Impact of Marine Pollution on Marine Biodiversity

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Topics

- Introduction (Biodiversity)
- Marine pollution (MP)
- Impact of MP
- Case studies
- Concerns and Final statement

1. Introduction

Biodiversity

The variation of life forms within a given ecosystem. It is often used as a measure of the health of biological systems. The biodiversity found in earth today consist of many millions of distint biological species, which are the product of 3.5 billion years of evolution (http:// www.biodiversity.sg)

Most concerned threat to Global Biodiversity

- **Climate change**
- **Pollution and deforestation**
- **At the same rate of warming and deforestation , it is expected that by the 2100 half of all the species present on earth today could have become extinct. (http:// www.biodiversity.sg)**

- **Many species can not cope with the rapid changes in physical parameters which are occurring to our environment.**
- **High levels of pollution results in toxicity.**
- **All substances are toxic. It all depends on the level of occurrence and to which capacity organisms can tolerate the substance.**
- **We are releasing substances in the environment to such a level that they are becoming toxic to many organism.**

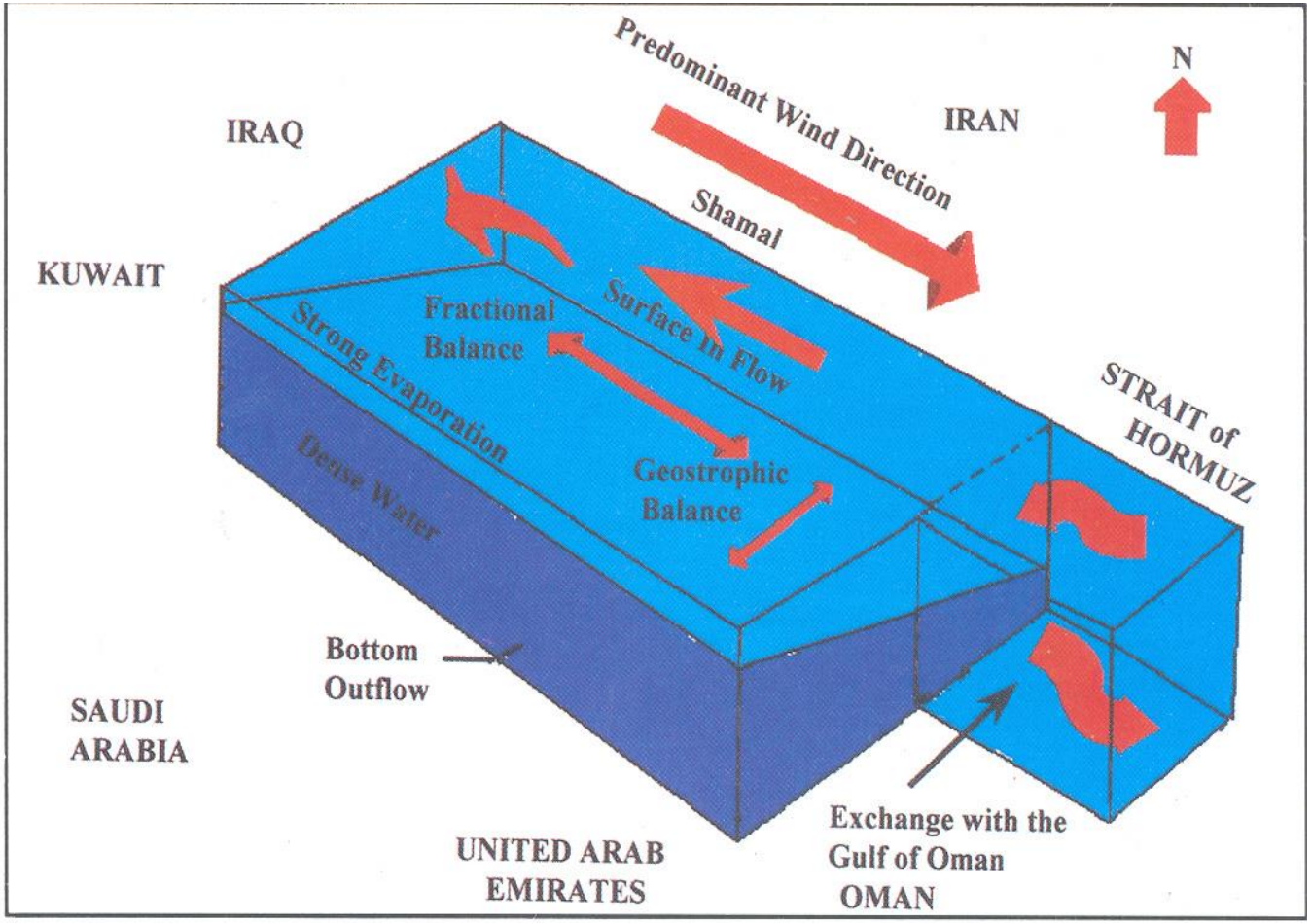
Main Biodiversity Rich ecosystem

Coral reefs

Mangroves

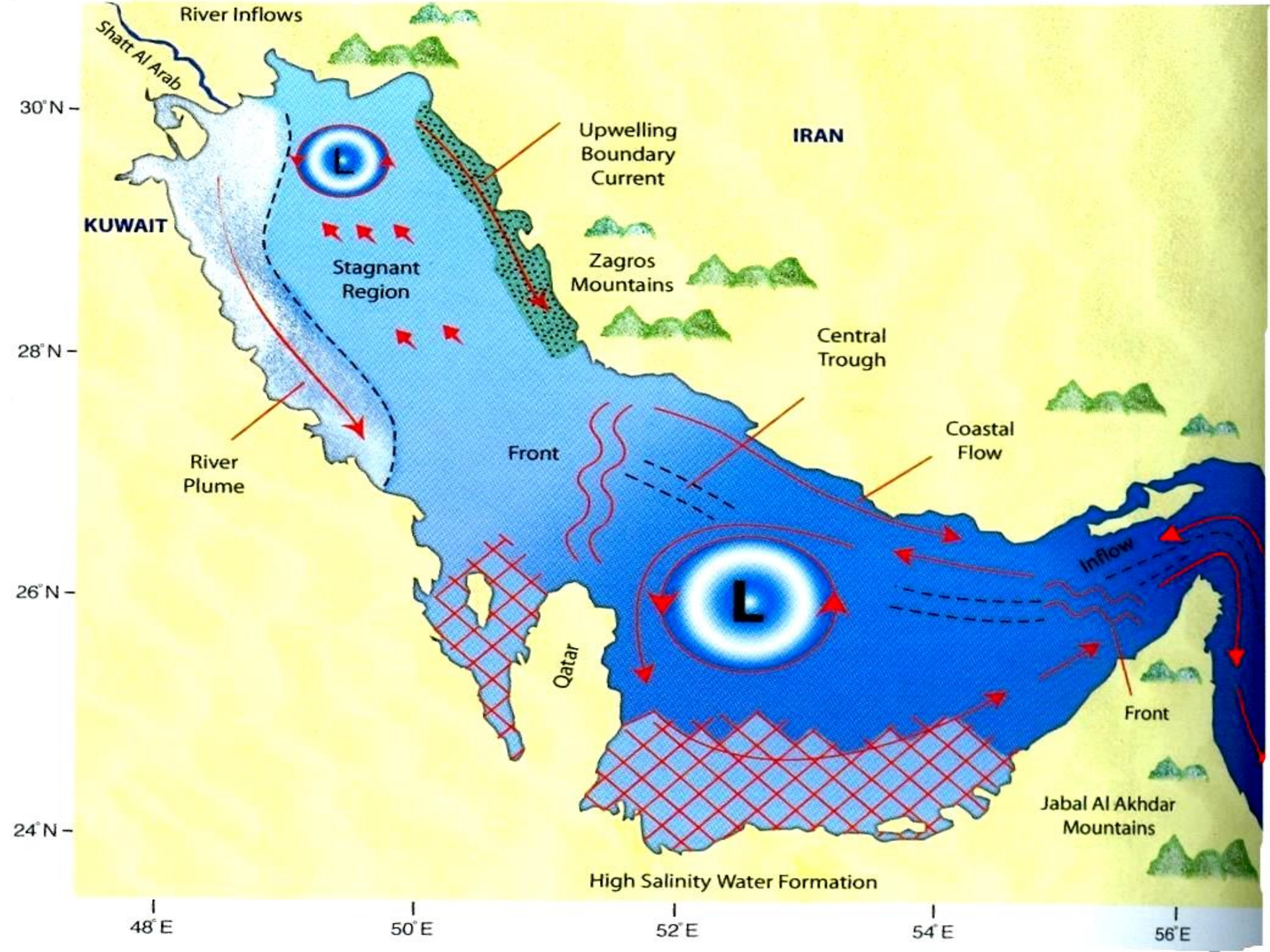
Isolated ecosystem

Sea grass beds

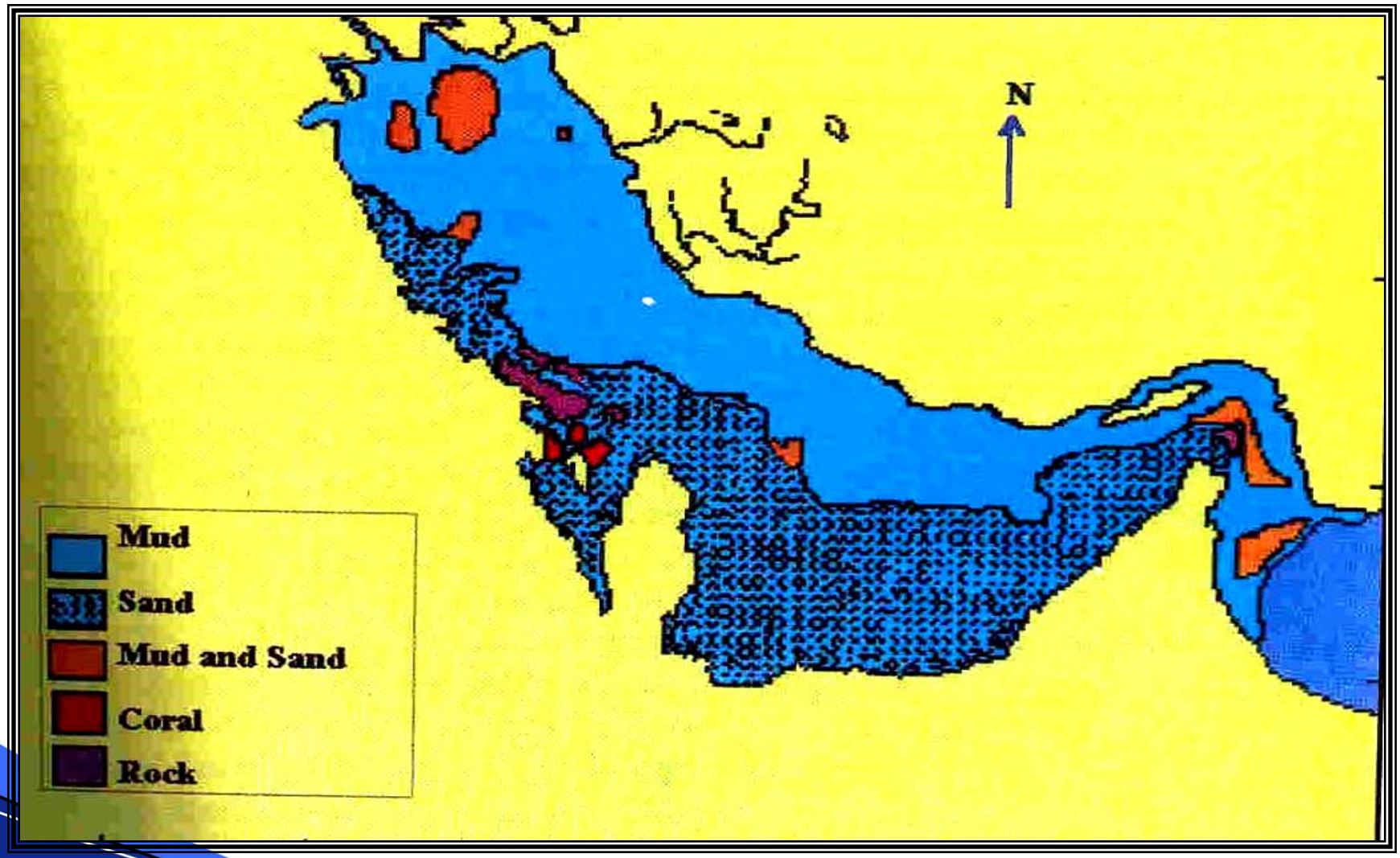


Density –driven Circulation of the RSA

(Hunter, 1983)


River Inflows
Shatt Al Arab
30°N
IRAN
Upwelling
Boundary
Current
KUWAIT
Stagnant
Region
Zagros
Mountains
28°N
Central
Trough
River
Plume
Front
Coastal
Flow
Inflow
26°N
Qatar
Front
Jabal Al Akhdar
Mountains
24°N
High Salinity Water Formation
48°E
50°E
52°E
54°E
56°E

Habitats



Exploitation of Renewable Resources.

Caspian Tern

A colonial breeder, nesting alongside other tern species on islands within the main Bubiyan channel. A colony of about 250 pairs is one of the largest known in the biogeographic region.

2. Marine Pollution

Sources and types of Pollution

Non fixed

- Oil pollution
- Ballast water from oil tankers
- Pesticides
- Radiation
- Suspended sediments from dust storms

Fixed

- Emergency outlets/ untreated sewage
- Petrochemical industry
- Marinas
- Oil exploration and Loading of crude oil
- Hospitals
- Power and desalination plants
- Coastal reclamation, chalets, and recreational activities
- Fish culturing
- Decrease in riverine input

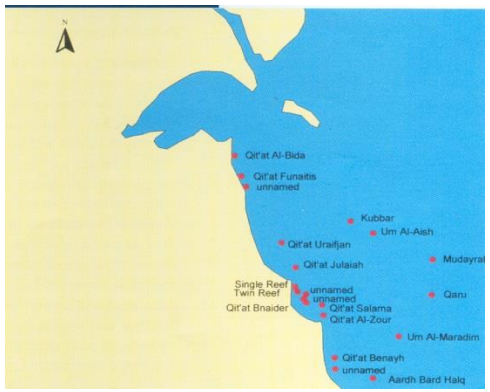
Anthropogenic Sources of pollution

- **Over fishing**
- **Mass tourism**
- **Organic and in-organic pollution**

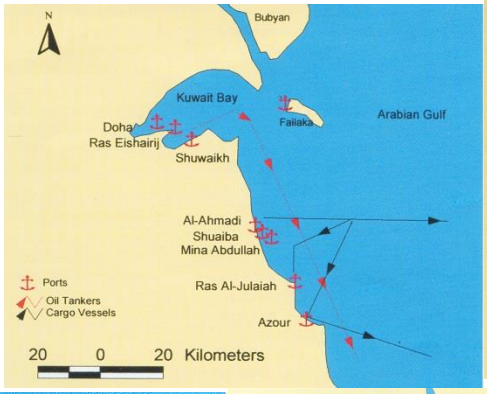
The coastal area exhibits variety of activities

Such activities are ranging from marinas, power plants, coastal reclamation, fishing, etc.

Coral reefs

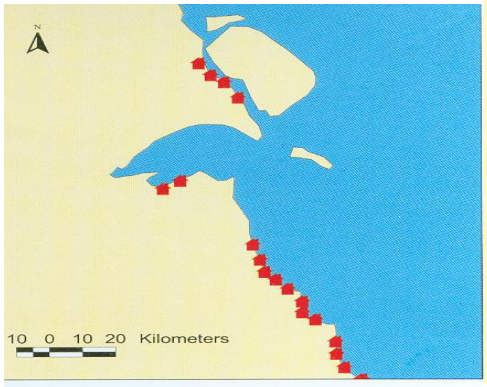


Port and Navigation routs

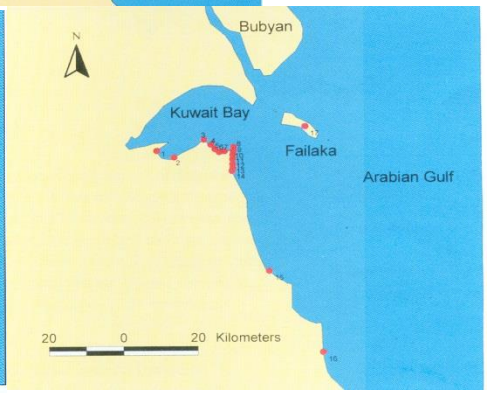


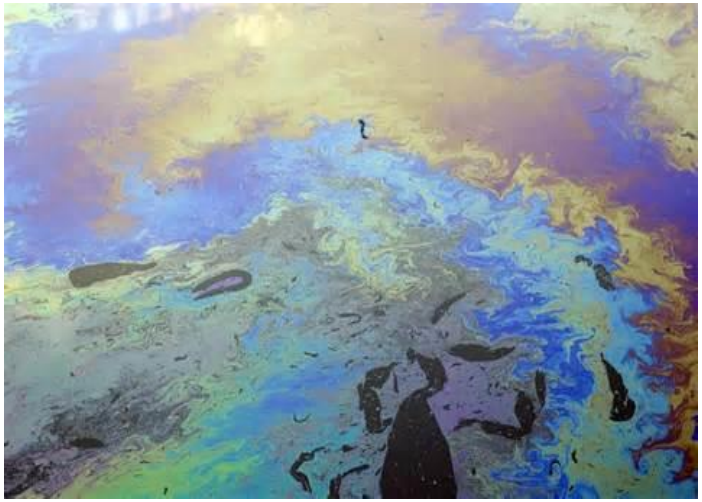
Desalination plants

Chalets

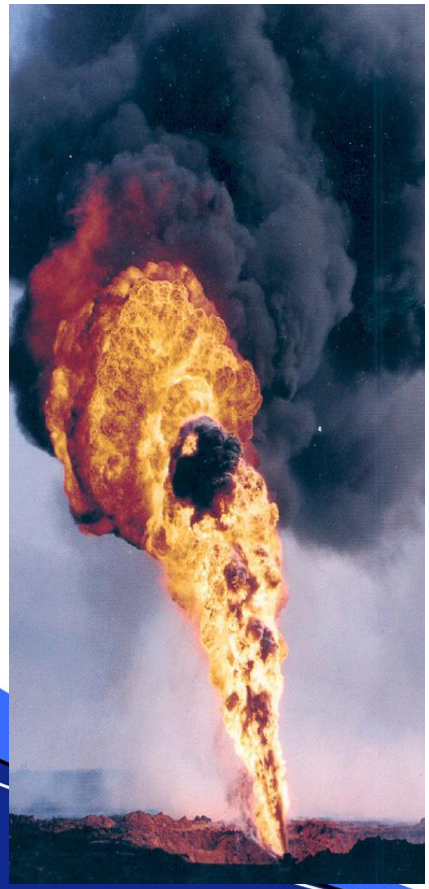


Recreational





Projects: PAAC

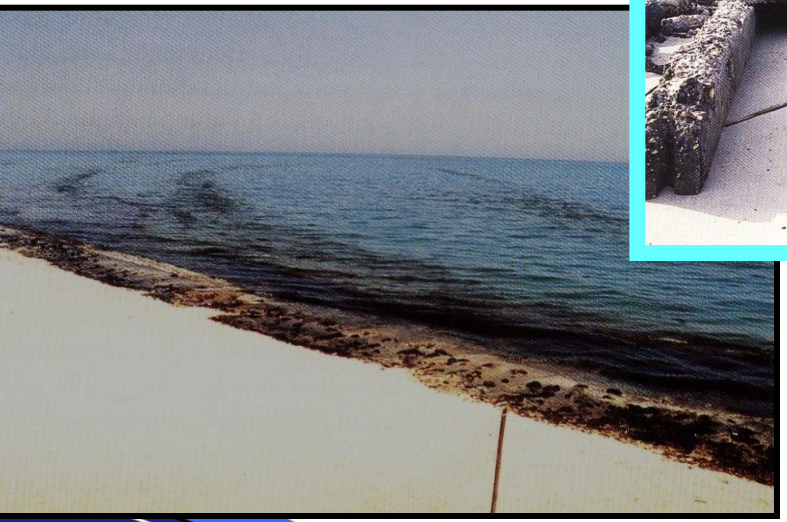


Oil Pollution

Pollution from Ships

Objective no4. project: New Location for Fish Farming Outside Kuwait Bay

EM010C



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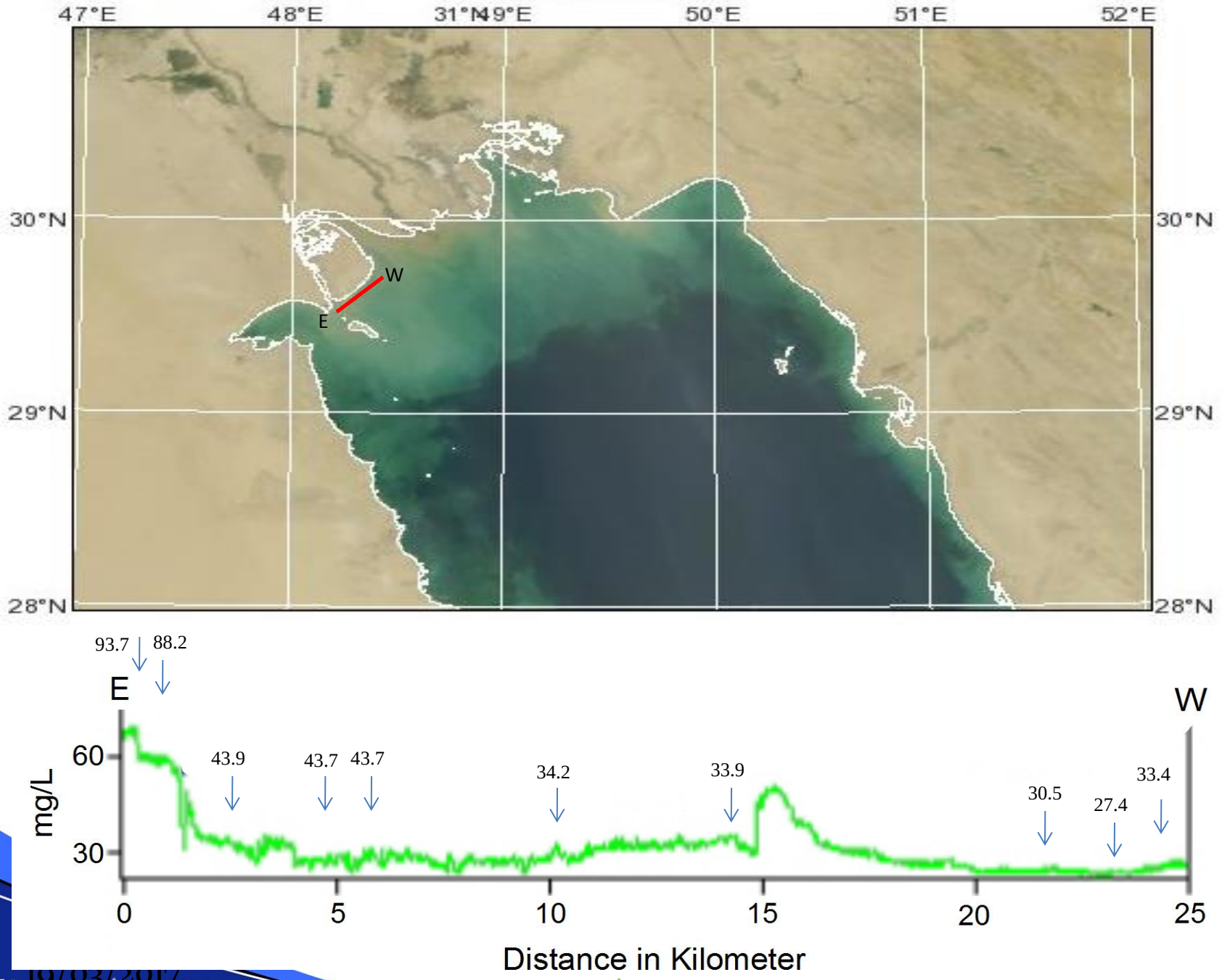
Types of Waste Discharges :

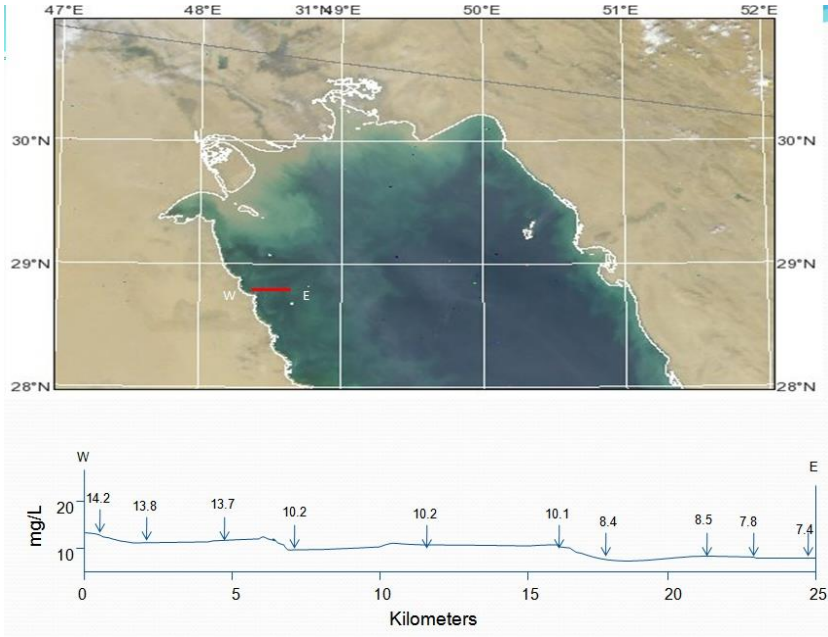
- Storm Drain and Emergency Sewage outlets.
- Industrial Waste Sources
- Solid Waste Disposal


Kuwait 1991


47°E
48°E
49°E
50°E
51°E
52°E
30°N
29°N
28°N
W
E
93.7
88.2
E
W
60
30
mg/L
43.9
43.7
43.7
34.2
33.9
30.5
27.4
33.4
0
5
10
15
20
25
Distance in Kilometer

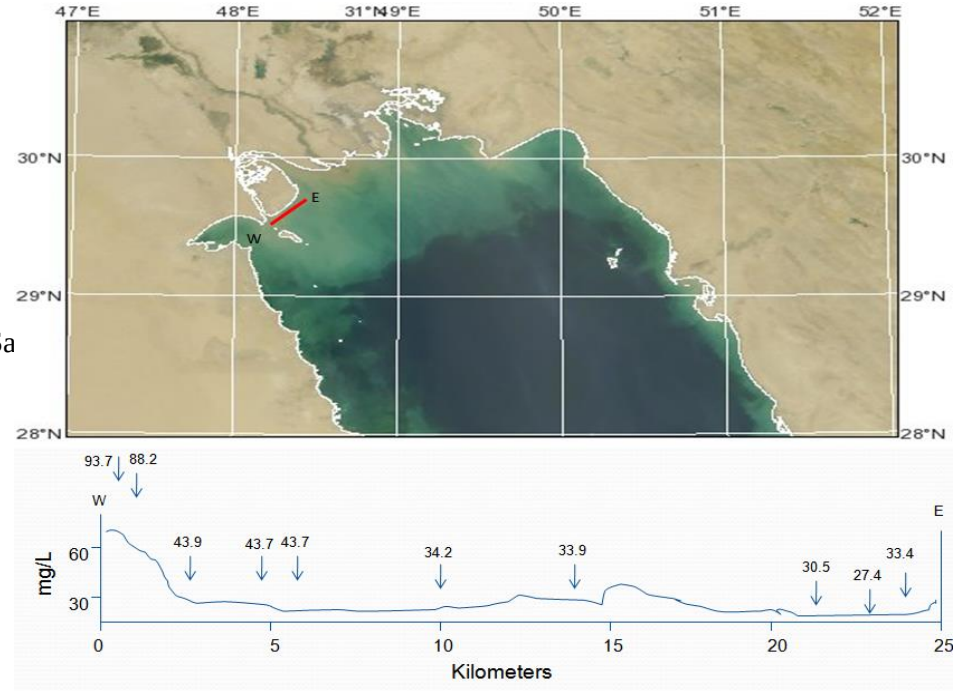
Satellite based SPM for understanding sediment transport

- A SPM algorithm using MODIS band 13 data centered at 667 nm.
- Satellite estimates of SPM are extremely well correlated with the in-situ measurements of SPM (p=0.97 and 1.00 for north (turbid) and south (clear) transects.
- Therefore this technique can be effective for SPM estimation in Gulf waters as a surrogate for in-situ measurements.

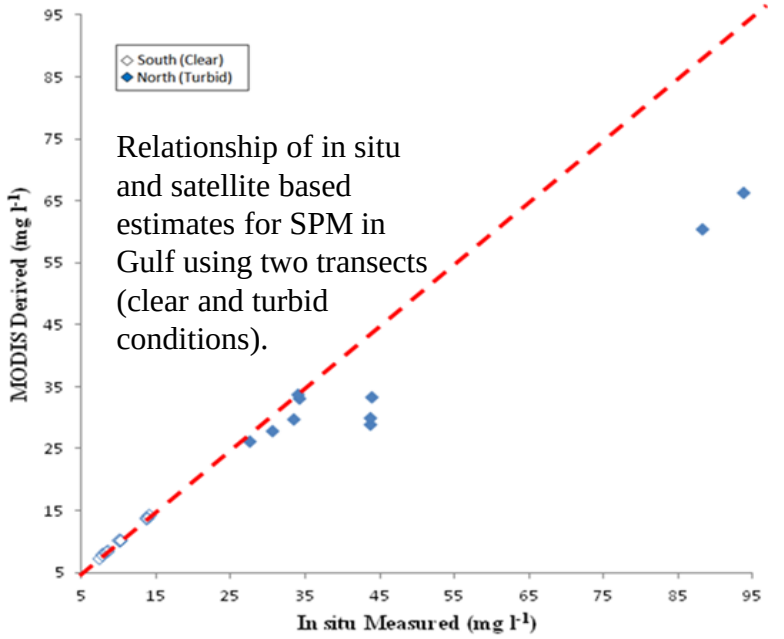


SPM profile along the transect using MODIS data and in-situ measured SPM at ten match up locations along southern transect (image: 28th April, 2010)

Sa

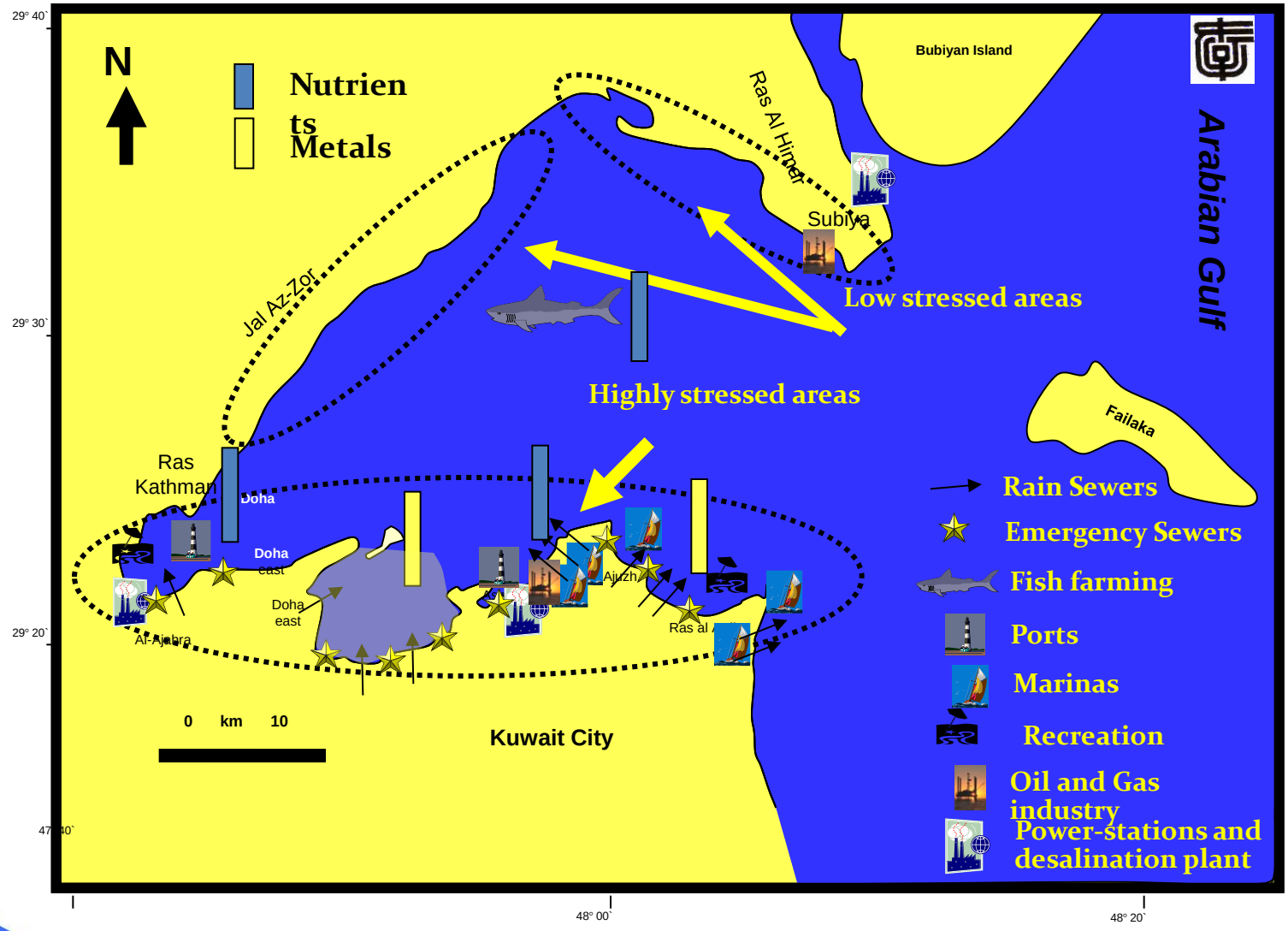


SPM profile along the transect using MODIS data and in-situ measured SPM at ten match up locations along northern transect (image: 26Th April, 2010).

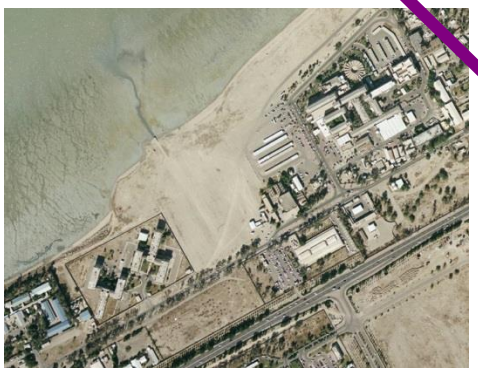


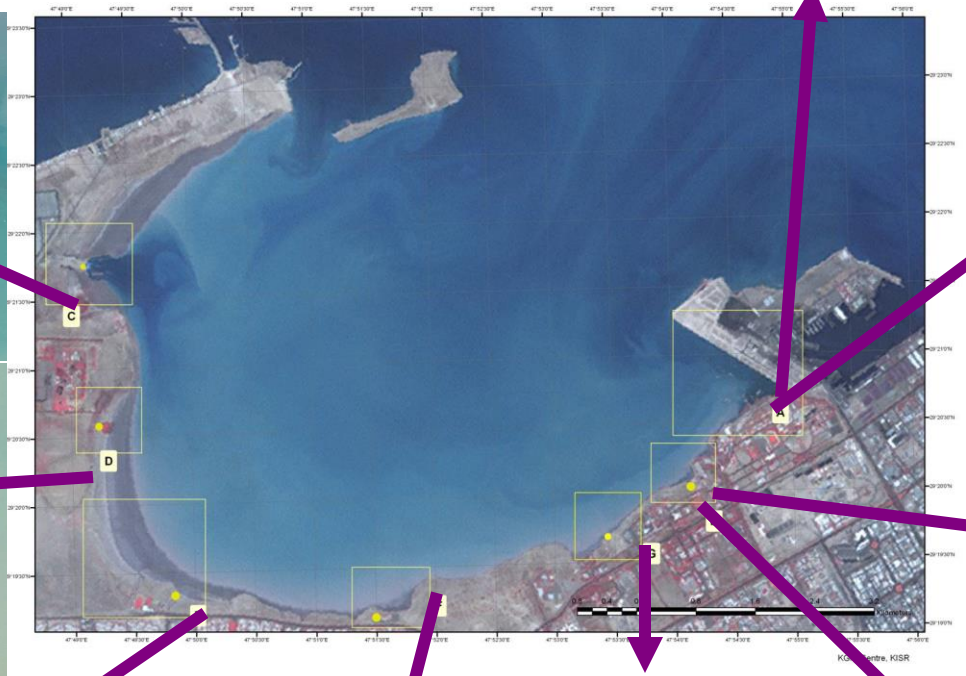
Relationship of in situ and satellite based estimates for SPM in Gulf using two transects (clear and turbid conditions).

