Regional Organization for the Protection of the Marine Environment

The Marshes-Shatt al-Arab- Gulf System

Status Report-Volume 1

2011

Marine Science Centre –University of Basra in Cooperation with Ministry of Environment

Executive Summary

In the present report series the Marine Science Centre at the University of Basra in co-operation with the Ministry of Environment (Iraq) will attempt to documents the scientific and technical efforts directed to monitor the status of the Gulf marine environment. However, the Iraqi marshes have been included in this series as they interact and influence the Shatt al-Arab as well as the Gulf region. Thus, we have decided to adopt the approach of the ***Marshes-Shatt al-Arab-the Gulf System*** to represent Iraq contribution within the frame work of ROPME programs. Data presented in these report, as appropriate, can be incorporated in SOMER reports. The series consists of:

- Volume 1 will address scientific and technical work prior to 2011.
- Volume 2 focuses on 2012 activities.
- Volume 3 focuses on 2013 activities

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Scientific Objectives

The general aim of this document is to summerize the ecological status of the marshes-Shatt al-Arab-the Gulf System from the period prior to 2011. Special attention was given to the responses of the system after the re-flooding of the marshes. Thus, we may summerize the main objectives of the report to:

- Carry out the preliminary scientific desk study on the influence of the Shatt Al-Arab and the Iraqi Marshes on the hydrodynamic, water quality and the biological productivity of the northern Gulf in order to assess functions of the Marshes in the regional ecosystem.
- Identify data and information gaps to understand the long-term scenario of potential impacts of the Marshes degradation on the Gulf marine environment.
- Network with regional experts for further regional research programme on the Tigris-Euphrates freshwater system and the Gulf marine environment.

In order to achieve the above goals several cruises in the Shatt al-Arab River & NW Gulf were carried out. Water, sediments & biological samples were collected according to ROPME Manual. Chemical & biological tests were conducted following the procedure given in ROPME protocol.

Introduction

Since 2003, international and national entities have carried out the researches, studies and projects for the restoration of the Iraqi Marshlands in the field of hydrology, socio-economy, and environment. While the results of those efforts contributed towards more sustainable management of the Marshlands in the post-conflict period, it is necessary to take a more integrated approach to develop and implement the concrete and long-term management and conservation plan for the area. The development of such plan needs to be based on credible and verifiable historical data, and in consultation with institutions and individuals with extensive knowledge in/of the area as well as the country. In addition, the ecosystem service of the Marshlands has been ignored and/ or underestimated for many years; which include the ecological function as the primary production source for the Gulf marine environment. Such true values of the Iraqi Marshlands should be precisely evaluated to raise awareness of its importance not only at a national level but also at a regional and global level. The longer-term management and conservation plan for the World Heritage inscription needs to give sufficient attention to the role of the Marshes in the regional ecosystem and to assess potential impacts of its degradation on the Gulf marine ecosystem.

This activity package is planned as part of evaluation of Outstanding Universal Values of the Iraqi Marshlands with a special attention to the relation between the Iraqi Marshlands (upstream) and the marine ecosystem of the Northern Gulf (downstream). It is point out by researchers that there is a large data and information gap with regard to the hydrodynamics and ecological relationships between the Shatt Al-Arab with its associated Marshes and the Gulf ecosystem. The project aims to fill such gaps to establish a scientific basis on the relationship between the Tigris-Euphrates system and the Gulf as well as to launch a regional network of academia, experts and scientific institutions among littoral counties for further assessment of the potential impacts of degradation of the Marshes on the regional freshwater/marine ecosystem.

The System

(Marshes – Shatt Al-Arab and Upper Gulf)

Part 1

Monitoring of the System variables

1 THE MARSHES

1.1 Hydrology & Sedimentology

Table 1-1 Water discharge (m^3/sec) into Al-Hawizeh Marsh

	2002-2003	2003-2004	2004-2005	2005-2006
January	66	135	200	195
February	97	160	190	190
March	128	265	220	223
April	137	260	240	208
May	128	245	210	190
June	280	345	391	410
July	264	410	505	465
August	225	360	395	387
September	218	332	355	298
October	145	207	275	315
November	108	245	224	245
December	98	187	231	200

Table 1-2 Water discharge (m^3/sec) into the Center Marsh

	2002-2003	2003-2004	2004-2005	2005-2006
January	110	130	195	183
February	110	190	200	140
March	123	260	200	175
April	150	165	202	180
May	161	128	180	175
June	180	200	200	177
July	179	200	200	205
August	184	200	215	197
September	190	207	213	216
October	90	195	200	200
November	110	515	215	205
December	110	222	200	187

Table 1-3 Total Organic Carbon concentration in sediment (mg/g dry weight)

		Average	SD	Min	Max
Central marshes	**Jun-05**	0.4	0.5	0.0	2.3
	Jan-06	0.5	0.9	0.1	4.6
	Aug-06	0.3	0.4	0.1	1.5
Seasonal Marshes	**Jun-05**	0.2	0.2	0.0	0.8
	Jan-06	0.2	0.3	0.2	0.3
	Aug-06	0.2	0.3	0.1	0.3
Hawizeh Marshes	**Jun-05**	0.2	0.3	0.3	1.3
	Jan-06	0.8	1.2	0.1	4.3
	Aug-06	0.2	0.3	0.2	1.1
Hammar Marshes	**Jun-05**	2.7	3.2	0.5	9.8
	Jan-06	1.1	1.4	0.2	3.9
	Aug-06	0.6	0.7	0.4	2.1

1.2 Water quality

Table 1-4 Average values of water quality

	WCD	Turb	TDS	TSS	EC	pH	DO	Ca	Mg	Cl	SO_4
	m	FTU	mgl-1	mgl-1	mS.cm-1		mgl-1	mgl-1	mgl-1	mgl-1	mgl-1
Al-Hawizeh marshes-05	2.3	15.5	95.4	8.3	1364.4	7.7	8.9	96.7	132.4	393.6	624.6
Central Marshes-05	1.8	7.5	215.1	14.3	2939.3	8.1	8.6	116.2	143.2	684.1	411.5
Al-Hammar marshes-05	3.6	15.0	212.0	19.2	3220.0	8.2	9.2	122.8	120.3	654.4	421.7
Al-Udhaim marsh-06	2.0	2.2	959.5	1.7	1755.0	7.8	6.9	126.9	81.1	265.2	271.7
Al-Hawizeh marshes-06	2.2	11.0	1146.6	13.4	1845.2	7.9	7.3	129.2	81.5	334.9	331.9
Central Marshes-06	1.4	6.5	263.1	12.0	3055.7	7.9	5.6	246.5	188.4	568.1	627.3
Al-Hammar marshes-06	1.9	14.7	281.8	21.4	3301.4	7.9	7.1	122.7	97.0	672.3	585.1
Al-Udhaim marsh-07	2.1	0.8	1747.9	2.3	1748.0	8.0	9.0				
Al-Hawizeh marshes-07	2.4	3.6	1727.4	4.2	1793.4	8.1	8.1				
Central Marshes-07	1.5	1.2		4.1	2283.6	8.2	8.5				
Al-Hammar marshes-07	1.4	8.8		14.7	5526.2	8.4	9.2				
Al-Udhaim marsh-08		2.3	1254.5	4.5	1900.0	8.1	11.6	87.3	61.6	269.9	345.7
Al-Hawizeh marshes-08		2.6	1226.7	6.0	2204.3	8.2	8.1	111.8	72.3	334.5	453.2
Central Marshes-08		4.0	1535.0	10.4	3035.0	8.0	6.5	126.1	101.5	459.9	551.4
Al-Hammar marshes-08		5.5	1923.0	12.7	3154.6	8.0	7.0	144.6	135.2	633.2	717.6

Table 1-5 The monthly variations of dissolved oxygen (mg/L) and oxygen saturation rate in the main Marshes . (Mean & standard error)

	Al-Hewaizeh		Central Marshes		Al-Hammar	
	DO	S%	DO	S%	DO	S%
Nov. 05	9.56±0.16 (A)abcd	100.25±1.49 (A)a	8.36±0.22 (B)cd	89.75±4,23 (B)bc	8.65±0.16 (B)bcd	95.77±1.98 (AB)a
Dec. 05	7.42±0.09 (B)ef	75.76±0.92 (B)bcde	8.3±0.38 (A)cd	85.11±3.87 (A)bc	8.76±0.27 (A)bcd	91.38±3.26 (A)ab
Jan. 06	9.94±0.68 (B)abc	94.61±7.76 (B)ab	11.89±0.33 (A)a	113.25±3.19 (A)a	10.35±0.10 (B)a	100.09±1.21 (AB)a
Feb. 06	10.14±0.14 (A)abc	100.56±0.79 (A)a	10.48±0.18 (A)b	98.15±1.99 (A)b	7.4±0.36 (B)d	69.52±3.06 (B)cdef
Mar. 06	9.01±0.11 (A)bcde	95.92±1.24 (A)ab	8.51±0.34 (A)cd	85.93±3.40 (AB)bc	8.46±0.52 (A)cd	83.12±5.50 (B)abc
Apr. 06	5.40±0.28 (A)g	62.73±3.11 (A)de	1.36±0.54 (B)h	15.56±6.28 (B)g	5.93±0.48 (A)e	70.23±6.31 (A)cde
6-May	7.86±0.82 (A)def	99.77±10.92 (A)a	1.14±0.15 (C)h	14.56±2.04 (C)g	4.37±0.25 (B)fghi	53.10±3.00 (B)fgh
Jun. 06	7.07±0.38 (A)g	86.75±4.45 (A)abc	2.7±0.11 (B)fg	33.39±1.38 (C)ef	3.4±0.06 (B)ghi	43.13±0.82 (B)gh
Jul. 06	5.13±0.62 (A)g	66.56±7.45 (A)cde	2.67±0.23 (B)fg	33.66±2.96 (B)ef	3.34±0.71 (B)hi	43.24±9.25 (B)gh
Aug. 06	4.35±1.16 (A)g	58.88±15.65 (A) e	1.8±0.22 (B)gh	23.96±2.97 (B)ef	4.37±0.66 (A)fghi	60.36±9.24 (A)defg
Sept. 06	4.77±0.09 (B)g	62.01±0.93 (B)de	3.23±0.30 (C)f	41.44±4.64 (C)e	5.75±0.34 (A)ef	75.11±4.76 (A)bcd
Oct. 06	7.72±0.86 (A)def	94.21±10.58 (A)ab	1.89±0.19 (B)gh	21.27±1.58 (B)fg	2.88±0.19 (B)i	36.63±2.36 (B)h

- Capital letters refers to significant differences among Marshes based on Duncan multiple range test at probability $P<0.05$.
- Small letters refers to significant differences among months based on Duncan multiple range test at probability $P<0.05$.
- DO = dissolved oxygen ; S % = oxygen saturation rate

Table 1-6 The monthly variations of primary productivity (mg C/m³.hr) for surface water in the main Marshes. (Mean & standard error)

	Al-Hewaizeh		Central Marshes		Al-Hammar	
	Surface	1 m depth	Surface	1 m depth	Surface	1 m depth
Nov. 05	18.75 ± 0.0	123.44 ± 114.07	23.21 ± 1.79	9.38 ± 9.38	46.88 ± 9.38	6.25 ± 31.25
Dec. 05	50.21 ± 27.87	12.25 ± 31.14	73.54 ± 19.96	11.02 ± 34.90	87.76 ± 51.53	55.21 ± 83.86
Jan. 06	47.62 ± 14.59	40.04 ± 67.32	18.56 ± 2.93	7.16 ± 20.36	37.37 ± 9.62	5.44 ± 38.54
Feb. 06	59.79 ± 17.80	4.75 ± 18.33	15.39 ± 5.80	3.96 ± 23.24	11.71 ± 3.81	11.10 ± 29.94
Mar. 06	57.92 ± 16.27	13.27 ± 64.38	28.75 ± 8.0	8.98 ± 37.50	26.76 ± 9.27	4.50 ± 23.29
Apr. 06	18.75 ± 4.27	79.09 ± 142.50	35.63 ± 16.38	12.55 ± 26.08	97.49 ± 6.89	4.88 ± 75.69
6-May	181.44 ± 56.46	14.56 ± 110.27	132.29 ± 12.80	12.41 ± 87.18	82.97 ± 3.73	5.73 ± 73.96
Jun. 06	73.54 ± 21.99	53.87 ± 101.63	107.74 ± 7.91	12.53 ± 99.73	73.49 ± 11.78	7.30 ± 41.77
Jul. 06	143.75 ± 46.66	18.84 ± 87.50	136.09 ± 14.03	25.26 ± 125.78	59.74 ± 5.61	7.85 ± 37.45
Aug. 06	249.79 ± 90.65	26.30 ± 119.79	75.69 ± 25.52	5.93 ± 51.39	45.83 ± 8.26	5.37 ± 27.2
Sept. 06	33.33 ± 9.50	4.19 ± 53.13	74.52 ± 11.16	13.78 ± 53.63	44.74 ± 13.0	16.63 ± 42.1
Oct. 06	62.50 ± 8.39	6.58 ± 47.92	59.17 ± 6.28	6.24 ± 64.25	45.42 ± 9.11	3.75 ± 26.32

1.3 Pollution

Table 1-7 Average concentration of Ptrolum Hydrocarbons in sediment (µg/g) dry weight

	Centeral Marsh	Hammar marsh	
Winter 2006	0.97	1.1	0.97
Spring 2006	0.79	0.82	0.81
Summer 2006	0.74	0.82	0.78
Fall 2006	0.66	0.71	0.55
Winter 2007	0.92	1.1	0.96

Table 1-8 N-Alkline concentration in sediment (µg/g)

	Winter 2006			Summer 2006		
	Centeral Marsh	Hammar Marsh		Centeral Marsh	Hammar Marsh	
C13	ND	1	0.3	ND	0.1	ND
C14	0.9	1.1	0.5	0.1	0.3	ND
C15	1.1	1.3	0.5	0.2	0.3	0.2
C16	0.7	1.3	1.8	0.2	0.5	0.1
C17	1.7	3.1	2.1	1.1	1.3	0.9
C18	0.4	3	1.1	1.1	1.1	0.9
C19	0.2	3.1	1.2	1	1.1	0.6
C20	0.2	2.1	1	0.5	1	0.4
C21	0.8	2.4	0.7	0.5	0.8	0.3
C22	0.6	2	0.2	0.2	0.2	0.2
C23	1	1.7	0.1	0.2	0.2	0.1
C24	0.5	1.2	0.3	0.1	0.3	0.1
C25	0.3	1.3	1.3	0.7	0.2	0.9
C26	0.2	1	0.9	0.1	0.9	0.1
C27	0.2	1	0.9	0.3	0.2	0.2
C28	0.1	0.7	0.7	0.5	0.5	0.5
C29	1.2	2.8	1.2	0.9	0.7	0.8
C30	1	1.1	0.9	0.2	1.1	0.1
C31	0.1	0.2	0.2	0.2	0.9	0.1
C32	0.1	0.1	0.1	0.1	0.4	0.7
Total	**11.3**	**31.5**	**16**	**8.2**	**12.1**	**7.2**
CPI	1.2	1.3	1.1	1.5	1.4	1.7
Pristane	1.5	2.2	1.8	1	1.1	0.8
Phytane	0.8	2.1	1.1	0.9	1	0.8
Pristane:Phytane	2	1	1.7	1.1	1	1
C17:Pristane	1.1	1.4	1.2	1.2	1.1	1.1
C18:Phytane	0.6	1.4	1	1.2	1	1.1

1.4 Biology

Table 1-9 Diatoms of the Marshes; oh: Oligohalobous (indifferent), mh: Mesohalobous, ph: Polyhalobous, al: Alkaliphilic, ac: Acidophilic, vr: very rar, f: frequent, c: common, Q: Central Marsh, A: Hammar Marsh, H: Hawizeh Marsh, species with asterisk are new records.

Species	Figure	Ecological preference	Relative abundance	Marsh
**Amphora copulata* (Kützing) Schoeman et Archibald	72,73	oh, al	f	Q
**Amphora macilenta* Gregory	71	mh	f	Q,A,H
**Amphora mexicana* A. Schmidt	68,69	p	f	Q,A,H
Amphora ovalis (Kützing) Kützing	70	oh, al	f	Q,A,H
Amphora veneta Kützing	75–77	oh	c	Q,H
Amphora sp.	74		vr	A
Bacillaria pxillifer (O. Möller) Hendey	158	mh	f	Q,A,H
Brachysira sphaerophora (Kützing) Round ex D.G. Mann	82	mh,al	r	Q
Caloneis permagna (Bailey) Cleve	83,84	mh	f	Q
Caloneis silicula (Ehrenberg) Cleve	85–87	ol, al	f	Q,H
Campylodiscus bicostatus W. Smith	175	mh	f	Q,A,H
Campylodiscus clypeus Ehrenberg	176	mh	f	Q,A
Cocconeis pediculus Ehrenberg	26–30	ol, al	c	Q,A,H
Cocconeis placentula Ehrenberg var. *placentula*	19	ol.al	c	Q,A,H
Cocconeis placentula var. *euglypta* (Ehrenberg) Grunow	20–25	ol;al	c	Q,A,H
Craticula cuspidata (Kützing) D.G. Mann	33,34	ol, al	r	Q,A,H
Craticula halophila (Grunow ex Van Heurck) D.G. Mann	35	ol, al	r	Q,A,H
Cyclotella atomus Hustedt		ol, al	c	Q,A,H
Cyclotella meneghiniana Kützing	31	ol, al	c	Q,A,H
Cymatopleura elliptica (Brébisson) W. Smith	164	ol, al	r	H
Cymatopleura solea (Brébisson) W. Smith var. *solea*	163	ol, al	f	Q,H
**Cymatopleura solea* var. *apiculata* (W. Smith) Ralfs	161,162	ol, al	f	Q
Cymbella cistula (Ehrenberg) Kirchner	116,117	ol, al	f	Q,A,H
Cymbella helvetica Kützing	121	ol, al	f	Q,A,H
Cymbella lanceolata (Ehrenbrg) Kirchner	112	ol, al	r	A
Cymbella tumida (Brébisson) Van Heurck	113–115	ol, al	f	Q,A,H
Diatoma tenuis C.A. Agardh	14,15	ol, al	r	Q,A,H
Diploneis smithii var. *pumila* (Grunow) Hustedt	38	ol, al	f	Q
Diploneis sp.	37		r	H
**Encyonema alpinum* (Grunow) D.G. Mann	118		r	A,H
**Encyonema caespitosa* Kützing	119,120		r	Q,A,H
Entomoneis corrugata (Giffen) Witkowski, Lange-Bertalot et Metzlin	88,89	mh	c	Q
Epithemia adnata (Kützing) Brébisson	133	ol, al	f	Q
Epithemia turgida (Ehrenberg) Kützing	134,135	mh	f	Q
Epithemia sorex Kützing	127–129	ol, al	c	Q,A
Eunotia formica Ehrenberg	166	ac	f	Q
**Eunotia monodon* Ehrenberg	165	ac	r	H

Fragilaria construens var. *binodis* (Ehrenberg) Cleve	12,13	ol, al	r	Q,A,H
Fragilaria pulchella (Ralfs ex Kützing) Lange-Bertalot	7–9	mh	c	Q,A,H
Frustulia rhomboides (Ehrenberg) De Toni	36	ac	r	Q
**Gomphonema affine* Kützing	126	ol, al	r	Q
Gomphonema coronatum Ehrenberg	131	ol, al	r	Q,A,H
Gomphonema gracile Ehrenberg	132	ol, al	f	Q,A,H
**Gomphonema olivaceum* var. *minutissima* Hustedt	130	ol, al	r	H
Gomphonema truncatum Ehrenberg	122–125	ol, al	c	Q,H
Gyrosigma acuminatum (Kützing) Rabenhorst	92	ol, al	f	Q,A,H
Gyrosigma fasciola (Ehrenberg) Griffith et Henfrey	95	mh	r	Q,A,H
Gyrosigma sinensis Ehrenberg	94	ph	r	Q
Gyrosigma spencerii (Quekett) Griffith et Henfrey	93	mh	f	Q
Hantzschia amphioxys (Ehrenberg) Grunow	141	ol, al	vr	Q
**Hippodonta capitata* (Ehrenberg) Lange-Bertalot, Metzeltin et Witkowski	42	ol, al	r	H
**Hippodonta hungarica* (Grunow) Lange-Bertalot,	41	ol, al	r	Q,A,H
**Luticola* cf. *saxophila* (Bock) D.G. Mann	40	ol, al	vr	A
Mastogloia braunii Grunow	50–53	mh	c	Q,A,H
Mastogloia elliptica (C.A. Agardh) Cleve var. *elliptica*	61	mh	f	Q,A,H
Mastogloia elliptica var. *dansei* (Thwaites) Cleve	64,65	mh	f	Q,A,H
Mastogloia pumila (Grunow) Cleve	54,55	mh	f	Q
Mastogloia smithii Thwaites var. *smithii*	56-58	mh	f	Q,A,H
Mastogloia smithii var. *amphicephala* Grunow	59,60	mh	r	Q,A,H
**Mastogloia recta* Hustedt	62,63	mh	r	H
Mastogloia sp.	66,67		r	Q,A
**Navicula confervacea* (Kützing) Grunow	43	ol, al	r	Q,A,H
Navicula digitoradiata (Gregory) Ralfs in Pritchard	46,47	mh	r	Q,A,H
Navicula radiosa Kützing	45	ol, al	r	Q,A,H
Navicula rhynchocephala Kützing	48	mh	r	Q,A,H
Neidium amplicatum (Ehrenberg) Krammer	140	mh	f	Q
Neidium iridis (Ehrenberg) Cleve	139	ol, al	r	H
Nitzschia amphibia Grunow	155	ol, al	f	Q,A,H
**Nitzschia dubia* W. Smith	153	ol, al	r	Q
**Nitzschia elegantula* Grunow	156	ph	r	Q
Nitzschia filiformis (W. Smith) Van Heurck	151	mh	r	Q,A,H
Nitzschia obtusa W. Smith	150	ol, al	c	Q,A,H
Nitzschia palea (Kützing) W. Smith	152	ol, al	f	Q,A,H
**Nitzschia recta* Hantzsch in Rabenhorst	149	ol, al	f	Q,A,H
Nitzschia scalaris (Ehrenberg) W. Smith	148	mh	r	Q
Nitzschia sigma (Kützing) W. Smith	154	ph	f	Q,A
Nitzschia umbonata (Ehrenberg) Lange-Bertalot	146	ol, al	f	Q,A,H
**Parlibellus crucicula* (W. Smith) Witkowski	90,91	mh	r	Q
**Petroneis plagiostoma* (Grunow) D.G. Mann	44	ph	vr	Q
**Pinnularia acrosphaeria* Rabenhorst	107	ol	r	Q
Pinnularia borealis var. *rectangularis* Carslon	109	ol	r	A

**Pinnularia legumen* (Ehrenberg) Ehrenberg	110,111	ac	r	Q
Pinnularia major (Kützing) Rabenhorst	105			
**Pinnularia nobilis* (Ehrenberg) Ehrenberg	104	ac	r	H
**Pinnularia streptoraphe* Cleve	106	ac	r	Q,A,H
**Pinnularia viridis* (Nitzsch) Ehrenberg	108	ol	r	Q,A,H
**Placoneis constans* (Hustedt) E.J. Fox	49	ol	r	A
Plagiotropis lepidoptera (Gregory) Kuntze	147	mh	r	Q
Planothidium lanceolata (Brébisson ex Kützing) Round et Bukhtiyarova	142,143	ol, al	r	Q,A,H
Pleurosigma angulatum (Quekett) W. Smith	96	ph	r	Q
Pleurosigma elongatum W. Smith	97	mh	r	Q,A,H
Rhoicosphenia abbreviata (C.A. Agardh) Lange-Bertalot	17,18	ol, al	r	Q,A,H
Rhopalodia gibba (Ehrenberg) O. Müller	99–103	mh	c	Q,A,H
Rhopalodia musculus (Kützing) O. Müller	98	mh	f	Q,A,H
Sellaphora pupula (Kützing) Mereschkowsky	39	ol, al	r	Q,A,H
**Stauroneis acuta* W. Smith	137,138	ol, al	f	Q,A,H
Stauroneis phoenicentron (Nitzsch) Ehrenberg	136	ol, al	f	Q
**Stephanodiscus alpinus* Hustedt	78	ol	f	Q,A,H
Stephanodiscus astreae (Ehrenberg) Grunow	81	ol, mh	r	Q
Stephanodiscus sp.	79,80		f	Q,A,H
**Surirella brebissoni* Krammer et Lange-Bertalot	167	mh	f	Q,A,H
Surirella capronii Brébisson	169	ol, al	f	Q,A,H
Surirella ovalis Brébisson	170	mh	r	Q,A,H
Surirella peisonis Pantocseck	171	mh	r	Q,A,H
Surirella cf. *robusta* Ehrenberg	174	ol	r	Q,A,H
Surirella striatula Turpin	172	mh	f	Q,A,H
Surirella tenera Gregory	173	ol, al	f	Q,A,H
Surirella sp.	168		r	Q,A
Synedra capitata Ehrenberg	5,6	ol, al	c	Q,A
Synedra ulna (Nitzsch) Ehrenberg var. *ulna*	2	ol, al	c	Q,A,H
Synedra ulna var. *biceps* (Kützing) Von Schönfeldt	4	ol, al	f	Q,A,H
Synedra ulna var. *claviceps* Hustedt	3	ol, al	c	Q,A,H
Tabellaria fenestrate (Lyngbye) Kützing	16	ac	f	Q,A,H
Tabularia tabulata (C.A. Agardh) Snoeijs	10,11	mh	f	Q
**Tryblionella coarctata* (Grunow) D.G. Mann	157	ph	r	Q
Tryblionella hungarica (Grunow) D.G. Mann	145	mh	r	Q,A,H
**Tryblionella levidensis* W. Smith	144	mh	f	Q,A,H
Tryblionella littoralis (Grunow) D.G. Mann	159,160	mh	f	Q

