Insights from Long-term Oceanographic Monitoring in Kuwaiti Waters

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Coastal and Marine Resources Program

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Environment and Life Sciences Research Center

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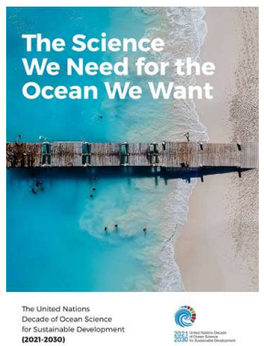


"There can be no healthy planet without a healthy ocean."
— Peter Thomson, UNSG's Special Envoy for the Ocean

First Intergovernmental Session of the IOC Sub-commission for the Central Indian Ocean (IOCINDIO-1)

IOCINDIO Workshop on Strengthening Ocean Sustainability, Emirate of Ras Al Khaimah, UAE

20 -05-2025

Dr. Turki Al-Said

Research Scientist
(Marine Biogeochemist)

Program Manager
Coastal and Marine Resources Program, ELSRC
Acting Science and Technology Director,
Environment and Life Sciences Research Center, KISR

- Ph.D in Marine Biogeochemistry from University of Southampton , UK
- M.Sc. in Oceanography from University of Southampton , UK
- B.Sc. In Marine Science from University of Qatar, Qatar

- Published research articles (>40) in Q1/Q2 journals, book chapters, attended several international conferences, completed several client funded research projects, including the Phase-I of the mega project on Sulaibikhat MPA (Client UNCC/KNFP)

- Phase-II study of the MPA (Dec 2024- Nov 2029)
- Client: UNCC/PAAF/KNFP

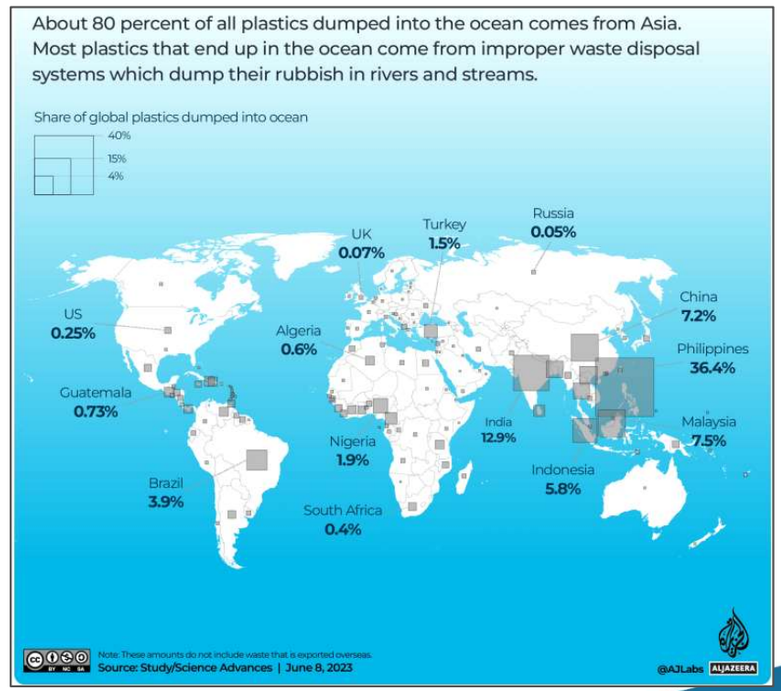
- Mega research projects aboard RV *AlMostakshif* in the entire EEZ of Kuwait (Dec 2024-Nov 2027) KFAS
- Ocean Health Project IAEA

Background

- A healthy ocean is essential for sustaining marine biodiversity and ecosystem functioning, supporting countless species and provide food and livelihoods for millions of people worldwide (UN SDG13: Climate Action & SDG 14: Life Below Water).

However, oceans bear the impact of humungous anthropogenic activities contributing to climate change.

- Global warming and ocean acidification, coastal eutrophication, increased HABs, legacy and emerging contaminants, affecting the Essential Ocean and Biodiversity Variables (EOVs and EBVs), affecting the marine food webs, productivity, challenging the marine food safety and security, ultimately putting the ocean and human health at risk.

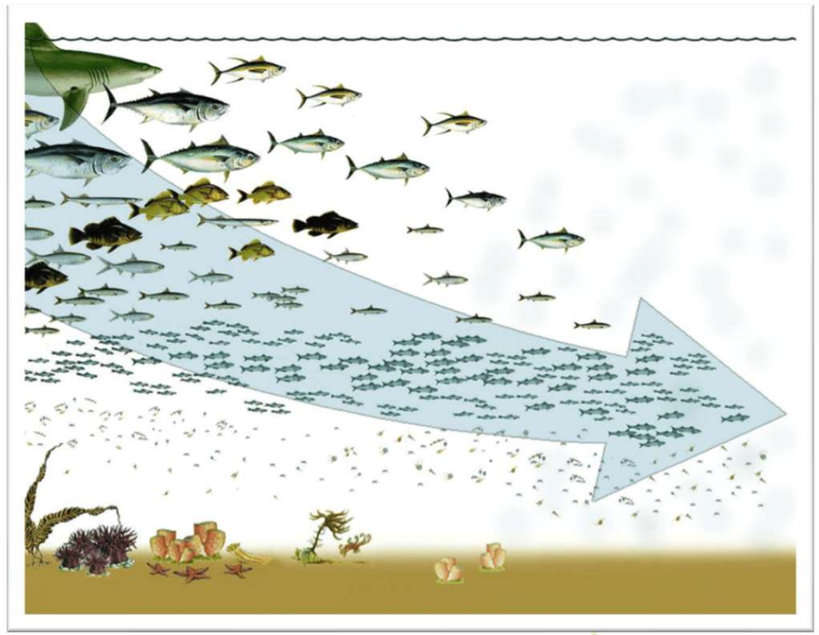


Current Challenges & Major Threats in Northern Gulf

- Global warming, ocean acidification, and anthropogenic impacts on marine ecosystem functioning
- Reduced fresh water supply from the SAR system
- Increased desalination activities
- Frequent dust storm events
- Ballast water introductions of alien marine species
- The collapse of prime fishery stocks and the decline in abundance and diversity of marine communities

Solutions

- Assess the impact of physical and biogeochemical processes in the northern Gulf.
- Study the impacts of climate change on marine resources and biodiversity.
- Explore marine resources for molecules of bioactive potential
- Rehabilitation and stock recovery approaches through stock enhancement practices and management plans.
- Food web dynamics to study the climate-change impact, and to support the development of food web modelling.
- Identifying ballast water introductions and risks assessment of HABs.
- Establishing DNA metagenomics and barcoding data for Kuwait's marine environment.



KISR
معهد الكويت للأبحاث العلمية
KUWAIT INSTITUTE FOR SCIENTIFIC RESEARCH

UN’s Sustainable Developmental Goals

Kuwait scenario

ALIGNING KUWAIT VISION 2035 AND KUWAIT NATIONAL DEVELOPMENT PLAN WITH THE SUSTAINABLE DEVELOPMENT GOALS

- Kuwait officially endorsed the 17 goals, 169 targets and 232 indicators of the Sustainable Development Goals (SDGs) in September 2015, the State has taken full ownership of Agenda 2030, reflecting its premises in Kuwait Vision 2035.

- Its ambition was to strategically match the seven pillars of Kuwait Vision 2035 and the National Development Plan with the SDGs goals and targets.

SDG-14 for the GCC Countries- Status Review

Target No.	Target	Sub-target	Country	Indicator value	Indicator year
14.1	Reduce Marine Pollution				
14.2	Protect and Restore Marine Ecosystems	Proportion of EEZs managed using Ecosystem-based approaches	Kuwait	20%	2016
			Qatar	100%	2019
14.3	Reduce ocean acidification	Average pH measured at agreed suit of representative stations	Kuwait	8.24	2016
			KSA	7.91	2019
			Qatar	7.8	2019
14.4	Sustainable Fishing	Proportion of fish stocks with biologically sustainable levels	Kuwait	25%	2016
			KSA	46%	2019
			Bahrain	12%	2017
			Qatar	85%	2019
14.5	Conserve Coastal and Marine areas	Coverage of Protected areas in relation to marine areas	Kuwait	3.0%	2017
			KSA	Data not avail.	2017
			Bahrain	2.8%	2017
			Qatar	6.2%	2018
			UAE	24.5%	2017
			Oman	6.3%	2019
14.6	End subsidies contributing to overfishing				
14.7	Increase economic benefits from sustainable use of marine resources	Sustainable fisheries as a proportion of national GDP	Kuwait	0.10%	2016
			Qatar	0.19%	2016
			Oman	0.54%	2017
14.8	Increase Scientific knowledge, research, and technology for ocean health				
14.9	Support small-scale fishers				
14.10	Implement and enforce international sea law				

Source: GCC-Stat, web site: https://geogcc.gccstat.org/SDGs/

Stakeholders of SDG-14 in Kuwait

ROPME
Regional Organization for the Protection of the Marine Environment - Kuwait

الهيئة العامة للبيئة
دولة الكويت

State of Kuwait
Ministry of Education

PUBLIC AUTHORITY OF AGRICULTURE AFFAIRS & FISH RESOURCES
الهيئة العامة لشئون الزراعة والثروة السمكية

KUWAIT UNIVERSITY
EXCELLENCE & INNOVATION
جامعة الكويت
1966

وزارة الكهرباء والماء والطاقة المتجددة
Ministry of Electricity & Water & Renewable Energy

KFAS
مؤسسة الكويت للتقدم العلمي
Kuwait Foundation for the Advancement of Sciences

MINISTRY OF HEALTH

الجمعية الكويتية لحماية البيئة
Kuwait Environment Protection Society

STATE OF KUWAIT
MINISTRY OF OIL

البترول الوطنية
KNPC
إحدى شركات مؤسسة البترول الوطنية
A Subsidiary Of Kuwait Petroleum Corporation

شركة نفط الكويت
Kuwait Oil Company

مؤسسة الموانئ الكويتية
KUWAIT PORTS AUTHORITY

وزارة التجارة والصناعة
Ministry of Commerce and Industry

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Historical Oceanographic Observations in Kuwaiti Waters; KISR efforts and accomplishments

(Since 1996)

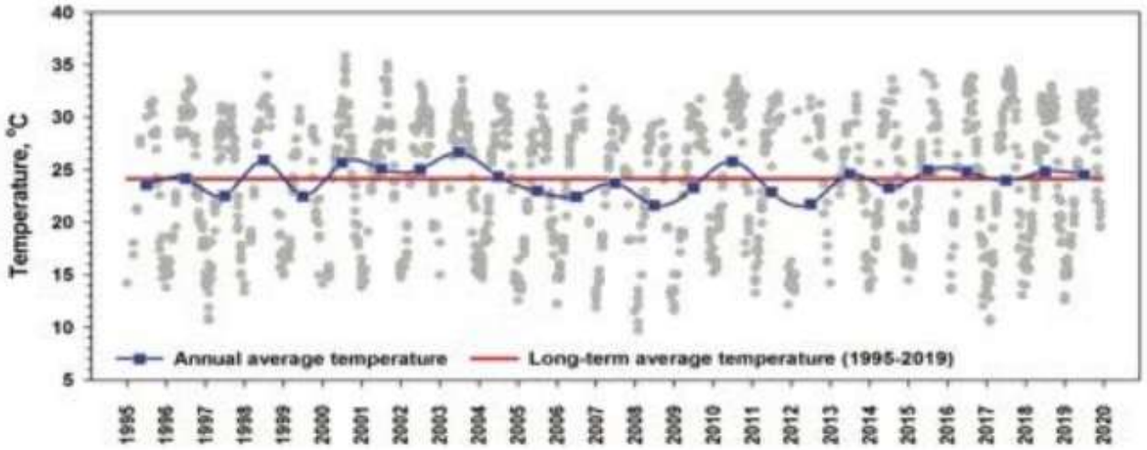
Historical Oceanographic Observations

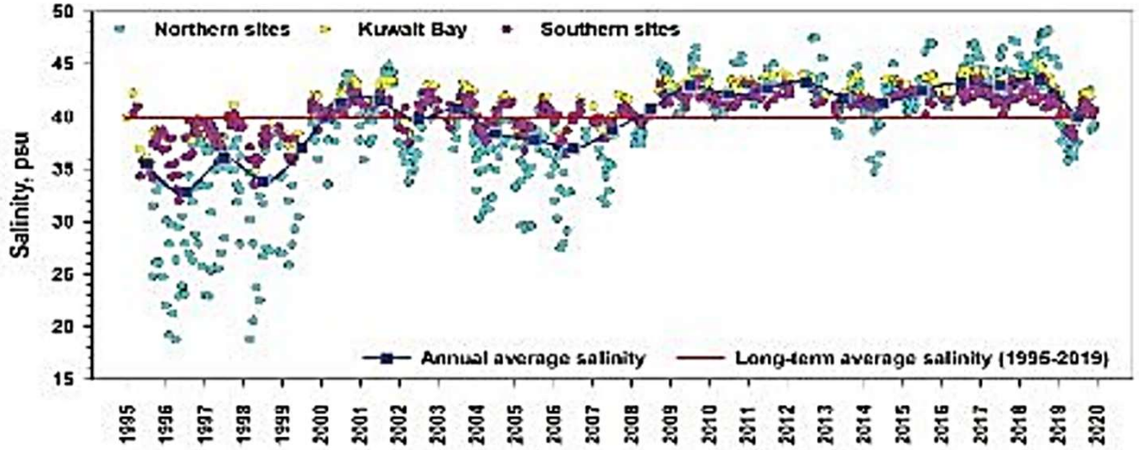
- 6 time-series stations since 1996
- Subjected to environmental extremes

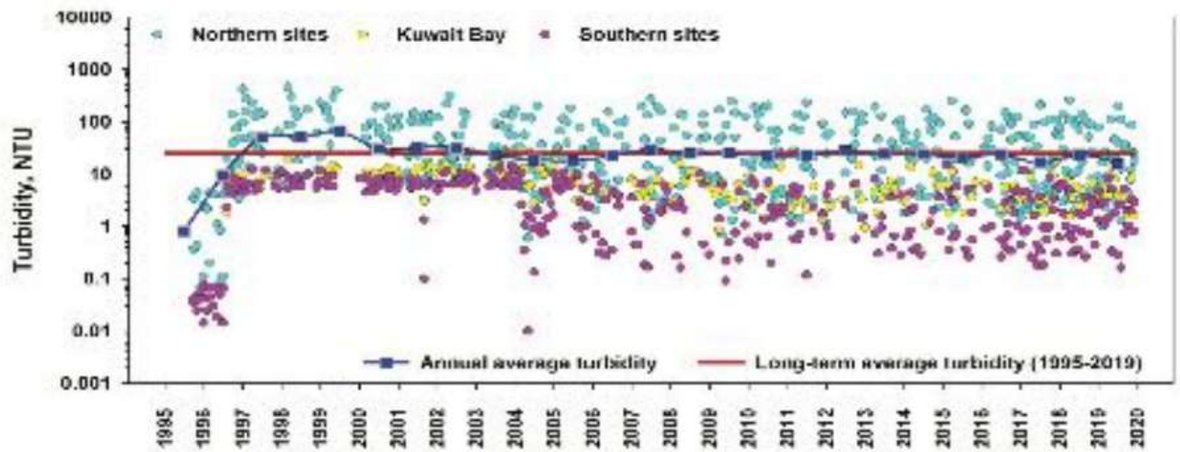
  Water temperature (WT): 15-36 ºC
  Salinity: 38 - 45

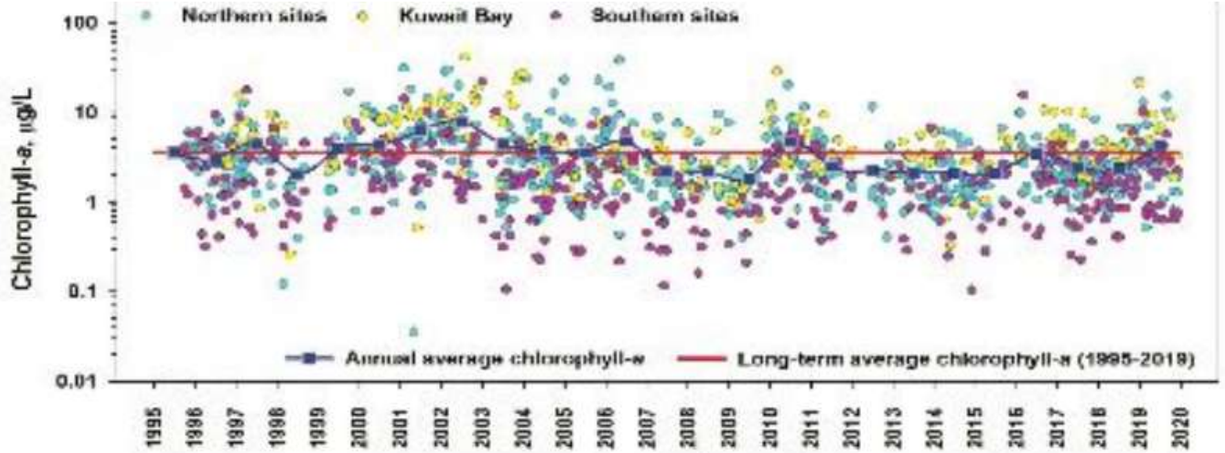
- Global warming and increased evaporation
- Reduced fresh water supply from the SAR system
- Increased desalination activities
- Frequent dust storm events
- Increased human perturbations