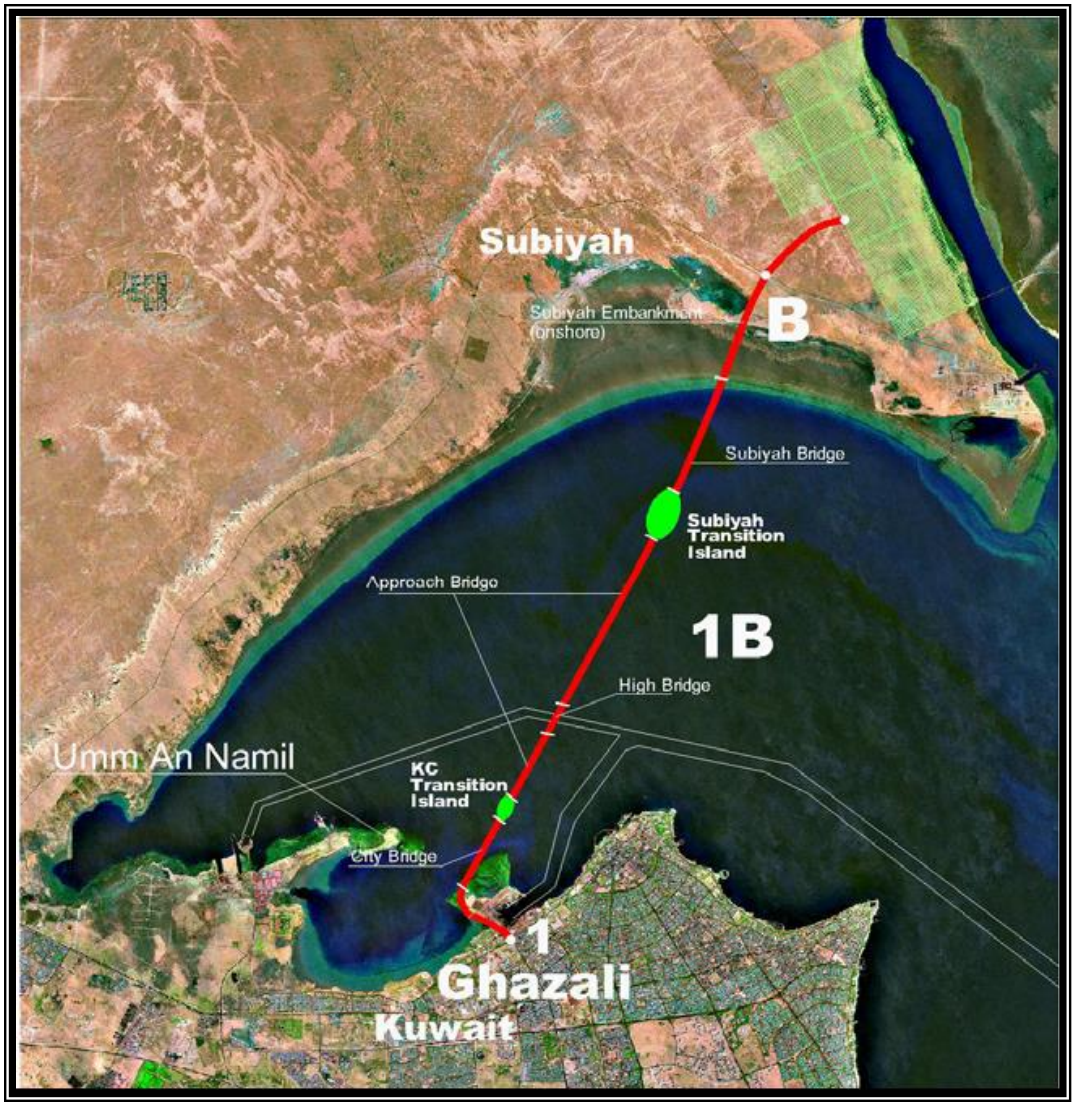
Highlight : This technique can be effective for SPM estimation in Gulf waters as a surrogate for in-situ measurements.


N
Nutrien
ts
Metals
Bubiyan Island
Ras Al Hirner
Subiya
Arabian Gulf
Jal Az-Zor
Low stressed areas
Highly stressed areas
Failaka
Ras
Kathman
Doha
Doha
east
Doha
east
Ajuzh
Ras al
Al-Ajaira
Rain Sewers
Emergency Sewers
Fish farming
Ports
Marinas
Recreation
Oil and Gas
industry
Power-stations and
desalination plant
0 km 10
Kuwait City
29° 40`
29° 30`
29° 20`
47° 40`
48° 00`
48° 20`

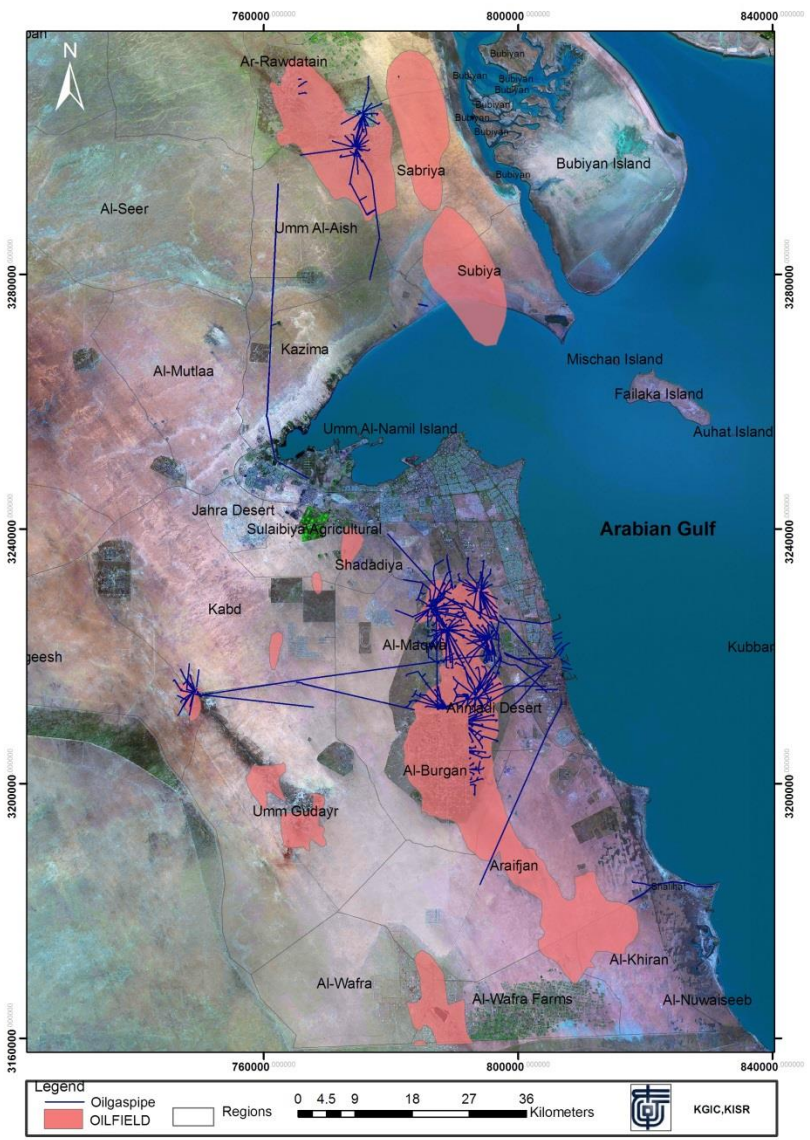
Sewage
“Suliabikhat Bay”

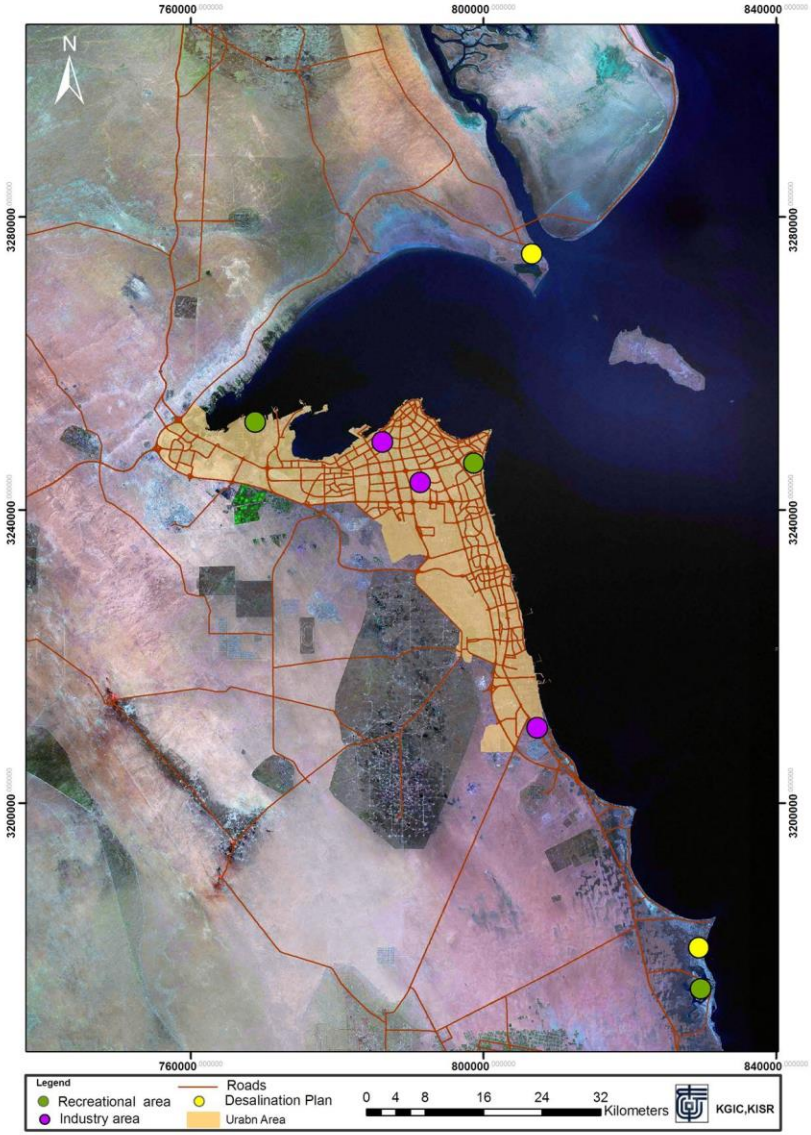





Subiyah
Subiyah Embankment
(onshore)
B
Subiyah Bridge
Subiyah
Transition
Island
Approach Bridge
1B
High Bridge
Umm An Namil
KC
Transition
Island
City Bridge
1
Ghazali
Kuwait

Human and Urban Development on the coastal area

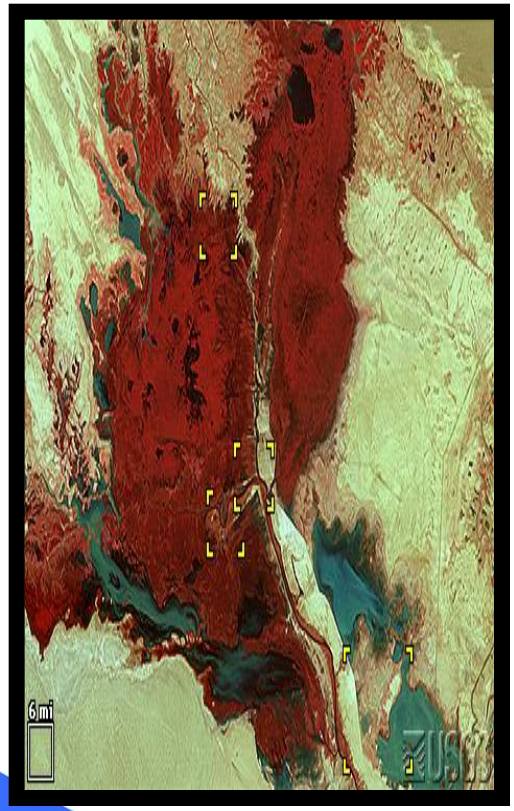





مارينا كريسنت، الكويت
Marina Crescent, Kuwait
الجزيرة الخضراء، الكويت
Green Island, Kuwait
سوق شرق، الكويت
Souq Sharq, Kuwait

Al Khiran and Az Zour Area

Temporal Changes in the Marshes of Southern Iraq

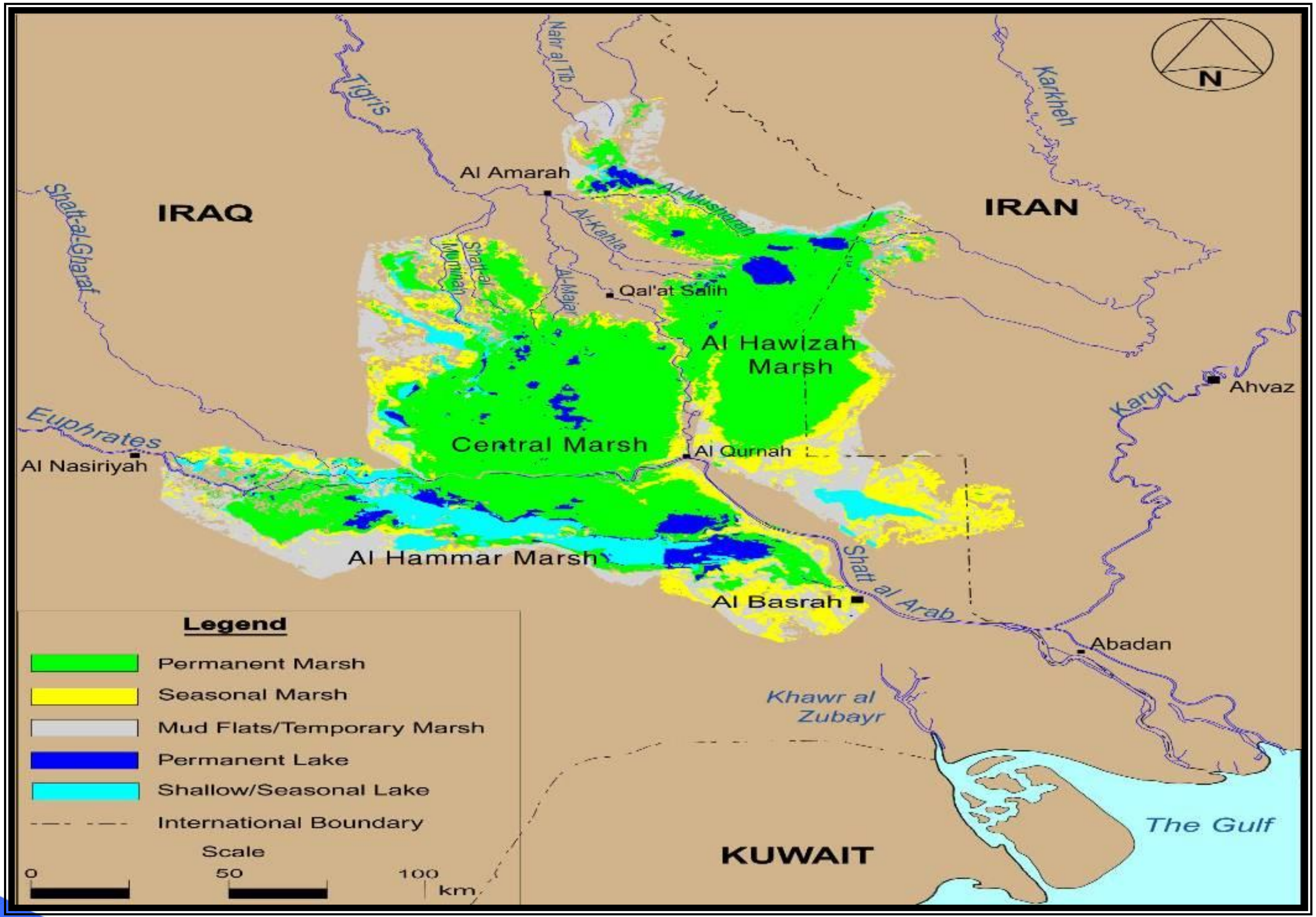


1972

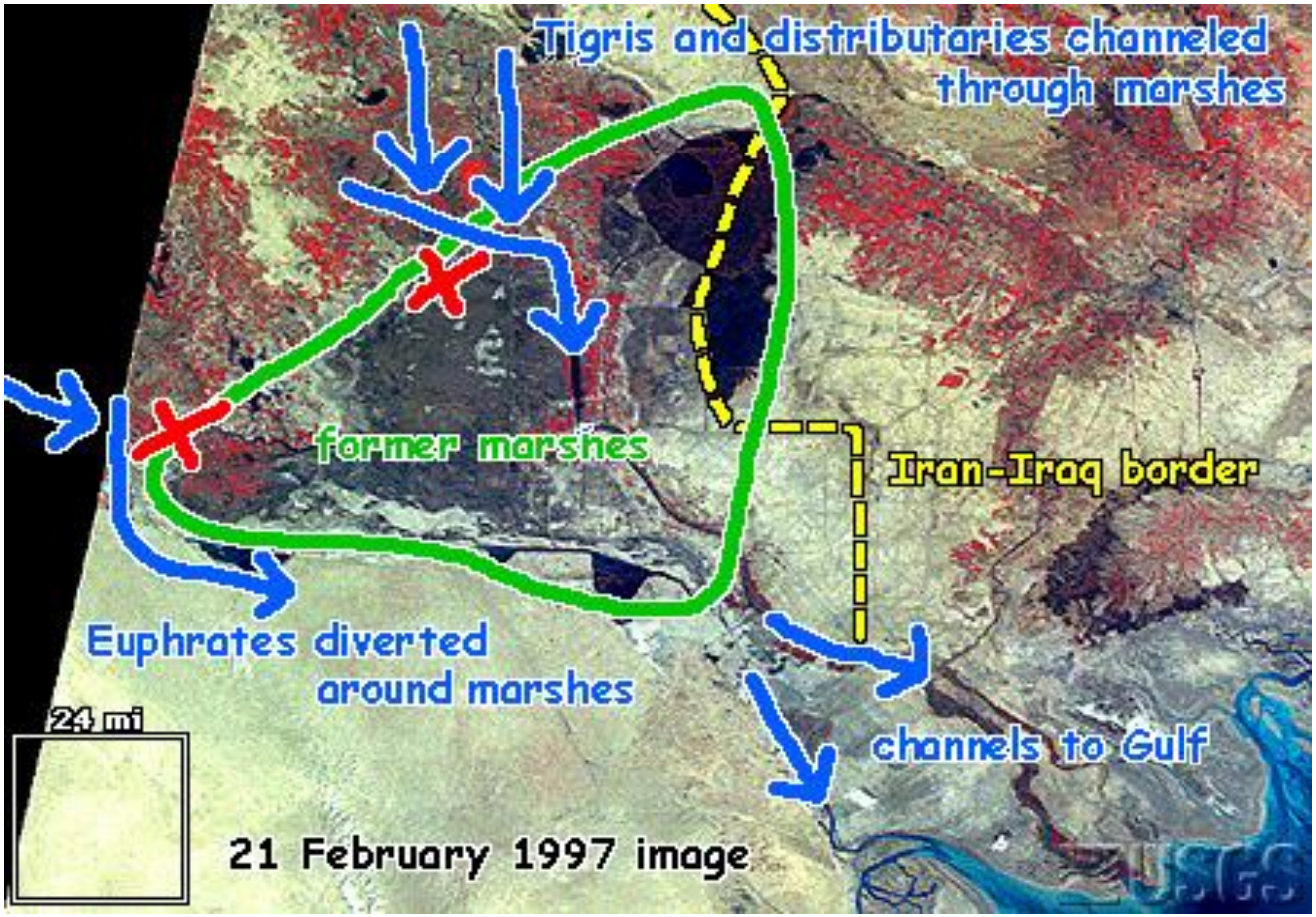
1990

1997

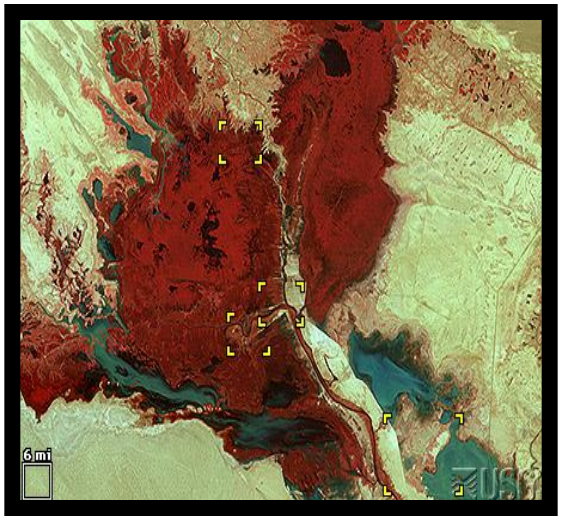
Drainage of Iraqi Marshes


IRAQ
IRAN
KUWAIT
Tigris
Nahr al Tib
Karkheh
Al Amarah
Al-Musharrah
Al-Kahla
Shatt-al-Gharaf
Qal'at Salih
Al-Majar
Al Hawizah Marsh
Ahvaz
Karun
Euphrates
Central Marsh
Al Qurnah
Al Nasiriyah
Al Hammar Marsh
Shatt al Arab
Al Basrah
Abadan
Khawr al Zubayr
The Gulf
Legend
Permanent Marsh
Seasonal Marsh
Mud Flats/Temporary Marsh
Permanent Lake
Shallow/Seasonal Lake
International Boundary
Scale
0
50
100
km
N

Euphrates, Tigris and the Third River



Temporal Changes in the Marshes of Southern Iraq

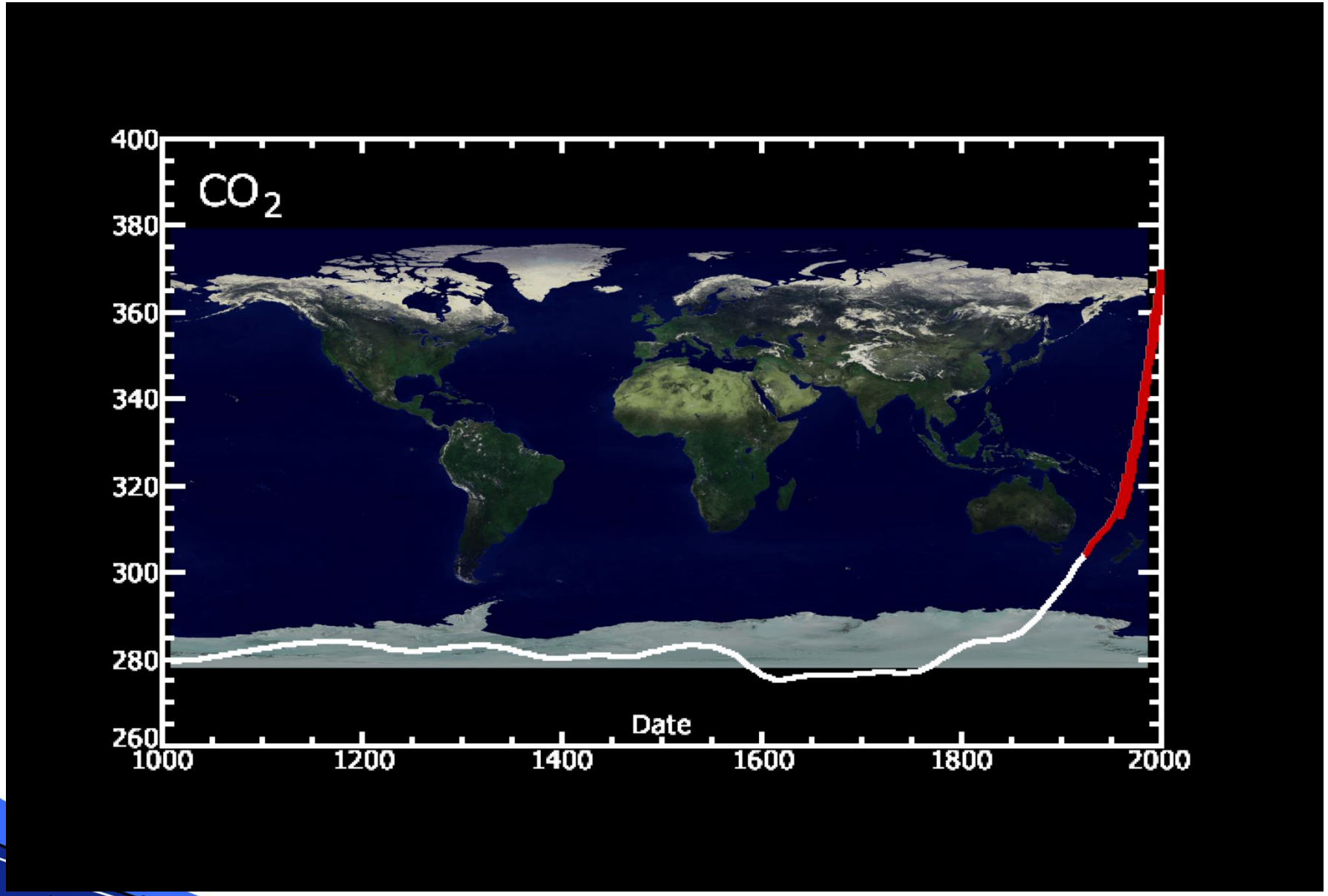


1972

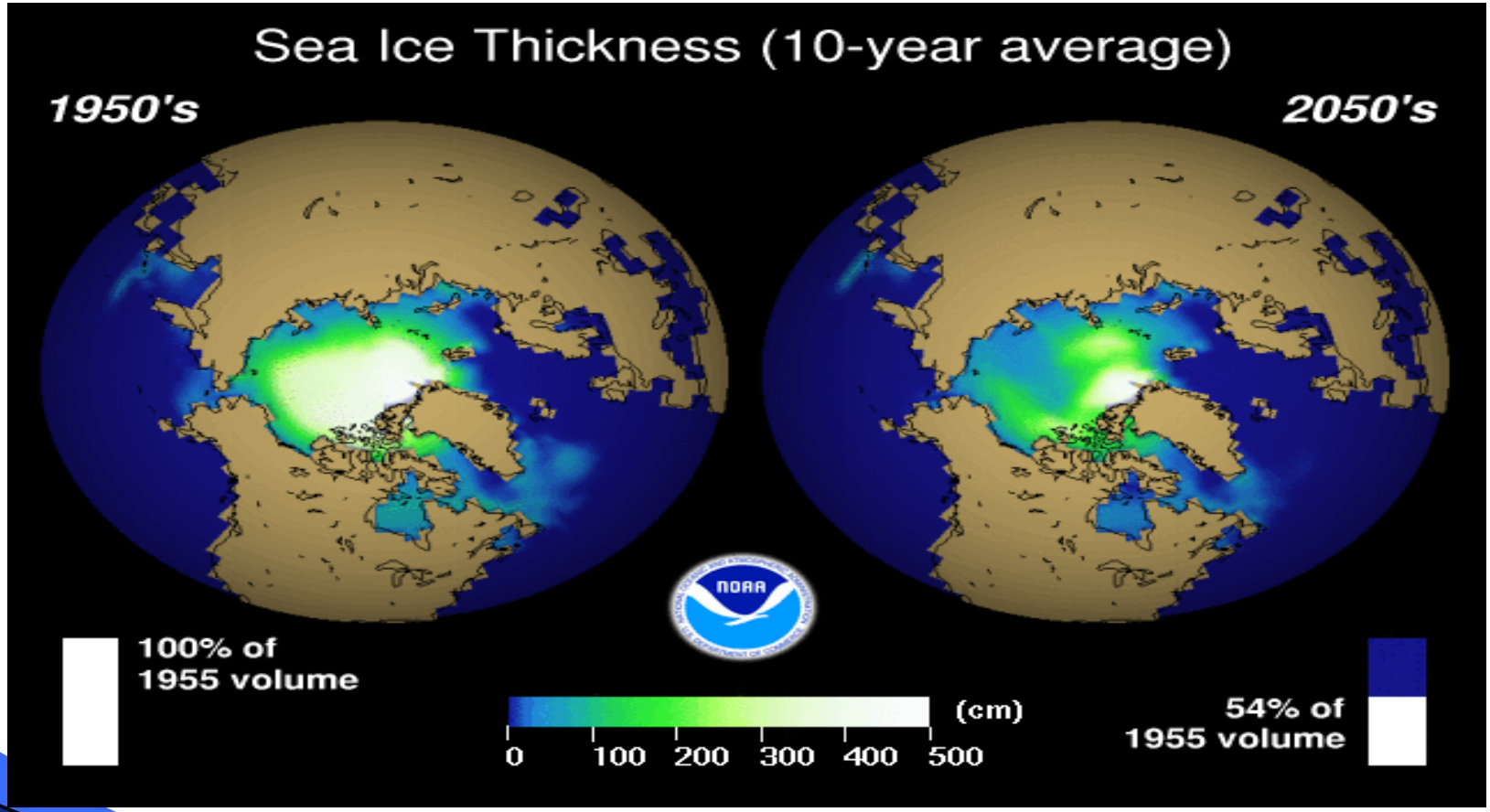
1990

1997

CO2 concentration in last 1000 years



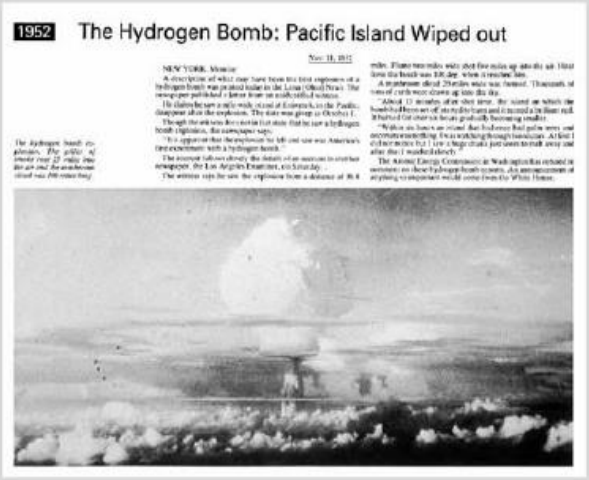
GLOBAL WARMING AND SEA LEVEL RISE



The use of fallout radionuclides (^{137}Cs) to document soil erosion

CAESIUM-137

HALF-LIFE: 30.2 years
ORIGIN: Weapons Testing


1952 The Hydrogen Bomb: Pacific Island Wiped out

NEW YORK, Monday

A description of what may have been the first explosion of a hydrogen bomb was printed today in the Long Island Press. The newspaper published a letter from an unidentified scientist.

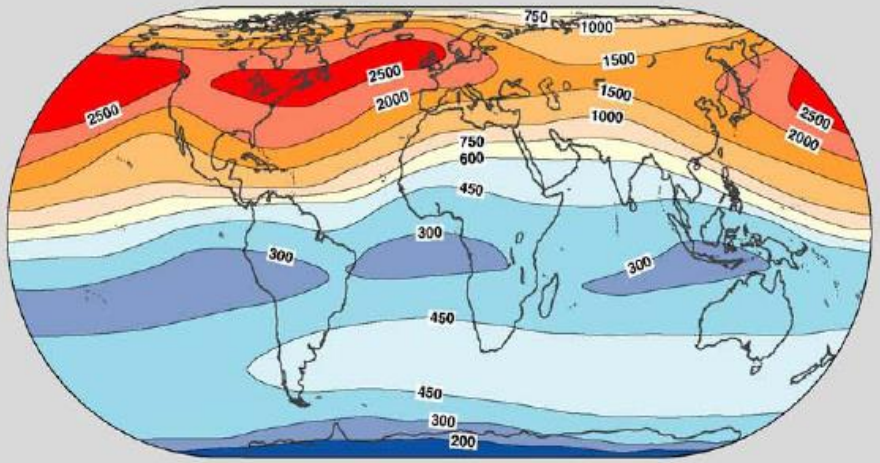
He claimed he saw a mile-wide crater at Eniwetok in the Pacific disappear after the explosion. The date was given as October 1.

Though the unknown first-person account did not say a hydrogen bomb explosion, the newspaper says:

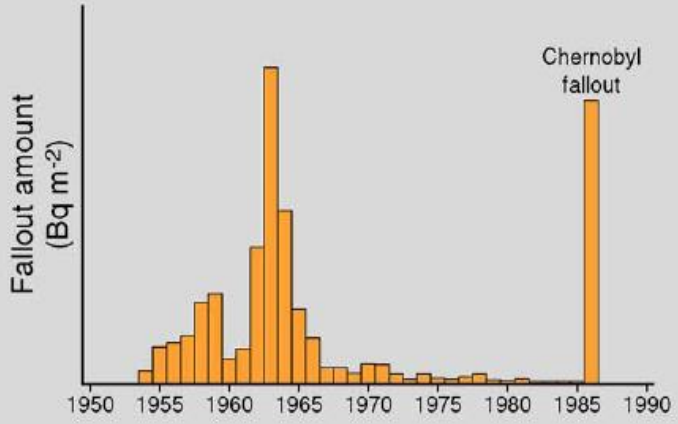
"It is apparent that the explosion we left our men was America's first experiment with a hydrogen bomb."

The account fell not directly the details of an exercise in another newspaper, the Los Angeles Examiner, on Saturday.

