.5 is called hardwater; hardwater does not pose a health risk, but can cause aesthetic problems (**Mosley et al. 2004**). In **Fig.7** the pH of all the water samples were around 8 except that at HZ 1 location which was greater than 8.5 due to the disposing of municipal wastewater from Kahlaa treatment plant.

Fig.8 shows the laboratory results of BOD_5 analyses and it can be noticed that there is a logical high concentration at HZ 1 location due to the high organic loading coming from Kahlaa plant. Nevertheless, a sharp decrease occurred after a few meters downstream of this location; reaching below 50 mg/l at the middle of the marsh. This can be attributed to two factors; first, there are no industrial activities that discharge pollutants directly into the marsh, and human pollution is low due to a limited number of small villages spreading inside Huwaiza marsh; second, the spreading of plants and the slow water velocity permit a long term of atmospheric aeration and photosynthetic activity which increase the efficiency of organic pollution digestion by bacteria.

Many inorganic ions such as sodium, chloride, magnesium, and calcium are present in surface water. EC or TDS is a measure of how much total salt (inorganic ions) is present in the water; the more ions the higher the conductivity. **Fig.'s 9 and 10** show the variation of EC and TDS concentrations respectively. It can be noticed that there is a fluctuating variation in the values of these parameters due to the following points:

- The first location reveals relatively high values of EC and TDS due to wastewater disposal from Kahlaa plant. These values decrease notably in samples taken from the middle of the marsh due to dilution from other feeders and the phytotechnology process that contributes to the decrease of TDS.

- EC and TDS values rise again especially at locations HZ 7 and HZ 8 because of the proximity of the Iranian dyke which sometimes leaked drainage water.

In **Fig.10** it can be seen that TDS concentrations were higher in summer compared with those in spring and winter. The high water losses in summer due to evapotranspiration process leads to higher TDS values in Huwaiza marsh. **Fig.11** shows the monthly evapotranspiration losses (**Iraqi Ministries of Water Resources, Municipalities and Public Works, and Environment, 2005**).

There are several different chemical compounds which are termed nutrients; most containing one of the elements nitrogen or phosphorous. In water, they provide nutrients for the primary producers such as algae, phytoplankton and seaweeds. If the nutrients reach high levels in water exposed to light, algal problems may arise. **Fig.'s 12 and 13** show the variation of NO_3 and PO_4 in Huwaiza marsh. There are high levels of NO_3 and PO_4 in the first half of the marsh because of the feeding of water containing high concentrations of NO_3 and PO_4 coming from the disposal of untreated municipal wastewater and a wide spread of agricultural farms that use fertilizers. These two ions gradually decrease subsequently due to the consumption by algae and phytoplankton whose spread at the water surface can be seen with the naked eye.

Fig.'s 14 and 15 show the variation of turbidity and TSS concentrations in the marsh. It is obvious that turbidity and TSS concentrations decrease as soon as the water flows through the marsh due to the low flow velocity (sometimes the water is virtually stagnant) and shallow water properties (**Al-Musawi, 2009**).

Disease causing microorganisms (pathogens) include salmonella, shigella, eschorichia coli, cysts or entamoeba histolytica, parasite ova, viruses and infectious heptitis. Usually the water is tested for faecal coliform to see the level of bacterial contamination (**Mosley et al., 2005**). Water used for primary contact activities (swimming, bathing) and for secondary contact activities (boating, fishing) should be safe from bacterial contamination. As pointed out previously, the water of the marshes may be used for these two kinds of contact activities. The Australian water quality guidelines for fresh and marine waters recommend that for primary contact activities the water should not have more than 150 Faecal Coliform/100ml and for secondary contact activities the water should not have more than 1000 Faecal Coliform/100ml (**ANZECC 1992 qtd. by Mosley et al., 2005).**

Fig.16 shows that there is a high bacterial contamination in locations downstream of the outfall of Kahlaa sewage plant; i.e. at the upstream end of the marsh. However, the level of bacterial contamination farther inside the marsh was found to be low reaching below 100 Faecal Coliform/100ml especially at locations HZ 4 to HZ 10. It can be concluded that whenever the Kahlaa sewage treatment plant is properly put back to work, all the marsh water may be considered safe for both primary and secondary contact acitivties like fishing and swimming.