Table 1-10 Zooplankton (Rotifera Species) composition of the Iraqi Marshes (-) absent, + rare (for one or two months), ++ common

	Al-Hammar Marshes		Al- Hawaizha Marshes
Albertia sp.	+	-	+
Anuraeopsis fissa	+	-	-
Anuraeopsis sp.	+	+	+
Argonotholca sp.	+	-	-
Ascomorpha saltans	+	+	-
Asplanchna sp.	++	++	++
Asplanchnopus sp.	+	+	-
Bachionus urceolaris	+	+	+
Brachionus angularis	++	++	++
Brachionus budapes	+	-	-
Brachionus calyciflorus	++	++	++
Brachionus leydigi	-	+	-
Brachionus nilsoni	-	+	-
Brachionus patulus	-	-	+
Brachionus plicatilis	++	++	++
Brachionus quadridentatus	++	++	++
Brachionus rotundiformis	+	-	-
Brachionus rubens	++	++	++
Brachionus sp.	++	++	++
Brachionus urceus	+	-	-
Cephalodella auriculata	+	+	-
Cephalodella gibba	++	-	++
Cephalodella sp.	++	++	++
Collotheca ornata	-	+	-
Collotheca sp.	-	-	+
Colurella abtusa	-	+	-
Colurella adriatica	++	++	++
Colurella bicuspidata	-	-	+
Colurella sp.	++	++	++
Cupelopagis sp.	+	-	-
Dicranophorus sp.	+	-	-
Epiphanes senta	+	-	-
Epiphanes sp.	+	+	-
Euchlanis deflexa	-	-	+
Euchlanis dilatata	++	++	++
Euchlanis sp.	++	++	++
Filinia longiseta	-	+	-
Filinia sp.	++	++	++
Gastropus sp.	++	++	+
Harringia sp.	-	+	-
Horaella sp.	+	++	++
Keratella cochlearis	++	++	++

	Al-Hammar Marshes		Al- Hawaizha Marshes
Keratella hiemalis	+	-	+
Keratella quadrata	++	++	++
Keratella sp.	++	++	++
Keratella tacta	+	-	+
Keratella tropica	++	++	++
Keratella valga	++	++	++
Lecana leontina	+	+	+
Lecane luna	++	++	++
Lecane lunaris	+	-	-
Lecane oblonga	-	-	+
Lecane sp.	++	++	++
Lepadella ovalis	++	++	++
Lepadella patella	+	+	++
Lepadella rhomboids	_	-	-
Lepadella sp.	++	++	++
Lophocharis salpina	-	+	+
Lophocharis sp.	+	-	-
Macrochaetus sp.	++	++	+
Manfredium sp.	++	++	++
Monostyla bulla	++	++	++
Monostyla closterocerca	++	++	++
Monostyla lunaris	+	++	++
Monostyla quadridentatus	++	+	++
Monostyla sinuata	+	-	-
Monostyla sp.	++	++	++
Monostyla stenroosi	+	+	+
Monostylla crenata	-	+	-
Mytilina mucronata	-	-	+
Mytilina sp.	++	++	++
Notholca foliacea	+	-	-
Notholca sp.	++	++	++
Notholca squamula	+	+	-
Philodina sp.	-	+	-
Platyias patulus	++	+	++
Platyias quadricornis	-	++	+
Platyias sp.	++	++	+
Platyias polyacanthus	+	-	-
Ploesoma sp.	+	++	+
Polyarthra remata	+	+	-
Polyarthra sp.	++	++	++
Polyarthra vulgaris	+	+	-
Pompholyx complanata	+	-	-
Pompholyx sp.	+	+	-
Proalides sp.	+	-	-

	Al-Hammar Marshes		Al- Hawaizha Marshes
Rotaria sp.	-	-	+
Scaridium longicaudum	+	+	+
Synchaeta oblonga	-	-	-
Synchaeta sp.	++	++	++
Testudinella patina	-	+	-
Testudinella sp.	-	++	++
Trichoerca longiseta	+	-	-
Trichocerca elongata	-	+	+
Trichocerca multicrinis	++	+	-
Trichocerca capucina	-	-	+
Trichocerca chattoni	-	+	-
Trichocerca cylindrica	++	+	++
Trichocerca flagellate	+	+	+
Trichocerca pusilla	+	++	+
Trichocerca sp.	++	++	++
Trichotria pocillum	++	++	++
Trichotria sp.	++	+	+
Trichotria tetractis	++	++	++
Wolga spinifera	+	-	-

Table 1-11 List of Cladocera of the Iraqi Marshes

Diaphanosoma brachyurum *D. orghidani* *D.leuchtenbergianum*	*Simocephalus vetulus* *S. exspinosus*	*Ilyocryptus agilis* *I. spinifer* *I. sordidus*
Macrothrix rosea	*Macrothrix spinosa*	*Dadaya sp.*
Macrothrix sp	*Scapholeberis kingi*	*Alona cambouei*
Pseudosida sp.	*Ceriodaphnia regaudi*	*Chydorus sphaericus*
Latonopsis occidentalis	*Moina brachiate* *M. micrura*	*Dunhevedia crassa*
Daphnia hyaline *D. laevis*	*Leydigia acanthocercoides*	*Bosmina longirostris*
Alonella exigua *A. karua* *A.rectangula* *A. guttata* *A. quadrangularis* *A. costata* *A. intermedia*	*Pleuroxus hastatus* *P. trigonellus* *P. aduncus* *P. denticulatus*	*Kurzia longirostris*
Acroperus sp	*Camptocercus uncinatus*	*Graptoleberis sp.*

2 SHATT AL-ARAB

2.1 Hydrology & Sedimentology

Table 2-1 Hydrological characteristic of Shatt Al-Arab

		Northern Shatt Al-Arab		Southern Shatt Al-Arab	
		Al-Khora	**Abu Al-Khaseeb**	**Al-Karoon**	**Al-Faw**
Width	m	400	450	320	600
Depth	m	13	9	13	10
Water Velocity	m/sec	0.4	0.5	1.2	1
Water Level x 10^{-5}	m/sec		3		
Water Discharge	m3/sec	690	690	1200	1200
Sedimentation Rate x 10^{-3}	cm/sec	2	0.4	1.6	1.5
Sediment erosion	kg/m	0.2	0.2	1	1.2
TSS concentration	mg/L	39	29	120	120
Particles Size	mm	0.01	0.002	0.13	0.004
TSS Velocity	m/sec	0.1	0.1	0.5	0.5
Reynolds Number		2.24×10^4	2.377×10^4	1.354×10^3	3.583×10^3
Froude Number		0.02	0.03	0.03	0.03

		Water Discharge	**Total Suspended Solids calculated based on Gregory & Walling (1973)**		**Total Suspended Solids calculated based on the Flow Energy described in Yang (1981)**	
		(m3/sec)	**Concentration (mg/L)**	**Load (kg/sec)**	**Concentration (mg/L)**	**Load (kg/sec)**
Northern Shatt Al-Arab	**Al-Khora**	690	39	27	33	38
	Abu Al-Khaseeb	690	29	20	19	22
Southern Shatt Al-Arab	**Al-Karown**	1200	120	144000	53000	64580
	Al-Faw	1200	120	120000	54215	62737

Table 2-2 TOC% in Shatt AL-Arab sediment

	Winter	**Spring**	**Summer**	**Fall**
	0.66	0.62	0.58	0.63
	0.53	0.50	0.46	0.52
	0.60	0.55	0.50	0.57
	0.91	0.75	0.62	0.67
	1.03	0.84	0.65	0.70
Average	**0.75**	**0.65**	**0.56**	**0.62**

Figure 2-1 Boring Log Data (BH-1) at Al-Ashar Side (Right Bank) at elevation of 2.65 m on S.L.

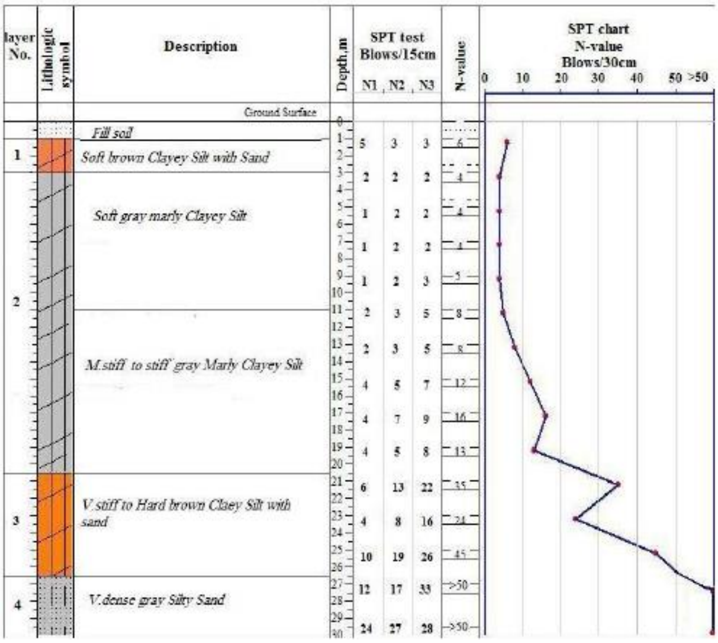


Figure 2-2 Sub bottom profiles of strata Box survey indicating the sedimentary layers, these are: stratified layers with obvious main layers, and sub layers detected with weak stratified thin layers. The sedimentary layer-dash red line-with high bearing capacity layer, which highlights at 30 m of the depth under the water surface after matching with data log of borehole.

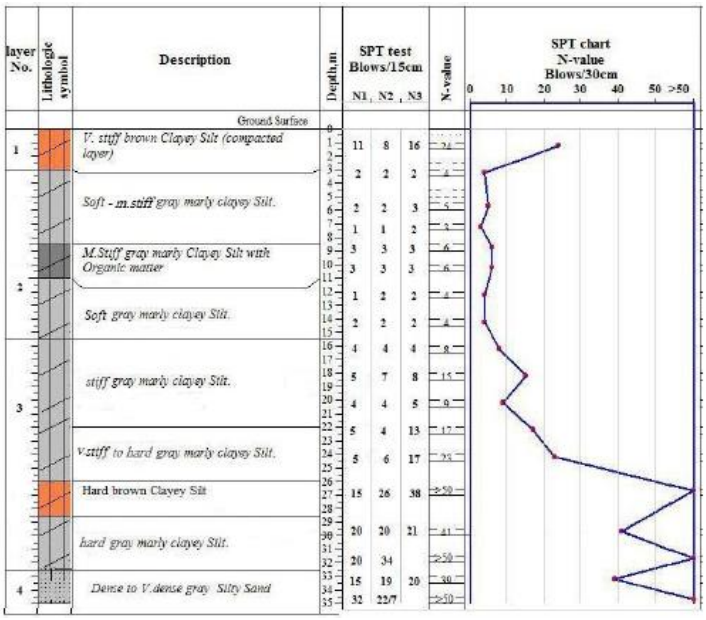


Figure 2-3 The final section of geotechnical model of the investigated site

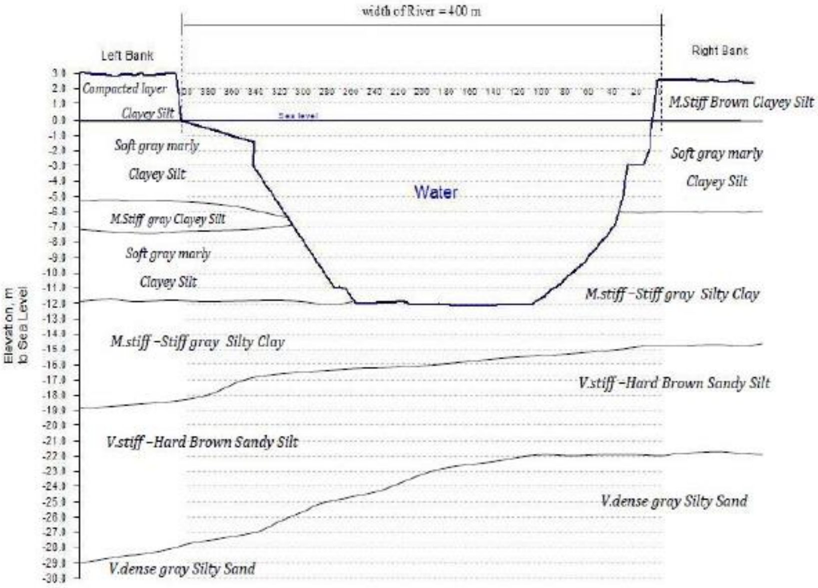


Figure 2-4 The locations of the drilling works (pink color), and the marine Geophysics survey (Blue color).

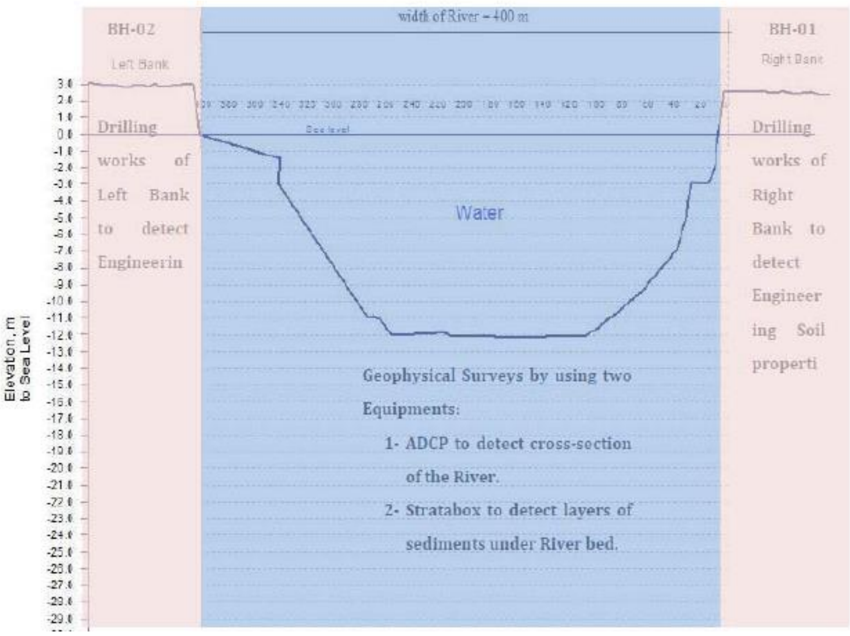


Table 2-3 Total OrganicCarbon concentration in sediment (mg/g dry weight)

	Average	SD	Min	Max
Jun-05	0.3196875	0.3842505	0.29	1.37
Jan-06	0.0798	0.0988989	0.32	0.61

2.2 Water quality

Table 2-4 Physical-chemical parameters of Shatt Al-Arab river (May 2010 - April 2011)

		WT	pH	DO	BOD	TRB	EC	Sal	Alk	Aci	TDS	PO4	NO3	NO2	NH3	SiO2	TC	Chl. A	FC	W Flow	WD
		C		Mg/l	Mg/l	NTU	mS/cm	ppt	Mg/l	Mg/l	Mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	Mg/l	Mg/l	Mg/l	M2	M3/sec
Abu AlKaseeb	**Min.**	13.0	6.6	7.0	0.8	60.0	2.2	1.5	177.8	0.1	1426.0	0.1	19.2	0.8	0.2	134.0	152.0	4.5	5800.0	0.1	116.0
	Max.	32.4	8.5	9.5	2.5	78.0	4.8	3.3	277.0	0.5	3198.0	0.4	53.0	1.7	0.6	176.6	199.0	8.0	15000.0	0.5	310.0
	Aver.	23.4	7.5	7.9	1.6	69.0	3.3	2.4	215.7	0.3	2339.6	0.3	34.3	1.2	0.4	154.4	170.0	6.2	11260.8	0.2	181.1
Yousfan	**Min.**	13.6	6.6	5.2	0.5	21.7	1.6	1.2	167.0	0.1	1416.1	0.2	24.9	1.0	0.2	126.0	141.0	10.5	7500.0	0.1	117.0
	Max.	32.9	8.2	9.3	2.3	84.0	4.3	3.1	232.0	0.5	2967.0	0.3	50.0	1.9	0.5	189.7	205.0	15.1	17000.0	0.4	307.0
	Aver.	23.7	7.4	7.2	1.1	40.8	2.9	2.0	194.6	0.4	2077.4	0.3	34.4	1.4	0.4	150.3	180.2	12.6	12670.8	0.2	181.2
Sarraji	**Min.**	14.0	6.9	6.0	0.8	17.9	1.4	1.1	154.1	0.2	1175.0	0.2	27.0	1.0	0.2	130.0	112.0	12.7	12000.0	0.1	114.0
	Max.	34.3	8.3	9.6	3.3	78.0	4.1	3.0	267.0	0.5	2656.0	0.4	54.0	2.3	0.6	229.5	207.0	21.0	24000.0	0.3	301.0
	Aver.	24.4	7.8	7.6	1.8	38.7	2.6	1.9	210.3	0.4	1942.1	0.3	35.7	1.5	0.4	180.0	155.8	16.8	16893.9	0.2	178.3
Ashar	**Min.**	14.4	7.0	5.0	0.6	22.8	1.5	1.3	123.0	0.2	1259.0	0.2	23.2	1.0	0.2	133.6	115.0	8.0	5700.0	0.1	117.0
	Max.	33.2	8.4	9.5	3.0	60.0	3.7	2.7	263.0	0.5	2776.0	0.5	44.0	2.2	0.6	221.0	203.0	16.4	19000.0	0.5	296.0
	Aver.	24.4	7.6	6.9	1.6	36.8	2.5	1.9	170.4	0.3	1861.0	0.3	32.9	1.6	0.4	175.8	157.2	10.8	12401.5	0.2	177.0
Muftia	**Min.**	14.5	7.2	5.6	0.6	17.7	1.6	1.1	121.0	0.2	1135.0	0.2	23.9	1.0	0.2	130.0	111.0	15.0	6600.0	0.1	116.0
	Max.	34.2	8.6	10.0	3.7	65.0	3.6	2.7	222.0	0.5	2667.0	0.4	50.0	1.9	0.6	229.7	107.0	25.5	19000.0	0.5	278.0
	Aver.	25.1	7.8	7.9	1.8	34.4	2.5	1.7	157.3	0.3	1886.6	0.3	34.6	1.3	0.4	169.8	162.2	19.2	12633.9	0.2	175.4
Sindebad	**Min.**	14.3	7.1	5.2	0.2	18.5	1.3	1.0	115.4	0.1	1114.4	0.1	20.7	0.8	0.2	83.0	125.0	11.0	3900.0	0.1	117.0
	Max.	33.4	8.5	10.3	2.1	76.0	3.4	2.5	291.0	0.5	2600.0	0.3	42.0	1.6	0.6	210.5	210.0	22.3	14000.0	0.5	285.0
	Aver.	25.2	7.7	7.7	1.1	39.3	2.2	1.6	193.2	0.3	1739.0	0.2	29.3	1.1	0.4	140.0	154.2	16.9	8753.1	0.2	174.2
Garma	**Min.**	15.0	7.3	5.3	0.4	28.5	1.7	1.1	102.5	0.2	1194.0	0.1	22.7	1.2	0.3	112.3	121.0	12.0	10200.0	0.1	116.0
	Max.	35.0	8.6	9.0	2.8	83.0	3.8	2.6	275.0	0.6	2702.0	0.5	51.0	2.0	0.7	187. 93	109.0	16.7	26000.0	0.4	289.0
	Aver.	25.4	7.9	7.1	1.6	49.3	2.5	1.8	200.1	0.4	1863.0	0.3	3 3.77	1.7	0.5	152.3	164.4	14.6	19197.5	0.2	177.9

Table 2-5 Average nutrients values (μg/l) of Shatt Al-Arab River

		Qurna-Tigris	Qurna-Euphrates	Saad Bridge	SIndibad	Najibia	Garmatt Ali	Ashar	Abu Al-Khaseeb	Seeba	Faw
Oct-09	NO2	-	0.5	0.3	-	-	4.4	9.4	8.6	0.4	2.6
	NO3	-	40.7	17.5	-	-	36.8	36.1	42.3	4.4	20.8
	PO4	-	5.4	3.4	-	-	7.4	8.0	5.1	7.4	4.3
	SiO2	-	65.4	59.3	-	-	76.2	68.5	58.3	24.8	37.7
Nov-09	NO2	0.9	0.9	2.2	9.7	9.8	-	9.0	9.9	1.1	1.6
	NO3	37.5	40.8	36.2	42.5	43.9	-	48.3	36.3	14.1	20.7
	PO4	7.2	7.1	5.1	11.2	12.4	-	9.3	7.6	3.6	3.4
	SiO2	62.1	66.6	76.7	71.1	66.0	-	67.5	45.6	32.4	40.2
Dec-09	NO2	1.7	0.6	1.4	2.7	1.7	2.3	5.5	4.1	6.3	2.1
	NO3	18.0	19.4	11.2	12.8	12.5	13.9	13.8	16.2	14.0	11.8
	PO4	3.4	6.4	1.6	3.9	4.3	4.4	5.7	2.6	1.6	2.2
	SiO2	34.3	47.0	40.3	64.2	62.7	45.1	50.0	49.3	70.1	41.0
Mar-10	NO2	0.9	0.8	0.5	1.2	1.0	1.0	1.8	1.6	1.1	1.3
	NO3	12.9	12.9	7.5	6.0	5.3	6.1	7.3	9.8	14.0	8.8
	PO4	1.9	2.4	1.6	2.5	2.8	1.9	5.1	0.7	0.8	4.5
	SiO2	51.7	43.3	34.2	32.0	21.0	33.2	30.4	44.5	57.7	52.9
Apr-10	NO2	0.5	0.5	0.6	0.9	1.4	1.6	2.9	2.9	1.1	1.3
	NO3	9.5	8.2	5.9	5.9	5.4	5.0	5.8	9.7	9.4	7.6
	PO4	0.9	1.8	0.8	2.0	1.8	0.8	3.7	1.5	2.0	2.7
	SiO2	34.9	27.4	30.0	19.5	15.9	30.9	27.5	34.8	39.4	43.1
May-10	NO2	0.4	0.4	0.2	0.5	0.7	0.5	0.3	0.4	0.3	0.3
	NO3	16.8	13.8	12.5	15.5	22.8	24.3	28.4	37.3	31.3	17.5
	PO4	2.8	3.0	4.5	9.5	4.3	4.1	3.1	8.0	2.8	1.2
	SiO2	21.2	25.1	17.4	18.3	20.3	20.5	30.8	32.4	44.6	49.2
Jun-10	NO2	0.3	0.3	0.2	0.3	0.4	0.4	0.1	0.3	0.2	0.2
	NO3	14.4	18.5	13.7	19.4	24.6	27.1	29.3	36.2	22.3	14.5
	PO4	5.8	6.1	5.6	9.3	2.0	4.2	9.9	11.2	3.7	3.0
	SiO2	23.8	28.8	25.6	19.1	21.4	23.1	27.4	28.0	31.1	40.8
Jul-10	NO2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.1
	NO3	29.9	25.6	23.1	30.7	29.9	20.9	24.6	32.3	28.0	19.5
	PO4	8.0	6.8	7.4	11.3	4.4	6.2	12.5	11.8	2.4	1.6
	SiO2	31. 24	33. 60	34.2	31.9	24.0	37.3	34.1	41.1	55.6	53.8

