Water quality index (WQI) for three southern restored marshes (East Hammar, Al-Huwaza, Suq Al-Shouykh) during the years 2005, 2006, 2007 and 2008.

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ABSTRACT

The WQI of the southern marshes (Al-Huwaza, East Hammar and Suq Al-Shouykh) were calculated according to the Canadian formula during the years 2005, 2006, 2007 and 2008.

Eight parameters were used include temperature, salinity, total dissolved solids, dissolved oxygen, pH, biological oxygen demand, orthophosphate and nitrate.

The results showed the water quality index (WQI) of the restored marshes was marginal (45-65) from scale of five categories .The highest Water quality of marshes was recorded during 2007, epically in Al-Huwaza and Suq Al-Shouykh marshes . East Hammar marsh showed higher average WQI during the survey period .Suq Al-Shouykh scored higher average of variances than those of the other two marshes.

INTRODUCTION

Water is one of the most important natural resource to sustain life and environment (Pesce and Wunderlin, 2000). Quality of water is defined in terms of its physical, chemical, and biological parameters (Bayacioglu, 2009). As certainly the quality is very crucial before use for various purposes such as drinking, agricultural, aquatic life, recreational, and industrial uses; etc (Khan *et al*., 2003).

Monitoring programs of aquatic ecosystem play a significant role in water quality control since it is necessary to know the contamination degree so as not to fail attempt to regulate its impact (Almedia, 2007). However water quality is difficult to evaluate from a large number of samples, each containing concentrations for many parameters (Almedia, 2007).

Traditional approaches comprise complex variable-by-variable and water body-by-water body statistical summaries, which are inadequate to integrate and interpret a picture of overall water quality to the public, managers, and policy makers, who require concise information about those water bodies (Bayacioglu, 2009).

The water quality index (WQI) is developed to simplify the reporting of compiles and technical water quality data (CCME, 2001).

WQI is a science based on communication tool that tests multi-variable water quality data against specified water quality benchmarks determined by the user (Rosamond, 2009).

The advantages of the WQI are its ability to represent measurements of variety of variables in a single number and the ability to combine various measurement units in a single metric (CCME, 2001).

The southern marshland of Iraq, represent the most important phase-geographical unit in southern Mesopotamia and formed a unique environment in the middle east and south western Asia (Yuaqub& Seikian 1992).This biotopes contains several rare biota threatened to be distinct .Several studied were published about the restored southern marshes concern after more than decay of desiccation like ,Richardson *et al.*, (2005) , Richardson and Hussain (2006) and Taher *et al.*, (2007) , Al-Saad *et al.*, (2008) and Gunzawi (2009) .

Few studies were traced concern with WQI of freshwater wetland, Sharifi (1990) in Iran ,Moundiotiya *et al.*(2004), Sisodia and Moundiotiya (2006) in India .

WQI is defined as a rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of aquatic life based on computed water quality index values.

To evaluate and calculated WQI for the restored southern marshes, the Canadian formula were adopted CCME (2001).

Material and Methods:

The southern Iraqi wetlands ranged from 8,000 to 25,000 km^2, making them the largest wetland system in the Middle East (Partow, 2001; UNEP 2004).

Data were collected from three marshes in southern Iraq included Al-Huwaza, Suq Al-Shouykh and East Hammar ,these data were typically analyzed and to obtain WQI score ,in attempt to assess water quality of these marshes. The basic data used were derived from ARDI (2006) and FAO (2008).

The WQI mathematically combines three measures of variance (Scope, Frequency, and amplitude) to

produce a value between 0 and 100 that represents the overall water quality it a site relative to the benchmark chosen (e.g protection aquatic life) (Rosamond, 2009).

Essentially, the Canadian WQI model consists of three measures of variance from selected water quality objectives (Scope; Frequency; Amplitude). The "Scope (F1)" represents the extent of water quality guideline non- compliance over the time period of interest. The "Frequency (F2)" represents the percentage of individual tests that do not meet objectives. The "Amplitude (F3)" represents the amount by which failed tests do not meet their objectives. These three factors combine to produce a value between 0 and 100 that represents the overall water quality. The formulation of the WQI as described in the CCME (2001) calculated as:

$$WQI = 100 - \left(\frac{\sqrt{F_1^{\,2} + F_2^{\,2} + F_3^{\,2}}}{1.732} \right)$$

The WQI of southern marshes are intended to describe on one range of value, from 0 to 100, the water quality assessed by quality ratings with the relationships that are:

WQI rating	WQI score	Description
Poor	0-44	depart from natural levels
Marginal	45-64	Often depart from natural levels.
Fair	65-79	Sometimes depart from natural levels.
Good	80-94	Rarely depart from natural levels.
Excellent	95-100	Very close to natural levels.