The witness says he saw the explosion from a distance of 30 ft



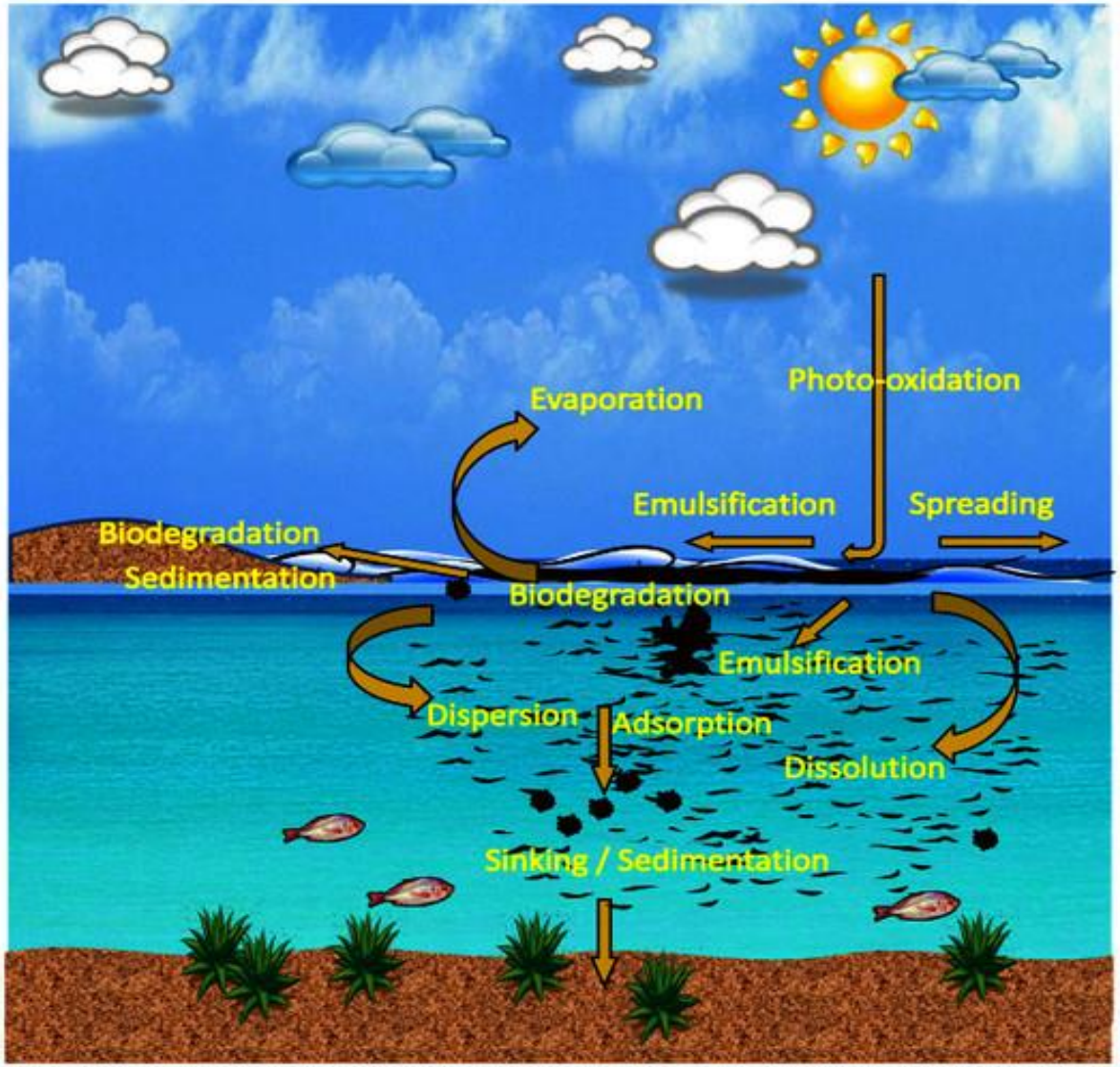
Fallout Record

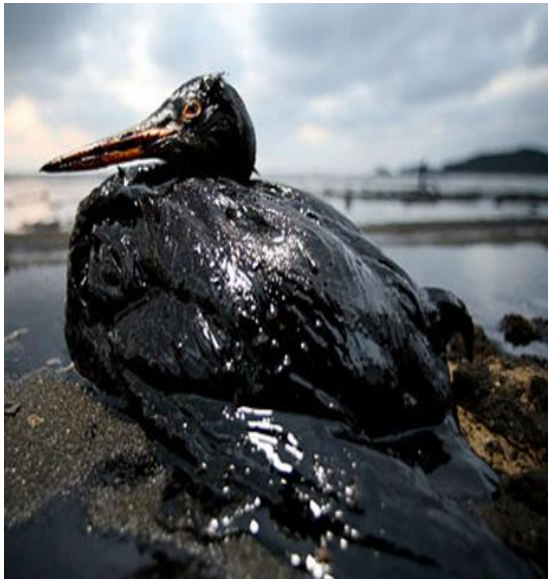


Cumulative Inventory

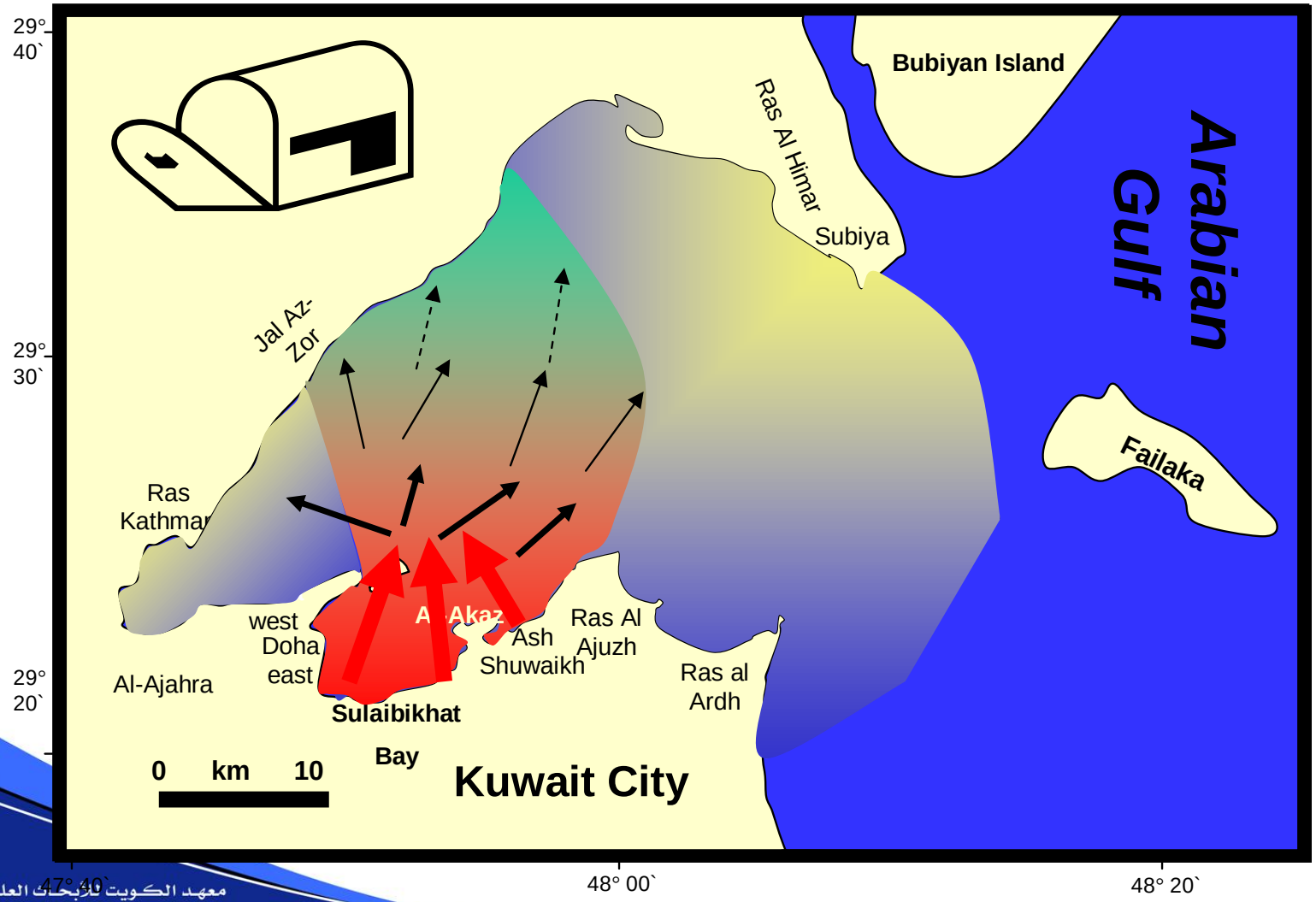
3. Impact of Marine Pollution

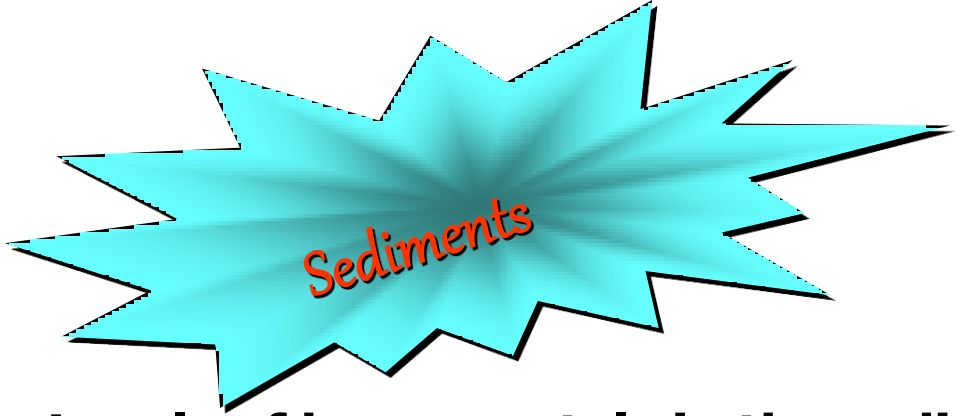
Fate of oil spill





Constraint Map





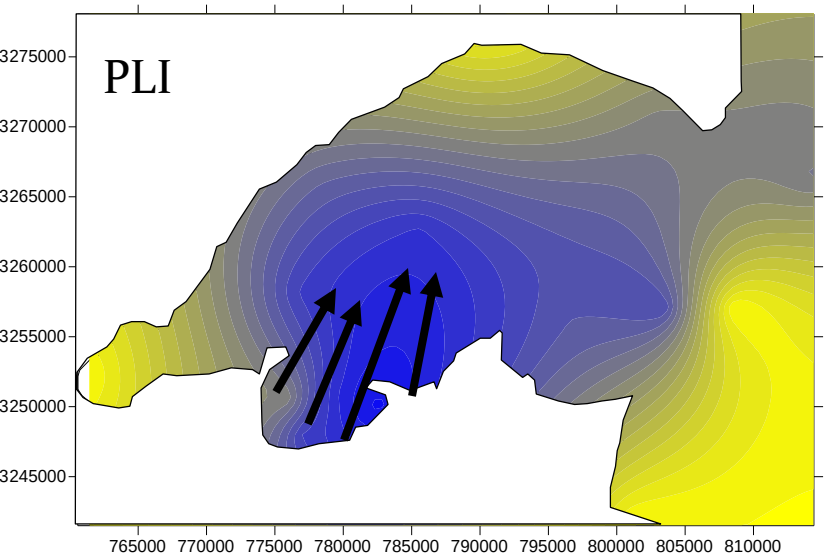
Heavy Metals

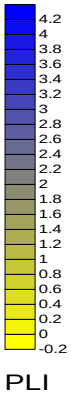
Levels of heavy metals in the sediments of Kuwait Bay comparing with Canadian Guideline and Dubai Creek

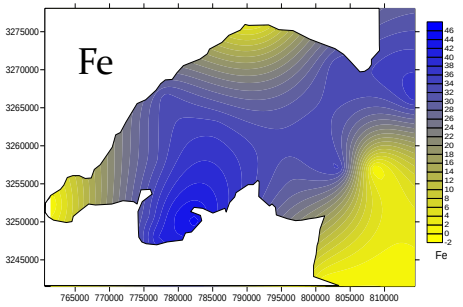
Concentration (ppm)	Kuwait Bay	SQ Guidelines (Canada)	Dubai Creek
Cadmium	7.73 - 22.83	0.6 - 10	3.38 - 7.2
Nickel	41.35 - 140.07	16 - 75	34.5 - 39
Lead	4.96 - 22.53	31 - 250	35.8 - 53.5
Mercury	0.03 - 0.06	0.2 - 2.0	ND
Chromium	58	26.0 - 110	ND
Copper	27	16.0 - 110	ND
Manganese	481	460 - 1100	ND

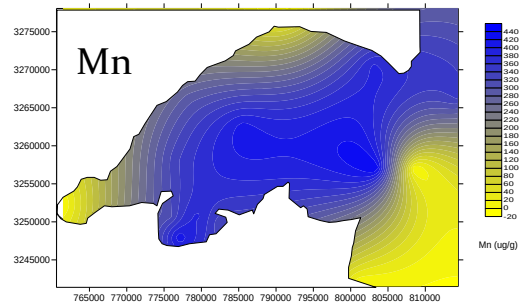
Sediments

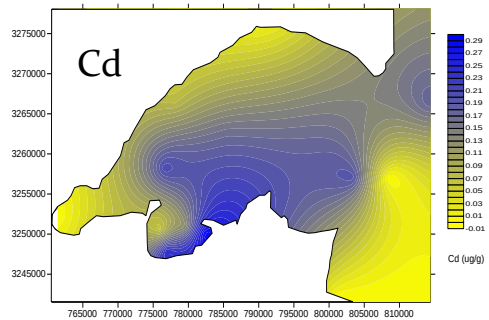
Heavy Metals

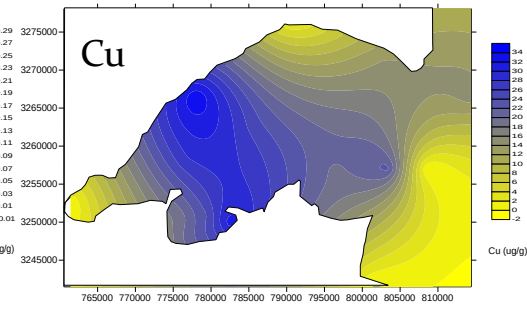


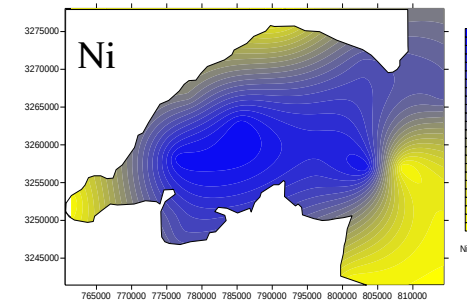


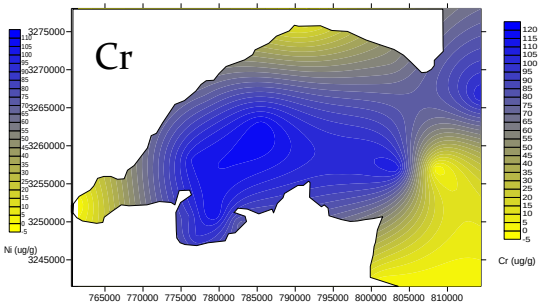


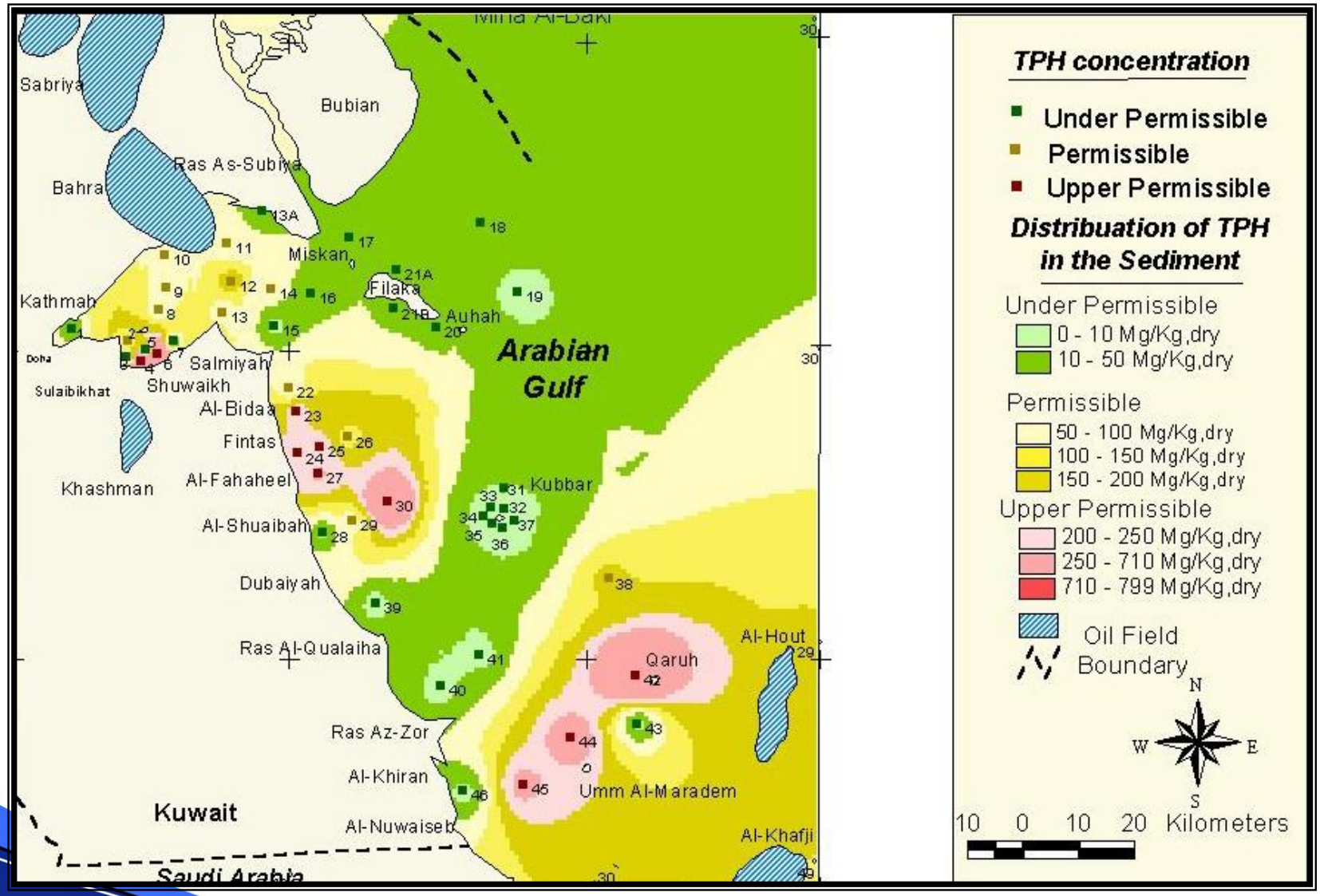


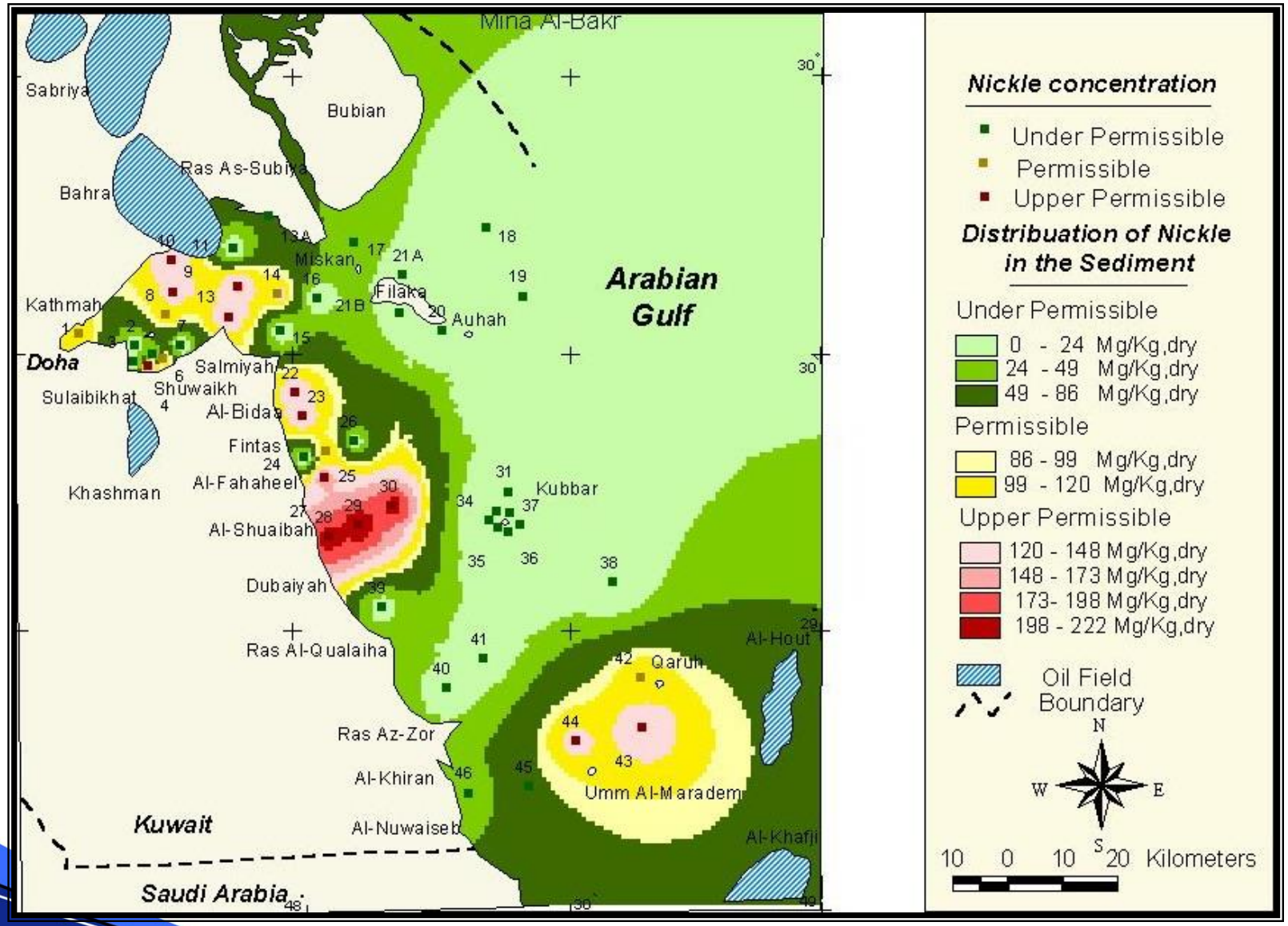


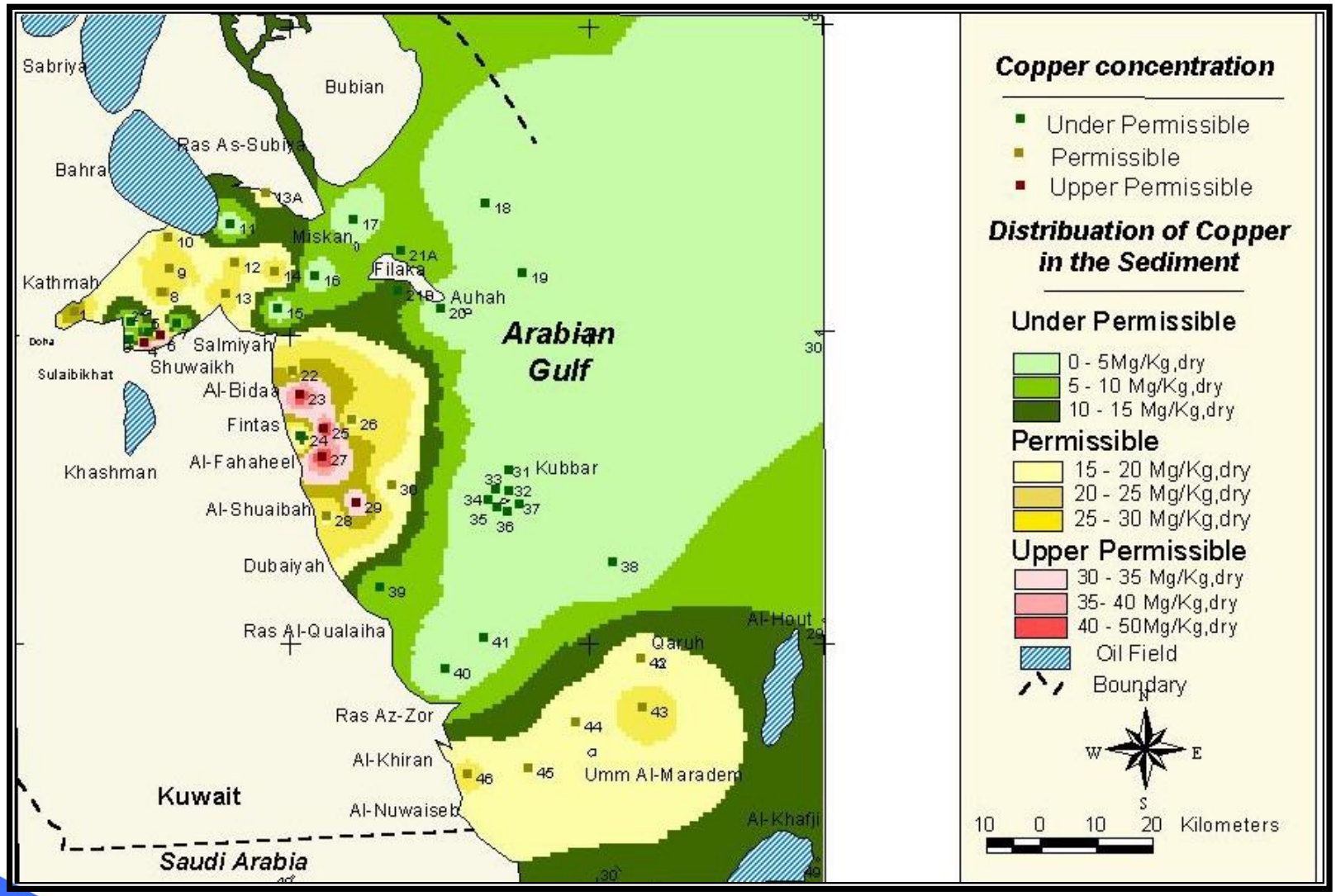






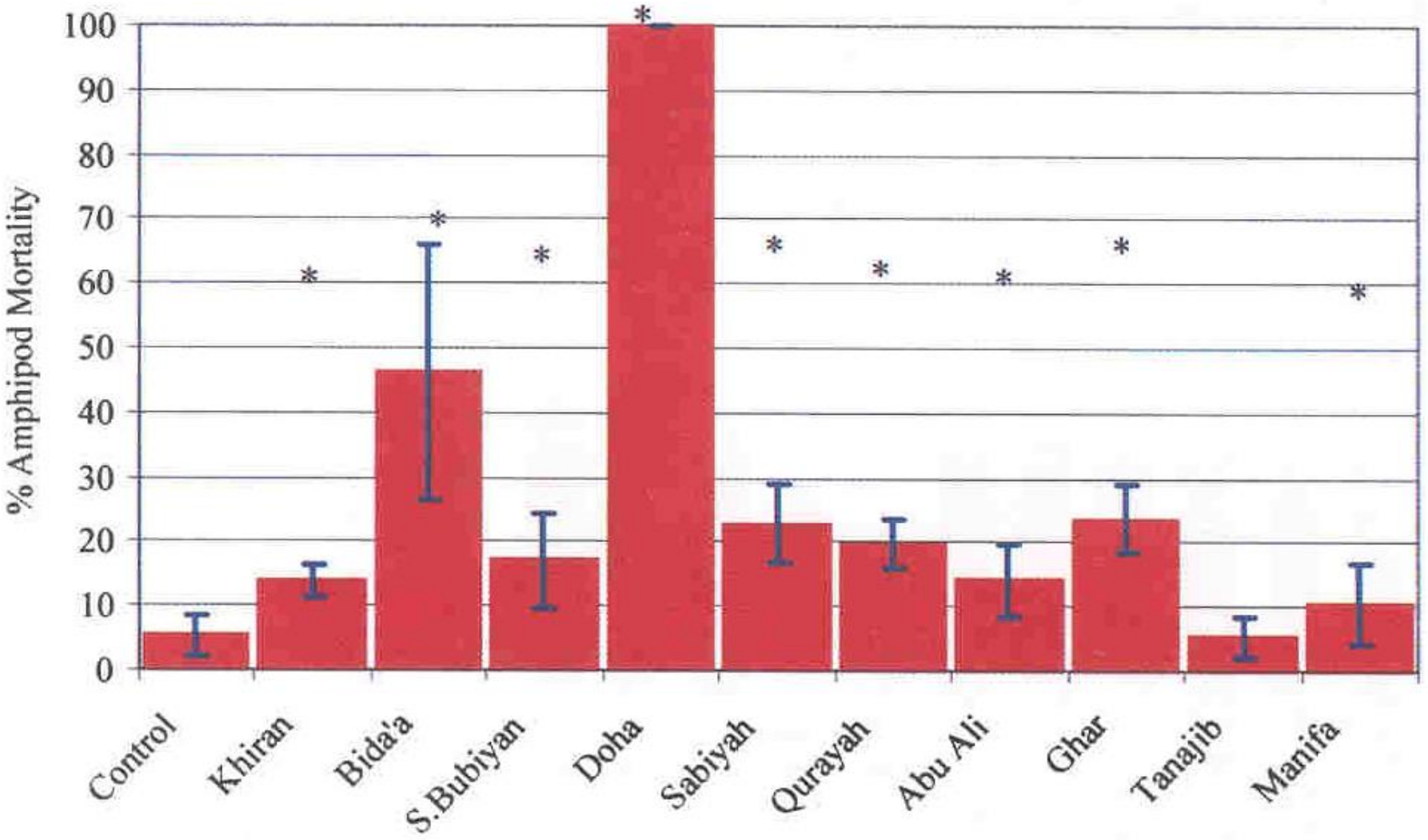

Sabriya
Bubian
Ras As-Subiya
Bahra
Miskan
Filaka
Auhah
Kathmah
Doha
Salmiyah
Shuwaikh
Sulaibikhat
Al-Bidaa
Fintas
Al-Fahaheel
Khashman
Kubbar
Al-Shuaibah
Dubaiyah
Ras Al-Qualaiha
Al-Hout
Qaruh
Ras Az-Zor
Al-Khiran
Umm Al-Maradem
Al-Nuwaiseb
Al-Khafji
Kuwait
Saudi Arabia
Arabian Gulf
TPH concentration
Under Permissible
Permissible
Upper Permissible
Distribuation of TPH in the Sediment
Under Permissible
0 - 10 Mg/Kg,dry
10 - 50 Mg/Kg,dry
Permissible
50 - 100 Mg/Kg,dry
100 - 150 Mg/Kg,dry
150 - 200 Mg/Kg,dry
Upper Permissible
200 - 250 Mg/Kg,dry
250 - 710 Mg/Kg,dry
710 - 799 Mg/Kg,dry
Oil Field
Boundary
N
W
E
S
10 0 10 20 Kilometers


Mina Al-Bakr
Sabriya
Bubian
Ras As-Subiya
Bahra
Miskan
Filaka
Auhah
Arabian Gulf
Kathmah
Doha
Salmiyah
Shuwaikh
Sulaibikhat
Al-Bidaa
Fintas
Al-Fahaheel
Khashman
Al-Shuaibah
Kubbar
Dubaiyah
Ras Al-Qualaiha
Al-Hout
Qaruh
Ras Az-Zor
Al-Khiran
Umm Al-Maradem
Al-Nuwaiseb
Al-Khafji
Kuwait
Saudi Arabia
Nickle concentration
Under Permissible
Permissible
Upper Permissible
Distribuation of Nickle in the Sediment
Under Permissible
0 - 24 Mg/Kg,dry
24 - 49 Mg/Kg,dry
49 - 86 Mg/Kg,dry
Permissible
86 - 99 Mg/Kg,dry
99 - 120 Mg/Kg,dry
Upper Permissible
120 - 148 Mg/Kg,dry
148 - 173 Mg/Kg,dry
173- 198 Mg/Kg,dry
198 - 222 Mg/Kg,dry
Oil Field Boundary
N
W
E
S
10 0 10 20 Kilometers


Sabriya
Bubian
Ras As-Subiya
Bahra
Miskan
Filaka
Auhah
Kathmah
Arabian Gulf
Doha
Salmiyah
Shuwaikh
Sulaibikhat
Al-Bida'a
Fintas
Al-Fahaheel
Khashman
Kubbar
Al-Shuaibah
Dubaiyah
Ras Al-Qualaiha
Al-Hout
Qaruh
Ras Az-Zor
Al-Khiran
Umm Al-Maradem
Kuwait
Al-Nuwaiseb
Al-Khafji
Saudi Arabia
Copper concentration
Under Permissible
Permissible
Upper Permissible
Distribuation of Copper in the Sediment
Under Permissible
0 - 5Mg/Kg,dry
5 - 10 Mg/Kg,dry
10 - 15 Mg/Kg,dry
Permissible
15 - 20 Mg/Kg,dry
20 - 25 Mg/Kg,dry
25 - 30 Mg/Kg,dry
Upper Permissible
30 - 35 Mg/Kg,dry
35- 40 Mg/Kg,dry
40 - 50Mg/Kg,dry
Oil Field
Boundary
N
W
E
S
10 0 10 20 Kilometers

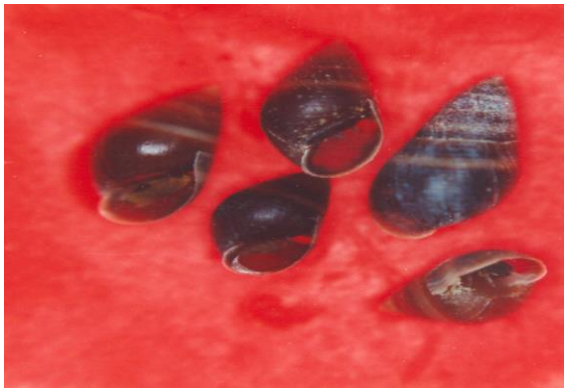
Toxicity of Ropme Sea Area Beach Sediments.