Long-term trends in Essential Environmental Variables (EEVs)- Kuwaiti waters

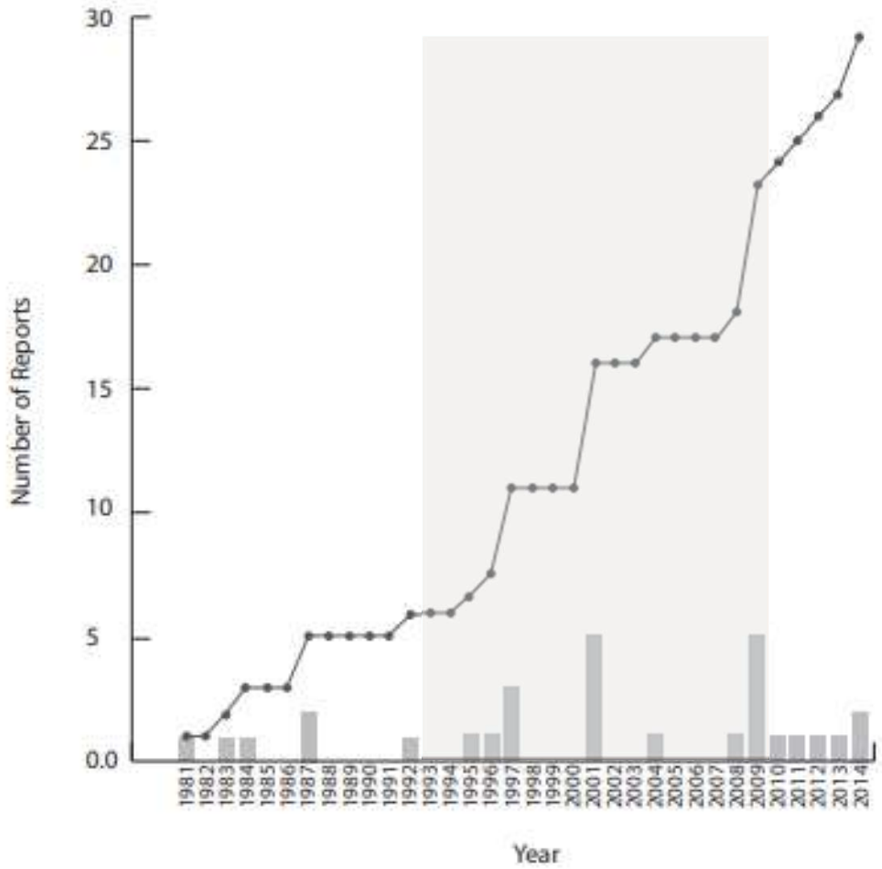




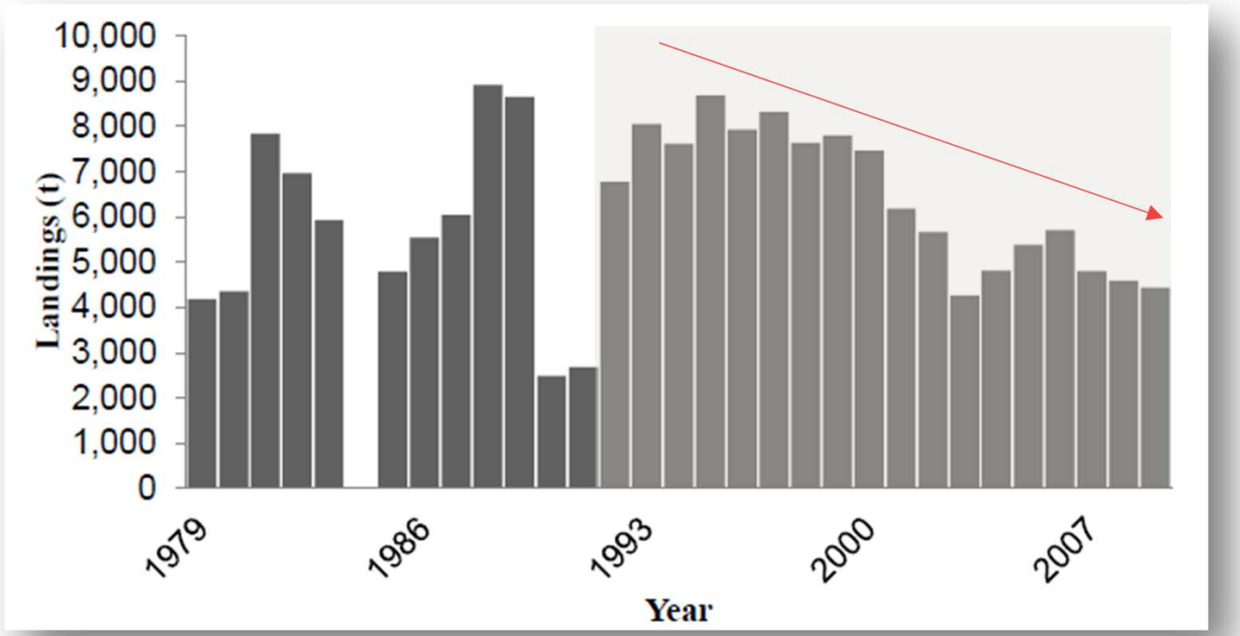




Long-term trends in invasive phytoplankton and marine fishery in Kuwait



Cumulative number of invasive marine species in Kuwaiti waters over time (Source: CEFAS, 2017).



Annual landings of Kuwait's finfish and shrimp from 1979 through 2009 (Al-Said, 2021).

HABs & Fish Kill Monitoring in Kuwaiti Waters

(A) *Myrionecta rubra* bloom, (B) Catfish kill, and (C) Foam formation from the *Nitzschia* sp. bloom

A high-density bloom of the toxic dinoflagellate caused bivalve mass mortality in the Doha area, Kuwait Bay (July 2020)

Invasive phytoplankton species and shell fish mortality in Kuwait (Summer 2020)

Contents lists available at ScienceDirect

Deep-Sea Research Part II

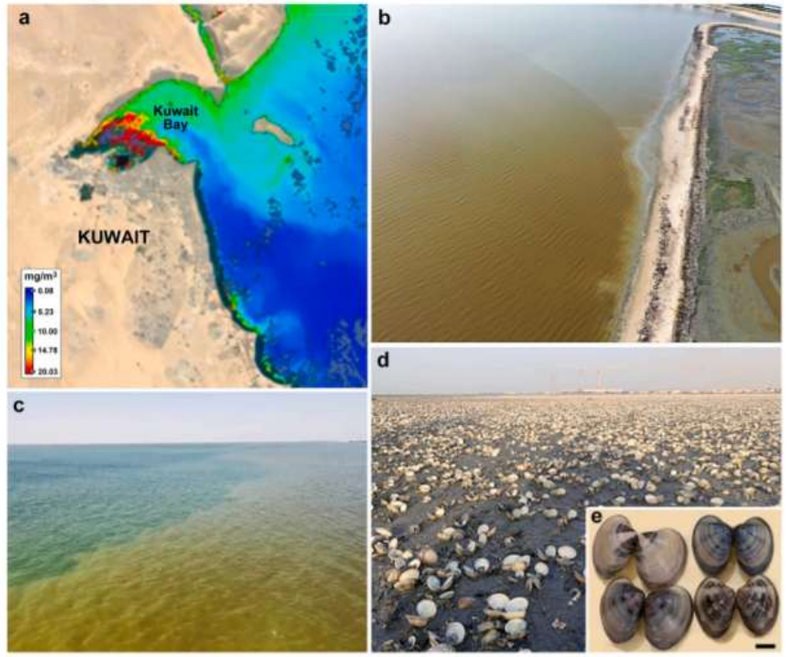
journal homepage: www.elsevier.com/locate/dsr2

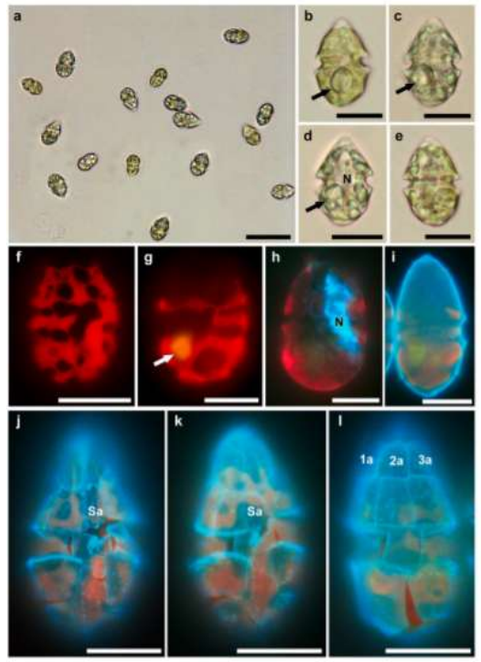
Alien toxic dinoflagellate *Heterocapsa circularisquama* from the Western Pacific in Kuwait, NW Indian Ocean

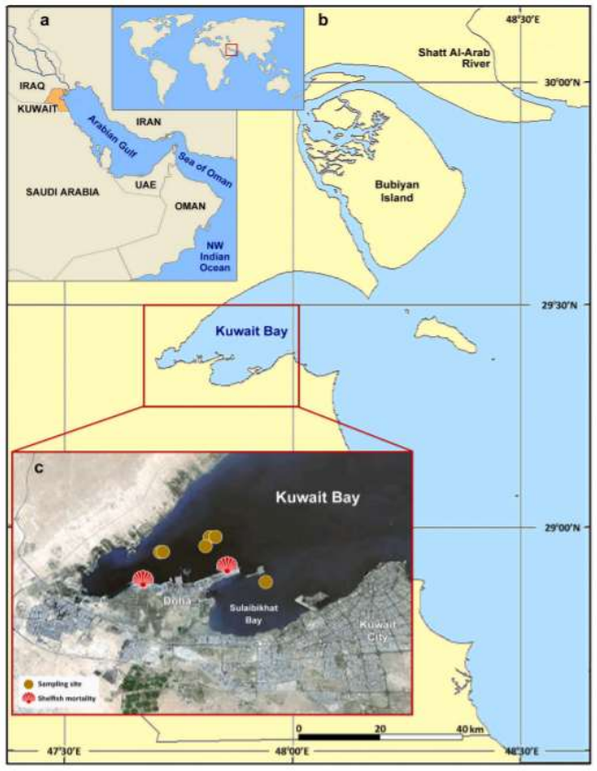
Maria Saburova [a,*], Manal Al-Kandari [a], Igor Polikarpov [a], Abrar Akbar [b], Sumaiah Hussain [a], Rita Rahmeh [b], Waleed Al-Zakri [a], Faiza Al-Yamani [a]

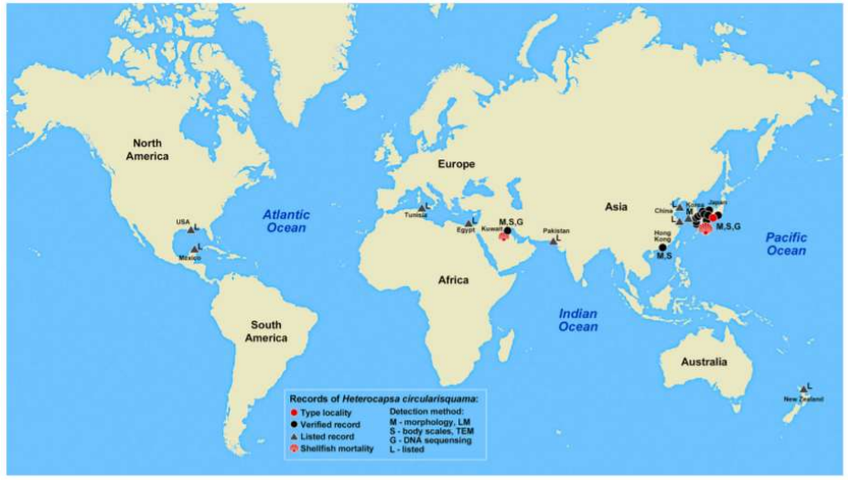
[a] Ecosystem-Based Management of Marine Resources Program, Environment & Life Sciences Research Center, Kuwait Institute for Scientific Research, P.O. Box 1638, Salmiya, 22017, Kuwait

[b] Biotechnology Program, Environment & Life Sciences Research Center, Kuwait Institute for Scientific Research, P.O. Box 24885, Safat, 13109, Kuwait



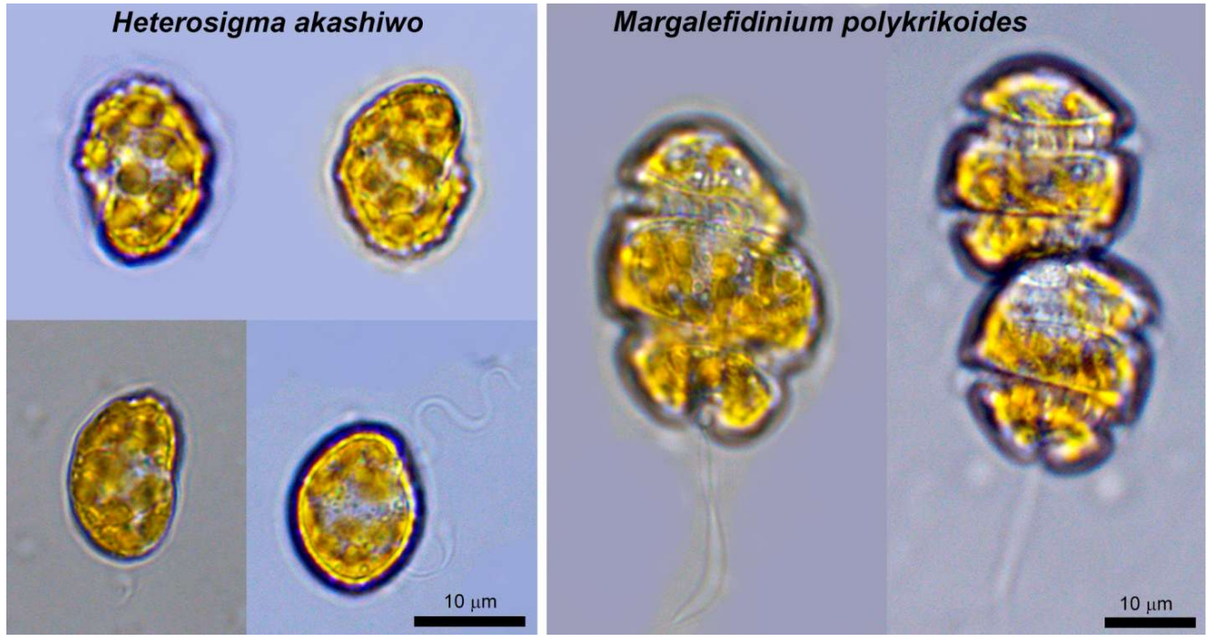






- The invasive harmful dinoflagellate *Heterocapsa circularisquama* from the Sea of Japan, caused mass mortality of molluscs in the coastal waters of Kuwait
- Their occurrence in very high cell density (>200 million cells/L) in summer (June-August) suggests a potential threat of recurrent blooms in Kuwait and its spread along the western Arabian Gulf coast
- Warrants comprehensive phytoplankton monitoring in the coastal areas of the neighbouring countries.

Recent Red tide events (A) along Al-Salam Beach, (B) near the entrance of Shuwaikh Port, (C) on the northwestern shore of Kuwait Bay, inset shows light microscopy image of the phytoplankton bloom; fish mortality (D-G) in the West Doha area on May 8, 2025.



Light microscopic images of bloom-forming raphidophycean flagellate *Heterosigma akashiwo* and dinoflagellate *Margalefidinium polykrikoides*.

Selected Research Publications from Oceanographic Monitoring Data

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Baseline

Environmental characterization of a semiarid hyper saline system based on dissolved trace metal-macronutrient synergy: A multivariate spatio-temporal approach

Turki Al-Said*, Rakhesh Madhusoodhanan, Tanuspong Pokavanich, Faiza Al-Yamani, Raziya Kedila, Aws Al-Ghunaim, Ali Al-Hashem

Environment and Life Sciences Research Center, Kuwait Institute of Scientific Research, PO Box 24885 Safat, 13109 Safat, Kuwait

Marine Pollution Bulletin 129 (2018) 35–42

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

High total organic carbon in surface waters of the northern Arabian Gulf: Implications for the oxygen minimum zone of the Arabian Sea

Turki Al-Said, S.W.A. Naqvi*, Faiza Al-Yamani, Alexandr Goncharov, Loreta Fernandes

Environment and Life Sciences Research Center, Kuwait Institute for Scientific Research, P.O. Box 1638, Salmiya 22017, Kuwait

Contents lists available at ScienceDirect

Marine Environmental Research

journal homepage: www.elsevier.com/locate/marenvrev

A preliminary study on benthic nutrient exchange across sediment-water interfaces in a shallow marine protected area of the Northwestern Arabian Gulf

Amit Sarkar[a,*], Turki Al-Said[a], Syed Wajih Ahmad Naqvi[a,b], Ayaz Ahmed[a], Loreta Fernandes[a], Rakhesh Madhusoodhanan[a], Fathima Thuslim[a], Takahiro Yamamoto[a], Faiza Al-Yamani[a]

[a] *Kuwait Institute for Scientific Research, Salmiya, P. O. Box 1638, Salmiya, 22017, Kuwait*
[b] *CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, 226001, India*

Contents lists available at ScienceDirect

Deep-Sea Research Part II

journal homepage: www.elsevier.com/locate/dsr2

The response of microzooplankton (tintinnid) community to salinity related environmental changes in a hypersaline marine system in the northwestern Arabian Gulf

Faiza Al-Yamani, Rakhesh Madhusoodhanan*, Valeriye Skryabin, Turki Al-Said

Ecosystem-Based Management of Marine Resources Program, Environment and Life Sciences Research Center, Kuwait Institute for Scientific Research, Salmiya 22017, Kuwait

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Environmental impact of a series of flash flood events on a hypersaline subtropical system in the Northwestern Arabian Gulf

Ayaz Ahmed[a,*], Turki Al-Said[a], Rakhesh Madhusoodhanan[a], S. Wajih A. Naqvi[a,b], Amit Sarkar[a], Loreta Fernandes[a], Fathima Thuslim[a], Waleed Al-Zakri[a], Faiza Al-Yamani[a]

[a] *Kuwait Institute for Scientific Research, P.O. Box 1638, Salmiya, 22017, Kuwait*
[b] *Department of Earth Sciences, Indian Institute of Technology, Kanpur, 208016, India*

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Marine Pollution Bulletin

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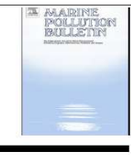


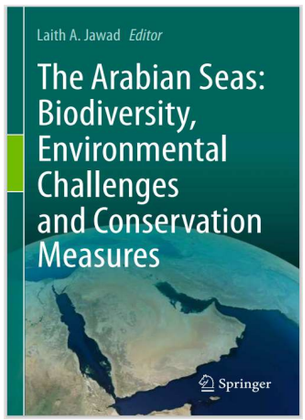
Dynamic hydrographic and water-quality variations in the northwestern Arabian Gulf, a sinking zone of reverse estuarine circulation

Takahiro Yamamoto*, Rakhesh Madhusoodhanan, Turki Al-Said, Ayaz Ahmed, Loreta Fernandes, Manickam Nithyanandan, Fathima Thuslim, Aws Alghunaim, Waleed Al-Zekri, S. Wajih A. Naqvi[1], Faiza Al-Yamani

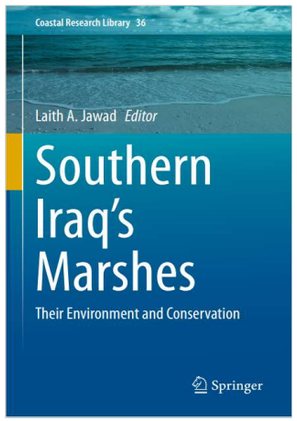
Ecosystem based Management of Marine Resources, Environmental and Life Sciences Research Center, Kuwait Institute for Scientific Research, Salmiya, Kuwait

Books & Book Chapters - Selected

Book Chapters



The Biogeochemical Features of Kuwaiti Water in the North western Arabian Gulf: Current State of Knowledge and Future

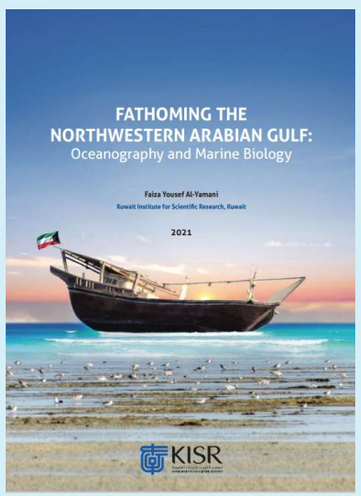


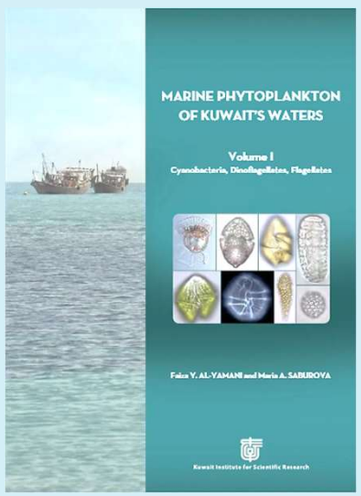
Northern Gulf Marine Biodiversity in Relevance to the River Discharge

