



Kuwait Institute
for Scientific Research

*Gulf II:
an international conference*



**The State of the
Gulf Ecosystem**

Functioning & Services

**Kuwait City, Kuwait
February 7-9, 2011**



Organized by
Kuwait Institute for Scientific Research
Aquatic Ecosystem Health & Management Society

Sponsors



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UNESCO, Doha



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La'Ala R.E



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Contents

Item

Page

Welcome from Environment & Urban Developmet / KISR

Welcome to GULF II from the AEHMS

Message from Sponsors

General Information

About the Scientific Program

About the Keynote Speakers

Program-at-a-Glance

Program

Oral Abstracts

Poster Abstracts



Welcome from Environment & Urban Development / KISR

Environment and Urban Development Division of Kuwait Institute for Scientific Research Welcome the Delegates of this Conference and Wishes for their Comfortable Stay in Kuwait.

The Kuwait Institute for Scientific Research (KISR) was established in 1967 as an autonomous non-profit research institute by the Arabian Oil Company (Japan) in fulfillment of an oil concession agreement with the Government of the State of Kuwait. The agreement states that KISR shall carry out applied scientific research in the fields of petroleum and fisheries.

In 1973, the Kuwait government assumed direct responsibility for the Institute through an Amiri decree that gave responsibility to the Kuwait Council of Ministers to assign a Board of Trustees chaired by a Minister delegated from the Council. The Amiri decree also specified that KISR should continue with its mission to carry out applied scientific research especially regarding issues related to industry, energy, agriculture, and the national economy in order to contribute to the economic and social development of the State. In addition, the Institute should be prepared to offer advice to the government on the country's scientific research policies. KISR continued to expand in the areas of food and environment studies and grow horizontally to incorporate almost all elements of the natural sciences.

In 1981, the status of KISR was reviewed and an Amiri decree was issued to define the objectives and update the role of KISR in the development of scientific research and technology in the country; the decree also specified membership of the Board of Trustees for the governance of KISR. This decree emphasized other research issues in addition to the ongoing studies such as preservation of the environment, investigation of natural wealth, promotion of energy, water and food resources and methods of agriculture exploitation. In addition, the law broadened the mission and entrusted the Institute with undertaking research and scientific and technological consultations, for both governmental and private sectors in Kuwait, the Gulf region and the Arab world, and encouraged collaboration with international institutes.

Since its establishment, the Institute has been sponsored by the government. More recently, the budget has been supplemented by complementary funds from external sources. Since 1979 the Institute has operated through five-year planning cycles. The current cycle is the sixth strategic plan and is in its final year.

Over two decades of progress in development of a solid research infrastructure suffered a major setback with the Iraqi invasion of Kuwait in 1990-1991, when both its physical infrastructure and intellectual resources were destroyed. The Institute managed to recover fully through the commitment of the staff and support from the government to rise again as a distinguished research institution.

In accordance with the institutional mandate, human resources development has been a center of attention due to its impact on efficiency of the Institute, and as a government priority. KISR was a pioneer within the nation to establish a dedicated unit to implement ambitious human resources development plans for its staff, as well as nation's youth through special education and training programs.

For the next strategic plan (seventh), KISR is developing a comprehensive long term strategy aiming at employing its competencies and expertise to provide active solutions of high standards and with commercial and industrial impact, to address future market needs of Kuwait. This comprehensive strategy aims to enhance KISR's contribution towards economic and social development, improve its scientific and professional effectiveness and efficiency, and further enhance its role and position both nationally and internationally with the objective of gaining a reputation as a centre of excellence for scientific research. For this purpose, KISR is developing a new vision, revisiting its mission and developing a comprehensive strategy and high level organizational structure, including its management systems, processes, roles and responsibilities to enhance future capabilities.





Welcome to GULF II from the AEHMS

On behalf of the Aquatic Ecosystem Health and Management Society (AEHMS) Canada, I would like to extend a warm welcome to the attendees of this conference. The AEHMS has maintained a global program of environmental networking, convening of conferences and publishing in the form of an international journal and peer reviewed books for more than 20 years.

The AEHMS is not new to the Gulf Region since it has been actively involved in various activities for almost a decade. For example, the Society was instrumental in organizing and publishing the first comprehensive book (*The Gulf Ecosystem: health and sustainability*; Khan et al. 2002) which was sponsored by the Kuwait Institute for Scientific Research (KISR). This was followed by the convening of the first GULF conference in collaboration with the United Arab University, Al Ain, in 2006 and resulted in the publication of a special issue of *Aquatic Ecosystem Health & Management: The State of the Gulf Ecosystem: future and threats* (Munawar et al. 2007). Furthermore, the society has recently published a major review article dealing with the state of the Gulf (*Protecting and Managing the Arabian Gulf: past, present and future*; Hamza and Munawar, 2009) which was one of the most downloaded articles from the journal.

The Organizing and Scientific Committees have worked hard to organize and convene the GULF II conference which has been designed to focus on the ecosystem health especially with regard to functioning and services. Themes to be explored include: Climatology and marine resources; Marine ecology and biodiversity; Marine pollution and its impact; Ecotoxicology and ecosystem health; Environmental Pollution and transboundary movement; Remote sensing applications in the marine environment, and Environmental management.

Once again, the AEHMS welcomes all the participants attending the GULF II conference and we sincerely hope that this conference will generate interest in the assessment of the ecosystem health, integrity and sustainability of the Gulf ecosystem.

M. Munawar

President, Aquatic Ecosystem Health and Management Society, Canada
Chief Editor, *Aquatic Ecosystem Health and Management*
Research Scientist, Fisheries & Oceans Canada

References

- Khan, N.Y., Munawar, M., Price, A.R.G. 2002. *The Gulf Ecosystem: health and sustainability*. Backhuys Publishers, Leiden, Netherlands, 509 pp.
Munawar, M., Hamza, W., Krupp, F., Böer, B; Al-Ghais, S. 2007. *The State of the Gulf Ecosystem: future and threats* (Spec. Iss.), *Aquat. Ecosyst. Health Mgmt.* 10(3).
Hamza, W. Munawar, M. 2009. *Protecting and Managing the Arabian Gulf: past, present and future*. *Aquat. Ecosyst. Health Mgmt.* 12(4): 429-439.





Message from Sponsors



Kuwait Foundation for the Advancement of Sciences (KFAS)

Kuwait Foundation for the Advancement of Sciences (KFAS) is a **private, non-profit organization**, established by an Amiri Decree issued on December, 12th 1976 (Thul-Hijjah, 21st 1396 AH).

KFAS is managed and administered by a Board of Directors (BOD), chaired by H.H. the Amir of the State of Kuwait. The Board is comprised of six members appointed by H.H for a period of three years.

KFAS receives financial contributions by the Kuwaiti Shareholding Companies, amounting to 1% of the net annual profit.

The Board of Directors appoints a Director General who manages the scientific, administrative and financial activities of KFAS and monitors the implementation of the policies set by BOD.

Goals:

KFAS Goal is to promote scientific, technological and intellectual progress within the State of Kuwait and the region.

Objective:

- Provide financial sustenance to research in basic and applied sciences.
- Support projects of national priority.
- Award prizes and recognition at national, regional and international levels.
- Organize scientific symposia and conferences.
- Enrich the Arabic language library by publishing journals, books and encyclopedias.
- Promote scientific and cultural awareness.

Based on KFAS objectives to transfer science and technology to develop Kuwait's scientific and technical potentials and to emphasize its scientific role at the international level, KFAS organizes and supports scientific conferences and workshops, organizes in-house training programs, funds various local and international training programs and provides grants to individuals.

KFAS also promotes the development of scientific culture among individuals in the society and among countries with emphasis on the role of Islamic and Arab civilization, advancement of people through mutual co-operation with the social, cultural and scientific organizations in the State of Kuwait and abroad. The various activities include publication of scientific books and magazines, promotion of scientific symposia and cultural competitions, support for international scientific Olympiads for students, production of scientific, cultural and documentary films and organization of cultural events.



Kuwait Fund for Arab Economic Development is the first institution in the Middle East that took an active role in the international development efforts.

The Kuwait Fund extends Loan on concessionary term to finance development projects in the developing countries. The Fund also provides technical assistance to finance the costs of the of the feasibility studies of projects, as well as the training of nationals of the borrowing countries. In addition, the Fund subscribes in the capital of international and regional development institutions.

Today, the Kuwait Fund forms a solid bridge of friendship and solidarity between the state of Kuwait and the developing nations.

Since is dependence in 1961, the state of Kuwait has been involved in global economic development efforts, motivated by firm beliefs in cooperation and humanitarian liaises and services. Thus the Kuwait Fund was established to become the first development financing institution in the middle east to assist Arab and other developing countries. The main feature of the Kuwait Fund Loans is its confessional nature facilitating the execution of development projects with the least burdens. Furthermore, the Fund extends technical assistance to finance the preparation of techno-economic feasibility studies thatn ensure the viability of projects, and to implement institutional support means to various government organizations. In addition, the Fund participates in the capital of regional and international development financing institutions. Today, the Kuwait Fund is playing an important role in establishing and maintaining friendly relations between the people of the state of Kuwait and the people of other countries. It is interesting to note that:

- The paid capital of the Kuwait Fund amounts to 6.6 billion US Dollars.
- The number of countries which benefited from Kuwait Fund loans is 104 countries.
- The total number of the loans that were extended by the fund up to 31 August, 2010 reached 781 loans with a total amount of 14.89 billion US Dollars.
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www.kuwait-fund.org



La'ala Al Kuwait Real Estate Company and Sabah Al Ahmad Sea City.

La'ala Al Kuwait Real Estate Company is a Multi disciplinary development organisation currently involved in the development of the Sabah Al Ahmad Sea City located in the Khiran area of southern Kuwait, some 80km south of Kuwait City.

With a directly employed labour force of over 800 and over 200 pieces of major plant and equipment La'ala Al Kuwait are a major construction organisation involved in earthworks, marine works, civil construction works and infrastructure development.

Despite the extremely difficult ground conditions experienced at Sabah Al Ahmad Sea City, La' Ala Al Kuwait's Marine and Earthworks team are able to move over 150,000 tonnes of material per day. Specialist techniques such as dynamic compaction and sand washing are used to densify the newly constructed building platform and prepare the high specification beach sands. Both of these processes have been utilised for the first time in Kuwait.

In addition, the environmentally conscious organisation ensures all marine works are carried out in the dry, thus minimising any impact on the environment during the operations and ensuring the highest level of accuracy in the marine works.

La'ala Al Kuwait's Construction Management teams build and manage the high quality infrastructure and civil construction works at Sabah Al Ahmad Sea City. Works including major marine structures, sanitary and storm sewers, roadwork's, potable and irrigation water, high and low voltage substations and cabling, street lighting and first time fibre optic to home communications networks are managed by the multi-national, multi disciplinary team. La'ala Al Kuwait has gained national recognition for the highest quality infrastructure construction works.

Sabah Al Ahmad Sea City is a major coastal development project extending over 8,500 Hectares. Mainly located on salty Sabkha land, this development has transformed the environmentally impoverished area into a thriving marine eco system. With over 1000 species of micro biota identified to date the colonisation of the waterways has been nothing short of miraculous.

Future climactic changes has been recognised in the project design and all building platforms are at a level as to be safe from any impact of sea level change. Additionally, minimal impact on the environment has been insured by the creation of salt marsh islands and the reintroduction of mangrove into this part of Kuwait. This unique experiment is recognised as the first of its kind.

With virtually no sandy coastline remaining, Sabah Al Ahmad Sea City will eventually provide more than double the available sand beach in Kuwait. All development plots are located at the edge of specially prepared golden beaches alongside clean and safe waterways.

Water quality has been of paramount importance at Sabah Al Ahmad Sea City and sophisticated computer modelling programmes have been utilised to ensure that water quality and flushing exceeds international standards. Utilisation of international designers and hydraulic consultants together with close collaboration with The Kuwait Institute for Scientific Research (KISR) has ensured the success of the project to date. Constant monitoring of the water quality by KISR has clearly demonstrated that the water within the lagoon network is in total harmony with that in the open Gulf.

Further consideration of the environmentally sensitive nature of the site led to the design and construction of the latest technology in waste water treatment utilizing SBR technology. All waste water is treated and returned as irrigation water with no potential for any discharge into the lagoon network.



Environment Public Authority (EPA) Kuwait

The Environment Public Authority is a competent authority which was established not only for limiting the environmental pollution but also safeguard the different natural resources and administer the same with a more rational way to achieve sustainable development and involve the environmental elements into planning structures, to overcome the various environmental problems. In order to achieve this, the Amiri Decree No. 21 was issued in 1995 and altered by the law no. 16/96 to establish Environment Public Authority (EPA). Accordingly, the law no. 21 of 1995 as amended under law no. 16 of 1996, establishing the Environment Public Authority granted it the necessary powers to safeguard various natural resources and to administer the same under a manner more fully rational to realize development and to involve the environmental element.

The objectives of the EPA are (1) keeping the environment in a state conforming with the public health requirements and preserving the natural resources, personal and public property, by preventing or alleviating polluting and maintaining purity of air, water, soil and the environment in general; (2) stressing balance and integration between the environmental considerations and development operations, ensuring their conformity with the citizen health requirements and avoiding adverse impacts on the environment and properties; (3) confronting the pollution problems across borders and intensifying efforts to prevent oil pollution accidents.

The mission of the Environment Public Authority is to safeguard environmental quality, consistent with social and economic needs of the country, so as to protect health, welfare, property and quality of life. EPA provides leadership in the nation's environmental science, research, education and assessment efforts. EPA works closely with other federal agencies and local governments, to develop and enforce regulations under existing environmental laws. EPA is responsible for researching and setting national standards for a variety of environmental programs, and monitoring and enforcing compliance.



General Information & Publication Plans

Badges

You should consider your personal name badge as a valuable entry ticket. Please wear your badge at all times during the conference.

Coffee and tea breaks

Coffee/tea breaks are included with registration. The locations will be announced at the time of the conference.

Registration Desk

The registration desk will be available at 8.00 am on Monday before the conference and throughout the conference at the venue (KISR/Kuwait).

Publication Plans

Selected manuscripts will be considered for publication subject to peer review in the ISI rated journal: *Aquatic Ecosystem Health and Management (AEHM)*. *AEHM* is an ISI rated international primary journal published by Taylor & Francis, Philadelphia.

Presenters are encouraged to submit manuscripts to the *AEHM* for consideration for publication subject to the AEHMS instructions to authors, and guidelines (www.aehms.org/Journal/ins_authors.htm). Due to the large number of manuscripts expected the AEHMS has set page limit guidelines as follows: Keynote: 8; Oral & Poster: 6 printed pages including tables and figures (Text: Times New Roman 11 pt, Margins: 2.7 cm (1”), Paper: letter size 21.6x28 cm (8.5x11”). For more information please contact Dr. M. Munawar, Chief Editor (mohi.munawar@dfo-mpo.gc.ca).

Presenters who are planning to publish in the special issues are requested to complete the publication questionnaire and return it the Registration Desk or by email to jennifer.lorimer@dfo-mpo.gc.ca, before the end of the conference.

Liability

Neither the conference organization, the Kuwait Institute for Scientific Research, nor the Aquatic Ecosystem Health & Management Society can be held responsible for damage, loss or theft during the conference.



About the Scientific Program

This conference is the second meeting on the state of the Gulf ecosystem in which scientists from the Gulf States are actively participating. In addition to that scientists from other countries who are closely connected with the studies on Gulf are also presenting their observations on the functioning of the Gulf. We received enthusiastic participation and practically it was impossible to accommodate every presentation in 3-days. However, we have selected 57 papers for oral presentations and another 35 papers for poster presentations. The conference is divided into 7-sessions lead by a keynote address by the scientist of international repute. The abstracts are arranged according to sessions.

The posters will be displayed for the entire period of conference in the exhibition hall beside an allocated time on the first day when the presenter will be available with his poster for discussion and interaction with the interested audience.

We believe this meeting will enhance our understanding about the Gulf environment, its functioning and services. The interaction of scientists will generate national, regional and international programs and result in close cooperation between scientists and institutions of the region for the protection of the Gulf ecosystem and human health.

**A. N. Al-Ghadban, M. U. Beg, M. Munawar
& Members of Scientific Committee**

About the Keynote Speakers



Dr. Carl Amos

School of Ocean and Earth Science,
National Oceanography Centre, Southampton, U.K.

Amos is a specialist in coastal marine processes and sediment dynamics with application to coastal morphodynamics. He has over 40 years of research experience and over 160 scientific publications. During his early career he was a member of the Geological Survey of Canada (Environmental Marine Geology) and was instrumental in development of techniques linking environmental management with science-based information. In the course of this work, he was involved in the development of innovative in-situ instrumentation (RALPH, Sea Carousel, BRAD, Mini Flume etc), and numerical models of coastal sediment transport (SEDTRANS). He has been chief scientist on over 20 scientific cruises and has lead numerous international projects on coastal research. Since 1999, he has taken the research experiences to the University of Southampton, National Oceanography Centre where he presently resides. He has lead coastal research at the University and is Co-Director of the Centre of Coastal processes, Engineering and Management, as well as the highly-successful MSc programme titled Engineering in the Coastal Environment. He is also Director of the coastal research company Tuscan Consultancy Limited, which is registered in UK.



Dr. Michel Collins, UK

Michael Collins has wide-ranging experience in the study of sediments (mud, sand, and gravel), including their supply, transport, and deposition in environments, ranging from the headwaters of rivers to the deep ocean. Professor Collins (BSc Civil Engineering (Brighton, 1967), DPhil Sediment Dynamics (Sussex, 1973) and DSc (Sussex, 1995)) has more than 30 years experience in the sediment dynamics of fluvial, estuarine, coastal, and open sea environments. From 1973 to 1986, he worked in the Department of Oceanography, University College of Swansea (Wales). In 1986, he was a Visiting Fellow at St Johns College, Cambridge. In 1987, he moved to the Department of Oceanography, University of Southampton, and was appointed as a professor in 1992. He was the leader of the Coastal and Shelf Seas Thematic Group of the Southampton Oceanography Centre, has published more than 200 scientific papers in refereed journals and authored extensive scientific reports, is the founding editor of the international marine science journal *Continental Shelf Research*, which he has continued to edit for the past 27 years, is a Fellow of the Geological Society of London, and is a consultant to many national and international organizations and industrial concerns.



Dr. Peter Literathy

Kuwait Institute for Scientific Research, Kuwait

As an environmental chemist, extensive experience in the field of environmental pollution monitoring and assessment, and water pollution control in general, and in water/seawater, drinking water and wastewater, aquatic sediment and terrestrial soil quality characterization; design and implementation of pollution monitoring programmes; establishment of environmental quality criteria/standards; studies on heavy metals, petroleum compounds and other trace organics in water, sediment/soil and biota; standardization of analytical procedures; organization of analytical quality control studies. His special research interest includes: interactions between water and sediment, pollutant dynamics in sediment; chemical/biochemical transformation of organic micropollutants, particularly petroleum compounds in aquatic and terrestrial ecosystems.

Expert services: to the United Nations Environmental Programme (UNEP), World Health Organization (WHO), UNESCO Intergovernmental Oceanographic Commission (UNESCO-IOC), International Atomic Energy Agency (IAEA), World Meteorological Organization (WMO) and the International Standardization Organization (ISO); participation in Task Force meetings organized by the Regional Organization for the Protection of the Marine Environment (ROPME) in the Kuwait Action Plan Regional Seas Programme, until 1990; Technical Co-ordinator of the UN-ECE Task Force on Laboratory Quality Management and Accreditation. Panel Member and Chairman of the Environmental and Earth Science and Technology Panel for the period 2000 to 2004 of the NATO Scientific and Environmental Affairs Division.

Between 1981 to 1990, research scientist at KISR, as Leader of the Marine Pollution Group, overall responsibility in planning and implementing marine pollution related research projects. Project Leader, Principal Investigator to regional and national projects, such as two phases of the "Monitoring of Oceanographic Characteristics and Baseline Studies of Oil and Non-Oil Pollutants in the Territorial Waters of Kuwait", as Kuwait's contribution to the KAP Regional Seas Programme; and the "Baseline Studies of Oil and Non-Oil Pollutants in the Marine Environment of Kuwait." Co-author of the 1st edition of the ROPME Manual of Oceanographic Observation and Pollutant Analysis Methods. After liberation of Kuwait, during April to August, 1991, assigned UNEP Task Team Leader/Coordinator of the UN Inter-agency Plan of Action for the ROPME Region aiming to survey and assess the environmental consequences of the Gulf war in Kuwait, and in the affected region. As follow-up on the assessment of the environmental damage and long-term effect on the desert environment in Kuwait, several consultations with KISR and to the Environment Public Authority in Kuwait.

As Director of the Research Institute for Water Pollution Control in Budapest, Hungary, during the 1990s, participated in major monitoring and assessment activities in the Danube river basin (Core Team leader of the first Joint Danube Survey expedition along 2581 km along the Danube). In 2000, returned back to KISR as Senior Advisor, assigned Program Manager of the UNCC supported 5-year program for monitoring and assessment of the environmental damages caused by the 1991 Gulf War. Recently, appointed as Manager of the Environment Management Program.



Dr. Mohiuddin Munawar,
Aquatic Ecosystem Health and Management Society, Canada

Dr. Mohiuddin Munawar received a Ph.D. in Physiological ecology of phytoplankton from Osmania University, India. In 1967 he moved to the United States to attend Southern Illinois University, Carbondale, for post-doctoral research with Dr. J. Verduin, a well-known Great Lakes ecologist sponsored by the U.S. National Science Foundation. In 1969 Dr. Munawar took another post-doctoral assignment with Dr. R.A. Vollenweider – an eminent limnologist – to conduct research on the phytoplankton ecology of the North American Great Lakes (sponsored by National Research Council of Canada) at the Canada Centre for Inland Waters, Burlington, Ontario. Following this he joined Fisheries & Oceans Canada as a Research Scientist to pursue his research. Since then, he has been actively involved in Great Lakes plankton research and has published more than 250 peer reviewed papers and given over 350 presentations dealing with physiological ecology of phytoplankton, microbial loop, planktonic food-web dynamics/interactions, ecotoxicology, ecosystem health and management. He has delivered several invited keynotes, plenaries and presentations. Dr. Munawar has convened and chaired numerous international symposia, conferences and eforums, and edited almost 35 special issues of primary journals and edited over 20 peer-reviewed books.