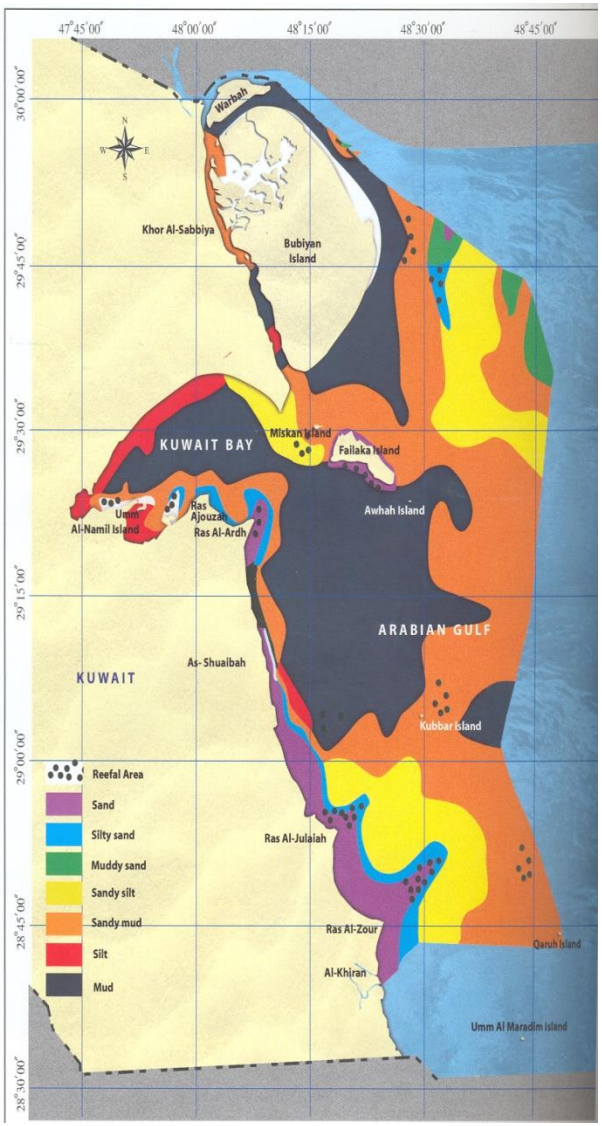
(Amphipod mortality %)

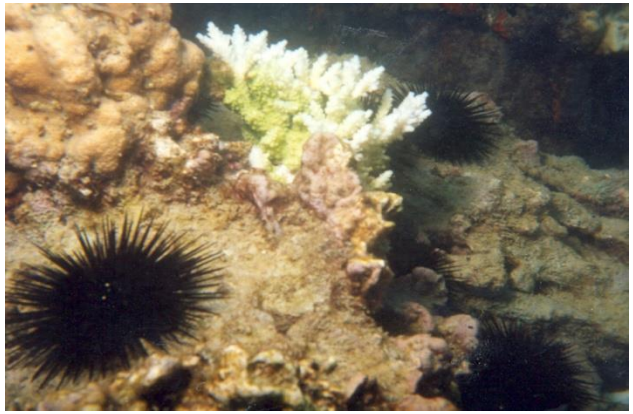


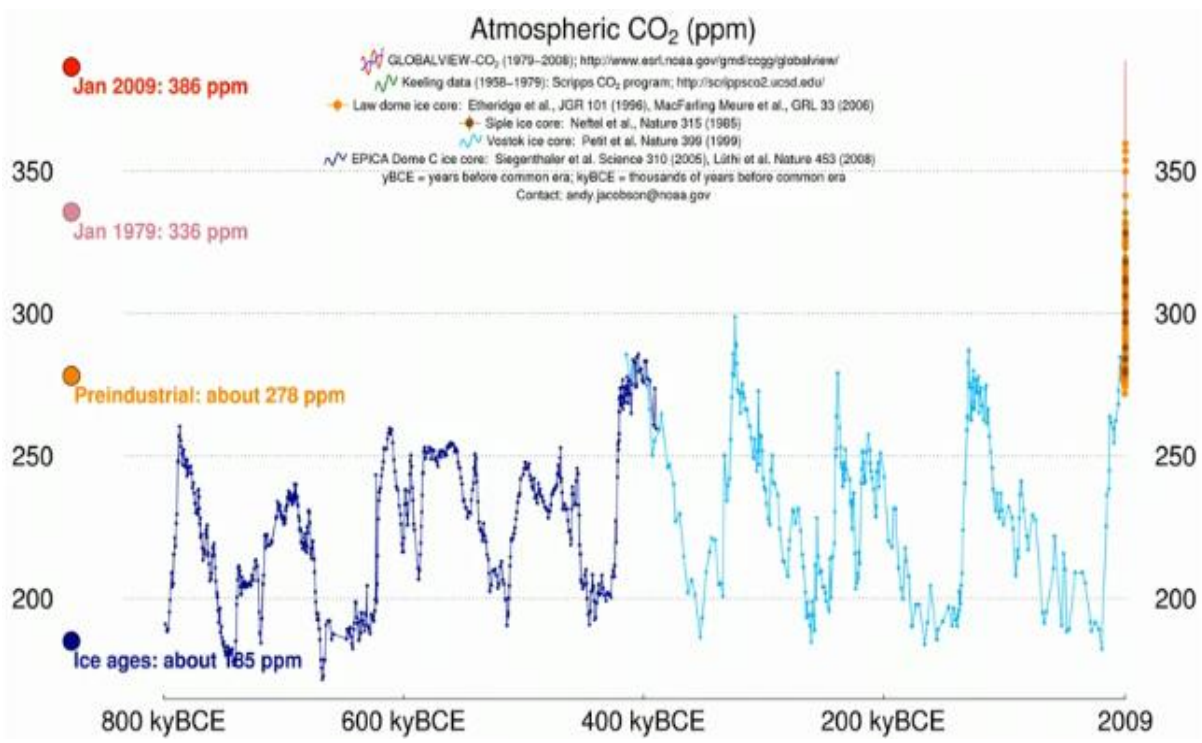
ENVIRONMENTAL ASSESSMENT OF THE COASTAL HABITATS AND CORAL REEF COMMUNITIES

VS023C



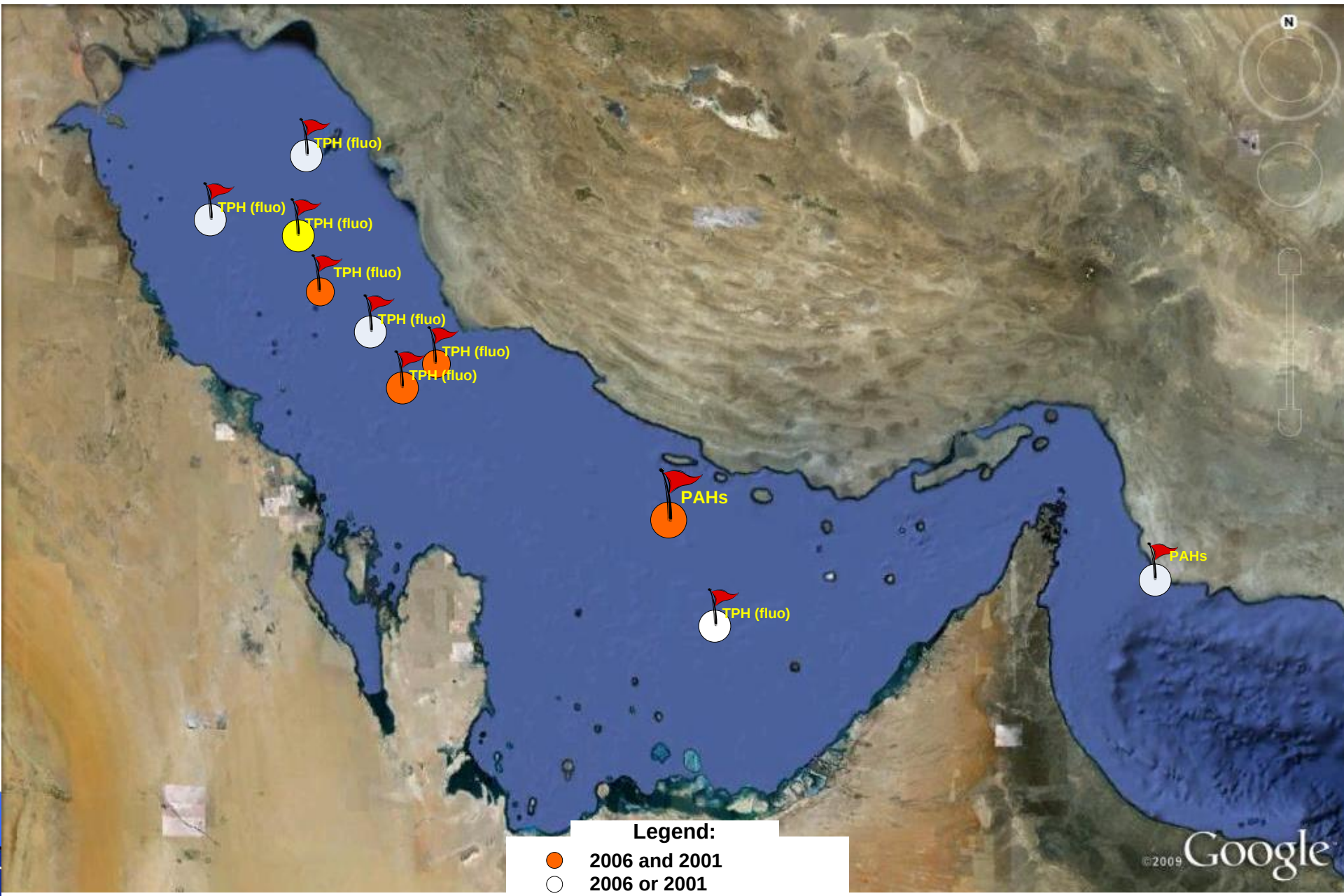




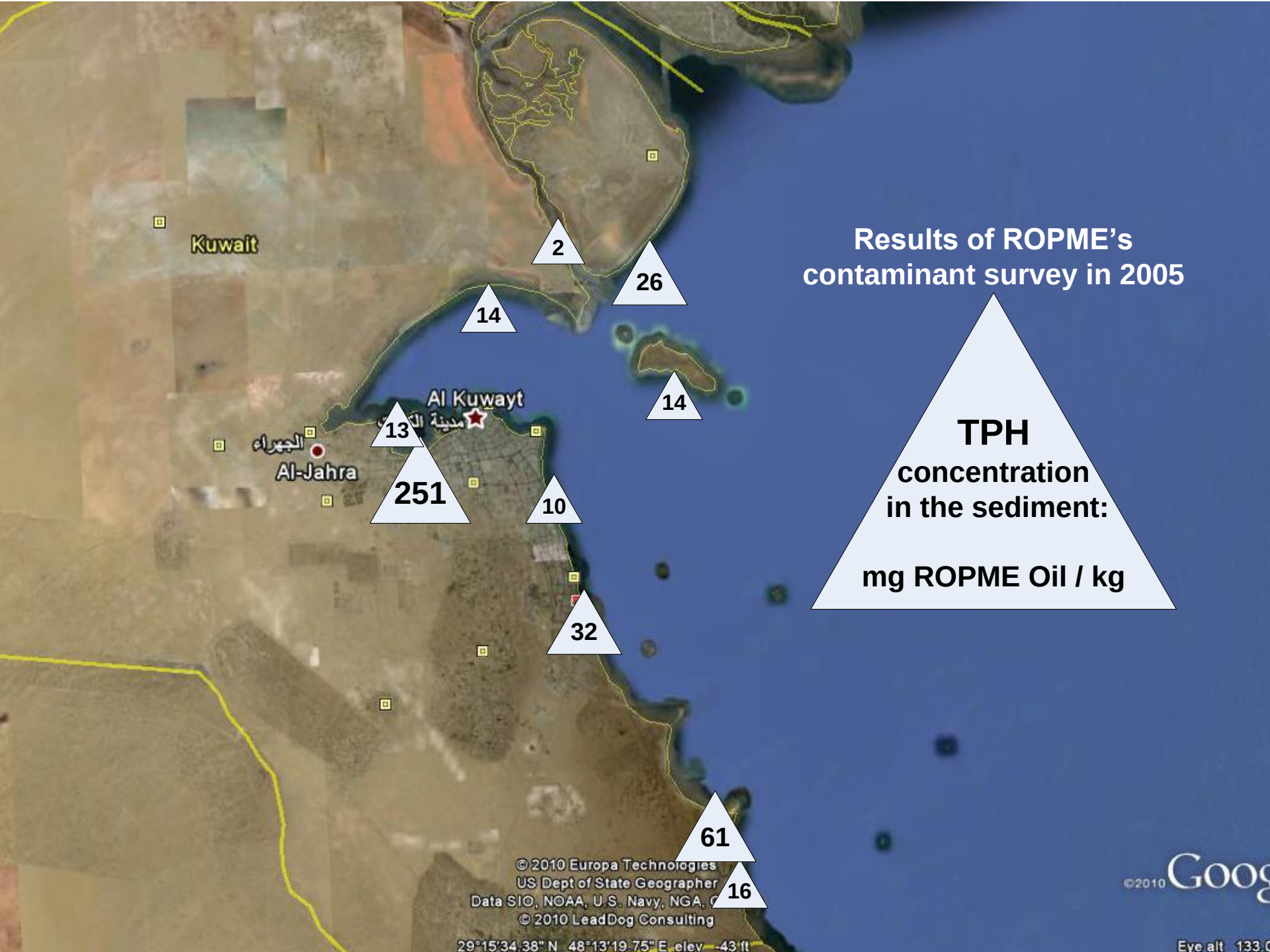


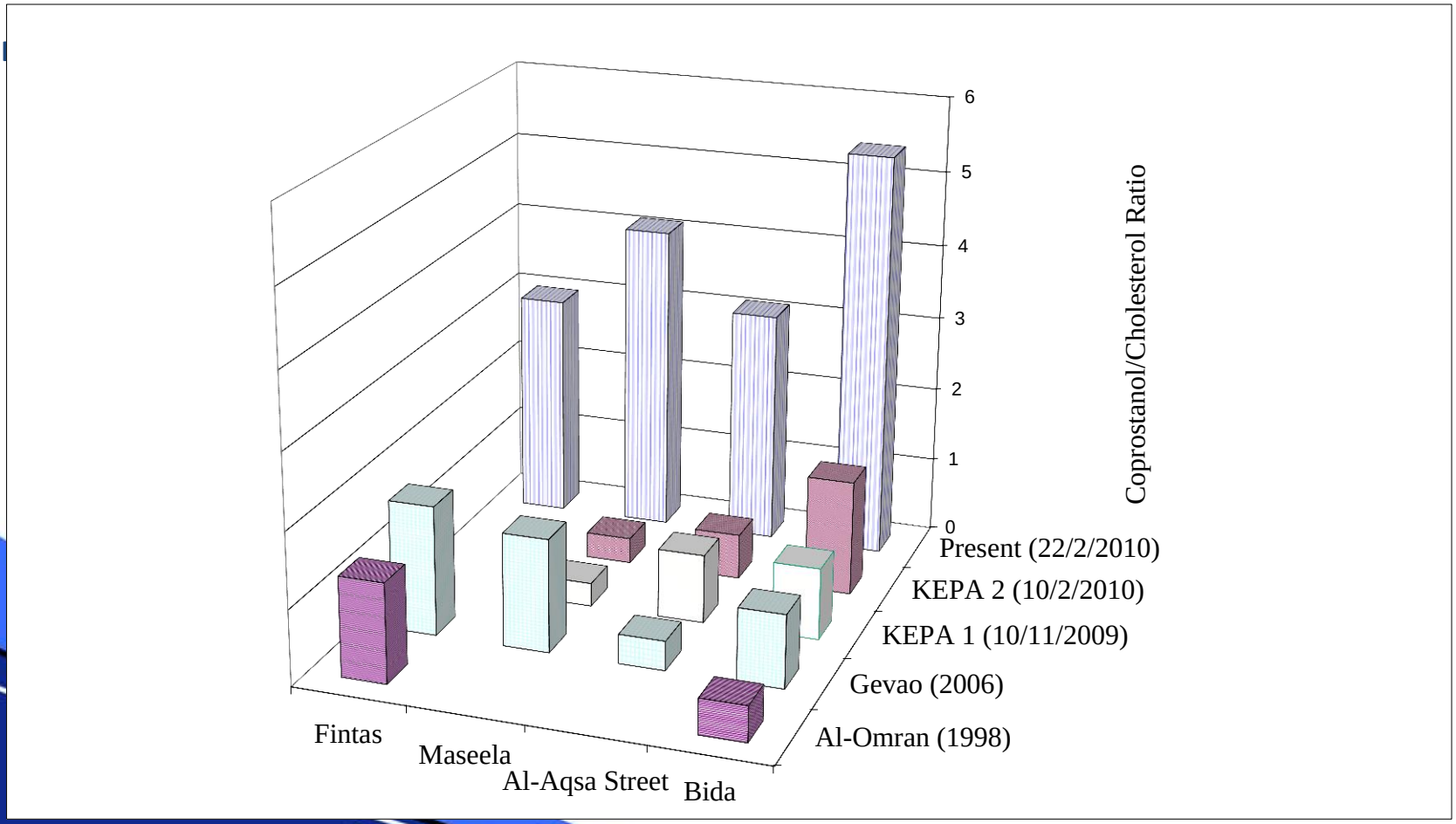
Global CO_2 concentration between 800,000 years BP to 2009 (source http://www.esrl.noaa.gov/gmd/ccgg/trends/history.html)

Bleached corals near Az Zour- They show a good seasonal recovery under current physico-chemical conditions. Reason for bleaching is high temperature and lower pH effects the calcification rate. How long is it sustainable…….?



“Hot-spots” of TPH and PAHs in the Gulf

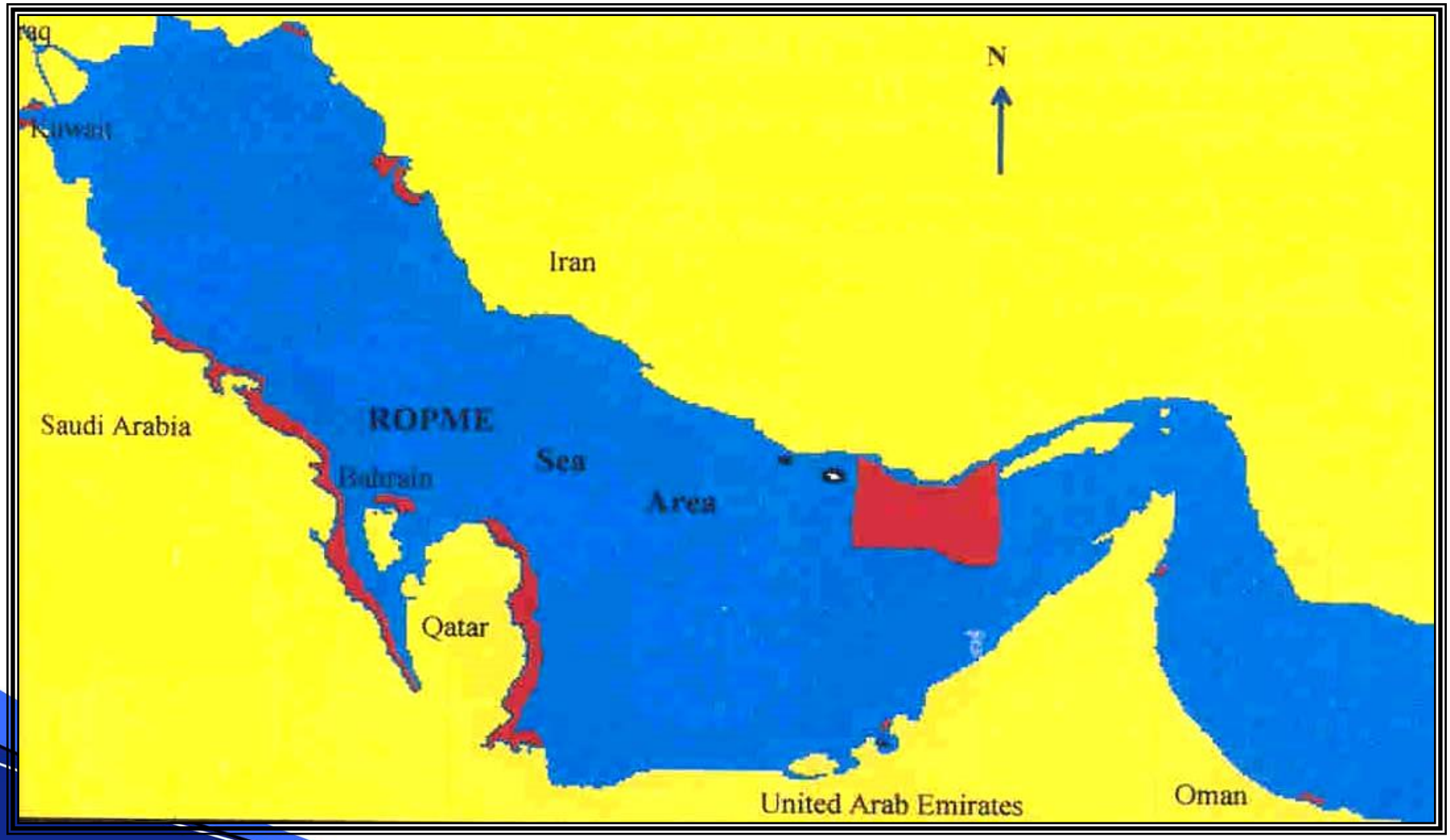

Kuwait
Al Kuwayt
الجهراء
Al-Jahra
2
26
14
14
13
251
10
32
61
16
Results of ROPME's contaminant survey in 2005
TPH concentration in the sediment:
mg ROPME Oil / kg
© 2010 Europa Technologies
US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA,
© 2010 LeadDog Consulting
29°15'34.38" N 48°13'19.75" E elev -43 ft
©2010 Goog
Eye alt 133.



Temporal Comparison of Coprostanol\Cholesterol Ratios from Kuwait's Coastal Areas

Fish kill

Eutrophication & Fish Mortality.



Impact On fisheries

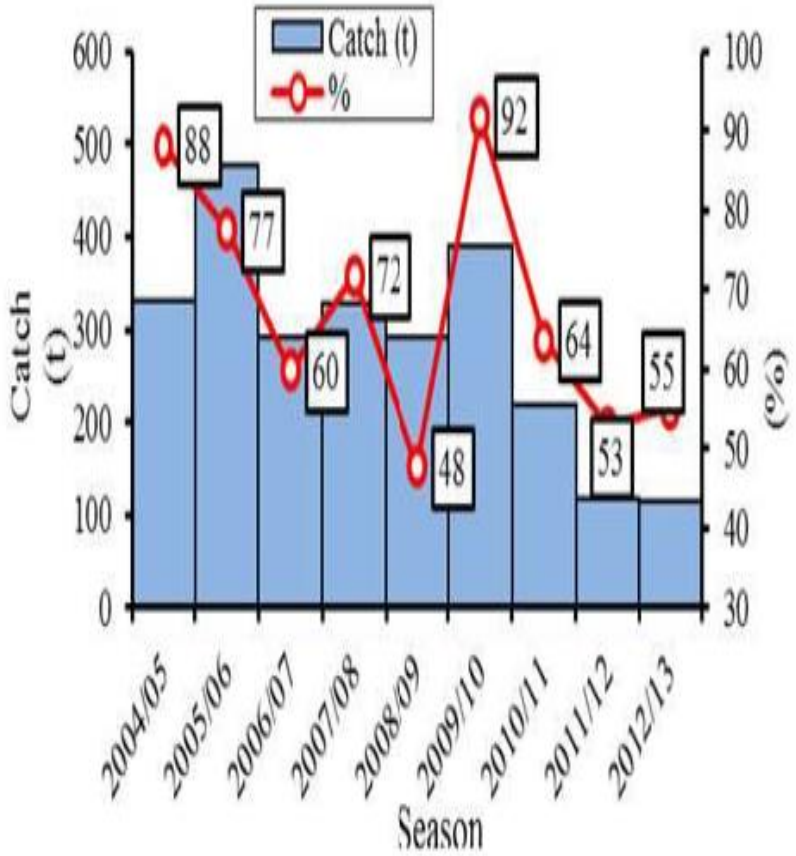
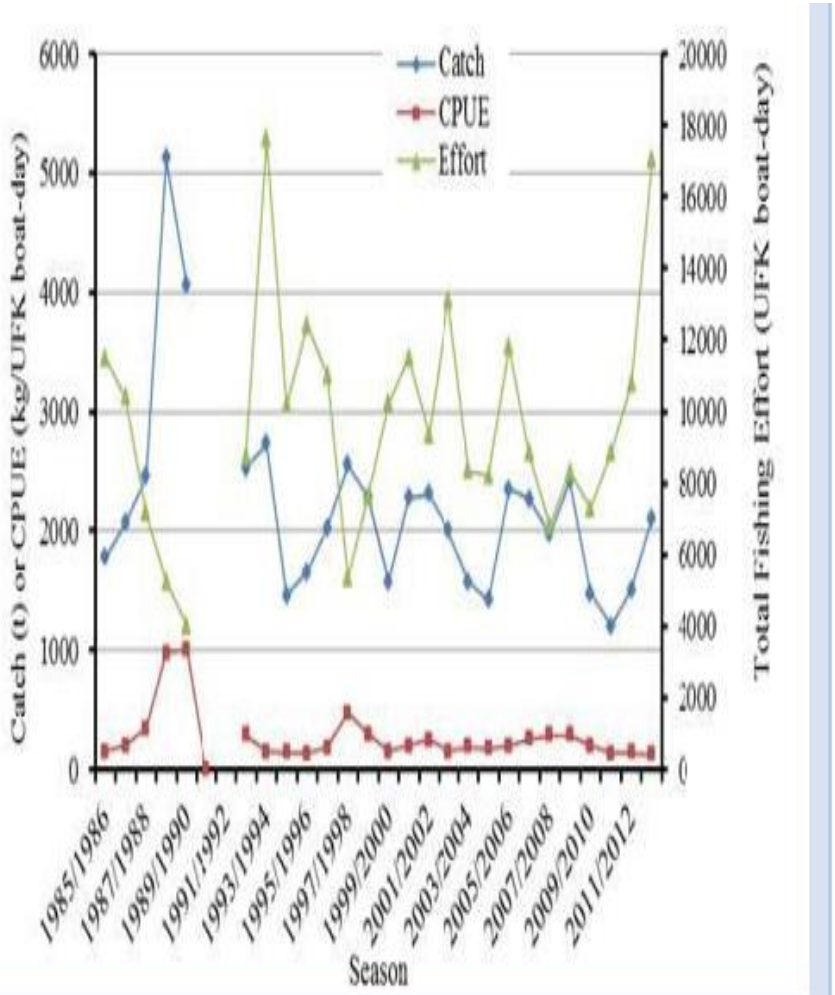
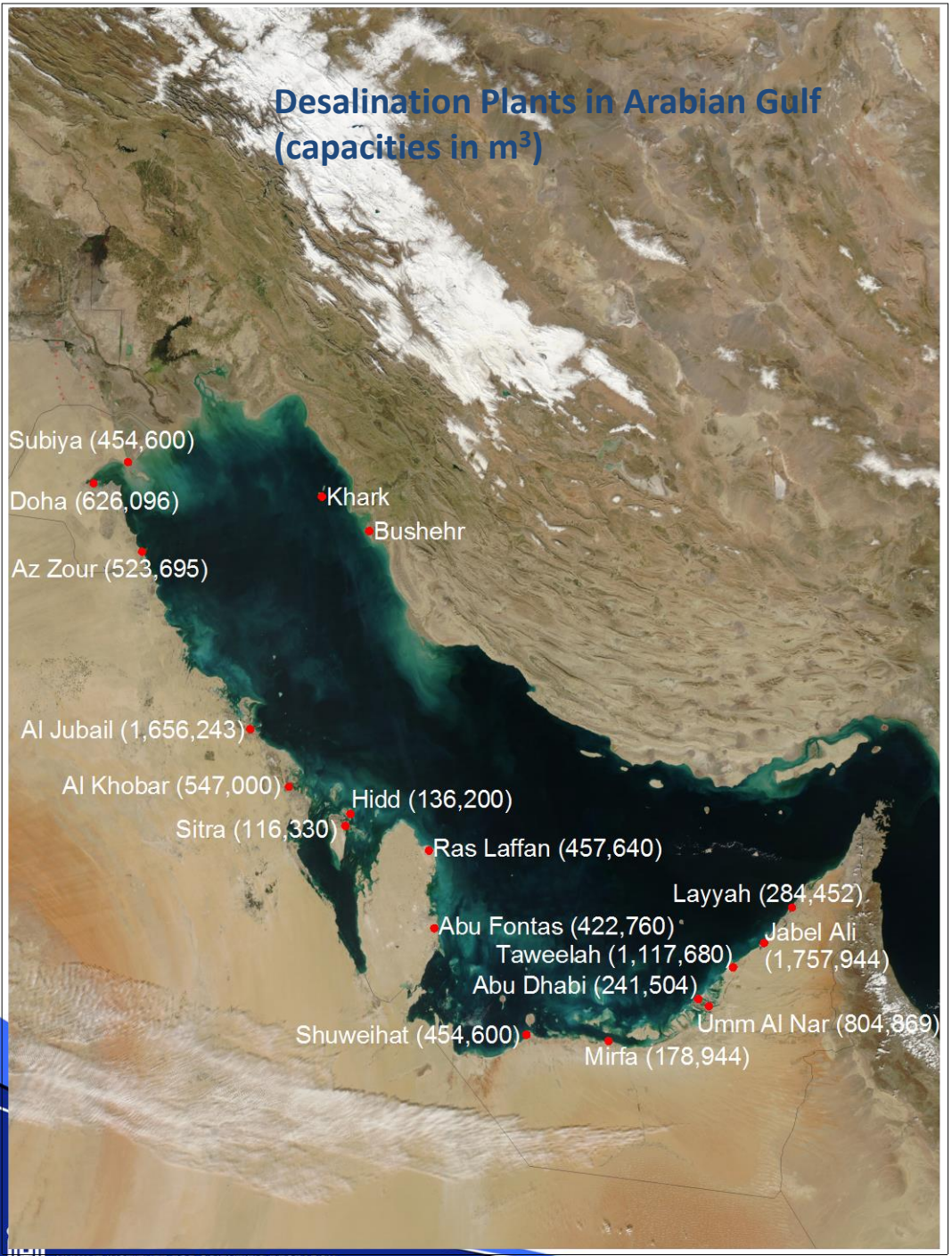
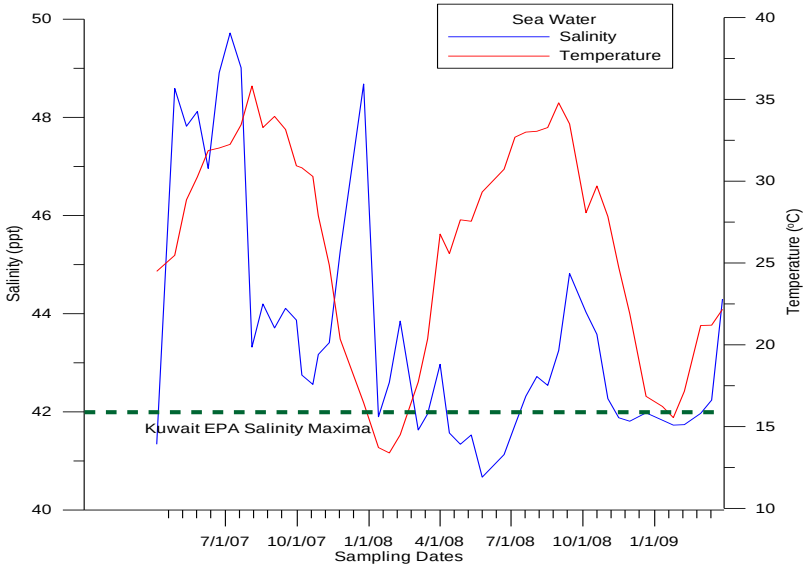


Fig. 2. Comparison of the total *P. semisulcatus* catch and





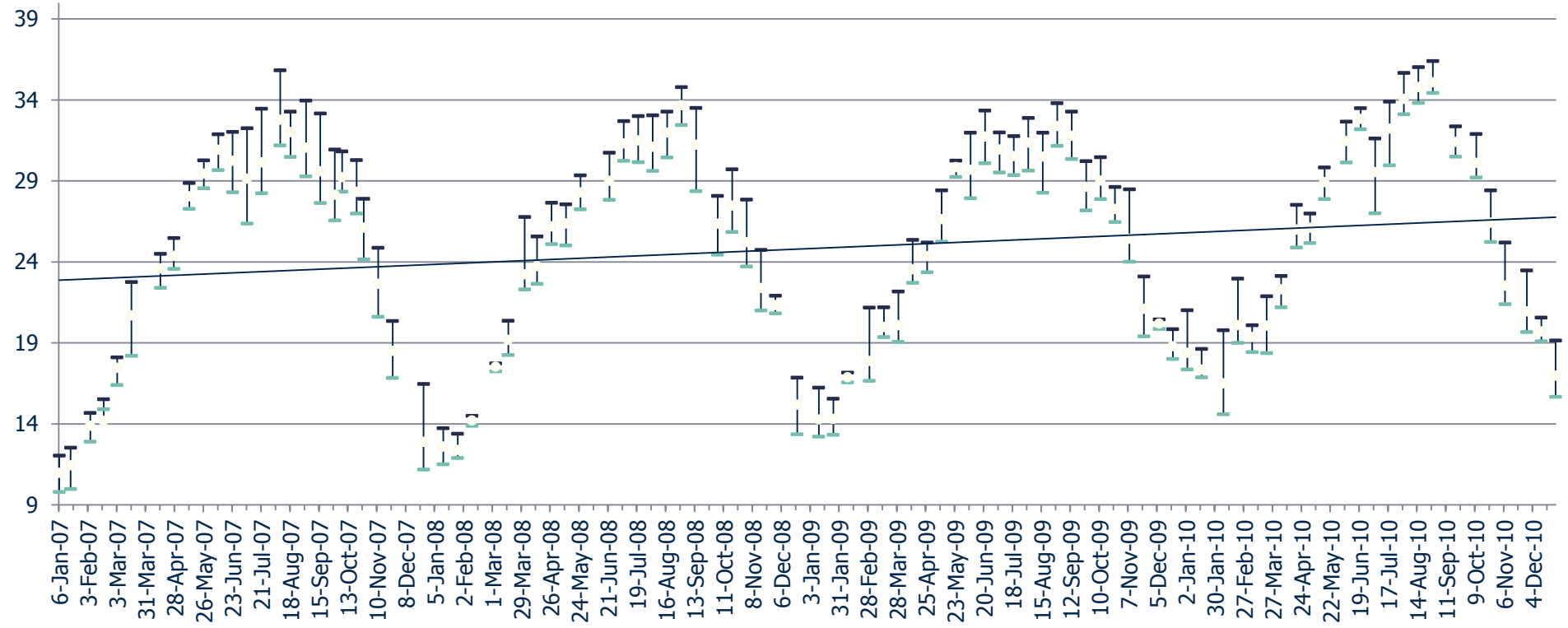


Salinity and Temperature trends at observation station in Open Gulf, south Kuwait.

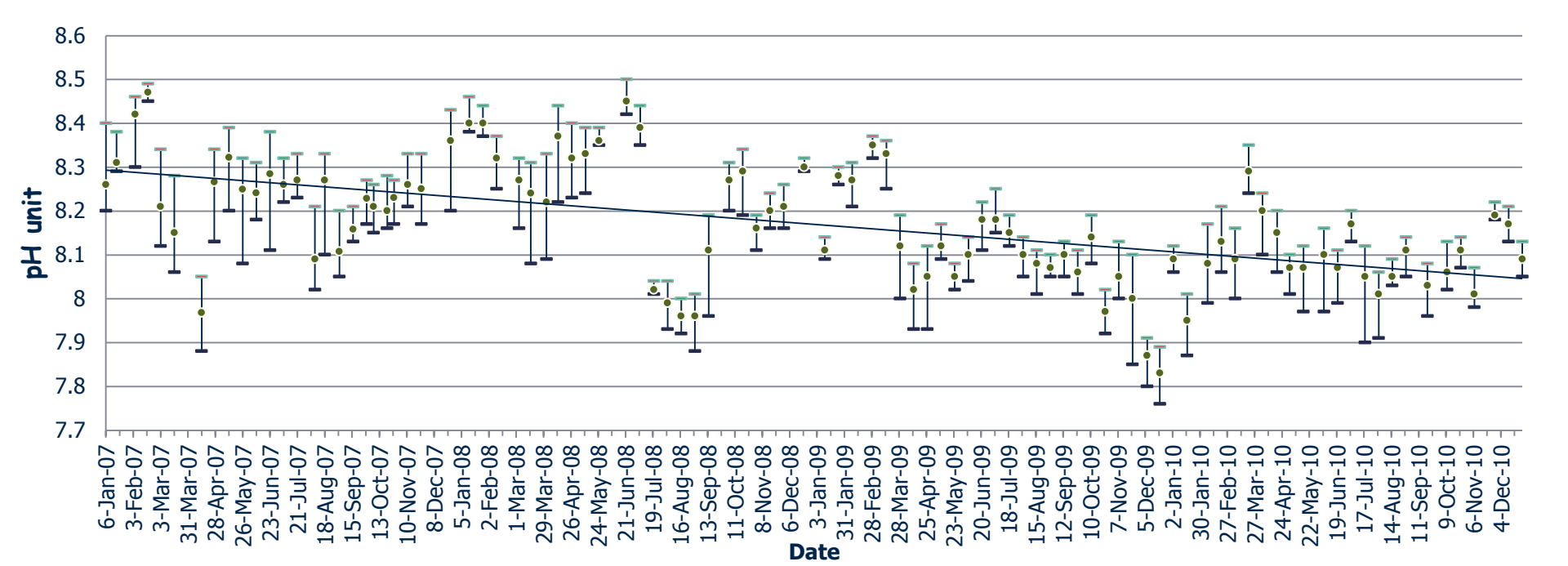
Highlights

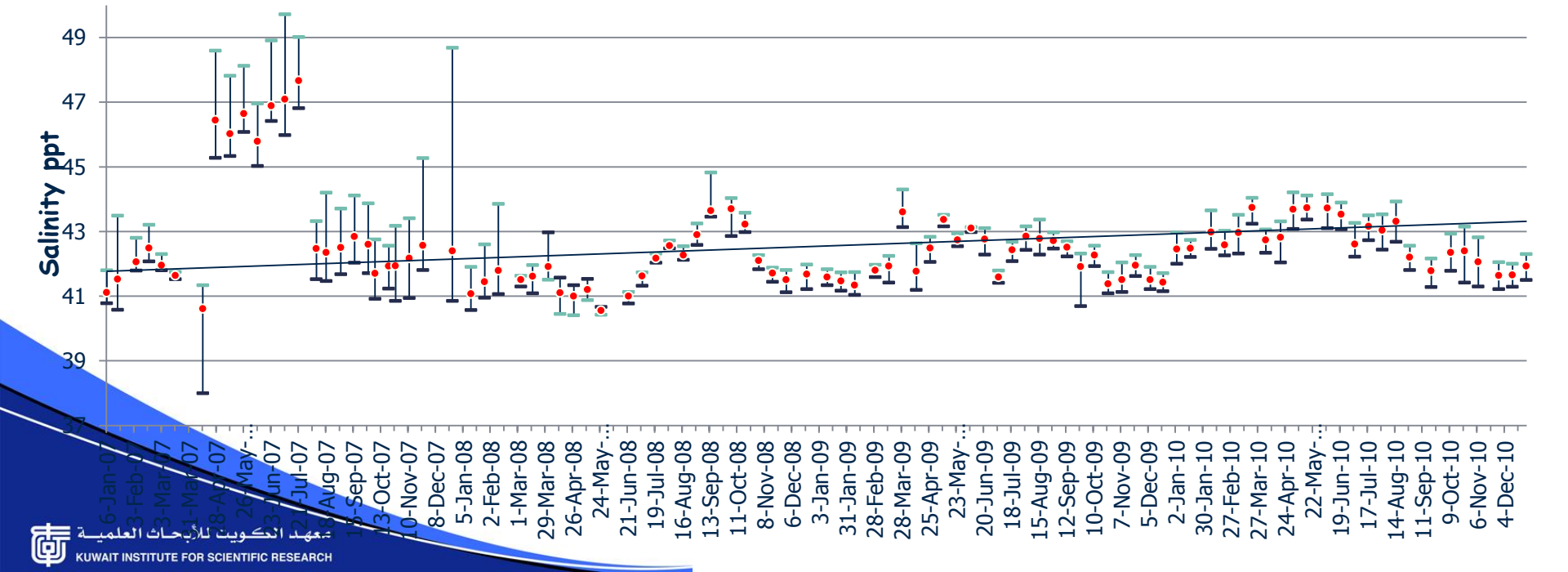
- Increased Salinity
- In most cases the salinity is above the KEPA limit
- There is a need to revisit the guidelines and permissible limits