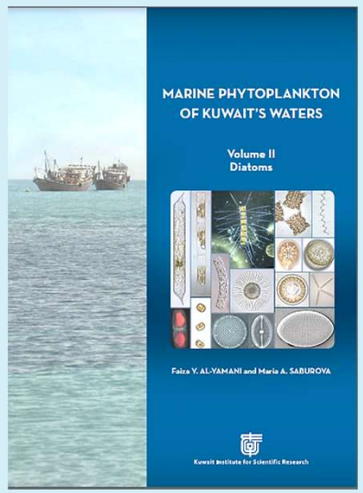
Book Chapters

- Physical and Biogeochemical Characteristics of the Indian Ocean Marginal Seas. *In: The Indian Ocean and its Role in the Global Climate System*. Elsevier.
- A comparison of potentially harmful microalgae and the phytoplankton blooms in the Arabian Gulf and the Red Sea In: N.M.A. Rasul, I.C.F. Stewart (Eds.) *Coral reefs and associated marine fauna around the Arabian Peninsula*. Taylor & Francis
- Fish larvae distribution in the Exclusive Economic Zone of Saudi Arabia in the Arabian Gulf: Spatio-temporal patterns in relation to water column characteristics. In: N.M.A. Rasul, I.C.F. Stewart (Eds.) *Coral reefs and associated marine fauna around the Arabian Peninsula*. Taylor & Francis
- An annotated checklist of heterobranch molluscs of the Arabian Gulf and their zoogeographic affinities with adjacent seas. In: N.M.A. Rasul, I.C.F. Stewart (Eds.) *Coral reefs and associated marine fauna around the Arabian Peninsula*. Taylor & Francis

Books







For more on research activities of the Oceanography research group of KISR, please scan

https://www.researchgate.net/profile/Faiza- Al-Yamani

https://www.researchgate.net/profile/Turki-Al-Said

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Most Recently Concluded Research Activities

Contracted Project

1. Sulaibikhat Marine Protected Area : Short-term Monitoring Program (STMP)

(Oct 2018 – March 2021)

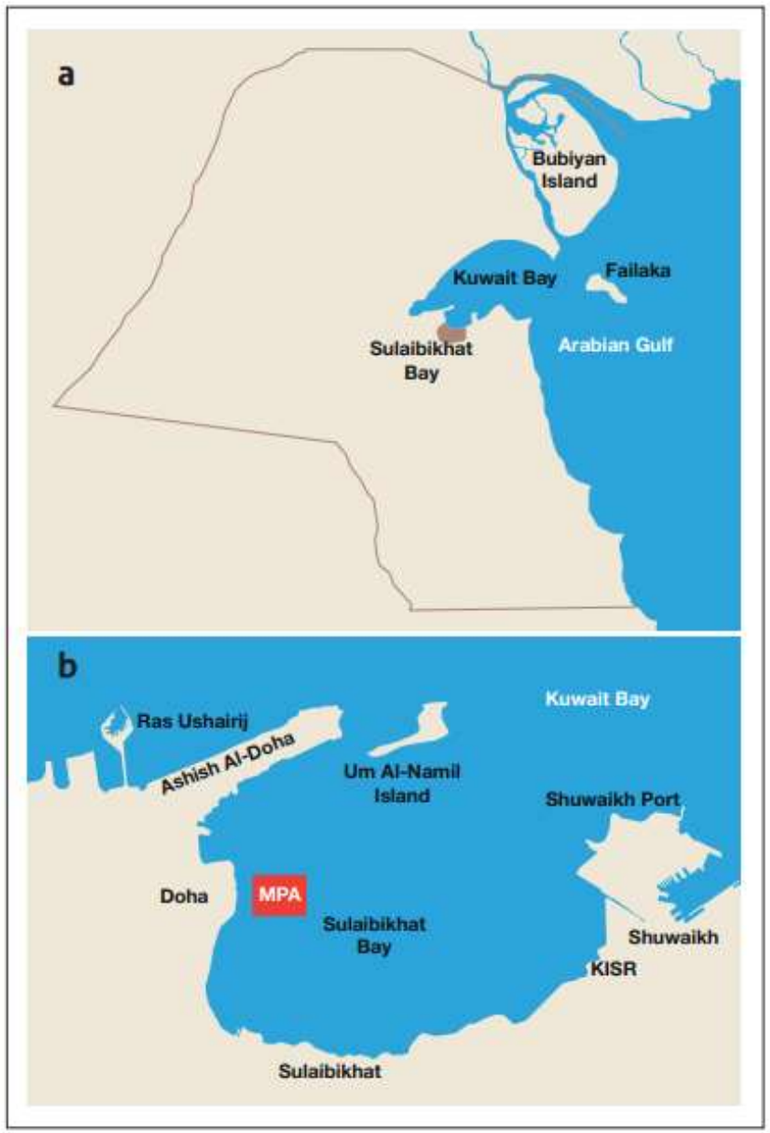

A

C

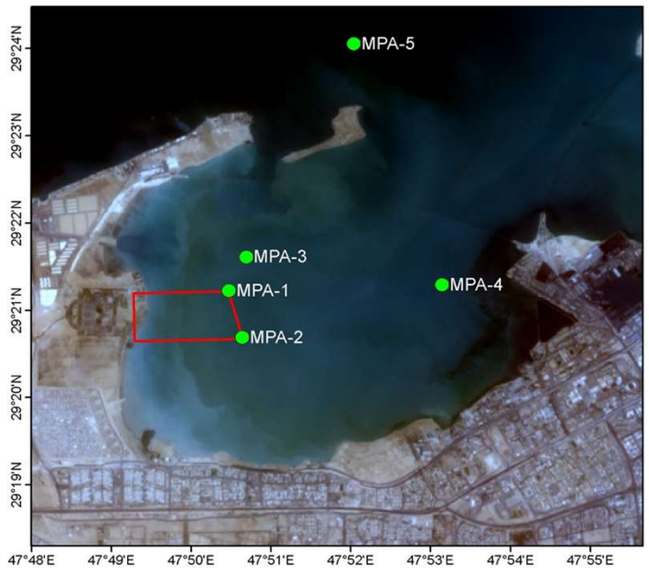

B

D

The Sulaibikhat Marine Protected Area



Subtidal sampling locations

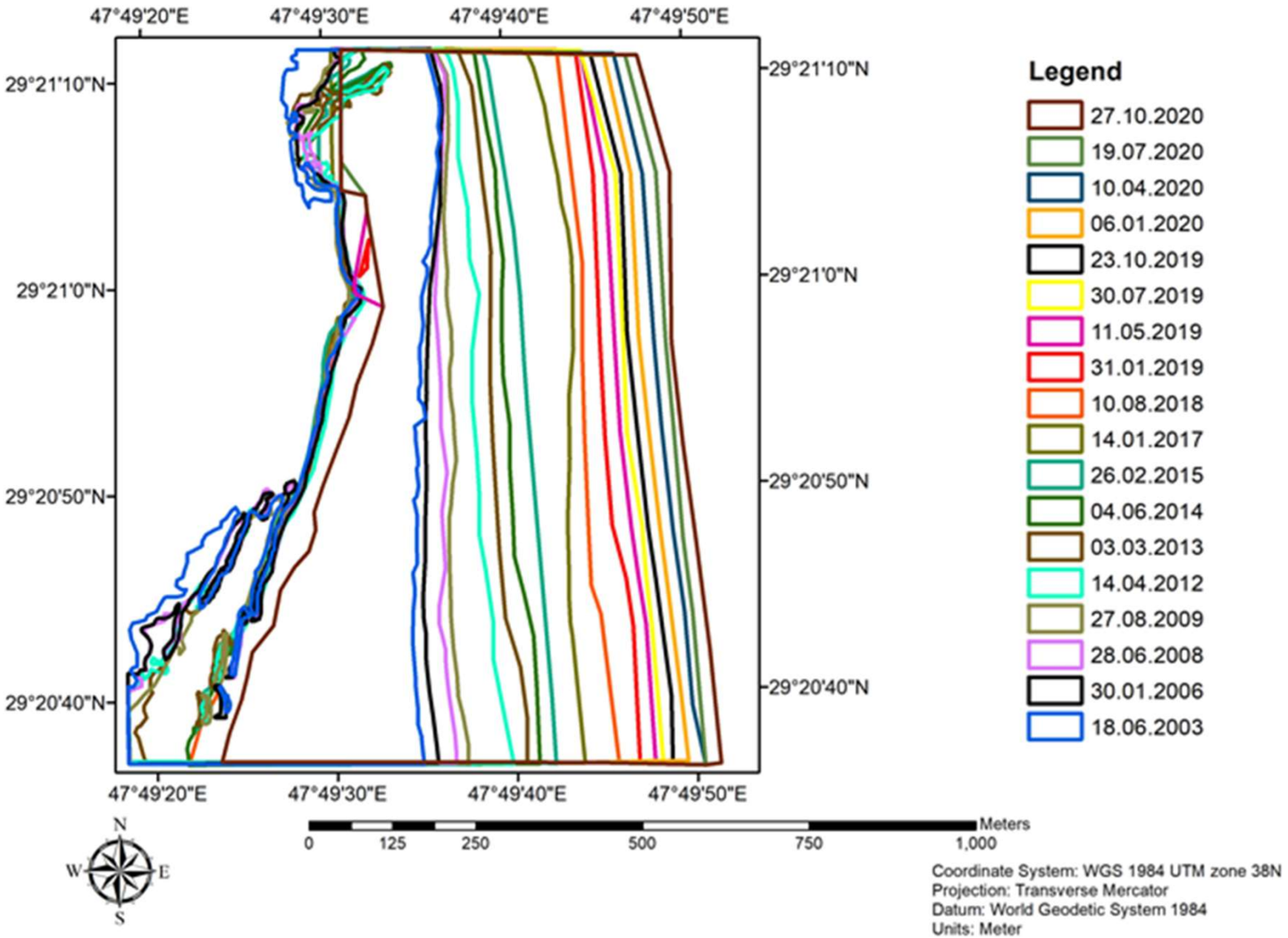


Inter-tidal sampling locations

- Established in 2015; Federally managed by Kuwait's Public Authority for Agriculture Affairs and Fish Resources (PAAF)
- 280 hectares (2.8 km^2) – Subtidal, intertidal, and supratidal habitats - To be managed for 15 years (to recompense for the ecological damages suffered during 1991 invasion of Kuwait) - (approved in the 74th GC Session 2012)
- MPA STMP by KISR, funded by UNCC through KNFP, completed (Oct 2018-Mar 2021)

Changes in Coastal Morphology - MPA

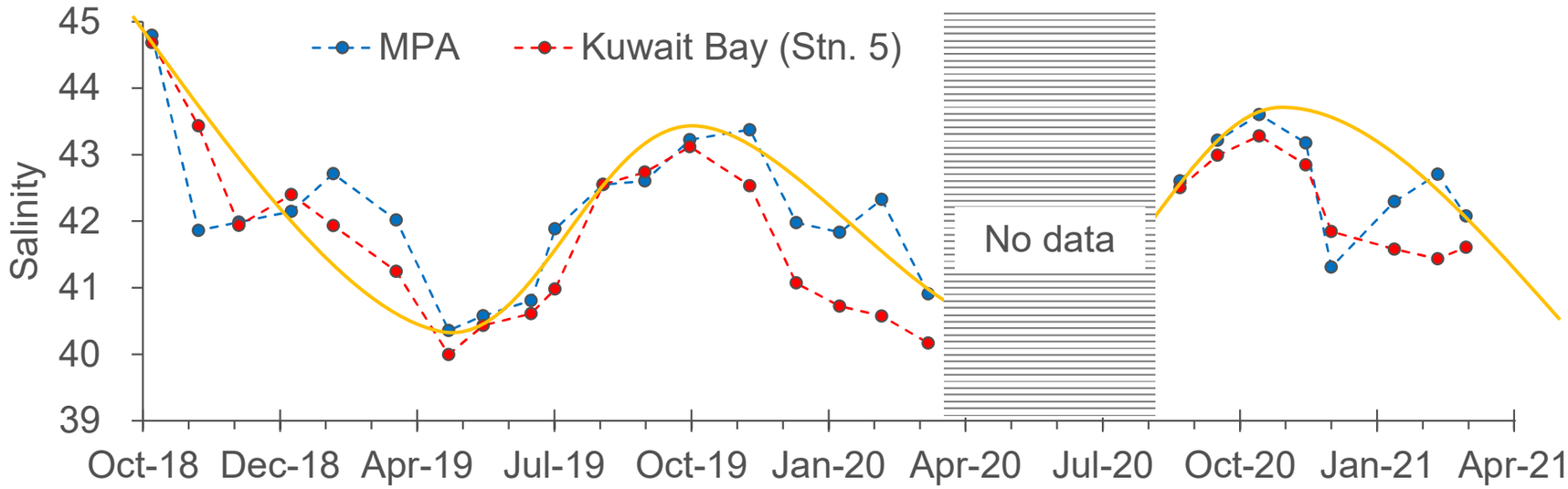
Tidal flat development in Sulaibikhat Bay: Chronology

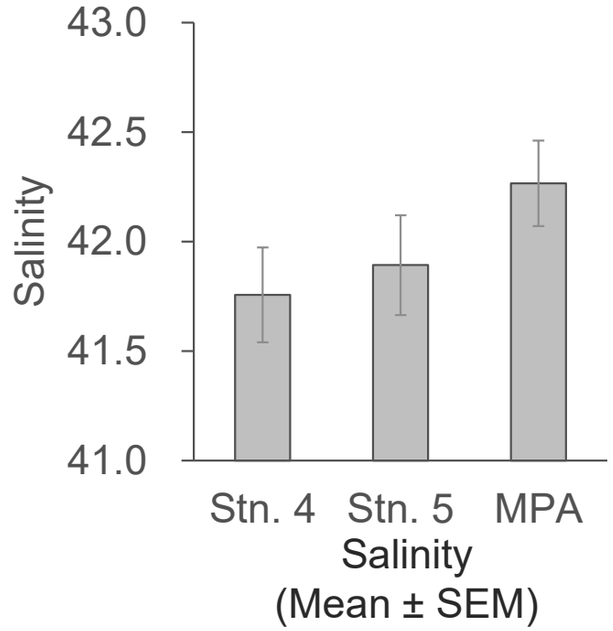


- Satellite imageries and waterline changes were used to study changes in coastal line morphology.
- Dominant changes in the intertidal morphology in and around the MPA since 2003.

Environmental Scenario - Physical

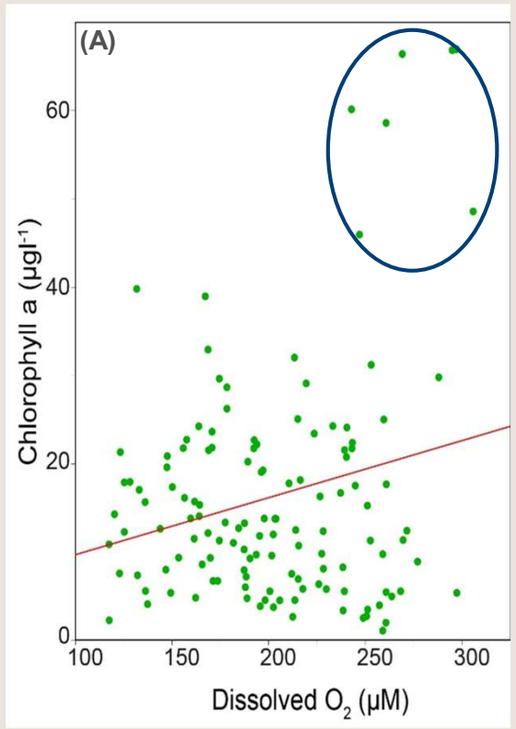
Salinity drops as a proxy for terrestrial fresh water input

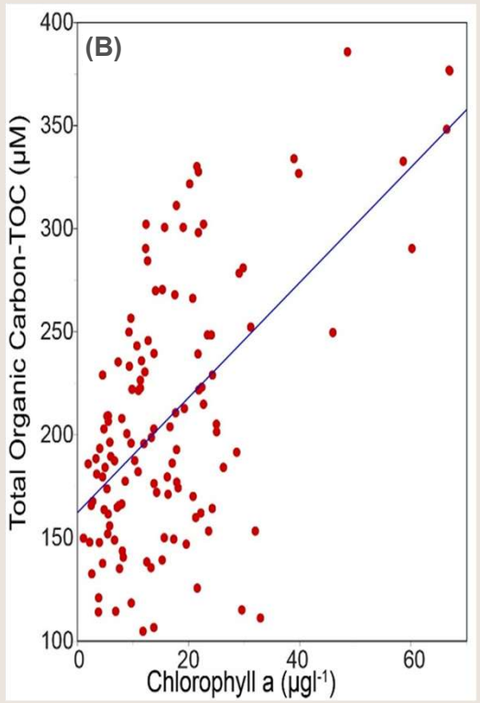


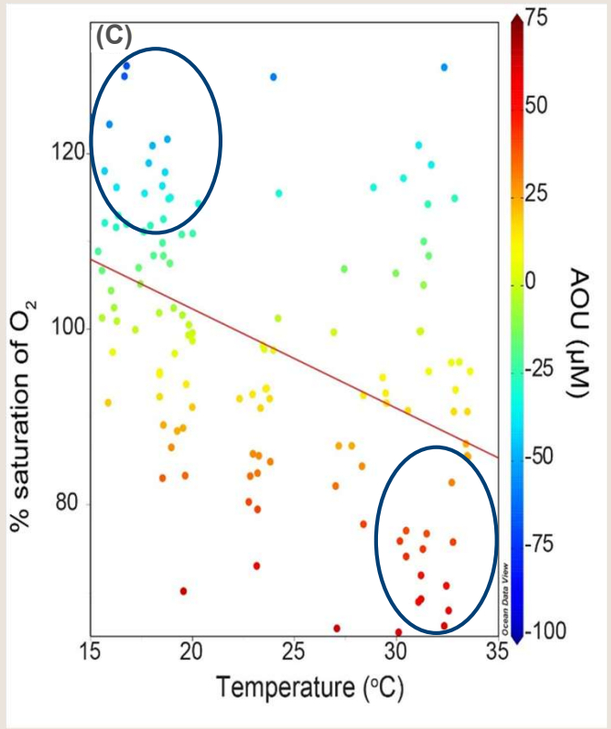


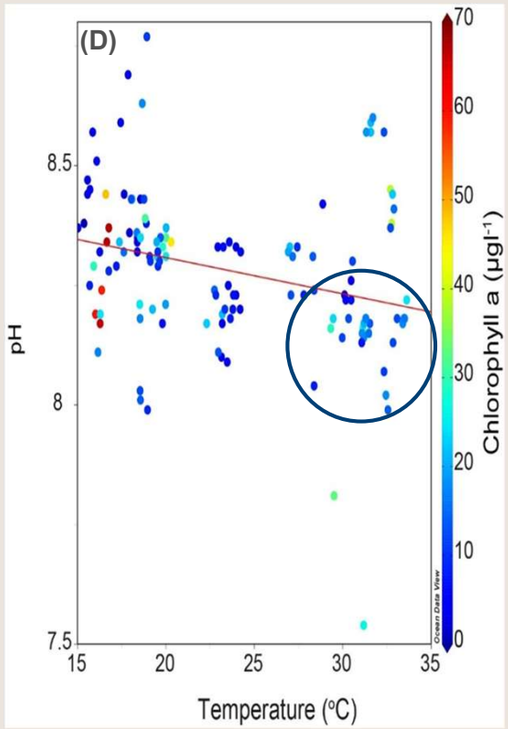
- The seasonal salinity drops in spring associated with a surge in Shatt Al-Arab River discharge, and that in fall-winter attributed to the intensive local rainfalls
- The rejected brine from the Doha desalination plant increases the salinity in the MPA.
- Significant salinity difference between eastern and western parts of SB, mainly due to the contrasting effects of sewage (east) and brine (west) discharges

Threats of Eutrophication and Ocean Acidification?