Conclusions

1. Due to Kahlaa sewage treatment plant being brokendown, the untreated sewage had a negative impact on the water quality of the upstream region of Huwazia marsh. However, the analyses of water samples taken from the middle and downstream end of the marsh showed that the marsh water is safe for fishing and swimming in these regions.
2. Because of the large surface area of Huwaiza marsh, the temperature of water varies slightly and depends largely on the ambient temperature.
3. The untreated wastewater from Kahlaa plant decreases the dissolved oxygen concentration below the allowable limit; but the marsh has the ability to improve the dissolved oxygen level back to its normal concentration.
4. All the water samples showed that the pH value was in the zone of low bacisity (7.5-8.5).
5. According to the laboratory results of BOD_5, Huwaiza marsh was efficient in treating organic pollution, sometimes reaching above 80%.
6. In Huwaiza marsh, removal of suspended solids occurs at the first few meters when the water enters the marsh due to low flow or nearly stagnant conditions and shallow water.
7. Despite of the TDS concentration decrease due to dilution by fresh water, drainage water

caused an increase in TDS concentration especially during the hot season.

8. The removal of nitrate and phosphate varied from 25 to 40% and depended on the agricultural season and the wastewater discharge.

Acknowledgment

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Table 1: Code, geographic coordinate and site description of the ten water sample locations

Code of water sample	Location		Site description
	E	N	
HZ 1	717129	3505861	This point represents the mixing zone between fresh water and the sewage discharged from Kahlaa plant.
HZ 2	736687	3496408	Point at the mouth of Kahlaa River with the marsh.
HZ 3	746511	3493290	Point inside the marsh.
HZ 4	751514	3492804	Point inside the marsh.
HZ 5	750885	3486989	Point inside the marsh.
HZ 6	752790	3483178	Point inside the marsh and near Iranian dyke.
HZ 7	753343	3474203	Point inside the marsh and near Iranian dyke.
HZ 8	744430	3483793	Point inside the marsh
HZ 9	738098	3476047	Point at Kassara outlet to the Tigris River.
HZ 10	741356	3441007	Point at Al-Swaib outlet to the Tigris River.

Table 2: Typical water quality parameters to be measured in different water types (Mosley et al., 2004)

	Water Type		
	Drinking	Surface	Marine
Microbiology:			
Total Coliform	Yes	No	No
Faecal Coliform	Yes	Yes	Yes
Physical:			
pH	Yes	Yes	No
Temperature	Yes	Yes	Yes
Colour	Yes	No	No
Turbidity	Yes	Yes	Yes
Conductivity/Total Dissolved Solids	Yes	Yes	No
Salinity	No	No	Yes
Dissolved Oxygen	No	Yes	Yes
Total Suspended Solids	No	Yes	No
Chemical-Inorganic:			
Ammonia	No	Yes	Yes
Nitrate	Yes	Yes	Yes
Nitrite	No	Yes	Yes
Phosphate	No	Yes	Yes
Hydrogen Sulphide	Periodically	No	No
Sulphate	Periodically	No	No
Fluoride	Periodically	No	No
Chloride	Yes	No	No
Hardness	Periodically	Periodically	No
Metals:			
Aluminum	Periodically	Periodically	Possibly
Cadmium	Periodically	Periodically	Possibly
Copper	Periodically	Periodically	Possibly
Iron	Periodically	Periodically	Possibly
Manganese	Periodically	Periodically	Possibly
Lead	Periodically	Periodically	Possibly
Zinc	Periodically	Periodically	Possibly
Chemical-Organic:			
BOD	No	Yes	Yes
COD	No	Yes	No
Oil and Grease	No	Possibly	Possibly
Pesticides	Periodically	Possibly	Possibly
Radioactivity	Possibly	Possibly	Possibly