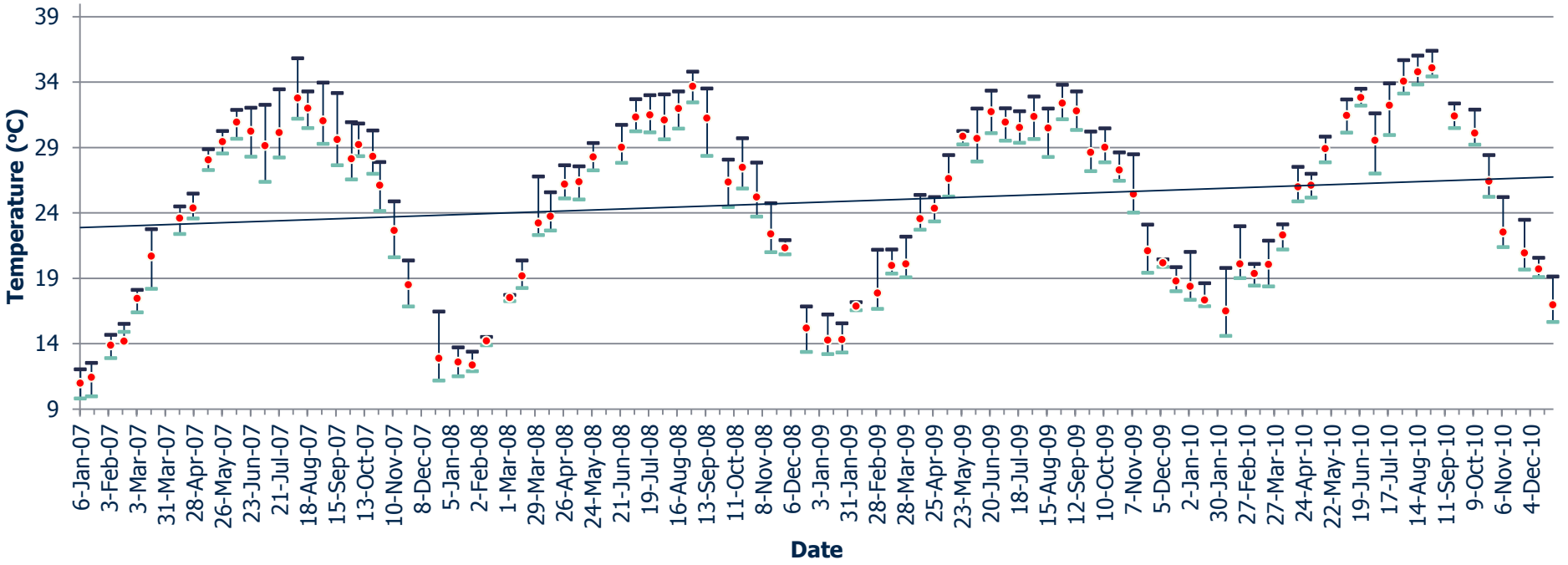
Temperature

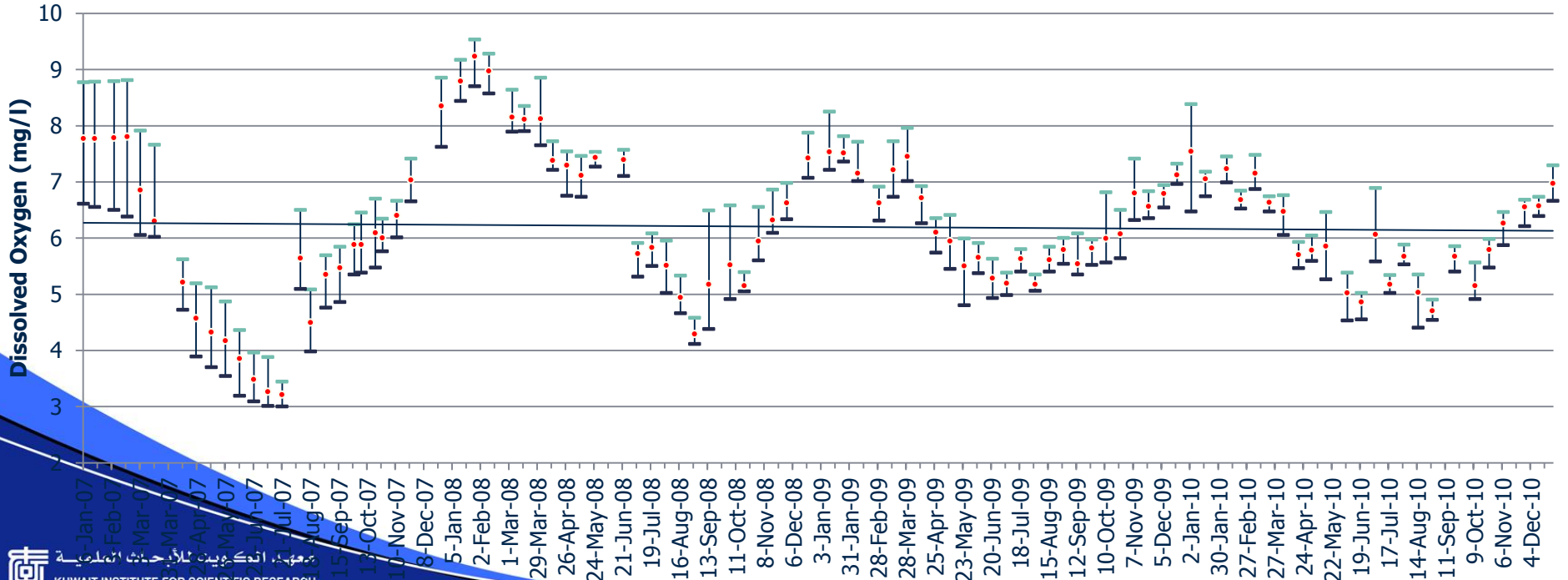


Temperature measurements during January 2007 to December 2010 in Kuwait territorial waters


pH unit
8.6
8.5
8.4
8.3
8.2
8.1
8
7.9
7.8
7.7
6-Jan-07
3-Feb-07
3-Mar-07
31-Mar-07
28-Apr-07
26-May-07
23-Jun-07
21-Jul-07
18-Aug-07
15-Sep-07
13-Oct-07
10-Nov-07
8-Dec-07
5-Jan-08
2-Feb-08
1-Mar-08
29-Mar-08
26-Apr-08
24-May-08
21-Jun-08
19-Jul-08
16-Aug-08
13-Sep-08
11-Oct-08
8-Nov-08
6-Dec-08
3-Jan-09
31-Jan-09
28-Feb-09
28-Mar-09
25-Apr-09
23-May-09
20-Jun-09
18-Jul-09
15-Aug-09
12-Sep-09
10-Oct-09
7-Nov-09
5-Dec-09
2-Jan-10
30-Jan-10
27-Feb-10
27-Mar-10
24-Apr-10
22-May-10
19-Jun-10
17-Jul-10
14-Aug-10
11-Sep-10
9-Oct-10
6-Nov-10
4-Dec-10
Date


Salinity ppt
49
47
45
43
41
39
6-Jan-07
3-Feb-07
3-Mar-07
31-Mar-07
28-Apr-07
26-May-07
23-Jun-07
21-Jul-07
18-Aug-07
15-Sep-07
13-Oct-07
10-Nov-07
8-Dec-07
5-Jan-08
2-Feb-08
1-Mar-08
29-Mar-08
26-Apr-08
24-May-08
21-Jun-08
19-Jul-08
16-Aug-08
13-Sep-08
11-Oct-08
8-Nov-08
6-Dec-08
3-Jan-09
31-Jan-09
28-Feb-09
28-Mar-09
25-Apr-09
23-May-09
20-Jun-09
18-Jul-09
15-Aug-09
12-Sep-09
10-Oct-09
7-Nov-09
5-Dec-09
2-Jan-10
30-Jan-10
27-Feb-10
27-Mar-10
24-Apr-10
22-May-10
19-Jun-10
17-Jul-10
14-Aug-10
11-Sep-10
9-Oct-10
6-Nov-10
4-Dec-10


Temperature (°C)
39
34
29
24
19
14
9
6-Jan-07
3-Feb-07
3-Mar-07
31-Mar-07
28-Apr-07
26-May-07
23-Jun-07
21-Jul-07
18-Aug-07
15-Sep-07
13-Oct-07
10-Nov-07
8-Dec-07
5-Jan-08
2-Feb-08
1-Mar-08
29-Mar-08
26-Apr-08
24-May-08
21-Jun-08
19-Jul-08
16-Aug-08
13-Sep-08
11-Oct-08
8-Nov-08
6-Dec-08
3-Jan-09
31-Jan-09
28-Feb-09
28-Mar-09
25-Apr-09
23-May-09
20-Jun-09
18-Jul-09
15-Aug-09
12-Sep-09
10-Oct-09
7-Nov-09
5-Dec-09
2-Jan-10
30-Jan-10
27-Feb-10
27-Mar-10
24-Apr-10
22-May-10
19-Jun-10
17-Jul-10
14-Aug-10
11-Sep-10
9-Oct-10
6-Nov-10
4-Dec-10
Date

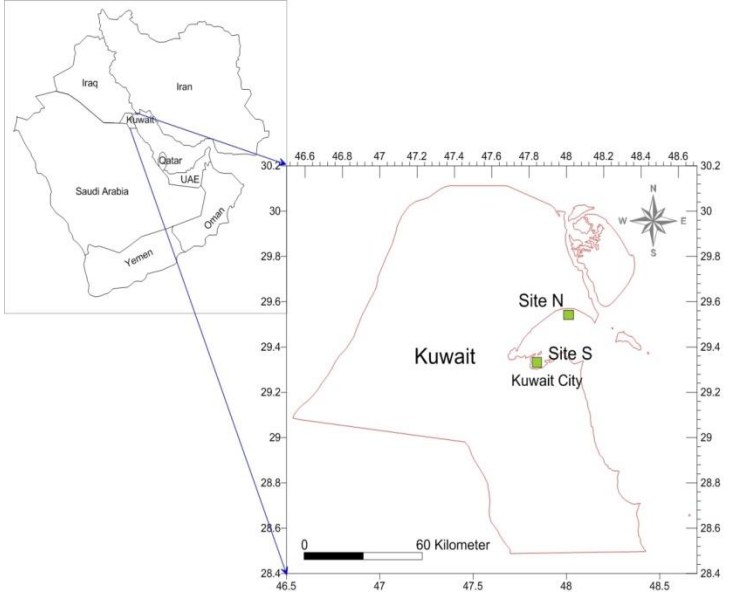

Dissolved Oxygen (mg/l)
10
9
8
7
6
5
4
3
6-Jan-07
3-Feb-07
3-Mar-07
31-Mar-07
28-Apr-07
26-May-07
23-Jun-07
21-Jul-07
18-Aug-07
15-Sep-07
13-Oct-07
10-Nov-07
8-Dec-07
5-Jan-08
2-Feb-08
1-Mar-08
29-Mar-08
26-Apr-08
24-May-08
21-Jun-08
19-Jul-08
16-Aug-08
13-Sep-08
11-Oct-08
8-Nov-08
6-Dec-08
3-Jan-09
31-Jan-09
28-Feb-09
28-Mar-09
25-Apr-09
23-May-09
20-Jun-09
18-Jul-09
15-Aug-09
12-Sep-09
10-Oct-09
7-Nov-09
5-Dec-09
2-Jan-10
30-Jan-10
27-Feb-10
27-Mar-10
24-Apr-10
22-May-10
19-Jun-10
17-Jul-10
14-Aug-10
11-Sep-10
9-Oct-10
6-Nov-10
4-Dec-10

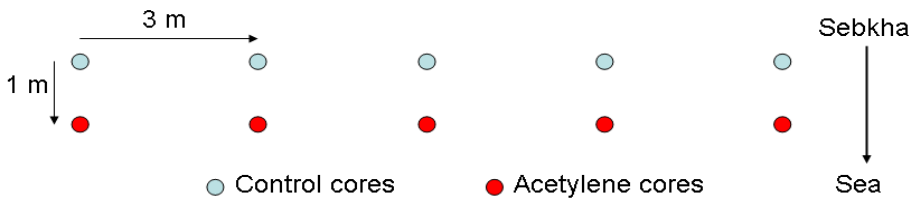
To establish denitrification potential of the Northern WG

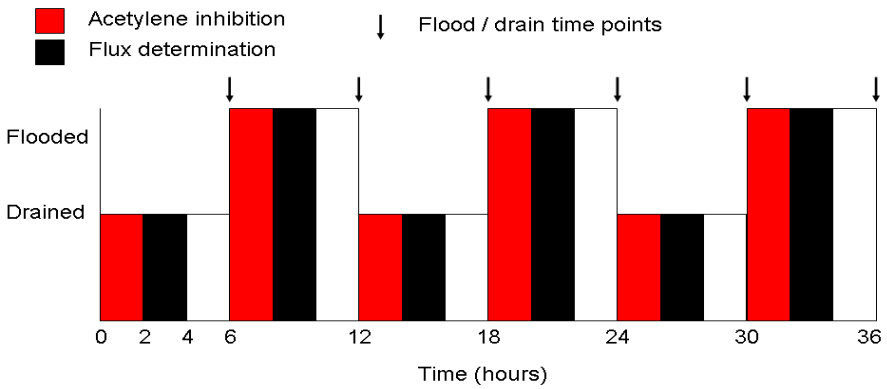
- Nitrogen critically affects the ocean productivity, obliterates acidity, oxidative capacity and radiative transfer capability of atmosphere.

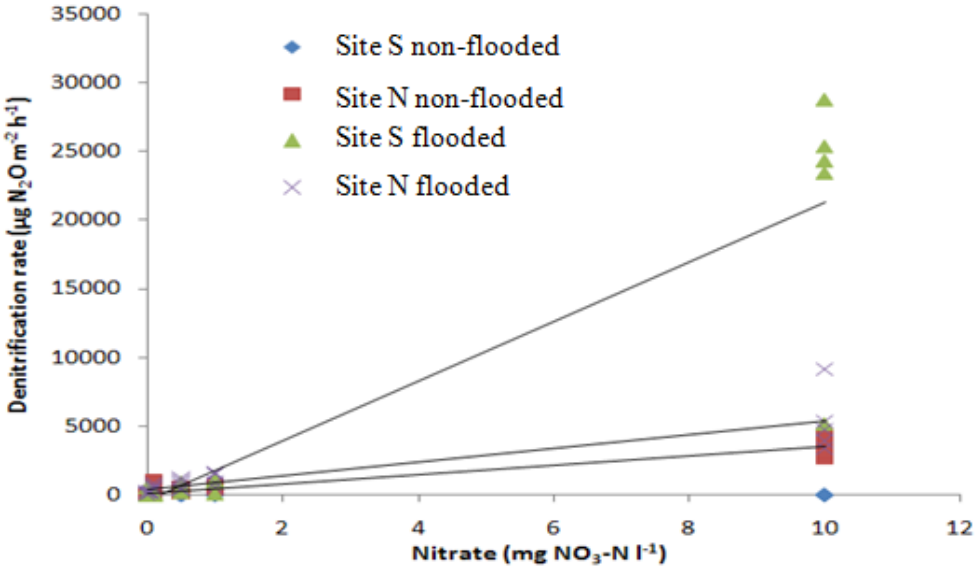
- The experiment in controlled laboratory conditions simulated the tidal cycles.

- **Redox potential was significantly lower at 10 cm depth compared to the surface in all cores ($P<0.001$). The redox potential at surface and at 10 cm depth was significantly lower at site S compared to site N, suggesting anaerobic sediments at site S.**



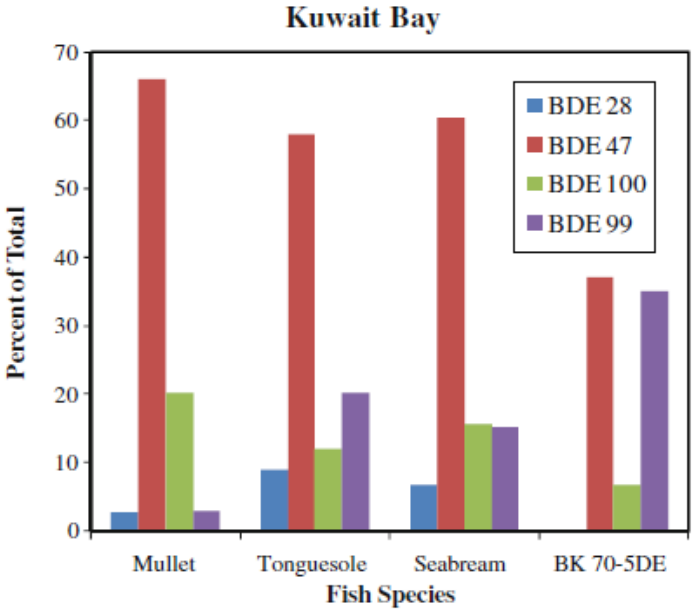


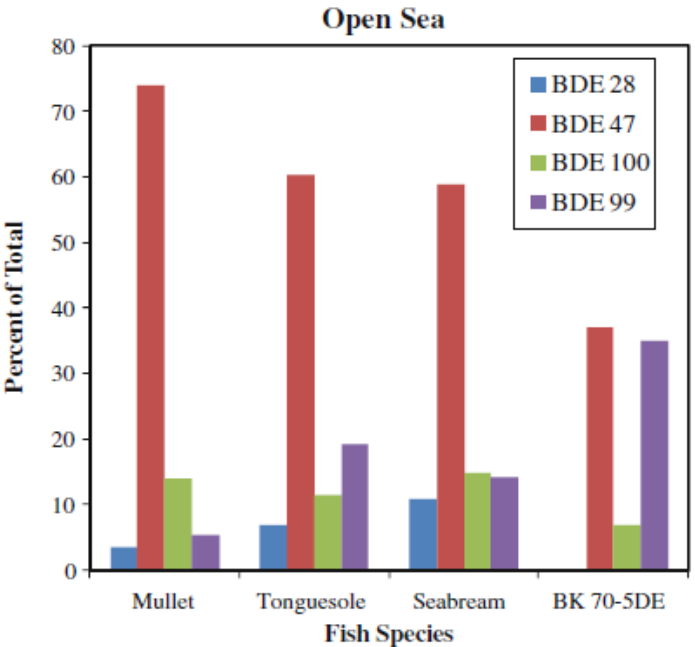


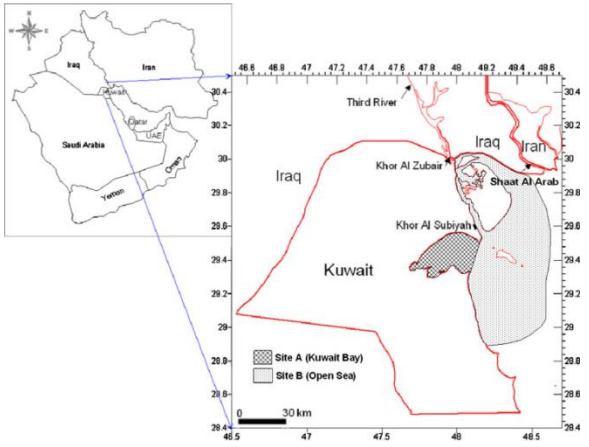


The effect of nitrate concentration on the rate of denitrification at Site S and Site N under non flooded and flooded conditions

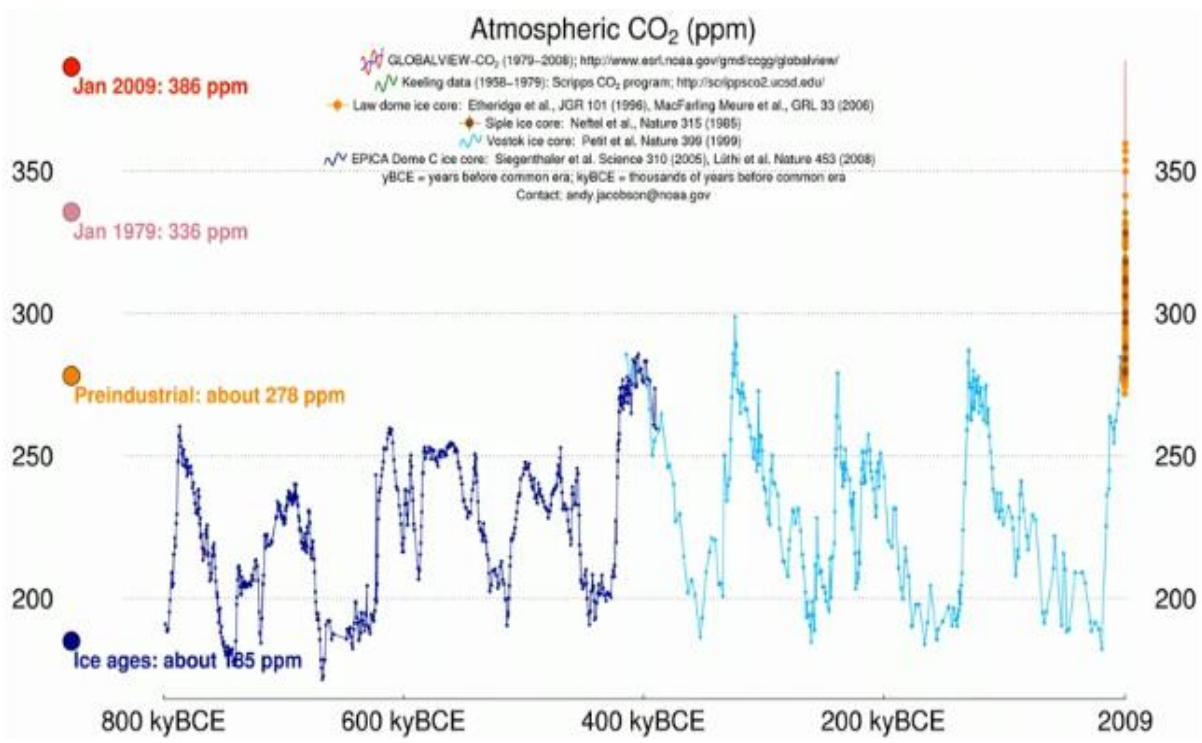
Polybrominated diphenyl ethers (PBDEs) were measured in three species of fish yellowfin seabream, a predatory fish; Klunzinger's mullet, a pelagic fish; and large-scaled tonguesole, a demersal fish collected from two sites in the northwestern part of theGulf.







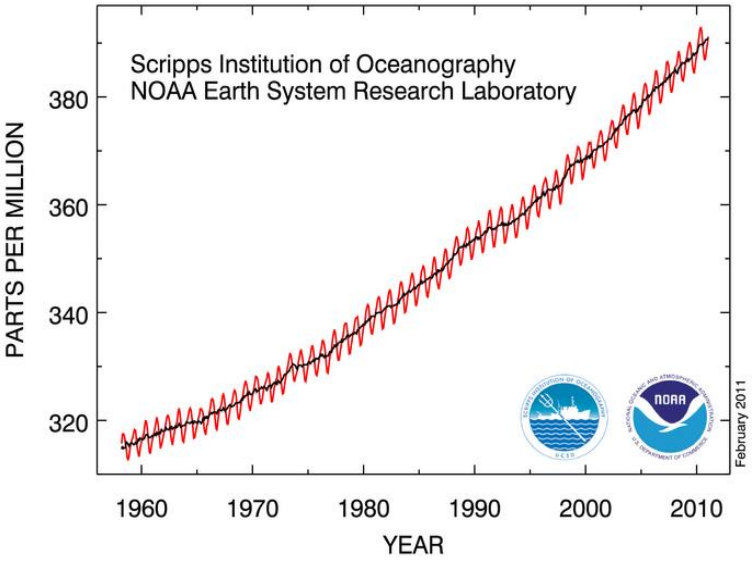
Congener	Mullet		Tonguesole		Seabream	
	Geometric mean	Range	Geometric mean	Range	Geometric mean	Range
Site A (Kuwait Bay)						
28	1.0	0.67–1.3	1.6	0.60–4.0	1.6	0.62–3.8
47	14	7.6–48	8.8	3.2–20	8.2	1.8–30
100	3.8	1.8–6.2	1.7	0.82–4.0	2.1	0.40–6.4
99	0.84	0.28–2.5	2.9	0.90–5.6	1.9	0.48–7.8
ΣPBDEs	25	11–57	14.7	4.9–38	14	2.8–48
% Lipid	30	6–55	8	3–12	11	7–22
Length (cm)	18	15–21	24	19–28	22	18–27
Weight (g)	76	40–128	59	31–98	189	101–346
Age (year)	3	2–5	2	1–4	2	1–4
Site B (open gulf)						
28	0.96	0.4–5.0	4.4	1.3–38	1.7	0.56–11
47	22	4.0–130	15	5.1–120	6.8	3.4–30
100	3.7	0.90–18	4.1	1.6–25	1.8	1.1–5.0
99	0.96	0.24–3.7	4.3	0.92–39	1.6	0.61–13
ΣPBDEs	29	6.0–160	24	8.3–190	10	7.1–62
% Lipid	27	6–53	7	2–14	14	7–23
Length (cm)	17	8–20	22	19–25.4	19	11–29
Weight (g)	65	29–101	49	24–71	153	30–515
Age (year)	2	1–6	2	1–4	2	1–4



Global CO_2 concentration between 800,000 years BP to 2009 (source http://www.esrl.noaa.gov/gmd/ccgg/trends/history.html)

Bleached corals near Az Zour- They show a good seasonal recovery under current physico-chemical conditions. Reason for bleaching is high temperature and lower pH effects the calcification rate. How long is it sustainable…….?

Global Warming and Climate Change effects on the Gulf



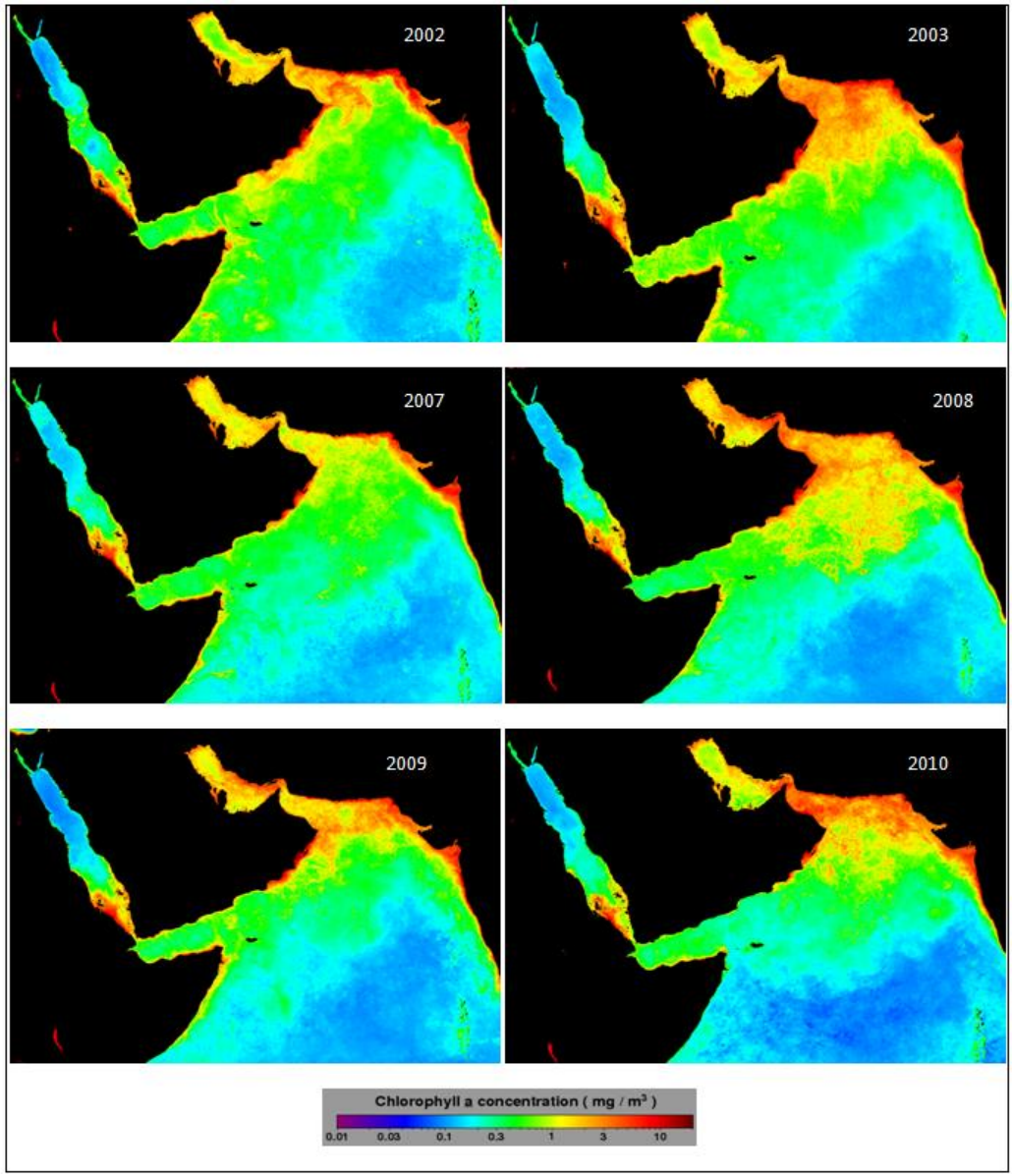
•Global CO_2 concentration between 1960 – 2010

• Current CO_2 Level is 394 ppm.

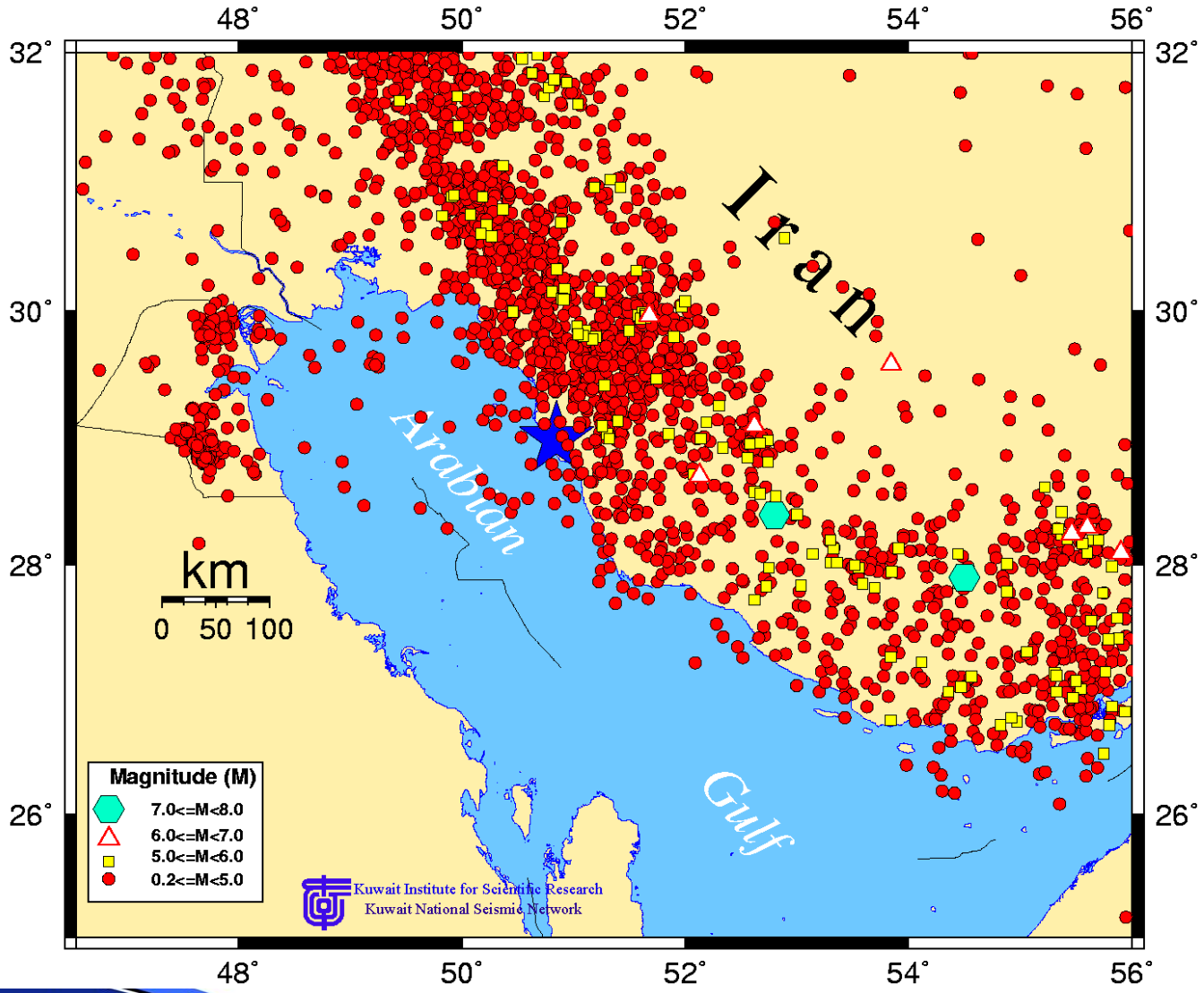
•Most of the CO_2 in the region is sequestered in the Gulf

•Likely effects of this is ocean acidification, increase productivity, change in oceanic biogeochemistry

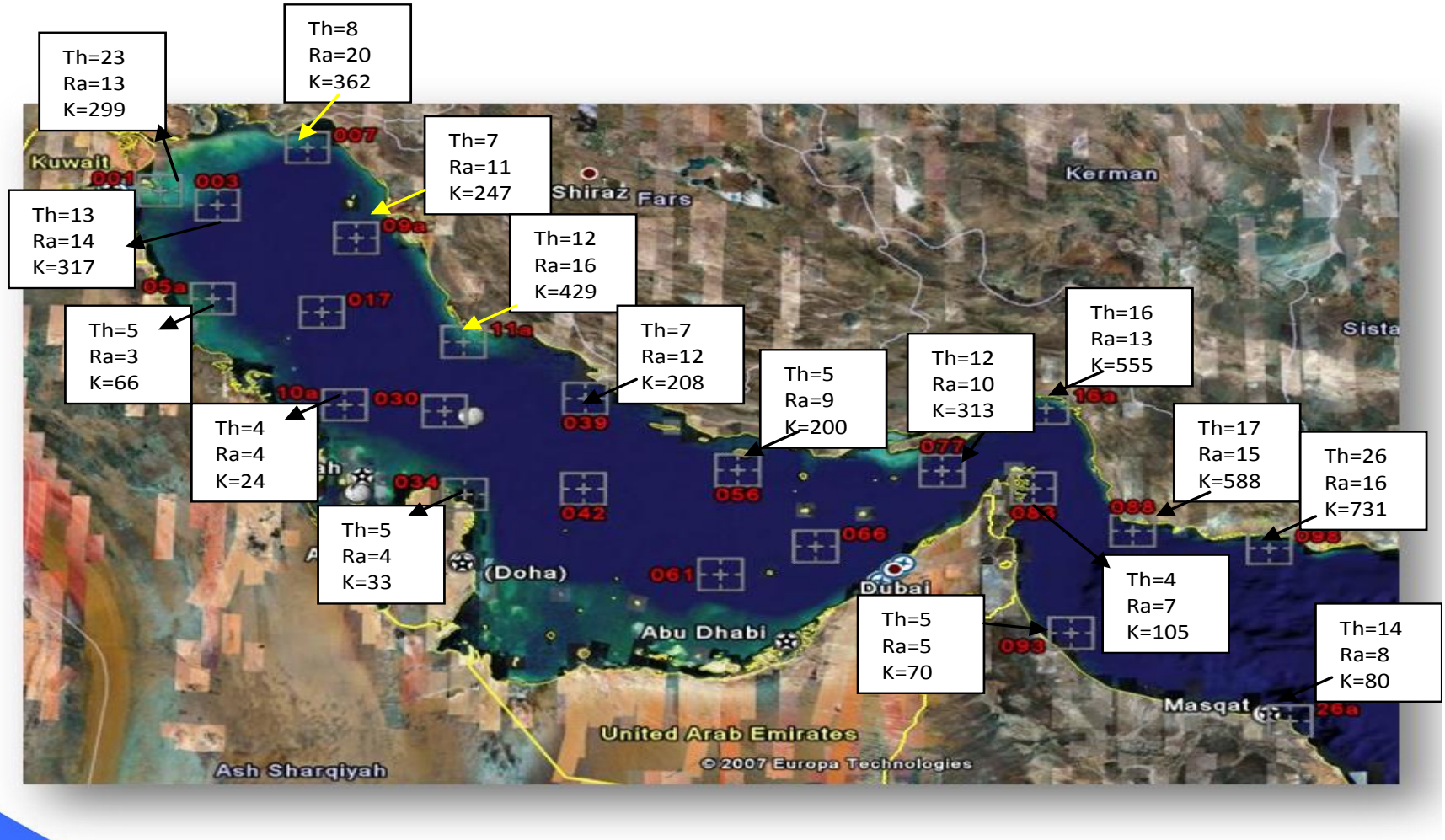
•Recent studies by S. Uddin, A.N. Al Ghadban et al., 2012 shows the rate of acidification in Gulf is much higher than predicted by IPCC for most oceans



•Increased Ocean Productivity, possible effect of availability of CO_2 and nutrients