Dr. Munawar is the founder-president of the *Aquatic Ecosystem Health and Management Society (AEHMS)*, Canada established in 1989. He also launched the Society's primary journal as the founder-chief editor of *Aquatic Ecosystem Health & Management*, published by Taylor & Francis, Philadelphia, USA. The quarterly journal is ranked by ISI and covered by Thomson Scientific. Later, due to the growing need for holistic environmental books focusing on the "total ecosystem", the *Ecovision World Monograph Series* was initiated by him. The series has already published more than 20 peer-reviewed books of global interest. Under the banner of the AEHMS, he has been successful in organizing several international conferences and symposia on diverse environmental topics and issues around the world.

Dr. Munawar has received several awards and distinctions such as the Chandler-Misner Award for best scientific manuscript of the year, Canadian Public Service Commission Award, the prestigious Anderson-Everett Award for life time contribution to Great Lakes Science, an honorary doctorate (Doctor Honoris Causa) from the Faculty of Science, Göteborg University, Sweden, and recently has been conferred the Fellowship of the Academy of Science, Engineering & Technology, from India. In 2008, Dr. Munawar was also awarded the Assistant Deputy Minister's Distinction Award by the Department of Fisheries & Oceans in recognition of his excellence, leadership and scientific contributions.



Dr. Hurtmot Neis

International Atomic Energy Agency
Environmental Laboratories, Monaco

Hurtmot Neis is section head of the Radiometrics Laboratory of the Marine Environmental Laboratories of the IAEA in Monaco and Director of the Marine Analytical Chemistry Laboratory of the BSH (since 1993). Dr. Neis as Chief Scientist organized various national and international cruises to the Baltic and North Seas and the Atlantic Ocean. He served as the chairman of the co-ordination group between Federal and State laboratories of the Monitoring programme in the North Sea (1995 – 2007).

He is a member of various international expert groups on monitoring the marine environment, e.g. OSPAR, HELCOM, NEA/OECD, IAEA, member of the national co-ordination group of Federal Agencies for environmental radioactivity monitoring in Germany, member of the Radio-ecological Advisory Committee of the German Radiation Protection Commission to the Ministry for the Environment, Nature Conservation and Nuclear Safety (between Jan. 1992 and Dec. 1996) and again since 1st January 2009, member of the German Society of Chemists (GDCh) and its topic groups “Nuclear Chemistry” and “Water Chemistry”, member of the International Union of Radioecologists (IUR) and associate editor of the scientific journal “The Scientific World”.



Dr. Andrew Price

University of Warwick Coventry, UK

Professor Andrew Price is a marine biologist, environmental advisor, consultant and writer. He has specialist knowledge of the Gulf – where his research began in 1974 - and wider Indian Ocean. For his evaluation of coastal damage from the 1991 Gulf War, Andrew received the British Consultant of Year Award ~ a prize open to entries from industry and academia. He is currently a visiting professor at Warwick University and honorary professor at York University. In 2003, Professor Price was elected Fellow of the Linnean Society. He has written or co-authored ~ 90 scientific publications, including 3 books on the Gulf/Middle East, several book chapters and many journal articles. His most recent book is *Slow-Tech: Manifesto For An Overwound World* (Atlantic Books, 2009). This shows how robustness helps ensure smooth-running in nature, in what we do and in the things we create.



Dr. Timothy J. Reilly, USA

Lighthouse Technical Consultants
Massachusetts, USA.

Mr. Reilly is a Principal and Founder of Lighthouse Technical Consultants, Inc. with over 25 years experience in assessing the distribution and toxicological interactions of oil and hazardous materials in surface water, groundwater and terrestrial environments. Mr. Reilly has played a key role in determining biological, physical and chemical response strategies, ecological restoration, and remedial and damage compensation options at hundreds of contaminated sites throughout the United States, Latin America, Oceania, Europe and the Middle East. Mr. Reilly has led national and international economic and environmental damage claim development and adjudicatory efforts for the associated with oil spills valued at hundreds of millions of U.S. dollars. He has assisted state and U.S. federal governments and industry in developing area spill response plans throughout the United States, and reviewing the adequacy of facility response plans for compliance to government requirements. During his years in consulting he has obtained extensive experience in contaminated site natural and cultural resource injury assessment investigations, evaluation of impacts to natural resources from proposed developments, spill response strategies, remediation, restoration, risk assessment, resource valuation, spill contingency planning and environmental sensitivity mapping. Mr. Reilly leads a high-level international team of scientists and engineers in the design of the Zero Carbon Inc. Recuperative Combustion System (RCS), which captures carbon in industrial flue gas and recycles this greenhouse gas into high-value petrochemical products and fuels.

Gulf II



Program – at – a – Glance

Day 1: Feb 7		Day 2: Feb 8		Day 3: Feb 9	
8:00 - 9:00	Registration	8:30 - 10:30	Session 3A	8:30 - 10:30	Session 6
9:00 - 10:00	Inauguration	10:30 - 11:00	Tea break	10:30 - 11:00	Tea break
10:00 - 10:30	Exhibits & Posters	11:00 - 12:30	Session 3B	11:00 - 12:30	Session 7A
10:30 - 12:00	Session 1	12:30 - 1:30	Lunch & Prayers	12:30 - 1:30	Lunch & Prayers
12:00 - 12:30	Poster Session	1:30 - 3:15	Session 4	1:30 - 3:15	Session 7B
12:30 - 1:30	Lunch & Prayers	3:15 - 3:30	Tea break	3:15 - 3:30	Tea break
1:30 - 3:00	Session 2	3:30 - 4:45	Session 5	3:30 - 4:15	Valedictory Session
3:00 - 3:15	Tea break				
3:15 - 4:30	Session 2				



Opening Ceremony

08:00 - 09:00	Registration
09:00 - 09:10	Recitation of Quran
09:10 - 09:20	Patronage Speech Sheikh Jaber Al-Mubarak Al-Hamad Al-Sabah H. E. The First Deputy Prime Minister Minister of Defence and Chairman of the Supreme Council of the Environment, Kuwait
09:20 - 09:30	KISR Speech Dr. Naji M. Al-Mutairi , Director General Kuwait Institute for Scientific Research (KISR)
09:30 - 09:40	ROPME Remarks Dr. Abdul Rahman Al-Awadi , Executive Secretary Regional Organization for the Protection of the Marine Environment (ROPME) Kuwait
09:40 - 09:50	Conference Briefing Dr. Dhari Al-Ajmi , Conference Chairman Division Director of Environment and Urban Development Kuwait Institute for Scientific Research (KISR)
09:50 - 09:55	Dr. Mohiuddin Munawar President, Aquatic Ecosystem Health and Management Society, Canada Chief Editor, Aquatic Ecosystem Health and Management Society, Canada
09:55 - 10:00	Mr. Mark Sutcliffe Environmental Science Project Officer UNESCO, Baharin
10:00 - 10:30	Opening of Exhibition, Posters and Reception

GULF II- Scientific Program: Oral Presentations

DAY 1: FEBRUARY 7, 2011

SESSION 1: CLIMATOLOGY, MARINE RESOURCES

		Chairman: Dr. M. Salman
		Co-Chair: Dr. D. Al-Ajmi
		<i>Keynote Address</i>
10:30-11:00	S1.01	Price, A. (UK) Making the Gulf more robust: strengthening environmental policies to prevent terminal decline
11:00-11:15	S1.02	Ramadan, E. (Kuwait) Dust and dust storms recurrence and their impact on the marine environment
11:15-11:30	S1.03	Al-Ghadban, A.N. (Kuwait) Geological and environmental overview of the Gulf
11:30-11:45	S1.04	Al-Husaini, M. (Kuwait) Survey of demersal fish stocks of the Gulf and Sea of Oman
11:45-12:00	S1.05	Burt, J. (UAE) Reef fish community structure throughout the eastern Arabian Peninsula: geographic patterns in community composition

12:00-12:30 POSTER SESSION

12:30-1:30 LUNCH & PRAYER BREAK

SESSION 2: MARINE ECOLOGY & BIODIVERSITY

		Chairman: Dr. H. Ali Morad
		Co-Chair: Dr. F. Al-Yamani
		<i>Keynote Address</i>
1:30-2:00	S2.01	Nies, H. (IAEA, Monaco) Monitoring of the marine environment - Role of IAEA Marine Environment Laboratories
2:00-2:15	S2.02	Ertfemeijer, P. (Netherlands) Seagrass habitats in the Gulf: distribution, tolerance thresholds and threats
2:15-2:30	S2.03	Elkhoury, J. (Qatar) Seagrass relocation and monitoring at the New Doha International Airport
2:30-2:45	S2.04	Almukhtar, E. (Iraq) An ecological study of the benthic invertebrate community in Iraq's southern marshes
2:45-3:00	S2.05	Al-Hashemi, A. (UAE) Coral reproduction in Jebel Ali reef (Dubai-UAE): with emphasis on <i>Acropora downingi</i> (Wallace 1999) and <i>Porites harrisoni</i> (Veron 2000) species
3:00-3:15	TEA BREAK	
3:15-3:30	S2.06	Moghimi, M. (Iran) A survey on habitat and biometrics characteristics of Hawksbill Turtles (<i>Eretmochelys imbricata</i>) in Nekhilou Island of Bushehr province of Iran
3:30-3:45	S2.07	Mahmoud, H. (Kuwait) The scraping effect of sea urchins on the development of microbial biofilms associated with coral reef formations south of Kuwait
3:45-4:00	S2.08	Khuraibet, A.M. (Kuwait) Intertidal and off-shore environmental assessment of the north of Kuwait ecosystem
4:00-4:15	S2.09	Javanshir, A. (Iran) The importance of rocky coastal ecosystems in heavy metal biosorption in the Gulf
4:15-4:30	S2.10	Ajdari, D. (Malaysia) Rehabilitation and effectiveness of artificial reef on population of lobsters in Oman Sea-south of Iran

DAY 2: FEBRUARY 8, 2011

SESSION 3: MARINE POLLUTION AND ITS IMPACT

		Chairman: Dr. N.Y. Khan Co-Chair: Dr. B. Gevao <i>Keynote Address</i>
8:30-9:00	S3.01	Literathy, P. (Kuwait) State of pollution in the Gulf
9:00-9:15	S3.02	Al-Imarah, F.J.M. (Iraq) Radiation pollution in the southern Iraqi wetlands and probable deterioration of the northern Gulf
9:15-9:30	S3.03	Alshemmari, H. (Kuwait) Trace metal speciation in marine sediments from Sulaibikhat Bay, Kuwait
9:30-9:45	S3.04	Saeed, T. (Kuwait) Effect of environmental factors on photodegradation of polycyclic aromatic hydrocarbons (PAHs) in the water-soluble fraction of Kuwait crude oil in seawater
9:45-10:00	S3.05	Al-Thukair, A. A. (KSA) Baseline study of pollutants at Jubail Industrial Port, Saudi Arabia
10:00-10:15	S3.06	Ali, L. (Kuwait) Contribution of desalination plants to marine pollution in Kuwait with the Gulf in perspective
10:15-10:30	S3.07	Al-Dousari, A. (Kuwait) Marine environmental impacts of power-desalination plants in Kuwait
10:30-11:00	TEA BREAK	

SESSION 3: MARINE POLLUTION AND ITS IMPACT (Continued)

		Chairman: Dr. H. Neis Co-Chair: Dr. L. Ali <i>Keynote Address</i>
11:00-11:30	S3.08	Collins, M. (UK) The establishment of a marine science database, for management and risk assessment purposes
11:30-11:45	S3.09	Al-Yamani, Faiza (Kuwait) Harmful algal blooms in Kuwait
11:45-12:00	S3.10	Al-Azri, A. (Oman) The occurrence of potentially harmful algal blooms (HAB's) in the Sea of Oman in relation to environmental changes
12:00-12:15	S3.11	Glibert, P. (USA) <i>Cochlodinium</i> blooms: Comparisons of the major 2008-2009 bloom in Omani waters with similar blooms worldwide
12:15-12:30	S3.12	Joydas, T. (Saudi Arabia) Status of macrobenthic communities in the Manifa-Tanajib Bay System (Saudi Arabia), fifteen years after the 1991 oil spill
12:30-1:30	LUNCH & PRAYER BREAK	

SESSION 4: ECOTOXICOLOGY AND ECOSYSTEM HEALTH

		Chairman: Dr. T.J. Reilly Co-Chair: Dr. A. Al-Dousari <i>Keynote Address</i>
1:30-2:00	S4.01	Munawar, M. (Canada) Globalization of ecosystem health assessment: promoting a "battery of ecological indicators" approach backed with multi-national agreements

2:00-2:15	S4.02	Beg, M.U. (Kuwait) Stress biomarkers in determining ecosystem health
2:15-2:30	S4.03	Zainal, K. (Bahrain) Selected environment and sustainable development indicators for the Kingdom of Bahrain
2:30-2:45	S4.04	Zare, R. (Iran) Sea turtles in Iran, population assessment, ecosystem health and conservation status
2:45-3:00	S4.05	Karam, Q. (Kuwait) Morphological abnormalities in early life stages of Sea Bream <i>Sparidentex hasta</i> exposed to WAF of Kuwait crude oil
3:00-3:15	S4.06	Bu-Olayan, A.H. (Kuwait) Effect of effluent discharges to Pomfret Fish: An indicator to marine pollution in Kuwait
3:15-3:30	TEA BREAK	

SESSION 5: ENVIRONMENTAL POLLUTION AND TRANSBOUNDARY MOVEMENT

	Chairman: Dr. M. Collins	
	Co-Chair: Dr. Saifuddin	
3:30-3:45	S5.01	Hamza, W. (UAE) Dust storms over the Gulf: An optimistic vision toward climate change consequences
3:45-4:00	S5.02	Al-Dousari, A.M. (Kuwait) Dust fallout properties within major dust storm trajectories in the Gulf
4:00-4:15	S5.03	Gevao, B. (Kuwait) Persistent organic pollutants in the atmosphere of the Gulf: Levels, sources and transboundary movement
4:15-4:30	S5.04	Holoubek, I. (Czech Republic) POPs global distribution in ambient air samples from MONET Network
4:30-4:45	S5.05	Aba, A.A. (Kuwait) Radiometric dating of sediment records in Kuwait Marine area

DAY 3: FEBRUARY 9, 2011

SESSION 6: REMOTE SENSING APPLICATIONS IN MARINE ENVIRONMENT

	Chairman: Dr. H. Mohannadi	
	Co-Chair: Dr. A.A. Al-Thukair	
	Keynote Address	
8:30-9:00	S6.01	Amos, C. (UK) Coastal seawater temperature trends – a review of recent interpretations
9:00-9:15	S6.02	Petrov, P. (Kuwait) Near-real-time remote sensing monitoring of algal bloom and oil pollution in the ROPME Sea Area
9:15-9:30	S6.03	Polikarpov, I. (Kuwait) Bio-optical study of Kuwait's waters
9:30-9:45	S6.04	Hamzei, S. (Iran) Functional investigation of MODIS AQUA, MODIS TERRA and SeaWiFS sensors in monitoring and detection of 2008-2009 Red Tide in the ROPME Sea Area with chlorophyll quantification algorithms
9:45-10:00	S6.05	Uddin, S. (Kuwait) Sediment transport in Northern Gulf – remote sensing overview
10:00-10:15	S6.06	Al-Dousari, A. (Kuwait) Identification of algal blooms in the Kuwait Bay using remote sensing data: Initial findings
10:15-10:30	S6.07	El-Gamily, H. (Kuwait) Shoreline changes around Qaruh Island south of Kuwait based on high resolution remotely sensed data
10:30-11:00	TEA BREAK	

SESSION 7: ENVIRONMENTAL MANAGEMENT	
	Chairperson: Dr. H. Awad
	Co-Chair: Dr. S. Al-Muzaini
	Keynote Address
11:00-11:30	S7.01 Reilly, T.J. (USA) Application of ecosystem-based analytic tools to inform natural resource damage assessments and environmental impact analyses in the ROPME Sea Area
11:30-11:45	S7.02 van der Knaap, M. (Netherlands) Status of fisheries management in the Gulf
11:45-12:00	S7.03 Esmacili, H.R. (Iran) Morphological diversity of urohyal bone and its importance in taxonomy and fisheries management of some marine fishes of Iran
12:00-12:15	S7.04 Nasab, S.M.A. (Iran) Ecotopes ranking in a coastal wetland around the Gulf by BIOSAFE Model for conservation and management planning: A case study of Shadegan International Wetland, Iran
12:15-12:30	S7.05 Eckhardt, C. (Germany) Geotourism Action Plan for Qeshm Global Geopark: Holistic management approaches for sustainable use and promotion of geo- and biodiversity
12:30-1:30	LUNCH & PRAYER BREAK
SESSION 7: ENVIRONMENTAL MANAGEMENT (Continued)	
	Chairman: Capt. Ali Haider
	Co-Chair: Dr. T. Saeed
1:30-1:45	S7.06 Cowie, W. (Qatar) Ballast water management: A vision for Qatar
1:45-2:00	S7.07 Jones, D. (Spain) Sabah Al-Ahmad Sea City, the creation of a sustainable coastal ecosystem in a saline desert anticipating sea level rise
2:00-2:15	S7.08 Murad, H.A. (Kuwait) Sub-regional cooperation initiatives for fisheries conservation and management in the northern Gulf
2:15-2:30	S7.09 Neelamani, S. (Kuwait) Extreme wave heights in the Kuwaiti territorial waters based on 12 and 15 year data sets
2:30-2:45	S7.10 Al-Muzaini, S. (Kuwait) Management of land based sources of marine pollution
2:45-3:00	S7.11 Vanneyre, L. (UAE) Sir Bu Nair, one of the most biodiverse islands of the Gulf
3:00-3:15	S7.12 Baby, S. (Bahrain) Environmental impact assessment of the marina construction, Kuwait National Guard Club, State of Kuwait
3:15-3:30	TEA BREAK
3:30-4:15	VALEDICTORY SESSION
	Ghadban, A. N., Beg, M.U. & Munawar, M. Panel Discussion & adoption of the recommendations of the conference

GULF II- Scientific Program: Poster Presentations

DAY 1: FEBRUARY 7, 2011

12:00-12:30 POSTER SESSION

Chairman: Dr. H. Alshemmari

Co-Chair: Mr. Q. Karam

CLIMATOLOGY, MARINE RESOURCES

- P1 Ksiksi, T. (UAE)**
Sea level rise and Abu Dhabi mangrove ecosystems
- P2 Dairi, M. (Bahrain)**
The effect of temperature and salinity on larval hatching of brown spotted grouper and Sobaity sea bream fish
- P3 Naser, H. (Bahrain)**
An investigation of salinity tolerance and salt secretion in protected mangroves, Bahrain
- P4 Daman, M. (Iran)**
Seasonal variability of the macrofouling community in Arvand River estuary (Shatt Al-Arab), Iran
- P5 Hamzei, S. (Iran)**
Seasonal variability of chlorophyll-a distribution in the ROPME Sea Area using satellite data

MARINE ECOLOGY & BIODIVERSITY

- P6 Al-Gheilani, H.M. (Oman)**
Marine ecology studies of Omani waters
- P7 Khaleqsefat, E. (Iran)**
Rotifer biodiversity on the north shore of the Gulf
- P8 Pournalak, L. (Iran)**
Biodiversity of Qeshm Island
- P9 Al-Khayat, J. (Qatar)**
Fish community of natural and planted mangroves with comparison to a sand flat in Qatar
- P10 Moghimi, M. (Iran)**
A survey on seaweed distribution and biomass in Nayband Bay, Bushehr, in the coastal waters of Iran
- P11 Al-Rashed, W. (Kuwait)**
Growth rates of some algal bloom species in Kuwait waters
- P12 Polikarpov, I. (Kuwait)**
Potentially harmful species in the phytoplankton composition of the north-western part of the Gulf (Kuwait's waters): Diversity, abundance and macroscale distribution
- P13 Al-Ibrahim, A. (Kuwait)**
The effect of invasive tunicates on coral and their associated bacteria in the Kuwaiti marine system
- P14 Ashkanani, A. (Kuwait)**
Coral microbiology: Studying the diversity of bacterial communities associated with coral mucus of various coral genera from the Kuwaiti waters
- P15 Erftemeijer, P. (Netherlands)**
Jellyfishes in the Gulf: An overview
- P16 Jabado, R. (UAE)**
The characteristics of the shark fishery in the United Arab Emirates

DAY 1: FEBRUARY 7, 2011

12:00-12:30 POSTER SESSION

Chairman: Dr. H. Alshemmari

Co-Chair: Mr. Q. Karam

- P17** **Zainal, K.** (Bahrain)
Natural diet and feeding behaviour of the commercial sand crab *Portunus pelagicus* (L)1766 along the coastal area of the Kingdom of Bahrain

ECOTOXICOLOGY & ECOSYSTEM HEALTH

- P18** **Al-Dufaileej, S.** (Kuwait)
Metallothioneins in fish and clams collected from Kuwait's marine area
- P19** **Al-Hasan, E.** (Kuwait)
Effect of nanometal oxides on marine algae
- P20** **Al-Shammari, F.** (Kuwait)
Assessment of levels of organic contaminants in Kuwait's coastal environment using bivalves as bioindicators
- P21** **Al-Shammari, J.** (Kuwait)
Response of four algal species to the water accommodated fraction (WAF) of Kuwait crude oil
- P22** **Al-Mouqati, S.** (Kuwait)
Assessment of potential microbial pathogens in oil-polluted soil in Kuwait
- P23** **Butt, S.A.** (Kuwait)
Toxicity assay of manufactured nanoparticles
- P24** **Paimpillil, J.S.** (India)
Seaweeds as indicators of the bioavailability of heavy metals in coastal waters

MARINE POLLUTION & ITS IMPACT

- P25** **Helaleh, M.** (Kuwait)
An advanced method for the analysis of OPCs and PCBs in Kuwait marine environment
- P26** **Al-Ghadban, A.** (Kuwait)
Denitrification potential of the northern Gulf – An experimental study
- P27** **Al-Khaled, H.T.** (Kuwait)
Tracking fecal coliform pollution trends in Kuwait coastal waters, 2007 - 2009
- P28** **Abdullah, H.I.** (Kuwait)
Assessment of sewage pollution of Kuwait coastal areas after a major pumping station failure
- P29** **Gevao, B.** (Kuwait)
Spatial and temporal distribution of phosphorus in coastal marine sediment from the northwestern Gulf
- P30** **Javanshir, A.** (Iran)
The role of scavenger gastropods in the biosorption of heavy metals in the north rocky shores of the Gulf: A case study on the performance of *Littorina saxatilis* and *Nassarius coronatus*
- P31** **Moghimi, M.** (Iran)
Environmental impacts of shrimp cultures on the marine coastal environment of Delvar and Mond sites in Bushehr Province, Iran