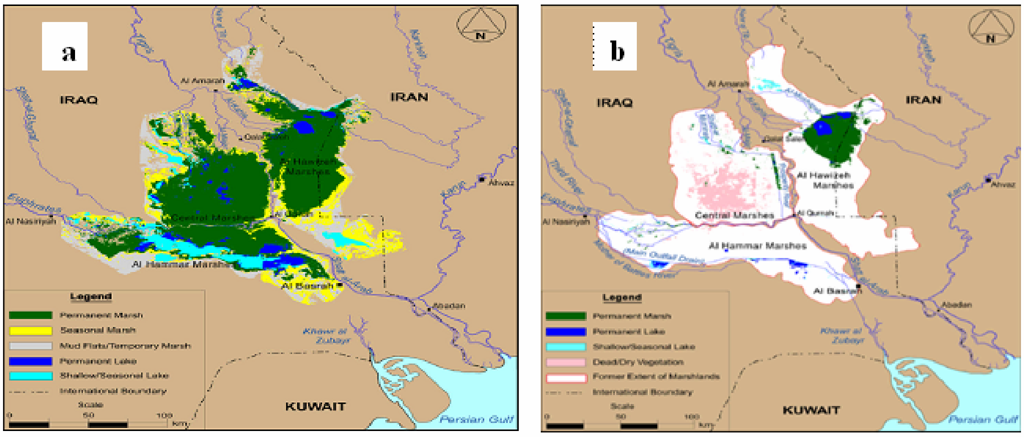

Fig.1 The Mesopotamian marshlands in Iraq, a: 1973-76, b: 2000
(After UNEP, 2001)