		Qurna-Tigris	Qurna-Euphrates	Saad Bridge	SIndibad	Najibia	Garmatt Ali	Ashar	Abu Al-Khaseeb	Seeba	Faw
Aug-10	NO2	0.3	0.2	0.3	0.3	0.2	0.2	0.3	0.4	0.3	0.2
	NO3	34.2	28.4	28.4	33.5	35.8	26.7	31.6	41.2	32.6	21.3
	PO4	2.9	3.4	2.5	3.5	3.7	2.9	6.2	1.7	1.8	3.5
	SiO2	35.8	30.8	30.4	22.6	26.2	31.5	29.0	23.2	48.1	41.5

Table 2-6 Average Major Ions concentrations (mg/l) of Shatt Al-Arab River

			Qurna-Tigris	Qurna-Euphrates	Qurna-Union	Dair Bridge	Sindibad	Ashar	Abu Al-Khaseeb	Seeba	Faw
Oct-09	EC	dS/cm	1	1	12	7	9	13	22	40	57
	Cl	Mg/l	465	599	4414	2905	4949	5618	8025	25680	34775
	Ca		82	92	352	281	214	352	450	911	1373
	HCO3		250	226	159	250	207	238	220	262	256
	Mg		55	39	484	230	216	80	96	120	152
	TDS		954	866	7187	5266	5235	8803	13883	26321	42409
	TH		430	390	2870	1730	1420	2450	3050	5250	7550
	TA		410	370	260	410	340	390	360	430	420
	SO4		343	289	1579	1015	650	674	741	1126	1891
Nov-09	EC	dS/cm				2	15	21	27	46	61
	Cl	Mg/l				497	10295	12425	14200	26980	38695
	Ca					120	437	656	457	272	316
	HCO3					207	220	281	250	256	311
	Mg					53	240	200	80	112	88
	TDS					1076	9982	14811	20615	35524	23782
	TH					520	2400	3600	2480	1400	1520
	TA					340	360	460	410	420	510
	SO4					206	579	683	845	1136	1555
Dec-09	EC	dS/cm	12	11			13	16	12	19	47
	Cl	Mg/l	4047	3852			4171	5361	4083	6710	18993
	Ca		296	330			338	413	306	464	1130
	HCO3		366	336			348	317	323	342	366
	Mg		240	140			224	240	192	248	444
	TDS		6069	6440			3833	8434	1289	7772	24307
	TH		1820	1710			1950	2300	1740	2530	5760

			Qurna-Tigris	Qurna-Euphrates	Qurna-Union	Dair Bridge	Sindibad	Ashar	Abu Al-Khaseeb	Seeba	Faw
	TA		600	550			570	520	530	560	600
	SO4		856	826			838	892	667	982	1672
Jan-10	**EC**	**dS/cm**			5		3	5	7	5	12
	Cl	**Mg/l**			1757		870	1562	2343	1757	4047
	Ca				226		136	182	216	146	306
	HCO3				342		293	293	311	299	317
	Mg				148		120	160	188	188	228
	TDS				3472		1658	3008	4765	3379	3878
	TH				1300		860	1150	1360	1070	1830
	TA				560		480	480	510	490	520
	SO4				793		474	637	834	641	745
Mar-10	**TH**	**mg/l**	840	820			940	1000	880	840	1040
	SO4		375	449			989	608	338	137	280
	pH		8	8			8	8	8	8	8
	EC	**mS/cm**	2	3			3	3	3	2	4
	Cl	**mg/l**	1136	1172			1172	1172	1420	1065	1846
	TA		500	500			580	520	560	540	520
	TDS		958	730			2226	2227	1464	2960	1362
	HCO3		305	317			317	342	329	317	73
Apr-10	**TH**	**mg/l**	500	940	860		820	840	820	720	820
	SO4		1464	3260	3458		3409	3131	2069	2109	3012
	pH		8	8	8		8	8	8	8	8
	EC	**mS/cm**	2	3	3		3	3	3	3	9
	Cl	**mg/l**	369	717	611		696	667	746	646	2769
	TA		500	400	500		480	420	440	440	500
	TDS		1060	2502	2158		2084	2096	2134	1646	2560
May-10	**EC**	**mS/cm**	2	4	3		3	3	3	3	4
	HCO3	**mg/l**	305	244	305		293	256	268	268	305
	Cl		746				817	710	888	710	10047
	Ca		80				80	160	80	40	400
	HCO3		1769				1769	1769	1830	1708	1830
	Mg		97				73	49	73	97	365
	TH		600				500	600	500	500	2500
	K		4				9	6	4	3	54

			Qurna-Tigris	Qurna-Euphrates	Qurna-Union	Dair Bridge	Sindibad	Ashar	Abu Al-Khaseeb	Seeba	Faw
	Na		368				485	502	352	385	1724
	TDS		812				1446	1632	1146	1084	13824
	SO4		178				252	353	234	164	517
	pH		8				8	8	8	8	8
Jun-10	**Cl**	**Mg/l**					533	497	781	462	1527
	Ca						80	72	56	80	88
	HCO3						378	366	427	354	488
	Mg						58	141	97	24	345
	TH						440	760	540	300	1640
	K						20	20	20	14	80
	Na						302	330	402	273	603
	SO4						204	442	473	66	404
Jul-10	**Cl**	**Mg/l**	746				817	710	888	710	10047
	Ca		80				80	160	80	40	400
	HCO3		1769				1769	1769	1830	1708	1830
	Mg		97				73	49	73	97	365
	TH		600				500	600	500	500	2500
	K		4				9	6	4	3	54
	Na		368				485	502	352	385	1724
	TDS		812				1446	1632	1146	1084	13824
	SO4		178				252	353	234	164	517
	pH		8				8	8	8	8	8
Aug-10	**Cl**	**Mg/l**	14129				284	533	284	533	1243
	Ca		360				80	160	120	96	144
	HCO3		329				329	354	305	329	366
	Mg		277				73	19	39	78	102
	TH		2040				500	480	460	560	780
	K		221				28	17	14	22	35
	Na		1580				373	302	230	330	503
	TDS		23232				122	192	122	2624	3270
	SO4		739				135	225	259	200	249
	pH		8				7	6	7	6	7

2.3 Pollution

Table 2-7 Heavy metals concentrations (µg/L) in water

		Garma	Kardnald	Ysfan	Um Al-Rasas	Faw	Faw	Shatt Al-Basra
Fe	winter	1623	9322	1244	2500	4162	8135	8180
	spring	988	17797	4007	---	15340	6747	5350
	summer	2161	8917	19559	12263	7891	18500	6433
	fall	1996	10089	25039	18920	14637	34208	3395
	winter	17249	7730	11130	4891	3133	44221	4112
Co	winter	551	1	Nd	Nd	Nd	2	455
	spring	73	547	92	---	Nd	505	92
	summer	ND	119	362	601	323	1033	516
	fall	419	285	921	Nd	1553	Nd	3
	winter	354	122	Nd	1	676	876	89
Pb	winter	324	436	371	233	185	193	301
	spring	111	620	180	---	212	566	231
	summer	139	444	299	844	320	603	414
	fall	419	290	637	146	498	175	468
	winter	653	122	335	98	228	167	570
Cd	winter	135	102	472	Nd	420	303	54
	spring	100	79	142	---	117	1	4
	summer	183	123	56	132	23	1	62
	fall	68	35	258	257	Nd	2	53
	winter	ND	11	561	120	10	57	51
Cu	winter	56	92	112	56	377	134	34
	spring	45	Nd	54	---	117	98	67
	summer	28	39	31	39	50	89	42
	fall	89	106	103	64	28	88	35
	winter	103	73	81	56	19	41	33
Ni	winter	ND	791	Nd	365	545	158	33
	spring	60	492	545	---	185	879	1002
	summer	176	384	395	501	70	483	829
	fall	324	527	88	218	Nd	1259	998
	winter	501	545	104	128	21	891	89

Table 2-8 Heavy metals concentrations (μg/g) in sediment

		Garma	Kardnald	Ysfan	Um Al-Rasas	Faw	Faw	Shatt Al-Basra
Fe	**winter**	4302	4138	4237	4168	4209	5213	4183
	spring	4300	5363	2214	---	4077	4273	5219
	summer	4750	5766	5301	3361	5091	3398	5318
	fall	4265	3095	3082	2266	4410	4182	3417
	winter	4261	4217	4229	3917	3976	4192	3400
Co	**winter**	32	50	63	43	25	30	72
	spring	55	43	13	---	55	28	62
	summer	59	43	30	29	44	13	64
	fall	13	13	45	30	57	45	55
	winter	19	17	79	20	48	58	49
Pb	**winter**	40	66	30	25	43	18	37
	spring	41	84	43	---	55	23	20
	summer	44	87	50	25	44	30	55
	fall	27	53	49	32	28	40	39
	winter	25	58	33	37	30	31	21
Ca	**winter**	11	18	2	0	1	0	0
	spring	5	15	0	---	13	0	4
	summer	8	13	1	10	9	5	13
	fall	9	1	2	1	2	13	14
	winter	6	2	1	4	6	3	6
Cu	**winter**	27	35	31	30	30	23	29
	spring	33	34	21	---	27	47	19
	summer	28	31	46	34	25	45	11
	fall	22	22	43	22	24	22	3
	winter	27	65	37	46	25	29	5
Ni	**winter**	51	49	75	48	0	44	53
	spring	106	40	31	---	101	79	67
	summer	29	63	18	13	89	38	71
	fall	1	76	113	76	26	1	42
	winter	115	105	1	14	54	106	34

Table 2-9 Heavy metals concentrations (µg/g) in invertibrates

		Garma	Kardnald	Ysfan	Um Al-Rasas	Faw	Faw	Shatt Al-Basra
Fe	winter	4017	4146	3735	4587	2190	4571	3681
	spring	2376	3544	3709	-----	4704	4349	4006
	summer	3134	2170	2151	3070	3707	2549	2562
	fall	1984	1548	1497	801	2002	2651	2191
	winter	3146	2944	771	1020	1986	2566	3374
Co	winter	28	38	99	53	19	58	55
	spring	33	106	40	-----	43	47	48
	summer	51	53	26	22	9	1	50
	fall	19	18	23	18	19	17	11
	winter	12	22	21	14	2	41	47
Pb	winter	29	55	46	41	31	32	51
	spring	26	21	36	-----	32	40	43
	summer	25	27	29	25	31	40	25
	fall	34	36	27	7	27	27	11
	winter	16	23	30	12	21	39	18
Cd	winter	30	22	20	17	15	45	32
	spring	35	18	21	-----	13	15	34
	summer	35	31	11	23	7	27	54
	fall	20	13	20	17	15	22	34
	winter	8	11	20	22	19	21	46
Cu	winter	104	118	114	111	135	69	261
	spring	97	52	77	-----	137	66	173
	summer	77	76	80	60	174	61	59
	fall	66	80	63	69	115	115	82
	winter	72	68	70	51	93	109	66
Ni	winter	210	143	249	180	103	166	241
	spring	138	85	151	-----	181	70	102
	summer	197	155	140	243	271	194	133
	fall	30	29	25	22	10	38	10
	winter	26	16	26	48	24	20	97

Table 2-10 Heavy metals concentrations (µg/g) in vertibrates

		Winter					Spring				Summer					Fall					Winter				
C. Fluminalis	**Fe**	3066	2382	2119	4913		1524	191	2561	1425	1701	1321	1014	1411		640	183	790	779		1761	1472	563	673	
	Co	53	Nd	Nd	Nd		Nd	65	Nd	22	Nd	Nd	22	Nd		Nd	11	5	15		6	43	11	2	
	Pb	45	38	29	35		8	19	7	11	28	21	20	35		13	22	43	12		12	29	26	14	
	Cd	13	6	19	45		25	22	3	17	44	43	15	26		17	8	12	25		13	4	16	21	
	Cu	182	50	170	78		11	34	27	24	131	43	141	48		75	46	107	110		85	42	73	50	
	Ni	114	207	Nd	334		13	22	79	38	290	197	127	244		27	27	12	29		18	13	58	21	
U. tigridis	**Fe**	3491					2175				1870					2103					2318				
	Co	Nd					Nd				79					31					Nd				
	Pb	20					16				11					8					8				
	Cd	21					6				18					11					1				
	Cu	25					13				21					16					14				
	Ni	88					13				180					21					17				
Crassostrea sp.	**Fe**	4537					1507				1249	1511				1429	1420				2521	3122			
	Co	103					7				0	Nd				6	1				5	76			
	Pb	38					19				79	13				49	8				115	10			
	Cd	89					76				137	76				58	51				7	61			
	Cu	965					833				68	21				384	103				296	81			
	Ni	44					30				101	48				80	22				30	17			
M. Nodosa	**Fe**	1107	1971	3421	4509		919	2379	2907		2236	4197	1700	2297		1404	459	1205	1306		1902	1343	559	768	
	Co	16	102	Nd	Nd		6	35	62		194	23	Nd	Nd		Nd	5	16	18		15	18	16	13	
	Pb	31	38	39	25		10	10	12		6	7	15	15		79	4	3	3		10	14	11	0	
	Cd	23	6	2	24		16	18	26		61	Nd	17	15		51	5	7	15		4	12	8	12	
	Cu	92	106	84	103		200	103	81		102	85	113	129		107	117	123	78		88	77	92	80	
	Ni	389	53	211	176		105	26	211		246	72	119	81		Nd	27	14	26		14	7	Nd	41	
M. tuberculata	**Fe**	2038	4391	3100	2525		1948	5398	4385	5971	2454	3066	2243	6156		1298	678	1120	1071	2245	5523	2113	898	798	868
	Co	Nd	43	Nd	114		69	155	50	20	39	37	109	32		20	29	19	19	9	19	44	8	7	1
	Pb	19	29	63	57		14	17	22	34	18	23	18	35		20	Nd	10	1	19	23	27	17	5	8
	Cd	50	41	36	15		17	Nd	Nd	27	3	5	9	20		Nd	9	19	9	6	Nd	10	12	5	40
	Cu	143	112	154	73		100	131	134	207	88	82	115	50		96	123	83	10	41	98	148	22	16	70
	Ni	176	62	88	252		66	44	70	650	163	180	259	450		9	Nd	46	Nd	1	60	Nd	51	Nd	41
T. Jordani	**Fe**	3583	2730	2813			3417	2897	4669		3625	372	2083			4955	2757	2008	1298		5026	3820	1423	1080	
	Co	57	54	251			40	155	50		Nd	182	2			44	16	14	16		Nd	Nd	26	15	
	Pb	17	95	9			18	31	33		31	28	33			110	0	63	1		25	46	35	19	
	Cd	Nd	Nd	41			18	19	22		6	15	14			66	7	14	38		20	Nd	14	41	
	Cu	31	22	26			28	9	23		29	17	25			42	25	13	21		23	22	22	23	
	Ni	Nd	163	185			Nd	220	97		97	105	124			4	60	6	10		Nd	Nd	10	9	
B. bengalensis	**Fe**	5295	4533	4227	6340		2273	2383	3439		3051	1248	3256	3668		1072	1450	1025	1134		3435	2609	1085	1186	
	Co	97	96	6	50		Nd	71	8		28	16	Nd	17		Nd	21	15	55		22	Nd	26	20	
	Pb	38	85	30	31		8	26	9		12	18	8	15		28	68	13	15		15	19	37	23	
	Cd	22	34	7	16		8	17	5		21	3	3	16		Nd	2	Nd	Nd		6	9	27	1	

		Winter					Spring				Summer					Fall					Winter				
	Cu	54	467	492	403		277	50	210		102	98	110	77		115	143	84	89		182	168	190	102	
	Ni	343	Nd	220	Nd		40	26	70		163	44	97	153		53	4	33	18		Nd	12	Nd	31	
L. auricularia	**Fe**	4474	4341	2319			2276	259	3590		3020					1018					4629	2515			
	Co	Nd	6	115			15	109	Nd		12					Nd					Nd	11			
	Pb	25	29	39			22	9	69		Nd					Nd					31	13			
	Cd	66	20	2			48	33	20		39					62					22	9			
	Cu	87	98	62			180	56	67		109					41					22	45			
	Ni	79	132	431			185	90	663		150					22					53	Nd			
P. acuta	**Fe**	6848	12271	7893			5750	2876	6208		7042										4335				
	Co	37	13	65			83	49	141		Nd										55				
	Pb	28	60	222			63	8	134		76										15				
	Cd	34	39	17			48	35	26		Nd										7				
	Cu	169	59	178			99	33	92		76										46				
	Ni	107	376	160			103	88	231		280										70				
N. violacea	**Fe**	2830	4431	1235			6323	4874	5286		3421	3213	2267			81	1122	3622			897	2696	3878		
	Co	7	Nd	3			87	Nd	46		35	3	12			Nd	3	18			1	8	121		
	Pb	39	89	42			43	26	57		41	34	43			12	38	27			31	36	20		
	Cd	11	92	23			14	19	16		4	Nd	70			26	20	19			20	13	29		
	Cu	46	87	32			59	47	10		42	86	19			29	45	53			27	39	63		
	Ni	48	120	185			26	83	19		221	75	31			Nd	9	36			28	29	38		
A. mesopotamica	**Fe**	2479					5113				4700					3646					2678				
	Co	Nd					43				0					8					1				
	Pb	16					44				29					40					51				
	Cd	7					5				25					40					34				
	Cu	232					185				473					369					290				
	Ni	97					114				55					Nd					8				
M. affinis	**Fe**						2771				1953					1733									
	Co						41				28					12									
	Pb						26				18					3									
	Cd						20				40					25									
	Cu						101				56					65									
	Ni						44				15					17									
B. amphitrite amphitrite	**Fe**	3375	6235				4470	5191			2914	1936				2004	1988	1892			5537	1149	2289	2368	
	Co	124	71				145	35			148	217				41	19	16			Nd	71	31	82	
	Pb	49	9				46	64			51	22				12	11	84			23	31	19	9	
	Cd	16	25				1	2			11	61				3	84	18			8	19	5	91	
	Cu	14	45				6	17			14	74				40	103	22			22	34	29	72	
	Ni	95	70				53	62			93	134				20	8	53			37	102	40	20	
E. kempi	**Fe**	5624	6104				3337	2996			2828	2002	4207	4724	3963	1686	1060	3996			4844	1595	1009		
	Co	14	11				16	22			7	1	1	Nd	Nd	Nd	78	20			4	7	51		
	Pb	23	47				29	38			21	14	72	46	50	109	30	40			26	10	38		
	Cd	13	16				30	21			6	91	6	16	8	1	98	36			16	25	61		

		Winter					Spring				Summer					Fall					Winter				
	Cu	56	98				20	63			31	90	62	53	78	44	44	80			64	42	82		
	Ni	352	454				123	46			190	90	167	551	397	69	50	28			59	116	Nd		
S. ananndalei ananndalei	**Fe**	4756	4244	5515	5738	4638	104	3985	3162	3745	4514	3792	2835	2324	2279	1459	1562	1579	2430	2351	2669	1477	1377	998	
	Co	Nd	60	Nd	39	Nd	13	161	22	154	11	254	Nd	20	Nd	3	87	13	8	Nd	112	37	28	3	
	Pb	31	56	34	51	19	16	25	21	11	17	57	23	4	20	25	39	42	9	12	14	11	Nd	16	
	Cd	12	6	22	Nd	34	70	17	39	30	72	52	7	65	Nd	7	7	9	15	5	Nd	16	41	14	
	Cu	89	115	36	38	30	53	61	14	87	67	80	39	48	45	18	70	52	109	71	84	53	21	71	
	Ni	79	237	299	255	281	580	18	114	35	137	460	127	109	259	Nd	44	53	39	31	56	Nd	81	32	
C. babaulti basrensis	**Fe**	1825					251	6446	2517		697					640	3369				275	900			
	Co	58					ND	99	57		Nd					32	16				16	12			
	Pb	Nd					37	40	47		23					Nd	30				9	6			
	Cd	32					3	Nd	8		10					6	31				27	31			
	Cu	204					28	50	89		77					58	228				112	23			
	Ni	211					70	230	132		123					18	29				31	41			
S. boulengeri	**Fe**						4762	1638			1720	1803	1896			990	161				360	600			
	Co						145	14			0	Nd	2			8	49				29	6			
	Pb						15	38			18	23	14			Nd	10				33	2			
	Cd						29	4			22	7	6			9	Nd				3	29			
	Cu						67	89			45	74	63			41	66				89	40			
	Ni						35	66			45	255	215			Nd	35				62	61			
Parasesarma sp.	**Fe**	2963	2980	3187			3055	4616	2380		2195	749	3845			1495	1294	3545			1224	2364	2944		
	Co	22	163	55			27	69	28		1	Nd	43			4	1	20			1	27	8		
	Pb	19	11	64			10	58	17		36	17	34			19	14	8			6	13	5		
	Cd	5	30	5			3	16	6		Nd	11	9			3	4	2			4	Nd	3		
	Cu	200	113	200			88	89	64		74	44	65			50	57	80			23	87	84		
	Ni	27	193	334			18	167	92		331	48	268			26	28	Nd			24	Nd	122		
M. nipponense	**Fe**	3991	4765				802	3232			815	250				381	1120	1676			180	1766	324	1244	
	Co	244	60				176	35			208	60				20	19	24			Nd	Nd	26	0	
	Pb	9	62				14	14			30	43				33	28	4			11	21	33	15	
	Cd	18	Nd				10	17			48	39				6	Nd	8			Nd	29	18	1	
	Cu	10	53				168	73			148	109				84	81	25			94	112	31	27	
	Ni	79	316				18	53			141	242				26	1	30			Nd	22	Nd	83	
N. indica	**Fe**	2727	4905	6282			5192	3442	7117	7461	5825	6006	703			6178	3610	3272			6177	5343			
	Co	5	318	92			48	157	20	167	82	57	36			63	13	44			30	59			
	Pb	37	33	63			85	31	29	98	62	65	59			38	16	71			28	38			
	Cd	41	54	6			122	17	61	73	32	67	21			55	8	5			31	59			
	Cu	53	52	48			111	18	46	19	32	151	29			33	35	20			48	31			
	Ni	Nd	278	510			388	209	26	373	325	31	79			167	29	16			Nd	265			

Table 2-11 Mean concentration of trace metals (µg/g) in *A. desmoresti mosopotamica*

	Male shrimp *A. desmoresti mosopotamica*				Female shrimp *A. desmoresti mosopotamica*			
	Summer 2008	**Fall 2008**	**Winter 2009**	**Spring 2009**	**Summer 2009**	**Fall 2009**	**Winter 2010**	**Spring 2010**
Lead	3.4	2.9	2.5	3.0	3.2	3.2	3.0	4.3
Manganese	8.6	6.7	7.2	6.7	5.4	6.1	5.8	7.8
Nickel	15.4	16.3	16.5	16.7	15.3	16.4	16.2	16.6
Iron	85.8	105.3	108.1	141.8	75.9	99.7	103.5	136.8
Copper	7.1	8.3	6.9	9.9	6.6	6.9	6.4	9.4
Zink	25.3	27.5	26.4	43.5	26.6	27.2	27.2	44.2

Table 2-12 Total Poly Aromatic Hydrocarbon

	Water (µg/l)				Sediment (µg/g)			
	Winter 2004	**Sipring 2004**	**Summer 2004**	**Fall 2004**	**Winter 2005**	**Sipring 2005**	**Summer 2005**	**Fall 2005**
	9.5	5.4	2.9	5.0	14.3	9.0	3.6	5.6
	7.9	5.1	2.7	4.8	13.5	8.1	3.2	4.7
	9.7	6.1	3.2	5.7	15.7	9.5	4.4	6.6
	15	8.0	3.9	7.0	40.0	21.7	9.8	17.3
	15.6	8.9	4.2	7.2	45.2	23.6	10.4	18.5
Average	**11.54**	**6.7**	**3.4**	**5.94**	**25.74**	**14.38**	**6.28**	**10.54**