DAY 1: FEBRUARY 7, 2011

12:00-12:30 POSTER SESSION

Chairman: Dr. H. Alshemmari

Co-Chair: Mr. Q. Karam

ENVIRONMENTAL MANAGEMENT

- P32 El-Sammak, A. (Bahrain)**
Integrated environmental assessment of Kuwait Bay: Policy analysis and scenario response
- P33 Bazyarizadeh, Y. (Iran)**
Community-based management models for ecosystems protection: A sure way to sustainable improvement of coastal ecosystem health
- P34 Fraser, A. (Qatar)**
Coral relocation and monitoring at the New Doha International Airport
- P35 Talebi, L.A. (Kuwait)**
An environmental database for meiofauna and microfauna in northern Gulf
- P36 Al-Shamroukh, D. (Kuwait)**
Evidence of CO₂ sequestration and ocean acidification from Kuwait territorial water

Oral Abstracts
(Arranged according to sessions)

SESSION 1: CLIMATOLOGY, MARINE RESOURCES

S1:01 Keynote

PRICE, A.R.G.¹, & MUNAWAR, M.²

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Making the Gulf more robust: strengthening environmental policies to prevent terminal decline

A recent review designates the Gulf as a young sea in decline (Sheppard et al., 2010). The region ranks as one of the world's most perturbed environments, and one of the most studied. Dredging and infilling have transformed extensive coastal areas into artificial, non-biological environments. Additional impacts include (accidental and deliberate) oil spillages, against a background of coral bleaching and other climate-induced events. These and other projects/disturbances now seriously threaten the integrity of the Gulf, whose ecosystems and wildlife populations (e.g. birds & megafauna) are of international significance. The sea itself is also crucial, not only for transport but also because desalination provides freshwater for ~ 80% of the population. A healthy marine environment matters for conservation, people and investment confidence. Short-term development policies have been largely responsible for the extensive collateral damage. Gulf States are party to comprehensive national and international legislation, and regional agreements through the Regional Organization for Protection of the Marine Environment (ROPME). However implementation remains a major obstacle, with much of the Gulf left vulnerable to various environmental threats and risks. Two specific interrelated measures are advocated to enhance conservation and help safeguard future development options. One approach is to expand the network of coastal and marine protected areas. The current number is ~ twenty-five, although many other candidate sites are proposed (Krupp, 2002). A complementary approach is to determine, specify then instill – through legally binding agreements – adequate levels of robustness for every coastal ecosystem. New metrics of robustness may facilitate this. Recent damage compensation claims for natural injuries induced by the 1991 Gulf War conflict and oil spill highlight the economic value of the region's natural systems. This may provide the impetus for greater recognition and implementation of existing and newly created regional environmental policies. International participation and involvement of NGO organizations is badly needed. Recently it is encouraging to notice professional activities in the Gulf region by NGO organizations like Aquatic Ecosystem Health & Management Society (AEHMS). This is actively convening conferences followed by publishing peer reviewed research in the form of special journal issues and a book, with the objective of protecting the ecosystem and human health in the Gulf region.

S1:02

RAMADAN, E.

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Dust and dust storms recurrence and their impact on the marine environment

Dust in general, sand and dust storms in particular, are major events in the dry and semi-arid desert regions. These regions are effected by lack of rain, loss of vegetation, and high winds, which depend on the nature of the air pressure systems and instability and are caused by air currents rising that help to raise the dust and sand.

Kuwait, like most of its neighbouring countries, is affected by the dust and sand storm phenomena due to the availability of all the above factors. Kuwait, by virtue of its geographical location in the northwest of the Gulf, is facing the prevailing north-westerly winds which are laden with sand and dust from outside the country, as radar images show. These winds travel over the south-west and north-western deserts of Iraq, and the south eastern deserts of Syria, and eastern Jordan as the satellite. The land of Kuwait itself is represented mainly by two large sand creeping dunes (illustrated satellite image and photographs). The most active dune is located in the north-west across the Kuwait-Iraq border in the Alhowaymlia. The other is located at the northern border in an area Algashania. The two sand dunes are the main sources of the Local drifting sands.

These dust storm and strong north westerly winds are also known to help raise light dust and to keep it in the air, causing erosion of topsoil, and transmission to water bodies where it impacts the marine environment both in the Gulf and even the Arabian Sea.

Our study analyzed this serious environmental problem, and looked for solutions to reduce the natural disaster, especially with the latest developments in global climate change, compounded by extreme weather in the region.

Various studies analyzed the climate data on dust storm phenomena from the year 1962-2009 and proved that dust storms are an increasing problem on local and regional scales at the same time. A geographical map of the main and major sources of dust storms and sandstorms, the movement of these storms, transition, components, sediment dirt and sand carried by wind to the Gulf, Gulf of Oman and the Arabian Sea is monitored by the satellite and radar images.

S1:03

AL-GHADBAN, A. N.

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Geological and environmental overview of the Gulf

The Gulf is a shallow marginal basin which was connected to the Arabian Sea during the Holocene transgression. Geologically the Gulf can be regarded as shallow basin of recent clastic sediments over the subduction zone of Arabian-Iranian block. The bathymetry of the Gulf is shallower in the west and deeper in the east. Influx of terrigenous sediments from Shatt Al Arab and Shatt Al Basrah into the Gulf renders a large part of northern gulf turbid.

During the last three decades extensive studies have been conducted by different member states on physico-chemical characteristics, biological and ecological aspects along with few regionally coordinated programs like Mt., Mitchel Curise, Mussel watch program, etc.

Our experience in Kuwait since early 1990's highlights a few key issues that includes bathymetric changes due to influx of sediments leading to micro-hydrodynamic modification, physico-chemical changes (salinity, temperature, which are critical for sustainability of desalination activity), organic contamination (PCBs, PBDEs, OCPs), influx of nutrients from land based processes – though elevated concentrations are not seen in waters, radionuclides and dust transport.

Recently concluded studies at KISR have highlighted the fact that hydrophobic pollutants, despite of their continuous input in the Gulf, are not detected in waters because they co-deposits with fine sediments and the sediment sinks acts as a repository for these contaminants. This makes the environment more vulnerable to physico-chemical changes which might trigger their release and make them bio-available which may lead to an environmental catastrophe of regional scale. Therefore, an in-depth scientific study to establish a good database for better environmental assessment of the Gulf is of paramount importance.

S1: 04

AL-HUSAINI, M.¹, AL-BAZ, A.¹, DASHTI, T.¹, AL-JAZZAF, S.¹, HUSAIN, H.¹, AL-BINALI, A.², AL-YAFAEE, E.³, AL-MAAMARI, J.⁴, SALMAN, S.H.⁵, & AL-RAMADHAN, A.⁶

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Survey of demersal fish stocks of the Gulf and Sea of Oman

The objective of this cooperative project is to assess the status of demersal fish stocks in the western Gulf and the Sea of Oman. Predetermined sampling stations in territorial waters of the GCC countries were surveyed on board of KISR's research vessel using acoustics equipment and a trawl net with a 19-m head rope and 21.6-m foot rope. Four survey cruises were conducted during the period from November 2008 to January 2011. At each trawling station, the full depth acoustic profiles have been acquired and stored in order to validate and calibrate the acoustics tracking data. The catch was sorted out to species, weighed, and measured for length. Biological observations were recorded for major fish species and key species for each country. In total, about 1460 km of acoustic tracking (at ship speed of 6.0 – 7.0 knots) survey has been recorded in 19 full days in the third cruise. The average demersal fish density (kg/km²) and the biomass for each key species, depth, stratum and country was estimated, and the length-frequency distributions of fish species in the catches and their mean lengths were calculated. The preliminary results of the first three cruises are presented.

S1:05**FEARY, D.A.^{1,2}, BURT, J. A.³, BAUMAN, A.G.^{1,4}, SALE, P.F.¹, USSEGLIO, P.^{1,5}, & CAVALCANTE, G.H.^{1,6}**

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Reef fish community structure throughout the eastern Arabian Peninsula: geographic patterns in community composition

Reef fish communities in the southern Gulf, the Gulf of Oman, and Arabian Sea were visually assessed and compared. Gulf fish communities were a depauperate subset of the Gulf of Oman and Arabian Sea fish communities, with lower estimates of community abundance, diversity and biomass. Functionally, Gulf reefs were numerically dominated by species with little association to live coral (i.e. herbivorous grazers); Gulf of Oman held significantly higher abundances of species closely associated with coral reefs (i.e. coral associated planktivorous damselfish) than the Gulf, while a significant reduction in corallivores, piscivore/invertivores, piscivores and a significant increase in the abundance of herbivorous grazers were apparent when comparing Arabian Sea communities with Gulf of Oman communities. Where these water bodies intersected (Gulf and Gulf of Oman within the Strait of Hormuz; the Gulf of Oman and Arabian Sea within the Ras Al Hadd region) there was little difference in abundance, diversity or biomass than in adjacent areas, indicating little effect of high seasonal productivity within either mixing zone. We discuss our results in terms of the importance of regional differences in the major oceanographic variables affecting each biogeographic region.

SESSION 2-MARINE ECOLOGY & BIODIVERSITY

S2:01 Keynote

NIES, H., OSVATH, I., ERIKSSON, M., SCHOLTEN, J., BOSC, E., JEFFREE, R., OH, J., & BETTI, M.

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Monitoring of the marine environment - Role of IAEA Marine Environment Laboratories

The world oceans and regional seas play a major role in climate and environmental health and for the economy of the world population. However, there is the continuing threat to the Marine Environment due to pollution of rivers and land. Normally, direct pollution at sea from ships or off-shore installations is of minor scale, but there are several examples of catastrophic impacts like the recent catastrophe of the Deep Water Horizon in the Gulf of Mexico.

Monitoring of all types of contaminants in regular time and space can indicate the sources and fate of these pollutions. Pollution does not stop at any border. Therefore, both regional and local programmes have to be installed and the data have to be assessed in Quality Status Reports. This will also help to increase awareness of environmental issues.

One contaminant issue is natural and artificial radionuclides discharged or deposited to the marine environment. They can be used to study and understand processes in the marine environment. Examples for input, behaviour and distribution in time and space will be given for a number of radionuclides, such as tritium, Sr-90, Tc-99, I-129, Cs-137, Pu-isotopes and Am-241. Examples for regional co-operation will be shown for the OSPAR and HELCOM marine area.

The Marine Environment Laboratories of the IAEA, in bilateral and regional co-operations, apply a great number of techniques in order to assist Member States to study the marine environment. These include

- Low-level gamma spectrometry measurements in an underground laboratory
- Applying tracer techniques for submarine groundwater discharge, climate and pollution studies in coastal areas and using radioactive tracers for studying fluxes, mixing and trans-boundary transport of water masses
- Advanced analytical techniques applied to marine studies on organic or inorganic pollutants
- Studies of marine particles fluxes and “hot” particles
- Study of contaminated marine areas
- Marine data base MARiS and some applications
- Production of reference materials for marine origin of radionuclides, metals and organic compounds
- Training and capacity building in regional seas areas

Examples of applied techniques and cooperative studies will be given in the presentation.

S2:02

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Seagrass habitats in the Gulf: distribution, tolerance thresholds and threats

Seagrass habitats in the Gulf constitute a critical marine resource in the Gulf region, sustaining a high primary production, harbouring a high biodiversity of associated plant and animal species, and serving as important nursery grounds for commercial penaeid shrimps, pearl oysters and other marine organisms. The extreme environmental conditions in the Gulf, with water temperature varying between 10 and 39°C and salinity ranging from 38 to 70 ppt, are tolerated by only three opportunistic pioneering seagrass species (*Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis*). At least 7,000 km² of seagrass habitat have been mapped in the Gulf to date, with particularly extensive meadows in the coastal waters of Bahrain, Qatar and United Arab Emirates. This area also sustains the world's second largest population of about 7,000 dugongs, which are known to feed almost exclusively on seagrasses. Meanwhile, massive land-reclamation projects and rapid industrial developments (incl. power- and desalination plants) are posing an increasingly significant threat to seagrass habitats in this region. The present paper provides a detailed overview of the current distribution of seagrass habitats in the Gulf and their tolerance thresholds for relevant environmental parameters (temperature, salinity, light reduction, sedimentation). The paper concludes with a summary of the main threats to seagrasses in the Gulf and recommendations for their conservation and management.

S2:03

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Seagrass relocation and monitoring at the New Doha International Airport

Qatar has experienced rapid growth over the recent years, instigating a construction boom in the capital city of Doha. Construction activities and dredging campaigns have exerted significant environmental pressures on the marine environment of Doha Bay, especially on species such as seagrass. Seagrass beds and meadows are productive ecosystems and key habitats for a variety of species, but have been on a global decline mainly due to human activities such as construction.

The New Doha International Airport (NDIA) is one of the major projects in Qatar with a comprehensive environmental management programme. A significant compensation and mitigation programme designed for the NDIA involves the relocation of approximately 600 m² of seagrass (*Halophila stipulaceae*) to allow for the construction of a slipway to be used as a boat ramp for a sea rescue station at the North of the NDIA site. This paper presents an overview of the planning and execution methodology for the first seagrass transplantation project delivered in Qatar, employing a sod relocation technique with results of the post relocation monitoring. The overall goal of the project is the preservation of Qatar's marine ecology, as well as making a contribution to sustainable construction and development.

S2:04

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An ecological study of the benthic invertebrate community in Iraq's southern marshes

The marshland of southern Iraq has been the focal point of scientific attention ever since the area was subjected to desiccation during the last two decades of the twentieth century. In 2003 restoration began to rehabilitate this unique freshwater habitat. By mid 2006 water has already re-covered about 41% of the original marshland area. This paper presents the results of a study carried out between July 2006 and June 2007. The aim was to obtain quantitative data on some water characteristics and the restoration of the benthic community. Six locations were selected within the three main marshes Al-Hammar, Al-Chibayish and Al-Haweizah, and for comparison, a seventh location on River Al Garma. Ekman grab was used to collect five random monthly sampling units from each location. In addition; monthly data on hydrogen ion concentration, dissolved oxygen levels, salinity and water temperature was also recorded.

Mean water temperature ranged between 17.2 to 33 °C in summer months, and 10.1 to 16.9 °C in winter months. Mean pH value was 6.6 to 8.73 and dissolved oxygen levels were between 0.53 and 11.38 mg/l. Salinity of the marsh water also fluctuated, rising rather highly at some sites between 0.2 and 3.4 ppt.

A total of 68 taxa have been classified and recorded. The macroinvertebrate community was mainly composed of Oligochaeta (54.83%), aquatic insects (15.99%), Mollusks (14.93%), Crustacea (8.4%), Polychaeta (3.45%), Nematoda (2%) and Nemertea (0.23%). Monthly ranges of total density were 3552 to 91375.2 individual/m², 2486.4 to 29032 individual/m², 310.8 to 91952.4 individual/m² and 77122.8 to 2930.4 individual/m² at sites Al-Haweiza, Al-Chibayesh, Al-Hammar and Al-Garma respectively. The highest population density of each taxa were 177.6 individual/m² for Nemertea, 5816.4 individual/m² for Nematoda, 39338.4 individual/m² for Polychaeta, 488.4 individual/m² for Oligochaeta, 2308.8 individual/m² for Hirudinea, 5328 individual/m² for Isopoda, 4573.2 individual/m² for Amphipoda, 1755.1 individual/m² for Ostracoda, 2664 individual/m² for Chironomidae and 31834.8 individual/m² for Bivalvia. Four taxa were considered as exotic to the area: *Spongilla* sp., Nemertea, Polychaete worms *Dendronereides heteropoda* and *Namalichastis indica*, and the crustacean Barnacle *Balanus amphitriti*. Diversity indices were found to be on an increasing trend towards the end of the study period. Pattern of faunal dispersion within each site was found to be Random in 54.75% of the total number of sampling units. It was evident that the benthic community was influenced by the decay of large amounts of organic matter which in this case may have resulted from considerable amounts of aquatic plant remains from the pre-desiccation period. Furthermore, the bottom sediments were observed to be continually affected by disturbance and movement of large herds of Buffalo that traditionally inhabited the area.

S2:05

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Coral reproduction in Jebel Ali reef (Dubai-UAE): with emphasis on *Acropora downingi* (Wallace 1999) and *Porites harrisoni* (Veron 2000) species

Very little information is known about coral reproduction in the Gulf marine environment. The present study was carried out at Dubai coastal area to examine variations in reproductive patterns in two species of coral in Jebel Ali reef for a period one year (2008-2009). The two species belong to the Acroporidae and Poritidae families (*Acropora downingi* and *Porites harrisoni*, respectively). The first is hermaphroditic and the second gonochoric. Histological and dissection analyses were performed to investigate their reproductive systems and to identify the approximate time of their spawning. The analyses include the number of their oocytes, their diameter and percentage of the colonies showing maturation in their reproductive organs. Our results indicated that the spawning period of both species might take place from March until May. It has been found that environmental factors such as water temperature, salinity, turbidity, dissolved oxygen, as well as chlorophyll, affect the reproduction of the studied species differently.

S2:06

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A survey on habitat and biometric characteristics of Hawksbill Turtles (*Eretmochelys imbricata*) in Nekhilou Island of Bushehr Province

This research was conducted during the entire period of laying eggs by Hawksbills from mid-February till early October in 2007. In this study, a number of Hawksbills were tagged and their entire biometric characteristics measured such as, curved carapace length, curved carapace width, plastron length and tail length. Also, reproduction features like the total number of eggs, the number of normal and yolkless eggs, weight and diameter of eggs were measured. This study revealed that only 49 percent of measured Hawksbills laid eggs. The analysis of soil in the various nesting sites and nesting success showed that the grains in examined beaches soil textures were 0.063 to 2 millimeters (shells, gravels and sands) in size. The average weight and direct length of turtles was 49.45 kg and 65.12 cm, respectively, which indicated that these turtles have lower weight and length in comparison with other populations of this species in other parts of the world. The average total number of eggs was 92 and the average diameter and weight of the eggs was 37.18 millimeters and 30.45 grams, respectively, which though fairly similar to other populations of this same species in other Gulf neighbouring countries, is much smaller than the same species in other waterbodies of the world. Lastly it is comprehended that the Hawksbills which lay eggs in this island are similar to other populations of this species in the marginal Arab gulf countries of the Gulf, in the ROPME sea area, but the size of their eggs and hatchlings are larger, and this leads to an increase in the survival rate in Hawksbill hatchlings in Nekhilou Island and other uninhabited islands in Bushehr Province of Iran.

S2:07

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The scraping effect of sea urchins on the development of microbial biofilms associated with coral reef formations south of Kuwait

Coral reefs are productive ecosystems in the marine environment. The successful establishment of new coral colonies depends primarily on the success of coral larvae attaching to new surfaces. Marine microbial biofilms were found to participate in recruiting and inducing metamorphosis in various marine invertebrate larvae including corals. Marine microbial biofilm organisms, both prokaryotes and eukaryotes, were found responsible for conditioning surfaces, making them suitable for larval attachment. Many factors affect these microbial biofilms, and marine animals as scrapers are currently an underrepresented factor. Sea urchins are marine animals known for their role as coral bioeroders. However, the relationship between their role as biofilm scrapers and population density has not been investigated. In this study the effect of sea urchins as biofilm scrapers was investigated in three major experiments on an inshore reef system, south of Kuwait. In the first experiment, glass substrata were deployed for 2 months in a reef heavily populated with urchins. The developed biofilms were harvested weekly and the abundance as well as the diversity of the heterotrophic, phototrophic and cultivable bacteria in the biofilms and seawater was studied. The results showed fluctuations in microbial numbers and diversity throughout the study on both sides of the deployed substrata. Identification of the cultivable bacteria using partial 16S rRNA gene sequences revealed the dominance of the γ -Proteobacteria particularly Vibrionaceae in all samples. The second experiment aimed at investigating the effect of sea urchins on the developed microbial biofilms on protected and non-protected substrata. The results showed significantly higher numbers of heterotrophic bacteria in week 2 on the protected substrata biofilms. Insignificant variation in the heterotroph numbers was recorded after 4 weeks of deployment. In all cases, the denaturing gradient gel electrophoresis showed distinctive variations between the bacterial population of the protected and the non-protected substrata, regardless of biofilm age. In the third experiment, the role of sea urchins as scrapers was tested under controlled laboratory conditions. The microbial numbers in the biofilms incubated with the sea urchins showed a significant reduction which was accompanied by a significant increase in the number of the planktonic heterotrophs. It was concluded that sea urchins have the potential ability to act as microbial biofilm scrapers in the coral reef system which may be reflected in the reduction of conditioned surfaces available for coral larval settlement.

S2:08

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Intertidal and off-shore environmental assessment of the north of Kuwait ecosystem

The northern marine zone of Kuwait is considered a very vital biological zone. Most of the coastal areas of this zone are still not subjected to development activities. An environmental investigation was carried out for a zone that extends for more than 15 square km north of Kuwait. The core of this investigation was to check the intertidal zone benthic macro-fauna in terms of their dominance and abundances; whilst for the off-shore area was to investigate sediment quality, if contaminated or not, and the presence of any deformity in foraminifera.

The investigation results indicated that the intertidal zone is dominated by mud-skippers and that the off-shore area is not heavily contaminated with petroleum hydrocarbons and pesticides. In addition, no significant deformities were observed in the foraminifera samples collected and analysed.