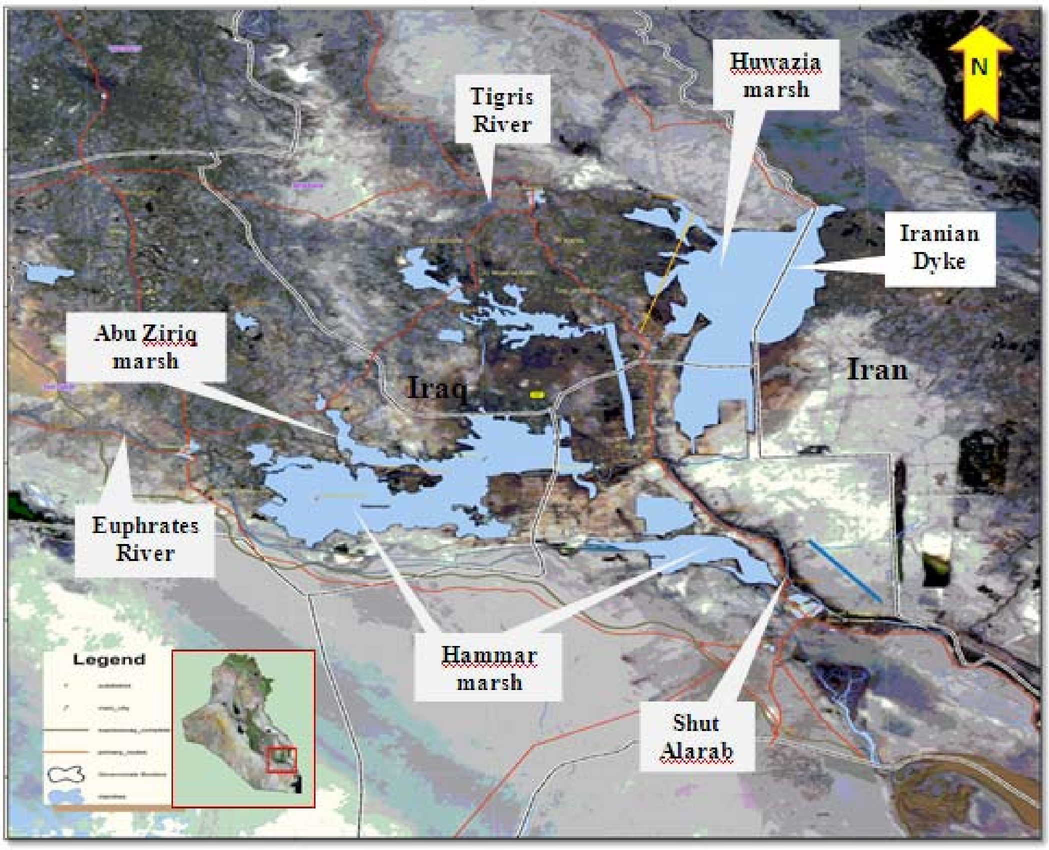

Fig.2 Iraqi marshland in 2007

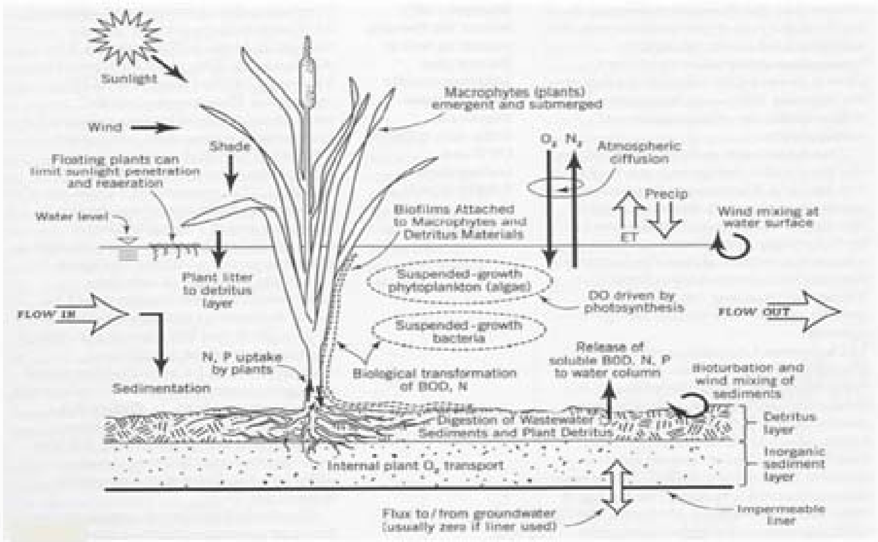

Fig.3 Major treatment processes in FWS marshes (After Wallace and Knight, 2006)