2.4 Biology

Table 2-13 Zooplankton dencity (individual/ m^3) in Al-Qurna

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
Alona costata	1	0	0	0	4	200	1	80	2	0	0	0
Alona rustica rustica	0	0	0	0	1	78	1	6	1	0	0	0
Alonella diaphana	0	0	0	0	0	0	0	0.33	0	0	0	0
Bosmina meridionalis	0	0	0	0	1	195	19	6	0	0	0	0
Camptocercus rectirostris	0	0	0	1	3	20	0	20	11	1	0	0
Ceriodaphnia rigaudi	41	1	0	1	1	0	0	0	0	0	0	0
Chydorus sphaericus sphaericus	0	0	0	0	1	165	2	130	1	6	0	0
Daphnia exilis	0	0	0	0	1	12	0	0	0	0	0	0
Daphnia hyalina	0	0	0	0	3	40	0	0	0	0	0	0
Daphnia lumholtzi	0	0	0	0	0	1	0	0.33	0	0	0	0
Diaphanosoma brachyurum	104	1	0	0	1	0	0	0	0	64	438	72
Dunhevedia crassa	0	1	0	0	0	0	0	0	0	1	0	0
Ilyocryptus agilis	0	0	0	0	0	0	0	0	0	6	3	0
Latonopsis fasciulata	3	0	0	0	0	0	0	0	0	0	0	0
Leydigia acanthocercoides	0	0	0	1	0	0	0	0	0	0	1	0
Leydigia macrodonta macrodonta	0	0	0	0	0	0	0	0	0.5	0	0	0
Leydigia sp.	0	0	0	0	0	0	0	0	0.5	0	0	0
Macrothrix spinosa	0	0	0	0	0	0	0	1	0	0	0	0
Moina affinis	3913	2	0	1	0	0	0	0	1638	1541	893	24
Pleuroxus paraplesius	0	0	0	0	1	10	0	0	0	0	0	0

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
Scapholeberis kingi	0	0	0	0	0	0	0	0.33	0	0	0	0
Simocephalus (Echinocaudus) exspinosus	0	0	0	0	1	8	0	2	0	0	0	0
Simocephalus (Simocephalus) vetuloides	0	0	2	1	9	120	0	58	2	0.15	0	0
Total of Cladocera	4062	5	2	5	27	849	23	304	1656	1619	1335	96
Calanoida	10	0	1	1	10	27	2	61	1	0	0	0
Cyclopoida	669	103	60	8	37	898	197	65	278	194	368	48
Harpacticoida	41	23	48	3	80	50	81	40	60	62	105	1
Nauplii larvae	31	1	92	2	50	40	51	50	2	0	0	0
Cirripedia larvae	733	9891	338	55	71	40	3022	2285	163	27	87	0
fish larvae	0	0	0	0	0	1	0	0	0	0	0	0
Foraminifera	0	0	0	0	1	0	0	0	8	1	37	0
Amphipoda	0	0	0	1	1	0	0	0	2	0	0	0
Isopoda	13	12	0	0	0	0	0	0	0	0.3	0	1
Ostracoda	2	3	0	1	0	0	1	40	0	0	0	0
Rotifera	83	17	1	3	12	155	32	15	1	1	0	0
zoea of crab	10	18	1	0	0	0	0	0	13	190	53	2
zoea of shrimp	13	1	0	0	0	0	0	1	42	166	105	24
total of others	121	51	2	5	14	156	33	56	66	358.3	195	27

Table 2-14 Zooplankton dencity (individual/ m^3) in Al-Hartha

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
Alona costata	0	0	0	0	1	3	0	0	0	0	0	0
Alona rustica rustica	0	0	0	0	0	1	0	0	0	0	0	0
Ceriodaphnia rigaudi	0	0	0	0	0	0	2	0	0	0	0	0
Chydorus sphaericus sphaericus	0	0	0	0	1	0	4	0.33	0	0	0	0
Daphnia exilis	0	0	0	0	0	1	5	0	0	0	0	0
Daphnia hyalina	0	0	0	0	1	3	15	0	0	0	0	0
Diaphanosoma brachyuru	0	0	1	0	0	0	0	0	64	9950	7443	395

Table 2-15 Zooplankton dencity (individual/ m^3) in Al-Sindibad

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
Alona costata	0	0	0	0	1	0	0	0	0	0	0	0
Ceriodaphnia rigaudi	0	0	0	1	2	1	0	0	0	0	0	0
Daphnia hyalina	0	0	0	0	0	2	0	0	0	0	0	0
Diaphanosoma brachyurum	0	0	0	0	0	0	0	0	0	7040	12250	4410
Moina affinis	1360	478	424	112	1	0	5	4421	18280	1115	3115	3375
Simocephalus (Simocephalus) vetuloides	0	0	0	5	1	1	1	4	0	0	0	0
Total of cladocera	1360	478	424	118	5	4	6	4425	18280	8155	15365	7785
Calanoida	0	0	0	0	5	8	0	1	0.33	0	53	135
Cyclopoida	105	19	61	50	35	24	362	259	1	65	25	135
Harpacticoida	121	53	6	27	6	0	41	12	10	0.33	0	1
Nauplii larvae	0	18	0	8	25	0	35	0	0	0	3	30
Total of copepoda	226	90	67	85	71	32	438	272	11	65	81	301
Cirripedia larvae	4507	5922	4265	1152	17	7	8707	25395	6950	5	963	14550
Foraminifera	0	0	0	0	0	0	0	0	0	30	0	0
Amphipoda	0	0	1	1	0	0	0	4	15	26	0	0
Isopoda	0	0	0	0	0	0	0	0	0	1	0	0
Ostracoda	67	42	1	7	0	0	0	430	5	0	0	150
Rotifera	27	248	18	3	3	0	0	0	5	0	53	0

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
zoea of crab	27	47	11	1	0	0	0	0.33	285	90	153	34
zoea of shrimp	0	0	0	0	0	0	0	30	175	120	53	15
total of others	121	337	31	12	3	0	0	464.3	485	267	259	199

Table 2-16 Zooplankton dencity (individual/ m^3) in Al-Ashar

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
Ceriodaphnia rigaudi	0	0	0	0	0	3	0	0	0	0	0	0
Daphnia hyalina	0	0	0	0	0	4	1	0	0	0	0	0
Diaphanosoma brachyurum	36	0	0	0	0	0	0	0	0	9699	2050	705
Latonopsis fasciulata	1	0	0	0	0	0	0	0	0	0	0	0
Moina affinis	2996	3326	186	127	0	0	1	94	35004	238	5688	2192
Simocephalus (Simocephalus) vetuloides	1	0	0	0	0.33	3	1	0.33	0	0	0	0
Total of cladocera	3034	3326	186	127	0.33	10	3	94.33	35004	9937	7738	2897
Calanoida	0	0	0	1	0.33	0	1	76	0	12	88	283
Cyclopoida	218	106	41	15	60	473	179	59	29	24	107	246
Harpacticoida	15	71	9	22	5	17	4	15	6		13	22
Nauplii larvae	0	35	0	3	27	320	36	0	0	0	0	0
Total of copepoda	233	212	50	41	92.33	810	220	150	35	36	208	551
Cirripedia larvae	14833	7449	1244	1206	12	840	7177	36017	1744	1547	2644	20355
Foraminifera	0	0	0	0	0	0	0	0	15	0	0	0
Amphipoda	0	0	1	0	0.33	0	0	0	6	1	1	0
Ostracoda	150	265	38	0	0	0	0	55	0	0	1	640
Rotifera	26	106	0	0	131	0	0	0	387	417	13	0
zoea of crab	46	141	3	1	0	0	0	5	72	595	401	327
zoea of shrimp	1	18	0	0	0	0	0	27	84	274	38	3
total of others	223	530	42	1	131.3	0	0	87	564	1287	454	970

Table 2-17 List of Rotifera at the Shatt Al-Arab region collected in the present survey

Class: Bdelloidea **Order: Philodinida**	*Family: Philodinidae* *Philodina sp.* *Rotaria neptunia (Ehrenberg, 1832)* *Rotaria sp.*
Class: Monogononta **Order: Collothecaceae**	*Family: Collothecidae* *Collotheca sp.*
Order: Flosculariaceae	*Family: Conochilidae* *Conochilus (C.) sp.*
	Family: Flosculariidae *Lacinularia sp.* *Sinantherina sp.* *Family: Hexarthridae* *Hexarthra polyodonta (Hauer, 1957)* *H. mira (Hudson, 1817)* *Hexarthra sp.*
	Family: Testudinellidae *Pompholyx sp.* *Testudinella patina (Hermann, 1783)* *Testudinella sp.*
	Family: Trochosphaeridae *Filinia brachiata Rousselet, 1901* *F. longiseta (Ehrenberg, 1834)* *F. saltator (Gosse, 1886)* *F. terminalis (Plate, 1886)* *Filinia sp.*
Order: Ploima	*Family: Asplanchnidae* *Asplanchna sp.*
	Family: Brachionidae *Anuraeopsis fissa Gosse, 1851* *Anuraeopsis sp.* *Brachionus angularis Gosse, 1851* *B. bidentatus Anderson, 1889* *B. budapestinensis Dady, 1885* *B. calyciflorus Pallas, 1766* *B. calyciflorus f. amphiceros (Ehrenberg, 1838)* *B. calyciflorus f. anuraeiformis Brehm, 1909* *B. calyciflorus f. calyciflorus Pallas, 1766* *B. calyciflorus f. dorcas (Gosse, 1851)* *B. calyciflorus f. spinosus* *B. dimidiatus (Bryce, 1931)* *B. leydigi Cohn, 1862* *B. plicatilis Müller, 1786* *B. quadridentatus Hermann, 1783* *B. quadridentatus Hermann, 1783 (long posterior spines form)* *B. quadridentatus Hermann, 1783 (short posterior spines*

	form) *B. rotundiformis Tschugunoff, 1921* *B. rubens Ehrengerg, 1838* *B. variabilis Hempel, 1896* *B. urceolaris Müller, 1773* *Brachionus spp.* *Keratella hiemalis Carlin, 1943* *K. quadrata (Müller, 1786)* *K. quadrata (long posterior spine form)* *K. quadrata (short posterior spine form)* *K. quadrata f. valgoides* *K. serrulata (Ehrenberg, 1838)* *K. taurocephala Myers, 1938* *K. tecta (Gosse, 1851)* *K. testudo (Ehrenberg, 1832)* *K. tropica (Apstein, 1907)* *K. tropica (Apstein, 1907) (with left posterior spine form)* *K. tropica (Apstein, 1907) (without left posterior spine form)* *K. tropica f. asymmetrica Edmondson & Hutchinson, 1934* *K. valga f. heterospina (Klausener, 1908)* *K. valga f. monospina (Klausener, 1908)* *Keratella spp.* *Notholca acuminata (Ehrenberg, 1832)* *N. labis Gosse, 1887* *N. squamula (Müller, 1786)* *Notholca sp.* *Platyias quadricornis (Ehrenberg 1832)*
	Family: Dicranophoridae *Aspelta bidentata Wulfert, 1961* *Dicranophorus dolerus Harring & Myers, 1928* *D. grandis (Ehrenberg, 1832)* *Dicranophorus sp.* *Encentrum eurycephalum (Wulfert, 1936)* *E. putorius Wulfert, 1936* *Encentrum sp.*
	Family: Euchlanidae *Euchlanis dilatata Ehrenberg 1832* *E. lyra Hudson, 1886* *E. triquetra Ehrenberg 1838* *Euchlanis sp.* *Tripleuchlanis plicata (Levander, 1894)*
	Family: Gastropodidae *Ascomorpha spp.* *Gastrobus sp.*
	Family: Lecanidae *Lecane bulla (Gosse, 1851)* *L. closterocerca (Schmarda, 1859)* *L. cornuta (Müller, 1786)* *L. crepida Harring, 1914*

	L. donneri Chengalath & Mulamoottil, 1974 *L. elasma Harring & Myers, 1926* *L. grandis (Murray, 1913)* *L. hamata (Stokes, 1896)* *L. ludwigii (Eckstein, 1883)* *L. luna (Müller, 1776)* *L. lunaris (Ehrenberg, 1832)* *L. obtusa (Murray, 1913)* *L. punctata (Murray, 1913)* *L. pyriformis (Daday, 1905)* *L. quadridentata (Ehrenberg, 1830)* *L. scutata (Harring & Myers, 1926)* *L. stenroosi (Meissner 1908)* *L. stichaea Harring, 1913* *L. subtilis Harring & Myers, 1926* *L. tenuiseta Harring, 1914* *L. thalera (Harring & Myers, 1926)* *L. thienemanni (Hauer, 1938)* *L. undulata Hauer, 1938* *L. ungulata (Gosse, 1887)* *Lecane spp.*
	Family: Lepadellidae *Colurella adriatica Ehrenberg, 1831* *C. colurus (Ehrenberg, 1830)* *C. hindenburgi Steinecke, 1917* *C. obtusa (Gosse, 1886)* *C. uncinata (Müller 1773)* *Colurella sp.* *Lepadella (L.) ovalis (Müller, 1786)* *L. (L.) patella (Müller, 1773)* *L. (L.) patella persimilis De Ridder, 1961* *Lepadella (L.) sp*
	Family : Lindiidae *Lindia (L.) truncata (Jennings, 1894)*
	Family: Mytilinidae *Lophocharis oxysternon (Gosse, 1851)* *L. salpina (Ehrenberg 1834)* *Mytilina crassipes (Lucks, 1912)* *M. ventralis (Ehrenberg 1830)* *Mytilina sp.*
	Family: Notommatidae *Cephalodella Catalina (Müller, 1786)* *C. delicata Wulfert, 1937* *C. dora Wulfert, 1961* *C. gibba (Ehrenberg, 1830)* *C. gracilis (Ehrenberg, 1830)* *C. hoodii (Gosse, 1886)* *C. megalocephala (Glascott, 1893)*

	C. megalotrocha Wiszniewski, 1934 *C. mucosa* Myers, 1934 *C. reimanni* Donner, 1950 *C. tantilloides* Hauer, 1935 *C. tenuiseta* (Burn, 1890) *Cephalodella* spp. *Eothinia* sp. *Monommata* sp.
	Family: Proalidae *Proales daphnicola* Thompson, 1892 *Proales* sp.
	Family: Scaridiidae *Scaridium longicaudum* (Müller, 1786)
	Family: Synchaetidae *Polyartha dolychoptera* Idelson, 1925 *Polyarthra* sp. *Synchaeta lakowitziana* Lucks, 1930 *S. pectinata* Ehrenberg, 1832 *S. oblonga* Ehrenberg, 1832 *S. tremula* (Müller, 1786) *Synchaeta* spp.
	Family: Trichocercidae *Trichocerca cylindrica* (Imhof, 1891) *T. dixonnuttalli* (Jennings, 1903) *T. elongata* (Gosse, 1886) *T. iernis* (Gosse, 1887) *T. multicrinis* (Kellicott, 1897) *T. porcellus* (Gosse, 1886) *T. pusilla* (Jennings, 1903) *T. rattus* (Müller 1776) *T. rousseleti* (Voigt, 1901) *T. similis* (Wierzejski, 1893) *T. stylata* (Gosse, 1851) *T. taurocephala* (Hauer, 1931) *T. tenuior* (Gosse, 1886) *Trichocerca* sp. Family: Trichotriidae *Macrochaetus subquadratus* (Perty, 1850) *Macrochaetus* sp. *Trichotria pocillum* (Müller, 1776) *T. tetractis* (Ehrenberg, 1830) *T. truncata* (Whitelegge, 1889) *Trichotria* sp.

3 UPPER GULF

3.1 Hydrology & Sedimentology

Table 3-1 Values of currents velocity through neep and spring tide cycle (typical)

	Tidal phase	Average Water Velocity		Maximum Water Velocity	
		Tide	**Ebb**	**Tide**	**Ebb**
Entrance of Khor Abdulla	25-Jul-05	0.83	0.76	1.40	1.27
	28-Sep-05	0.68	0.55	1.24	1.00
Upper Reaches Khor Abdulla	27-Jul-05	0.90	0.94	1.30	1.50
	30-Sep-05	0.60	0.48	1.03	0.88

Table 3-2 percentage contribution to the bottom current to the surface current through spring tidal cycle (typical) in station #1

	Time												
	730	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1930**
Water Velocity (m/sec): Surface	0.7	0.75	1.12	1.02	0.5	0.72	1.35	1.4	1.22	0.9	0.4	0.74	1.27
	tide	tide	tide	tide	tide	ebb	ebb	ebb	ebb	ebb	tide	tide	tide
Water Velocity (m/sec): Bottom	0.5	0.58	0.9	0.7	0.5	0.56	0.8	0.9	0.7	0.5	0.4	0.72	0.92
	tide	tide	tide	tide	tide	ebb	ebb	ebb	ebb	ebb	ebb	tide	tide
%	69	77	80	69	90	78	59	61	57	59		97	72

Table 3-3 percentage contribution to the bottom current to the surface current through spring tidal cycle (typical) in station #2

	Time												
	700	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1900**
Water Velocity (m/sec): Surface	1.5	1.25	1.05	0.65	0.8	1.3	1.25	1.2	0.8	0.5	0.9	1.5	1.45
	tide	tide	tide	tide	ebb	ebb	ebb	ebb	ebb	tide	tide	tide	tide
Water Velocity (m/sec): Bottom	0.9	0.8	0.66	0.3	0.4	0.89	0.7	0.6	0.51	0.7	0.8	1.03	0.89
	tide	tide	tide	tide	ebb	ebb	ebb	ebb	ebb	tide	tide	tide	tide
%	57	64	63	46	56	68	56	55	64	144	96	69	61

Figure 3-1 Flower mode of the tidal current of the surface

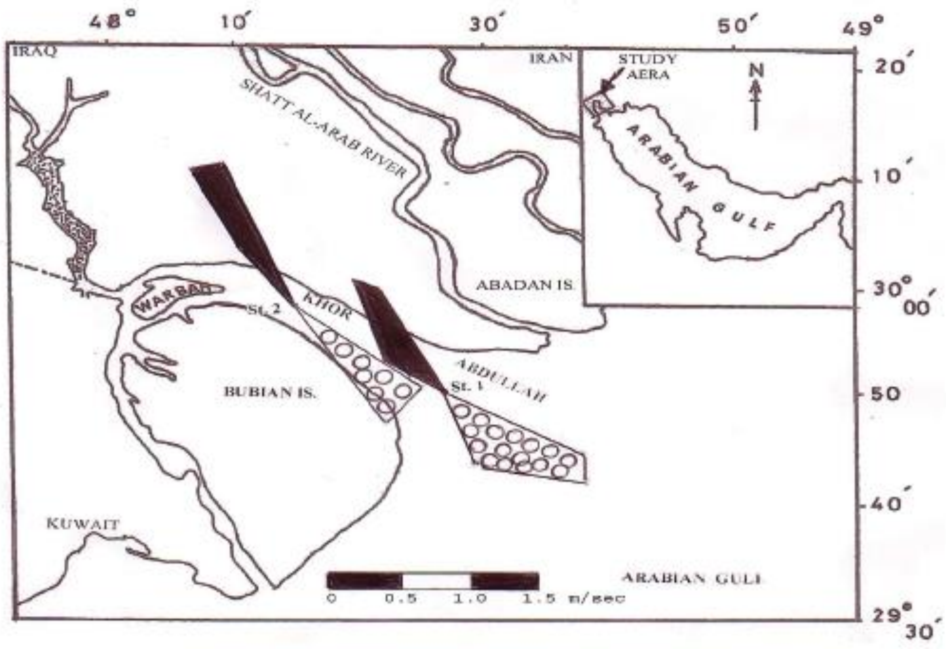


Figure 3-2 Flower Mode of the tidal current of the bottom

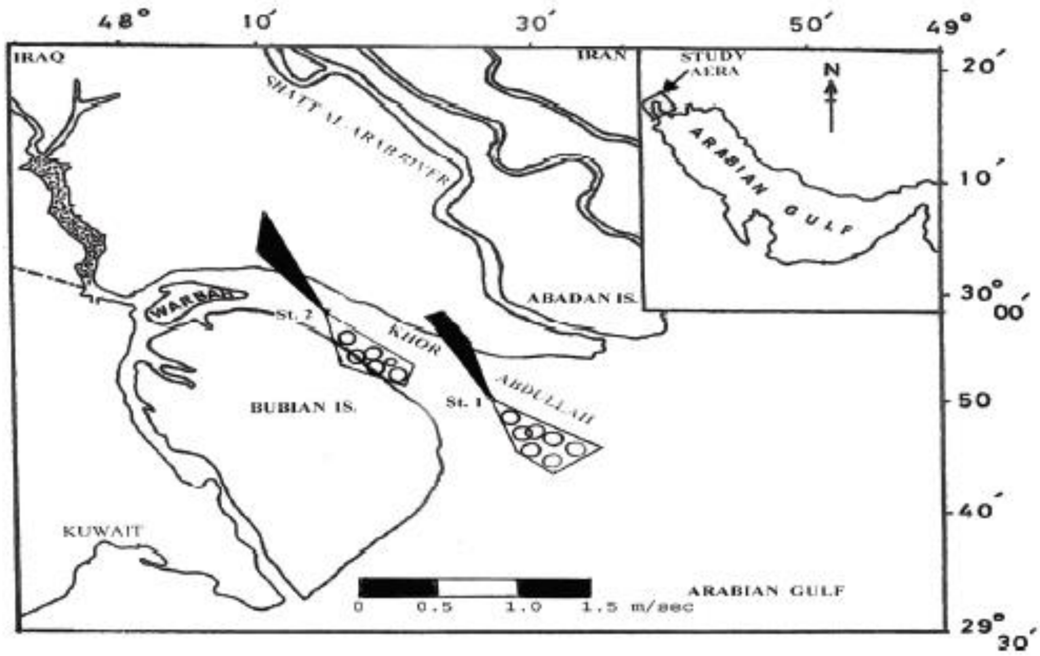


Table 3-4 Sediment structure

	Sand%	Silts %	Mud %
May-10	3.42	82.12	14.46
	28.56	55.74	15.7
	14.16	80.64	5.2
	3.33	79.48	17.3
Jul-10	6.19	74.65	19.16
	28.71	59.29	12
	15.28	58.64	26.08
	53.63	36.85	9.52
Sep-10	2.63	82.63	14.74
	32.56	55.26	12.18
	35.39	54.99	9.62
	19.95	69.11	10.94
Nov-10	4.23	74.29	21.48
	54.55	39.63	5.82
	15.5	66.97	17.53
	11.4	72.62	15.98
Jan-11	10.53	67.49	21.98
	22.19	76.29	1.52
	21.53	45.11	16.68
	32.3	53.88	13.82
Mar-11	1.49	81.69	16.82
	23.55	64.95	11.5
	29.09	56.75	14.24
	22.86	67.32	9.82
May-11	11.27	62.7	26.03
	25.82	59.15	15.03
	15.32	59.68	25
	27.64	57.13	15.23
Jul-11	5.7	64.7	29.6
	57.49	34.91	7.6
	20.89	65.74	13.37
	22.67	61.47	15.87
Sep-11	4.9	75.24	18.87
	64.21	28.69	7.1
	27.51	57.02	15.47
	23.53	61.67	14.8

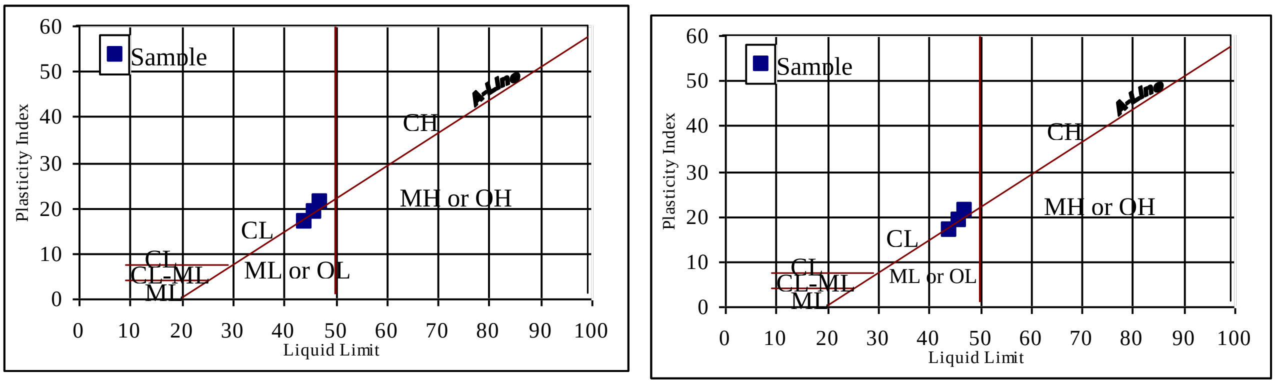
Table 3-5 Total Organic Carbon (mg/g) in the sediment

	Station 1	Station 2	Station 3	Station 4	Average	SD
May2010	1.03	0.93	0.97	0.95	0.97	0.04
July2010	0.74	0.39	0.52	0.41	0.52	0.16
September2010	0.56	0.54	0.45	0.35	0.47	0.09
November2010	1.01	0.74	0.93	0.93	0.9	0.12
January2011	0.84	0.37	0.06	0.39	0.42	0.32
March2011	0.77	0.89	0.76	0.86	0.82	0.06
May2011	0.52	0.23	0.58	0.43	0.44	0.15
July2011	0.47	0.39	0.59	0.59	0.51	0.09
September2011	0.62	0.68	0.66	0.74	0.68	0.05

Table 3-6 Results analysis of Consolidation Parameters of study area.