Phytoplankton production increases the DO levels; the highest being in the spring

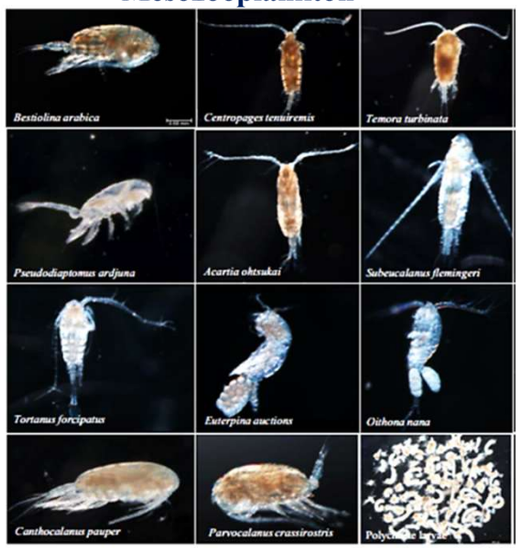
Significant contribution from phytoplankton on autochthonous organic matter (TOC) accumulation

High heterotrophic O_2 utilization reduces DO saturation in summer

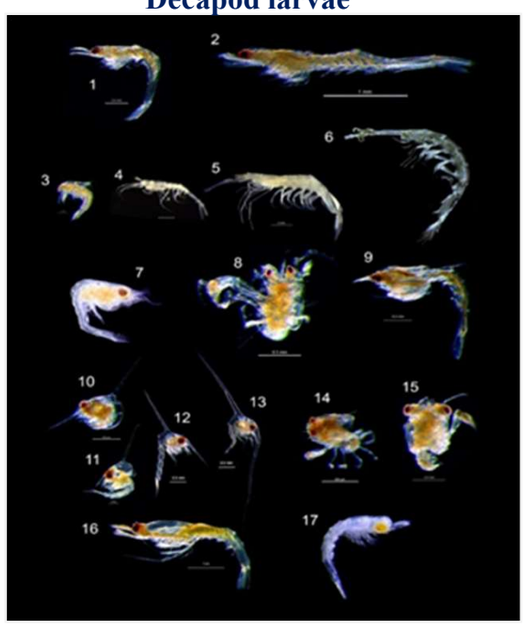
Low pH at high temperature

Environmental Scenario - Biological

Mesozooplankton



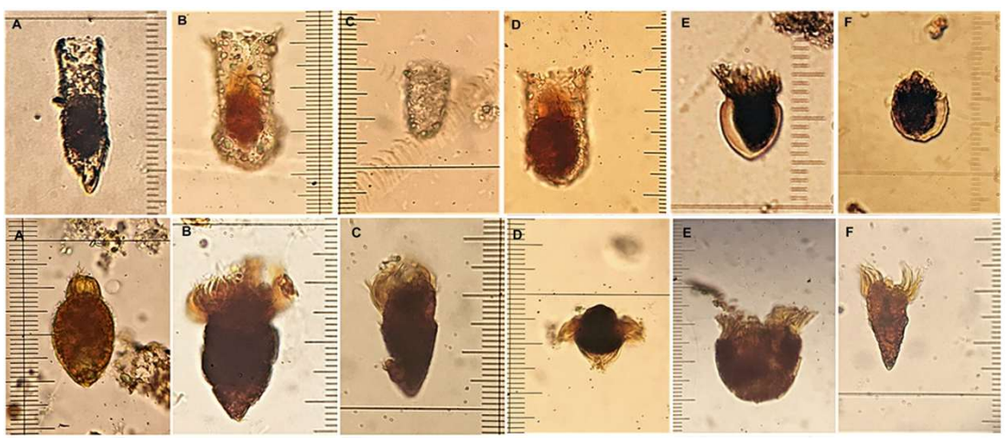
Decapod larvae



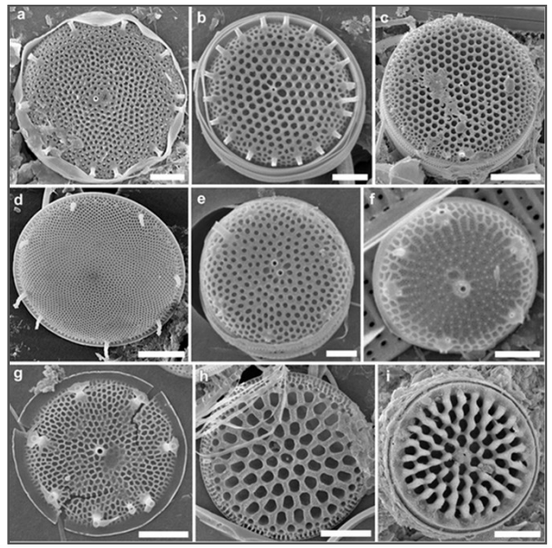
Plankton biodiversity: Total 477 taxa

	Number of taxa
Phytoplankton	232
Microzooplankton (Ciliates)	86
Mesozooplankton	92
Decapod larvae	50
Fish larvae (families)	17

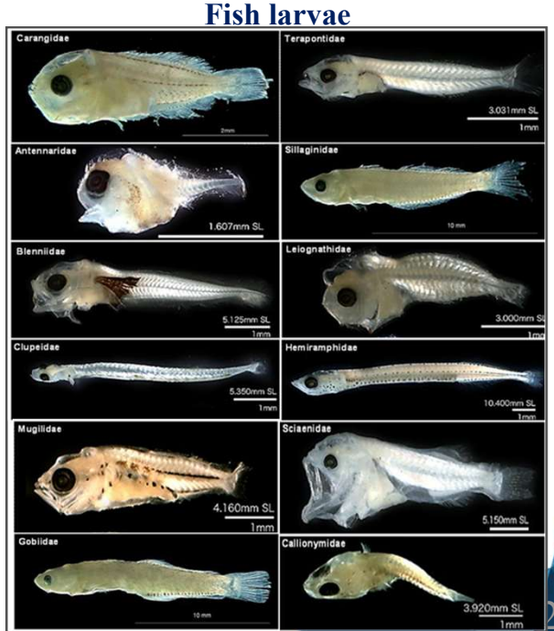
Microzooplankton (Ciliates)



Phytoplankton

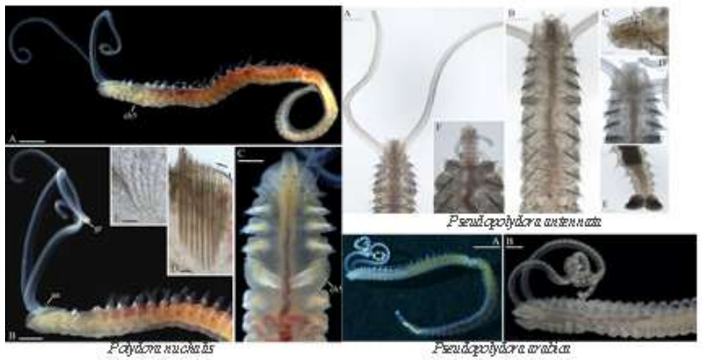


Fish larvae

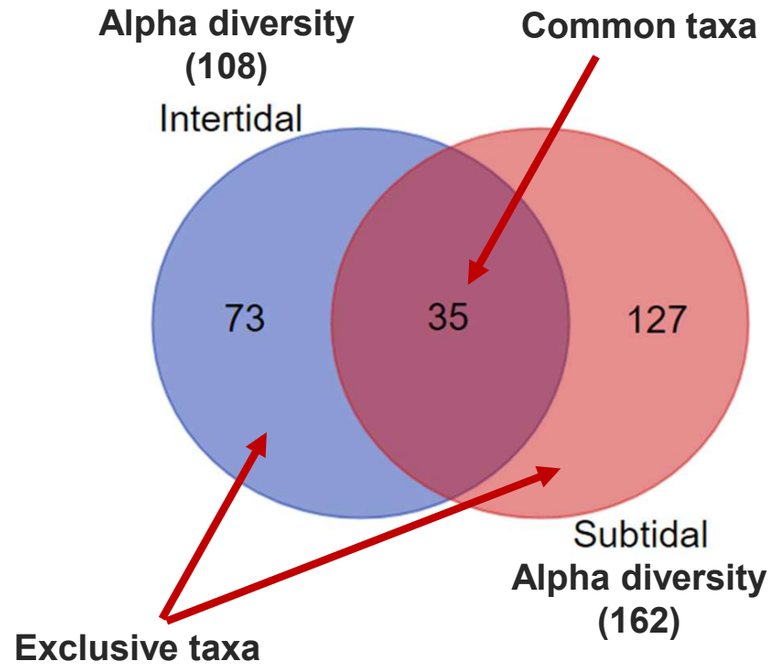


Benthic Macrofaunal Biodiversity

(Intertidal & Subtidal areas of the MPA)

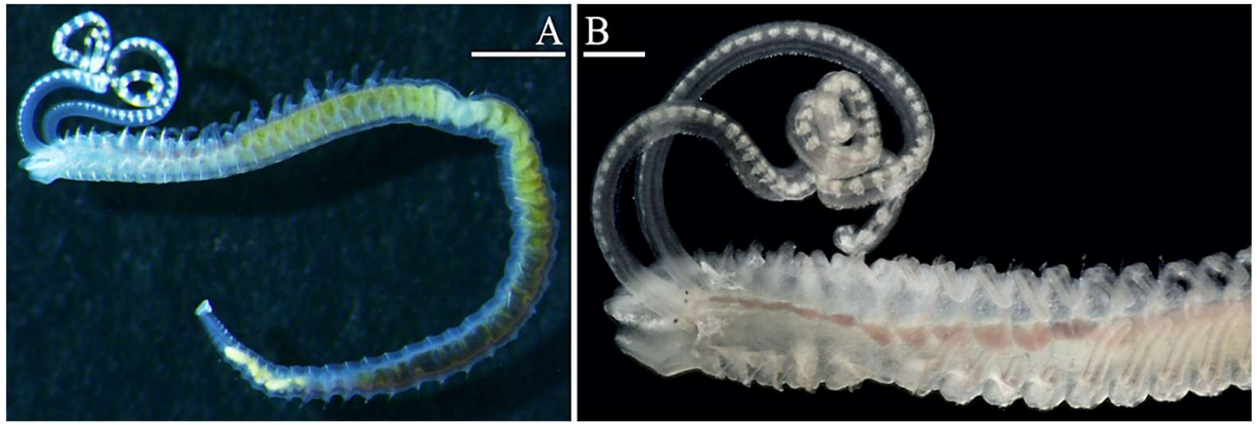


Gamma diversity (total number of taxa): **235**



- Subtidal habitat shows high taxa turnover compared to intertidal habitat

Polychaete species from the MPA (intertidal): New to Science

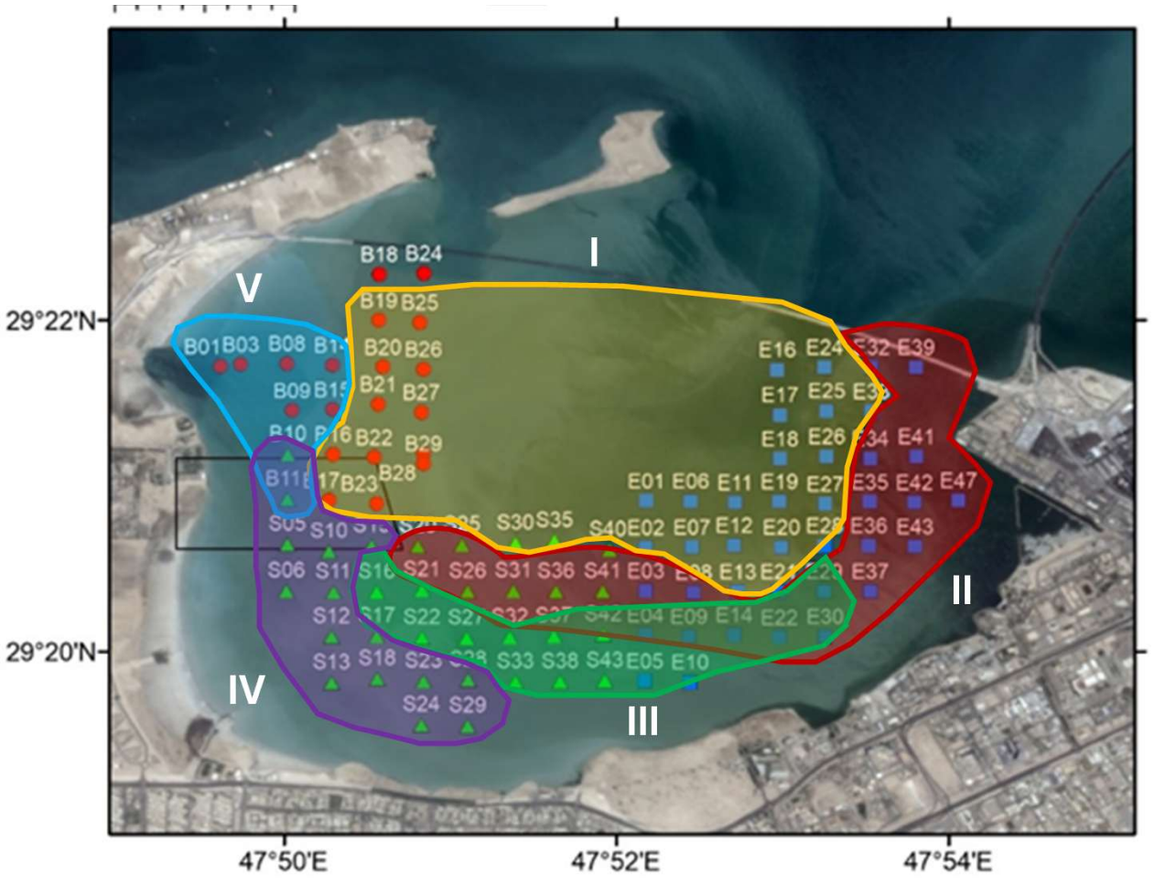


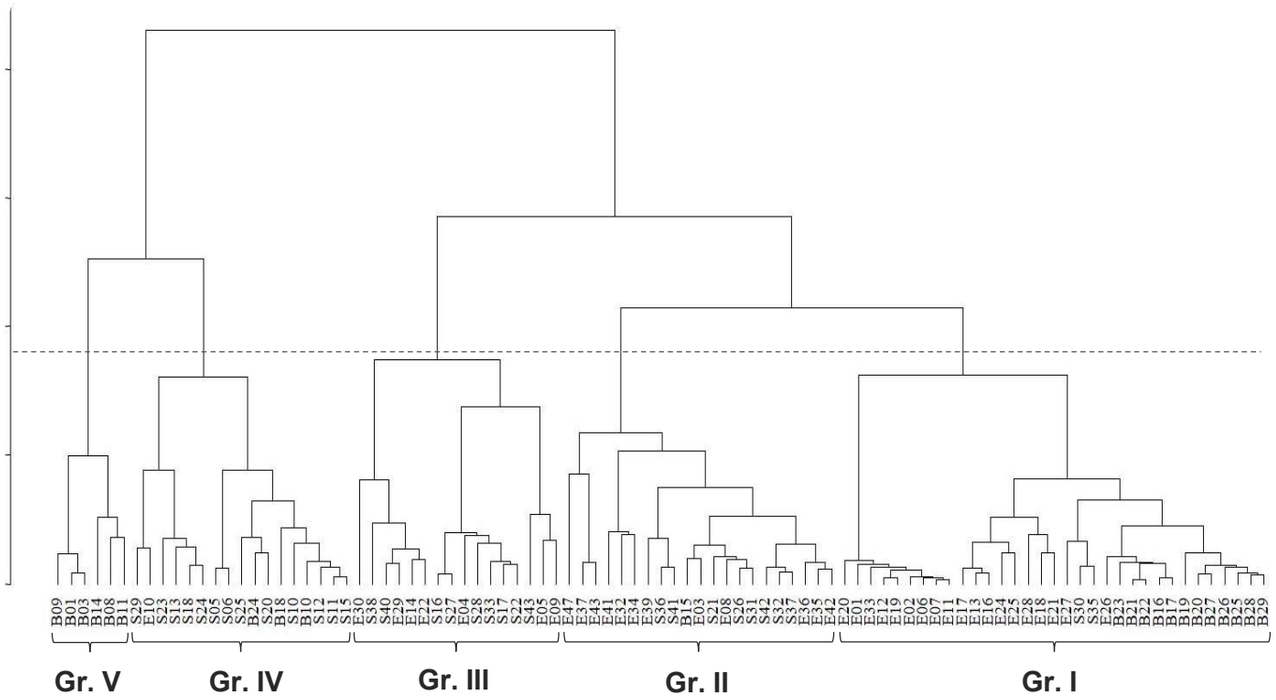
Adult ***Pseudopolydora arabica*** sp. nov.

Several new records ; some new to science

Adult ***Pseudopolydora Kuwaiti*** sp. nov.