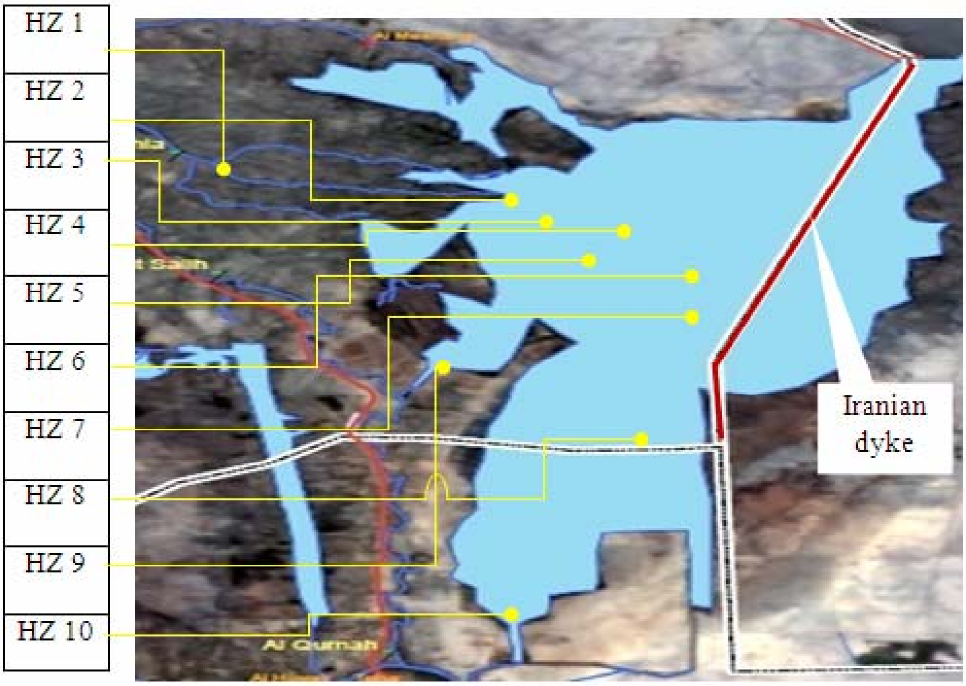

Fig.4 locations of water samples taken from Huwazia marsh

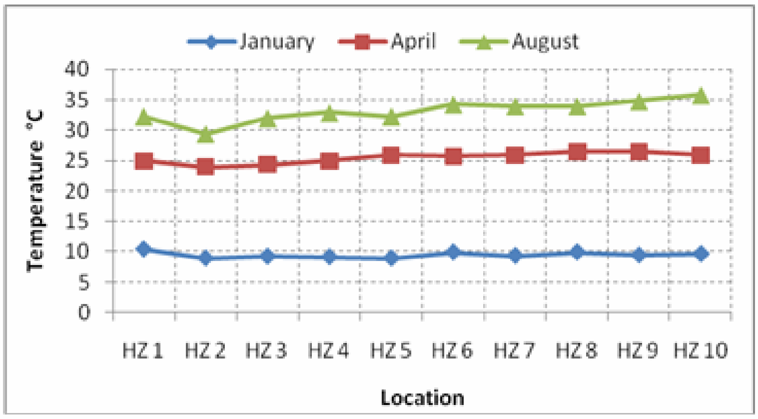

Fig.5 Variation of water temperature

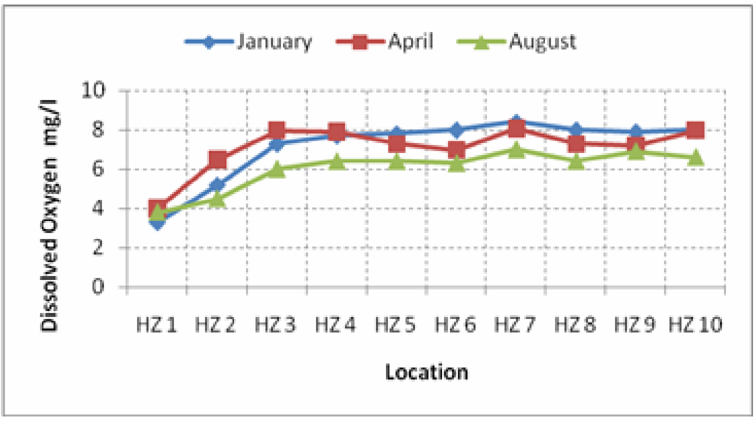

Fig.6 Variation of dissolved oxygen

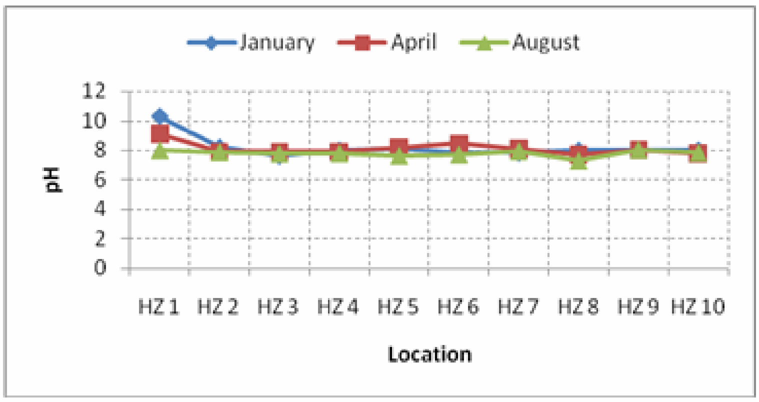

Fig.7 Variation of pH

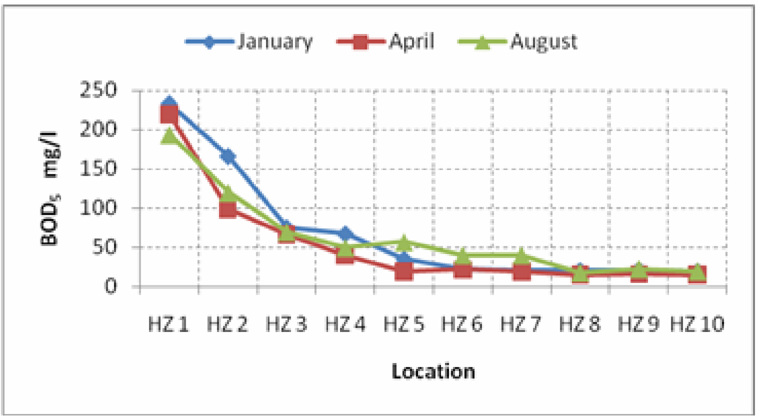