S2:09

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The importance of rocky coastal ecosystems in heavy metal biosorption in the Gulf

Vanadium and Nickel absorption as oil contaminant indicators were examined in an intertidal zone in Queshm Island (North Gulf) during the early summer of 2009 using in situ mesocosm conditions. The role of these two heavy metals has been well documented as causing important mortalities in sessile communities. *Ballanus improvisus* (Cirripedia; Crustacea) was chosen as the dominant benthic species in rocky coasts of south Queshm Island. Preliminary observations and knowledge indicated that species in intertidal bands have to be abundantly clear during prior high tides to compensate the metabolite and toxic component produced during their exposure to the air. 10 times of exposure to the initial concentration was examined at 4 minute intervals. Alternative laps of exposure to initial concentration ($100 \mu\text{g L}^{-1}$ for Nickel and $50 \mu\text{g L}^{-1}$ for Vanadium) were chosen in order to understand the absorption and filtration behaviour of the species when exposed to constant concentrations of non-essential toxic heavy metals. These initial concentrations were reconsidered when the latter was multiplied two, three and four times, reaching to $250 \mu\text{g L}^{-1}$ for Nickel and $200 \mu\text{g L}^{-1}$ for Vanadium. Observations and data analysis suggest that, in low concentrations, barnacles can significantly clear a water body from toxic components. Barnacles could clear up to 95% when the concentration was low. This value can decrease to as low as 10% in high concentrations regardless of exposure time. Auxiliary results suggest there might be significant differences between the same species from high tide band when compared to low tide communities; high tide species consistently show important filtration and absorption efficiencies.

A major part of rocky shores in north Gulf is built of barnacle reefs which have contributed to the building of these shores of many kilometres long and up to 5 m thick during the geological era. Barnacles have made a habitat for many unique species of the intertidal zone including molluscs, crustaceans, seaweeds and fishes. This study, and others undertaken to show their clearing role in a sea endangered by huge petrol traffic and oil spills may encourage the need for protection of such coasts.

S2:10

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Rehabilitation and effectiveness of artificial reef on population of lobsters in Oman Sea-south of Iran

Marine structures, whether man-made or natural, have a recognized potential to attract and concentrate fish. The effectiveness of artificial reefs in increasing productivity depends on the design of a reef structure, in particular whether it meets the specific habitat requirements of individual target species and age groups. There exists three main spiny lobster species *Panulirus homarus*, *P. versicolor* and *P. polyphagus* in the southern coast of Iran. These are commercial species which for many years have been a main resource for local anglers, but in recent decades the catches have declined. Data from 2003 show a 72% decrease. Creating artificial reefs could be a conservation approach for these aquatic species. Our research looked at 30 artificial reefs located in Ramin, designed with three different forms and floor sizes with regard to bio-characteristics of lobsters. Comparisons of *P. homarus* were made between structures. After a year, results showed a significant difference between the lobsters nestling in the different reef formations. Different ages of lobsters have preferred heights for the holes and gaps in the reef. It showed that design of the reef is an important factor in the attraction of assemblages of lobsters, based on their preferences.

SESSION 3: MARINE POLLUTION AND ITS IMPACT

S3:01 Keynote

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State of Pollution in the Gulf

Pollution surveys in the Gulf started around 30 years ago, when ROPME initiated the 18-month monitoring and research programs on oil and non-oil pollutants, in the frame of oceanographic surveys. These surveys were conducted by the member states using sampling and analytical methods in the MOOPAM. Quality assurance and analytical quality control elements of the survey were limited, causing problems in data comparisons among the different laboratories.

Harmonized pollution surveys started in the 1990's, first the 100-day Mt. Mitchell marine cruise. During 2001 and 2006, ROPME organized marine cruises in the offshore area of the Gulf, particularly surveying the sediments for organic and inorganic pollutants. Additionally, near-shore contaminant surveys were conducted in the territorial waters, particularly in sediments and biota, of the member states.

During these surveys, quality assurance and control were major concerns during the sample preparation and analysis; most of the samples were analyzed in a single laboratory, IAEA-MEL in Monaco, to at least avoid likely discrepancies among different laboratories.

The survey results revealed low levels and variations in the presence of inorganic compounds (heavy metals) in the sediments. Good correlation was found between the concentration of the individual heavy metals and the geochemical characteristics of the sediment. This was likely due to the lack of major heavy metal pollution sources in the Gulf region. Some near-shore samples indicated slightly elevated levels of some heavy metals without exceeding sediment quality guidelines.

Regarding the organic pollutants, oil-related quality variables, e.g., TPH and PAHs, were present generally in low concentration despite the most significant pollution sources in the Gulf. Similarly, organo-chlorine compounds were detected in some parts of the Gulf without exceeding quality guidelines with a few exceptions.

S3:02

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Radiation pollution in the southern Iraqi wetlands and probable deterioration of the northern Gulf

Southern Iraq, specifically its aquatic wetlands, are suffering from continuous radiation pollution as a result of the second (1991) and third (2003) Gulf Wars where coalition forces used sophisticated weaponry containing depleted uranium (DU) against targets inside Iraq. This led to the destruction of most of the war materials, which in turn were left on the battle front for a long time. Studies which covered environmental media, soil, plant and water from most parts of Southern Iraq revealed an increase in levels of radiation exposure, as well as recording high levels of radionuclides Ra^{226} , Pb^{214} , Bi^{214} within the decay series of U^{238} . Values reported for Ra^{226} in the sediments of the Main Outlet Drainage (MOD) were decreased from 356 $\mu\text{rad/h}$ during 1991 to 91 $\mu\text{rad/h}$ during 1999 then down to 75-80 $\mu\text{rad/h}$ during 2000. The levels reached 51-57 $\mu\text{rad/h}$ in Shatt Al-Basrah channel, and then reached 39-46 $\mu\text{rad/h}$ in Khor Al-Zubair. All of these water ways are main water flow routes to the North West Gulf. They could be deteriorated by certain radionuclides that are transported by means of aquatic phyto- and zooplanktons already existing in the area, in addition to expected transportation by air, due to the existence of ordinance in the battle fronts from the 2nd and 3rd Gulf Wars.

S3:03

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Trace metal speciation in marine sediments from Sulaibikhat Bay, Kuwait

The chemical speciation of trace metals (Cd, Co, Cr, Cu, Ni, Pb and Zn) in marine sediments from Sulaibikhat Bay, Kuwait was determined using a three-step sequential extraction procedure. To obtain a mass balance, a fourth step, i.e. digestion and analysis of the residue, was undertaken using a microwave-assisted acid digestion procedure. The sum of the 4 steps (acid-soluble + reducible + oxidizable + residual) was in good agreement with the total content, suggesting that the microwave extraction procedure was efficient. The results showed that all metals, except for Pb and Zn, were present at higher percentages in the residual fraction. The reducible fraction was the second most significant followed by the oxidizable fraction. The exchangeable fraction was least important as a host for most metals. The mobility order of exchangeable fraction of the elements in surface sediments decreased in the order Cd > Zn > Cu > Co > Pb > Ni > Cr; the reducible fraction in the order Pb > Zn > Cu > Cd > Co > Ni > Cr; the oxidizable fraction in the order Pb > Cu > Cd > Ni > Co > Zn > Cr, and the residual fraction in the order Cr > Ni > Co > Cu > Cd > Zn > Pb. The data showed that the speciation of trace elements in sediments close to a sewage outfall was different from the sediment from the other parts of Sulaibikhat Bay. This suggests that the contribution of the sewage outfall to metal pollution in an adjacent marine area is positive, and is associated with fine-grained sediments with a high level of organic content, which are major controlling factors for the distribution of trace metals in this part of the Bay.

S3:04

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Effect of environmental factors on photodegradation of polycyclic aromatic hydrocarbons (PAHs) in the water-soluble fraction of Kuwait crude oil in seawater

The main objective of this study was to investigate the effect of different environmental factors such as light intensity, dissolved oxygen, seawater temperature and presence of photosensitizer on the rate of degradation of PAHs in the water-soluble fraction (WSF) of Kuwait crude oil in seawater. The concentration of PAHs in the WSF was determined by the analysis of concentrated extract by gas chromatography/mass spectrometry in selected ion monitoring mode. The results indicated that all factors investigated had significant effect on the degradation rates of PAHs. At 15 °C almost all PAHs optimally degraded at oxygen level of 4 ppm. For lower PAHs, light intensity of 500 W/m² in presence of sensitizer worked well. Higher PAHs degraded at faster rates with light intensity 750 W/m². At 30 °C, most of the PAHs degraded optimally at an oxygen level of 0 ppm and light intensity of 500 or 750 W/m² in presence of sensitizer. At 40 °C, most of PAHs degraded optimally at low oxygen concentrations (0 and 4 ppm) and light intensity of 500 W/m² in presence of sensitizer.

S3:05

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Baseline study of pollutants at Jubail Industrial Port, Saudi Arabia

Anthropogenic contaminants are considered to be major sources of pollutants in the marine environment. Spilled oil and sewage loaded with organic compounds and heavy metals eventually end up in the water column or in the sediment or in both. A baseline study was conducted in 2009 of the Jubail industrial port to assess the current status of various hydrocarbon pollutants including: Naphthalene, Methyl Naphthalene, Acenaphthene, Flourene, Phenanthrene, Anthracene, Pyrene, and Fluoranthene. Heavy metals (V, Ni, Zn, Cu, Cr, Pb) and trace metals (Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, V, Zn) were also measured in sediments and water columns for eight stations allocated within the industrial port, using established EPA methods (EPA 3050B and EPA 3545) and analyzed using an ICP, GC/MS.

The results of this study for sediment samples indicated that Naphthalene is present in all sites. However, the highest concentration, 6.75 ng/g, was found in site 3. 2-methylnaphthalene was found in all sites except 6 and 8; its highest concentration, 1.9 ng/g, being found in site 2. Phenanthrenes were present in sites 2, 4, 5, and 8. However the highest concentration, 2.1ng/g, was found in site 2. All sites consist of Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, V., and Zn, the highest concentration of those elements being found in site 2. Naphthalene is present in all sea water samples, with the highest concentration of 0.18 ng/ml found in site 3. 2-methyl naphthalene was present in sea water of all sites except site 2. The highest concentration 0.03ng/ml was found in site 1. Various elements such as Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, V., and Zn were present in all sites of sea water, with the highest concentrations found in sites 4 and 7. The level of pollution in all sites for water samples and sediments were within the acceptable limit ranges set for Saudi Arabia. We believe that the presence of hydrocarbon compounds, heavy metals, and trace metals in sediment and water samples is related to shipping activities including, oil spills and chemical products spills occurring during loading. Therefore, it is recommended that safety measures be enforced during loading to prevent spills and accumulation of such pollutants within the port vicinity.

S3:06

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Contribution of desalination plants to marine pollution in Kuwait with the Gulf in perspective

Due to scarce fresh water resources, Kuwait, as well as other gulf states, depends heavily on desalination of seawater to produce its water supply needs. Currently eight dual-purpose sites for water production and power generation, along a 120-km shoreline are developed in Kuwait. However, by virtue of the desalination process, large volumes of seawater are utilized for this activity, which are discharged back to the sea body after use, usually at higher salinity and temperature. These outputs are associated with several pollutants from the desalination pre-treatment operation. In view of the importance of desalination plants as one of the major land-based sources of marine pollution, an assessment of the impacts of the effluent discharge from three desalination plants located at different marine environments on the north and south of Kuwait's coastline was carried out. The assessment included physical, chemical and biological impacts.

In this paper, findings related to the type and extend of impacts on the adjacent marine ecosystem will be presented and discussed in relation to the physiochemical, geological and biological setting of the impacted areas at each desalination site. Based on these findings an interpolation of the potential impacts of desalination plants on the Gulf's integrity will be made in view of the semi-enclosed

S3:07

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Marine environmental impacts of power-desalination plants in Kuwait

Kuwait's Ministry of Electricity and Water (MEW) is planning to supplement the existing electric power generation capacity in the country by constructing new Combined-Cycle Gas-Turbine Station (CCGTs) at Shuaiba North Power Station (SNPS) and Subiya Power Station (SPS) in order to meet the increasing power demand. The plans also include installation of a Multistage Flash (MSF) Distillation Plant for seawater desalination at the SNPS to increase Kuwait's supply of potable water. In Shuaiba, the proposed site of the new CCGT-MSF cogeneration plant is the decommissioned Shuaiba North Thermal and Gas-Turbine Power Station, located within the existing Shuaiba Area Authority Industrial Complex, about 50 km south of Kuwait City. In Subiya, the proposed site of the new CCGT is within the existing SPS, which is about 100 km north of Kuwait City.

Construction of these new facilities will impact the environment. Thus, the MEW contracted the Kuwait Institute for Scientific Research (KISR) to conduct an initial environmental impact assessment (EIA) for these sites, as per the guidelines of Kuwait's Environment Public Authority. The EIA was performed in three parts: air, marine, and hydraulics, by separate multidisciplinary teams that conducted field surveys, took measurements, collected and analyzed samples, and in some cases, carried out predictive numerical modeling studies of the potential impact of plant operations on the surrounding environment. These EIA studies took into account the impact of the already existing as well as the planned power generation and desalination facilities.

This report presents the results and a discussion of the marine water and sediment analyses, including the marine ecology surveys. It also summarizes the results of the hydraulic surveys and modeling studies conducted by KISR in Shuaiba and Subiya. The expected environmental impacts of the proposed facilities are evaluated via a Rapid Impact Assessment Matrix (RIAM) analysis, and recommendations are given for design criteria, monitoring, and mitigation. The principal environmental impacts of both facilities include: impingement and entrainment of organisms in seawater intakes; thermal and chemical (chlorine and metals) contents of seawater discharges; and potential reductions of the abundance and biodiversity of organisms in the local marine ecosystems.

S3:08 Keynote
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The establishment of a marine science database, for management and risk assessment purposes

Increasingly, knowledge of forcing mechanisms for water movement and interaction with the underlying sea bed and adjacent river inputs is needed for coastal and inner continental shelf systems. Within this context, sediment dynamics plays an important part, in terms of the understanding and prediction of: sea bed mobility; morphological changes; contamination of coastal and shelf environments; coastal management; and interactions with biota. Different spatial and temporal scales need to be examined, through wide-ranging approaches, e.g. field measurements, laboratory investigations and modeling. Likewise, sediment budgets on a regional scale (such as the Gulf) need to be established. These approaches are intended to permit an assessment of environmental status, at the ecosystem level.

Various approaches to sediment dynamics are described, ranging from wave-induced flows to satellite/airbourne remote sensing. Confidence in the derived results, on rates and directions of transport, will be assessed.

Within a European context, various initiatives have been developed: the Habitats Directive; the Water Framework Directive; and the Marine Strategy Framework Directive. The contents and approaches in these Directives will be examined, within the context of management and risk assessment of the Gulf ecosystem.

S3:09

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Harmful algal blooms in Kuwait

Microalgal blooms occur in Kuwait's waters year round. Seasonal blooms are normal phenomena in Kuwait's waters and in the Gulf region. In general, microalgal blooms can cause discoloration of the water (generally known as red tides) and have harmful effects causing mass mortalities in fish, invertebrates, birds, and mammals. The ecology and taxonomy of phytoplankton in Kuwait's waters have been studied during the past few decades; however limited taxonomical studies have been done on marine phytoplankton and on potentially harmful species.

Kuwait's waters are rich in nutrients. The continuous discharge of nutrients into the northern Gulf area due to the influence of Shatt Al-Arab and the Third River has important biological implications. Additionally, discharges of untreated sewage and other wastes (including chemicals, fertilizers, aquaculture etc), are polluting the coastal waters with excess nutrients. These levels of nutrient inputs into Kuwait's waters have the potential to cause eutrophication and algal blooms.

Benthic microalgae are also important primary producers in the intertidal zone in Kuwait's marine environment. Although marine microbenthic communities in some parts of Kuwait's coastline were examined previously, these studies were focused on general productivity and/or diversity, especially for the diatom/cyanobacteria components. Potentially toxic microalgae were observed within the intertidal community of Kuwait.

A total of 77 identified taxa can be categorized as potentially harmful species in the collected samples from Kuwait's waters and intertidal flats. Among them, 30 taxa were potentially toxic to humans and other higher animals, 24 taxa were potentially harmful to fish and invertebrates, 13 species caused blooms in Kuwait's waters and 10 species were potentially bloom-forming.

Most of the microalgal blooms in Kuwait's marine environment were harmless and potentially toxic species were recorded in low densities. The only documented toxic bloom in Kuwait's waters that caused fish and marine mortalities was that of *Karenia selliformis* and *Prorocentrum rhathymum* in the summer of 1999 in Kuwait Bay, when a significant loss of maricultured and wild fish was recorded. However, the presence of a significant number of potentially harmful species in the phytoplankton composition of Kuwait's waters, even in low concentrations, can be regarded as an important finding with the potential of causing harmful incidents in the future. Sporadic high densities and species richness of the toxic phytoplankton species requires comprehensive, long-term studies of Kuwait's marine environment.

S3:10

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The occurrence of potentially harmful algal blooms (HAB's) in the Sea of Oman in relation to environmental changes

The Gulf and Sea of Oman experienced devastating Harmful Algal Blooms (HABs) in 2008 that caused massive kills of marine organisms and had significant economic impacts on desalination plants and tourism. Over the past 10 years these outbreaks have been on the rise and the forces contributing to more frequent blooms are still unclear. One of the limitations has been the lack of a dedicated monitoring program, and a systematic multivariate sampling strategy along the coast and offshore waters at regular time intervals. As a consequence, the region is poorly investigated in terms of seasonal and inter-annual variability of phytoplankton communities, and their related driving forces.

In order to achieve conservation and long-term sustainable use of marine living resources we need to build a fundamental understanding of the coast through continuous monitoring and research that will allow us to differentiate between anthropogenic and natural variability. We have been collecting data from three monitoring sites, two of which are located in the Sea of Oman and one in Arabian Sea at Masira from 2004 onwards. Data collected includes phytoplankton diversity, and hydrographic parameters such as temperature, salinity, nutrients and oxygen that will not only provide us with baseline data necessary for future studies on anthropogenic impacts on this ecosystem but also a better understanding of the seasonal and interannual changes associated with monsoonal forcing. In this paper we address the seasonal monsoonal cycle and its impact on the biology of the coastal waters and use our findings to arrive at conclusions about how variability in phytoplankton and its environment could impact the food chain of this ecosystem.

The diversity of harmful algal blooms (HABs) and their impacts present a significant challenge to those responsible for the management of coastal waters resources. The abundance and distribution of HAB's in coastal water of Oman is poorly investigated.

The occurrence of potentially HAB species was examined over a 2-year (2004-2005) period in the coastal water of the Gulf of Oman that has been subject to ecologically significant events which have been related to HAB's. The results of our study reveal a significant presence of more than three species of phytoplankton that have been shown to be toxic in other regions of the world. In addition the abundance of these species appears to have been associated with changes in environmental conditions over the last 2 years. It may be hypothesized that changes in environmental conditions driven by large scale events such as mesoscale eddies contributed to these biological changes. The significance of these results is discussed within the context of the ecological changes of the coastal water of Oman.

S3:11

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***Cochlodinium* blooms: Comparisons of the major 2008-2009 bloom in Omani waters with similar blooms worldwide**

Harmful algal blooms are increasing in frequency, intensity and geographic distribution globally. One of the harmful algal species of concern is *Cochlodinium polykrikoides*. In 2008-2009 a massive bloom of this species occurred off the UAE and Omani coasts causing considerable ecological and economic harm. Of concern is the fact that this species is known to cause fish kills.

The goal of this talk is to describe some of the common ecological and physiological aspects of this algal species in blooms worldwide. It has become a frequent bloom-former in Chesapeake Bay, as well as in other embayments along the east coast of the USA and throughout many regions in Asia. It can reach very high cell density when it blooms, and blooms can be near monospecific, suggesting that it out competes all other phytoplankton once blooms develop.

Cochlodinium, like many dinoflagellates, appear to proliferate in waters in which the ratio of available N:P is low relative to “Redfield” proportions, indicating its high requirement for phosphate. Furthermore, while it can take up and use all forms of N, the most common forms of nitrogen that appear to support its growth are those that are chemically reduced: ammonium, urea, or organic nitrogen. *Cochlodinium* is also a mixotroph and has the ability to graze other phytoplankton to obtain some of its nutrition. The nutrient relationships of the Omani bloom appear consistent with those relationships from other blooms.

S3:12

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Status of macrobenthic communities in the Manifa-Tanajib Bay System (Saudi Arabia), fifteen years after the 1991 oil spill

The 1991 Gulf oil spill caused deleterious effects on the benthic fauna of the northern Gulf. The most heavily affected were the lagoons and bays located between Ras Al-Khafji in the north and Ras Abu Ali in the south. Manifa-Tanajib Bay System (MTBS), located within this affected area was studied in detail during 2006 to comprehend the status of macrobenthic communities fifteen years after the oil spill. Benthic samples were collected from 25 locations (0.5 – 8.5 m) of MTBS representing inner bay and outer bay regions. Post spill studies have reported the heavily polluted status in sediments (200 – 10,000 mg kg⁻¹ of Total Petroleum Hydrocarbons, TPH) in several locations of MTBS and the sediment-depth profile studies revealed a higher concentration ranging from 0-5 cm during 1993, while it was at 10-20 cm during 2002-2003. This study showed detectable levels of TPH only in two stations, one in the inner bay and another in the outer bay. Altogether, 39 macrobenthic taxa were recorded from the study area, of which, polychaetes comprised 39% of the total individuals and had undergone detailed community structure analyses. Opportunistic polychaete/amphipod ratio (BOPA index) indicated high (80%) and good (20%) ecological status in the study area. Our results indicated that the benthic communities in the MTBS are devoid of any kind of stress from the oil pollution.

SESSION 4: ECOTOXICOLOGY AND ECOSYSTEM HEALTH

S4:01 Keynote

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Globalization of ecosystem health assessment: promoting a “battery of ecological indicators” approach backed with multi-national agreements

Aquatic ecosystem health has suffered from multiple anthropogenic stressors including pollution, eutrophication, over-exploitation of fisheries, the establishment of exotic biota and currently, climate change. Due to rapid globalization and increased human populations, the impacts of these stressors have been compounded. The proliferating, cumulative challenges to aquatic ecosystems require integrated, adaptive, science-based strategies to management. An integrated approach to ecosystem management must balance both the maintenance of and benefits from healthy ecosystems. A “battery of ecological indicators” approach was developed in the North American Great Lakes and has been successfully used to combat pollution. Underlying this success has been the Great Lakes Water Quality Agreement (GLWQA), an international treaty between Canada and the United States which has provided a focal point for research and management initiatives. The GLWQA and its predecessor treaties have been in place for over 100 years and the lessons from long term management have generated ecosystem based management tools which are equally applicable to large marine ecosystems. Needless to say, such international agreements between sovereign governments serve as building blocks for the development of integrated and holistic strategies. The Gulf provides a unique opportunity to develop a similar international agreement between the 8 riparian countries for assessing and managing the multiple stressors which the Gulf is confronted with. This presentation will highlight research tools and techniques as well as management strategies that will pave the way for an international agreement to manage the shared resources of the Gulf region.