The impact of wastewater discharge on the MPA





- The MPA is affected by both brine and sewage discharges

93 stations were sampled

- Water column turbidity in MPA is the highest among all stations

Group I – Central water mass
Group II – Area affected by coastal contamination (from sewage+industrial effluents)
Group III – Area primarily affected by sewage (mostly Al-Ghazali sewer outlet)
Group IV – Area affected by waste water outlets other than Al-Ghazali sewer outlet
Group V – Area affected by brine discharge from Doha desalination plant

Major achievements - Phase-I study
(STMP, Oct 2018- Mar 2021)

- The baseline information for all essential ocean variables and biodiversity variables were obtained and archived in the marine database designed for Sulaibikhat MPA.
- The pelagic and benthic fishery stocks, diversity, and seasonality (of fin fish) in the Sulaibikhat Bay area documented
- Terregenous impact (sewage and desalination wastewater) and environmental stressors on the MPA investigated
- Multiple Database Interface (MDI) established for the MPA long-term monitoring.
- Monitoring of essential variables (physical, chemical, and biological) to impart endurance to MPA long-term monitoring and management - Ongoing

Research Publications in Peer-reviewed Q1/Q2 journals
(from the Sulaibikhat Bay MPA Phase-I study)


frontiers | Frontiers in Microbiology

TYPE Original Research
PUBLISHED 09 January 2025
DOI 10.3389/fmicb.2024.1479542

Check for updates

OPEN ACCESS

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Shotgun metagenomics reveals the interplay between microbiome diversity and environmental gradients in the first marine protected area in the northern Arabian Gulf

Saja A. Fakhraldeen[1]*, Rakhesh Madhusoodhanan[1], Nazima Habibi[2], Sakinah Al-Haddad[1], Surendraraj Alagarsamy[1], Sabeena F. K. Habeebullah[1], Walid M. Al-Zakri[1], Fathima Thuslim[1], Loreta Fernandes[1], Faiza Al-Yamani[1] and Turki Al-Said[1]


Kuwait Journal of Science 51 (2024) 100246

Contents lists available at ScienceDirect

Kuwait Journal of Science

journal homepage: www.sciencedirect.com/journal/kuwait-journal-of-science

ELSEVIER

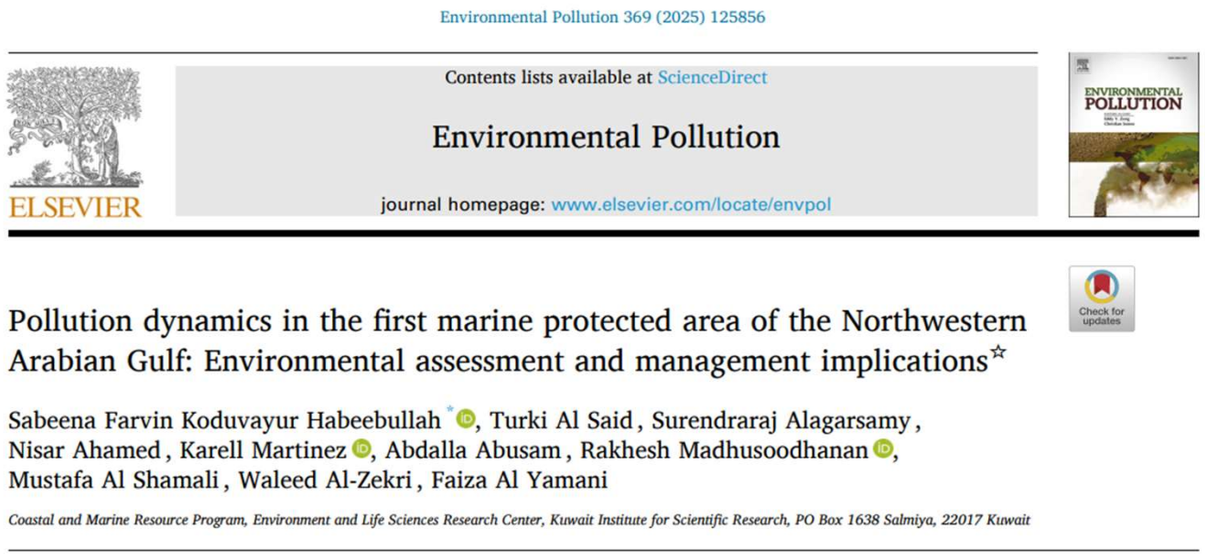
Full Length Article

Molecular taxonomy of fish larvae in the Northwestern Arabian gulf: A baseline study from Kuwait's first marine protected area

Check for updates

Manickam Nithyanandan*, Rakhesh Madhusoodhanan, Turki Al-Said, Ayaz Ahmed, Sakinah Al-Haddad, Waleed Al-Zekri, Faiza Al-Yamani

Ecosystem-Based Management of Marine Resources, Environment and Life Sciences Research Centre, Kuwait Institute for Scientific Research, P.O. Box.1638, Salmiya, 22017, Kuwait


Environmental Pollution 369 (2025) 125856

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

ELSEVIER

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Pollution dynamics in the first marine protected area of the Northwestern Arabian Gulf: Environmental assessment and management implications☆

Sabeena Farvin Koduvayur Habeebullah*, Turki Al Said, Surendraraj Alagarsamy, Nisar Ahamed, Karell Martinez, Abdalla Abusam, Rakhesh Madhusoodhanan, Mustafa Al Shamali, Waleed Al-Zekri, Faiza Al Yamani

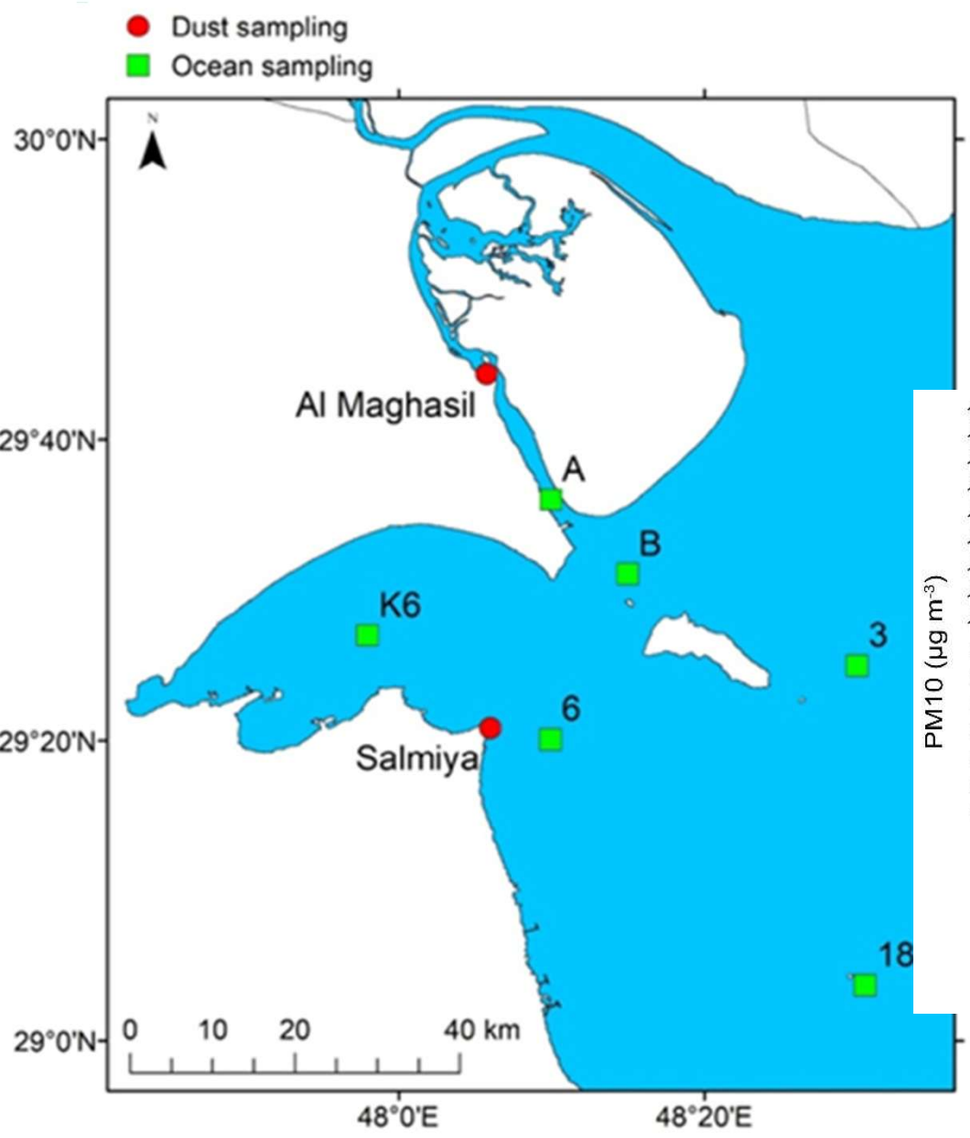
Coastal and Marine Resource Program, Environment and Life Sciences Research Center, Kuwait Institute for Scientific Research, PO Box 1638 Salmiya, 22017 Kuwait

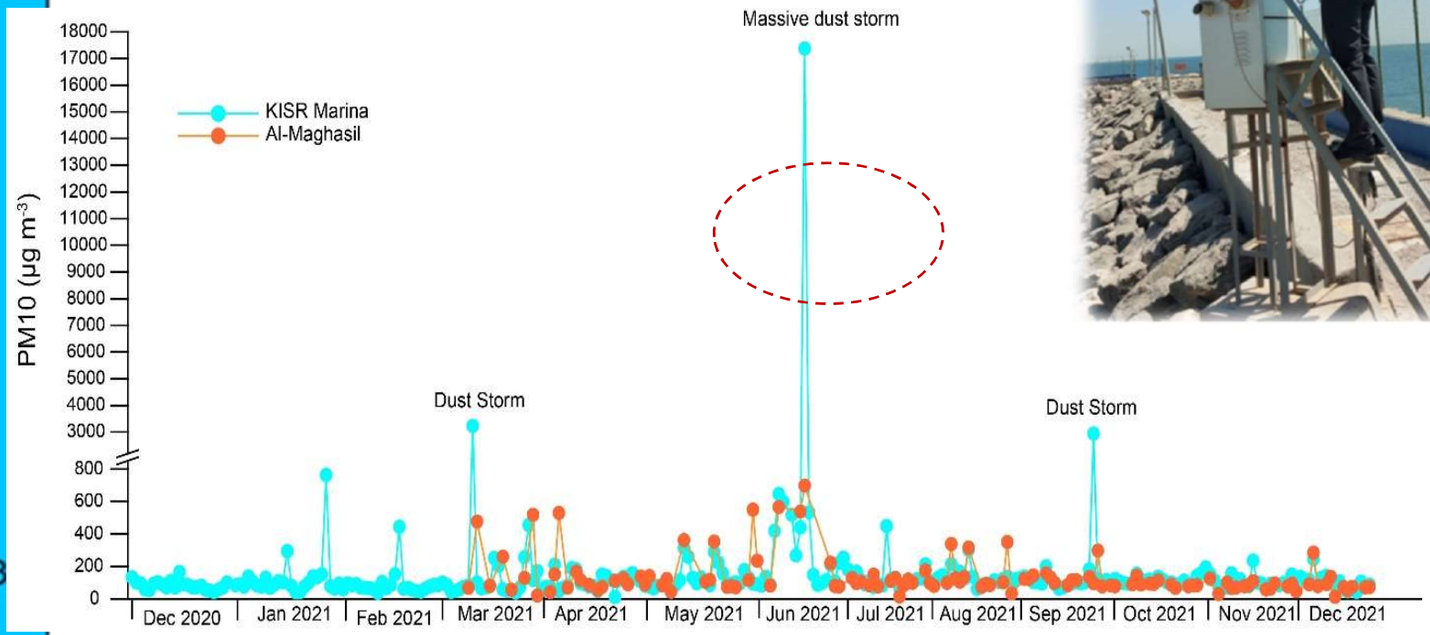
Manuscripts under review (Journal quartile: Q1)

- Madhusoodhanan, R*., Al-Said, T., Al-Yamani, F., Mantha, G., Yamamoto, T., Fernandes, L., Ahmed, A., Manickam, N., Sarkar, A., Habeebullah, S. H. K., Thuslim, F., Al-Zekri, W., Sebastian, J., Al-Enezi, M. *Environmental Stressors and Mesozooplankton Community Dynamics in Kuwait's First Marine Protected Area in the Northwestern Arabian/Persian Gulf*. **Deep Sea Research Part II: Topical Studies in Oceanography** (Reviewers' comments received on 13 May 2025)
- Yamamoto, T*., Alghunaim, A., Al-Said, T., Madhusoodhanan, R., Fernandes, L., Ahmed, A., Al-Zekri, W., Thuslim, F., Rahman, A. *Environmental Characteristics and Key Drivers of an Urban Coastal Marine Protected Area in the Northern Arabian/Persian Gulf*. **Deep Sea Research Part II: Topical Studies in Oceanography** (Under Review)

2. The Impact of Aeolian Mineral Dust on Ocean Productivity and Biogeochemistry in the Northern Gulf

(Project code: FM104C; Period: Dec 2020-2021; Client: KFAS)

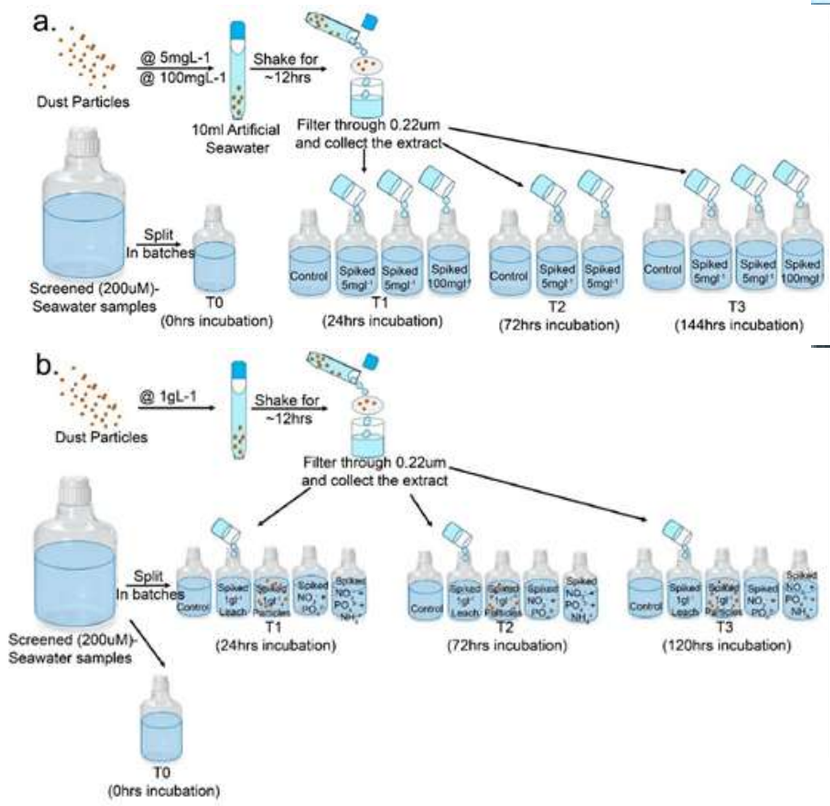




A massive dust storm hits Kuwait on 17 June 2021

Probing mineral dust characteristics & Impact on the marine system

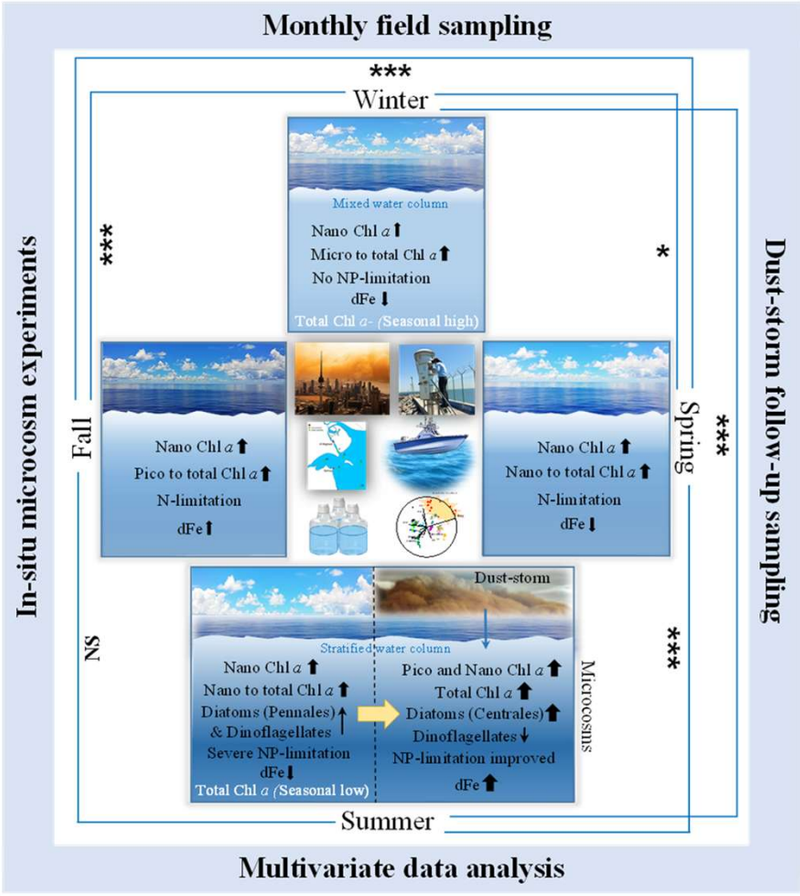
- Collection of mineral dust (Coarse PM10 fraction)
- Geochemical composition of PM10
- Identification of sources of severe dust storm in Kuwait and transport pathways
- Monthly field sampling & Physicochemical and biological analysis of water samples
- Dust storm follow-up sampling in the coastal waters
- Microcosm incubation experiments with mineral dust enriched coastal and offshore waters.



Science of The Total Environment
Available online 18 November 2023, 168583
In Press, Journal Pre-proof What's this?

Aeolian dust and hydro-biological characteristics: Decoding dust storm impacts on phytoplankton in the northern Arabian Gulf

Rakhesh Madhusoodhanan, Turki Al-Said, Amit Sarkar, Loreta Fernandes, Ayaz Ahmed, Takahiro Yamamoto, Fathima Thuslim, Ali Al-Dousari, Walid Al-Zakri, Mariam Al-Enezi, Aws Al-Ghunaim



PERMANOVA - *P* (perm): > 0.05 NS, ≤0.05*, ≤0.001***

Highlights

- Hydrobiological impact of dust storms studied in the Arabian Gulf closer to dust source regions.
- Severe dust storms profoundly influence hydro-biological conditions in the NAG.
- Dust storms alter dFe, DIN, and DIP levels and their stoichiometry and affect nutrient dynamics.
- Dust storm enhances phytoplankton growth and increases diatom size structure and biomass.
- Dust storms disrupt hydro-biological seasonality, with effects lasting up to two weeks.