Fig.8 Variation of five-day biochemical oxygen demand

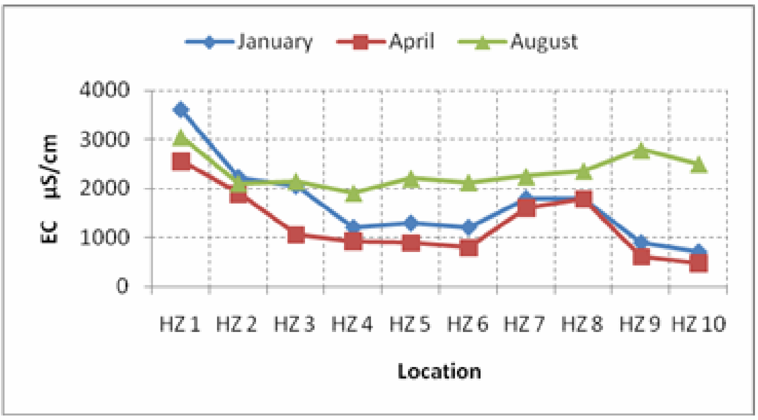

Fig.9 Variation of electrical conductivity

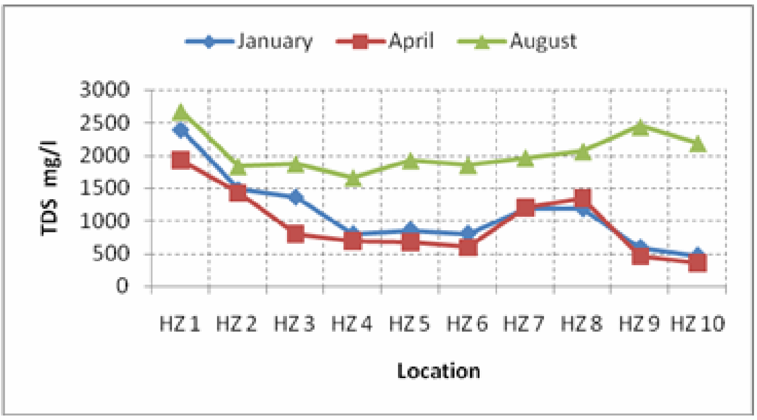

Fig.10 Variation of total dissolved solids

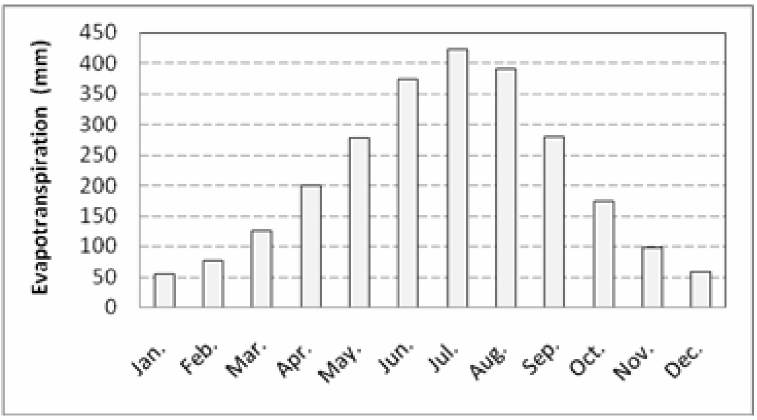

Fig.11 Monthly evapotranspiration losses in Huwaiza marsh

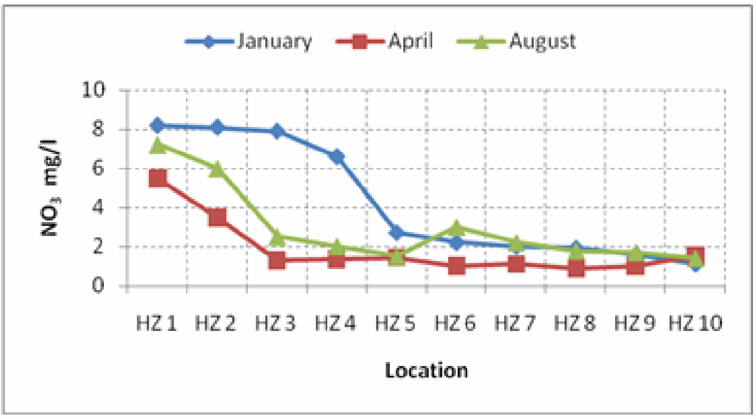