48°
50°
52°
54°
56°
32°
30°
28°
26°
Iran
Arabian
Gulf
km
0 50 100
Magnitude (M)
7.0<=M<8.0
6.0<=M<7.0
5.0<=M<6.0
0.2<=M<5.0
Kuwait Institute for Scientific Research
Kuwait National Seismic Network

Natural radionuclides concentration (Bq/kg) in RSA reference sites



Radionuclide concentration in commercial fish species of Kuwait

Scientific names of the commercial fishes and their dry factor

Fish	Scientific Name	Dry Factor (%)
Meid	*Liza klunzingeri*	39.50
Shea 'am	*Acanthopagrus latus*	32.81
Beyah	*Liza subviridis*	28.22
Sobaity	*Sparidentex hasta*	27.56
Nuwaibi	*Otolithes ruber*	24.51
Battan	*Crenidens crenidens*	29.24

^{210}Po and ^{90}Sr massic activity in important commercial fishes in Kuwaiti waters

	^{210}Po		^{90}Sr	
Fish	Bq/kg (fresh)	Uncertainty	Bq/kg (fresh)	Uncertainty
Meid	2.29	0.43	1.65	0.28
Shea 'am	1.46	0.26	1.46	0.25
Beyah	2.40	0.04	1.73	0.17
Sobaity	**0.69**	**0.15**	**1.17**	**0.20**
Nuwaibi	1.16	0.07	1.49	0.21
Battan	**3.30**	**0.26**	**4.13**	**0.34**

Concentration of various radioisotopes in Fish samples from Kuwait (dry weight)

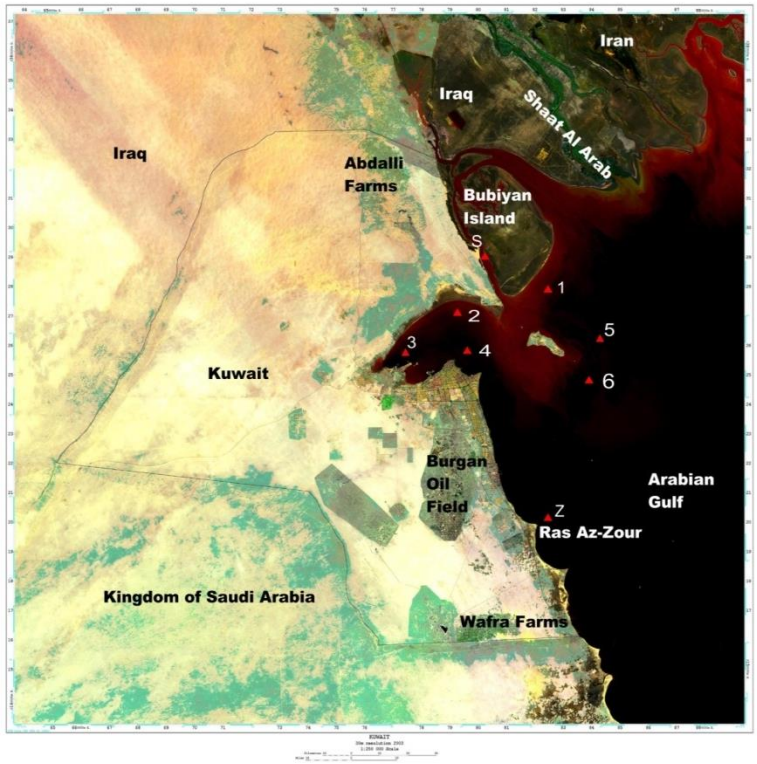
Fish	^{40}K (Bq/Kg)			^{226}Ra (Bq/Kg)			^{224}Ra (Bq/Kg)			^{228}Ra (Bq/Kg)			^{137}Cs (Bq/Kg)		
	Activity	Uncertainty	MDA	Activity	Uncertainty	MDA	Activity	Uncertainty	MDA	Activity	Uncertainty	MDA	Activity	Uncertainty	MDA
Meid	335	7.3	2.2	7.3	0.14	0.5	6.60	0.15	0.28	15.80	0.44	0.9	BDL		0.08
Shea 'am	279	6	1.6	1.3	0.06	0.3	0.80	0.05	0.20	1.70	0.10	0.7	BDL		0.07
Beyah	383	16	3.1	5.0	0.20	0.9	2.26	0.20	0.60	9.90	0.54	1.9	BDL		0.17
Sobaity	412	17	2.0	1.15	0.12	0.7	BDL		0.60	BDL		1.5	BDL		0.08
Nuwaibi	477	11	2.4	0.70	0.10	0.5	0.50	0.06	0.32	1.20	0.20	1.2	BDL		0.07
Battan	230	8	1.6	1.10	0.08	0.4	1.46	0.07	0.20	2.40	0.17	0.9	BDL		0.06

Highlights:

- **Among the six commercial fish species in the food basket of Kuwait, Battan has the highest activity of ^{210}Po and ^{90}Sr, while Sobaity has the lowest activity.**
- **Based on the massic activity in the fishes of Kuwait, they are comparable to concentrations found in other regions of the world.**
- **No apparent concerns and risks.**
- **The ^{210}Po concentration in fishes is closely associated with the their feeding habit and tropic level. (this is an ongoing study to see the concentration mechanism and food chain transfer)**

Radionuclide Concentration in Seawater Samples

Station	^{3}H (TU)	^{90}Sr (mBq/l)	^{210}Po (mBq/l)	^{137}Cs (mBq/l)
1	1.26 ± 0.01	0.68 ± 0.08	0.50 ± 0.06	1.06 ± 0.01
2	1.04 ± 0.01	0.73 ± 0.05	0.68 ± 0.08	1.06 ± 0.01
3	1.36 ± 0.01	0.65 ± 0.05	0.54 ± 0.08	1.06 ± 0.01
4	1.22 ± 0.01	0.78 ± 0.10	0.63 ± 0.02	1.04 ± 0.01
5	1.10 ± 0.01	0.77 ± 0.08	0.68 ± 0.02	1.01 ± 0.01
6	1.01 ± 0.01	0.61 ± 0.08	0.64 ± 0.20	1.04 ± 0.01
S	1.12 ± 0.01	0.57 ± 0.05	0.48 ± 0.07	1.06 ± 0.01
Z	0.92 ± 0.01	0.68 ± 0.10	0.49 ± 0.08	1.04 ± 0.01



•This concentration is on higher side expected from global fall out in this latitude belt (IAEA, 2001). Mainly attributed to sediments and remobilization of ^{90}Sr from the catchment.

• The ^{137}Cs concentration is between 1.01 – 1.06 mBq/l. This concentration is comparable to the range reported from Pacific and Indian Oceans where the ^{137}Cs concentration during 2000 ranged between 0.1 – 2.8 mBq/l.

•The low baseline level of tritium in 0.92 – 1.36 TU range can be attributed to very limited atmospheric tritium fall out due to scanty precipitation and no apparent tritium discharge from nuclear power plant in the area.

•The baseline concentration of ^{210}Po in seawater ranges between 0.48 – 0.68 mBq/l, it is mostly taken up by algae.

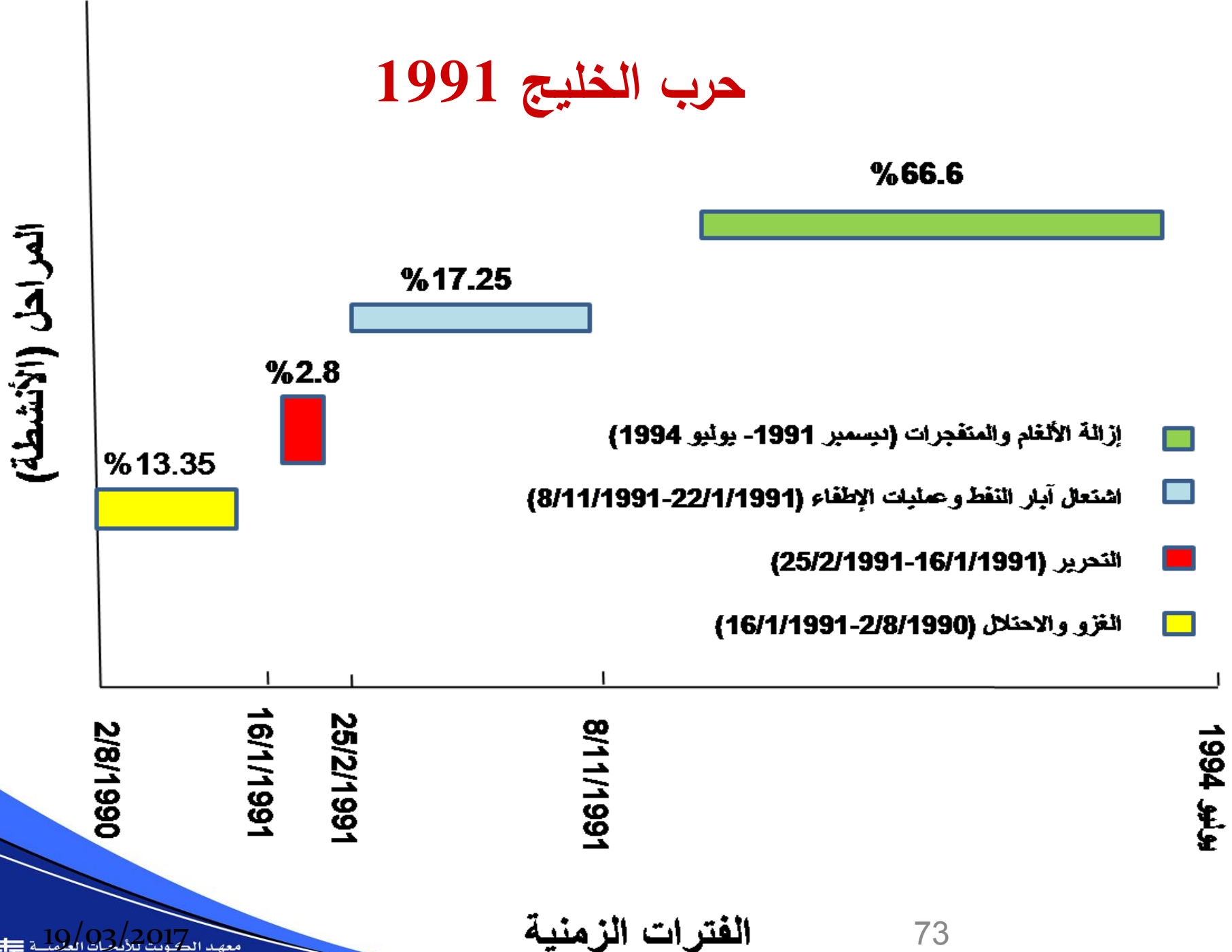
The radionuclide baseline in Kuwait suggest levels comparable to other marine waters in the northern hemisphere.

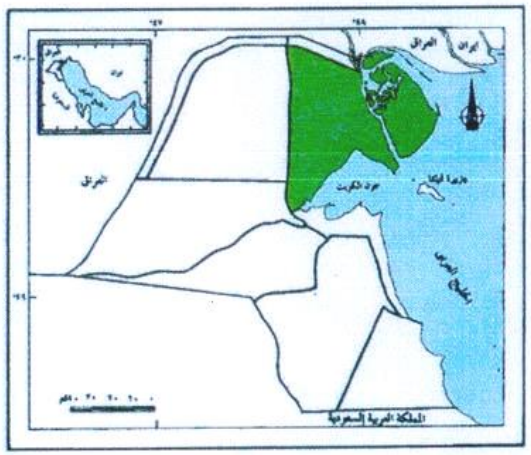
4. Case studies

CASE STUDY NO. 1

PAAC project

حرب الخليج 1991





Total No. of pits
Pakistani Sector

IRAQ

7397

8791

4699

4033

15

6951

7657

1715

41

6403

10460

5332

995

8520

7433

2665

5200

6991

7392

8684

1635

8558

7169

15670

2265

6653

ARABIAN GULF

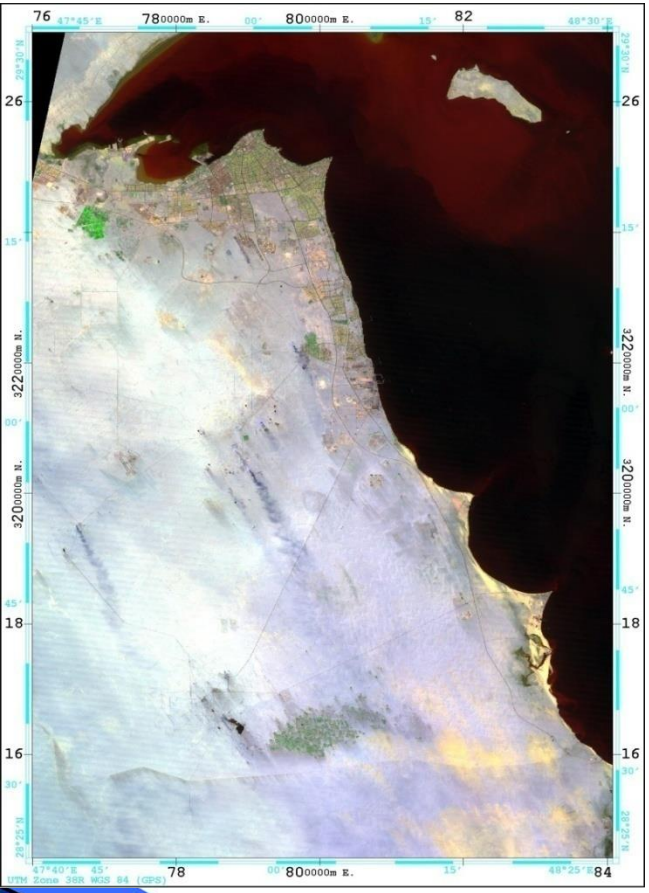
12554

2857

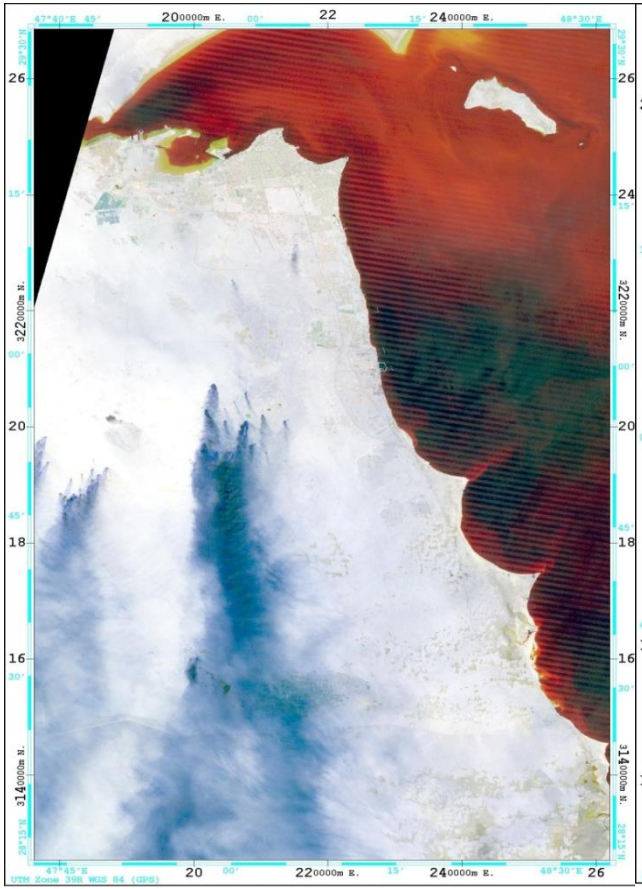
kUWAIT BAY

كارثة حرائق النفط – الكويت 1991

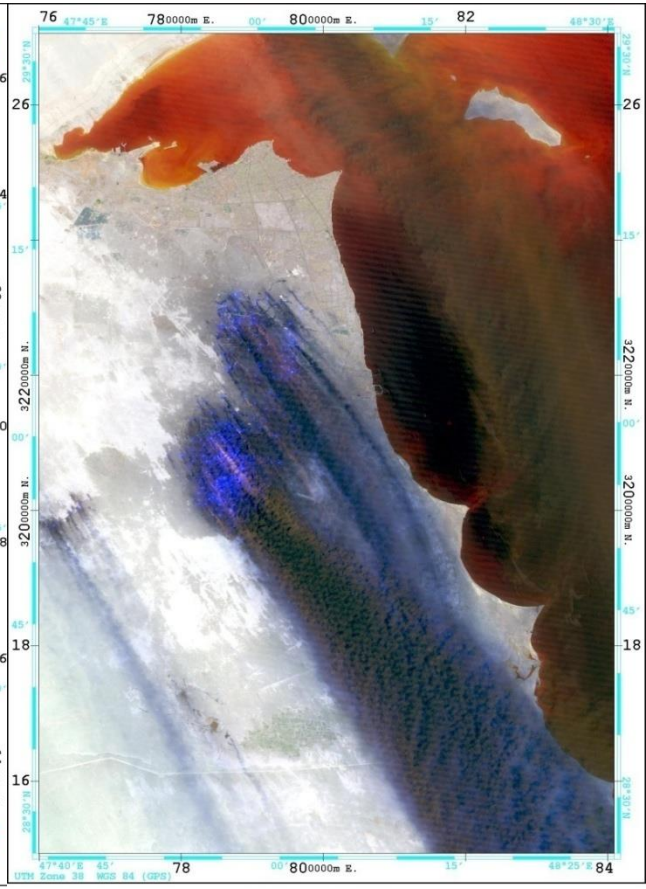
25/6/1989



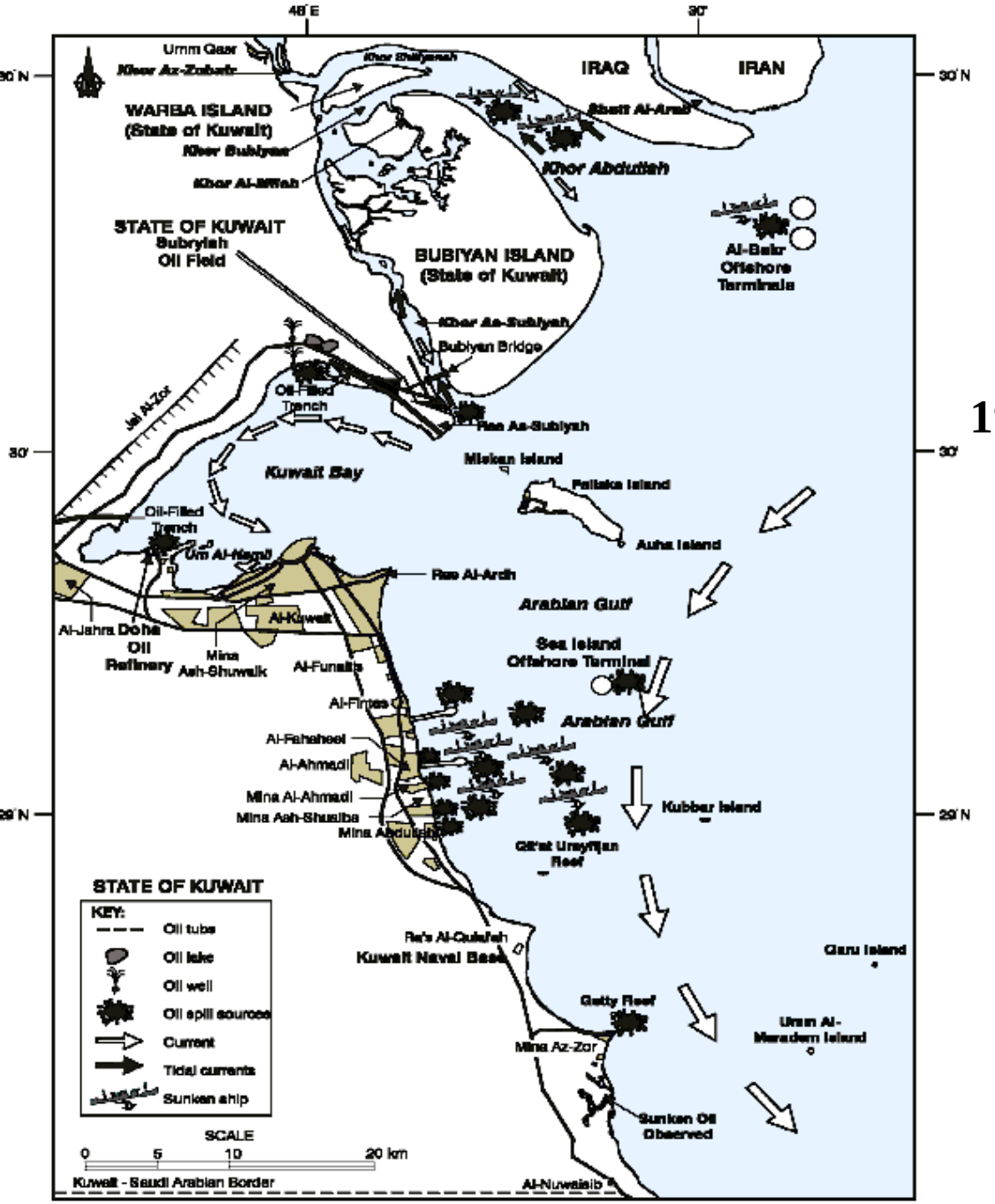
15/2/1991



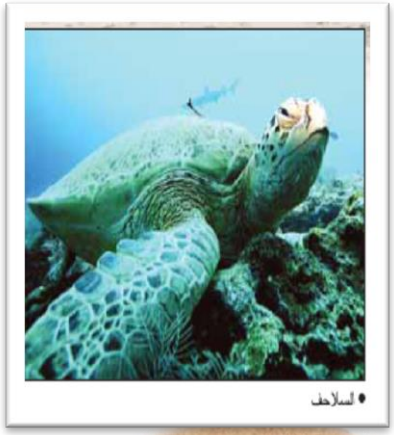
28/4/1991



كارثة حرائق النفط – الكويت 25 فبراير 1991



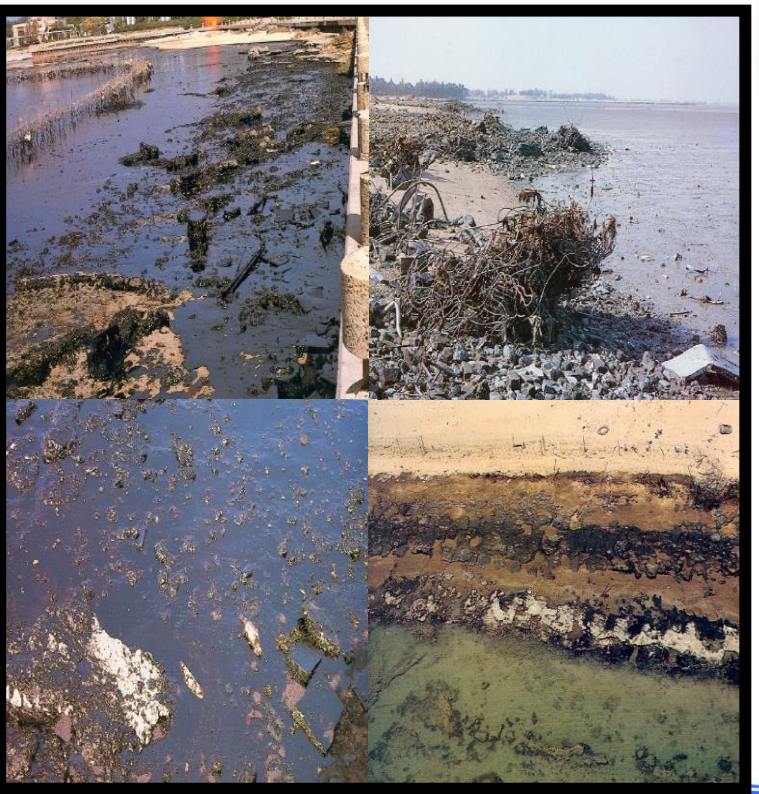
1991 Gulf war oil releases sources locations (Source: Ecology & Environment and Dr J.M. Al-Hassan, 1994)

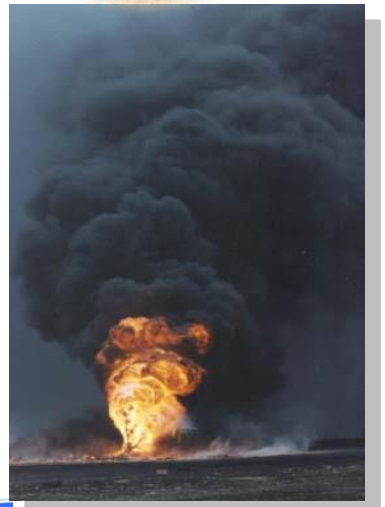


● السلاحف

● الاسماك الرجانية

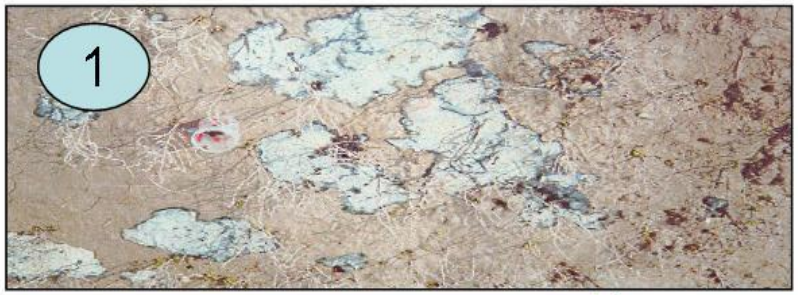
● قنديل البحر

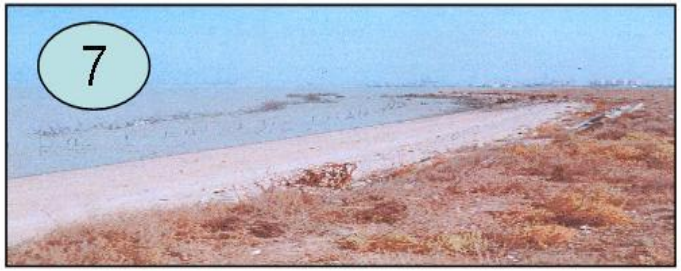




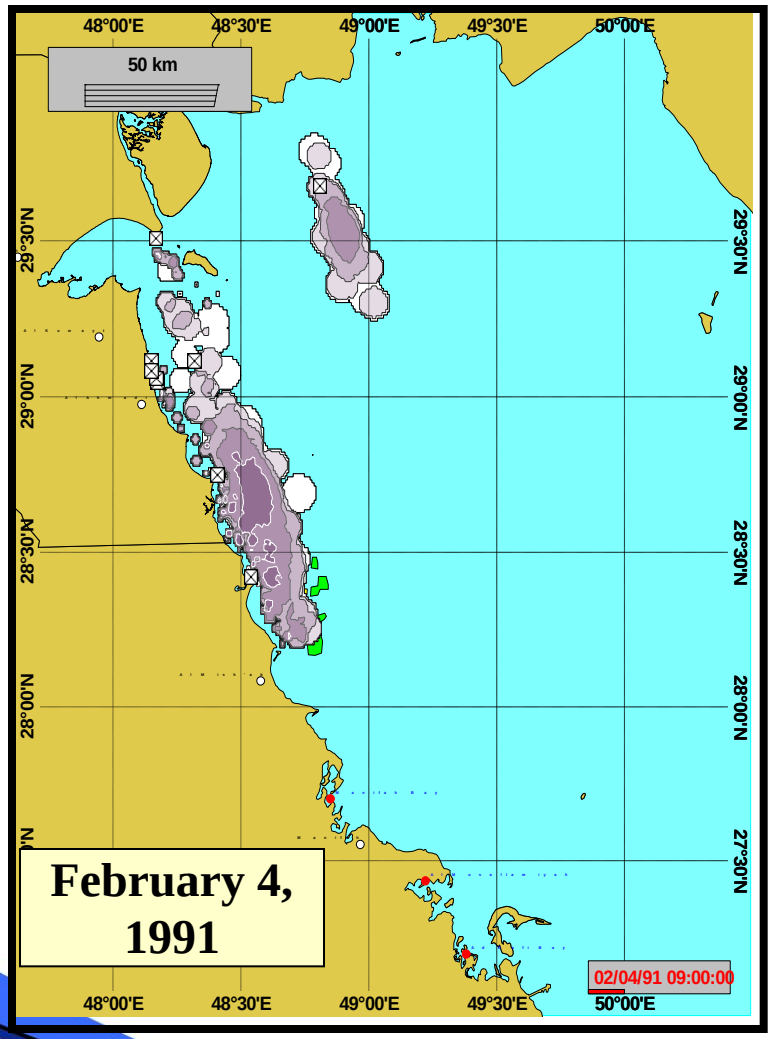



The Iraqi Invaders looted or ruined sewage pumping stations causing raw sewage to be discharged directly into Kuwait Bay

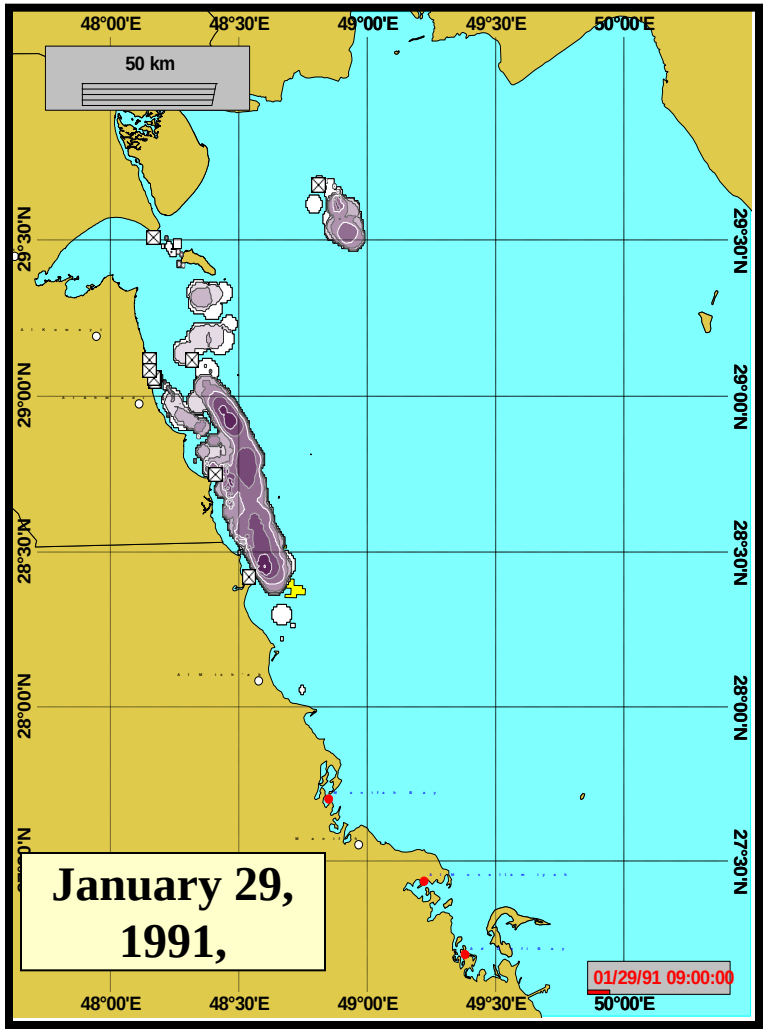




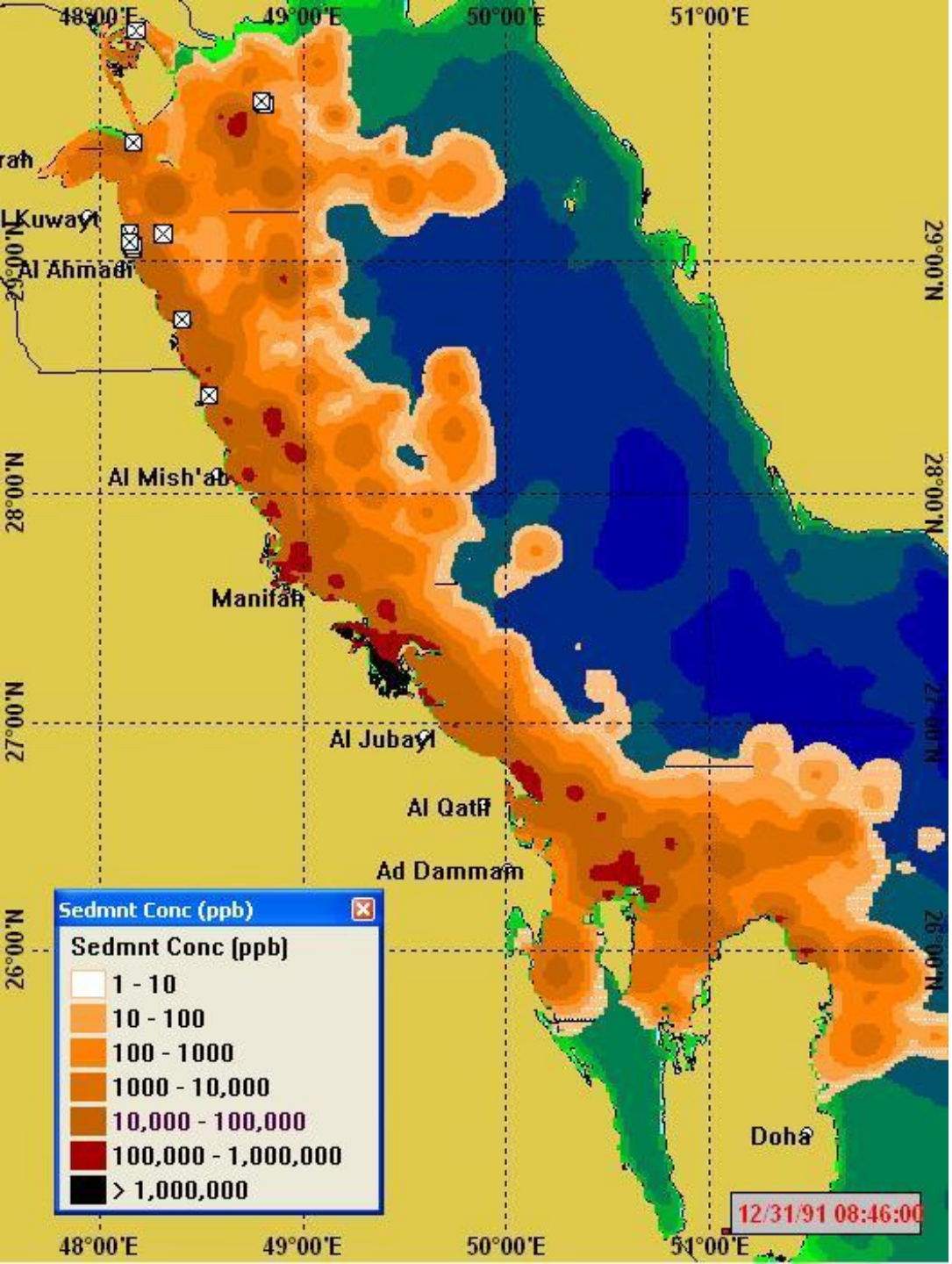
Simulated surface oil distribution compared with remotely sensed observations of the southernmost edge of the slick.



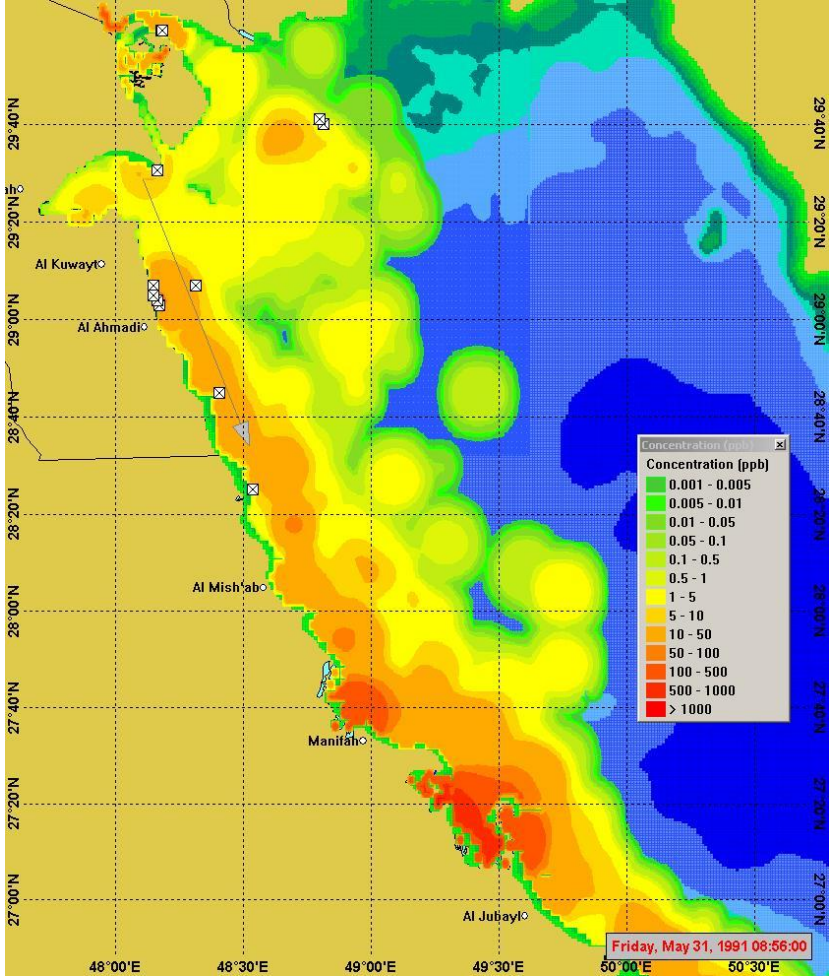
(green polygons, partially covered by oil).