Sample	Cons. Coeff. Cv m^2/y.	Cons.Index Cc	Swelling Index Cs	Pre-Con. Pc kN/m^2	Void ratio e_o	Compressibility m_v m^2/kN $x10^{-3}$
1	0.1307	0.146	0.0365	30.9	0.888	7.05
2	0.169	0.425	0.106	39.8	0.481	0.873

Figure 3-3 Plasticity charts



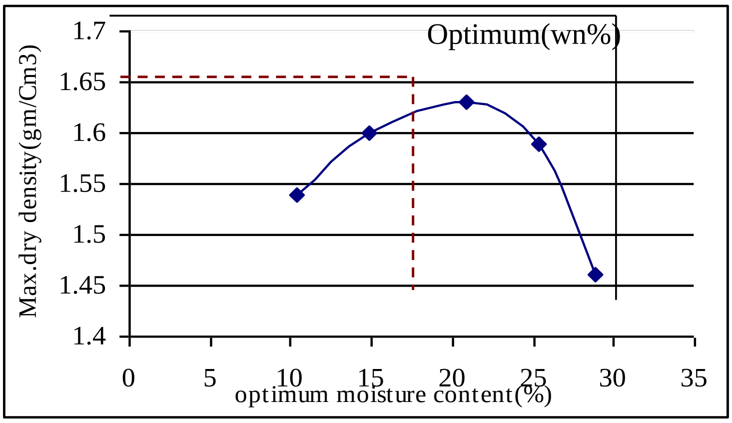


Figure 3-4 Compaction curve

Figure 3-5 A diagram showing a model profile of western bank of Khor Al-Zubair coast

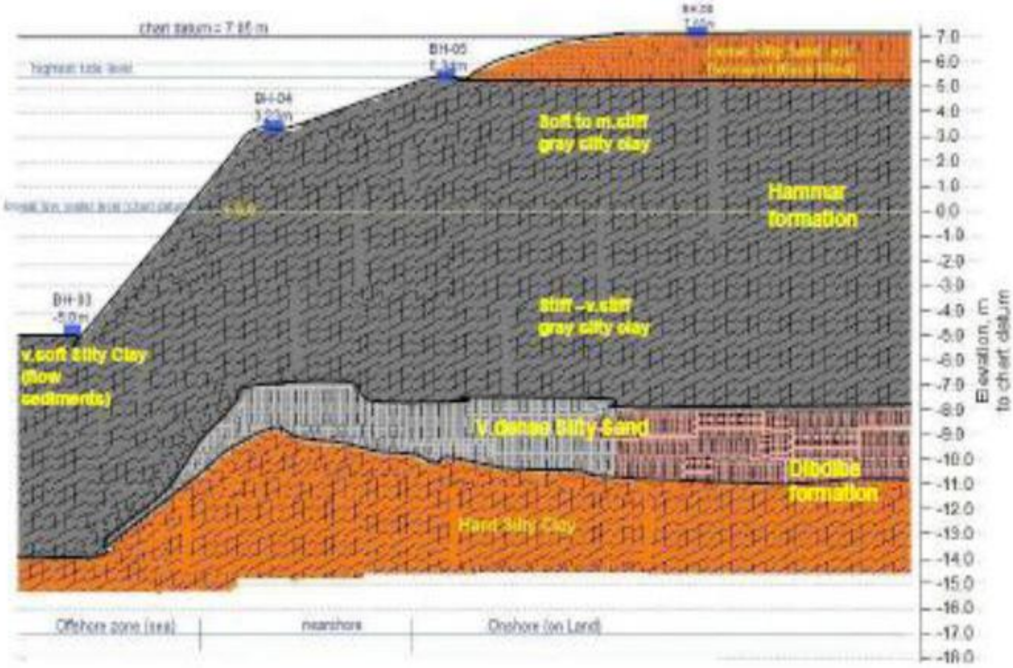
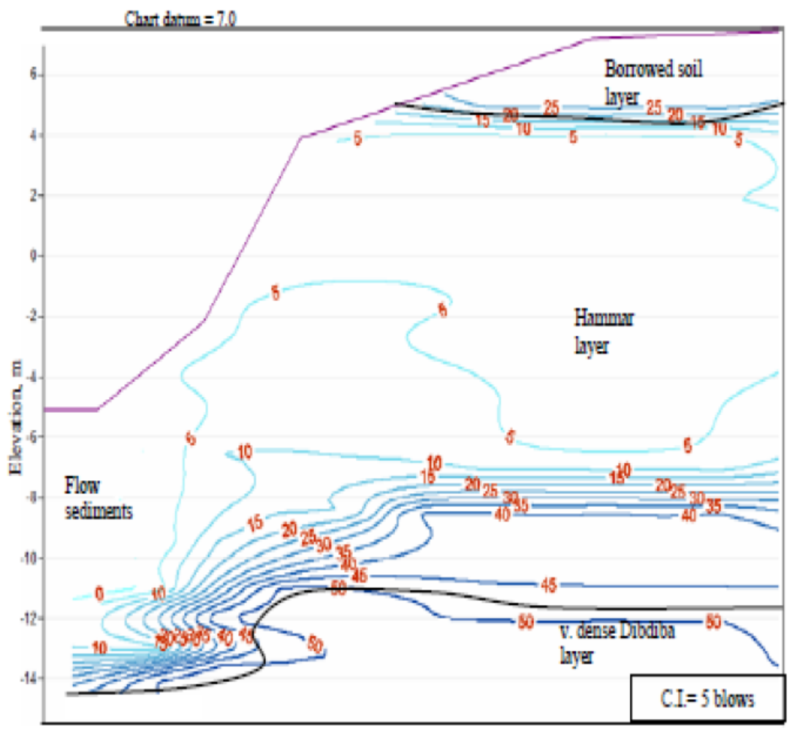


Figure 3-6 Contour lines with the elevation of the main layer forming the western bank of khor Al-Zubair channel



3.2 Water quality

Table 3-7 Water quality measurments

	AT	WT.	Salinity	Turbidity	pH	DO	BOD
	°C	°C	gm/l	FTU		mg/l	mg/l
May-10	32.3	31.5	21.2	23.09	7.62	8.4	2.8
	30.8	30.8	34.37	64	8.03	6.6	2
	30.9	28.3	36.48	54	8.05	6.4	1.9
	29.5	27.6	35.84	27.1	8.13	7.6	1.6
Jul-10	38	36.2	26.49	26.65	7.9	7.2	3.4
	37	34.7	38.97	26.42	8.01	7	2.8
	37.9	33.5	39.17	27.43	8.01	6.6	2.8
	35.2	33.9	38.91	23.71	8.07	6.4	3
Sep-10	36	33.5	22.21	40	7.8	8.2	0.2
	34.9	32.1	37.25	164	7.93	8	1.3
	34.2	31.8	36.87	192	7.94	6.2	1
	33.6	31.4	36.35	55.6	7.99	7	1.2
Nov-10	21.3	19.6	20.22	105	7.84	8.4	0.2
	21.1	18.9	39.23	293	7.93	9.6	2.4
	20.6	18.3	39.1	296	8.02	9.6	1.2
	20	18	38.65	205	8.03	8.9	1.6
Jan-11	15	13.3	22.72	62	7.96	14	3
	14.8	12.5	31.87	242	8.15	13	1
	14.5	11.9	31.74	260	8.15	12.4	1
	13.7	11.3	30.59	95	8.12	10.4	1
Mar-11	25	21.6	14.27	43.44	8.25	11.2	4.8
	23.7	21	36.42	344	8.11	9.8	4.6
	23.4	20.5	35.2	70	8.22	8.4	4.3
	22.8	20.1	34.18	103	8.2	6.2	4.2
May-11	33.4	30.1	15.42	52	8.63	11.4	3.4
	33	29.2	32.704	70	8.68	9	0.8
	32.7	29	31.36	52	8.66	8.2	0.6
	32.1	28.5	29.07	69	8.57	9	0.2
Jul-11	35	33.2	30.02	135	7.75	8.5	3.8
	34	32.7	39.42	95.9	7.9	5.7	1
	34	32.5	39.36	173	7.92	5.8	1.6
	33	31.9	38.98	155	7.92	6	2.8
Sep-11	37.8	35.5	27.39	288	7.8	4.4	4
	37	35	40.45	288	7.8	4.2	2.6
	36.5	34.1	40.38	182	7.9	5.4	2.2
	36	33.2	39.94	230	7.95	4	2.8

Table 3-8 Particulate fatty acids in Water (µg/g)

	Summer 1993	Fall 1993	Winter 1994	Spring 1994	Summer 1994
C13	ND-0.03	ND-0.13	ND-0.22	0.02-0.06	ND-0.23
iso C14	ND-0.1	0.03-0.44	ND-0.29	0.02-0.1	ND-0.31
C14	0.01-0.18	0.07-0.68	0.06-0.6	0.03-0.22	0.08-0.46
iso C 15	0.02-0.21	0.03-0.53	ND-0.72	0.03-0.2	ND-0.16
ante C15	0.02-0.23	0.03-0.45	0.09-1.33	0.06-0.3	0.04-0.31
C15	0.07-0.28	0.08-0.42	0.13-1.04	0.09-0.26	0.08-0.42
iso C16	0.07-0.42	0.11-0.57	0.12-0.58	0.03-0.36	0.14-0.32
C16:1	0.09-0.73	0.13-0.67	0.18-0.63	0.09-0.46	0.18-0.36
C16	0.1-0.98	0.21-0.85	0.26-1.49	0.13-0.65	0.28-0.76
iso C17	0.06-0.13	0.05-0.74	0.11-0.99	0.1-0.62	ND-0.11
ante C17	0.06-0.16	0.11-0.45	0.13-0.77	0.09-0.67	ND-0.16
C17	0.04-0.38	0.11-0.49	0.2-1.68	0.20-0.78	0.1-0.47
C18:2	0.12-0.88	0.13-0.56	0.2-0.99	0.12-0.68	0.11-0.34
C18:1	0.14-0.74	0.16-0.76	0.24-1.15	0.1-0.72	0.14-0.51
C18	0.12-0.29	0.25-0.88	0.28-1.73	0.09-0.45	0.2-0.86
C19	0.07-0.17	0.1-0.51	0.2-1.48	0.05-0.45	0.06-0.35
C20:1	0.1-0.17	0.08-0.35	0.12-1.03	0.04-0.36	ND-0.232
C20	0.09-0.15	0.07-0.32	0.1-0.95	0.03-0.28	0.03-0.26
C21	0.07-0.1	0.03-0.26	0.08-0.63	0.02-0.22	0.02-0.18
C22	0.08-0.12	0.03-0.28	0.06-0.51	0.02-0.18	0.02-0.28
C23	0.03-0.08	ND-0.17	0.05-0.38	0.01-0.09	ND-0.16
C24	0.02-0.05	ND-0.09	0.02-0.19	0.01-0.05	ND-0.33

3.3 Pollution

Table 3-9 Total hydrocarbons in water (µg/l)

	Station 1	Station 2	Station 3	Station 4	Average	SD
May2010	9.61	8.47	8.4	7.97	8.612	0.7
July2010	5.84	7.41	6.77	5.7	6.43	0.807
September2010	10.96	10.96	9.68	9.4	10.25	0.827
November2010	13.02	13.28	12.89	10.76	12.487	1.163
January2011	13.12	13.59	14.67	18.14	14.88	2.268
March2011	11.03	10.53	10.67	10.75	10.745	0.21
May2011	9.89	10.18	8.12	3.78	7.992	2.952
July2011	1.15	3.14	1.79	3.36	2.45	0.935
September2011	4.63	5.27	9.54	5.7	6.285	2.214

Table 3-10 Total hydrocarbons in sediment (µg/g)

Date	Station 1	Station 2	Station 3	Station 4	Average	SD
May2010	14.15	15.64	19.9	20.9	17.647	3.261
July2010	30.88	25.33	25.19	24.76	26.54	2.903
September2010	11.95	14.97	17.91	17.99	15.705	2.87
November2010	8.05	10.96	8.43	11.91	9.837	1.891
January2011	2.39	2.99	2.78	3.28	2.86	0.374
March2011	6.62	4.24	4.34	4.71	4.977	1.113
May2011	13.01	14.89	18.35	20.79	16.76	3.479
July2011	25.9	16.22	20.3	22.26	21.17	4.034
September2011	8.64	11.48	14.09	15.46	21.417	3.011

Table 3-11 Total average Poly Aromatic Hydrocarbon (ng/L)

	Average	Range	SD
May-10	0.79	2.99 -0.11	0.729
Jul-10	1.02	4.35-0.02	1.024
Sep-10	1.07	4.16-0.09	1.04
Nov-10	1.19	5.55-0.09	1.18
Jan-11	0.59	2.65-0.03	0.57
Mar-11	1.54	6.84-0.03	1.808
May-11	4.39	12.85-0.19	4.47
Jul-11	1.36	6.49-0.01	1.754
Sep-11	5.4	24.15-0.05	6.52

Table 3-12 Poly Aromatic Hydrocarbon concentrations in water (ng/L)

Compounds	May-10	Jul-10	Sep-10	Nov-10	Jan-11	Mar-11	May-11	Jul-11	Sep-11
Naphthalene	2.44	0.91	7.36	9.24	6.91	0	0	0	0
Indole+2-methyle naphthaline	0	0	0	0	0	0	0	0	0
1-Methyl naphthalene	0	0	0	0	0	0	0	0	0
Biphenyl	0	0	0	0.15	0.25	0	0	0	0
Acenaphthylene	0	0.02	0.17	0	1	0	0	0	0
Acenaphthene	0	0	0	0	0	0	0	0.014	0
Dibenzofuran	0	0	0	0	0.04	0	0	0	0
Fluorene	0	4.39	1.26	0	1.17	0	0	0	0
Phenanthrene	0	0.52	0	0.09	0	1.32	21.53	4.21	27.92
Anthracene	0	0.64	0.38	0.21	0.49	0	3.28	0	0
Carbazole	0.45	2.86	2.5	7.41	4.34	13.25	43.16	6.49	12.15
Fluoranthene	0	0.84	1.38	0.98	1.06	1.31	3.48	2.67	0.7
Pyrene	0.83	1.88	0.72	2.16	1.28	0.35	0.34	1.215	0
B(A)anthacene	1.73	2.27	1.11	4.08	2.82	3.2	7.23	4.86	45.33
Chrysene	2.79	3.122	4.25	7.47	3.05	4.633	0	5.873	0.36
B(b+k)fluoranthene	6.13	4.09	5.68	2.7	2.62	0	0	2.13	0
B(A)pyrene	1.93	5.96	2.64	5.8	1.52	0	0	0.23	0
Indeno(1,2,3,cd)pyrene+di benzo	2.75	0.93	2.64	1.35	0.89	0	0	0.904	0
Benzo(g,h,i)perylene	0.59	2.16	0	0.62	0.23	0	0	0	0
Total	**25.19**	**34.77**	**25.04**	**42.87**	**26.16**	**24.59**	**79.01**	**28.58**	**86.45**

Table 3-13 Poly Aromatic Hydrocarbon concentrations in sediment (ng/g)

Compounds	May-10	Jul-10	Sep-10	Nov-10	Jan-11	Mar-11	May-11	Jul-11	Sep-11
Naphthalene	7.518	0	18.667	37.296	0.023	25.878	0.04	0	0.306
Indole+2-methyle naphthaline	0	0	5.161	26.94	25.98	7.544	24.763	0	0
1-Methyl naphthalene	2.295	0	1.185	0.024	20.8	0.215	2.624	13.76	0
Biphenyl	3.317	0	6.531	28.82	4.879	5.05	5.76	36.659	9.04
Acenaphthylene	0.901	0	2.22	0	19.1	2.38	9.1933	0	1.64
Acenaphthene	0.413	0	0.165	0.035	15.23	0.019	3.645	0	0.123
Dibenzofuran	0	0	3.983	0	6.522	0	0	0	0
Fluorene	0.2	0	0.049	0.009	3.98	6.211	1.159	1.936	0.561
Phenanthrene	0	2.9	0.005	0	0	0.929	1.935	0	0
Anthracene	0.993	1.526	0.006	0	0	1.204	0	0	0
Carbazole	7.154	4.974	0.347	0.86	0	4.321	0.904	61.99	11.489
Fluoranthene	0.777	4.225	0.316	0.057	2.454	1.15	1.495	1.682	1.723
Pyrene	4.468	4.406	1.968	2.43	0.053	0.156	0.064	1.178	0.122
B(A)anthacene	0.642	0.825	0.3	0.975	7.004	1.503	2.753	58.03	11.555
Chrysene	9.856	6.372	0.033	0.237	0.269	0.184	0.1352	0	4.426
B(b+k)fluoranthene	15.131	8.35	0.087	0.033	3.069	1.979	3.917	0	0.384
B(A)pyrene	2.667	0.958	0.103	0.152	0.499	0.906	0.17	0	0.537
Indeno(1,2,3,cd)pyrene+di benzo	0	0.38	1.122	0.554	6.276	8.805	11.341	0	0.851
Benzo(g,h,i)perylene	0	0	2.68	1.665	0	0.931	1.766	0	0
Total	**56.35**	**34.93**	**44**	**43100**	**116.2**	**69.37**	**72.15**	**175.26**	**42.772**

Table 3-14 Poly Aromatic Hydrocarbon concentrations in Fish and Shrimps in July2010 (ng/g)

Compound	*Otolithes ruber*	*Johnieops sina*	*Tenualosa ilisha*	*Nematalosa nasus*	*Synaptura orientalis*	*Acanthopagrus latus*	*Metapenaeus affinis*	*Thenus orientalis*
Naphthalene	1.18	3.91	0.38		0.23			
Indole+2-methyle naphthaline	0.35				0.29			
1-Methyl naphthalene	0.05	0.64	8.76		1.28			
Biphenyl	0.29	0.39	2.7		1.01			
Acenaphthylene	0.44		1.75					
Acenaphthene								
Dibenzofuran	0.28	0.22	0.71					
Fluorene	1.16	0.29	25.83		0.77		3.29	5.27
Phenanthrene	0.73	0.59		13.26	2.63	0.71		
Anthracene	4.72	3.1			5.86	9.07	36.58	0.89
Carbazole	0.87	1.14	14.59		0.23	39.68		3.4
Fluoranthene	3.07	11.85	0.02	2.48	7.26	0.6	1.65	0.55
Pyrene	0.51	0.85	1.56	0.85	0.05	3.46	0.16	
B(A)anthacene	0.98	2.03	0.6		0.12	3.72		
Chrysene	1.54	0.81	6.66	4.62	0.98	7.74	17.82	0.79
B(b+k)fluoranthene	2.26	1.79			0.94			
B(A)pyrene	5.8	8.23			1.86			
Indeno(1,2,3,cd)pyrene+di benzo	1.09	1.46			1.26			
Benzo(g,h,i)perylene	0.19				0.31			
Total	**25.51**	**37.64**	**63.56**	**21.2**	**25.08**	**64.98**	**59.5**	**10.91**

Table 3-15 Poly Aromatic Hydrocarbon concentrations in Fish and shrimps in September2010 (n gram/gm)

Compound	***Otolithes ruber***	***Johnieops sina***	***Tenualosa ilisha***	***Nematalosa nasus***	***Synaptura orientalis***	***Alepes melanoptera***	***Pampus argenteus***	***Liza subviridis***	***Achanthopagrus latus***	***Metapenaeus affinis***	***Thenus orientalis***
Naphthalene	0.25	0.04		0.48	0.39	0.39	0.25	0.03	0.14	0.31	0.02
Indole+2-methyle naphthaline	0.99	0.07		4.28	0.04	0.04	0.41	0.76	1.2	0.67	0.44
1-Methyl naphthalene	0.1	0.16				0.14	0.15	0.33		0.26	0.16
Biphenyl	0.2	0.12			0.91	1.01	1.25	2.69		1.55	1.27
Acenaphthylene	0.07	1.89				0.4	0.25	1.34		0.22	0.64
Acenaphthene	0.04	0.07				0.13	0.04	0.06		0.06	0.05
Dibenzofuran	2.44	3.56				0.7	1.07	2.69		0.05	1.11
Fluorene	0.03	0.03			0.12	0.14	0.03	0.02		0.02	0.01
Phenanthrene	0.01	0.01				0.05		0.01		0.01	
Anthracene	0.06	0.1			0.6		0.03	0.12		0.17	0.07
Carbazole	0.01	0.02		0.02	0.15	0.1	0.02	0.04		0.1	0.02
Fluoranthene	0.11	0.28		0.25	0.36	0.5	0.07	0.04	0.35	0.31	0.12
Pyrene	0.02	0.01		0.23	0.2	0.25	0.03	0.02	0.25	0.05	0.03
B(A)anthacene	0.01	0.01	2.21	0.009	0.69	0.04	0.02	0.01	0.42	0.01	0.02
Chrysene	0.01	0.06	5.05	0.01	0.06	0.05	0.01	0.02	0.08	0.02	0.02
B(b+k)fluoranthene	0.01	0.03	5.88	0.02	0.05	0.06	0.01	0.24	0.09	0.14	0.06
B(A)pyrene	0.06	0.06	11.62	0.02	0.46	0.26	0.35	0.46	0.63	1.04	0.01
Indeno(1,2,3,cd)pyrene+di benzo	0.43	1.2	2.22	0.18	0.84	0.55	0.26	1.52	0.07	0.87	0.14
Benzo(g,h,i)perylene	0.31	5.18		0.69	1.74	0.21	0.49	0.14	0.98	1.51	1.37
Total	**5.13**	**12.89**	**26.9**	**6.19**	**6.63**	**5.04**	**4.76**	**10.52**	**4.94**	**7.36**	**5.56**

Table 3-16 Poly Aromatic Hydrocarbon concentrations in Fish and shrimps in November2010 (ng/g)

Compound	*Otolithes ruber*	*Johnieops sina*	*Tenualosa ilisha*	*Nematalosa nasus*	*Synaptura orientalis*	*Alepes melanoptera*	*Scomberomorus commerson*	*Chirocentrus nudus*	*Pumpus argenteus*	*Liza subviridis*	*Metapenaeus affinis*	*Thenus orientallis*
Naphthalene	0.11		0.14		5.41	0.15	23.96	0.74	0.24		15.3	
Indole+2-methyle naphthaline	1.02	0.11	0.61	1.46	4.66	0.34	0.3	0.05	0.17	0.12	12	
1-Methyl naphthalene	0.21		0.29			0.16	0.14	0.21				
Biphenyl	3.04		1.46			0.85	0.65	8.88	0.32			
Acenaphthylene	0.45		0.49			0.31	0.26					
Acenaphthene	0.23		0.05			0.04	0.04	0.33	0.09			
Dibenzofuran	1.22		1.34			1.06	0.69	1.69				
Fluorene	0.03		0.01			0.03		0.13				
Phenanthrene			0.01				0.008	0.07				
Anthracene	0.14		0.02			0.06	0.022					
Carbazole	0.06		0.04			0.02	0.03	0.04				0.38
Fluoranthene	0.12		0.09	0.06		0.19	2.08	0.13	0.08		0.09	0.07
Pyrene	0.03	0.66	0.97	0.73	0.83	0.01	0.29	0.4	0.05	0.59	0.72	0.71
B(A)anthacene	0.02	0.01	0.32	0.23	0.29	0.01	0.49	0.009	0.16	0.24	0.01	0.01
Chrysene	0.04	0.01	0.08	0.01	0.01	0.01	0.09	0.008	0.06	0.01	0.04	0.01
B(b+k)fluoranthene	0.02	0.03	0.02	0.05	0.01	0.01	0.007	0.032	0.02	0.06	0.02	0.01
B(A)pyrene	0.09	0.02	0.13	2.29	0.01	0.01	0.034	0.15	0.01	0.01	0.02	0.03
Indeno(1,2,3,cd)pyrene+di benzo	1.86	0.29	0.5	0.06	0.12	0.49	0.45	1.09	0.09	0.21	0.14	0.5
Benzo(g,h,i)perylene	4.64	0.64	0.77	3.47	0.12	1.22	1.69	2.09	0.36	0.16	0.17	0.49
Total	**13.3**	**1.75**	**7.22**	**8.34**	**11.5**	**4.99**	**31.24**	**16.05**	**1.56**	**1.39**	**28.9**	**2.21**

