WOSC

World Ocean Science Congress 2024

Sustainable Utilization of Oceans in Blue Economy

ABSTRACT VOLUME

27-29 February, 2024 at IIT Madras Research Park, Taramani, Chennai-113

किरेन रीजीजू
KIREN RIJIJU

मंत्री
पृथ्वी विज्ञान
भारत सरकार
**MINISTER
EARTH SCIENCES
GOVERNMENT OF INDIA**

MESSAGE

It is with great pleasure that I extend my warmest greetings to all participants of the 3rd World Ocean Science Congress (WOSC-2024), to be held at IIT Madras Research Park during 27-29 February 2024, under the theme "Sustainable Utilization of Ocean in the Blue Economy."

I am delighted that the National Institute of Ocean Technology, Chennai, a key centre of the Ministry of Earth Sciences, along with IIT Madras and Vijnana Bharati, is organizing this event in a grand manner, involving major stakeholders such as researchers, academics, industry, policymakers, fishermen, and more.

Oceans are a vital part of our planet, covering more than 70% of the Earth's surface and playing a crucial role in regulating the climate, providing food and livelihoods, supporting biodiversity, and driving economic growth. As we navigate the challenges of the 21st century, it is imperative that we recognize the importance of sustainable ocean management and harness the potential of our oceans for the benefit of current and future generations.

The theme of this conference, "Sustainable Utilization of Ocean in the Blue Economy," underscores the need for responsible and equitable utilization of ocean resources to promote economic growth while ensuring the health and integrity of marine ecosystems. It reflects our collective commitment to fostering innovation, collaboration, and actionable strategies to achieve a balance between economic development and environmental conservation.

I commend the organizers, authors, and contributors for their dedication and commitment to advancing the goals of sustainable ocean utilization and the blue economy. I am particularly pleased to note the significant number of abstracts submitted by students and young researchers, highlighting the enthusiasm and dedication of the next generation of ocean scientists.

I am confident that the discussions and insights shared during this conference will contribute significantly to shaping policies, strategies, and actions to ensure the long-term health and prosperity of our oceans.
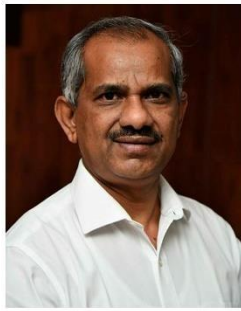
I extend my best wishes for a successful and productive conference.

(Kiren Rijiju)

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सचिव
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MESSAGE

It gives me great pleasure to extend my warmest greetings to all participants of the 3rd World Ocean Science Congress (WOSC-2024) to be held at IIT Madras Research Park during 27-29 February 2024 under the theme "Sustainable Utilization of Ocean in the Blue Economy." I am glad that National Institute of Ocean Technology, Chennai, a centre of the Ministry of Earth Sciences together with IIT Madras and Vijnan Bharati is organising this event in a grant manner involving the key stakeholders such as researchers, academics, industry, policy makers, fishermen, etc.

Oceans are a vital part of our planet, covering more than 70% of the Earth's surface and playing a crucial role in regulating the climate, providing food and livelihoods, supporting biodiversity, and driving economic growth. As we navigate the challenges of the 21st century, it is imperative that we recognize the importance of sustainable ocean management and harness the potential of our oceans for the benefit of current and future generations.

The theme of this conference, "Sustainable Utilization of Ocean in the Blue Economy," underscores the need for responsible and equitable utilization of ocean resources to promote economic growth while ensuring the health and integrity of marine ecosystems. By focusing on innovative solutions and actionable strategies, we aim to strike a balance between economic development and environmental preservation, thereby paving the way for a resilient and prosperous blue economy.

The papers presented in this book of abstracts reflect the collective efforts of researchers, scholars, and practitioners dedicated to advancing our understanding of ocean science and promoting sustainable ocean management. Covering a wide range of topics, from marine biodiversity conservation to renewable energy and coastal tourism, these papers offer valuable insights and recommendations for policymakers, industry leaders, and civil society stakeholders.

I commend the authors for their contributions and commend the organizers for their tireless efforts in bringing together experts from diverse backgrounds to share knowledge and best practices. I am confident that the discussions and outcomes of this conference will contribute significantly to shaping policies and initiatives aimed at realizing the sustainable utilization of ocean resources for the benefit of all.

I extend my best wishes for a successful and fruitful conference, and I look forward to witnessing the impactful outcomes of our collective endeavours in advancing the goals of ocean conservation and the blue economy.

(M. Ravichandran)

राष्ट्रीय समुद्र प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
पृथ्वी प्रणाली विज्ञान संगठन/Earth Systems Sciences Organisation

(पृथ्वी विज्ञान मंत्रालय, भारत सरकार)
(Ministry of Earth Sciences, Government of India)
एन.आई.ओ.टी. केम्पस, वेलच्चेरी ताम्बरम मेन रोड, पल्लिकरणै, चेन्नै–६०० १०० भारत.
NIOT Campus, Velachery - Tambaram Main Road, Pallikaranai, Chennai-600 100 INDIA.

डॉ. जी.ए. रामदास
निदेशक

Dr. G.A. RAMADASS
Director

MESSAGE FROM DIRECTOR, NIOT

It is a pleasure and privilege for the National Institute of Ocean Technology (NIOT) to be a co-organizer of the 3rd World Ocean Science Congress (WOSC-2024) along with IIT Madras and Vignana Bharati. The main theme of the conference is "Sustainable Utilization of Oceans in the Blue Economy" appropriately chosen in the decade of the ocean.

India has a long coast line with a large exclusive economic zone. With various deep sea-bed areas allotted to India by the International Seabed Authority (ISA), United Nations, India's sea area is comparable to the land area. This can contribute immensely to the blue economy and to the country's GDP as well.