S4:02

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Stress biomarkers in determining ecosystem health

Several studies conducted in our laboratory documented the influence of pollution on the sediment transport, sediment quality, benthic ecology and the coastline of Kuwait. Persistent toxic substances and other priority pollutants have also been determined in Kuwait's marine environment. To gain understanding of the relationship between the exposure to physical and chemicals stressors and the changes in the biological response of the exposed organisms, a research program on bio-indicators has been initiated. Three varieties of fish species, sea bream, mullet and tonguesole were captured from Kuwait Bay, and outside the Bay in summer and winter seasons, and examined for biomarkers. Glutathione-s-transferase (GST), 7-ethoxy resorufin-O-dethylase (EROD), acetylcholine esterase (AChE) and metallothioneins were determined as indicators of exposure to planar hydrocarbons, neurotoxic inhibitors and trace metals. Heat shock proteins (HSP70) were determined to study seasonal effects on induced proteins. Species, seasonal and site differences were experienced and will be discussed in relation to chemical analysis of the sediment and fish tissues and PAHs metabolites in bile. The study provided information about the range of various biomarkers in fish captured from the two areas, influenced by seasonal variation, mixed pollution and variable thermal stress. Attempts have been made to define intrinsic and induced levels of biomarkers in fish and the significance of these changes as indicators of stress in an ecological system.

S4:03

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Selected environment and sustainable development indicators for the Kingdom of Bahrain

A selected set of indicators were highlighted based on the criteria previously introduced by the UN-Commission for Sustainable Development (CSD) studies. Ministries and other organizations were consulted but the main data source was the Central Information Organization in Bahrain whose responsibility is to collect data from other organizations. The required data were readily available only in some organizations but in different formats. Based on data availability, twenty working and measurable indicators have been identified. The results of this study could be divided into three main groups. The first included data on indicators that meet the definition laid down by the CSD such as: Emission of CO₂, Arable and Permanent Crop Land Area, Annual Withdrawals of Ground Waters, and Mortality Rate Under 5 Years. The second group of indicators were those based on the data that needed accurate extraction, formatting and further interpretation such as: Use of Fertilizers, Annual Catch by Main Species and Protected Area as Percentage of Total Area. The third group was not available and needed to be developed such as Coastal Water Quality, Change in Surface Water Discharge, and Threatened Plant Species as Percentage of Total Known Plant Species. The indicators used in this study were those belonging to the first two groups. It is recommended that a national multiparty committee should be established in order to develop these and more indicators. The committee should also be supported by the available technological advancement and a unified and accessible mechanism put in place in order to collect updated data on a regular basis.

S4:04

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Sea turtles in Iran, population assessment, ecosystem health and conservation status

In Iran, the locations of most marine turtle rookeries are known and most researches have revealed that the main nesting grounds for sea turtles are at islands, with smaller numbers recorded in mainland coasts. Annual nesting numbers remain speculative due to lack of standardized monitoring on several nesting beaches. The hawksbill turtle (*Eretmochelys imbricate*) is a most important species and nesting of this species is recorded in many islands of the Gulf. A second species is the green turtle (*Chelonia mydas*) which spawns in some restricted areas of the Oman Sea. Globally, both species are categorized as endangered in the 2000 IUCN Red Data list. In this study, nesting activity of hawksbill turtle was studied in some important islands (average nesting success; 58.4%). Nesting season of this species occurs from March to May. In some beaches, nests threatened by inundation were relocated to safe areas of the beach and also protective metal grids were placed over some nests to prevent predation. Unfortunately in some beaches there is egg harvesting and predation of adult females. In this work, efforts were made to raise public awareness of the biological and social importance of marine turtles in Iran. There is severe development pressure along the many coasts, and if the population of nesting turtles at most of beaches is to survive, immediate conservation efforts should be implemented.

S4:05

**KARAM, Q.¹, BEG, M.U.¹, AL-KHABBAZ, A.¹, AL-BALLAM, Z.², DAKOUR, S.³
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Morphological abnormalities in early life stages of Sea Bream *Sparidentex hasta* exposed to WAF of Kuwait crude oil

The present study was aimed at determining the effects of the water accommodated fraction (WAF) of Kuwait crude oil (KCO) exposure on the early life stages of sobaity sea bream (*Sparidentex hasta*) including fish egg hatching, survival of larvae, and deformities in exposed eggs and larvae. The study revealed that exposure to WAF caused no effect on the hatching success of sobaity eggs. However, survival of sobaity larvae was affected by exposure to WAF prepared at variable oil loadings (0.125 to 80 g KCO/l seawater). WAF prepared at lower oil loading (0.125 & 0.25 g KCO/l seawater) exerted severe toxic effects showing LC₅₀ values at <10 mg KCO/l of seawater. Exposure to WAF prepared at ≥ 1 g KCO/l WAF exhibited less toxicity in terms of mortality, but produced deformities in exposed larvae. For morphological deformity in sobaity larvae, the lowest observable effect concentration (LOEC) was 0.06 g KCO/l seawater (≅0.019 mg TPH) at which 9% of the exposed larvae were found deformed. Deformity increased to 31% at exposure levels of 1 g KCO/l seawater (≅0.31 mg TPH). Most frequent deformities observed were of Type-A (lordosis-inward curvature of spine or V-shaped), Type-B (kyphosis-hunchback) and Type-C (scoliosis-lateral bending of spine). WAF prepared at higher oil loadings could not increase the overall oil toxicity and deformity percentage or type of deformities since separation of aqueous and oil layer was distinct; whereas WAF prepared at lower oil loadings contained inseparable micro droplets that partitioned in dilutions and exerted harmful effects. The types of deformities frequently observed in this study resembled the reported deformities in the literature due to the presence of certain polycyclic aromatic hydrocarbons (PAHs) that were also detected in the WAF of KCO which may possibly be the causative agents.

S4:06

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Effect of effluent discharges to Pomfret Fish: An indicator to marine pollution in Kuwait

The intensification of environmental stress greatly contributes to the significant rise of trace metal pollution in Kuwaiti water resources, making threats on aquatic life. This instigated a study to determine the effects of effluent discharges that mainly contained trace metals (Pb, Ni, V, Cd and As), on the commercially relished Pomfret, *Pampus argenteus* and also in relation to nutrient levels in seawater. The sequence of Pb>Cd> Ni> V>As levels were observed in both Kuwait Bay and Coastal waters sites. Nutrient levels were observed in the sequence of Silicate>Nitrate>Phosphate in both the sites. Observations showed higher trace metal and nutrient levels in Kuwait Bay, than those in the coastal waters. Besides the observations of high trace metal concentrations in the body parts of *P. argenteus*, statistical tests showed significant correlations between fish length (15cm-30cm) and the body parts. Furthermore, the bioaccumulation factor (BAF) in their body parts was in the sequence of As> V> Ni > Cd>Pb and higher in Kuwait Bay than in the coastal waters. These results not only validated aging studies as indicators to trace metal pollution, but also supported evidence to the intensity and effect of accidentally discharged effluents from various thermal, power and desalination plants on the marine environment.

SESSION 5: ENVIRONMENTAL POLLUTION AND TRANSBOUNDARY MOVEMENT

S5:01

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Dust storms over the Gulf: An optimistic vision toward climate change consequences

Dust storms frequencies and strengths have been monitored during 2009 at different locations along the coastal areas of the United Arab Emirates as a representative site of the Gulf marine environment. The results have been compared with the previous five years data set. Moreover, mineralogical components of the collected dust samples during the study period have been analyzed using both XRD and XRF techniques. The results of comparison have allowed changes occurring in dust storm characteristics over the Gulf to be evaluated and to be considered as a sensitive signal of climate changes over the region. It has been also found that due to the different wind patterns over the Gulf, the dust sources are variable both temporally and spatially, and its variability can be confirmed by mineralogical composition of the dust samples. Furthermore, the mineralogical analyses have also helped in evaluating the beneficial nutritive contribution of dust deposition to the microbial productivity in the marine ecosystem of the Gulf.

S5:02

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Dust fallout properties within major dust storm trajectories in the Gulf

Dust deposition rates were measured and analyzed in Bubiyan and Warba islands in the northern Gulf in order to estimate the amount of fallen dust within major dust trajectories in the gulf. All collective data from different satellite images from 2000 to 2010 were compared to all major dust events and their trajectories of long range transport. There were 8 major trajectories identified. Samples were collected from different parts within these major trajectories. The Gulf receives between 56 to 120 tons/km² annually of fallen dust which represents the highest in the world. The amount of fallen dust from these major trajectories into the gulf was estimated as 30 million tons/yr. The grain size percentages are trimodal with dominancy of very fine sand, coarse silt and clay (21%). The records of fallen dust show an increase within the last five years. This kind of increase in the amount of fallen dust is expected to affect the biodiversity in the gulf by increase in phytoplankton such as the cyanobacteria, but negatively affect the coral reefs. The mineralogical composition and grain surface area illustrate slight or no physical and mineralogical variations with time in the Gulf, but large variations in comparison to the world dust fallout. The future increase in the temperature and aridity due to climate change is a major factor in enhancing aeolian activities fallen dust quantities.

S5:03

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Persistent organic pollutants in the atmosphere of the Gulf: Levels, sources and transboundary movement

Persistent organic pollutants (POPs) have received intense international attention in recent years because of their ubiquity, persistence, high bioaccumulation potential and harmful biological effects. These concerns eventually led to the development of the "Stockholm Convention" on POPs, a global treaty aimed at reducing and eventually banning an initial list of the twelve "worst" POPs, in 2001. In Kuwait, and most of the Middle East, there is scarcity of information on loads and emissions, persistence and degradation in different media, monitoring data, and therefore of time series data. In response to the requirements of the "Stockholm Convention", a monitoring campaign was initiated in Kuwait to measure these compounds in air using high volume and passive samplers, to produce time series data so that compliance with the treaty could be assessed. The results, to date, of spatial, temporal, and diurnal variability for polychlorinated biphenyls (PCBs), a "legacy" POP, and polybrominated diphenyl ethers (PBDEs), an "emerging" POP which has recently been added to the target list of compounds in the Stockholm convention, will be presented and discussed with the view to gain insights into their sources and processing in the Gulf region.

S5:04

HOLOUBEK, I., KLÁNOVÁ, J., ČUPR, P., KUKUČKA, P., BORŮVKOVÁ, J., KOHOUTEK, J., PROKEŠ, R., & KAREŠ, R.

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POPs global distribution in ambient air samples from MONET Network

The Stockholm Convention (SC) on Persistent Organic Pollutants (POPs), Article 16, states that its effectiveness shall be evaluated starting four years after the date of its entry into force, and periodically thereafter at intervals to be decided by the Conference of the Parties (COP). A Global Monitoring Plan (GMP) has been developed with an objective of evaluating whether the POPs were actually reduced or eliminated on a global scale. GMP should outline a strategic and cost effective approach built on existing monitoring programmes to the extent possible. It has to be simple, practical, feasible and sustainable.

In the last few years a range of passive air samplers (PAS) have been developed as new tools for air quality monitoring. PAS offer a cheap and versatile alternative to the conventional high volume air samplers, and they have been recommended as one of the methods suitable for the purpose of new long-term monitoring projects.

MONET programme (MONnitoring NETwork) is driven by RECETOX as the Regional Center of the Stockholm Convention for the region of Central and Eastern Europe. The summary report with results of the ambient air POPs monitoring activities in the Central and Eastern European region (CEEC), Central Asia, Africa and Pacific Islands was published recently. Based on these positive results, the National POPs monitoring network, using the PAS technique, has been established in the Czech Republic (MONET-CZ). The design of the MONET network containing 37 sites (including 15 backgrounds) was introduced and initiated in January, 2006. It has been maintained since, collecting thirteen 28-day samples from each site every year.

As Central, Southern and Eastern Europe is the region with a lack of data on the atmospheric POP, three screening campaigns were organized between 2006 and 2008 (MONET-CEECs). The philosophy was the same as for the model network in the Czech Republic: 5-20 sampling sites were selected per country (according country size) and they were monitored for 5 months. The goal was not only to determine the background levels, but also to provide information on the extent of pollution. In addition to the Central and Eastern European region (CEEC), 26 sites from the African continent (MONET-AFRICA) and 21 sites from Central Asia (former Soviet Union countries as a part of MONET-CEECs) were monitored in 2008, as well as 3 sites from the Pacific Islands between 2006 and 2007 (MONET-PIs). From March 2009, MONET was expanded to include all of Europe (using the EMEP stations mainly) and now, a one year campaign which covers 55 sampling sites in the whole of Europe is being performed. It is the first study looking at the determination of temporal and spatial trends of POPs in ambient air of Europe.

The goal is to maintain sustainable PAS monitoring at the majority of sites. That would greatly improve the understanding of the sources, fate and transport of POPs in Europe and provide rich information for the modeling databases. At the same time, it would create necessary synergies between the Stockholm Convention and the Convention on Long-Range Transboundary Air Pollution.

S5:05

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Radiometric dating of sediment records in Kuwait Marine area

Sediment cores from six different stations of shore areas inside and outside the Kuwaiti bay, collected as part of the project “measurement and assessment of radionuclides concentration in coastal marine” areas, were dated radiometrically by ^{210}Pb . Two models; the simple ^{210}Pb dating Constant Flux Constant Sedimentation rate and Constant Rate of Supply were implemented to estimate the constant and variable sedimentation rates. The average rate was found to vary significantly between 0.16 and 1.15 cm y^{-1} , outside and inside the bay respectively. The variability of the sedimentation rate was due to the hydrodynamic and industrial activities in this region. In addition, the approach of using the fallout radiotracer ^{137}Cs to construct a realistic chronology for these cores was tested and presented in this work. The observation of the artificial radionuclide ^{137}Cs in almost the entire selection of core slices suggested two different sources of the suspended particulate matter; fluvial and Aeolian, which needs more investigation.

SESSION 6: REMOTE SENSING APPLICATIONS IN MARINE ENVIRONMENT

S6:01 Keynote

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Coastal seawater temperature trends – a review of recent interpretations

There is a growing body of literature and ongoing measurements that indicate increases in seawater temperature within the coastal regions of the world that are significantly higher than those published by IPCC (2007) in the Fourth Assessment Report. According to this report, sea surface temperature (SST) is rising in the world's oceans at a rate of 0.2 °C/decade. Contrast this with trends measured by CEFAS (Joyce, 2007) at 39 stations around the coast of UK that show warming rates between 0.5 and 1 °C/decade for much of the east coast and North Sea. This warming trend in the North Sea began abruptly in 1985 and is evident in almost all stations as a distinct change in slope of the mean annual temperatures. These trends have been mirrored in the intensive and expansive measurements made in the Baltic Sea and German Bight by GKSS and others since 2003. A similar warming trend has been found in the northeastern USA, where WHOI have monitored SST for over 100 years. Prior to 1965 no trend was apparent, whereas after this time a steady warming of 0.6 °C has been measured. AVHRR data from the Gulf, analysed by Alrashidi et al. (2008) show a steady warming of the northern Gulf at a rate of 0.6 °C/decade: a trend that was in part ascribed to regional and local drivers of temperature change. Measurements of SST in Venice lagoon also show increases in SST at rates equal and greater than those in the Gulf. Similar trends are also emerging from the densely populated and heavily industrialised coastal regions of Japan and Korea, and are interpreted to reflect an expansion of the Heat Island Effect (normally attributed to built-up terrestrial regions) to coastal waters. Thus it appears that coastal waters in regions of high population are suffering rapid and relatively-recent warming that is well above those reported by IPCC (2007). Whilst it is true that these effects are very small compared to the global thermal budget, they are having a profound effect locally in terms of habitat viability, oxygen carrying capacity, anoxia, fish mortalities, and coral bleaching. It is thus essential that coastal nations monitor and mitigate local and regional contributors of heat to the coastal ocean and not rely exclusively on trends published by IPCC. This paper will show the results of coastal seawater warming at a number of sites around the world, and discuss strategies for monitoring these changing trends.

S6:02

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Near-real-time remote sensing monitoring of algal bloom and oil pollution in the ROPME Sea Area

The Satellite Receiving Station established in ROPME allows remote sensing observations over the ROPME Sea Area (RSA) in near-real-time mode. The observations are based on the utilization of the Direct-Broadcast mode (DB) of operation of the Moderate resolution Imaging Spectrometer (MODIS) of NASA EOS Terra and Aqua satellites. The utilization of DB provides unique possibilities to have short daily visiting periods of observation over the Region and allows the tracing of highly dynamic events and disaster zones. Systematic regional observations are leading to a better understanding of the status of the marine environment.

Early warning of massive algal-blooms in the RSA allows marine mortality to be addressed. Recent algal blooms show large areas affected by algae mats. The patterns show specific size distributions in the Sea of Oman and internal RSA.

Oil pollution is another challenge in the RSA with significant negative impacts. The assessment of oil spills, fire and maritime accidents are key inputs provided for regional environmental monitoring. There is great number of oil spill emergencies resulting in substantial pollution to the marine environment. Recent MODIS observations show the most frequently affected areas in RSA together with specific types of observed pollution.

Hot-spot monitoring uses data at 0.25, 0.5 and 1 km spatial resolution. Despite the arid conditions, the system was found to be useful in addressing the issues related to coastal management, air traffic and transboundary pollution, monitoring of the arid land, vegetation status and urban or coastal interfaces. High spatial resolution satellite data, airborne measurements and field measurements are part of the validation of MODIS products,

The Station's capabilities include the cooperation with member states to perform monitoring of accidents and their transboundary environmental impact. Therefore the station acts as a prototype of an early warning system, focusing on anthropogenic events and significant environmental impacts. The MODIS archive allows major environmental events to be inventoried.

ROPME is seeking new ways to make near-real-time remotely sensed products more accessible. It also aims to expand the overall operational use of data processing and state-of-the-art remote sensing technology, e.g., with an assessment of a small satellite initiative.

S6:03

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Bio-optical study of Kuwait's waters

The bio-optical characteristic of the Kuwait's waters was studied for the first time during 2005-2009. High values of chlorophyll *a* and total suspended matter concentrations have been previously reported for these waters, associated with phytoplankton abundance and re-suspension of bottom sediments. The main goal of this study was measurements of seawater constituents to identify the sources of variability of inherent and apparent optical properties and the sources of uncertainty in the bio-optical data. This study was initiated in March 2005 at five sampling stations using both *in situ* and laboratory methods. The bio-optical properties of Kuwait's waters displayed pronounced but irregular seasonal and inter-annual variation with significant spatial differences.

Re-suspension of bottom sediments might play a dominant role in the modulation of dissolved and particulate matter. The contribution of detritus to total particulate absorption significantly varied and was similar with chlorophyll *a*. The main regional distinction between the northern waters compared to the southern waters is the sharp differences in the spectral absorption and attenuation as well as in remote sensing reflectance.

Results of this study indicate that the sun light was mainly absorbed in studied water by CDOM together with non-algal suspended matter at the north of studied area. A decrease in the contribution of non-algal suspended matter to light absorbance from station in Kuwait Bay southwards to Kubbar Island was revealed.

No definite relationship between the light absorption by phytoplankton and the chlorophyll *a* concentration at the red spectral maximum was revealed for northern waters. However, the acceptable relationship was observed for these parameters in the southern area.

S6:04

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Functional investigation of MODIS AQUA, MODIS TERRA and SeaWiFS sensors in monitoring and detection of 2008-2009 Red Tide in the ROPME Sea Area with chlorophyll quantification algorithms

Problems associated with red tide or blooms of unicellular marine algae, known as Harmful Algal Bloom (HAB), are global and appear to be increasing in severity and extent. This phenomenon has many economic, ecological, and human health impacts, such as mass mortalities of fish and marine mammals; economic loss due to reduced tourism, fish stocks, and shellfish harvests, and a suite of public health problems associated with the consumption of contaminated fish and shellfish, in addition to direct exposure to toxins.

Remote sensing with satellite is a beneficial way to identify the phenomenon that occurs in surface waters and lands. The most common method for identifying a red tide is estimating the total chlorophyll using one of the several standards remote sensing chlorophyll algorithms.

A red tide composed of *Cochlodinium polykrikoides* was engendered during early autumn 2008 and lasted until early spring 2009 in the ROPME sea area. This HAB occurrence revealed many unknown phenomena where there is not much available information.

For this research we utilized the data and images MODIS sensor of Aqua and Terra satellites and SeaWiFS Sensor. By analyzing this information, we made temperature, chlorophyll *a* (chl-*a*) and organic carbon pictures using an autochthonous algorithm for the Gulf and Oman Sea during the red tide. These images with field measurements and real images, studied analogy measurements of the red tide and attractive results were achieved. Figures showed increasing chl-*a* with decreasing temperature led to production of the algae *Cochlodinium polykrikoides* which causes red tides in the Gulf waters.

Results of this research showed decreasing water temperature to 25 °C produced trace propagation of a HAB. Satellite images of satellite showed growing chl-*a* and organic carbon in waters in HAB's regional area.

In the regional crowded industrial city of Hormuz strait, density of HAB was more than other places and major currents of the Gulf moved HAB to the west regions. Most density and development of HAB were seen in satellite images of the northern Strait of Hormuz.

S6:05

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Sediment transport in Northern Gulf – remote sensing overview

The sediment transport in the Northern Gulf (NAG) is a dominant process having influx of sediments load from the upland Mesopotamian basin through the northern rivers. It is important to characterize the source, transport and sinks of the sediment load. High concentration of suspended particulate matter (SPM) directly affects the water column and benthic process such as phytoplankton productivity, corals, nutrient dynamics and transport of pollutants. The quantity and distribution pattern of the sediments is highly variable both spatially and temporally, rendering most of the field sampling methods ineffective for comprehensive understanding of sediment transport process in complex coastal waters. To overcome these limitations, remotely sensed data has been used to map the suspended particulate matter (SPM) in coastal waters using SeaWiFS band 5 data. The band 5, corresponding to 555 nm wavelength, is highly sensitive to lower suspended particulate concentration and is not impacted by light absorption from phytoplankton pigments. A strong correlation is observed in SPM concentration and spectral radiance L_{λ} . This relationship is a cumulative effect of suspended particulate in atmosphere and water, which is addressed by atmospheric correction using dark pixel method. The SPM concentrations vary between 30 to 60 mg/L across considered section, which is in agreement with *in situ* measurements.