The approach for developing water quality index for marshes aquatic life source consisted of three parts:

(1) Guideline selection: Selecting guidelines that are appropriate in assessing global water quality for aquatic life. The guidelines for the variables selected compared well across Iraqi environmental standards and environmental international agencies, with certain deviation to suit the southern marshes environment and water characteristic their (Table 1).

(2) Variable selection: The following variables are selected, included: Temperature, Salinity, Total Dissolved Solid, Dissolved Oxygen, pH, Biochemical Oxygen Demand, Ortho Phosphate, and Nitrate. These were the major metrics affecting the water quality in southern marshes.

(3) Data range: Data from three marshes selected which measured variables consistently during years (2005, 2006, 2007, and 2008).

Results:

1- **Annual values of WQI of the marshes:**

The highest Water quality of marshes was recorded during 2007; exceeding values of both 2005 and 2008, epically in Al-Huwaza and Suq Al-Shouykh marshes .The level of WQI rating exceed class fair, the same happen in Suq Al-Shouykh during 2008 fig (1).

In general the WQI for the southern marshes improved in 2007 in comparison with previous years, but decline again in 2008.

Fig. (1) Demonstrates WQI values of annual measurements of the parameters at each marsh during years 2005, 2006, 2007 and 2008. Higher WQI value recorded in Al-Huwaza (H) marsh during 2007 and the lower in Suq Al-Shouykh (S) marsh during 2005. While East Hammar (E) marsh was in between.

2-Annual categorization and variance (F1,F2 &F3)

WQI of East Hammar was marginal fluctuating between 56-60 during the years 2008&2007 respectively ,the same happen to three variance as illustrated in table (2).

WQI of Al-Huwaza varied from marginal to fair 49-68 during 2008&2007 respectively .F1 variance score higher values than that of East Hammar with higher F2 also in 2005 & 2008 (table 2).

WQI of Suq Al-Shouykh changed from poor in 2005 to fair 2008 i.e. showing successive annual improvement .F1 variance varied largely from 88 in 2005 & 2006 to 50 in 2008 .F3 scored higher values than that of Al-Huwaza (table 2).

3- **Average of WQI categorization F1, F2 and F3**

East Hammar marsh showed higher average WQI during the survey period in comparison with the other two marshes. Suq Al-Shouykh scored higher average of variances than those of the other two marshes.

Discussion:

The marshes of southern Iraq is the only populated marshes around the world ,consequently their available water resources are used for several purpose namely drinking ,farming ,livestock watering and on top of that the unique wetland environment. The quality and quantity of water are the decisive factors in wetland, with it no marshes existed .On their hand also decide the type of wetland if they are openness or pond wetland or either freshwater or oligosaline.

The increase of discharge of water resources entering to the southern marshes will improve the Water quality as happen during 2006 & 2007 were consider the best in comparison with other years like 2008 .In general the WQI for the southern marshes never

exceed fair class level .Water resource of southern marshes unstable during the last seven years depend largely on discharge of Tigris, Euphrates and Shatt Al-Arab rivers and on annual rain fall in Mesopotamia basin

The variables selected were similar in general to other used in various wetlands. These were the major metrics affecting the water quality in southern marshes.

The water quality index of the southern marshes fluctuate between poor to marginal level depend largely on the particular marsh. WQI of Al-Huwaza and Suq Al-Shouykh are marginal while it was poor in East Hammer marsh, the first two are consider freshwater to oligosaline marshes, the third describrd as brackish water marsh. Al-Huwaza and Suq Al-Shouykh get their waters from Tigris and Euphrates respectively ,with reasonably unimpaired high quality freshwater water .East Hammer get it water from Shatt Al Arab river consider to be polluted by effluent of domestic sewage from Basrah city (Richardson *et al*., 2005). Low quality or polluted water definitely decrease the WQI of that water body like East Hammer marsh simply through the effect on dissolved oxygen level, increase of BOD, increase of nitrate and phosphate.

The low value of WQI of southern marshes could be attributed to several factors ,first the water of the marshes spread over vast area with shallow depths which lead to increase of evaporation especially during extended long summer season (over six months) consequently increase the salinity and conductivity . Secondly the original water resources to the marshes already degraded due to the release of untreated domestic sewage and industrial effluent to the Tigris and Euphrates directly without treatment.

The weak current in marshes resulted in stagnation of water which let more time for interaction between the water column and sediments below increasing the concentration of anions and cations in the water column. On the other hand the marshes are characterized by their higher primary productivity of phytoplankton and aquatic plants resulting in high organic detritus content in the water column and the bottom sediments, led to the blooming of microbial activities resulting in depletion of dissolved oxygen increasing the Biological oxygen demand (BOD) and also chemical oxygen demand (COD) numbers.

Yearly fluctuation of WQI in the studied marshes could be as resultant of decrease discharge of the Tigris and Euphrates rivers during 2008,on the contrary to 2006. Even the average WQI of southern marshes was marginal but still higher than that of Kalakholake (poor) in India (Sisodia and Moundiotiya 2006) and that of Anzali in Iran (Sharifi1990).