Immediate response of the coastal waters to the Aeolian dust input in the northern Gulf

Science of the Total Environment 960 (2025) 178254

Contents lists available at ScienceDirect

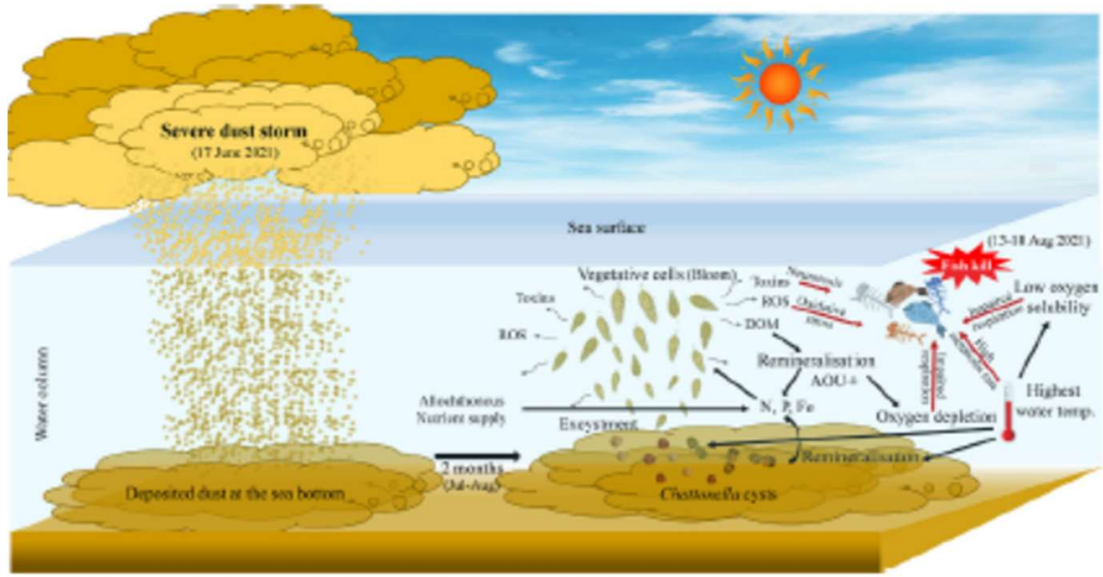
Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Environmental triggers and ecological implications of a harmful algal bloom in the northern Arabian/Persian Gulf: Insights into the driving forces and consequences

Rakhesh Madhusoodhanan *, Faiza Al-Yamani, Turki Al-Said, Maria Saburova, Manal Al-Kandari, Takahiro Yamamoto, Ayaz Ahmed, Loreta Fernandes, Amit Sarkar, Sabeena Farvin Koduvayur Habeebullah, Igor Polikarpov, Waleed Al-Zekri, Jessy Sebastian, Maryam Al-Enezi

Coastal and Marine Resources Program, Environment & Life Sciences Research Center, Kuwait Institute for Scientific Research, Salmiya 20001, Kuwait



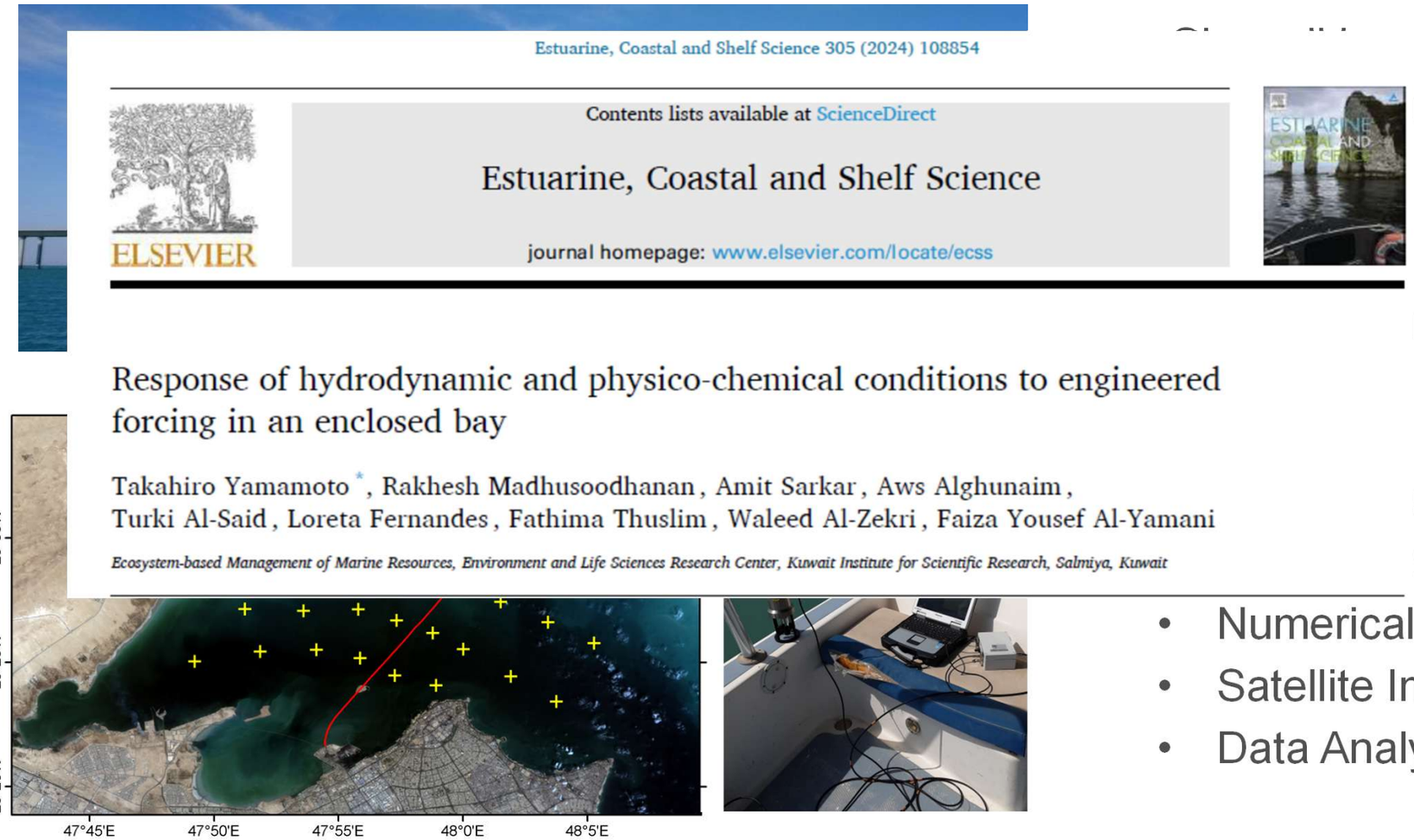
Key- AOU: Apparent Oxygen Utilization, DOM: Dissolved Organic Matter, ROS: Reactive Oxygen Species, N: Nitrogen, P: Phosphorous, Fe: Trace metals (Iron as representative)

Highlights

- The *Chattonella* bloom in August 2021 caused significant fish mortality in the NAG off Kuwait.
- The bloom was postulated as NAG's late response to a severe Aeolian dust storm of June 2021.
- The bloom initiated in the shallow waters of Kuwait Bay and spread to deeper areas outside the Bay.
- *Chattonella* toxicity levels and cell properties correlated well with deteriorating water quality.
- The study shows how atmospheric and human activities induce HABs and affect the marine ecosystem.

Long-term impact of Aeolian dust in the coastal waters

3. Environmental Impact Assessment of Sheikh Jaber Al-Ahmad Al-Sabah Causeway



Subiya

(38 km)

Bridge piers

l Impacts?

surements

al Analyses

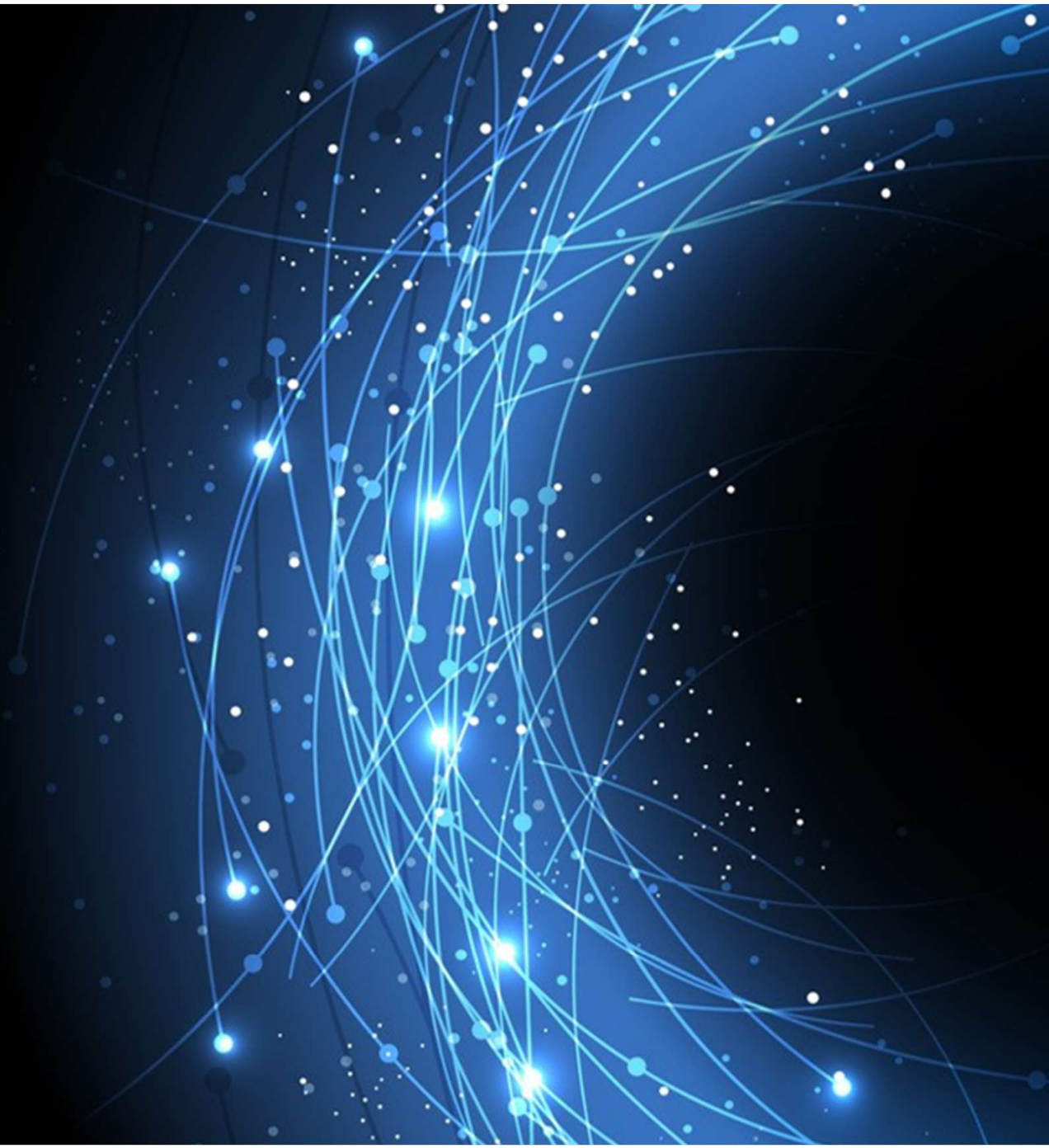
- Numerical Simulation
- Satellite Image
- Data Analyses

Blockage Effect of Bridge piers → Slowing Ocean Current → Intensified Stagnation → Horizontal Environmental Gradients → Ecological Impacts

KISR
معهد الكويت للأبحاث العلمية
KUWAIT INSTITUTE FOR SCIENTIFIC RESEARCH

Advanced offshore Ocean Research Capabilities of Kuwait

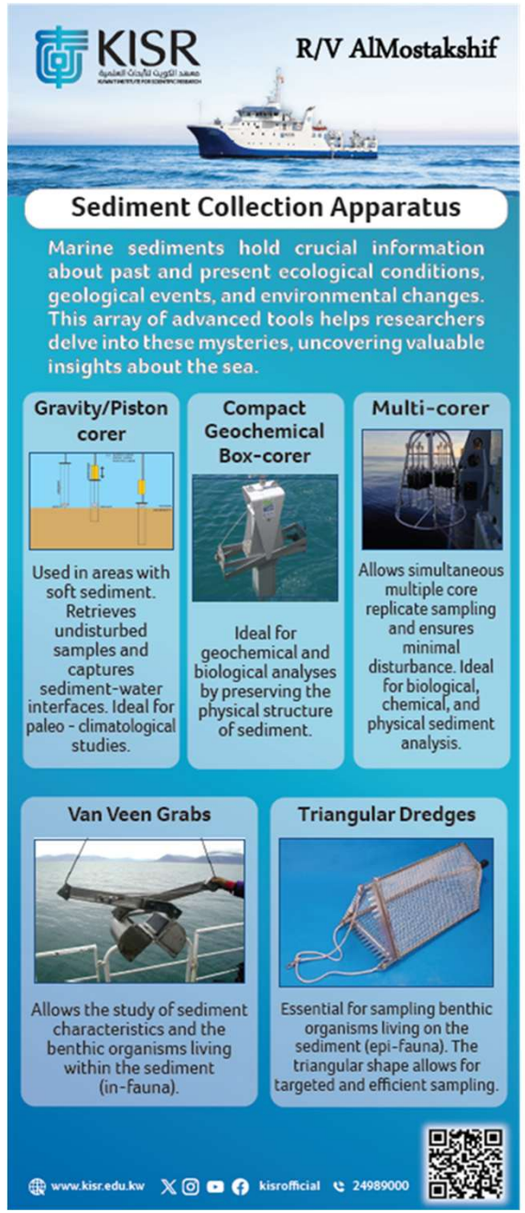
Facilities on-board the fishery and oceanographic research vessel, **RV *AlMostakshif***



KISR's infrastructure to support UN SDGs 3,14 & 17

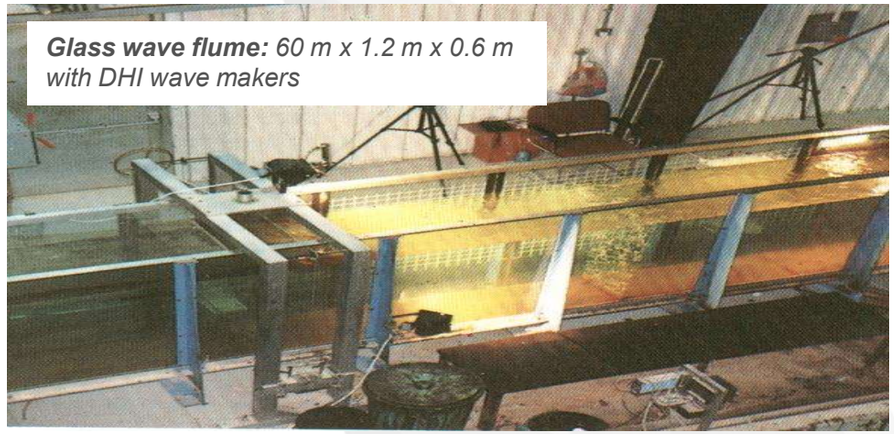
Scientific equipment onboard Almostakshif

Rosette samplers with CTD (multiprobed) and Niskin samplers for water sampling, Plankton nets (Single ring WP-2 closing net, Bongo net, Multiple Plankton Net (Midi)), Flow-through nutrient and chlorophyll analyser, under water camera, Remotely Operated Vehicle (ROV), Underwater particle-size profiler, Sonar depth finder, Current profiler, Ferry Box, Weather station, Biosafety cabinets, Ultra cryocentrifuge, Water baths, Mini-autoclave, MilliQ and Distilled water systems, Ovens for microbial incubation, Salinometer, Flow cytometry, FlowCAMs (for micro- and mesozooplankton), HPLC, FRRF, Paricle-size analyser, High-end microscopes with digital cameras, Elemental Analyzer, TOC analyser, pH meters, DO analyzers, Specrophotometers, Nutrient auto-analyser (Skalar), Ad-CSV for trace metals from water samples, fish nets, Digital balances.....



Physical Modeling Facilities

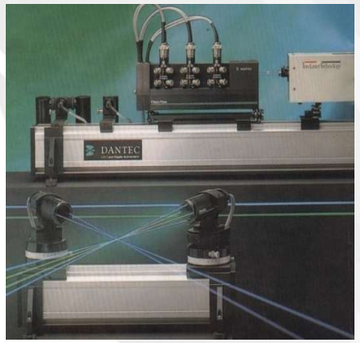
Wave basin: *56 m x 37 m x 0.8 m with DHI wave makers*



Glass wave flume: *60 m x 1.2 m x 0.6 m with DHI wave makers*

Concrete wave flume: *40 m x 2.5 m x 0.2 m with DHI wave maker*

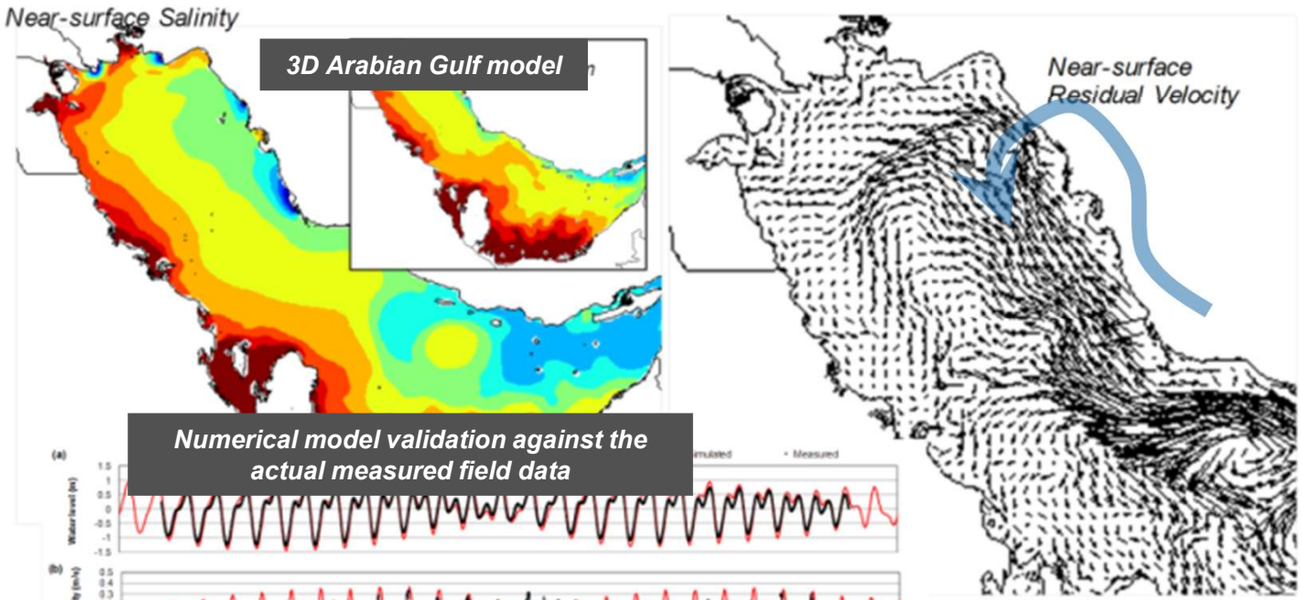
Experienced research staffs, laboratory equipments, fabrication workshop, etc.