Fig.12 Variation of nitrate

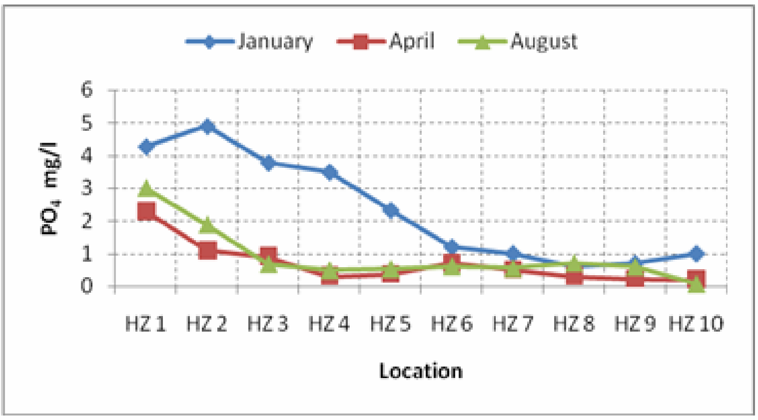

Fig.13 Variation of phosphate

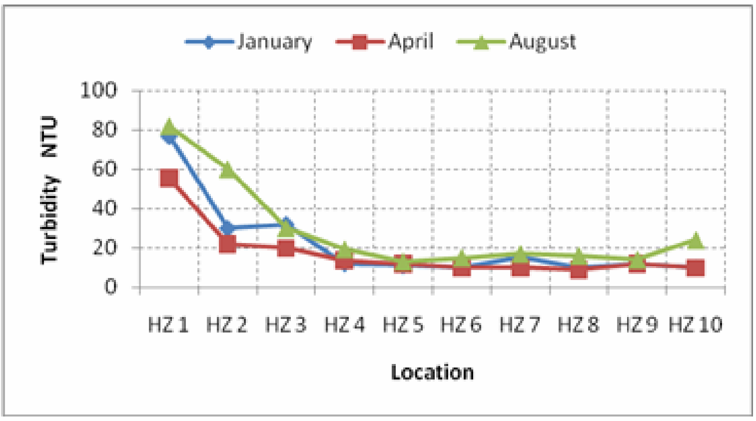

Fig.14 Variation of turbidity

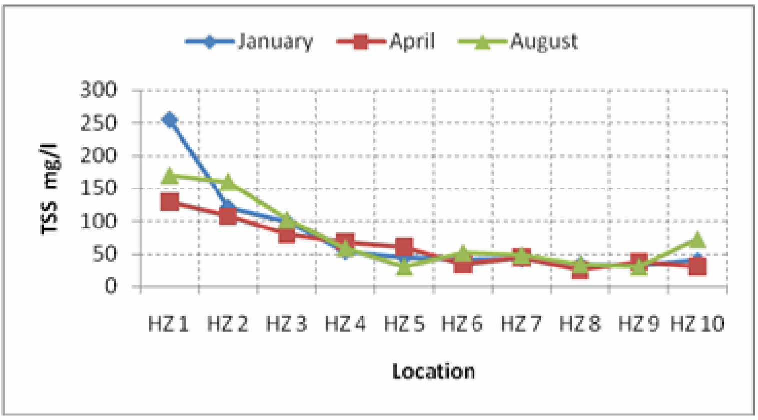

Fig.15 Variation of total suspended solids

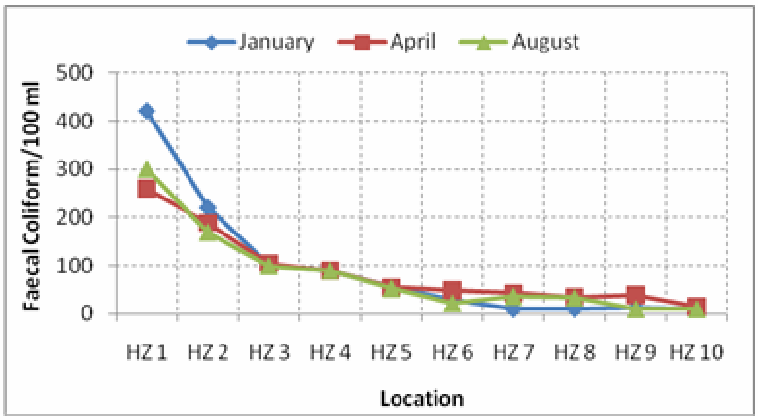

Fig.16 Variation of faecal coliform per 100ml water sample