S6:06

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Identification of algal blooms in the Kuwait Bay using remote sensing data: Initial findings

With the advancement of space technology over years and availability of multiple sensors with improved spatial, temporal and spectral resolutions, it is now possible to monitor elements of, and processes operating in, oceans, atmosphere, and on land.

In this regards, scientists from Kuwait Institute for Scientific Research (KISR) and Western Michigan University extracted observations from two sensors, namely, MODIS, and SeaWiFS for the purpose of mapping the temporal and spatial variations in the Kuwait Bay water quality parameters (e.g., chlorophyll concentration, turbidity) and in its physical properties (e.g., temperature). For such applications previously developed algorithms (e.g., Carder algorithm applied in SeaDAS) were applied after being fine-tuned for Kuwaiti waters.

Initial findings for the Kuwait Bay show: (1) promising results when it comes to extraction of water quality parameters and physical properties from global remote sensing data sets and applying standard retrieval algorithms, and (2) previously identified harmful algal bloom occurrences correlated with increased chlorophyll concentration and high sea surface temperatures.

S6:07

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Shoreline changes around Qaruh Island south of Kuwait based on high resolution remotely sensed data

Qaruh is one of the Kuwaiti southern Islands with coral reefs surrounding it. The island is eroding along some sections and suitable erosion control measures are required for future planning. These measures must be properly designed to protect the island from future erosion without damaging the sensitive coral reefs. The choice of suitable and sustainable erosion protection measures requires determination of the affected areas and rates of erosion.

Previous studies on Qaruh only determined the areas of erosion and deposition. Furthermore, all previous studies did not provide any information on whether the island is being reduced in size. This study provides an estimate of the rate of erosion and changes in size. High resolution remotely sensed images were used to monitor the shoreline around Qaruh Island. The stacking function of ERDAS Imagine software was used to extract a suitable band from two images taken on different dates and produce new image files that highlight the changes.

SESSION 7: ENVIRONMENTAL MANAGEMENT

S7:01 Keynote

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Application of ecosystem-based analytic tools to inform natural resource damage assessments and environmental impact analyses in the ROPME Sea Area

Given the fragmented political jurisdictions, and substantive environmental damages from petroleum spillage, human development and other anthropogenic perturbations, a need exists for developing a coordinated set of protocols and approaches for determining impacts to activities exerting extra-territorial environmental and ecological pressures on coastal and offshore natural resources in the ROPME Sea Area (RSA), as well as strategies for restoring (or mitigating) natural resources by human activities. Such environmental impact analytic and natural resource damage assessment (NRDA) protocols may be readily developed at the ecosystem level to directly inform localized coastal and marine resource decision-making by resource managers with harmonization to the RSA level. Instead of traditional methods for gauging environmental impacts (or damages) on a single resource or habitat, impacts of anthropogenic activities may be reviewed on an ecosystem level. This way, relative impacts to each indicator resource in an ecosystem can be evaluated in order to determine the overall impacts to the system as a whole, rather than simply to a few targeted resources that exclude critical ecosystem components. Examples of such methodologies are discussed in the context of past RSA events (e.g., oil spills resulting from the 1990-91 Iraqi Aggression in Kuwait) and other international case studies. Considerations, limitations and strategies for adopting these ecosystem based approaches are presented.

S7:02

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Status of fisheries management in the Gulf

An overview is presented of the evolution of fisheries production in the GULF as a whole and the changes over time are discussed in the light of existing fisheries management measures and international agreements. An overview is presented of fisheries bills and regulations, and recommendations given for harmonization. Attempts have been made to study the impact of fishing on species composition of catches. The role of existing Marine Protected Areas is reviewed in the light of considering additional MPAs to be established for conservation purposes.

S7:03

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Morphological diversity of urohyal bone and its importance in taxonomy and fisheries management of some marine fishes of Iran

Study of the hard structure of fish such as scale, otolith, cleithrum and urohyal bone can provide complete information on age, subdaily, daily and annual growth rates, size and age at first maturity, harvestable size, mortality and survival rates, spawning season(s) metamorphosis, maximum size and weight, migration, taxonomic position, water pollution, discrimination between hatchery reared and wild populations and also ascertain the past living conditions of a fish through the elemental analysis. The urohyal bone is a single median solid bone with anterior tip generally connected to the ventral hypohyal and to the first basibranchial, and posterior end attached to the pectoral girdle by means of muscle. This bone generally has been used for age determination, but it has been distinguished that its morphology is diverse in different groups of fishes and could be used in fish taxonomy. In the present research, morphology of urohyal bone in 57 marine fishes from 46 genera, 32 families and 7 orders has been studied. Results showed that the urohyals were varied in: ratio of length and width relative to total length and head length of fish, ventral shape, presence and number of processes in the anterior part, origin of dorsal keel (distance from anterior tip), groove in ventral portion and some other characteristics. The urohyal shape is highly correlated to general fish body shape, habitat and also food and feeding habits of fish, so can provide valuable information on these subjects. Moreover, the obtained results may be used in population dynamic and pollution studies which are important parameters in fisheries management programs. Based on these findings, we could also prepare a key for identification of these fishes for the first time.

S7:04

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Ecotopes ranking in a coastal wetland around the Gulf by BIOSAFE Model for conservation and management planning: A case study of Shadegan International Wetland, Iran

Shadegan International Wetland is a coastal wetland around the Gulf in the south of Iran which consists of four ecotopes: intertidal ecotope, freshwater ecotope, khooremoosa and islands, and riparian and other lands. These are important for conservation and management planning for the natural environment in the Shadegan International Wetland. BIOSAFE is a management model for harmonic suitable strategy in conservation of nature in land use planning. For this study PTB, PTE, ATB, TEI, TBS, ATE, TES, ATEI indices were determined. The maximum PTB index was 2250.75 for birds; the maximum PTE index was 1052.75 for intertidal ecotope. Maximum ATB index was 1852.25 for birds. The maximum TEI index in freshwater ecotopes for amphibians, in intertidal ecotope for birds, in khooremoosa and islands for reptiles and in riparian and other lands for mammals was also determined. The maximum ATE index was observed in freshwater ecotope for amphibian, in intertidal ecotope for birds, in khooremoosa and islands for reptiles and in riparian and other lands for mammals. The maximum TES index was 87.68 in riparian and other lands; the maximum ATEI and TES indices for birds in freshwater ecotope were 17.68, and 57.46, respectively. These indices for fishes in khooremoosa and islands were 9.56, and 28.43, respectively. For mammals in riparian and other lands these indices were 2.802, and 10.43, respectively, while for reptiles in khooremoosa and islands they were 5.16, and 9.25. For amphibians in freshwater ecotope, 1.28 was determined.

S7:05

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Geotourism Action Plan for Qeshm Global Geopark: Holistic management approaches for sustainable use and promotion of geo- and biodiversity

Qeshm Global Geopark is located in the southwest of Qeshm Island, the largest island in the Gulf. As one of the three Free Trade Areas of Iran, Qeshm is intended to develop to an economic hub in the region. At the same time, the island offers a magnificent natural heritage, a unique culture and traditional hospitality in a typical local ambience. Qeshm Geopark has been awarded membership in the Global Geoparks Network supported by UNESCO in 2006. The main obligations of a Global Geopark are related to the application of holistic approaches for the management of geo- and biodiversity, the provision of awareness-raising environmental education programs and the participation of the local population in order to enhance “protection by sustainable use” of landscape resources and thereby to contribute to sustainable economic development.

In 2008, a Geotourism Action Plan had been jointly established by the geopark management, national experts and a member of the management team of the Global Geopark Bergstraße-Odenwald, Germany. This co-operation has been realised in the frame of the Global Geoparks Network and has been facilitated by the Division of Ecology and Earth Sciences of UNESCO.

The Action Plan provides a tailored concept for Geopark infrastructure: services and promotion. The entire plan considers the specific conditions and sensitivities of Qeshm Island with regard to landscape and cultural aspects, and identifies strategic objectives and respective priority actions, development actions and consolidating actions. One long term objective is the enhancement of “Geopark-ownership“ for the local population as one of the most important prerequisites for the viable protection of geological and ecological heritage and sustainable Geopark operation.

Besides the outstanding geology of Qeshm Island, the Action Plan addresses the unique biodiversity with its special and typical habitats. Furthermore, traditional handicraft and architecture are integrated in the multi-tiered set of actions. The most prominent sites for ecotourism are already presented to the public and are operating with basic tourism programs, such as boat tours into the Mangrove Forest or turtle observations at Shibderaz village.

The development of joint packages encompassing ecological, geological and cultural highlights will increase the attractiveness of sustainable tourism offers and thereby enhance economic benefits, as well as sustain the protection of natural heritage. The Action Plan builds on local, regional and global networking in order to open opportunities to learn from each other, to share expertise and best practice within protection and management of natural resources and the development of respective institutional and community capacity.

S7:06

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Ballast water management: A vision for Qatar

The intentional or accidental transport and subsequent introduction of marine species to new regions is one of the primary threats to biological diversity in ocean-bordered countries. Invasive Marine Species (IMS) can have potentially significant impacts on economic, ecological, social and cultural aspects of coastal marine environments, impacts that are often irreversible and typically cumulative. IMS are transferred by a number of vectors; however, ballast and hull fouling are considered the most significant of these. In recognition of this, and in alignment with Qatar Petroleum (QP)/Ras Laffan Industrial City (Operations) (RLC) policy to manage environmental sustainable matter as an integral part of its activities, QP via RLC (Operations) and in conjunction with GHD Global Pty Ltd (GHD) have engaged to develop the first comprehensive Ballast Water Management Strategy for Qatar covering Ras Laffan Port and Halul Island Port to protect Qatar's marine environment from IMS, for future generations. This keystone initiative is testament to QP's vision to implement best practice management of the State's natural marine resources. This initiative is timely given that international shipping activity from Ras Laffan Port alone has increased from two ships loaded in 1996 to approximately 600 ships in 2006 with forecast growth in shipping traffic expecting to result in approximately 3,600 ships per annum by 2013.

For the first time in Qatar, a series of comprehensive legal, management and scientific studies focusing on ballast water management is being completed to develop a comprehensive Ballast Water Management Strategy (BWMS) to manage the risk of IMS at each of QP's Port Operations. Various aspects of the BWMS included a detailed review of international, regional and Qatari ballast water legislation/guidelines, management practices, and a detailed review of international and regional alien and invasive species, in addition to comprehensive seasonal surveys to determine baseline status of IMS in QP's Ras Laffan and Halul Island Ports.

This paper presents the key findings to date and associated challenges of developing Qatar's first BWMS, while also elucidating potential regional implications of this initiative within the Gulf Cooperative Council (GCC).

S7:07

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Sabah Al-Ahmad Sea City, the creation of a sustainable coastal ecosystem in a saline desert anticipating sea level rise

Predicted sea level rise during this century is between 90-880 mm with a mean of 480 mm. NASA maps show that much of the low lying sabkha coastline of Kuwait may be inundated. Already the highly productive intertidal and near shore subtidal ecosystems in Kuwait have been degraded by infill and dredging. While sea level rise will extend these systems landwards, high evaporation rates will produce hyper-saline conditions with poor productivity.

Hence the construction of a city for 100,000 people on land safely above future high tide levels; by excavating saline desert and creating marine waterways, this serves to pre-empt future loss of marine productivity. Since the first waterways were connected to the sea in 2004, all artificially created beaches, mangrove and saltmarsh islands, together with benthic habitats, have been monitored with daily physical and annual biological surveys.

The waterway system was modeled before excavation and designed to utilize only tides and winds for flushing. With 3 phases completed (84km), these natural forces have proved very successful with all water quality measurements meeting the Environmental Protection Authority's criteria. Within 5 years of opening to the sea all artificially created intertidal and subtidal marine habitats have a species diversity and abundance which exceeds that of similar open sea habitats in Kuwait, and elsewhere in the south west Gulf. Over 1000 species of macro biota now exist within the desert waterways including over 100 species of fish and shellfish. Many of these are commercial species which breed, or utilize the waterways as nursery and feeding grounds. With circa 84km the waterways already represent a significant reservoir for the marine fisheries of Kuwait. Human habitation, already present on phase A1 and A2, shows minimal impact, demonstrating that man can co-exist with a productive marine environment. The project also demonstrates that compensation for any future climate driven sea level rise may be accommodated in advance by a multidisciplinary approach to coastal management and planning.

S7:08

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Sub-regional cooperation initiatives for fisheries conservation and management in the northern Gulf

Fisheries provide a vital source of food, recreation, trade and economic well being for the people of Kuwait. Though Kuwait is one of the pioneering countries in the region to introduce management measures for its fisheries since 1980, Kuwait's fish production is in a declining trend in recent years due to over exploitation and habitat degradation. The Republic of Iran and Iraq are also experiencing similar declining trend.

Uncontrolled fishing activities by neighboring countries in the International waters is a new challenge to Kuwait fishery management as these waters are open access areas and are beyond the management regime of Public Authority of Agriculture Affairs and Fish Resources. Continuing fishing activities in the international waters result in a serious repercussions on Kuwait's fin fish and shrimp stocks.

It is greatly realized that regional cooperation is critical in dealing with common issues such as fish stock assessment, illegal, unreported and unregulated fishing, management of fisheries exploiting shared stocks, harmonization of data formats and aquaculture sector development and management. The regional cooperation is consistent with the principles of the Code of Conduct for Responsible Fisheries stating that where shared stocks occur, coastal countries share the responsibilities of sustainable fisheries management through joint effort and sub-regional cooperation. The State of Kuwait is taking a lead role in association with Islamic Republic of Iran and Iraq for promoting regional cooperation for conservation and sustainable utilization of fishery resources with ecosystem perspectives in the Northern Gulf region. The present paper delineates the current initiatives and future plan of action with special emphasize on Kuwait fisheries management.

S7:09

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Extreme wave heights in the Kuwaiti territorial waters based on 12 and 15 year data sets

Robust estimates of extreme wave heights for different return periods are essential for the safe and cost effective design of various marine structures, including the hardware for open sea mariculture. The reliable assessment of such information requires either measured or hind-casted wave height data for as many years as possible. The assessment of extreme significant wave heights for return periods of 12, 25, 50, 100 and 200 years from 19 different locations in the territorial waters of Kuwait were carried out based on 12 year hind-casted data from 1st Jan 1993 to 31 Dec 2004 using a WAM model. The peak over threshold method was used for selecting the data for the extreme wave analysis. In general, the Weibull distribution was found to fit the data well as compared to the Gumbel distribution for all locations. Our previous work showed that the significant wave heights for a 100 year return period varied from 1.86 to 4.02 m among these 19 locations.

The data base was recently expanded to cover 15 years and the number of locations was increased from 19 to 38. New predictions were generated based on this revised data set. A comparison of the predicted extreme wave height was made based on both the 12 and 15 year data sets. We found that the value of the extreme waves for the 100 year return period had increased from 0.0 m to 0.6 m above the previous estimates.

A large number of marine projects are in progress in Kuwaiti territorial waters with many projects planned for the future including offshore oil exploration. The revised results of the present study will be highly useful for the optimal design of many marine structures in Kuwaiti territorial waters.

S7:10

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Management of land based sources of marine pollution

The coastal waters of Kuwait bay have been used extensively for the disposal of domestic wastes, thereby increasing the level of pollutants in coastal waters. Recent studies showed that the amount of wastes inputted into Kuwait bay is expected to grow further because of sewage discharges and illegal disposal of partially treated sewage or industrial wastes in marine waters. They are responsible for major part of pollution inputs of heavy metals, hydrocarbons, and fecal coliform bacteria impacting Kuwait's marine environment and lowering sea water quality. This research paper presents overall information relating the pollution level in the marine environment from land based sources and compares the level of pollutants in marine waters with the standard limits. An environmental waste management procedure is highlighted and recommended to control waste discharges to the marine environment with a view to future aspects of sustainability development.

S7:11

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Sir Bu Nair, one of the most biodiverse islands of the Gulf

Sir bu Na'air island in the Gulf has been identified as an significant biodiverse area. A designated marine protected area, the island has prompted the Emirates Marine Environmental Group to design a five-year monitoring program assessing the success of nesting turtle populations, species diversity of the island's coral reef ecosystems, and the size of nesting bird colonies.

It is widely cited that two species of turtle are commonly encountered within the UAE - *Eretmochelys imbricata* and *Chelonia mydas*. In total, 311 hawksbill turtle nests were identified during the March-June 2010 nesting season. Early results obtained from 93 nest inventories suggest 6,989 hatchlings were produced during 2010 with the average emergence rate reaching 76.72%. Evidence of nesting green turtles has proven inconclusive.

In May 2010, 4 hawksbill turtles were tagged with satellite transmitters as part of a wider Arabian Peninsula satellite tracking program executed by EWS-WWF and the Marine Research Foundation, Malaysia. To date, the program has illustrated interesting results regarding both hawksbill nesting patterns and foraging grounds.

Over 2000 *Larus hemprichii* were recorded nesting at the island following extensive transect surveys and colony mapping – a significant discovery for the Gulf. Large colonies of *Stena anaethetus* were also recorded nesting at the island.

Quantitative and qualitative coral and fish surveys, point transects and CPCe analysis established percentage cover of key substrates and coral species. Thirty-seven species of corals were found: *Acropora* sp. (53% cover at 5m depth), *Stylophora* sp., *Platygyra* sp., *Favia* sp., *Porites* sp. Fifty-eight fish species were recorded with up to 900 fishes on one 30m transect. *Gobiodon citrinus*, previously unrecorded in the Gulf, was identified.

Coral bleaching and mortality rates were assessed. Gulf-wide successive bleaching events (1996, 1998, and 2002) resulted in high coral mortality rates, especially in *Acropora* species. Encouragingly little evidence of bleaching was recorded here.

S7:12

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Environmental impact assessment of the marina construction, Kuwait National Guard Club, State of Kuwait

This study was undertaken to assess the potential impacts from the development of a marina for the Kuwait National Guard Club on the coast of the Kuwait Gulf. The possible potential impacts due to the proposed project and beach development were considered. RIAM (Rapid Impact Assessment Matrix) studies were conducted for the construction and operation phase of the project to understand the impact scenarios. Important components such as coastal land use change, local water quality, coastal dynamics, prediction of shoreline changes, sand accretion and erosion, etc. were part of the assessment process. Recommendations and mitigating measures were given. The distributions patterns for water quality parameters (pH, salinity, temp., TSS, TPH, grain size, sediment, TOC, various metals, etc.) are presented using ARCGIS software. The intensive study showed that the proposed projects will have minimal impact on the coastal land-use and cause minimal disturbances to the coastal water, but will cause irreversible changes in the coastal morphology.

Poster Abstracts
(Arranged according to sessions)

CLIMATOLOGY & MARINE RESOURCES

P1

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Sea level rise and Abu Dhabi mangrove ecosystems

Sea level rise (SLR) is threatening many coastal ecosystems around the world, including the United Arab Emirates (UAE). Very little is known about the impact of SLR on the coastline of the entire Gulf. It is urgent, therefore, to improve our preparedness to deal with such phenomenon. The present study aims to assess the impact of SLR on the coast line of Abu Dhabi Emirate and to identify the most vulnerable coastal areas. Digital elevation models were used to estimate potential effects of different SLR scenarios on mangrove ecosystems within Abu Dhabi. The maximum area affected reaches 25.54 km² (or about 81.5% of the study area) under a 3 meter SLR scenario. The estimates reported here highlight the size of the potential loss in mangrove habitats, even under the lowest SLR scenario. The estimates in the present study are far more alarming than what was reported in other studies at various parts of the world.

P2

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The effect of temperature and salinity on larval hatching of brown spotted grouper and Sobaity sea bream fish

The effects of temperature and salinity were investigated in two commercially important fishes, the brown spotted grouper and Sobaity sea bream. Fertilized eggs were brought from the Directorate of Fisheries and the stage of development was recorded. Specimens were placed in a small water bath with controlled temperatures (at 41, 31, 21 and 11 with ± 0.5 °C) at different salinities (55, 45, 35, 25 and 0 ppt). The percentage of both hatching and deteriorated eggs was determined. Development was synchronized. There were significant differences between the two types of fishes regarding the effect of different temperatures and salinities on larval hatching. It was found that a temperature of 31°C was the optimal condition for brown spotted grouper resulting in 82% hatching. On the other hand, 21°C was the most effective temperature, resulting in the highest hatching rate (86%), of Sobaity sea bream larvae. Moreover, salinity of 45 ppt was found to be optimal for hatching in both fish species and is more or less at the same range of Gulf waters. Our preliminary results may contribute to the optimization of commercial production of these important aquatic creatures.

P3

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An investigation of salinity tolerance and salt secretion in protected mangroves, Bahrain

Mangroves in Bahrain are among the most productive coastal habitats which provide food, shelter and nursery areas for variety of marine fauna and wader birds. Despite national and international designations as a protected area, at Ramsar the remaining mangrove stands and associated ecosystems are under threat from coastal development and pollution. Continuing alteration and degradation of mangrove stands indicates the need for rehabilitation of mangrove ecosystems. Planting mangroves is recognized as a means of rehabilitating mangrove ecosystems. Successful re-establishment of mangroves depends critically on the tolerance of these plants to salinity at the early stages of development. This study therefore investigates the salinity tolerance and associated salt secretion in *Avicennia marina* that could be utilized for potential rehabilitation of mangrove ecosystems. This study found that growth was affected by salinity gradients. The highest rates of growth were found in plants at very low salinities. At the highest salinities tested, 30 and 40 psu, the growth rate was extremely low and the highest concentration caused death after a short exposure time. Secretion rates of sodium ion were positively correlated with salt content of the growing medium. The study indicated that successful establishment and growth of mangrove plants under natural conditions in Bahrain depends on moderate levels of salinity. This study discusses the implications of mangrove rehabilitation on conservation objectives for mangrove ecosystems in Bahrain.