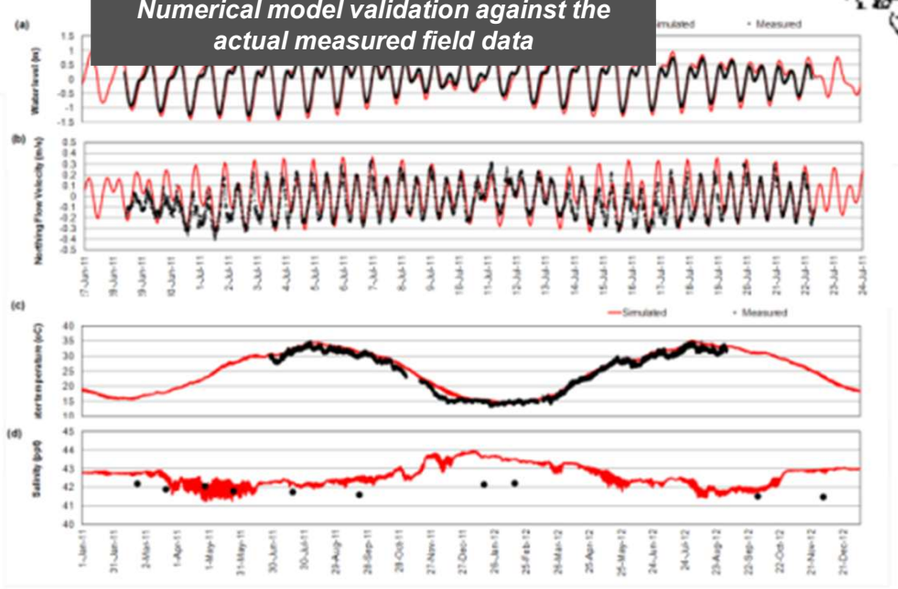
"KISR only has these unique physical modeling facilities in the GCC."
~ Engr. Morten, DHI expert

Numerical modeling Facilities

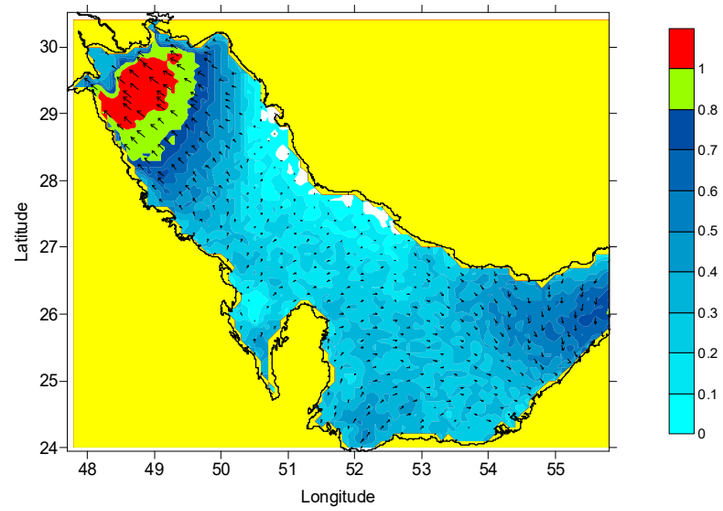
3D Arabian Gulf model



Numerical model validation against the actual measured field data



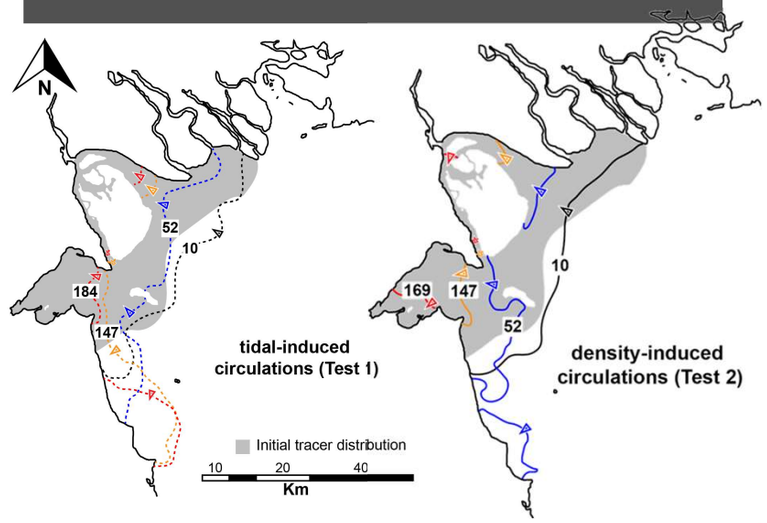
Arabian Gulf wave model



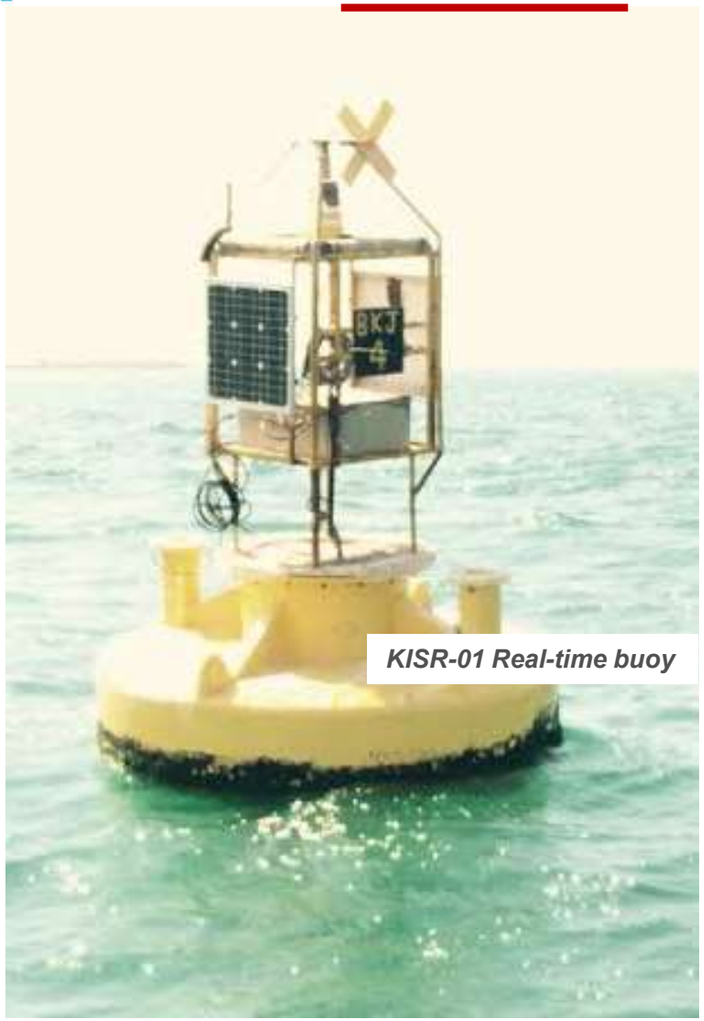
14 Days

3D Kuwait water model

Kuwait Bay water quality model



Field surveying facilities



KISR-01 Real-time buoy

Various type of field instruments

AAQ-RINKO
Multi-parameter CTD profiler
(JFE Advantech Co., Ltd., JAPAN)

YS16600
Multi-parameter CTD Logger
(YSI Inc, USA)

CASTAWAY
Miniature CTD (YSI Inc, USA)

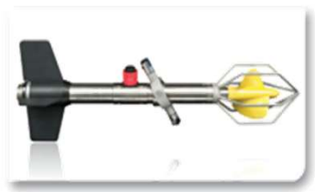
SENTINEL ADCP
Flow Velocity Profiler
(Teledyne Instrument, USA)

HOBO-TEM, HOBO-WLL
Water Temperature, Water Depth
(Onset Inc USA)

RCM7, RCM9, WLR7
Flow Velocity, Wave & Temperature Logger
(Aanderaa, Norway)

ACTW & CT
Conductivity(Salinity)-Temperature Loggers
(JFE Advantech Co., Ltd., JAPAN)

ARGONAUT ADCP
Flow Velocity Profiler
(A Xylem Brand, USA)



M106
Flow Velocity & Temperaqture Logger
(Valeport, UK)

DO-RINKO
Dissolved Oxygen & Temperature Loggers
(JFE Advantech Co., Ltd., JAPAN)

Transponder System
(RJE Inc., USA)

Fluorometer
Chlorophyll – (TurnerDesigns, USA)

EM
Flow Velocity & Temperature Logger
(JFE Advantech Co., Ltd., JAPAN)

ST
Flow Velocity, Salinity and Temperature Logger
(InterOcean Systems Inc., USA)

WH
Wave and Water Depth Loggers
(JFE Advantech Co., Ltd., JAPAN)

ADTW, ATURBI
Chlorophyll-Turbidity & Temperature Loggers
(JFE Advantech Co., Ltd., JAPAN)

HYDRO-CAT
CTD Logger
(SeaBird Inc., USA)

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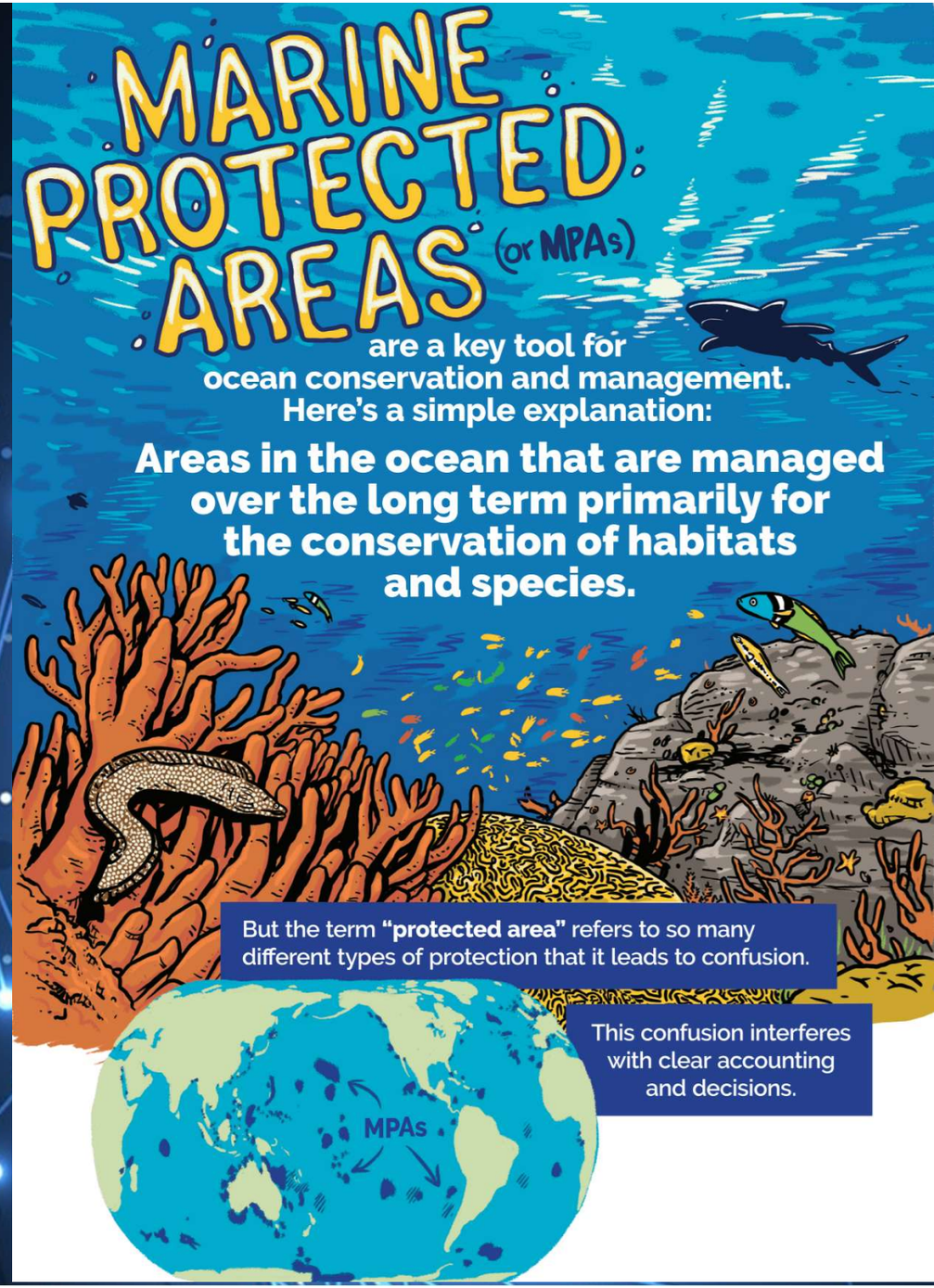
New Research Initiatives

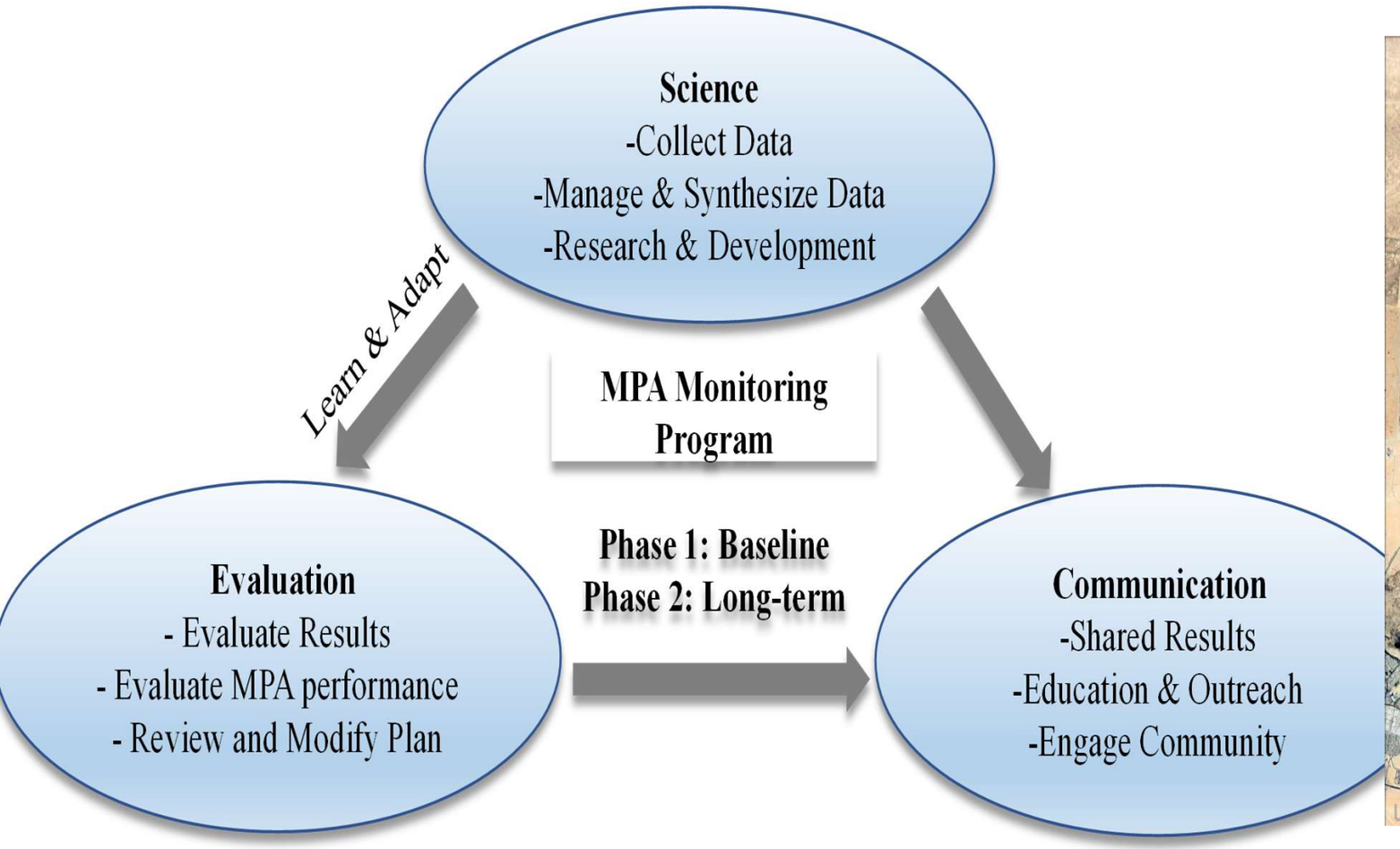
1. **Sulaibikhat Marine Protected Area : Long-term Management Plan**

(ongoing)

(Dec 2024 – Nov 2029)



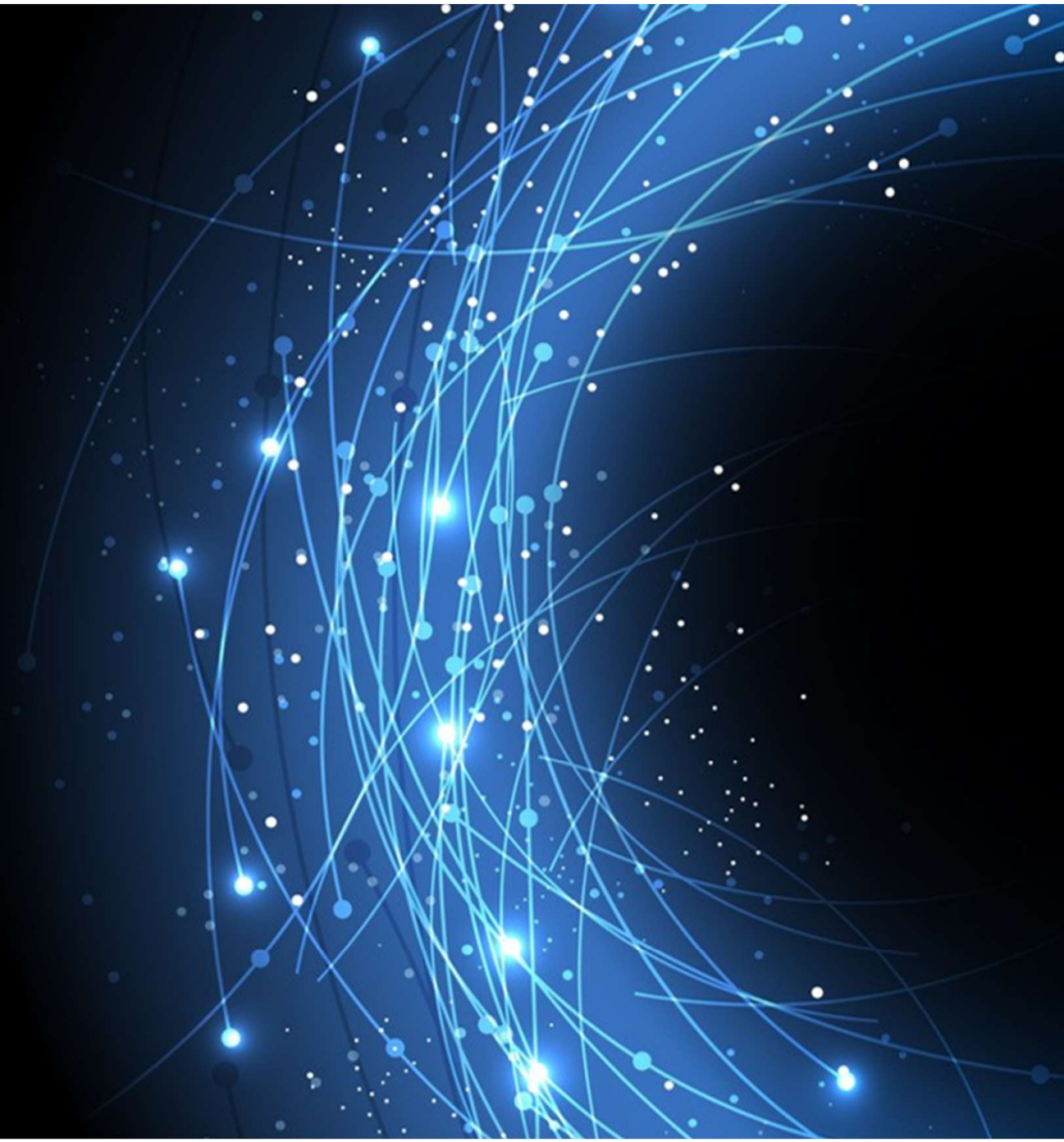
The Core Elements in the Adaptive Management of the MPA Monitoring Program.