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Table (1) Ranges of environmental water quality metrics used to calculate WQI for aquatic life guideline to the southern marshes.

Variables	**Units**	**Lower**	**Upper**
Temperature	C^o	11	30
Total Dissolved Solid	mg/L	700	1000
Salinity	ppm	0.2	1
Dissolved Oxygen	mg/L	6	9.5
pH	-	6.5	8.3
Biochemical Oxygen Demand	mg/L	0.5	5
Ortho Phosphate	mg/L	0.3	2
Nitrate	µg.at.No3	10	50

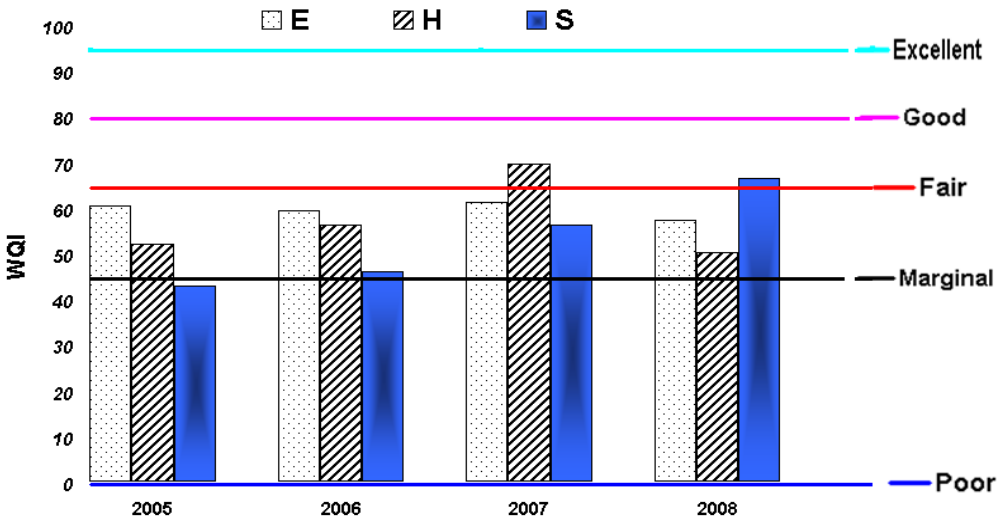

Table (2) WQI categorization and variance (F1,F2 &F3) during 2005,2006,2007 and 2008 in the three studied marshes East Hammar, Al-Huwaza and Suq Al-Shouykh ,with their yearly categorization.

Marsh	East Hammar			
Years	2005	2006	2007	2008
WQI	59	58	60	56
Categorization	marginal	marginal	marginal	marginal
F1 (Scope)	62	62	50	62
F2(Frequency)	30	35	44	41
F3(Amplitude)	11	13	22	16
Marsh	Al-Huwaza			
Years	2005	2006	2007	2008
WQI	51	55	68	49
Categorization	marginal	marginal	Fair	marginal
F1 (Scope)	75	75	50	75
F2(Frequency)	41	20	22	45
F3(Amplitude)	6	4	8	10
Marsh	Suq Al-Shouykh			
Years	2005	2006	2007	2008
WQI	42	45	62	65
Categorization	poor	marginal	marginal	Fair
F1 (Scope)	88	88	62	50
F2(Frequency)	46	38	41	33
F3(Amplitude)	14	13	21	13

دليل نوعية المياه (WQI) لثلاثة من ألاهوار الجنوبية المسترجعة (شرق الحمار والحويزة و سوق الشيوخ) للأعوام ٢٠٠٥ و٢٠٠٦ و٢٠٠٧ و٢٠٠٨.

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الخلاصة

حسب دليل نوعية المياه (WQI) لثلاثة من ألاهوار المسترجعة (شرق الحمار والحويزة و سوق الشيوخ) للأعوام ٢٠٠٥ و٢٠٠٦ و٢٠٠٧ و٢٠٠٨.استخدمت ثمانية عوامل لحساب الدليل وهي درجة الحرارة و الملوحة والمواد الصلبة الذائبة و الأوكسجين المذاب ودرجة الحموضة و المتطلب الحيوي للاوكسجين والاورثوفوسفات والنترات وحسبت على الطريقة الكندية.

أظهرت النتائج إن دليل نوعية المياه WQI للاهوار المسترجعة هو حافي (الحدود الدنيا للقبول) من الدليل المؤلف من خمسة مراتب.اعلى دليل لنوعية المياه سجل خلال عام ٢٠٠٧ خصوصا في هوري الحويزة و سوق الشيوخ . معدل نوعية المياه اعلى كان في شرق الحمار خلال فترة الدراسة. أعلى المتغيرات للمياه سجلت في سوق الشيوخ.