P4

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Seasonal variability of the macrofouling community in Arvand River estuary (Shatt Al-Arab), Iran

Biofouling is the settlement, attachment and growth of plants and animals on submerged surfaces such as ship hulls, navigation beacons, buoys and wharf pylons. These organisms also attach to natural hard substrates. The seasonal variability in macrofouling community recruitment on submerged artificial substratum was studied in Arvand River estuary (Shatt Al-Arab) waters at Khuzestan province in south western Iran. During the warm (May-July) and cold (January-March) seasons, macrofouling organisms on 10×10 cm² panels were counted. Two species (2 phyla) of sessile organisms and eight species (3 phyla) of non-sessile associates were recorded. The results indicated that macrofouling community recruitment occurred throughout the year with varying intensities. Cirripedia, isopoda, decapoda, amphipoda, polychaeta, bivalvia and macro algae were identified from the test panels. Abundance of fouling organisms were significantly ($p < 0.05$) higher in the warm season than in the cold season. Barnacles (*Balanus amphitrite*) were the major macrofouling group in both seasons and diversity indices showed that variability in the warm season was higher than in the cold season.

P5

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Seasonal variability of chlorophyll-a distribution in the ROPME Sea Area using satellite data

The present paper discusses the spatial and temporal distribution of chlorophyll-a (Chl-a) in the coastal and offshore waters of the ROPME Sea Area using Aqua, Terra and SeaWiFS satellite data. The Chl-a concentration was high along the southern and northern Oman Gulf waters. Possible interactions between Chl-a measurements, eddies and Sea Surface Temperature (SST) are discussed. Algal blooms have been observed in autumn and winter in the ROPME sea area.

In Oman Sea, mesoscale eddies and currents have important roles in the transmission of algal blooms to the western ROPME Sea Area at the Strait of Hormuz. Results of this paper suggest that most of the chl-a in ROPME Sea Area occurred in the autumn 2008 until end of winter 2008. Maximum density and lifetime was in the northern Strait of Hormuz. In winter, the North West monsoon and upwelling formed in the northern coastal Gulf of Oman prepare the conditions for algal blooms and increasing chlorophyll.

MARINE ECOLOGY & BIODIVERSITY

P6

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Marine ecology studies of Omani waters

Marine ecology studies were established by Ministry of Fisheries Wealth in Oman beginning in 1976. These studies include monitoring of various phenomena such as red tide, hypoxia and mortalities of marine organisms as well as other physical, biological and chemical parameters. These studies were conducted by the Ministry of Fisheries Wealth often in collaboration with other local organizations such as Sultan Qaboos University and Ministry of Environment and Climate Affairs and regional and international organization such as Regional Organization of Marine Environment (ROPME) and Intergovernmental Commission of Oceanography (IOC). The research program involves field sampling, real time data collection and intensive surveys. The data collected from these studies and marine phenomena are analyzed and discussed.

P7

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Rotifer biodiversity on the north shore of the Gulf

A two-year sampling program has recently been started to prepare an inventory of rotifer fauna in some parts of Iran. In a survey on the species composition of rotifers in 10 natural ponds and rivers on the north shore of the Gulf, more than 30 rotifer species were recorded during May to August 2008. Samples were collected by filtering 30 L of water through a 30 μm sieve. Some main physico-chemical factors of water were also measured to estimate their influence on rotifer diversity and distribution in the sampled sites. Initial examination of live animals was accomplished by screening rotifers from other zooplankton using a stereomicroscope. For reliable identification, the trophi was isolated by dissolving their surrounding soft tissues in dilute NaOCl (5%) and studied in detail. Identified species belonged to 15 genera, 8 families and 4 orders of Eurotatorian rotifers. With respect to species diversity, the observed families were of the following orders: Notommatidae> Brachionidae> Lecanidae> Synchronidae> Philodindae> Testudinellidae > Lepadellidae> Euchlanidae. The Shannon-Weiner species diversity index ranged from 1.4 to 2.9. Among these, species of the genus *Brachionus* were the highest in both frequency and concentration in both autumn and spring.

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Biodiversity of Qeshm Island

Qeshm Island with an area of more than 1550 km sq. is located in the Hormoz Strait and constitutes the largest island of the Gulf. Despite its semi-tropical climate, the island has a mosaic of habitats including coral reefs in the south, mangrove forests on the north-west, mudflats on the northern shores and sandy shores on the southern coast. In addition, there are mountain ecosystems, seasonal grasslands, and palm orchards inland. All these habitats together host a unique combination of flora and fauna. This article is the result of six years of continuous research by various experts (local, national and international) to record its biodiversity. 220 species of birds have been recorded, most importantly a population of 500 *Pelecanus crispus*, over 2000 crab plover (*Dromas ardeola*) and more than 15 species of birds of prey such as *Falco concolor* nesting in summer, and a large number of *Pernis ptilorhynchus* in summer and winter. There is also a high diversity of reptiles, the most precious of which are four species of marine turtles: *Chelonia mydas*, *Eretmochelys imbricate*, *Dermochelys coriacea*, *Olive ridley* which either nest and/or feed in the coastal waters. In addition five species of snakes and 17 species of lizards as well as one amphibian species (*Bufo olivaceus*) have been recorded. Coral reefs in the southern parts of the island as well as around Larak and Hengam islands have formed a triangle that is a very suitable habitat for marine mammals. Indeed 17 mammal species have been identified including *Rousettus aegyptiacus*, *Suncus etruscus*, *Neophocaena phocaenoides*, *Tursiops eduncus* (seen all year around in stocks of 30-80 mainly in the southern waters of Qeshm), *Delphinus delphis*, *Sousa plumbea*, *Megaptera novaeangliae*, and *Dugong dugon*. The Harra Protected Area (100 km²) constitutes a permanent habitat for some of these mammals such as *Neophocaena phocaenoides*. *Sousa plumbea* may be seen among the mangrove forests as well as the coral reefs around the island. This article focuses on the biodiversity in Qeshm Island and local community mobilization since the establishment of QFA to protect the islands biodiversity.

P9

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Fish community of natural and planted mangroves with comparison to a sand flat in Qatar

The present study is an attempt to examine the fish diversity of natural and planted mangroves in the north-east, east and south east coast of Qatar. The survey was carried out on 3 natural mangrove sites, 4 planted mangrove sites and 1 sand flat site. The study revealed that 47 species belonging to 27 families were caught by seine net, gill net and hand net. Most of these fish are economically important. Also, the study revealed that natural and planted mangroves were considered as a nursery ground for different fish species, especially those which are economically important such as *Lethrinus* spp.(Lethrinidae), *Siganus canaliculatus* (Family: Siganidae) and *Gerres oyena* (Family: Gerreidae). The number of species caught by each type of gear was: seine net (17), gill net (40) hand net (19).

P10

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A survey on seaweed distribution and biomass in Nayband Bay, Bushehr, in the coastal waters of Iran

This work was carried out to survey the seaweeds of Nayband Bay in the south-west part of Bushehr, Iran. There was no previous survey of seaweeds in the area. The seaweed species were collected in every month from October 2007 to July 2008. Five stations were sampled randomly along each of 5 transects covering the intertidal zone of Nayband Bay. Samples were collected in quadrates of 0.25 m². The species found in the quadrates were identified and counted during the survey. A total 65 species belonging to 4 divisions of seaweed were identified. Chlorophyta was represented by 15 species, Rhodophyta had 30 species, Cyanophyta had 1 species, and Phaeophyta had 12 species. The highest seaweed diversity observed was 65 species at Hale and the lowest was 25 species at Abshirinkon. The maximum seaweed wet weight was recorded at Hale (1020 g m⁻²) and the minimum was recorded at Harra (259 g m⁻²). The highest biomass for any one division was 725 g m⁻² recorded for brown algae at Demageh station and the lowest observation was 18 g m⁻² of green algae at Abshirinkon station. The maximum biomass for green algae in summer was 320 g m⁻² and for red algae was 500 g m⁻².

P11

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Growth rates of some algal bloom species in Kuwait waters

Five phytoplankton species were cultured using Guillard's media. They have been recultured several times to reach the final volume of 1.5 L. Non-continuous enrichment with fresh media was used and exposed to continuous light for 26 days. Chemical measurements were done for all cultures. On days 0, 2, 4, 7, 9, 11, 14, 16, 18, 21, 23 and 25, samples were collected. Chlorophyll-*a* concentration and phytoplankton density were measured for all cultures. Highest chlorophyll-*a* concentrations for filamentous blue green algae, picoplankton (*Prochlorococcus* sp.), flagellates (*Pyramimonus* sp.), green algae (*Dunaliella salina*) and dinoflagellate (*Prorocentrum* sp.) were 56.88 µg/l (day 4), 83.22 µg/l (day 4), 59.06 µg/l (day 2), 819.56 µg/l (day 4) and 55.20 µg/l (day 2), respectively. Highest phytoplankton densities for the same previous sequence of species were as follows: 1.18×10^{10} cells \pm 2.79×10^9 (day 16), 7.56×10^9 cells/l \pm 1.74×10^9 (day 2), 4.2×10^8 cells/l \pm 1.17×10^8 (day 16), 2.39×10^9 cells/l \pm 5.7×10^8 (day 14) and 4.4×10^7 cells/l \pm 1×10^7 (day 2), respectively. Growth rates were calculated for all phytoplankton species during the 26 days.

P12

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Potentially harmful species in the phytoplankton composition of the north-western part of the Gulf (Kuwait's waters): Diversity, abundance and macroscale distribution

The composition, abundance and contribution of potentially harmful species within the phytoplankton community were analyzed from Kuwait's waters during 2004 - 2008. A total of 42 identified taxa belonging to 5 different classes were considered potentially harmful, out of which 22 phytoplankton taxa were potentially toxic to humans. Most potentially toxic species were recorded in low concentrations with a low HAB index. However, diatoms from the genus *Pseudonitzschia* and dinoflagellates *Karenia* spp. and *Pyrodinium bahamense* v. *compressum* were observed in significant numbers (10^3 - 10^4 cells/l) in some periods. The lowest numbers of potentially harmful species were detected within northern waters, whereas the greatest diversity and abundance of HAB species were associated with southern area. The portion of potentially harmful algae increased along a north - south gradient due to increasing species richness within Dinophyceae. Comparative analysis of phytoplankton from various areas of Kuwait's waters detected an increasing trend in total phytoplankton diversity along a north - south gradient. Phytoplankton composition within the northern waters was characterized by a high prevalence of diatoms (72 - 80% of total species richness) whereas dinoflagellates contributed only 13 - 21%. The contribution of diatoms to total phytoplankton diversity linearly decreased through the north - south gradient ($r^2=0.93$). A significant transformation of the phytoplankton structure along the north - south gradient can be related to a linear increase of dinoflagellates from the northern area towards the southern Kuwait waters ($r^2=0.91$). The ratio Diatoms/Dinoflagellates was close to 1 within southern waters (115 diatom species (50 %) versus 108 dinoflagellates (47 %)). Transformation of phytoplankton composition can be related to considerable environmental changes along the north - south gradient due to a reduction of the influence of the Shatt-Al-Arab system indicated by changes in salinity, turbidity and silicate concentration.

P13

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The effect of invasive tunicates on coral and their associated bacteria in the Kuwaiti marine system

Coral reefs are considered the most productive and biologically multifarious ecosystems on earth. The capacity of coral reefs must be secured to supply the world with ecological merchandises and services. Loss of resilience is caused by unwise uses of the reef itself as well as the impact of invasive organisms. An invasive tunicate species has been observed threatening the benthic community of coral all over the world. Kuwait coral reefs are also under the threat of the tunicates invasion. The work described herein identifies the ecological role of tunicates upon *Acropora* spp. and reveal the ecological significance of coral's microbes during tunicate invasion. *Acropora clathrata* and *A. arabensis* invaded by tunicates were sampled from Umm Al-Mardaim and Qaroh islands on August 2008 and May 2009. The microbial population of both healthy and infected coral tissue was examined using DNA-PCR-DGGE. The results showed that the tunicates affect both coral and their associated microbes where they contribute positively to resistance reduction in healthy corals.

P14

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Coral microbiology: Studying the diversity of bacterial communities associated with coral mucus of various coral genera from the Kuwaiti waters

The corals in the Gulf are subjected to extreme variations in environmental conditions such as water temperature, salinity and ambient light which threaten their health. Coral mucus is known for its importance in protecting corals from the effect of these factors as well as for protecting corals from the attack of pathogens by harbouring microbes with ability to produce antimicrobial agents.

The abundance and diversity of the mucus-associated cultivable bacterial population were studied in *Poritess compressa*, *Psammocora contigua*, *Acropora clathrata*, *Stylophora pistillata*, *Platygyra daedalea*, *Cyphastrea serailis*, *Favia speciosa*, *Pavona decussata*, *Coscinaraea columna* and *Favites pentagona*, sampled from an inshore (Qit'at Benayh) and an offshore reef system (Umm Al-Maradim) south of Kuwait. Coral mucus as well as seawater samples were microbiologically studied using conventional and molecular techniques. The results showed that the numbers of the cultivable bacteria were higher in the mucus than in the seawater samples. Differences in the cultivable bacterial community were found between coral mucus and seawater samples; γ -Proteobacteria, especially *Vibrio* spp., were the most dominant group.

Between site variations in the mucus-associated cultivable bacterial diversity were higher than within site variation when the mucus-associated bacteria of *P. compressa* were compared. Evidence for the presence of cultivable bacteria as key species was found in *P. compressa* inhabiting different niches, as well as in different coral hosts inhabiting the same ecological niches. It was concluded that temporal and spatial changes, as well as the host type, affect the abundance and diversity of cultivable bacteria in coral mucus.

P15

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Jellyfishes in the Gulf: An overview

There is growing concern that human activities may be contributing to major increases in jellyfish populations worldwide. Reports of increasing problems with jellyfish include interference with tourism by stinging swimmers, effects on fisheries by clogging nets and killing fish in pen-nets, and impacts on power- and desalination plants by clogging intake structures. Climate change, eutrophication, fisheries over-exploitation (removing jellyfish predators and competitors), accidental introductions of exotic jellyfish species and marine structures (providing habitat for benthic stages of jellyfish) have been reported to contribute to an increasing frequency of jellyfish blooms in several regions of the world. The presented overview focuses on jellyfishes in the Gulf. After describing the different species of jellyfish known to occur in the Gulf, existing data and information on incidences of jellyfish blooms and their socio-economic impacts (especially on power- and desalination plants) in the region will be summarised. The potential role of increased human activities and structures in the marine environment in causing jellyfish blooms in the Gulf will be outlined.

P16

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The characteristics of the shark fishery in the United Arab Emirates

Preliminary studies at landing sites across the United Arab Emirates (UAE) are showing that the elasmobranch catch is increasingly high which suggests unsustainable levels of fishing. Furthermore, it is believed the UAE is serving as a hub in the ROPME area for the export and trade in shark fins to Asia. The aim of the present study is to monitor catch and trade of these animals while collecting biological information on the species occurring in these waters.

In order to do this, interviews were conducted with fishermen across the country while field surveys are ongoing at landing sites and in coastal areas. So far, the obtained results suggest a recent large decline in shark abundance in UAE waters in parallel with the growth of a shark targeted fishery. Furthermore, market surveys have confirmed the presence of approximately 32 species of elasmobranchs in UAE waters. Commercially important species include the milk shark *Rhizoprionodon acutus*, and the spottail shark, *Carcharhinus sorrah*, while the giant guitarfish, *Rhynchobatus djiddensis*, is the most valued for its fins.

Additional data collected includes information on the fishery characteristics, species composition and seasonal abundance, feeding ecology, genetics as well as fin trade of sharks. These results will be discussed and concrete scientific recommendations will be formulated to lay foundations for the development of both national and regional shark fisheries management plans.

P17

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Natural diet and feeding behaviour of the commercial sand crab *Portunus pelagicus* (L)1766 along the coastal area of the Kingdom of Bahrain

Portunus pelagicus has a worldwide geographic distribution and is an important commercial species throughout subtropical waters. Although local consumption of this species is low, it supports a fast growing and flourishing international industry. Data are lacking on the natural diet of Portunid crabs along most of the coastal areas of Bahrain and throughout the Gulf. Diet analysis data provides the basis for understanding ecological and behavioral aspects of the species and assessing its potential for mari-culture. The purpose of this study was to investigate the natural diet and feeding of *P. pelagicus*. A total of 232 stomachs were obtained from local fish-trap (Hadhrah) catches during 2003, 2006 and 2007. The difference between sexes and seasonality were assessed. Data were analyzed using SPSS and Primer statistical packages. The results indicated that the diet of this species is highly variable reflecting the ability to adopt different modes of feeding. The preference for animal matter as a food item was obvious. However, the occurrence of sediment in almost all stomachs is indicative of periods of deposit feeding. In addition, many individuals had synthetic fibers and plastic spherules in their stomachs indicating the presence of these pollutants in the surrounding waters. No significant dietary difference was obtained between the sexes although the trend for greater stomach fullness was particularly apparent in the males.

ECOTOXICOLOGY & ECOSYSTEM HEALTH

P18

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Metallothioneins in fish and clams collected from Kuwait's marine area

Stress on the aquatic biota of the Kuwait marine area was assessed by studying metallothioneins (MT), a low Molecular weight (7 kDa) cysteine rich, metal-binding protein. MT play a crucial role in homeostasis of essential trace metals (Cu, Zn, Co, Ni), in detoxification of excess intracellular levels of these and of non-essential metals (Cd, Hg, Ag, Pb), and in protection against various forms of oxidative injury. For this study the target fish species was yellow fin sea bream (*Acanthopagrus latus*) and clams (*Pephia textile*) collected from Kuwait's marine area. The trace metals analysis was done in the freeze dried samples of the clams and fish using ICP-OES. A spectrophotometer method was used to determine the levels of MT in different tissues of the fish and bivalves. The levels of MT and trace metals were higher in the clams than the fish. Liver in fish and the digestive gland in clams possessed higher levels of MT in relation to other parts of the body. In bivalves, a strong positive correlation was observed for Cr and Cu with MT in digestive gland, gills and whole body whereas Ni and Zn were negatively correlated. Low levels of MT in biota observed in our study indicated that currently stress due to trace metals is of lower magnitude.

P19

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Effect of nanometal oxides on marine algae

Microalgae constitute the base of food chain in aquatic ecosystems; therefore impacts on their productivity will affect the productivity of a given ecosystem. The algal growth inhibition test is recommended for the evaluation of the safety of chemicals expected to be released in the aquatic environment as Tiers 1 and II toxicity tests. The algal growth inhibition test with the unicellular algae *Nanochloropsis* was used in this study to determine the toxicity of nano metal oxide, nano titanium dioxide, nano copper oxide, and nano zinc oxide. The selected metal oxides have widespread uses and are already being produced on an industrial scale. Nanoparticles of titanium dioxide and zinc oxide are used in cosmetics as sunscreens, transparent UV-protection films and filters, chemical sensors and in dentistry as antibacterial agents. Nanoparticles of copper oxide find usage in wood preservation, antimicrobial textiles, as a catalyst for carbon monoxide oxidation, and as a heat transfer fluid in machine tools. Nanoparticles of zinc oxide together with nano titanium dioxide are also used as sunscreen and in other cosmetic products. In addition nano zinc oxide is also used in self-cleaning coatings and textiles. The bioassay indicated that all the tested nano metal oxides exerted inhibitory effects on algal growth. Among tested compounds, nano titanium dioxide was least toxic with a high EC50 value of 29.5 mg Ti/l, followed by nano copper oxide (EC50: 21.8 mg Cu/l), and nano zinc oxide (EC50: 7.5 mg Zn/l). The EC50 value of zinc oxide was about one third that of copper oxide but EC10 and EC1 values were similar indicating that low levels of damage occurred at similar concentrations. Monitoring of cell counts and chlorophyll *a* in nano zinc oxide-exposed cultures suggested that chlorophyll depletion precedes cell death.

P20

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Assessment of levels of organic contaminants in Kuwait's coastal environment using bivalves as bioindicators

With the aim to conserve and protect the marine environment, the Regional Organization for the Protection of Marine Environment (ROPME) has initiated a Mussel Watch Program for the ROPME Sea Area. This study was initiated to provide preliminary data on the extent of pollution in Kuwait's coastal marine environment by using bivalve organisms as bioindicator. Bivalves have the ability to bioaccumulate many environmental contaminants to levels exceeding those found in the water or sediments. Thus they can provide more accurate information on the levels of contamination than water or sediment does in a particular environment. Three sites; Doha, Fahaheel and Nuwaiseeb, along Kuwait's coastline were investigated in this study. Bivalves and sediment samples were collected from these sites in November 2009 and analyzed for polycyclic aromatic hydrocarbons (PAHs) and persistence organic pollutants (POPs) including polybrominated diphenyl ethers (PBDEs), organochlorines (OCs) and polychlorinated biphenyls (PCBs).

The results showed that the Σ PAHs detected in bivalves collected from Doha, Fahaheel and Nuwaiseeb areas are 744.18 ng/g, 530.85 ng/g and 920.87 ng/g, respectively, and in sediment samples are 720.37 ng/g, 35.89 ng/g, 104.51 ng/g, respectively. The detected Σ PBDs in biota are 9.39 ng/g in Doha, 18.49 ng/g in Fahaheel, and 21.46 ng/g in Nuwaiseeb. The detected Σ PBDs in Doha sediment equal to 12.84 ng/g, while in Fahaheel and Nuwaiseeb sediment are 0.21 ng/g and 4.48 ng/g, respectively. Σ OCs in the biota samples from Doha is 9.46 ng/g and in Fahaheel and Nuwaiseeb are 7.78 ng/g and 4.15 ng/g; respectively. Σ OCs are only detected in sediment for Doha with a concentration of 1.1 ng/g. Σ PCBs in Doha biota is 21.79 ng/g and in Fahaheel 7.49 ng/g and in Nuwaiseeb 1.12 ng/g and in sediment samples are 0.34 ng/g, 0.11 ng/g, and 0.02 ng/g; respectively.

Overall, the concentration of Σ OCs, Σ PCBs, Σ PBDs and Σ PAHs in biota are higher than in the sediment samples. However, when comparing the three sites, the results revealed that in bivalves, the Nuwaiseeb site showed the highest concentration of Σ PBDs and Σ PAHs, while the Doha site showed the highest concentration of Σ OCs, Σ PCBs. The Fahaheel site also showed higher concentration of Σ PBDs in bivalves than those measured in Doha and higher concentration of Σ OCs, Σ PCBs than was found in Nuwaiseeb. In sediments, concentration of the four contaminant groups was the highest in Doha compared to the other two sites. These findings indicate that bivalves are a better indicator of the level of contamination and should be used in future monitoring/ assessment programs in the Gulf.