Table 3-17 Poly Aromatic Hydrocarbon concentrations in Fish and shrimps in January2011 (ng/g)

Compound	*Otolithes ruber*	*Johnieops sina*	*Tenualosa ilisha*	*Nematalosa nasus*	*Synaptura orientalis*	*Alepes melanoptera*	*Scomberomorus commerson*	*Chirocentrus nudus*	*Liza subviridis*	*Acanthopa grus latus*	*Metapenaeus affinis*	*Thenus orientallis*
Naphthalene	9.05	0.28	0.04		0.14	0.17	0.14	0.19	0.12	0.19	0.24	0.22
Indole+2-methyle naphthaline	10.6	0.64	0.04		0.5	0.39	0.47	0.39	0.91	0.35	1.64	2.5
1-Methyl naphthalene		0.14	0.17		0.11	0.25		0.23	0.14	0.26		0.018
Biphenyl		0.88			0.59	1.89	0.28	1.78	0.87	1.13	0.54	0.47
Acenaphthylene		0.69			0.23	0.43	0.14	0.47	0.3	0.47	0.3	0.27
Acenaphthene		0.04			0.03	0.14	0.02	0.04	0.04	0.27	0.02	0.02
Dibenzofuran		2.08	0.21		0.66	1.44	0.08	1.45	0.93	1.39		
Fluorene		0.013	0.03			0.02		0.01	0.01	0.01		0.011
Phenanthrene	0.01					0.009	0.006	0.05		0.02		
Anthracene		0.09								0.06		
Carbazole	0.02	0.7			0.02	0.02	0.03	0.03	0.02	0.02		
Fluoranthene	0.15	0.19		0.28	0.08	0.19	0.12	0.31	0.06	0.41	1.44	0.09
Pyrene	0.42	0.05	0.79	0.91	0.48	0.94	0.019	0.04	0.55	0.04	0.03	0.013
B(A)anthacene	0.01	0.01	0.02	0.01	0.01	0.007	0.01	0.05	0.01	0.01	0.02	0.004
Chrysene	0.01	0.012	0.007	0.01	0.01	0.019	0.02	0.02	0.02	0.03	0.01	0.009
B(b+k)fluoranthene	0.04	0.01	0.01	0.02	0.04	0.03	2.47	0.15	0.02	0.02	0.77	0.19
B(A)pyrene	0.02	0.16	0.005	0.02	0.03	0.04	0.02	0.05	0.01	0.17	0.06	0.09
Indeno(1,2,3,cd)pyrene+di benzo	0.13	0.79	0.09	0.11	0.19	0.19	0.06	0.52	0.11	1.62	0.06	0.54
Benzo(g,h,i)perylene	0.22	0.37	0.69	0.72	0.35	1.05	0.13	0.03	0.53	0.12	0.17	0.11
Total	**20.2**	**7.16**	**2.09**	**2.09**	**3.46**	**7.22**	**3.99**	**5.71**	**4.62**	**6.59**	**5.28**	**4.58**

Table 3-18 Poly Aromatic Hydrocarbon concentrations in Fishis and shrimps at March 2011 (n gram/gm)

Compound	*Otolithes ruber*	*Johnieops sina*	*Tenualosa ilisha*	*Nematalosa nasus*	*Synaptura orientalis*	*Alepes melanoptera*	*Pampus argenteus*	*Liza subviridis*	*Acanthopagrus latus2*	*Metapenaeus affinis*
Naphthalene	0.003	0.006	0.005		0.005	0.01	0.006	0.005	0.23	0.01
Indole+2-methyle naphthaline	14.16	13.99	38.24		9.71	3.32	20.57	24.17		11.89
1-Methyl naphthalene	0.52		1.53		1.92	1.24		0.91	0.49	
Biphenyl	1.06	1.52	3.63		3.65	25.5	2.01	2.23	1.83	2.89
Acenaphthylene	13.68	23.36	11.17		3.87	8.65	12.74	7.64		4.01
Acenaphthene	3.91	1.29	3.46		13.13	14.4	0.79	10.78	1.79	1.24
Dibenzofuran	0.43	0.66	2.05		0.37	6.42	0.64	0.57	0.44	
Fluorene	1.49	0.85	1.15		4.72	1.72	13.61	4.31	3.06	
Phenanthrene	1.29		2.63		4.12	7.52	3.82	1.76		
Anthracene	4.09	21.48	10.71		6.34	12.2	6.72	11.91	1.86	3.23
Carbazole	15.63	32.8	10.93		8.78	13.9	26.11	5.37	1.32	1.22
Fluoranthene	1.25	0.65	0.31		0.33	1.78	0.23	0.46	0.91	4.07
Pyrene	0.27	0.22	0.15		0.03	0.19	0.19	0.17	0.01	0.09
B(A)anthacene	0.98	0.27	1.59		0.94	1.08	0.97	11.95	1.35	0.63
Chrysene	0.12	0.07	0.08		0.03	0.43	0.29	0.06	0.28	0.05
B(b+k)fluoranthene			18.04		1.38	12.2	18.11	17.05	6.75	0.51
B(A)pyrene	11.29	53.7	22.39		6.52	28.8	16.11	13.03	3.21	5.08
Indeno(1,2,3,cd)pyrene+di benzo	23.03	28.3	24.22		7.24	9.56	5.23	29.02	5.21	19.83
Benzo(g,h,i)perylene	1.86	3.97	15.19		0.25	7.23	11.9	0.44	0.17	1.17
Total	**95.09**	**183.1**	**167.5**		**73.34**	**156.3**	**140.1**	**141.9**	**28.9**	**55.92**

Table 3-19 Poly Aromatic Hydrocarbon concentrations in Fish and shrimps at May 2011 (ng/g)

Compound	***Otolithes ruber***	***Johnieops sina***	***Tenualosa ilisha***	***Nematalosa nasus***	***Synaptura orientalis***	***Alepes melanoptera***	***Pampus argenteus***	***Chirocentrus nudus***	***Liza subviridis***	***Acanthopagrus latus***	***Metapenaeus affinis***	***Thenus orientallis***
Naphthalene	0.13	0.05	0.13	0.16	0.17	0.31	0.13	11.04		0.07	0.08	0.69
Indole+2-methyle naphthaline	1.35	0.04	1.31	0.18	0.05	0.04	0.03	0.14	0.04	0.04	0.05	0.69
1-Methyl naphthalene		0.26		0.41	0.36		0.34		0.09		0.11	
Biphenyl		0.88			0.93		2.4	1.16	0.6	1.2	1.11	
Acenaphthylene		0.38		0.42	0.87		1.46		0.52		0.46	
Acenaphthene		0.09		0.11	0.18	0.19	0.42		0.13	0.09	0.07	
Dibenzofuran					0.96		11.21		0.39		0.57	
Fluorene				0.08	0.06		0.13					
Phenanthrene					0.1							
Anthracene					0.43		1.64		0.12	0.27		
Carbazole	1.99	0.34	0.19	0.77	0.08	0.24	0.47	0.12	0.07	0.09	0.73	
Fluoranthene					0.77		4.77		0.38	0.39		
Pyrene	0.93	1.22	1.04	1.04	0.27	0.33	0.34	1.17	0.13	0.12	0.94	0.94
B(A)anthacene	0.28	0.07	0.27	0.25	0.45	0.19		0.34	0.03	0.06	0.18	0.24
Chrysene	0.28	0.06	0.23	0.21	0.08	0.09		0.29	0.06	0.05	0.06	0.19
B(b+k)fluoranthene	0.08	0.28	0.05	0.09	0.29	0.13	0.26	0.07	0.17	0.15	0.21	0.07
B(A)pyrene	0.15	0.16	0.23	0.08	0.09	0.09	0.33	0.05	0.16	0.19	0.59	0.16
Indeno(1,2,3,cd)pyrene+di benzo	0.07	0.55	0.04	1.79	0.99	0.17	1.99	0.72	3.47	1.63	0.66	0.83
Benzo(g,h,i)perylene		0.07	0.86	3.22	3.25	0.04	0.05	0.87	5.75	0.05	3.15	1.18
Total	**5.25**	**4.44**	**4.37**	**8.81**	**10.4**	**1.83**	**26.1**	**16.3**	**12.2**	**4.41**	**8.98**	**4.99**

Table 3-20 Poly Aromatic Hydrocarbon concentrations in Fish and shrimps in July 2011 (ng/g)

Compound	*johnieops sina*	*Tenualosa ilisha*	*Synaptura orientalis*	*Synaptura orientalis*	*Pampus argenteus*	*Liza subviridis*	*Acanthopagrus latus*	*Metapenaeus affinis*	*Thenus orientalis*
Naphthalene		15.07			17.94		4.24		0.17
Indole+2-methyle naphthaline		0.041							0.17
1-Methyl naphthalene		0.32			0.19		0.13		0.19
Biphenyl		0.38	14.65		2.97		2.38		4.39
Acenaphthylene		0.22							0.41
Acenaphthene		0.08					0.24		0.08
Dibenzofuran		0.49							
Fluorene		0.025			0.047				0.04
Phenanthrene		0.03	4.49			3.9	0.1	6.08	
Anthracene			0.06			4.7	0.34		
Carbazole	20.51	0.03	0.05		0.26	0.68	0.32	0.09	0.52
Fluoranthene		0.33				0.59	3.34		0.36
Pyrene	0.28	0.06			0.59	0.005	0.41	1.25	0.69
B(A)anthacene	0.04	0.02	0.29		0.32	10.85	0.25	0.24	0.05
Chrysene		0.13			0.25		0.05		0.07
B(b+k)fluoranthene		3.09			0.06		0.23		0.14
B(A)pyrene		0.62			0.18		0.11	4.03	0.12
Indeno(1,2,3,cd)pyrene+di benzo		1.61			0.65		0.51		3.14
Benzo(g,h,i)perylene		0.18			4.43	0.41	0.07		7.63
Total	20.83	22.69	19.54		27.9	21.17	12.74	11.68	18.01

Table 3-21 Poly Aromatic Hydrocarbon concentrations in Fish and shrimps in September 2011 (ng/g)

Compound	*Otolithes ruber*	*Johnieops sina*	*Tenualosa ilisha*	*Nematalosa nasus*	*Synaptura orientalis*	*Scomberomorus commerson*	*Pumpus argenteus*	*Liza subviridis*	*Acanthopagrus latus*	*Metapenaeus affinis*
Naphthalene	0.05	0.35	0.38	0.62	0.23	0.15	0.14	0.6	0.71	1.55
Indole+2-methyle naphthaline	0.29	0.64		0.96			1.01			0.22
1-Methyl naphthalene	0.25	3.91		17.59			0.4			
Biphenyl				0.04		0.89	0.13			
Acenaphthylene	0.28					3.4		0.97	1.29	
Acenaphthene	1.18		1.58	2.71		0.55			0.14	
Dibenzofuran	0.44			0.26						
Fluorene			5.93	14.28					1.74	
Phenanthrene	0.19		0.06	1.84					0.31	
Anthracene	2.44				2.64					
Carbazole	1.16		12.08	0.001		0.79			9.07	0.31
Fluoranthene	0.87		0.03	19.59	3.24	5.27				
Pyrene	0.73		10.4	4.77	1.64	0.26				
B(A)anthacene			11.29	10.01		0.48	0.26	0.02	0.35	0.44
Chrysene	4.72		3.59	12.01	1.28	0.31	0.06	0.46	0.42	0.16
B(b+k)fluoranthene	0.51				0.77	0.26	0.21	1.52	0.09	0.64
B(A)pyrene	3.07		4.42		1.82	0.67	0.55	0.24	0.63	1.27
Indeno(1,2,3,cd)pyrene +di benzo	0.98						0.05		0.07	0.05
Benzo(g,h,i)perylene	1.54									
Total	**18.71**	**4.9**	**49.8**	**84.67**	**11.61**	**13.04**	**2.81**	**3.8**	**14.81**	**4.63**

3.4 Biology

Table 3-22 Percentage of occurrence of the zooplankton

ZOOPLANKTON	%	Occurrence
Acrocalanus gibber	60	Common
Paracalanus aculeatus	85	Very Common
Parvocalanus crassirostris	100	Very Common
Subeucalanus subcrassus	30	Rare
Clausocalanus minor	30	Rare
Euchaeta concinna	5	Very Rare
Centropages tenuiremis	5	Very Rare
Pseudodiaptomus marinus	60	Common
Temora turbinata	20	Very Rare
Labidocera minuta	10	Very Rare
Acartia(Odontacartia) pacifica	100	Very Common
Acartia (Acartiella) faoensis	60	Common
Tortanus forcipatus	5	Very Rare
Bestiolina arabica	100	Very Common
Arctodiaptomus(Rhabdodiptomus) salinus	15	Very Rare
Cyclops sp.	15	Very Rare
Halicyclops sp.	15	Very Rare
Oithona attenuta	65	Common
Oithona sp.	50	Rare
Microsetella sp.	65	Common
Macrosetella gracilis	5	Very Rare
Euterpina acutifrons	55	Common
Clytemnestra scutellata	20	Very Rare
Aegisthus sp.	20	Very Rare
Ectinosoma (Halectinosoma) sp.	5	Very Rare
Harpacticoida 1	5	Very Rare
Harpacticoida 2	5	Very Rare
Oncaea clevei	60	Common
Sapphirina sp.	5	Very Rare
Corycaeus(Dithrichocorycaeus) dahli	25	Very Rare
Corycaeus(Dithrichocorycaeus) lubbocki	10	Very Rare
Corycaeus(Dithrichocorycaeus) andrewsi	10	Very Rare
Corycaeus(Dithrichocorycaeus) sp.	10	Very Rare
Copepod nauplii	100	Very Common
Copepodite stages	100	Very Common
Egg sacs of copepoda	15	Very Rare
Foraminifera	10	Very Rare
Tintinnida	55	Common
Ceratium sp.	5	Very Rare
Protoporidinium sp.	15	Very Rare
Dinoflagellate	10	Very Rare

ZOOPLANKTON	%	Occurrence
Hydrozoa	10	Very Rare
Jellyfish and medusa	10	Very Rare
Nematode	15	Very Rare
Sagitta sp.	55	Common
Keratella quadrata	5	Very Rare
Rotifera	65	Common
Eggs of rotifera	10	Very Rare
Polychaeta adults and larvae	85	Very Common
Ostracoda	75	Common
Shrimp larvae	45	Rare
Mysis larvae	5	Very Rare
Isopoda	10	Very Rare
Aplacophora	5	Very Rare
Amphipoda	10	Very Rare
Cladocera	15	Very Rare
Megalopa	65	Common
Cirripedia larvae	95	Very Common
Planktonic bivalves	95	Very Common
Planktonic gastropoda	80	Very Common
Appendicularia (Oikopleura sp.)	35	Rare
Fish eggs and larvae	85	Very Common

Part 2

Supporting Articles

1 HYDROLOGY & SEDIMINTOLOGY

1.1 Estimate the suspended load of the Shatt al-Arab River

This study shows the possibility to determine Shatt A-Al-Arab suspended load throughout applying mathematical formulas and field measurements according to a hydrological characteristic of the river course. Field measurements were accomplished into two main segments, Northern and Southern part of Shatt Al-Arab River. The results shows that the flow regime of Shatt Al-Arab is similar to that of Mississippi River as a tranquil and turbulent flow due to increasing of inertial forces in contrary with viscous and gravitational forces, which belongs to increasing of flow depth and velocity in addition to decreasing of median grain size of bed sediments .The observed total suspended load in Northern part ranging between 20 and 27 kg/sec in Abu Al-Khaseeb and Al-Khorah sections, respectively, while its ranges in Southern part are between 120-144 kg/sec in Fao and Karun confluence, respectively. This study advice to use Yang (1980) equation to calculate a stream power according to Bagnold (1980) formula because it gives much closer results to one that measured, in contrary with that calculated by Bagnold (1966) formula.

1.2 Geotechnical properties of some tidal flat sediments of Khor-Abdullah coast, southern Iraq

Mesopotamian Journal of Marine Sciences, 25(1): 75-82, 2010

Sediment samples were taken from three dug boreholes (4.10 ft) depth distributed over a wide area (48 km^2). Undisturbed samples were collected using Shelby tube (100mm in diameter). All sediment samples were taken during the ebb periods. While disturbed samples were taken at close to the Boreholes. Tests were carried out according to British Standard (BS) 1377, 1990. Sediment engineering properties were done in the sediment mechanics laboratory, at engineering college and engineering geology labrotory at Marine Science Centre in University of Basrah. For chemical analysis of these sediments are carried out in the analytical Chemistry Lab. in Marine Science Centre.

Geotechnical properties of some tidal flat sediments of Khor-Abdullah coast the studied sediments are classified as silty clay sediments with high percentage of clay (65-85%), and also with a high natural moisture contents. Unconfined compression tests reveal low to medium bearing capacity sediments. Their maximum Dry densities were low, so they need to be stabilized or reinforced when starting to construct big establishments. These types of sediments are liable to settlement and consolidation. These studied sediments have high concentrations of salt ions and effected by seawater of khor-Abdullah channel. High percentages of calcium carbonate will lower the sediment index properties, which lead to aggregate the grains of these sediments. High contents of sulphates and chlorides enhance the corrosion of the concrete foundations. The study shows that these kinds of sediments should be reinforced by the traditional means such as piles or other new methods.

1.3 Investigation of Cavities using Ground Penetration Radar (GPR) Technique

The present paper deals with an area located at southwest of Basra were many strategic projects were constructed, where gypsiferous soils caves have been occur. The existence of these caves and sinkholes represents for such new urban area. Therefore, it is important to know the size, position and depth of natural voids and cavities before building or reconstruction. Recently, cavity imaging using geophysical surveys has become common. In this paper, Ground Penetration Radar (GPR) technique has been applied to the petrochemical construction at Al-Zubair town to image shallow subsurface cavities. The radar survey was conducted among 11 profiles passing through 3 units, Cooling, Ethylene and Energy unit. The data were processed and interpreted integrally to image the cave. As a result, many cavities were determined which are extended with variable depths, most of these cavities were noticed especially at the Energy unit. This is because of creating solution in gypsum sediments as found with soil that caused by leaking in artificial water pipes.

1.4 The effect of vegetation on the stream bank erotionof Shatt Al-Arab River, South Iraq

Marsh Bolletin, 5(1): 1-13, 2010

Khora, Hamdan and Abu-Flus have been selected to determine the root length density on Shatt Al-Arab River bank. The types of vegetation are murran (Paniam repens), bardi (Typha domingensis) and khwesa (Vallisneria spiralis). Natural moisture content, weight density, plasticity index, shrinkage limit, grain size distribution and Maximum Shear resistance were determined. Besides the erodibility coefficient and erosion rate, the shear stress of flow on the bank toe and safety factor of the bank stability were calculated for the period from October 2007 to December 2008. The results showed that there are noticeable variations in geotechnical properties between the sites that chosen for this study. Also, this study proved that the root length density values in the bank toe are 0.049-0319 cm.cm-3, 0.147-0.516 cm.cm-3 and 0.221-0.688 cm, cm-3 for murran, bardi and khwesa plants respectively. The values of maximum shear resistance caused by the roots are 9.0 - 20.0 Pa, 14.0 - 29.0 Pa and 20.0 -37.0 Pa in soil vegetated by murran , bardi and khwesa plants respectably ,while this values in the unvegetated soils was 4.2 Pa, 9.0 Pa and 8.0 Pa in site 1, site 2 and site 3 respectively. The safety factor of soil reached up to 1.29, 1.67 and 1.89 in soils that vegetated by murran, bardi and khwesa plants respectively, while these values in all of unvegetated soil were below the 1.00 unite. The results of this study have concluded that the density and distribution of roots within a River bank play an important role in River bank erosion and stability, and the shear resistance of cohesive soils that vegetated by plants can not be a unique criterion for erodibility estimation, also the cohesion that measured by Coulomb equation in vegetated soils is not represented the true cohesion of soil, but it is apparent (true cohesion combined with additional cohesion by roots).

1.5 Some geotechnical soil properties of western bank of Khor Al-Zubair channel coast at Khor Al-Zubair Port location, southern Basrah, Iraq

Mesopotamian Journal of Marine Sciences, 25(2): 15-24, 2010

Five Offshore Boreholes have been drilled by the National Construction Center at Basrah with cooperation the Marine Science Center/Basrah University, together with three Onshore Boreholes at the western bank of Khor Al-Zubair channel during July 2009. The drilling machine of Auger type has been used for drilling. Representative soil samples were taken at appropriate intervals ranged between 0.5 and 2.0 meters depth or where the stratum has been changed. Onshore boring depths ranged from 19.0 – 20.5 m, from natural ground surface, while, the offshore borings were from 7-16 m from the bed level. The depths of drilling reached the bedrock which is hard enough to require N-value of more than 50 blows. Standard Penetration Test (SPT) has been carried out for each 2m depths. Grain size analysis, moisture content, Atterberg limits of these soils were also determined. The results show that there are two main strata making up the coast bank of the navigational channel of Khor Al-Zubair. First is Marly silty Clay or fat clay soil which has of a thickness18 m, and gradually changes from very soft- m. stiff to stiff-v.stiff which belongs to the Hammar deposits. The second is Silty Sand layer which has two types of sandy soil, these are: (1) borrowed Back filled layer as surficial compaction soil with of a thickness 2.0 m, and (2) are interacted lenses stratum between the gray stiff silty clay and the hard brown silty clay in the near and onshore Boreholes which belongs to the Dibdiba formation. Physics

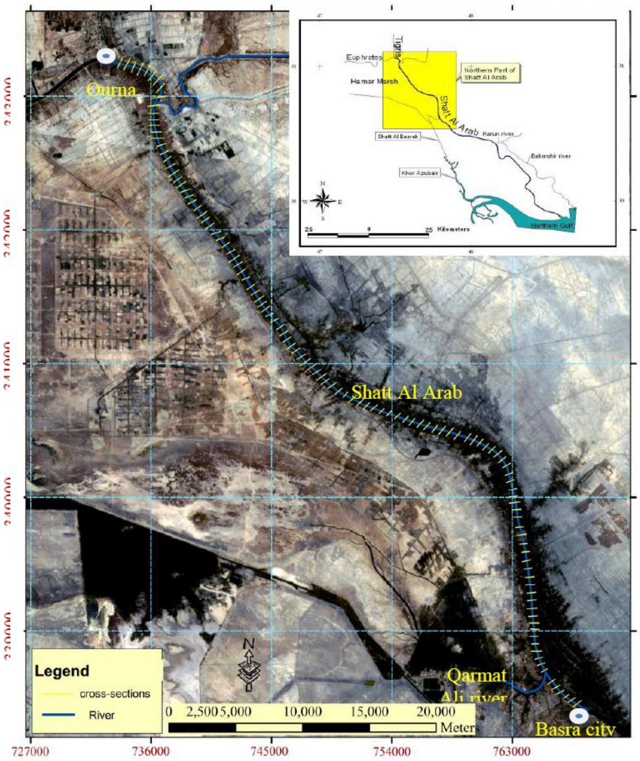
1.6 Some Features of Tidal Currents in Khor Abdullah, North West Arabian Gulf

Journal of King Abdul Aziz University-Marine Sciences, 21(1): 163-182, 2010

This study is an endeavor to understand tidal currents characterization by measuring speed and direction of the currents in the upper and lower reaches of Khor Abdullah during typical neap and spring tides. The results show that the averages and maximum surface velocities during flood period are great than during the ebb period at station No. 1 at both phase of neap and spring tides. Whereas, this status mutate at station No. 2 during the spring tide and then maximum surface and average velocity were recorded of order of 1.50, 0.94 respectively during the ebb period. Velocities values decline with the depths at both stations. The bottom layer (z/h = 0.95) contain active velocities at each station, therefore, the lowest velocity amounted 0.36 m/sec at station No. 2 during the ebb period of neap tide. Bottom current value percentage to the surface is exceeding 50% of the surface current value at both stations. The relatively high velocities (more than 1.0 m/sec) are restricted to station No. 2 which penetrate for more than water column one third (z/h = 0.40) through some hours of the tide cycle during the flood period. While, like those velocities recess to the surface layer (z/h = 0.05) during the ebb period. Generally, water mass motion seems to be semilinear, so, the currents directed to the northwest between (290°-330°) during the flood and towards southeast between (110°-140°) during the ebb on surfaces and bottom layers.