2. Marine Ecosystem Dynamics of Kuwaiti Waters

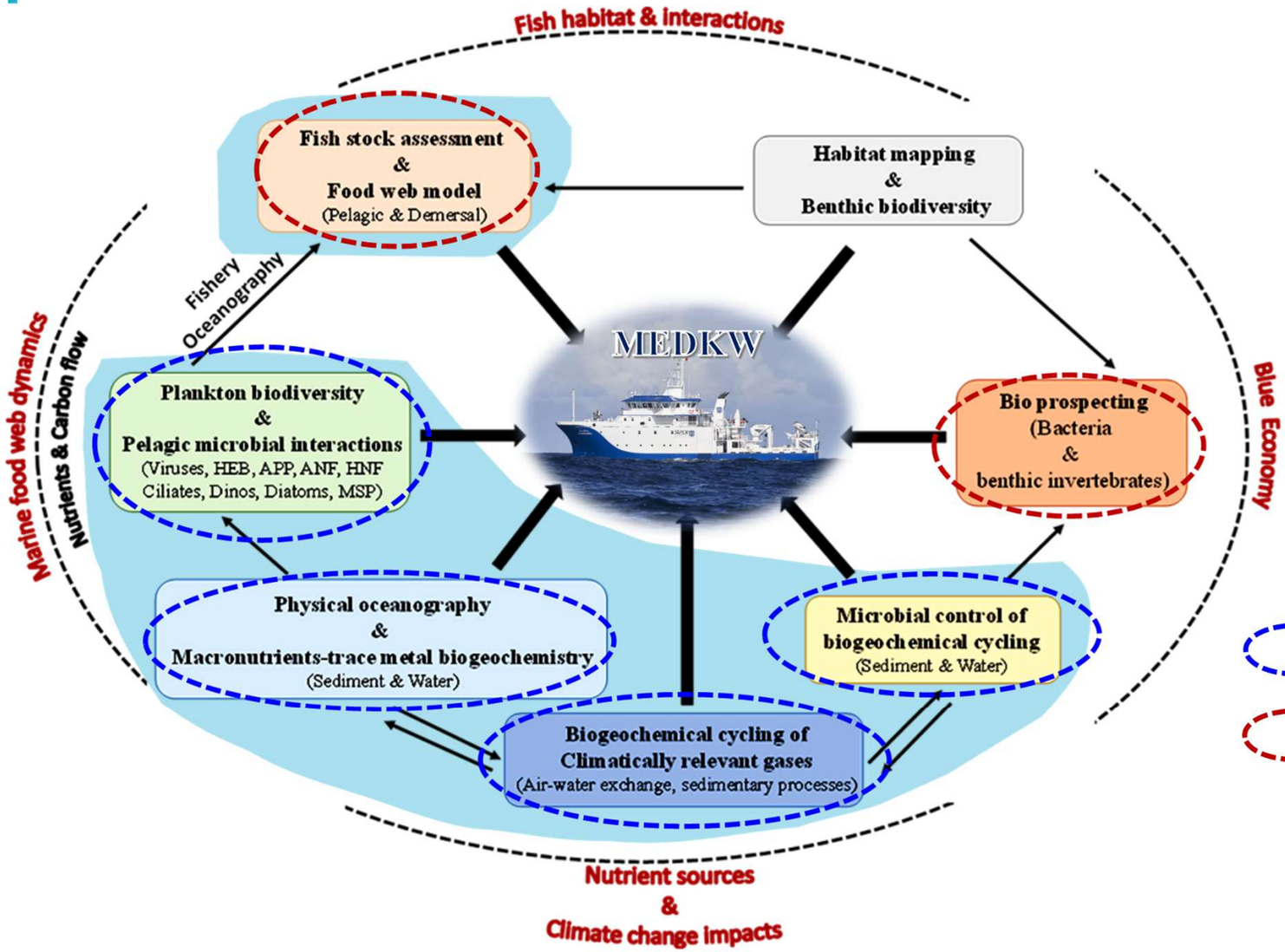
(ongoing)

(2024-2029)



The Lagrangian (Ecosystem-based) Approach

(2024-2029)



HEB: Heterotrophic Bacteria; APP: Autotrophic Picoplankton; ANF: Autotrophic nanoflagellates; HNF: Heterotrophic nanoflagellates
Dinos: Dinoflagellates; MSP: Mesozooplankton; MEDKW: Marine Ecosystem Dynamics of Kuwaiti Waters

Individual, well connected research activities contribute to the better understanding of the central theme 'Marine Ecosystem Dynamics of Kuwaiti waters' (MEDKW)

Entire Exclusive Economic Zone EEZ of Kuwait

Coastal and selected offshore locations

3. Microplastics Research in the Gulf

(upcoming)

Macro- and microplastic pollution is emerging as one of the biggest threats to marine ecosystems, globally.

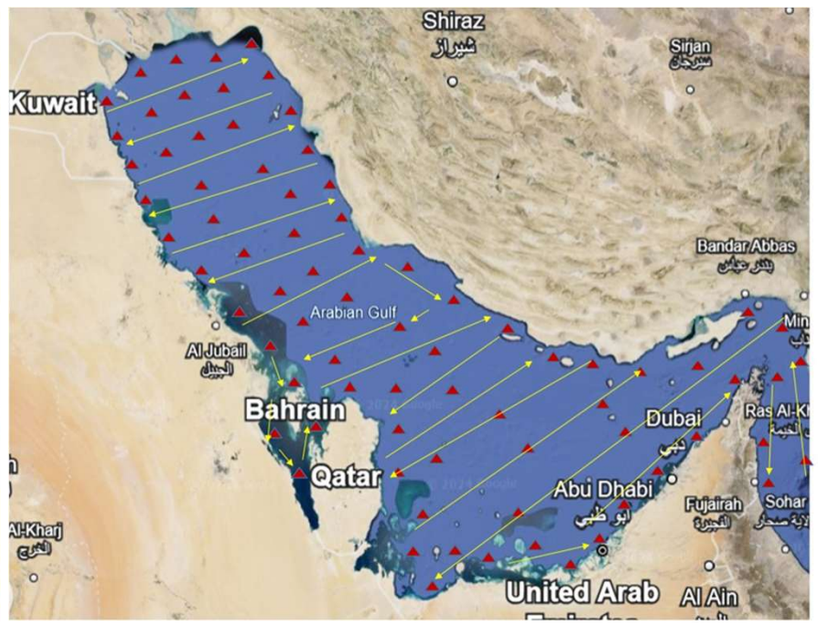
(Sources: UN Environment Programme, Marine Pollution Bulletin)

Assessing Ocean Health:
Microplastics Diversity and Distribution
A collaborative venture of KISR, IAEA, KFAS, and ROPME

The venture was officially launched during the COP28 Climate Change Conference held in Dubai, UAE (30 November - 12 December 2023).

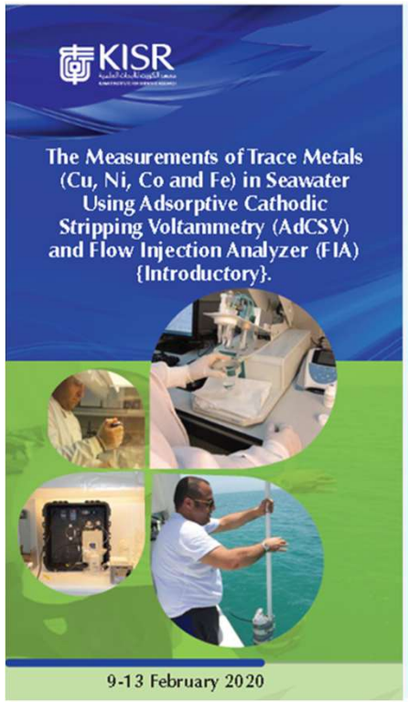


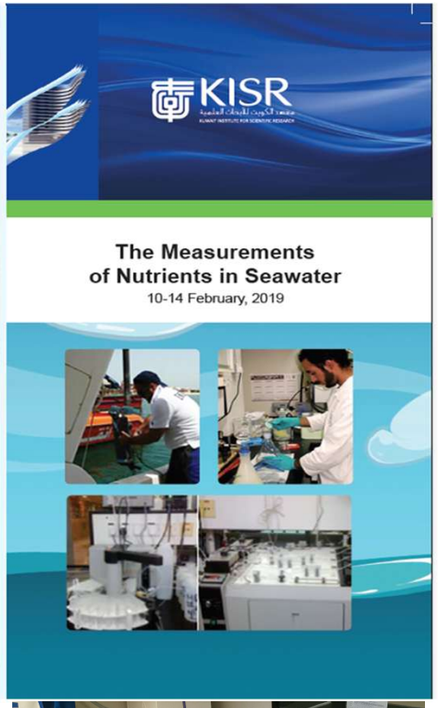


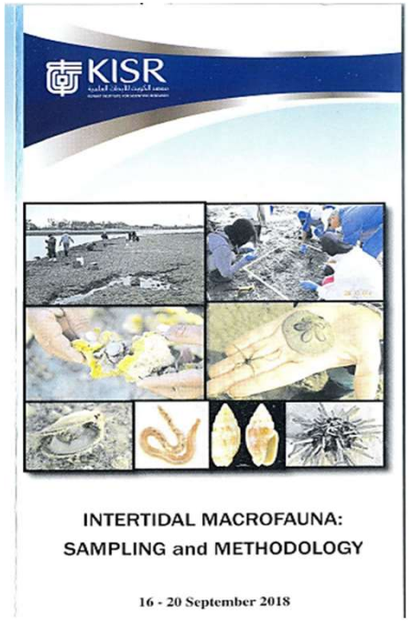


A series of three regional cruises are proposed to assessing ocean health

- Cruise 1 will cover the Arabian/Persian Gulf
- Cruise 2 will focus on the Red Sea and the Mediterranean
- Cruise 3 will extend into the Indian Ocean, reaching up to the Bay of Bengal







Marine Manpower Development in Kuwait: Training programs

Number	Course Title	Proposed Year
1	Techniques in Marine Sampling and Sample Processing	2025-2026
2	Fundamentals of Physical Oceanography and Meteorology: Data Collection and Analysis	2025-2026
3	Biodiversity Monitoring of Intertidal and Subtidal Macrobenthos: Collection and Sample Processing	2025-2026
4	Automated Nutrient Analysis Using SKALAR Autoanalyzer	2026-2027
5	Dissolved Trace Metal Analysis in Marine Samples	2026-2027
6	Trace Metal Analysis in Sediments and Particulate Organic Matter Using GF-AAS or MP-AES	2026-2027
7	Optical Characterization of Marine Plankton Using Advanced Plankton Characterization Techniques	2027-2028
8	Quantitative Analysis of Phytoplankton Pigments Using High-Performance Liquid Chromatography (HPLC)	2027-2028
9	Introduction to Visualization and Analysis of Spatial Datasets Using GIS Software	2028-2029
10	Data Interpretation in Oceanography: Statistical Approaches	2028-2029

Concluding Remarks

- Since the adoption of the UN Sustainable Development Goals (SDGs) in 2015, Kuwait has implemented institutional frameworks and measures to support their achievement.
- Kuwait has wide scope and opportunities to improve its achievements on different targets under SDG14 (Life underwater)

- Coastal & Marine program at KISR is fully equipped to expand its research activities across Kuwait's entire EEZ, the Gulf, and beyond, hence increased regional and international collaboration

- Given the regional and international significance of KISR research vessel RV *AlMostakshif*, keen to collaborate with national & international partners focused on climate change, marine pollution, biogeochemistry, plankton dynamics, biodiversity, and fishery stock management – supporting effective ecosystem management & sustainability .

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission


Thank You.....

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SDGs Achievements of Kuwait (as of 2019)

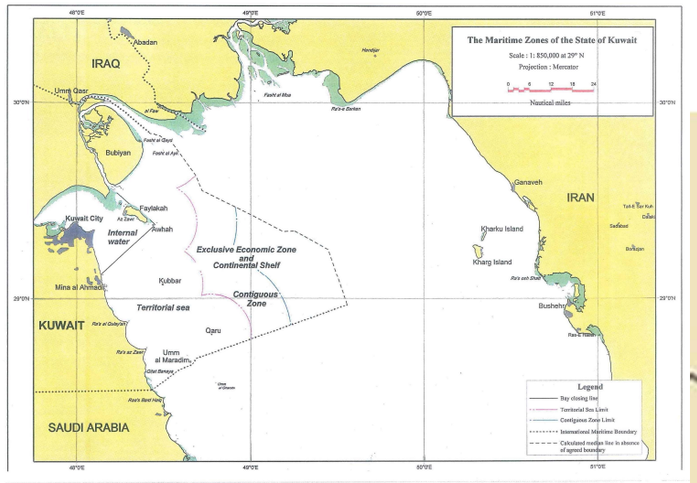
SDGs	% of Achievement
SDG 1: End Poverty	100%
SDG2: Zero Hunger	65.20%
SDG 3: Health and Well-Being	84.80%
SDG 4: Quality Education	74.70%
SDG 5: Gender Equality	55.80%
SDG 6: Clean Water	50%
SDG 7: Clean Energy	86.60%
SDG 8: Decent Work and Economic Growth	77.60%
SDG 9: Industry and Innovation	45.70%
SDG 10: Reducing Inequalities	Actions to achieve this goal are in force
SDG 11: Sustainable Cities	44.60%
SDG 12: Production and Consumption	28.90%
SDG 13: Climate Change	43.80%
SDG 14: Life Below Water	**37.40%**
SDG 15: Life on Land	55%
SDG 16: Promoting Peace, Justice and Strong Ins	73.90%
SDG 17 : Partnership	52.90%

(Source: Kuwait Voluntary National Review, 2019)

Objectives

1. To preserve the normal functioning of environmental processes of Sulaibikhat Bay and thereby ensure the sustainability of the ecological services lost during Kuwait's occupation in 1990-91.
2. To conserve and protect the Marine Protected Area (MPA) from human activities through long-term environmental monitoring and management interventions.
3. To continue maintaining the database on the environmental scenario obtained during Phase-I of the MPA monitoring (STMP, Oct 2018- Mar 2021), since May 2021.
4. To ensure the cultural ecosystem services (educational, scientific, cultural heritage) through outreach activities on the importance of the Sulaibikhat MPA and ensure public participation in the conservation and maintenance of the MPA.

Sampling locations in the EEZ of Kuwait



Source: Flanders Marine Institute, 2019.
http://www.marineregions.org/eezdetails.php?mrgid=8357

- Seasons & Period
  Summer, Winter, Spring

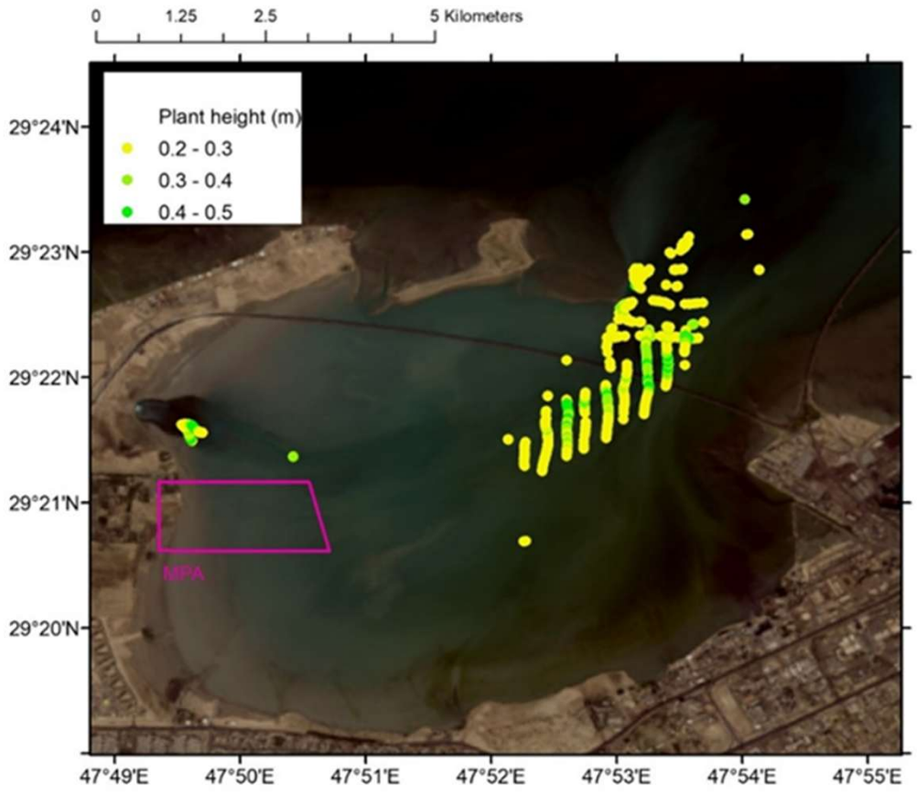
  2 years

- Duration of cruise onboard AlMostakshif

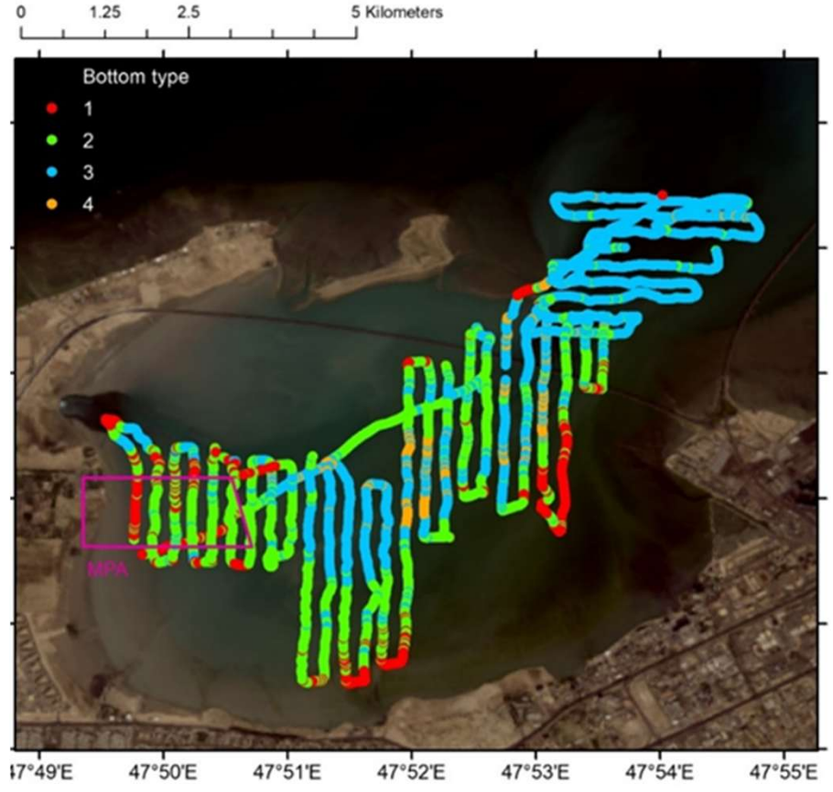
  12-15 days - depends on the final no. of diurnal stations

Submerged Vegetation & Bottom Sediment type

DT-X aquatic echo-sounder



Submerged vegetation
height detected by the aquatic echo-sounder.



Bottom sediment type
distribution derived from the hydroacoustic data

Strategic Research Objectives – CMRP/ELSRC

- Increase the proportion of EEZ managed using ecosystem-based approaches in congruence with UN's SDG14.
- Guidelines for the establishment of Marine Protected Areas (MPAs) and development of biodiversity conservation measures.
- Prediction models for HABs and mitigation measures.
- Evaluation of climate change and ocean acidification: mitigation and solution.
- Assessment and enhancement of fishery stocks and science-based policy recommendations

A B S T R A C T

Marine causeways are becoming more common in many coastal regions to improve vehicular transportation and social integration across landscapes segmented by bays and estuaries. The construction of barrier-type structures has profound implications by altering the geomorphological, hydrodynamic, and ecological conditions in the coastal marine environment. This study investigates the impact of one such newly constructed marine causeway in an enclosed bay in the Arabian Gulf. We hypothesized that the underwater structure of the bridge affects hydrodynamic and physicochemical conditions in the bay. Through extensive physicochemical monitoring, we found that the bridge acted as a physical barrier diminishing tidal currents, thereby resulting in decreased water exchange and heightened stagnation within the bay. Consequently, environmental gradients intensified and nutrient dynamics altered across the bridge. This will have implications for the plankton dynamics, ecosystem function, and overall health of the bay and its surrounding waters. Based on these results, it is recommended to increase efforts to mitigate the stagnation in the bay. Additionally, future coastal development needs to avoid further compromising the water exchange ability of the bay. Our findings also highlight the importance of continuous monitoring and adaptive management strategies to mitigate the environmental impacts of such developments.