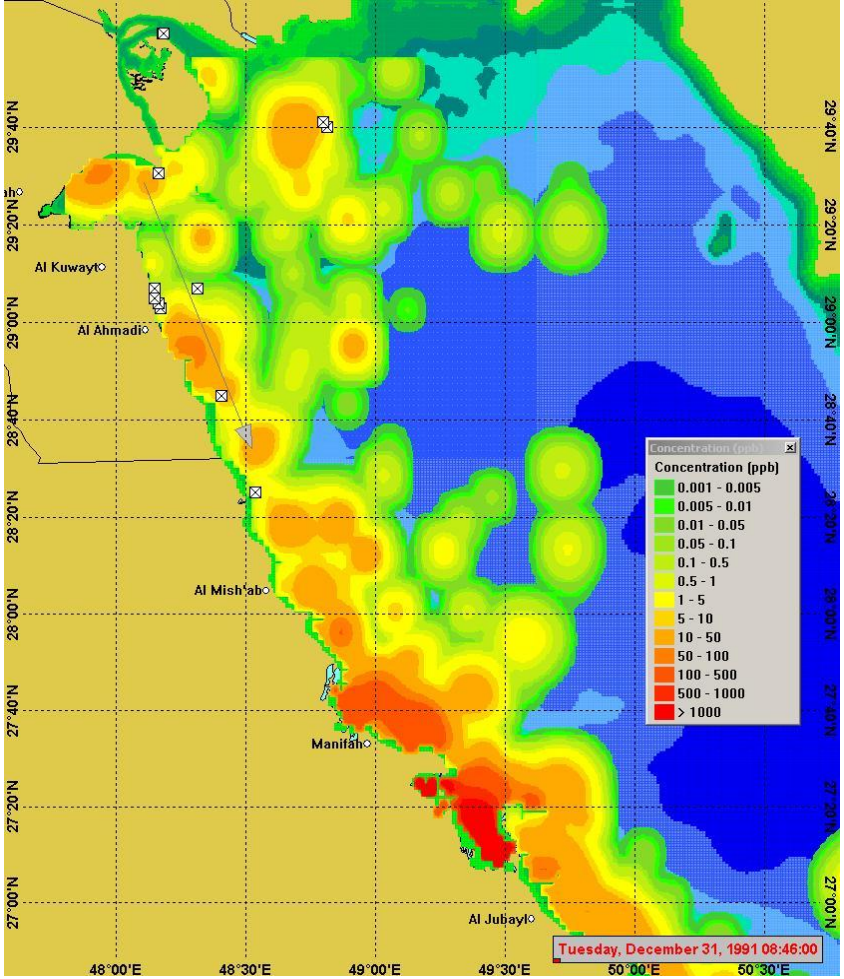


Yellow polygons, partially covered by oil

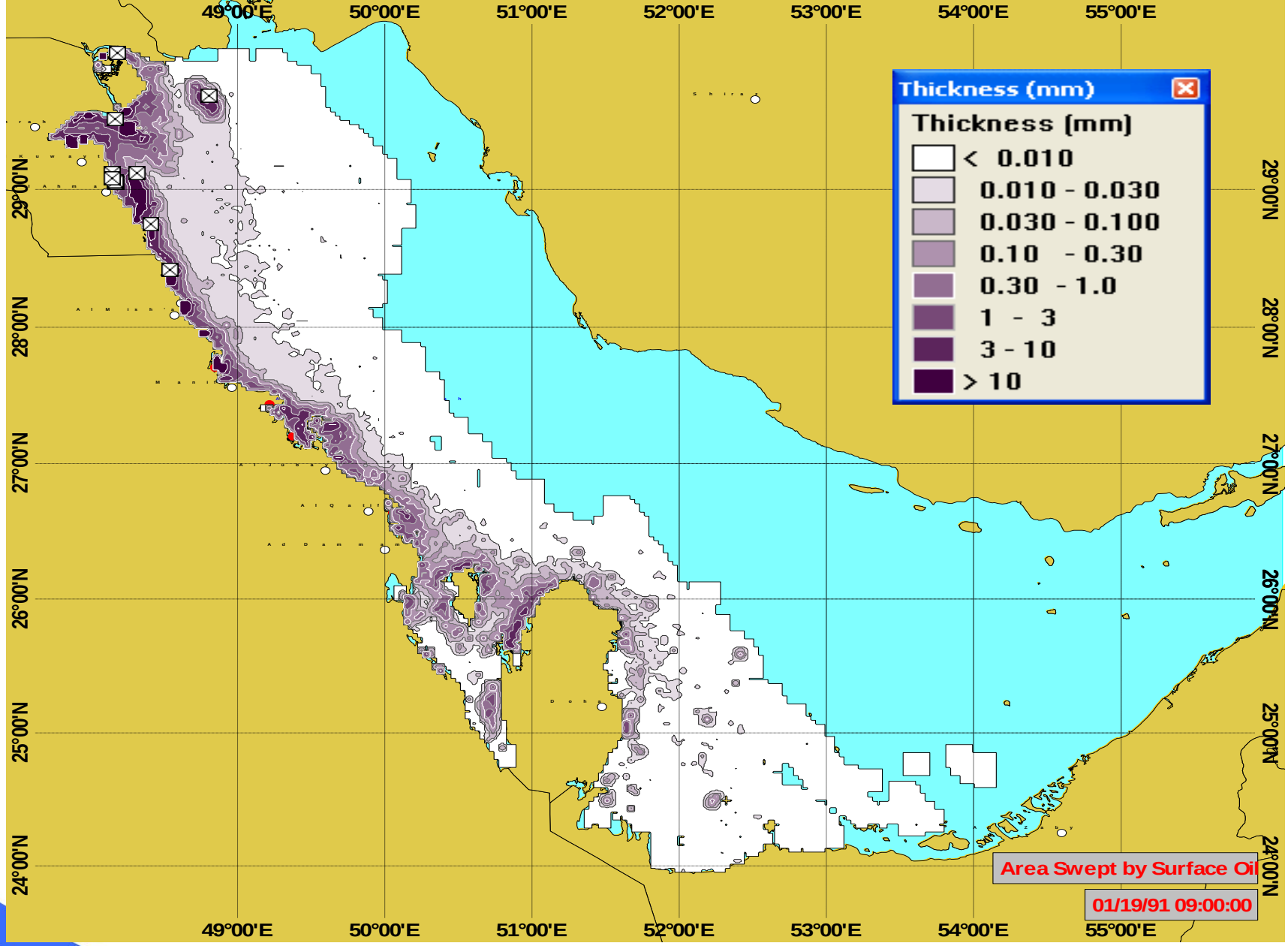


Modelled distribution of total hydrocarbon concentrations in the sediments as of December 31, 1991

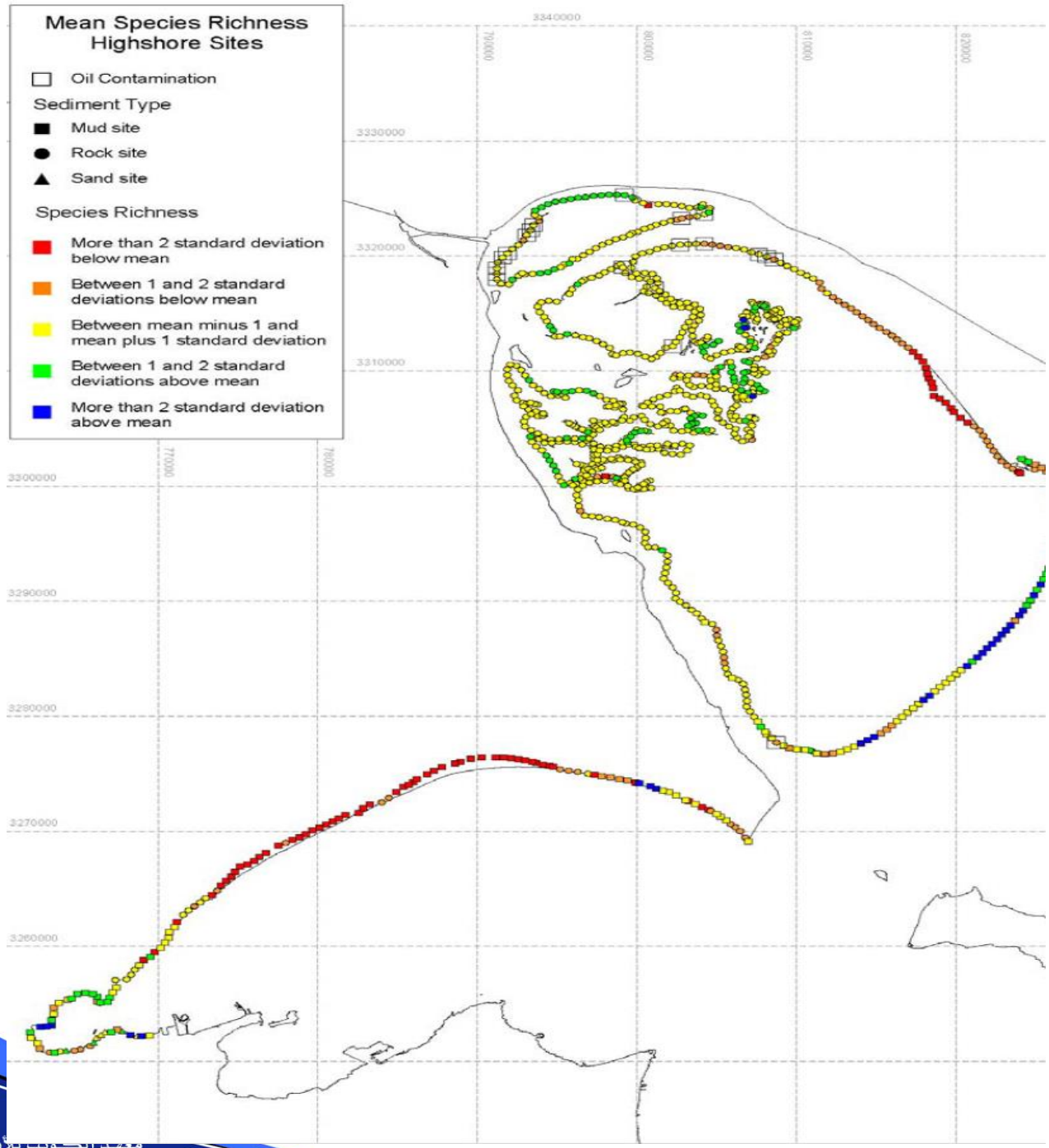


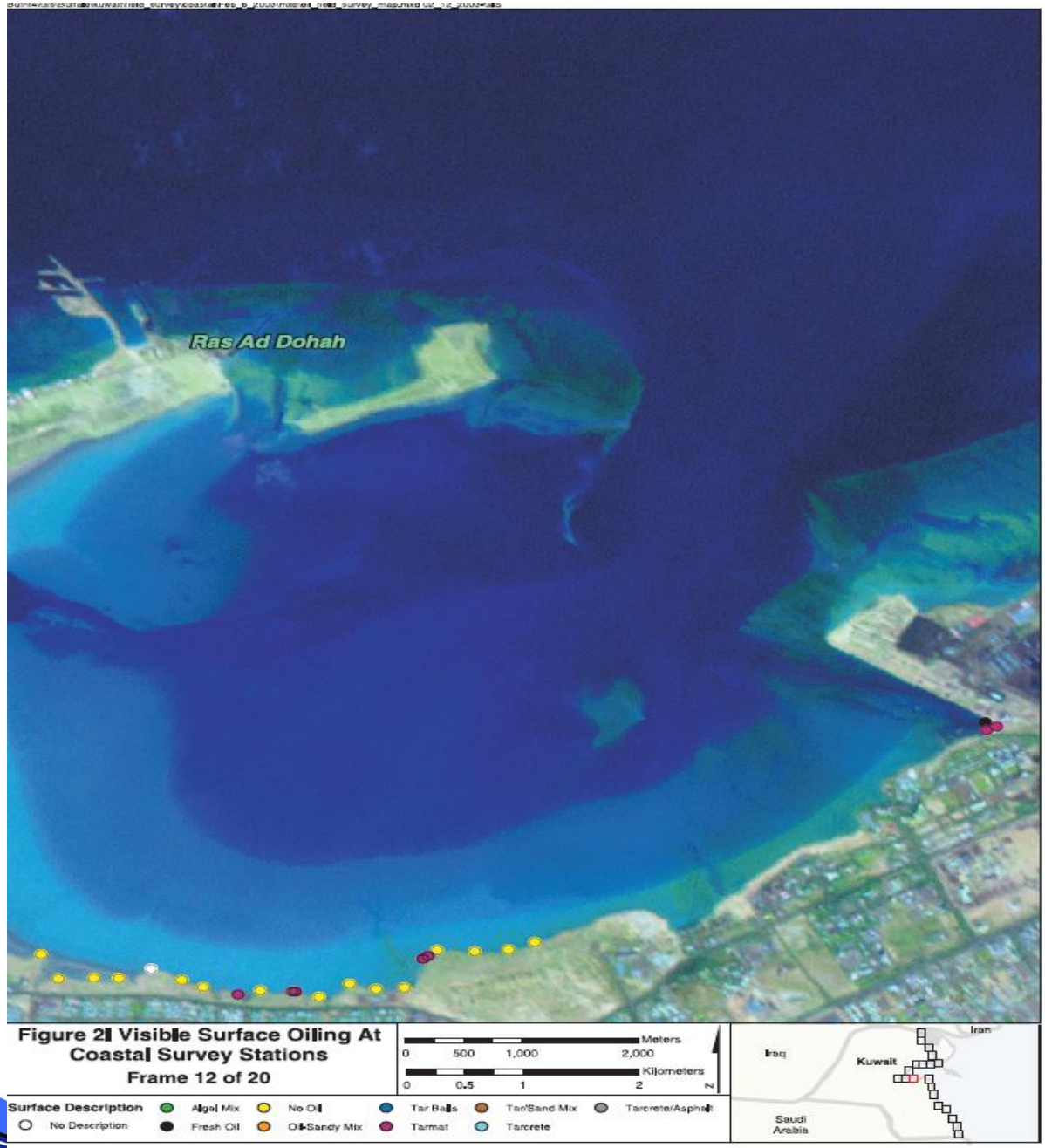


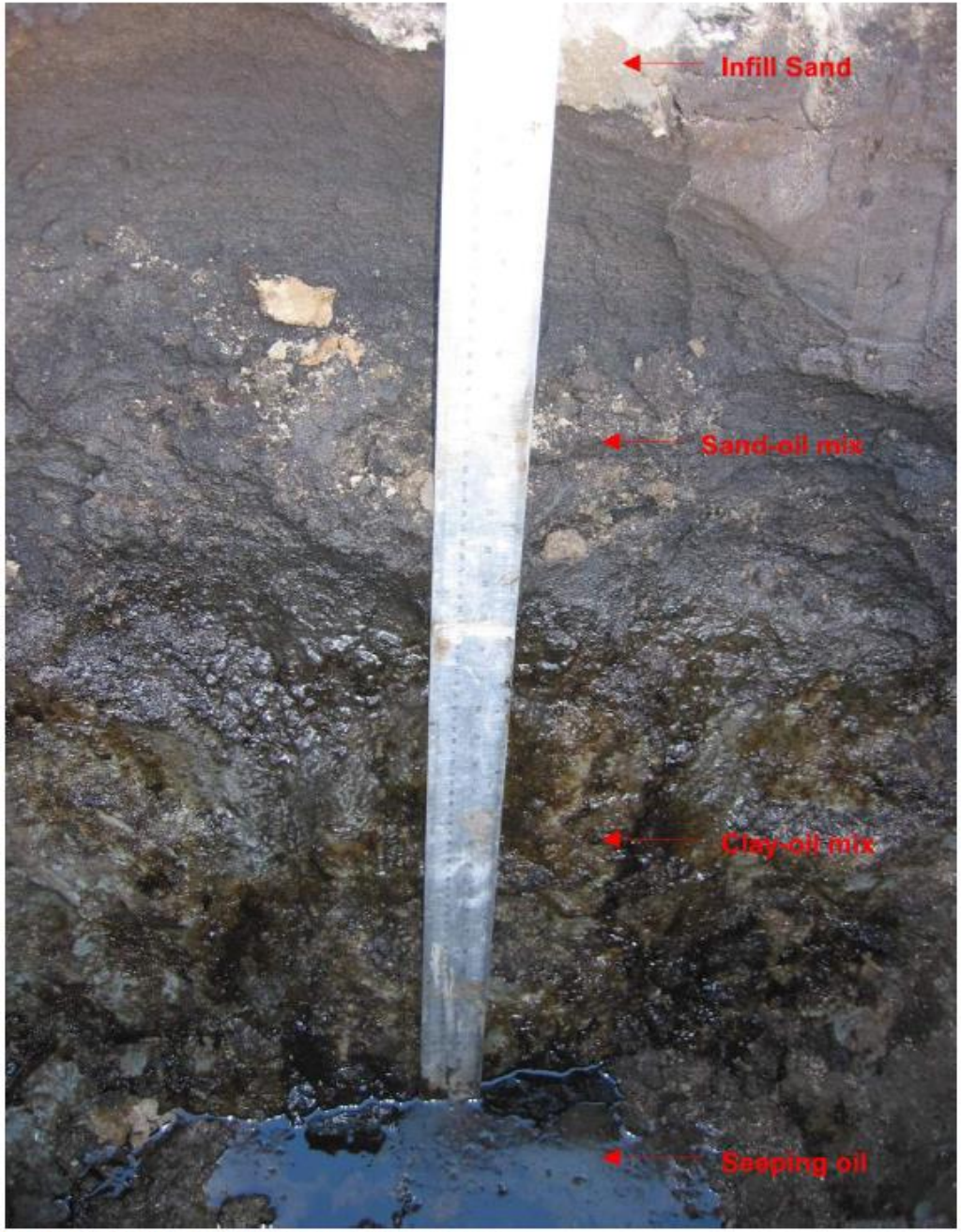
Modelled concentration of water-accommodated fraction (WAF) of hydrocarbons on May 31 (left) and December 31, 1991. Maximum values in Kuwaiti waters are about 40 ppb above background.



Total area swept by surface oil slicks during the 700 day simulation.


Mean Species Richness
Highshore Sites
Oil Contamination
Sediment Type
Mud site
Rock site
Sand site
Species Richness
More than 2 standard deviation below mean
Between 1 and 2 standard deviations below mean
Between mean minus 1 and mean plus 1 standard deviation
Between 1 and 2 standard deviations above mean
More than 2 standard deviation above mean
3340000
3330000
3320000
3310000
3300000
3290000
3280000
3270000
3260000
790000
800000
810000
820000
770000
760000


Ras Ad Dohah
Figure 2I Visible Surface Oiling At Coastal Survey Stations
Frame 12 of 20
Meters
0 500 1,000 2,000
Kilometers
0 0.5 1 2
N
Surface Description
No Description
Algal Mix
Fresh Oil
No Oil
Oil-Sandy Mix
Tar Balls
Tarmat
Tar/Sand Mix
Tarcrete
Tarcrete/Asphalt
Iran
Iraq
Kuwait
Saudi Arabia

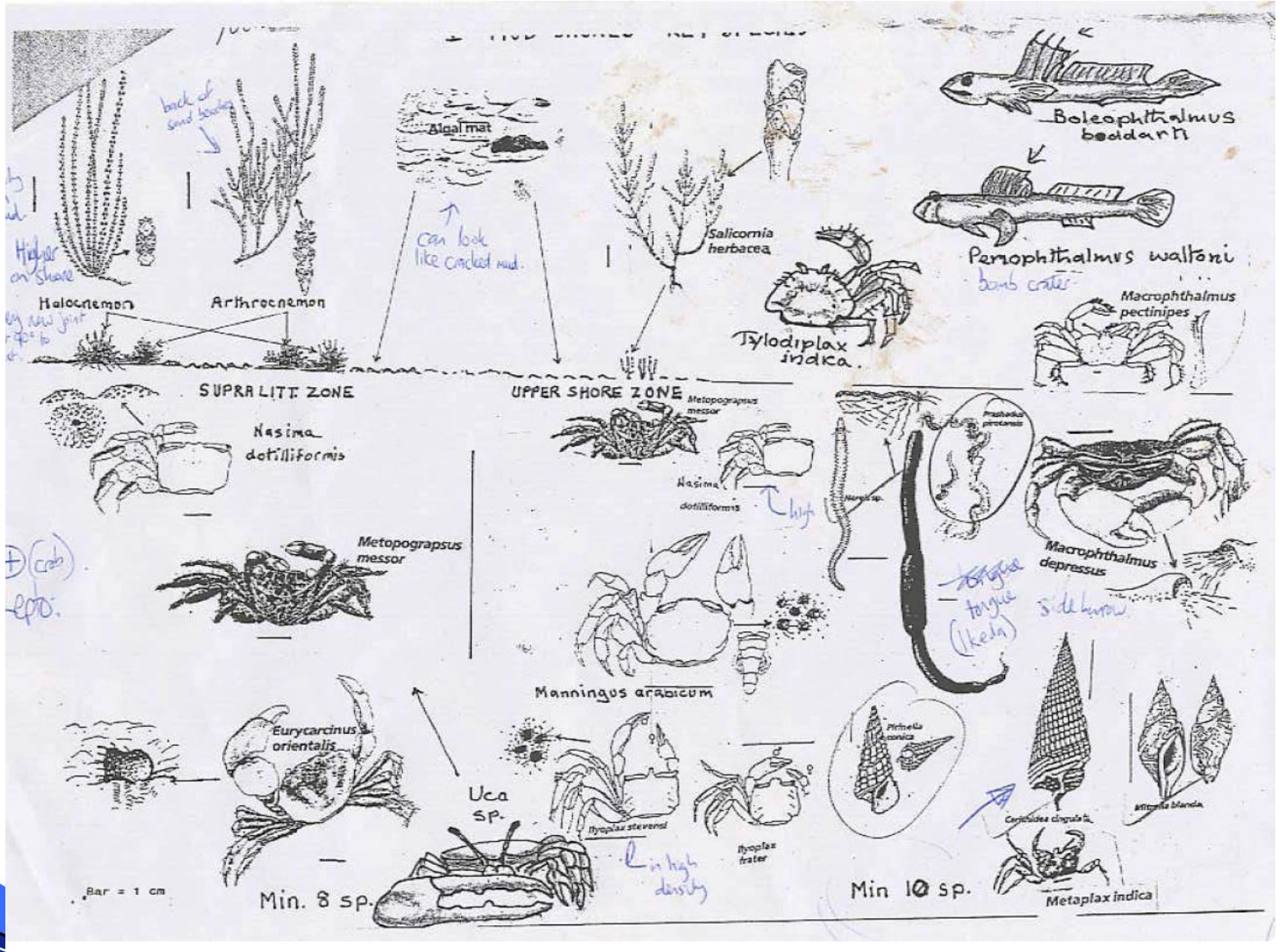


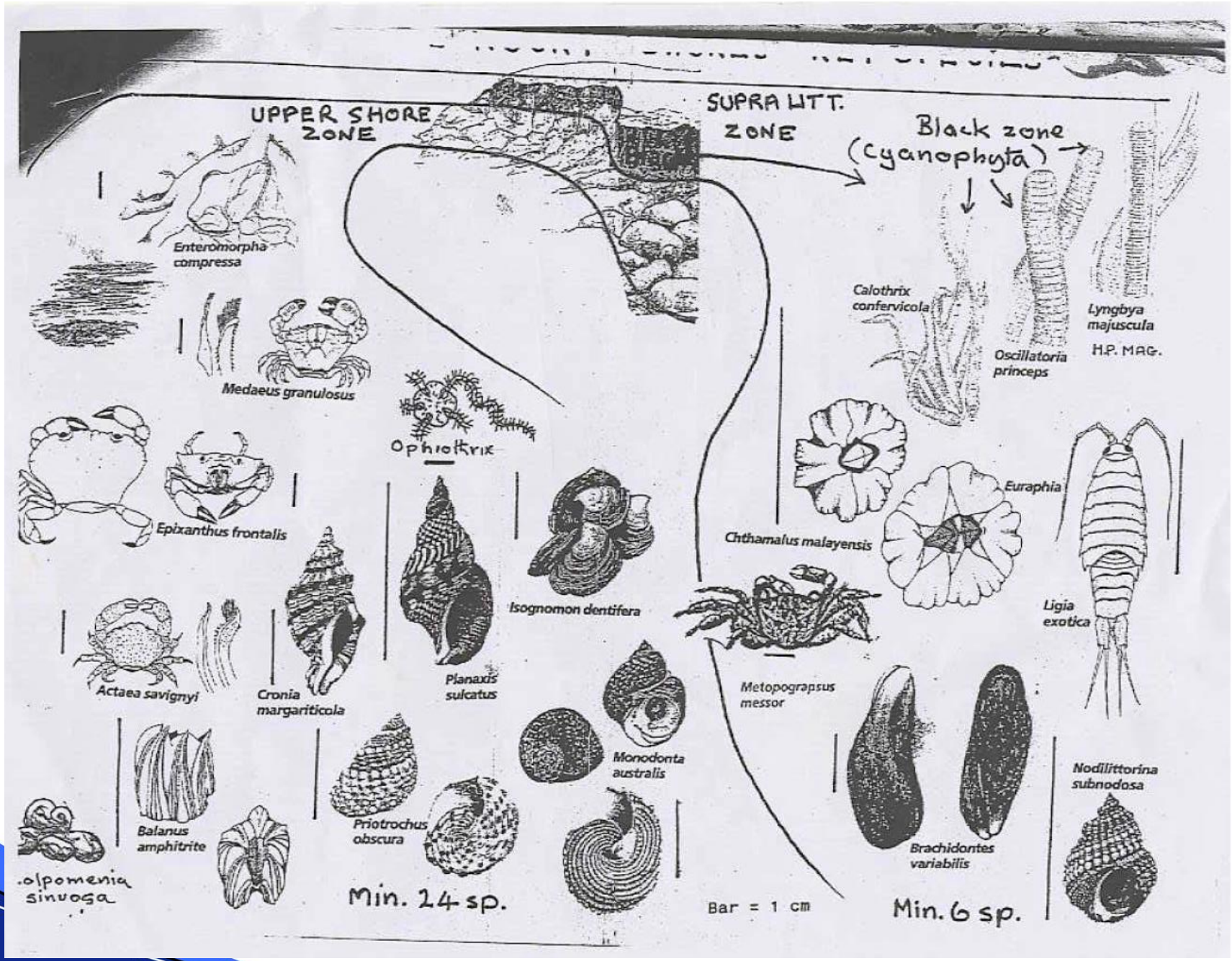
Photograph 19 *Subiyah* oil trench excavation.

Photograph 4 Coastal weathered oil deposit.

Photograph 12 Excavation T1342 CS, northern Kuwait Bay oil deposit.

Photograph 12 Excavation T1342 CS, northern Kuwait Bay oil deposit.





Percentages of Stations and Transects Where TPH Was Detected

Location	Percentage of Stations with TPH detected	Percentage of Transects with TPH detected
South Coast	94	99
Khiran Inlets	93	99
Kuwait Bay	94	99
Khor As Subiyah	84	98
Bubyan Island	81	93
Warbah Island	93	100
All Kuwait	87	96

Contaminated Shoreline Areas by Beach Type

Beach Type	Area (square kilometers)
Sand	24.8
Mud	445.8

Contaminated Shoreline Segment Areas

Coastal Segment	Beach Type	Area (MOD Charts) (square kilometers)
An Nuwaysib to Ras al Ardh	Sand	24.1
Khiran inlets	Sand	0.7
Kuwait Bay	Mud	247.5
Khor as Subiyah	Mud	18.8
Bubyan Island	Mud	167.2
Warbah Island	Mud	12.2
TOTAL		470.5

Observations

- **Macro faunal diversity was affected and impoverished at later stage (3 years after the spill)**
- **Mud flats and sand beaches had low diversities and were extended to khor As Subiya**
- **It was suggested that impacts was more intensive compared to prediction at that time.**

observations

- Results from 2002/2003 surveys showed an overall mean diversity of 1.3. in contrast the 1985 survey from similar sites gave a mean diversity of 1.44
- Upper shores with lower indices in 2002/2003 than in 1985 included north Kuwait bay, Sulaibikhat, Shuwaikh, Fintas, mina abdullah ,doha , Al Zour and khor as Subiyah.

CASE STUDY NO. 2

Foraminifera and ostracods close to kubber island

After Dr. E. Al-Enezi

Station	TOC	Pesticide	Trace metal					Normal foram	Deformed	Diversity
			Al%	Cu%	Fe%	Ni%	V%			
Ranges	0.93-3.6	8.45-4615	8.7-59.4	5.8-62	1.2-28.4	11.4-60	9.1-78.4	272-6452	0.04-0.36	5-12.7
St.1	+++	++++	++	+++	++	++	++	++	+++	++
St.2	++	++++	+	++++	+	+	+	++++	++	++
St.3	+++	++	++	+	++	+++	++	+++	+++	++
Mah	++	+	+++	++++	+++	++++	++++	++++	++++	+++
Mab	+	+	+	+++	+	+	+	++	++	+++
Kh	+++	+	++++	+++	++++	+	+	+	+	++
Ku	++++	+	++	+	+++	+++	++	++	+++	++
S	+++	+	+	+	++	+++	++	++	+++	+++

+ Low value

++ Moderately

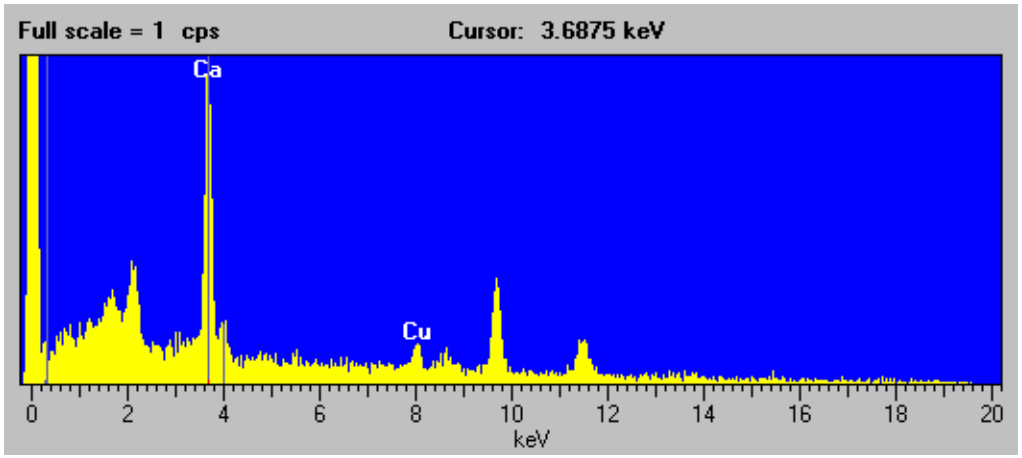
+++ High

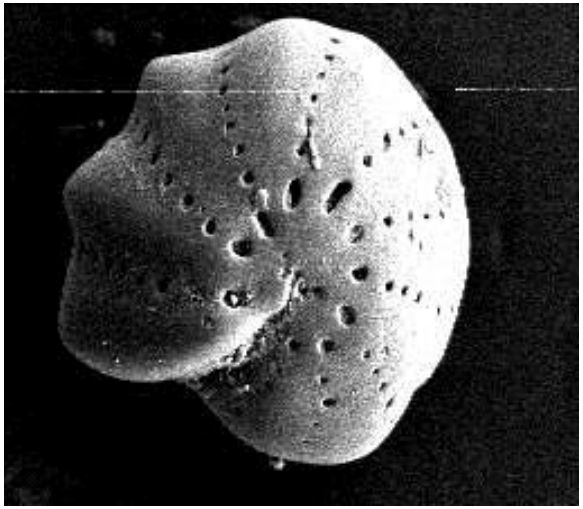
++++ very high

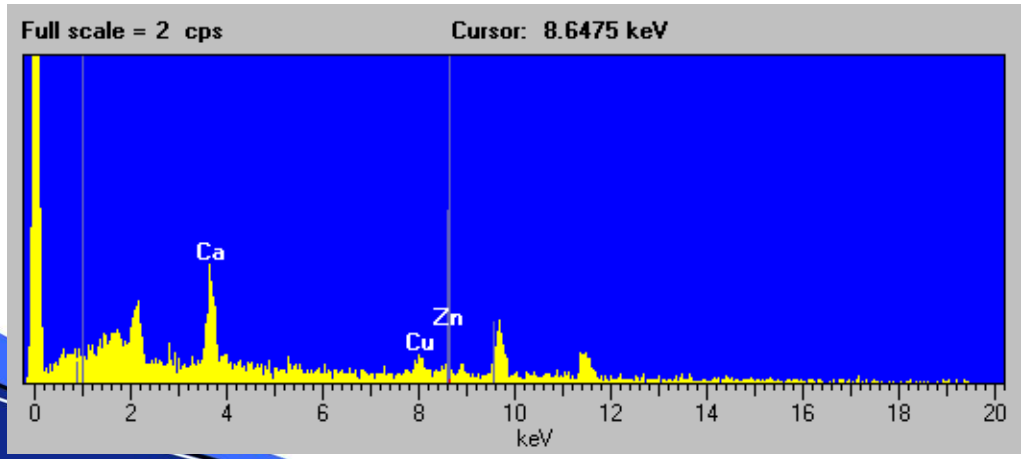
Impact of pollution

Energy Dispersal Spectroscope

(EDS)