1.7 One dimensional model to study hydrodynamics properties for north part of Shatt Al Arab River (south Iraq)

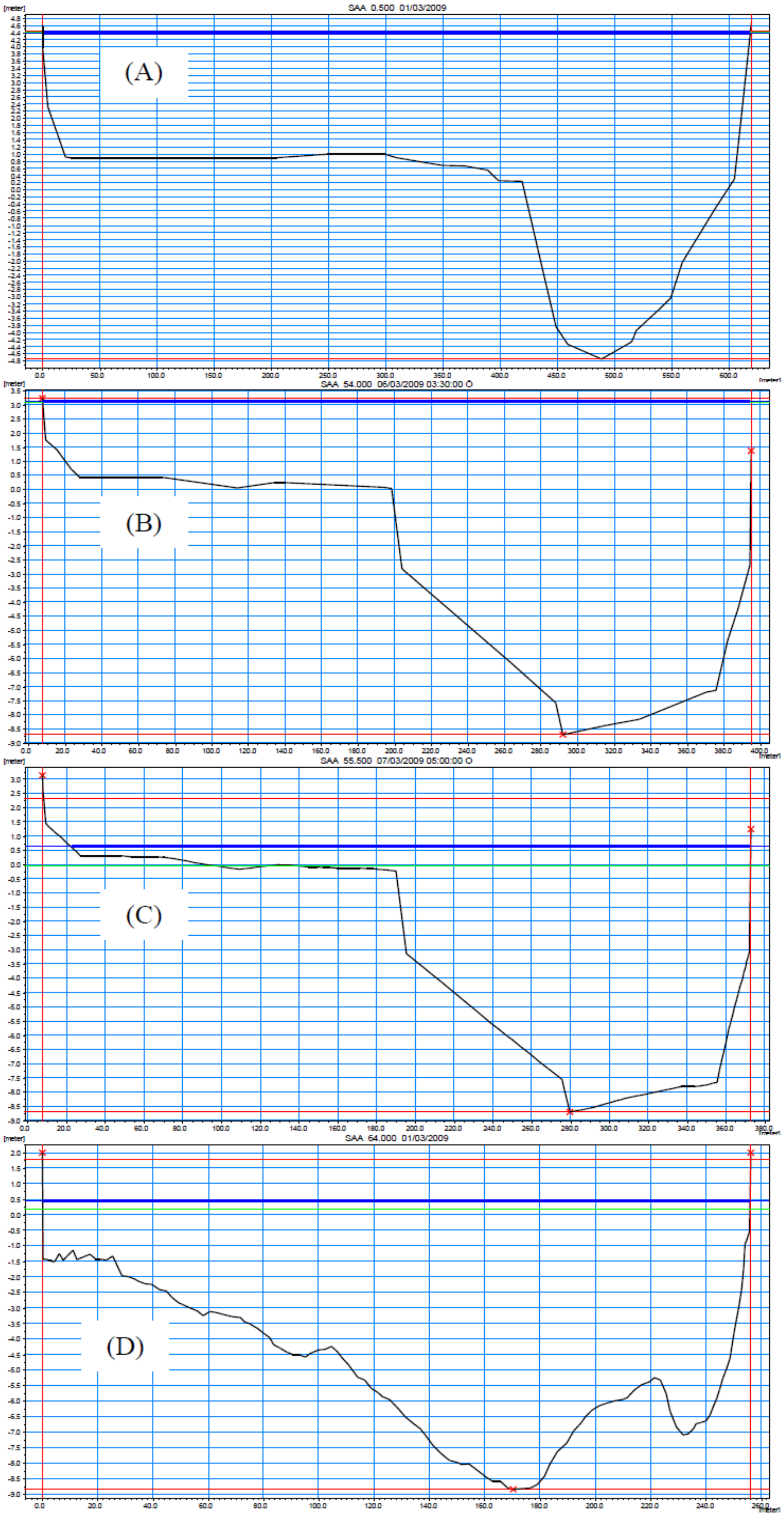
Mike 11 hydrodynamic (HD) modeling is used for simulating hydrodynamic behavior of northern part of Shatt Al-Arab which has 64 Km length starts from Qurna confluence (upstream river) toward Basrah city at Maqal port (downstream river). Mike 11 is river modeling system developed by Danish Hydrologic Institute, (DHI). Its performed an implicit finite difference computation of unsteady flow in rivers based on the saint Venant equations. The process of simulation has achieved in Marine Science Center, Basra University in Iraq, where the package softwere is introduced. The study area grid has created by TM Landsate Satellite image, and five of cross sections distributing along studied river part, which necessary data to make network file for simulation processes, as well as, It is open boundary type of upstream and downstream, where the discharge(Q) value at upstream is constant that equals 300 m3/s. And the time series file of water level (H) of Shatt Al Arab downstream was created with 30 days period, which started 01 /03 / 2009 to 31 /03 / 2009.



Some processed hydrodynamic parameter results of the north part of Shatt AL-Arab

Chainage (m)	Level	Cross-section Area	Radius	Storage width	conveyance
1000	4.671	3029.155	5.506	618.929	9444.699
2000	4.643	3033.011	5.539	617.857	9494.438
3000	4.614	3036.972	5.572	616.786	9545.409
4000	4.586	3041.037	5.607	615.714	9597.613
5000	4.557	3045.207	5.642	614.643	9651.048
6000	4.529	3049.482	5.678	613.571	9705.717
7000	4.5	3053.862	5.715	612.5	9761.617
8000	4.471	3058.346	5.752	611.429	9818.75
9000	4.443	3062.935	5.791	610.357	9877.114
10000	4.414	3067.629	5.83	609.286	9936.711
11000	4.386	3072.428	5.87	608.214	9997.54
12000	4.357	3077.331	5.91	607.143	10059.602
13000	4.329	3082.339	5.952	606.071	10122.897
14000	4.329	3082.339	5.952	606.071	10122.897
15000	4.271	3092.67	6.037	603.929	10253.19
16000	4.243	3097.992	6.08	602.857	10320.188
17000	4.214	3103.42	6.124	601.786	10388.422
18000	4.214	3103.42	6.124	601.786	10388.422
19000	4.157	3114.588	6.215	599.643	10528.599
20000	4.129	3120.33	6.262	598.571	10600.544
21000	4.1	3126.176	6.309	597.5	10673.728
22000	4.071	3132.127	6.357	596.429	10748.152
23000	4.043	3138.183	6.406	595.357	10823.817
24000	4.014	3144.343	6.455	594.286	10900.724
25000	3.986	3150.609	6.505	593.214	10978.875
26000	3.957	3156.979	6.556	592.143	11058.272
27000	3.929	3163.453	6.607	591.071	11138.915
28000	3.9	3170.033	6.659	590	11220.806
29000	3.871	3176.717	6.712	588.929	11303.949
30000	3.843	3183.506	6.766	587.857	11388.344
31000	3.814	3190.4	6.82	586.786	11473.995
32000	3.786	3197.399	6.875	585.714	11560.904
33000	3.757	3204.502	6.931	584.643	11649.074
34000	3.729	3211.71	6.987	583.571	11738.511
35000	3.7	3219.023	7.044	582.5	11829.218
36000	3.671	3226.44	7.102	581.429	11921.201
37000	3.648	3236.726	7.164	580.357	12028.307
38000	3.638	3255.382	7.236	579.286	12178.289
39000	3.629	3274.102	7.308	578.214	12329.681
40000	3.619	3292.886	7.381	577.143	12482.488
41000	3.61	3311.734	7.454	576.071	12636.719
43000	3.569	3277.15	7.536	559.385	12596.875
44000	3.538	3219.61	7.554	543.769	12395.735
45000	3.508	3158.026	7.58	528.154	12186.373
46000	3.477	3092.398	7.612	512.538	11966.553
47000	3.446	3022.725	7.649	496.923	11734.256
48000	3.415	2949.009	7.688	481.308	11487.621
49000	3.385	2871.248	7.73	465.692	11224.915
50000	3.354	2789.443	7.772	450.077	10944.502
51000	3.323	2703.594	7.813	434.462	10644.834
52000	3.292	2613.701	7.851	418.846	10324.43
53000	3.262	2519.764	7.885	403.231	9981.875
54000	3.231	2421.783	7.912	387.615	9615.809
56000	3.067	2278.216	7.847	359.144	8996.458
57000	2.933	2232.657	7.781	346.289	8766.604
58000	2.8	2183.081	7.728	333.433	8533.522
59000	2.667	2129.487	7.689	320.578	8295.525
60000	2.533	2071.876	7.66	307.722	8051.048
61000	2.4	2010.247	7.641	294.867	7798.627
62000	2.267	1944.601	7.63	282.011	7536.881
63000	2.133	1874.937	7.627	269.156	7264.506
64000	2	1801.256	7.629	256.3	6980.261

Sections model, A section at 500m, B section at 54000m, C section at 55500 m, and D section at 64000 m of changes.



2 CHEMISTRY

2.1 Modified method for the determination of cobalt (II) and copper (II) ions by adopting schiff base complexes in water of Shatt Al-Arab river

Mesopotmia Journal of Marine Science, 26(2): 170 -181, 2011

A new method of complex formation between cobalt or copper ions and Schiff Base (derived from Schiff Base of salicyldehyde and amino acids) was adopted for the determination of cobalt and copper ions in water samples of Shatt Al-Arab River. For water sampling three stations along Shatt Al-Arab River were selected as follows: 1) discharging point in Shatt Al-Arab from Basrah paper and mill industries, 2) Karmatt Ali Bridge, and 3) Siba downstream to the southern region of Shatt Al-Arab river. After the formation of a complex with Schiff Base, Cobalt and Copper in the water of Shatt Al-Arab were determined spectrophotometricaly at wave length of 270 nm and 295 nm respectively. It is found that cobalt concentrations were (0.152, 0.174, 0.165) mg.l$_{-1}$ and copper concentrations were (0.014, 0.021, 0.023) mg.l$_{-1}$ in stations 1, 2 and 3, respectively. The method is reliable with sensitivity, accuracy, standard deviation and detection limit of (0.0235 gm.cm.l$_{-1}$, 3.05×10$_{-6}$, 0.00184, 0.52×10$_{-7}$) for cobalt complex and (0.0135 gm.cm.l$_{-1}$, 3.31×10$_{-6}$, 0.00215, 0.6×10$_{-8}$) for copper complex, respectively.

2.2 Investigation on Nutrient Behavior along Shatt Al-Arab River, Basrah, Iraq

Journal of Applied Sciences Research, 7(8): 1340-1345, 2011

Shatt Al-Arab River is the main vital water resource in southern Iraq. Changes have come about in the last few years which could results in alteration in water characteristics of the river, among which are nutrients. Undersurface water samples were collected from ten stations along Shatt Al-Arab River during the period October 2009 to September 2010. The present study has revealed that range of nitrite and nitrate concentrations were 0.1to 9.88 and 4.4 to 43.9µg-at.N/l respectively. Variation in phosphate concentration was between 0.76 and 12.48µg-at.P/l, whereas the minimum and maximum silicate concentrations were 15.9 and 76.7 µg-at.SiO_2/l. Downstream stations showed higher nutrients concentration compared to upstream stations because they are more impacted by pollutant from both diffuse and point sources. Climatic changes as well as reduction in water income to the river have resulted in alteration in nutrients concentration. The river water is eutrophicated and load of nutrients to coastal area might results in high growth of primary producers.

2.3 The Distribution of Fecal Indicator Bacteria in Umm Qasr and Khor AL-Zubair – Basrah/Iraq

***Pakistanian Journal of Biotechnology*, 8(1): 17-27, 2011**

Maintenance of the microbiological quality of water has been used as an important means for preventing waterborne disease throughout the twentieth century. The commonest microbiological tests done on water are for coliforms and *Escherichia coli* (or faecal coliform). In this study 432 samples were taken for total and fecal coliforms and biological demand oxygen. The samples were collected at 12 stations from Khor Al-Zubair and Um Qasr port / Basrah- Iraq. From each site three samples were taken from different depths (surface, middle and bottom). The samples were collected in four periods at 6 hours during April- May 2009. Results indicated that the logarethmic no. of total coliforms ranged from (2.18- 2.84) CFU/100ml, while the logarethmic no. of fecal coliforms ranged from (0.86-1.94) CFU/100ml. The biological oxygen demand (BOD_5) values ranged from (16.47- 20.07) mg/L. These reults indicated that the recipient environment was polluted and poses a great concern.

2.4 The Effect of industrial effluents polluting water near their discharging in Basrah Governorate /Iraq

Journal of Basra Researches, 37(1): 21-32, 2011

Six stations had been chosen to collect water samples these industrial statisis in this study were paper factory, Al-Harth Electric Station and Al-NAjebiah Electric Station on Shatt Al-Arab. On other side, the fertilizer factory and petrochemicals companex throw their discharges in Shatt Al-Basra canal. The water samples were collected from the river near the discharge point of these factories, The sampling was carried out during months 2006 to 2007. The results showed that there were about 4679.48, 3470.99, 2.60, 0.76,70.07,14274 and 690.71 ton.year$_{-1}$ of Cl , SO_4 , PO_4,NO_3 , Oil , TDS and TSS and respectively added to Shatt Al-Arab River represent 47% - 99% of these discharge coming from the paper factory compared with Al-Harth Electric Station and Al-NAjebiah, and there were 12026.16, 11335.94, 34.52, 1.14, 32875.37, 35525 and 8262.15 ton.year$_{-1}$ of the above parameter added to Shatt Al Basrah canal , most of them coming from the discharge of fertilizer and petrochemicals factories.

2.5 Chemical parameters in Shatt Al-Arab and NW Gulf

This study was conducted in Iraqi marine waters, Samples were collected from Four stations which included the region between latitude 29°52 '24.70' N, 48°33 '58.46' E and 29°48 '16.10' N, 48°35 '5.10' E and includes water and sediment and 10 species of fishes and two species of shrimps, sample were collected extent to 18 month for the period from May, 2010 to September, 2011. The present study was included the measurements of some environmental factors (water and air temperatures, salinity, Turbidity, pH, dissolved oxygen and Biological Oxygen Demand) which they ranged between 13.7- 38 °c, 11.3 - 36.2 °c, 14.27- 40.45 mg/L, 23.09 – 344 FTU, 7.62 – 8.68, 4 – 14 mg/L and 0.2 – 4.8 mg/L, respectively. The Total Organic Carbon's content in sediments ranged from 0.23% to 1.03%. The concentration of total petroleum hydrocarbon were determined spectroflourometrically and the mean concentration in water were varied from 1.51 µg /L in first station during July 2011 and 18.14 µg /L in fourth station during January 2011. While the concentration of total petroleum hydrocarbon in sediments were varied from 2.39 µg /L dry weight in first station during January 2011 to 30.88 µg /L dry weight in first station during July 2010 . The concentration of total petroleum hydrocarbons in fish samples were in Otolithes ruber muscles varied between 1.44 µg/g d.w. in September 2011 and 31.15 µg/g d.w. in July 2010 and in Johnieops sina muscles between 4.14 µg/g d.w. in January 2011 and 38.69 µg/g d.w. in May 2010 and in Tenualosa ilisha muscles between 1.72 µg/g d.w. in May 2011 and 54.46 µg/g d.w. in May 2010 and in b Nematalosa nasus muscles between 3.28 µg/g d.w. in January 2011 and 30.01 µg/g d.w. in July 2010 and in Synaptura orientalis muscles concentrations varied between 4.06 µg/g d.w. in May 2011 and 37.11 µg/g d.w. in July 2011 and in Alepes melanoptera muscles between 7.33 µg/g d.w. in November 2010 and 31.58 µg/g d.w. in May 2010 and in Scomberomorus commerson muscles concentrations varied between 0.23 µg/g d.w. in January 2011 and 31.72 µg/g d.w. in May 2010 and in Chirocentrus nudus muscles between 6.34 µg/g d.w. in November 2010 and (35.65) µg/g d.w. in May 2011. And in Pampus argenteus muscles concentrations varied between 10.82 µg/g d.w. in September2011 and 31.22 µg/g d.w. in July 2011 and in Liza subviridis muscles between (2.29) µg/g d.w. in January 2011 and 31.01 µg/g d.w. in July 2010. And in Acanthopagrus latus muscles concentrations varied between 1.29 µg/g d.w. in May 2011 and 29.02 µg/g d.w. in July 2010. In shrimp Metapenaeus affinis concentrations varied between 9.11 µg/g d.w. in January 2011 and 21.06 μg/g d.w. in July 2011 and in shrimp Thenus orientalis between 3.57 μg/g d.w. in January 2011 and 36.26 μg/g d.w. in July 2010 . Gas chromatography was used to identify the concentrations and type of Polycyclic Aromatic Hydrocarbons (PAHs) and the total concentration of PAHs in water ranged from 0.59 ng/L in January 2011 and 12.7 ng/L in March 2011, with predominance of chrysene and high molecular weight PAHs over Low molecular weight PAHs which indicate a Pyrogenic origin for PAHs compounds in water. C The total concentration of PAHs in sediment ranged from 12.15 ng/g D.W. in September 2010 to 47.38 ng/g D.W. in November 2010. The sources of PAHs in sediment were Pyrogenic and Petrogenic with predominance of Carbazole and Anthracene in high concentration which indicates a Pyrogenic origin, and present naphthalene with 1+2 methyl naphthalene and Flourene and Phenanthrene which indicate a Petrogenic origin. The total concentration of PAHs in fishes ranged in Summer 2010 between 10.42 ng/g D.W. in *Sc. commerson* muscles and 65.23 ng/g D.W. in *T. ilisha* muscles , and in Autumn 2010 ranged between 3.92 ng/g D.W. in *P. argenteus* muscles and 31.24 ng/g D.W. in *Sc. commerson* muscles , While in winter 2011 ranged between 2.09 ng/g D.W. in fish *N. nasus* muscles and 20.15 ng/g D.W. in *O. ruber* muscles , and in Spring 2011 ranged between 28.91 ng/g D.W. in *Ac. latus* muscles and 183.12 ng/g D.W. in *J. sina* muscles , And in Summer 2011 ranged between 1.83 ng/g D.W. in *Al. melanoptera* muscles and 19.81 ng/g D.W. in fish *L. subviridis* muscles and in Autumn 2011 ranged between 2.81 ng/g D.W. in *P. argenteus* muscles and 84.67 ng/g D.W. in fish *N. nasus* muscles . With calculated the ratio of low molecular weight to high molecular weight of PAHs and the ration of (Phenanthrene to Anthracene) and (Flouranthene to Pyrene), it is showed that the PAHs origin in fishes were Pyrogenic and Petrogenic. The levels of PAHs in water were less than in sediment due to nature of water Hydrophobic and due to the interaction many processes like d photoxidation and sedimentation and were in sediments higher than in water. The present study *T. ilisha* was occur high ability to accumulate PAHs and cancered compounds like Carbazole , B(A) Pyrene and Flouranthene in muscles compared with other fishes , there was different ability in fish to accumulate the PAHs from surrounded environments .

2.6 Characteristics of lipid tracer compounds transported to the Arabian Gulf by runoff from rivers and atmospheric dust transport

Arab Journal of Geoscience, 3: 113-131, 2010

River runoff and atmospheric fallout (dust and air particulate matter) are major input sources of natural and anthropogenic terrestrial organic and inorganic components to the Arabian seas. In this study, we report on the various lipid tracer compounds that might be transported to the Arabian Gulf by rivers, dust, and air particulate matter. These are based on geochemical analysis of sediment, dust, and particulate samples collected from Iraq, Kuwait, and Saudi Arabia. The samples were extracted with a dichloromethane/methanol mixture and analyzed by gas chromatography-mass spectrometry. The extractable organic compounds (lipids) in the samples include n-alkanes, n-alkanoic acids, nalkanols, methyl n-alkanoates, steroids, triterpenoids, carbohydrates, and petroleum hydrocarbons. The steroids and triterpenoids were major components in river and wetland samples. The major sources of these lipids were from natural vegetation, microbial (plankton and bacteria) residues in the sediments, sand, and soils, with some contribution from anthropogenic sources. Accordingly, these sources could be major inputs to the Arabian seas besides the autochthonous marine products. Future studies of the organic and inorganic biogeochemistry on river, dust, and coastal areas are needed to characterize the various regional sources, transformation, and diagenetic processes of the organic matter en route to the marine environment.

2.7 Determination of phosphate levels in the southern part of Al-Hammar marsh water by flow injection analysis

Mesopotamian Journal of Marine Science, 25(1): 99-109, 2010

Flow Injection Analysis (FIA) was applied to determine phosphate concentration in water of the southern part of Al-Hammar marsh water from July 2007 to July 2008. A linear line was obtained over the range 0.25- 1.75 µg/ml of phosphate with regression coefficient for seven points is 0.9999. The detection limit was 0.075 µg/ml with % R.S.D for ten replicate analyses of 1.0 µg/ml phosphate is 0.511% and the dispersion coefficient in the flow system is 5.4. The samples can be analyzed at rates exceeding 72 sample per hour .It was noted that phosphate concentration ranged 0.295 - 1.450 µg/ml, whereas the maximum phosphate concentration was recorded in spring 2008 and the minimum in autumn 2008.

2.8 Water quality of the Iraqi southern marshes

Mesopotamian Journal of Sciences, 25 (2): 79 – 95, 2010

After inundation, water quality surveys were designed and implemented during November 2005 to September 2006 at six locations, 4 in the Hor Al-Hammar (Al-Barga, Al-Nagara and Al-Baghdadia 1 and 2) the other 2 locations in Hor Al-Hwaaiza (Um Al-Warid and Um Al-Neiach). The sampling locations were selected to cover the distribution of the pollutants in these marshes. Physical and chemical stressors including the natural water quality parameters, dissolved oxygen (DO), biological oxygen demand (BOD), turbidity, total suspended solids (TSS), total dissolved solids (TDS), electrical conductivity (EC), total hardness (TH), temperature, salinity and pH as well as nutrients were studied. The mean range of the following parameters were recorded: pH (7.56-7.84), EC (1.29-3.22 mmohs/cm2), Ca (87.18-130.26 mg/l), Mg (60.35-111.17 mg/l), Cl (304.7-753.31 mg/l), TSS (11-38.58 mg/l), TDS (891-2040.42 mg/l), DO (5.16-10.05 mg/l), turbidity (4.57-39.03 FTU), salinity (0.53-1.7 ppt), water temperature (21.09-22.47 C°), air temperature (23.54-35.26 C°), SO4 (285.73-663.89 mg/l), HCO3 (204.39-255.22 mg/l), and TH (481.67-777.5 mg/l). These marshes are also rich in nutrient especially nitrate and phosphate which enhance their suitability for growth and billings of aquatic plants and phytoplankton. Also the seasonal variation of all the parameters were monitored during this study, and the result showed some fluctuation in some of them during different seasons at different locations of the marshes. The results obtained during this survey established important background information and a baseline for further restoration work and indicate reasonable signs of successful restoration

2.9 Mycobiota of surface sediments in marshes of Southern Iraq

***Marsh Bolletin*, 5(1): 14-26, 2010**

Twenty sediment samples were taken from ten sites in the southern marshes of Iraq and analyzed for the presence of fungi by three isolation methods. The dilution technique yielded the highest number of genera identified (32 genera). Phenol and acetic acid treated sediments yielded 17 and 16 genera respectively. Phenol treatment method was more selective for ascomycetous fungi yielded the isolation of 12 genera.Sixty seven species assigned to thirty seven genera in addition to sterile mycelia were identified. The isolates were assigned to 43 mitosporic fungi, 20 species of ascomycetes and 4 species of zygomycetes. The most frequent species were in decreasing order: *Aspergillus terreus, A.niger, Acremoniumkiliense, Sterile mycelia, Graphiumputredinis, Preussia dispersa, A. fumigatus, Dichotomomyces ceipii* and *Rhizopus sp*., our findings were compared with those from similar survey on mycobiota in sediments in several parts of the world.

2.10 Seasonal variations of particulate fatty acids in waters of Shatt Al-Arab River and northwest Arabian Gulf

***Mesopotamian Journal of Marine Sciences*, 25(1): 41-52, 2010**

The particulate fraction of the fatty acids was investigated in water samples collected from different stations along the Shatt Al-Arab River and North-West Arabian Gulf during the period June 1993 to July 1994. Samples were analyzed by gas chromatography. Several qualitative and quantitative differences were observed. In general, palmitoleic acid (16:1), palmitic acid (16:0), heptadecanoic acid (17:0), stearic acid (18:0), oleic acid (18:1) and linoleic acid (18:2) were found to be the most abundant fatty acids in the region. Total particulate fatty acids showed large variations, from 1.45 µg/gm at station 7 (Arabian Gulf) during summer 1993 to 18.91 µg/gm at station 2 (Shatt Al-Arab River at Al-Fao town) during winter 1993. The main sources of odd and even number of fatty acids were phytoplankton and microbial activities, while aquatic plants were missing in most sites.