P21

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Response of four algal species to the water accommodated fraction (WAF) of Kuwait crude oil

Algae have been extensively applied as sensitive indicators of the aquatic environment because of their rapid reproduction rates and short life cycles. Algae harness energy from sunlight and provide food for other organisms in aquatic ecosystems. Four varieties of algae *Nanochloropsis*, *Chlorella*, *Tetraselmis* and *Dunaliella* were exposed to the water accommodated fraction (WAF) of Kuwait crude oil (KCO) to determine their relative sensitivity. EC50, EC10 and EC1 values were determined. The lowest EC50 value, 998- μ l KCO/l seawater, was obtained with *Tetraselmis* and close to this value were *Dunaliella* and *Chlorella*. *Nanochloropsis* was the most resistant algae to KCO with an EC50 value of 2083- μ l KCO/l. The EC10 value of 183- μ l KCO/l seawater for *Dunaliella* showed its sensitivity for low grade damage. Calculation of the EC1 value provided a better indication than either the no observable effect concentration (NOEC) or the lowest observable effect concentration (LOEC) for the protection of algae in general. Potassium dichromate, used as a reference chemical showed EC50 for the algae tested in the range of reported EC50 values against *Skeletonema* and *Phaeodactylum* suggesting satisfactory test conditions. The inhibitory oil loading values obtained in algal growth inhibition tests were higher than the reported petroleum hydrocarbon (PHC) contamination in Kuwait's marine area, suggesting that the background concentration may not cause any serious damage to the algal community. However, occasionally higher contamination may induce damage that is expected to be recovered on decreasing the concentration in the environment.

P22

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Assessment of potential microbial pathogens in oil-polluted soil in Kuwait

A huge amount of oil-contaminated soil remains unremediated in the Kuwait desert. The contaminated oil has the potential to cause pollution of underground water and to affect the health of people in the area. Petroleum biodegradation hydrocarbons in desert soil environment are a result of indigenous heat-adapted microorganisms able to degrade these contaminants.

In this study, the target was to isolate and identify organisms of the genus *Nocardia* as indication of a possibility of opportunistic pathogen emergence in contaminated desert soil.

Twelve oil-contaminated locations were tested, and 73 soils were sampled from these various sites of oil-contaminated soil in Kuwait and screened for microorganisms capable of oil degradation. Various methods were used to characterize hydrocarbon-degrading population in soil. The shape and the gram reaction of cell were observed through a microscope, and the physiological characterization was studied. Paraffin baiting technique was used for the selection of hydrocarbon utilizing bacteria. Paraffin was used as the only carbon and energy source to minimal medium. Potential hydrocarbon degrader bacteria were isolated from soil samples that have been exposed to crude petroleum oil spills; bacterial isolates included *Bacillus* spp. *Enterobacteriaceae*, *Acinetobacter*, *Pseudomonas* spp., *Nocardia* spp., *Streptomyces* spp. and *Citrobacter* spp.

Conclusively, the slow decomposition of aromatic compounds was due to the low population of aromatic compound-decomposing bacteria in the Kuwait desert soil. These bacteria could as well be opportunistic pathogens. In this preliminary study, it was established that the oil-contaminated desert soil could support the growth of the opportunistic pathogens such as *Nocardia*, and these organisms due to the dust storms could be transferred to the neighboring town, and become a potential hazard to the health of immunocompromised patients.

P23

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Toxicity assay of manufactured nanoparticles

Nanotechnology is a fast growing scientific field which may present a variety of hazards for environmental and human health due to the unique properties of manufactured nanoparticles. Therefore, studies have been initiated in our laboratory to check various assays for the suitability of toxicity testing of nanomaterials. In the present study, a quick bioassay method that employs the marine bacterium *Vibrio fischeri* (Microtox toxicity test) was used to assess the toxicity of nano metal oxides (nano titanium dioxide, copper oxide and zinc oxide) and organic nanomaterial (single walled carbon nanotube SWCNT, and Fullerene C-60). The results showed that nano TiO₂, SWCNT and Fullerene C-60 were not toxic to the marine bacterium, whereas, nano CuO and nano ZnO were extremely toxic. The bulk material of these metal oxides exerted delayed toxicity and salts including copper sulphate and zinc sulphate were equally toxic. The present study suggests that Microtox toxicity tests could effectively differentiate toxic and non toxic nanoparticles and the system can be employed for primary screening.

P24

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Seaweeds as indicators of the bioavailability of heavy metals in coastal waters

The mining and transportation of iron and ferromanganese ores throughout the year greatly influences their availability in the marine environment leading to their accumulation in aquatic organisms of the Arabian Sea coastal regions of India. The accumulation potentials of heavy metals (Zn, Fe, Mn, Cd, Pb and Cu) in 8 seaweed species collected off Anjuna coast, India were estimated. The species showed various degrees of accumulation of heavy metals. *Geladiella* sp. (Rodophyta) recorded the highest level of Fe (2350.6 ppm) and Zn (23.25 ppm) while *Ulva fasciata* (Chlorophyta) recorded the highest concentration of Mn (191.66 ppm). The only seaweed that had accumulated Cd was *Chondria armata* (Rhodophyta) and it also had the highest Cu accumulation (18.89 ppm). A notable phenomenon was that none of the seaweeds had any detectable Pb level. The metal accumulation ranges of seaweeds were 169.23 – 2350 ppm for Fe, 26.28- 191.66 ppm for Mn, 5.5 - 23.15 ppm for Zn, 0 – 18.89 ppm for Cu and 0 -2.76 ppm for Cd. The high values of Fe followed by Mn reflect the bioavailability of these metals in the surrounding waters and the capacity of these seaweeds to take them up. These seaweeds can be used as monitors to give information on heavy metal levels or metal availabilities in the surrounding environment.

MARINE POLLUTION & ITS IMPACT

P25

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An advanced method for the analysis of OCPs and PCBs in Kuwait marine environment

A fast and selective automated PLE extraction followed by power^{prep} clean-up system were used for the extraction and clean up of organo-chlorinated pesticides (OCPs) and polychlorinated biphenyls (PCBs) in various environmental marine samples such as fish, squid, bivalves shell, octopus and shrimp. OCPs and PCBs were simultaneously determined in a single run using negative chemical ionization gas chromatography-mass spectrometry (GC-MS-NCI). About 5 g of each biological marine samples was mixed with anhydrous sodium sulphate, the sample was filled into the extraction cell. The PLE system is controlled by means of a PC using software (DMS 6000). Purification of the extract was accomplished by automated power^{prep} clean-up system. Hexane extracts were loaded and pumped through silica column. All OCPs and PCBs were eluted from the silica column using a mixture of hexane and dichloromethane (1:1). A wide variety of fish and shellfish were collected from a supermarket and analyzed. Concentrations of PCBs were in the range of 0.02-0.82 ng/g, 0.02-1.33 ng/g, 0.02-0.28 ng/g, 0.02-0.55 ng/g and 0.07-23.42 ng/g for fish, squid, bivalve shells, octopus and shrimp, respectively. Concentrations of OCPs were in the range of 0.03-5.09 ng/g, 0.02-0.48 ng/g, 0.02-0.68 ng/g, 0.08-3.11 ng/g and 1.38-5.65 ng/g for fish, squid, bivalves shell, octopus and shrimp, respectively. Lipids were removed with gel permeation chromatography (GPC). Analytical criteria such as recovery, reproducibility and repeatability were evaluated through the range of the biological matrices. The feasibility of the proposed PLE/ power^{prep} method was evaluated by analyzing certified reference materials and spiked samples with satisfactory results.

P26

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Denitrification potential of the northern Gulf – An experimental study

The study aims to establish the denitrification potential of the Northern Gulf, as nitrogen critically affects ocean productivity, acidity, oxidative capacity and radiative transfer capability. This experimental study was conducted by taking cores from intertidal zones from two different sites in North and South, referred as Sites N and S; representing distinct environmental milieu. The experiment was conducted under controlled laboratory conditions simulating the tidal cycles. Multiple cores were taken and loaded with seawater with different N concentrations and the redox potential was established for each condition. Redox potential was significantly lower at 10cm 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 ($P < 0.001$; $F = 714.2$), suggesting anaerobic sediments at Site S. Effects of Nitrate Spiked Seawater on denitrification under non flooded and flooded conditions at the two sites were also studied. Three - way ANOVA analysis indicated that site, nitrate concentration and flooding had significant main and interactive effects on the denitrification rate. The results suggest that under ambient nitrate concentrations ($0.03 \text{ mg NO}_3\text{-N l}^{-1}$), $6.3 \pm 2.1 \text{ g NO}_3\text{-N ha}^{-1} \text{ day}^{-1}$ can be denitrified by inter-tidal zone sediments. At a nitrate concentration of $1 \text{ mg NO}_3\text{-N l}^{-1}$, $92 \pm 16 \text{ g NO}_3\text{-N ha}^{-1} \text{ day}^{-1}$ may be denitrified. At a very high nitrate load of $10 \text{ mg NO}_3\text{-N l}^{-1}$, the sediments may attain a rate of denitrification close to $404 \pm 78 \text{ g NO}_3\text{-N ha}^{-1} \text{ day}^{-1}$.

P27

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Tracking fecal coliform pollution trends in Kuwait coastal waters, 2007 - 2009

The distribution of fecal coliform bacteria in the coastal waters of Kuwait and especially at the southern area of Kuwait Bay was studied between January 2007 and December 2009. Fecal coliform, *E.coli* and Fecal *Streptococci* levels were detected using the Membrane Filtration Technique and their levels were monitored according to the European Commission's guidelines. Twelve sampling locations were selected and marked by letters (So, S1, S2, ..,S11) starting from Al-Salam Beach as the first location down to Al-Amiri beach, Bnaid Al-Gar, Al-Shaab beach, Ras Al-Ardh beach, Al-Salmiya beach, Al-Bedaa beach, Al-Mesila beach, /abu-AlHasaniya, Al-Fintas beach, Al-Mangaf beach, and Al-Fahaheel beach in the south and samples were collected on a weekly basis. Very high counts were detected closer to the emergency exits of the main pumping stations of sewage treatment plants and several illegal connections to the rain water outlets were found to have affected the number of fecal coliform in that area. The rest of the stations had counts below 500 cfu/100ml which can be considered safe for coastal and recreation waters.

P28

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Assessment of sewage pollution of Kuwait coastal areas after a major pumping station failure

This study was undertaken to assess the sewage pollution of Kuwait's coastal areas that received the untreated sewage after a major pumping station failure. About 180,000 – 200,000 m³/day of untreated sewage was continuously released for more than one year (continuing to date). Fecal sterols (especially coprostanol), considered to be ideal markers for sewage pollution were used for the assessment. A total of 28 sediment samples were analyzed for the sterols. Coprostanol and cholesterol levels and their ratios were determined by GC/MS selective ion monitoring. The results showed that coprostanol levels were relatively high in the study area. Coprostanol/cholesterol ratios (an indicator of sewage pollution) clearly showed that the coastal areas receiving untreated wastewater were heavily contaminated with sewage related pollutants. Comparison with previously collected samples and reported values clearly showed the trend of increasing pollution.

P29

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Spatial and temporal distribution of phosphorus in coastal marine sediment from the northwestern Gulf

This study reports the spatial and temporal variability of total phosphorus (TP) and its forms in sediments from Kuwait Bay, a semi-enclosed water body in the northwestern corner of the Gulf. The mean (and range) concentration of TP in surficial sediments is 19.4 (12.2 to 24) $\mu\text{mol-P g}^{-1}$ dry weight. Of this, inorganic phosphorus (IP) comprised the largest reservoir of phosphorus, contributing about $83.5 \pm 6.8\%$ with organic phosphorus (OP) contributing $16.5 \pm 7.3\%$ of the measured TP. The highest concentrations were measured in the deeper portions of the Bay which is characterized by fine grained sediments. The vertical profile in the sediments was characterized by a gradual increase in concentration from depth to a subsurface maximum (at approximately 4-5 cm) followed by an exponential decrease to the sediment-water interface. The sedimentary profile of TP correlated remarkably well with changes in the population of Kuwait over the last three decades, suggesting that wastewater inputs into the Bay from treatment plants is an important source of phosphorus in the Bay. The decrease in concentration in sediment deposited over the last five years maybe as a direct consequence of the commissioning of an improved wastewater treatment plant with higher phosphorus removal efficiency. This study shows how better wastewater management practices can lower the levels of phosphorus inputs to coastal marine waters and reduce the likelihood of eutrophication particularly in semi-enclosed water bodies.

P30

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The role of scavenger gastropods in the biosorption of heavy metals in the north rocky shores of the Gulf: A case study on the performance of *Littorina saxatilis* and *Nassarius coronatus*

Calcium inhibition and binding with cadmium in many animals has been well documented in the scientific literature. Cadmium has to be absorbed through a calcium channel, thus different concentrations of Calcium may change the absorption efficiency of Cadmium in dissolved state. Intertidal Gastropods can absorb heavy metals via two methods: passive absorption and consumption.

Two different herbivorous and scavenger species of the intertidal zone (*Littorina saxatilis* and *Nassarius coronatus*, respectively) were examined in situ using mesocosms in order to understand the absorption of cadmium when dissolved Calcium concentrations in sea water change. These two species represented dominant gastropods in all parts of tidal bands in the study area and play a key role in the transfer of energy between primary producers and fish. Different concentrations of Verapamil, a Calcium channel blocking agent, was used instead of changes in available dissolved Calcium. Three states of 5 $\mu\text{g L}^{-1}$, 50 $\mu\text{g L}^{-1}$ and no Verapamil treatments were combined parallel to constant concentrations of 50 $\mu\text{g L}^{-1}$ of CdCl_2 in dissolved form. Exposure periods varied from 10 minutes to 60 minutes separated by flushing the mesocosm with seawater for 2 minutes in order to re-initialize the experiment.

Our observations suggest that in high concentrations of Verapamil (i.e. low Calcium), Cadmium uptake was significantly higher than in the low Verapamil and no Verapamil treatments (i.e. high concentrations of Calcium). Significant differences were also observed between the two species. *L. saxatilis* absorbed much more contaminants than *N. coronatus*, probably due to their respective diets. *L. saxatilis* being herbivorous, fed with radulae during experiments and absorbed contaminants by both active and passive manners. However, *N. coronatus* fed only on debris and detritus when present.

P31

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Environmental impacts of shrimp cultures on the marine coastal environment of Delvar and Mond sites in Bushehr Province, Iran

This work was carried out to study the impacts of shrimp culture on the water quality of shrimp projects during 2006 - 2007. In this survey, the supply and drainage canals of Delvar and Mond sites in Bushehr Province were evaluated. The statistical analysis was done through SPSS 15 software. The variation of 9 physical and chemical parameters such as dissolved oxygen, pH, salinity, temperature, TSS, BOD, total ammonia, nitrate and phosphate were measured. The range of variation for each parameter was: 22.5- 36.5 °C for temperature, 7.9- 8.2 for ph, 36 – 43 ppt for salinity, 5.3 - 7.5 mg/l for dissolved oxygen, 0.1 - 2.5 mg/l for BOD5, 0.001 - 0.040 mg/l for total ammonia, 0.022-0.235 um/l for nitrate, 29 - 143.5 µg/l for total suspended solids and 0.001-0.039 mg/l for phosphate.

Overall results show that the parameters in selected stations compare with other shrimp culture sites. However, BOD5, nitrate, phosphate, salinity, total ammonia, and total suspended solids in the drainage and supply canals in Delvar and Mond stations were significantly higher than in other shrimp culture sites.

ENVIRONMENTAL MANAGEMENT

P32

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Integrated environmental assessment of Kuwait Bay: Policy analysis and scenario response

Kuwait Bay is an important resource for the State of Kuwait. It has a number of major activities including business, industry and recreation. The amount of construction and development of projects and their resulting pollution have led to major changes in the features of the area. The purpose of this research is to provide a management tool for decision-making through the environmental assessment of Kuwait Bay with an analysis of current policies.

Due to the multiplicities and diversities of the man-made activities in the bay and the natural environmental setting, the impacts are examined holistically rather than singularly. The DPSIR model, recommended by UNEP, was used in order to analyze different scenarios for managing the bay.

The southern areas of the bay are the main recipients of pollutants that travel northward to cover the central region. Sulaibikhat Bay (South-West sector) is the most vulnerable area due to its exposure to anthropogenic activities such as reclamations, sewage inflow and other activities. The area near Shuwaikh Port is suffering due to reclamation processes. The northern and north-west sectors suffer from coastal erosion as well as from pollutants arriving via Shatt Al Arab.

The driving forces include economic pressures, rapid urbanization, limited land resources and uncertain events. The states include deterioration of the marine environment, fish kill events and decreasing biodiversity. Policy instruments including economic expenditures, regulations and institutional instruments were scanned based on the most important environmental pressures. The policy appraisal method was done following according to the GEO5 Report. This includes identification of benefits and drawbacks for each policy. Policies were then ranked and the 4 top-ranking policies were then proposed for further analysis using Policy Performances Indices. It is concluded that the sustainability scenario was the most recommended scenario that can help preserve the Kuwait bay environment.

P33

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Community-based management models for ecosystems protection: A sure way to sustainable improvement of coastal ecosystem health

Population growth and industrial development, especially oil, gas and petrochemical, has resulted in increased energy production, consumption and marine transportation in the Gulf. This situation along with climate change and multiple pollutants entering the gulf, has exposed this vital ecosystem to serious damages. For example, a red tide phenomenon occurred in the surrounding coasts of Qeshm Island (south of Iran), between September 2008 to June 2009 with harmful consequences. We have designed a community-based model to address the damaging effects of these various environmental stressors. This model was developed from the experience gained from community-based management of rescue operations during the November 27, 2005 and the September 10, 2008 earthquakes. In this study, residents living in coastal villages, especially citizens working in professions associated with the sea, gained membership on committees. Committees were formed with the support of Red Crescent Society and cooperation of local institutions such as the Islamic Council. The citizens participated in training to be familiar with the emergence of red tides, its consequences and other polluting agents harmful to the coastal waters. The training increased average environmental awareness, accountability and promoted citizen participation. This participation led to the prevention of domestic, industrial and semi industrial sewage pouring into the sea as well as other benefits. Ultimately, this process significantly reduced the harmful effects of red tide. This study shows that a community-based management model to protect ecosystems is reliable and complementary to existing government programs that promote sustainable improvements in ecosystem health.

P34

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Coral relocation and monitoring at the New Doha International Airport

Coral reefs are some of the most diverse ecosystems in the world sustaining life for thousands of species. Corals are also the major contributors to the physical structure of the coral reefs that develop in tropical and subtropical waters. Corals are sensitive organisms, which can be affected by slight changes in physicochemical parameters of the water. The magnitude of construction currently taking place in Qatar has the potential for significant environmental stress on the surrounding marine environment and especially on corals.

The New Doha International Airport (NDIA) is one of Qatar's signature projects with a comprehensive environmental management programme. A significant compensation and mitigation initiative designed for the NDIA involved the relocation of approximately 90 corals to allow for the construction of a slipway to be used as boat ramp for a sea rescue station at the South of the NDIA site. This paper presents an overview of the coral relocation and monitoring project aimed at reducing the environmental impact on this key habitat during and after construction of the slipway.

P35

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An environmental database for meiofauna and microfauna in northern Gulf

The study highlights the use of GIS technology for structuring the spatio-temporal information on micro and meiofauna in Kuwait's marine environment. The studies on micro and meiofauna have been done in Kuwait's water since 1970's, but the information is not available on a uniform, easily retrievable and spatial scale. Integration of this data unites using Arc GIS, enabled researchers to generate spatio-temporal information on macro and meiofauna. The database structure is created taking into account different parameter that were covered by each study and a unified system is designed to allow temporal correlation on different spatial scales.

P36

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Evidence of CO₂ sequestration and ocean acidification from Kuwait territorial water

The marine systems play a key role in maintaining fundamental biogenic elements including Carbon dioxide (CO₂). Addition of CO₂ due to fossil fuel use, changes in terrestrial landuse-landcover and cement manufacturing are considered as primary forces contributing to global warming. Most of the Arabian Gulf countries are oil producers and emitters of green house gasses including CO₂. Increase in CO₂ concentration is considered as one of the main contributor for global warming. The added CO₂ is usually sequestered by ocean and results in the formation of carbonic acid and lowers the ambient sea water pH. The CO₂ sequestration in the Oceanic water leads to acidification. The countries in this region are fast growing economies which have huge energy demands essentially met by fossil fuel consumption. The vegetation cover is limited both in spatial and temporal terms. Usually the atmospheric water vapor is very low. In this environmental setting, the elevated atmospheric CO₂ concentrations are likely to be sequestered in the Arabian Gulf waters. Evidence of acidification is observed from the pH measurements between 2007 – 2010 in Kuwait Territorial water. The drop of ~0.2 pH units is observed in sea water measurements and secondary data collated from Kuwaiti EPA reports (2007-2009). The data of acidification is too high and remains an enigma.

P37

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Hair as a Biomonitoring Tool for Persistent Organic Pollution in Kuwait

This study report concentrations of polycyclic aromatic hydrocarbons(PAHs) and polybrominated diphenyl ethers (PBDEs) hair samples collected from 24 healthy individuals and ten sheep (*Ovis aries*) from Kuwait. Σ PBDE concentrations ranged from 0.6 – 50ng/g (mean, 18.6±13 ng/g) for humans and from 0.6 – 1.4ng/g (mean, 1.1±0.25 ng/g) for sheep. The Σ PAH concentrations in human air were log-normally distributed and ranged from 98-2529 ng/g (mean, 334±117 ng/g) whereas the importance were phenanthrene (42-44%), fluorine (12-16%), anthracene (11%), fluoranthene (10%) and pyrene (7-9%). The concentrations in hair measured in this study for both classes of compounds were compared with indoor and outdoor and concentrations measured using polyurethane foam passive samplers to explore the relationships between air concentrations and hair for POPs. Very strong correlations ($r>0.9$) were found between concentrations of PBDEs and PAHs in human and sheep hair with concentrations measured in indoor and outdoor air respectively using polyurethane foam passive samplers. The present study provides preliminary evidence that hair can be used as a passive sampler for POPs, however further studies on larger scale is required to validate the use of hair as a biologic measure of exposure to persistent organic pollutants (POPs) environmental monitoring studies.

This study also provides further evidence that the current analytical method for hair analyses is reliable. However further studies should focus on standardizing procedures for hair sampling, and addressing the contentious issue distinguishing endogenous contamination.