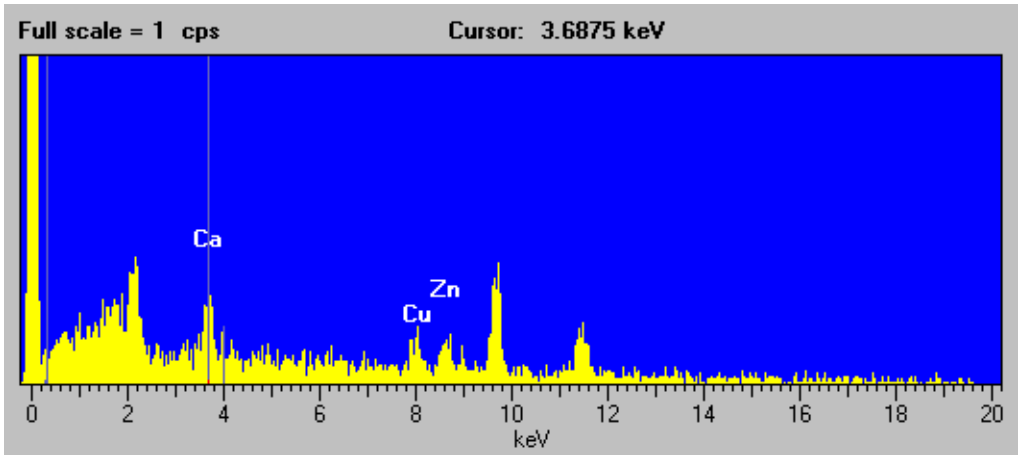


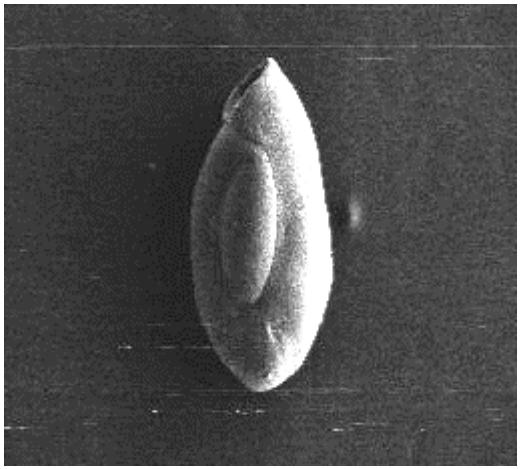


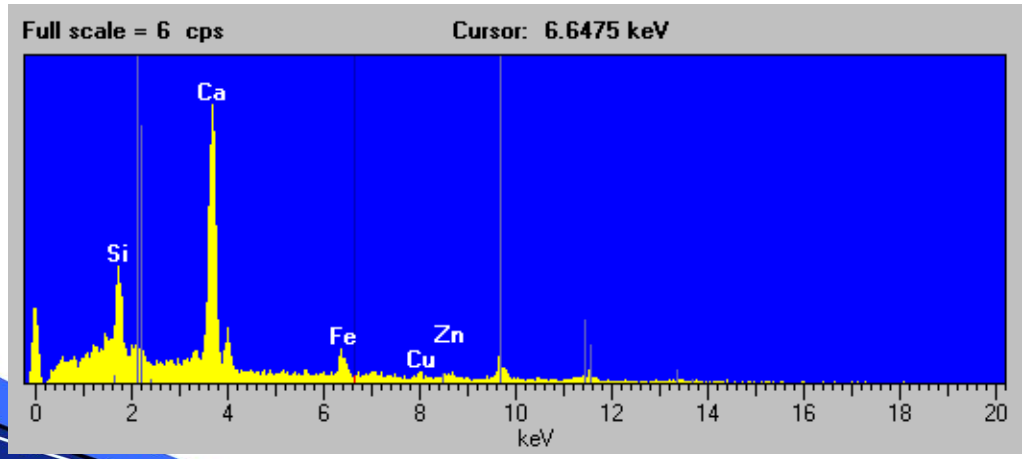


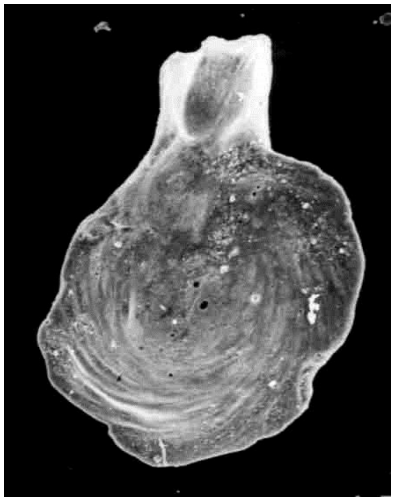
Impact of pollution

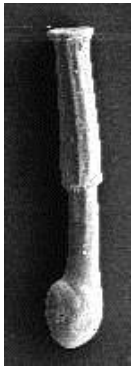
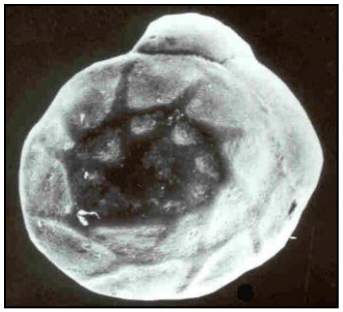
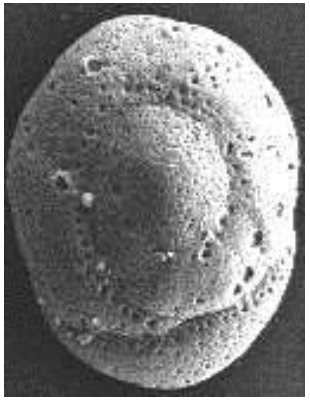
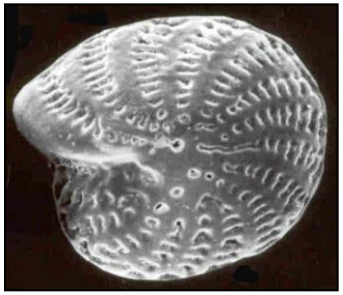
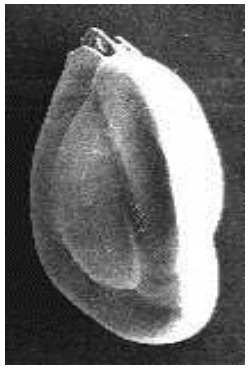
Energy Dispersal Spectroscope (EDS)









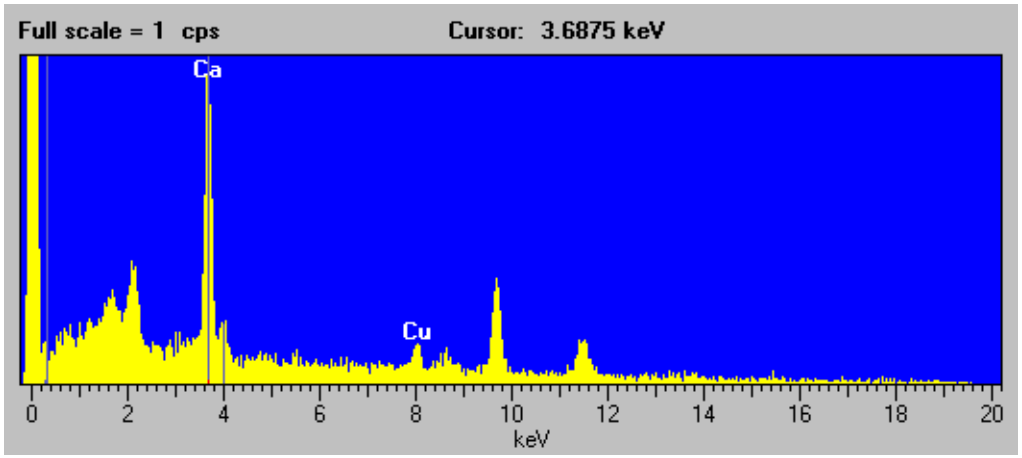







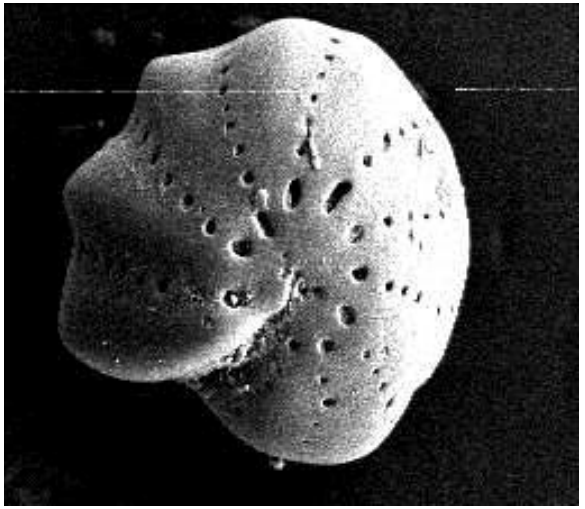

Quinloculina sp, _Adelosina_ Sp., _Spiroloculina_ sp., _Triloculina_ sp. and _Ammonia_Sp. As indicator to polluted by trace metals (V,Cr,Cu)

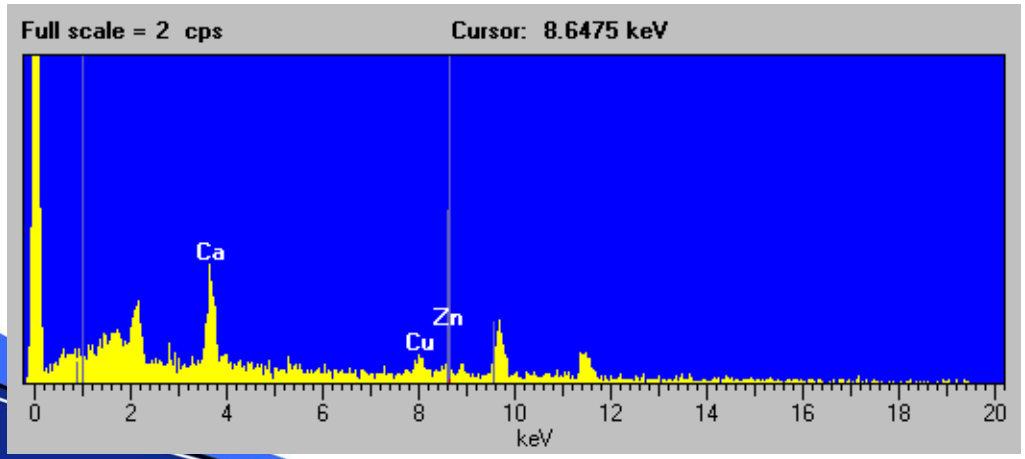
Impact of pollution

Energy Dispersal Spectroscope

(EDS)

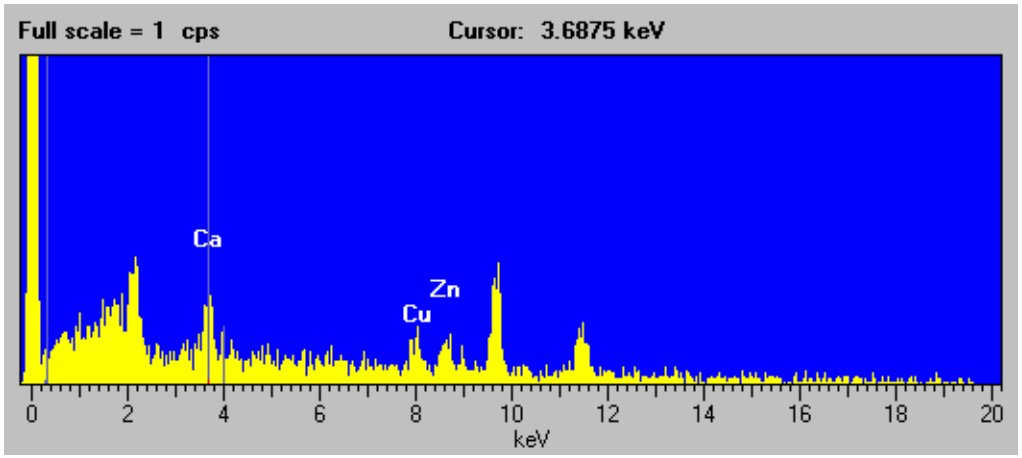


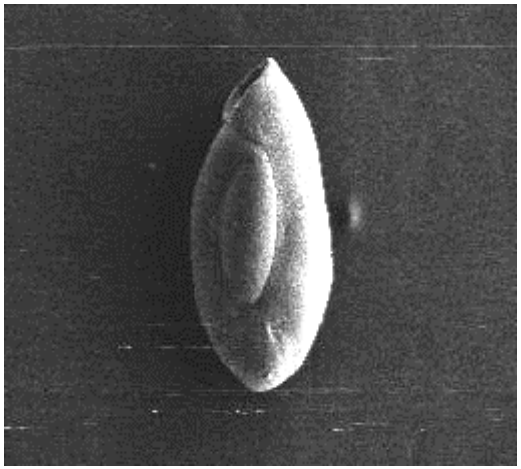


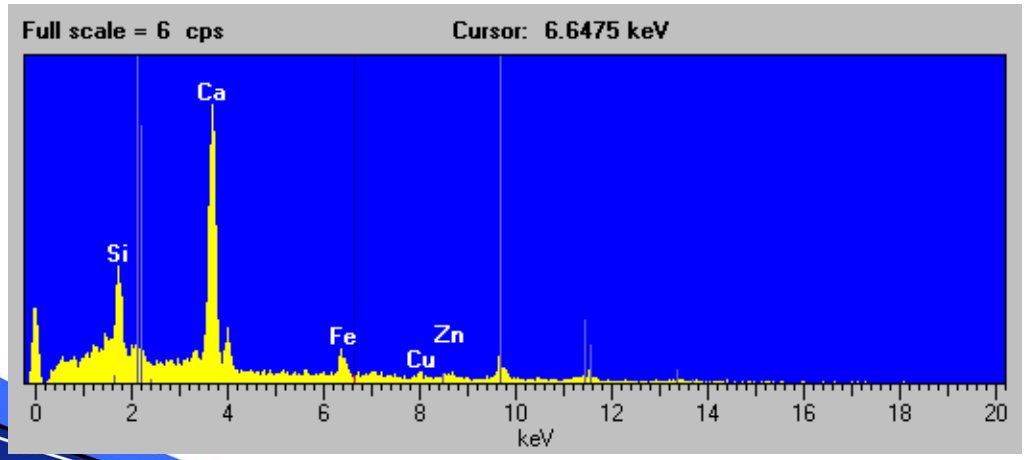


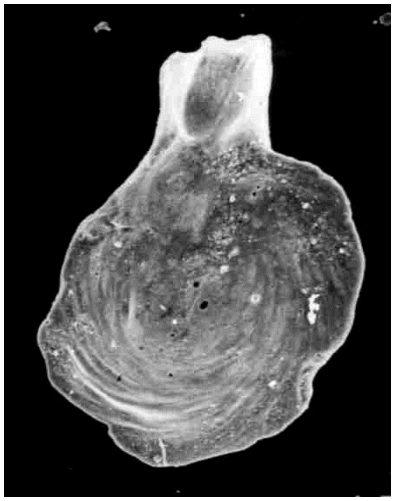
Impact of pollution

Energy Dispersal Spectroscope (EDS)









Factors	Correlation	Effect	Common Species
Salinity	Positive	Size/Diversity/ Production/Deform	*Peneroplis planatus, Coscinospira hemprichii*
Temperature	Positive	Abundance of Foraminifera	*Q.spp, Adelosina ssp.Ammonia ssp*
pH & Dissolved Oxygen	Positive	Abundance of Foraminifera	------
Depth	Positive	Abundance of Foraminifera	*All Species*
CaCO3	Positive	Increase size Abundance	*Calcareous foraminiifera*
Fine Sediment	Positive	Size & Diversity	*All species*
TOC	Negative	Deform species/ Less Abundance	*Ammonia ssp, Operculina complanata*
Trace Metals	Negative	Deform species/ Less Abundance	*Q.spp, Adelosina ssp.Ammonia ssp*
Pesticides	Negative	Less Abundance	*All species*

Culture

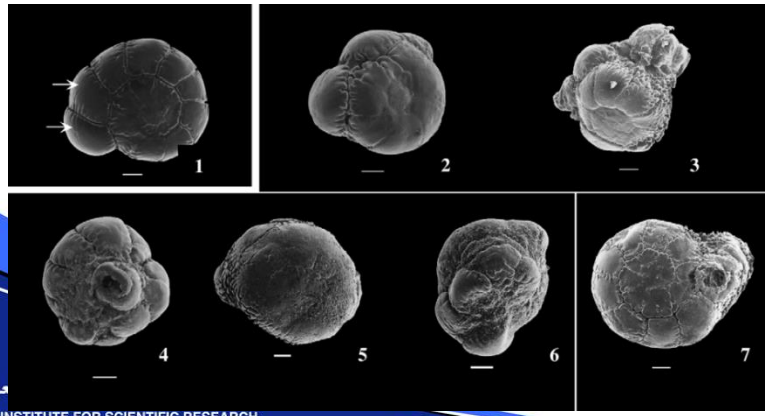
experiments with trace element

Cu (10-500 µg/l) – up to 1 year

Two species (*Ammonia beccarii* and *Ammonia tepida*)

Effects:

- increasing delay before reproduction and decreasing number of juveniles, explaining low density
- increasing proportion of deformed tests
- cytological modifications (i·e· thickening of the organic lining, proliferation of fibrillar and of large lipidic vesicles, increased number of residual bodies) occurred only in deformed specimens

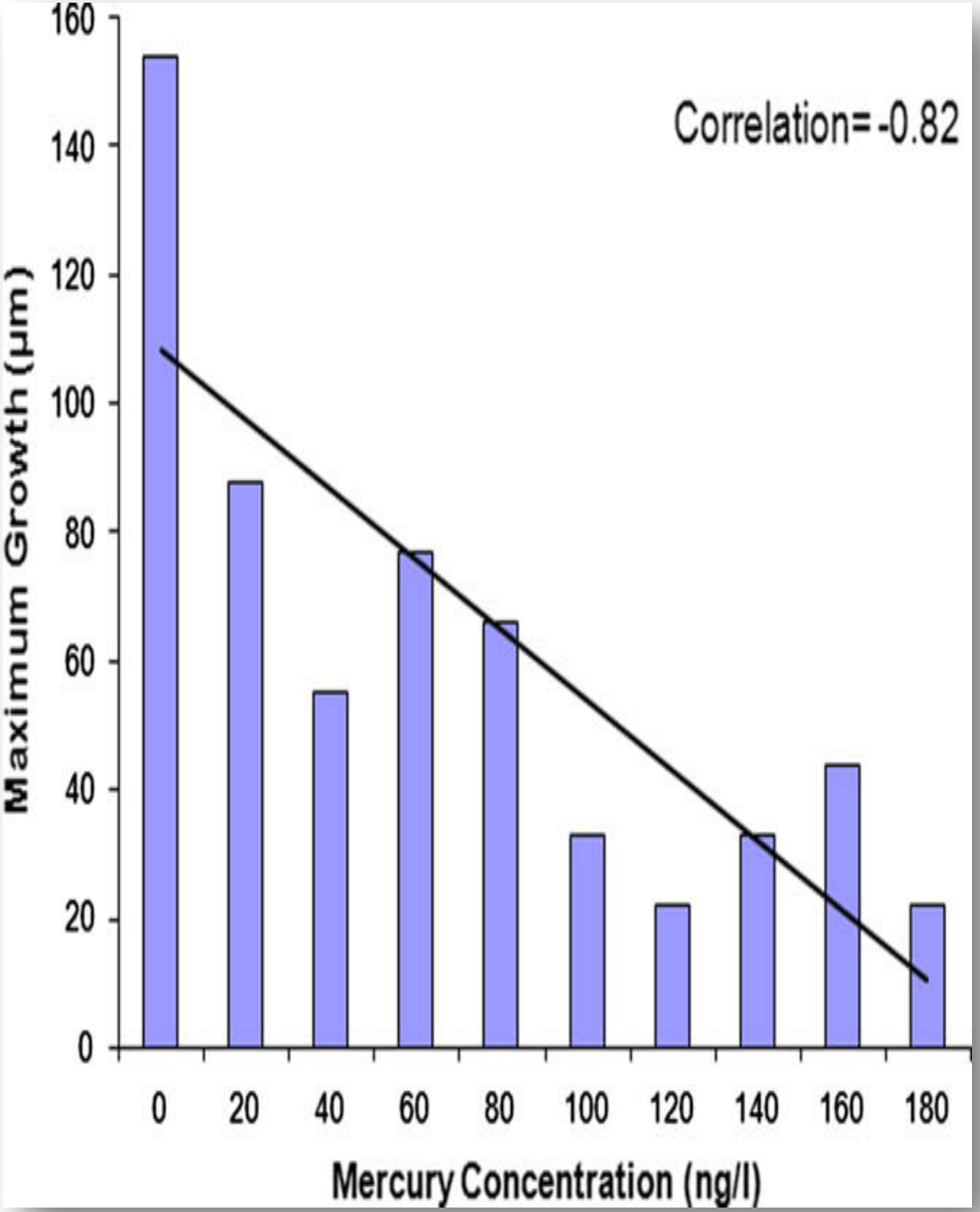


from Le Cadre and Debenay (2006)

Culture

experiments with trace element

Hg (0-260 ng/l) – up to 180 days

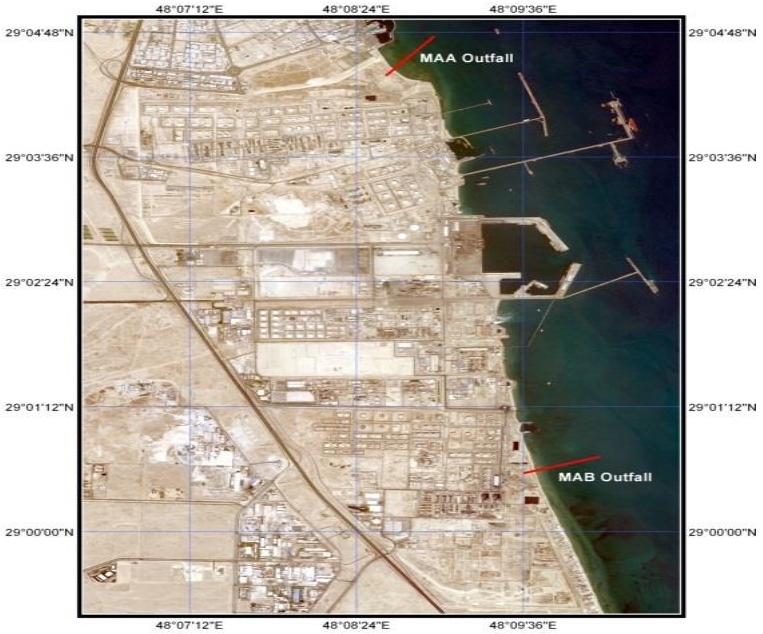


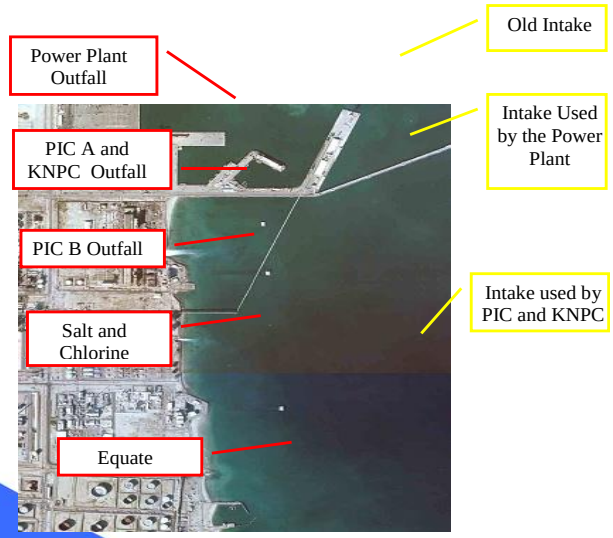
from Saraswat et al. (2004)

CASE STUDY NO. 3

KNPC project

After Dr. Saif Uddin and Al-Ghadban


48°07'12"E
48°08'24"E
48°09'36"E
29°04'48"N
29°03'36"N
29°02'24"N
29°01'12"N
29°00'00"N
MAA Outfall
MAB Outfall


Power Plant Outfall
Old Intake
Intake Used by the Power Plant
PIC A and KNPC Outfall
PIC B Outfall
Intake used by PIC and KNPC
Salt and Chlorine
Equate

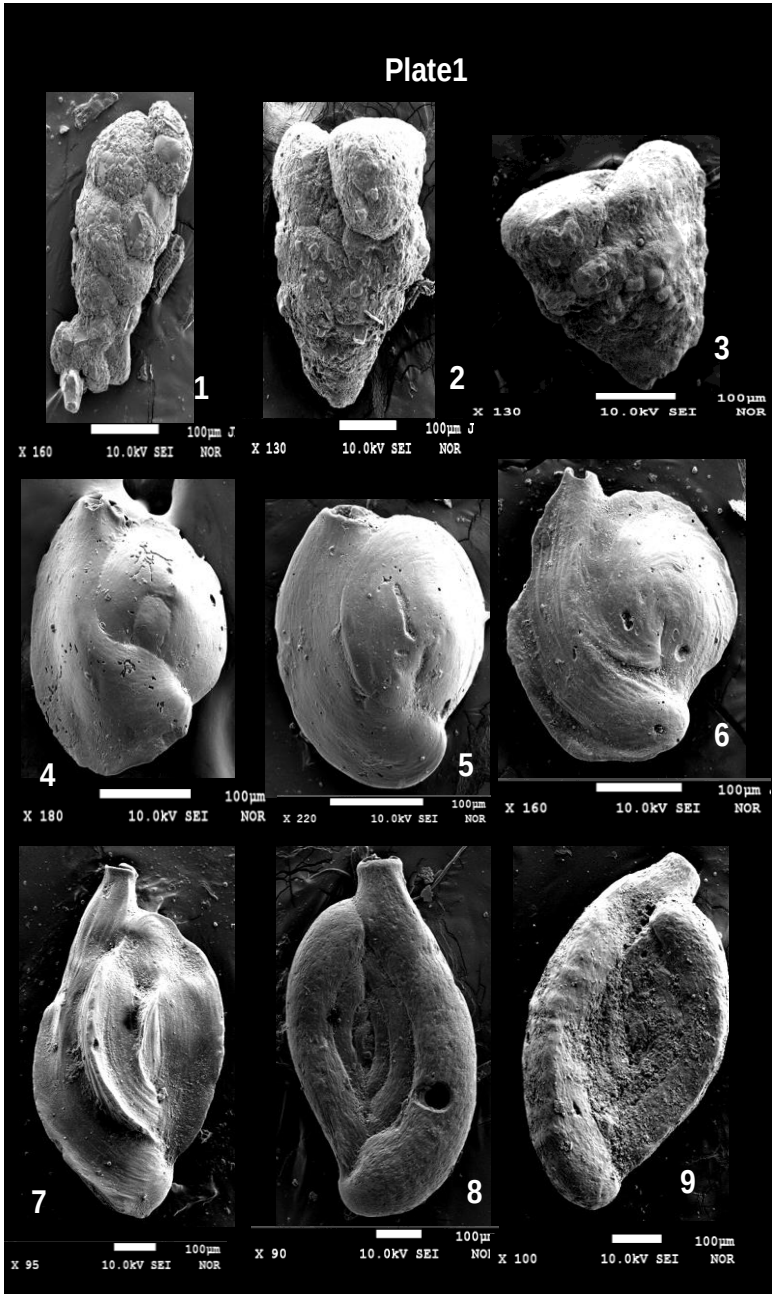
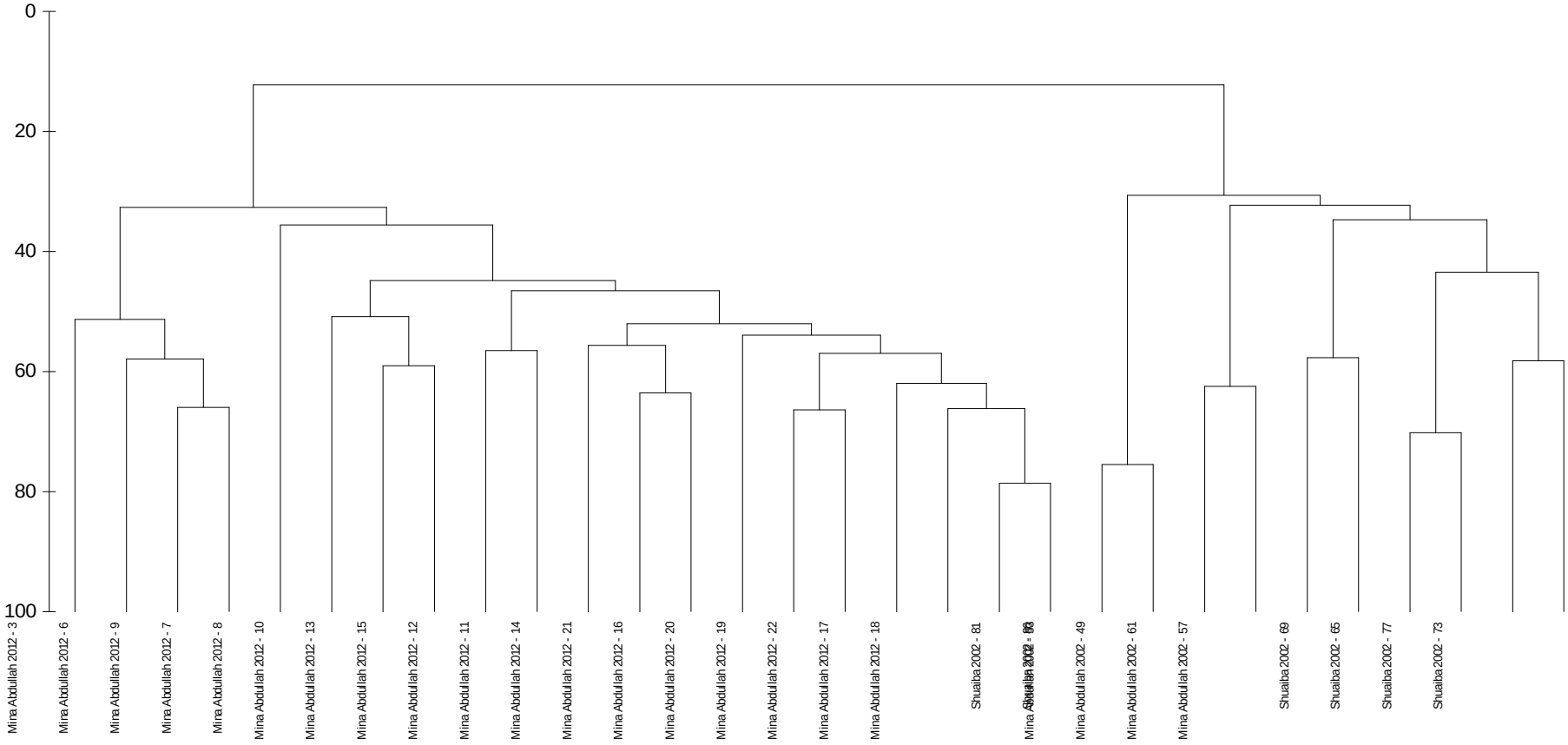
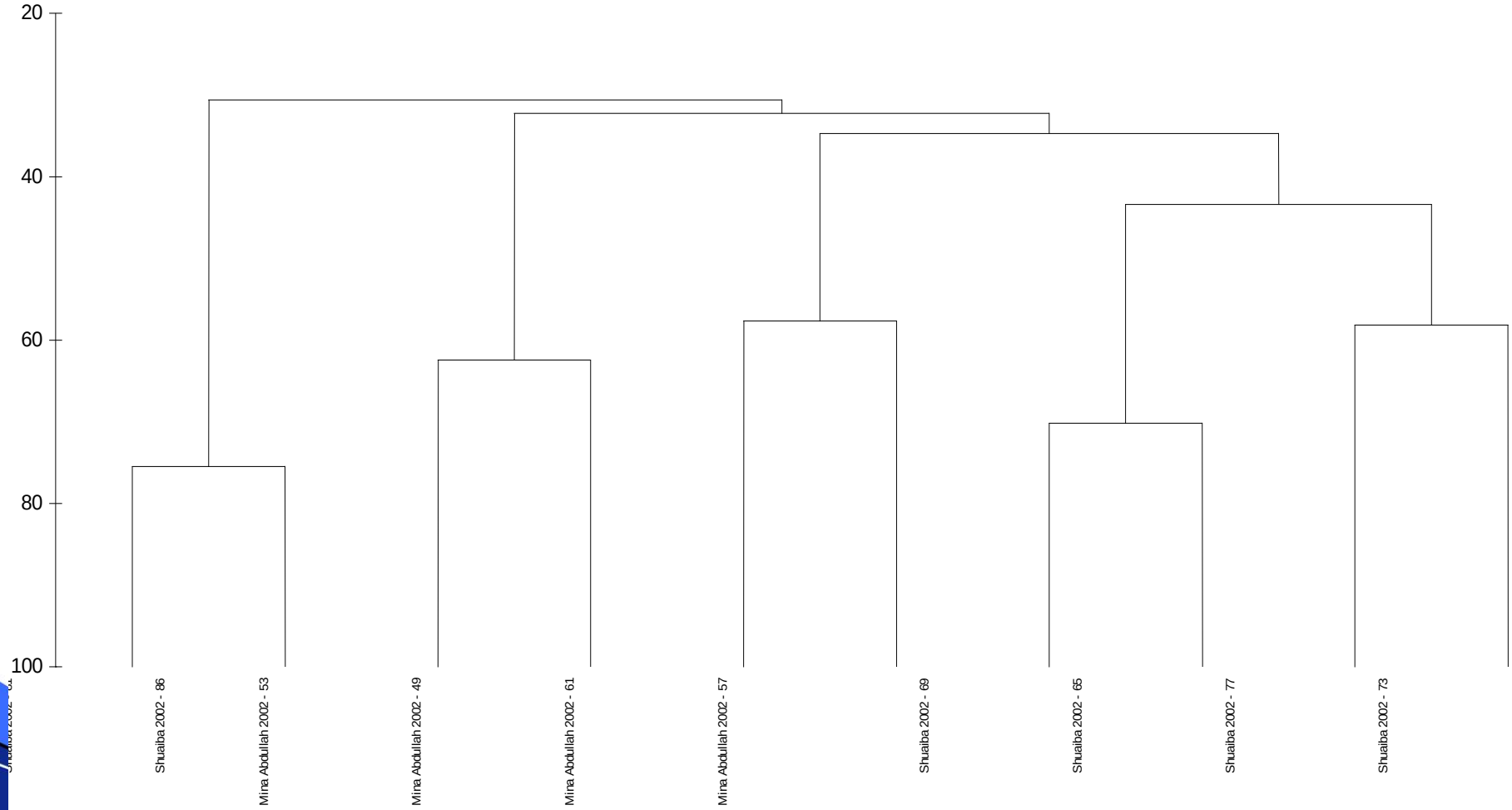


Plate1
1
X 160 10.0kV SEI NOR
2
X 130 10.0kV SEI NOR
3
X 130 10.0kV SEI NOR
4
X 180 10.0kV SEI NOR
5
X 220 10.0kV SEI NOR
6
X 160 10.0kV SEI NOR
7
X 95 10.0kV SEI NOR
8
X 90 10.0kV SEI
9
X 100 10.0kV SEI NOR

Mina Abdullah/Shuaiba 2002 data combined Mina Abdullah 2012 and Mina Shuaiba per station; Bray-Curtis similarity (Forth-root transformed)



Mina Abdullah/Shaiba 2002 data per station; Bray-Curtis similarity (Forth-root transformed).



Mina Abdullah/Shuaiba 2002 Univariate Analyses per Station

Transect/ Sample	No. of Species	No. of individuals	Richness	Pielou's Eveness	H'- Shannon Wiener (log2)	Simpson diversity
M. Abdullah 53	10	53	**2.267**	0.757	2.516	0.774
M. Abdullah 49	6	104	**1.077**	0.579	1.498	0.515
M. Abdullah 61	24	189	**4.388**	0.798	3.660	0.878
M. Abdullah 57	23	114	**4.645**	0.785	3.551	0.859
Shuaiba 69	18	147	**3.407**	0.750	3.128	0.839
Shuaiba 65	19	148	**3.602**	0.769	3.266	0.849
Shuaiba 77	21	130	**4.109**	0.816	3.583	0.877
Shuaiba 73	20	194	**3.607**	0.754	3.257	0.842
Shuaiba 81	6	53	**1.259**	0.629	1.626	0.601
Shuaiba 86	6	32	**1.443**	0.796	2.058	0.738

- Comparing species richness and abundance levels found in the present surveys with similar data for surveys in 2002 and elsewhere in the western Gulf. **It is immediately obvious that species richness found during present surveys was the lowest recorded for the western Gulf.**
- **Overall mean benthic species richness was 66 ranging from 28 in Kuwait Bay to 150 species in the south of Kuwait in the UNCC surveys of 2002-2005 (UNCC, 2005). These surveys collected over 900 species of benthic macrofauna. .**

- **Significant biodiversity intervention was observed in Sabah Al-Ahmed Sea city, only 8 mo after exposing new artificially created benthos to the open sea, 33 macrospecies settled in the A3 waterways in Sabah Al-Ahmad Sea City, south Kuwait. Within 2 y species richness in A3 has grown to a mean of 63.5 species with an abundance of 19,404 m^{-2} . Hence, the potential colonization rate of the benthos by marine life in Kuwait is high, providing the substrata is unpolluted. Initially, opportunistic species settled in high abundances, as seen in Sea City waterways when first opened to the sea. These were rapidly replaced by species adapted to particular niches, so that as species richness rose, overall abundance have been seen to increase (Sheppard et al., 2010). In polluted substrata this sequence did not occur so that a few pollution-tolerant species were seen to dominate, often in high abundances**

5. Concerns and Final statement

Concerns

- **The Gulf is facing biodiversity loss due to stress resulted from different sources of oil and non oil pollution.**
- **Several studies should be conducted to know how many species disappeared already and the tolerance levels of the rest.**

World Population predictions

- In 1950 it was 2.53bn; 2009 it was 6.83bn; expected in 2050 to be 9.15bn
- As such more land needs to be cultivated or used, more pollution will be put to the marine environment. This would result to a more pressure to the environment.
- Humans and human related activities are already the greatest threat to biodiversity.

Levels at which biodiversity can be found

Level	Impact of pollution at the Northern part of the Gulf
Ecosystem level	Moderate
Species level	Severe
Genes	Needs to be covered

Final statement

Despite Punctual degradation of the living environment, we must remember that the main threat to biodiversity is resulting globally as a combination of all anthropogenic pressures that we human beings have been and are continuing to put (at increasing rates) on the world ecosystems. (http:// www.biodiversity.sg)


Thank You