2.11 Seasonal variations of particulate fatty acids in waters of Shatt Al-Arab River and northwest Arabian Gulf

Mesopotamian Jornal of Marine Sciences, 25(1): 41-52, 2010

The particulate fraction of the fatty acids was investigated in water samples collected from different stations along the Shatt Al-Arab River and North-West Arabian Gulf during the period June 1993 to July 1994. Samples were analyzed by gas chromatography. Several qualitative and quantitative differences were observed. In general, palmitoleic acid (16:1), palmitic acid (16:0), heptadecanoic acid (17:0), stearic acid (18:0), oleic acid (18:1) and linoleic acid (18:2) were found to be the most abundant fatty acids in the region. Total particulate fatty acids showed large variations, from 1.45 µg/gm at station 7 (Arabian Gulf) during summer 1993 to 18.91 µg/gm at station 2 (Shatt Al-Arab River at Al-Fao town) during winter 1993. The main sources of odd and even number of fatty acids were phytoplankton and microbial activities, while aquatic plants were missing in most sites.

3 POLLUTION

3.1 Distribution of Coliform Bacteria in Khor Al-Zubair and Umm Kasr Harbors in Basra

Basra Journal of Agriculture Sciences, 24(2): 2011

A total of 432 water samples were collected from khor Al-Zubair channel and Umm Kasr in twelve sites, from each site three samples have been taken from different depths (surface, middle, and bottom). The samples were collected in four periods at 6 hours during April – May 2009. The bacteriological tests had been undertaken to determine the counts of both total and facal coliform bacteria obtained in this study, the average of bacteria were variable from nil in some stations to uncountable in most stations in different depths or periods of collections. There is no effect to the depth or period of collection on the bacterial counts obtained in the study.

3.2 Effect of Water Soluble Fraction (WSF) of Crude Oil on some Biochemical Characters of Juveniles common

Basra Journal of Veternary Research, 9(1), 2010

This study was carried out juveniles common carp, *Cyprinus carpio* to determined the effect of (WSF) of crude oil on blood glucose and hemoglobin of blood values and glycogen of liver and muscles exposed to sub lethal effects for using different concentration. Study showed lower levels of blood hemoglobin and glycogen of liver and muscles, while blood glucose values have risen when exposed to concentrations of crude oil used.

3.3 The Geoaccumulation Index of Some Heavy Metals in Al-Hawizeh Marsh, Iraq

E-Journal of Chemistry, 7(S1), S157-S162, 2010

Heavy metals have a great ecological significance due to their toxicity and accumulative behavior. The geoaccumulation index (Igeo) in 10 stations in Al-Hawizeh Marsh, (*i.e* Al-Adaim (I & II), Um Al-Neaj (I & II), Um-Awarded, North Al-Soudah, South Al-Soudah, Al-Beda, Lissan Ejerdah and Majnoon) were calculated in this article. The sediment pollution was investigated by following the concentration of six heavy metals (As, Cd, Cr, Co, Cu and Pb). Inductively coupled plasma mass spectroscopy (ICPMS) was used for analysis. According to the geoaccumulation index (Igeo) the results of all the 10 stations were analysed and discussed in detailed.

3.4 Impact of Al-Najebiya thermal energy power plant on aquatic ecosystem of Garmat Ali canal: II. Monthly differences in abundance and distribution of alge

Basra Journal of Science (B), 28(1): 9-19, 2010

Heated effluent, discharged from Al-Najebia power station imposed tremendous impact on availability, abundance and distribution of alge in Garmatt Ali canal. Garmatt Ali canal was investigated on monthly basis from November 1997 to October 1998. Area affected by discgarge of wastewater was determined and extended to 750 m. a total of 79 algea (chlorophyta) 13 species were indentified. Diatoms (Bacillariophyta) 12 species, but only one species was appeared of Euglrnophyta and Xanthophyta. Discharge points on cooling water possessed the highest number of species (60 species). Also, peack abundance in total count of algal cells was encounted closer to discharge points (5998 cell/cm2) in January. Datoms dominated samples followed by blue green algae. However, blue green algae dominated others near discharging points particularly during summer months.

3.5 Assessment of the accumulation of some trace metals in whole body of fresh water shrimp *Atyaephyra desmaresti mesopotamica* from Shatt Al-Arab River, Basrah, Iraq

Mesopotamian Journal of Marine Sciences, 25(2): 37-44, 2010

Concentrations of heavy metals (Pb, Mn, Ni, Fe, Cu, and Zn) were determined in shrimp *Atyaephyra desmaresti mesopotamica* collected from Shatt Al-Arab River, Basrah, Iraq. The elements content were determined in whole body biomass. The seasonal variations of the element concentrations, and the relationship between element concentrations in males and females were estimated in this study. Measurements were done to evaluate trace metals in shrimps tissues in Qurmat-Ali in Shatt Al-Arab River between summer (May- August) 2008 and spring (March and April) 2009. Samples were collected seasonally. Tissue samples were analyzed by flame atomic absorption spectrophotometry. Females accumulated the trace metals in their bodies in spring higher than other seasons. Males accumulated the trace metals in their bodies in Spring higher than other seasons, except for Pb and Mn. Regarding to concentrations; the highest values were 141.80 µg g_{-1} d.w in males and 136.79 µg g_{-1} d.w in females for Iron, while the lowest values were 2.49 µg g_{-1} d.w in males and 2.96 µg g_{-1} d.w in females for Lead. Regarding to seasons; in Summer the concentrations of trace metals were higher in males than in females, except Zn, in Autumn they were higher in males than in females, except Pb and Ni, in Winter they were higher in males than in females, except Pb and Zn, in Spring they were higher in males than in females, except Pb, Mn and Zn.

3.6 Toxicity of aromatic hydrocarbons to several species of molluscs from Shatt Al-Arab River

Marsh Bolletin, 5(1): 103-117, 2010

The present study includes toxicity experiments carried out under laboratory conditions for 24- and 48- hours periods by using renewal toxicity test system to determine the comparative toxicities of three types of aromatic hydrocarbons (hydroxylated aromatic hydrocarbon (phenol and β-naphthol), azaarenes (quinoline and acridine) and polycyclic aromatic hydrocarbons (naphthalene and phenanthrene)) to several species of molluscs found in Shatt Al-Arab river. These species of molluscs are snails, Lymnaea auricularia, Theodoxus jordani,Physa acuta, Melanopsis nodosa, and Melanoides tuberculata and bivalves, Corbicula fluminea and Corbicula fluminalis. The toxicity experiments show that the more toxic aromatic compounds to species of molluscs is phenanthrene and the less toxic is quinoline. In each of these types of aromatics, the compound with the greater number of aromatic rings always exerts a greater toxicity to species of molluscs. The order of sensitivity of molluscs tested to aromatic hydrocarbons is as follows: L. auricularia> P. acuta > M. nodosa > T. jordani > M. tuberculata > C. fluminalis > C. fluminea. The overall acute effects of hydrocarbons on the species of molluscs tested are abnormal activities, narcosis and anesthesia, the loss of ability to react to the external cue, rapture the tissues and die.

3.7 The ability of some species of cyanobacteria to accumulate the aromatic hydrocarbons

Basra Journal of Science, 28(2): 1-16, 2010

The present study deals with the isolation and identification of three species of blue green algae (cyanobacteria): *Microcystis aeruginosa*, *Hapalosiphon aureus* and *Anabaena variabilis* which were collected from different stations of Shatt AL-Arab River (Abu AL-Khasib). They are purified isolated in vitro to oftain unialgal and axenic culture to test the ability of three species to accumulate total aromatic hydrocarbons for two weeks. The results demonstrated the ability of these three species to accumulate these compounds. The results indicate that *A. variabilis* accumulated more hydrocarbons than the other species 88.5 ppm in contrast to *H. aureus* 86.9 ppm and *M. aeruginosa* 58.6 ppm. There were significant differences $P<0.05$ between the species and the exposure period. The results showed that the concentration increased as the period increased.

3.8 N – Alkanes in molluscs of Shatt Al-Arab River

Mesopotamian Journal of Marine Sciences, 25(1): 83-98, 2010

This study comprises monitoring of the n-alkanes in the Shatt Al-Arab River by using the seven molluscs species as bioindicators. These species are: snails *Lymnaea auricularia*, *Theodoxus jordani*, *Physa acuta*, *Melanopsis nodosa*, and *Melanoides tuberculata* and bivalves *Corbicula fluminea* and *Corbicula fluminalis*. The species of molluscs are collected from different locations of the Shatt Al-Arab River (along the region extended from Abu Al-Khasib to Garmat-Ali) during 2004 and 2005. Each species consisted of at least 3500 adult of individuals of uniformsizes. The hydrocarbons from these species were extracted and analyzed both by spectroflurometer (total hydrocarbons) and highresolution capillary gas chromatography (n-alkanes). The concentrations of total hydrocarbons in mollusc's species of the Shatt Al-Arab River ranged from 1.93 µg/g dry weight in *T. jordani* to 26.56 µg/g dry weight in *C. fluminea*. The range of carbon chain length of nalkanes in these individuals was ranging from C_{13} - C_{32}. The bimodal distribution with two maxima around C_{17} and C_{27} suggested two different sources of hydrocarbons both biogenic and anthropogenic. The dominance of the odd carbon numbers n-alkanes (C_{15}, C_{17}, C_{25} and C_{29}) in the mollusc's species indicated biogenic origin of hydrocarbons .The pristane values were more than those of phytane. Pristane andphytane in the mollusc's species suggest biogenic origin. CPI values are more than one indicating a biogenic origin of hydrocarbons inthese species. Squalane is also present in some these species intimately related to anthropogenic sources of hydrocarbons. The presence of Unresolved Complex Mixture (UCM) reflects theanthropogenic sources. The lower fat contents were found in *T. jordani* (0.33 mg/g) and the higher were in *C. fluminea* (0.98 mg/g). A significant relationship is found between the fat contents and hydrocarbons concentrations in the tissues of molluscs species (r =0.8 - 0.9).

3.9 Seasonal and reagional variatitions of hydrocarbon concentrations and origin of n-alkanes in sediments of Iraq Southern marshes

Marsh Bolletin, 5(2): 197-206, 2010

From the period January 2006 to February 2007, sediment samples were collected from different sites of Iraq southern marsh land; Al-Bargah, Al-Hammar and Al-Gebayesh station. Analysis was done for the determination of total hydrocarbon concentrations using the spectroflurometric method by comparing samples with a standard solution of Iraq crude oil. Total Petroleum Hydrocarbon Concentrations (TPH) indicated that there were regional and seasonal variations. TPH ranged from 0.458 µg/g dry weight in Autmn season at Al-Hammr station to 1.250 µg/g dry weight at Al-Gebayesh station during winter 2006. Gas hromatography also used to identify the concentration and origin of n-alkanes in sediment samples, total n-alkanes ranged from 6.53 µg/g dry weight at Al-Hammar station during summer season to 31.46 µg/g dry weight at Al-Gebayesh station during winter 2006. Studying Pristan, Phytan and Carbon Prefrence Index indicated the biogenic source of hydrocarbone compounds. Temporal and spatial variations of petroleum hydrocarbons in water and sediments from Northern parts of Shatt Al-Arab River, IraqEffect of water soluble fraction and the oil –in water dispersions of crude oil on the survival rate of crab *Sesarma boulengeri* from Hamdan canal a branch of Shatt Al-Arab.

3.10 Temporal and spatial variations of petroleum hydrocarbons in water and sediments from Northern parts of Shatt Al-Arab River, Iraq

Mesopotamian Journal of Marine Sciences, 25 (1): 65 – 74, 2010

Regional and temporal distribution of Total Petroleum Hydrocarbons (TPH's) and percent Total Organic Carbon (TOC %) were investigated in water and sediments from 5 stations along Shatt Al-Arab river (1-Qurnah, 2-Shafi, 3- Deer, 4-Nihran Omer and 5-Sinbad close to expected sources of pollution by petroleum hydrocarbons. Measured TPH's in the dissolved phase of water were ranged from 5.10 ng/l in station 3 to 9.48 ng/l in station 5 comparable to Basrah light crude oil. In the sediments levels of PHC's ranged between 7.37 mg/l in station 3 and 24.41 mg/l in station 5.Seasonal variations in TPH's in waters and sediments were found as lower concentrations 2.65–4.20 and 3.15–10.36 mg/l respectively during summer, while higher concentration recorded during winter were found to be 7.86–15.60 µg/l in water and 13.52–45.21 mg/g in sediments. % TOC measured in the sediments were ranged from 0.50 % to 0.81 % in stations 2 and 5 respectively. Strong positive correlations were found between TPH's and TOC for all stations with correlation coefficient (r = 0.93).

4 BIOLOGY

BIODIVERSITY

4.1 Distribution and abundance of zooplankton in Shatt Al-Basrah and Khour Al-Zubair Channels, Basrah, IRAQ

Journal of Basra Researches, 38(4), 2011

Monthly variation in the quality and quantity of zooplankton was studied in Shatt Al-Basrah and Khour Al-Zubair Channels, Basrah from March 2009 to May 2010. Samples of zooplankton were collected by plankton net (0.120 mm. Mesh size). In Shatt Al-Basrah Channel, the population density of zooplankton ranged between 5811 – 95514 Individual/m^3 during August and April, 2009 respectively. The results showed that the Crustacea was the dominated group 62.9 %. Copepoda constituted about 44.7 % followed by Rotifera 31.0 %, Cirripede larvae 14.7 %, polychaetes 5.5 % and Cladocera 3.1 %. While in Khour Al-Zubair Channel the population density of zooplankton ranged between 3548 and 20328 Ind./m^3 during January 2010 and October 2009, respectively. Crustacea was also the dominant group 83.7 % Copepoda formed about 66.6 %, Cirripede larvae and megalopa of crabs 8.4 % , Gastropoda 6.1 % and polychaetes 2.3 %.

4.2 Diatoms from the restored Mesopotamian marshes, South Iraq

Algological Studies, 133: 65–103, 2010

This study is the fi rst to provide a fl oristic list of the diatom fl ora in the restored Mesopotamian marshes in South Iraq. One hundred and sixteen taxa were recorded representing forty-nine genera. All taxa recorded are documented with light microscope micrographs. Owing to the change in the water chemistry after marsh restoration and rehabilitation, a relatively large number of taxa encountered have not previously been reported from the Iraqi inland waters (33 taxa). Diatom assemblages in the slightly brackish marshes were a mixture of taxa of variable environmental amplitudes and were represented by 42 % oligohalobous (indifferent), 30 % mesohalobous, and 25 % alkaliphilic forms. A small number of species of marine origin were found. Some acidophilic taxa were also frequently observed in these alkaline habitats.

4.3 Composition, abundance and distribution of zooplankton in the Iraqi marine and brackish waters

Zooplankton composition and abundance of marine and brackish water, Southern Iraq were studied seasonally from winter to autumn 2010. Five stations were chosen: Shatt Al-Basrah, Khor Al-Zubair, Al-Fao and Iraqi marine and coastal water. Samples were collected by plankton net (120 µm mesh size). Some physical and chemical parameters of the water were measured. Quantitative and qualitative studies of zooplankton were carried out. Sixty taxa of zooplankton were identified in the present study. 35 taxa were belonging to copepods, while 25 taxa were belonging to other zooplankton. The more abundant copepoda and other zooplankton at all stations were, *Paracalanus aculeatus*, *Parvocalanus crassirostris*, *Acartia (Odontacartia) pacifica*, *Bestiolina arabica*, Polychaets; adults and larvae, cirripedes larvae, planktonic bivalves, planktonic gastropods and fish eggs and larvae. Copepoda is the major group of zooplankton in the study area, while calanoid copepod was the most dominant order followed by cyclopoid, harpacticoid and poecilostomatoid. Seven taxa of copepods were recorded for the first time in the study area. The total number of zooplankton at all stations were 194266 ind/m^3 recorded in autumn at station 1, while the lowest number was 6804 individual/ m^3 reported during winter at station 3.

NEW RECORDS

4.4 New record of the fiddler crab Uca (Paraleptuca) sindensis (Crustacea: Brachyura: Ocypodidae) from Khor Al-Zubair, Basrah, Iraq

***Marine Biodiversity Record*, 1-3, 2010**

Specimens of the fiddler crab Uca (Paraleptuca) sindensis were collected from the intertidal zones of Khor Al-Zubair, Basrah, Iraq in 2009. A literature review on the distribution of this species revealed that this is the first report of U. (P) sindensis from the Iraqi coast and only the third country in which this species has been recorded. A note on the morphological features of this species and a photograph is provided to confirm the identification of the crab.

4.5 First record of the Marine Calanoid Copepod *Pseudodiaptomus* c.f. *ardjuna* from Shatt Al-Arab River, Iraq

Mesopotamian Journal of Marine Science, 1, 2011

The marine calanoid copepod *Pseudodiaptomus* c.f. *ardjuna* (Brehm, 1953) was recorded from some freshwater habitats in some regions of the Shatt A-Arab River during March – July 2009. These regions include Al-Kurnish area, Al-Sindebad Island during April-August 2009 and at Al-Gurna city on March 2009 only. The species is briefly described in this work and its morphological characters are compared with earlier descriptions from Iraqi coastal water, like the total length of female and male, body shape, female genital segment, the shape of the male posterior prosomal segment and number of the setae of the furcal rami.

A comparison of the diagnostic feacheres of Pseudodiaptomus ardjuna from Shatt Al-Arab with those from India

Characters		Ummerkutty described	Pillai described	Present specimens
Total length (mm)	Female male	1.31 1.1	1.20-1.23 1.03-1.10	1.17-1.36 1.03-1.12
Shape body		Rounded anteriorly	-	Pointed anteriorly
Female genital segment		Genital operculum without spines	Provided with clusters of spinules on anterior half of lateral and dorsal margins.	Provided with rows of spinules on the antero-ventral surface, and have a clusters of spinules on the antero-lateral margin. Paired gonopors covered by operculum bearing a pair of unequal process.
The spines of the male th5		less pronounced	Pronounced pointed	Various ; either both spines present or both spines absent or either spine may be present
Male and female urosomal segments		-	Female urosomal segments I-III with triangular spines on disto-dorsal margin, whereas in the male they are found on segments II-IV.	In the female these spines present on dorso-lateral surface. But in the male, they are around the margin of each segment, the spinules, in the female U III and in the male U IV are much longer than those on the other segments.
Furcal setae		Each ramus 5 setae, 4 of apical and 1 outer subapical	-	Each ramus bears 6 setae, 4 apical, 1 outer subapical and 1 small dorsal

5 FISHERIES

5.1 Study of Occurrence and some of Biological aspects of Liza subviridus (Valencieunes, 1836) in Shatt Al-Basrah channel

Journal of Basra Researches, 36(6): 143-156, 2010

The occurrence and some biological aspects of *Liza subviridus* in Shatt Al-Basrah channel were studied during the period from June 2008 to May 2009 .Two station were chosen, the first station was far 5km from South the regulating gate and the second located near the Zubair bridge, North the regulating gate. The highest occurrence of fish was recorded during April and May at the two stations which composed 17.7% and 13.4% of the total catch at the first and second station respectively. Analysis of food items of individuals at lengths more than145ml was showed significant differences between the stock at first and second stations according to point method, the highest percentage were of algae 30% at the first station and plant roots 28% at the second station. The highest feeding activity was recorded on June 2008 89% and July 91.8% at first and second stations respectively. Monthly fluctuations of feeding intensity showed that the maximum value was on March and April (11.7 point/Fish) and (10 point/Fish) respectively. Fifth age groups were recorded the highest group (V_+) was of individuals. The value relative condition factor of fishes ranged between 0.89 -7.05 for age group I-V. study was deferent monthly the highest temperature recorded was 25◦ on July at the first station and 24◦ on August at the second station, Salinity reached 50ppt on August at the first station and 41ppt at the second station. There were Significant differences ($p>0.05$) among monthly values temperature, Salinity and Occurrence ratio of number type between two stations.

5.2 Embryonic Development of common carp *Cyprinus carpio* (L, 1758)

Basra Journal of Veternary Research, 9(1): 26-31, 2010

Embryonic development stages were described during artificial fertilizing in Marine Science Center hatchery of fishes. Temperature of incubation was 23c◦, period of incubation was 48 hours. Embryonic stages examined under microscope each 6 hours. The fertilized egg begun division till formation morula. After that vertebral cord brewed then yolk sac and the eyes brewed after 30 hours from fertilization. Lineament of the head and tail were clear during 42 hours. Eggs hatched after 48 hours from fertilization.

5.3 The effect of water currents on the movement behaviour of the Oriental River Prawn, *Macrobrachium nipponense* (De Haan, 1849)

Iraqi Journal of Aquaculture, 7(1): 43-54, 2010

The present study showed the effect of water currents (0.20–0.25 m/sec.) on the movement behaviour of *Macrobrachium nipponense* during 2 and 24 hour periods inclusive of weight group five (g). In the first period, the results indicated that group one (0.10 – 0.49 g) aggregated towards the water currents or contrary currents by the relative percentage of 64.47 & 35.33 %, where as the groups was distributed in the following sequences: two, three and four 44 & 56, 40.67 & 59.33 and 38 & 62 %, respectively. But the results of group five were 3.33 & 96.67 %. However, the results of the second period for the five groups were: 38 & 62, 27.33 & 72.67, 22 & 78, 19.33 & 80.67 and 13.33 & 86.67 %, respectively. The distribution of these agegroups determined at different parts of the tank.

5.4 Food selection of Liza subviridis in Shatt Al-Basrah canal

Journal of Basra Researches, 36(5): 48-58, 2010

The food of 68 fish of *Liza subviridis* from Shatt Al-Basrah canal was studied during the period April – June/ 2009. The study revealed that the fish tend to be a herbivorous where the animal preys consist 0.19, 2.5% of the food consumed estimated as frequency of occurrence and numeric proportions respectively. This proportion increased to be 34% when calculated according to the volume of food items. This fish consumed 25 plant food items and two animal food items. *Coscinodiscus sp.* ranked the first important food item according to the relative importance index while *Guinardia sp., Sorerella sp., Cyclotella sp., Gyrosigma sp., Noctiluca sp*. and *Naviculla sp*. occupied the next importance in sequence. Other preys were of less importance. Ivelev's selectivity index was applied to determine the food selectivity of this fish and revealed that it prefers *Coscinodiscus sp., Guinardia sp., Noctiluca sp*. and *Gyrosigma sp*. in sequence of preference. Other food items were consumed due to scarcity of the preferred food items in the environment.

5.5 Check of the taxonomyof fresh water fishes of Iraq

Iraqi Journal of Aquaculture, 7(2): 101-114, 2010

Taxonomic studies on freshwater fishes of Iraq were reviewed. Considerable differences in number of species that have been recorded in Iraqi freshwater were noticed, the number ranged from 44 to 70 species. The difference might be due to recording of synonyms or incorrect records. The continuous record of new species on various periods may have contributed to such variation. Thiety eight species, mainly cyprinids, fell into the disagreement category. A final list of the species which have revised majority agreement was proposed with a total of 53 species and 12 families.

5.6 Taxonomic study of *Alburnus mossulensis*, *Acanthobrama marmid* and *Hemiculter leucisculus* by Electrophoresis of Protiens in southern Iraqi marshland

Jordanian Journal of Agriculture Sciences, 6(4), 654-663, 2010

Leuciscine fishes (samnan) from southern Iraqi marshes (Hammar and Al-Hawizeh) were classified depending on electrophoretic protiens analysis. Fish samples were collected by seine and fixed gill nets, and electro-fishing gear during the period from October 2006 to August 2007. The electrophotic analysis of lateral muscle protiens revealed thar SDS-PAGE can be considered a good taxonomic criterion to differentiate among *Alburnus mossulensis*, *Acanthobrama marmid* and *Hemiculter leucisculus*. The result showed that five protein bands were diagnosis in the first species, six bands in the second species and seven in the third species. The protein bands for the three species varied in intensity strength and in mobile activity. The molecular weight of protein bands ranged from 18197 to 97723 daltons for *A. mossulensis* and *A. marmid* and from 19054 to 128824 daltons for *H. leucisculus*