NIOT is an autonomous institute under the MoES, has the mandate to design, develop and demonstrate technologies for the sustainable utilization of living & non-living resources of the oceans. NIOT also plays a major role in the Deep Ocean Mission of the Government of India sphere headed by the MoES. It is apt that NIOT and IIT Madras are joining hands with VIBHA in organizing the 3rd edition of WOSC.

It is heartening to see that the WOSC-2024 bringing together the major contributors and stake holders of the blue economy of India. The themes are carefully chosen to cover almost all aspects of the blue economy and no stone was left unturned to involve all concerned in this endeavour.

I am hopeful that the interactions and deliberations during the conference will pave the way for enhancing the contribution of blue economy to the India's GDP and will also ensure the sustainability of the seas and oceans surrounding India.

I extend my warm wishes for the successful conduct of the conference.

[G.A.RAMADASS]

vibha

विज्ञान भारती

Message

It gives me great pleasure to extend my warmest greetings to all participants of the World Ocean Science Conference under the theme "Sustainable Utilization of Ocean for the Blue Economy."

Oceans are a vital part of our country which has a long coastline of over 8000 km and 2.2 million square kilometers of Exclusive Economic Zone. The ocean surrounding us are playing crucial roles in regulating the climate, providing food and livelihoods, supporting biodiversity, and driving economic growth. As we navigate the challenges of the 21st century, it is imperative that we recognize the importance of sustainable ocean management and harness the potential of our oceans for the benefit of current and future generations.

The theme of this conference, "Sustainable Utilization of Ocean for the Blue Economy," underscores the need for responsible and equitable utilization of ocean resources to promote economic growth while ensuring the health and integrity of marine ecosystems. It reflects our collective commitment to fostering innovation, collaboration, and actionable strategies to achieve a balance between economic development and environmental conservation.

I commend the organizers, authors, and contributors for their dedication and commitment to advancing the goals of sustainable ocean utilization and the blue economy. I am confident that the discussions and insights shared during this conference will contribute significantly to shaping policies, strategies, and actions to ensure the long-term health and prosperity of our oceans. I note that large number of abstracts have been submitted by the students and young researchers and this abstracts volume will be serve as a quick reference material.

Once again I wish all success for WOSC-2024 and an enjoyable productive stay for the participants.

(Shekhar C. Mande)
National President, Vijnana Bharati

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प्रो. वी. कामकोटि
Prof. V. Kamakoti
निदेशक
Director

FOREWORD

It is with my great pleasure to welcome you all to the Third World Ocean Science Congress (WOSC-2024). The main theme "Sustainable Utilization of Ocean in the Blue Economy" of the Congress is the core voice of the world to address from the livelihood to the economy which will be discussed from multiple fronts from February 27–29, 2024, at IIT Madras Research Park. It is critical that we understand the significance of sustainable ocean management and optimum utilization of the the potential of our oceans for the benefit of present and future generations as we traverse the difficulties of the twenty-first century. It is foremost to address the three major planetary crisis: Climate Change, Loss of biodiversity & nature and pollution. The conference's topic, "Sustainable Utilization of Ocean in the Blue Economy," emphasizes the necessity of using ocean resources in an equitable and accountable manner to foster economic development and protect the integrity and health of marine ecosystems. I am happy that the major players in this event, including researchers, academics, industry, policy makers, the fishermen, and others stakeholder from coast and ocean, are being involved in its grant-style with the front organization by the National Institute of Ocean Technology, Chennai, a Center of the Ministry of Earth Sciences (MoES), IIT Madras and Vijnan Bharati.

Over 70% of Earth's surface is made up of oceans, which are an essential component of our planet since they control the climate, provide food and livelihoods, maintain biodiversity, and stimulate economic growth. We want to create a sustainable and thriving blue economy by balancing economic development with environmental protection through creative solutions and practical techniques. The papers included in this collection of abstracts for the conference are the result of the combined efforts of academics, practitioners, and researchers who are committed in improving our knowledge of ocean science and encouraging sustainable ocean management. These papers, which address a variety of subjects such as renewable energy, coastal tourism, and the preservation of marine biodiversity, provide insightful analysis and practical suggestions for decision-makers in government, business, and civil society.

I appreciate the authors' efforts and the organizers' diligent work in bringing together professionals from many fields to exchange best practices and expertise. I have no doubt that the conference's dialogues and recommendations will have a big impact on the activities and policies designed to achieve the sustainable use of ocean resources for the good of all. I offer my warmest wishes for a successful and productive conference, and I eagerly anticipate seeing the significant results of our joint efforts to further improvise ocean conservation policies and the blue economy.

V. Kamakoti

Prof. V. Kamakoti

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World Ocean Science Congress 2024

27th to 29th February 2024
at IIT-Madras Research Park, Chennai, Tamil Nadu

- Indian Ocean Summit
- Fishermen Meet
- Seminars
- ECOP Meet
- Exhibition
- Students' Competitions
- Panel Discussions

Theme

Sustainable Utilization of Ocean in Blue Economy

Sub Themes

- Fisheries with a special focus on offshore cage culture technology & policy.
- Tourism: Development of tourism in coastal state and island & policy.
- Ocean observations, processes & modelling.
- Harnessing of marine mineral & other resources: Exploration EIA perspectives.
- Policy requirements for sustainable utilization of ocean.
- Ocean technologies for sustainable development.
- Coastal protection and restoration of coasts.
- Marine biodiversity & ocean ecosystem.
- Ocean services: existing & required
- Underwater domain awarness

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World Ocean Science Congress 2024

27th to 29th February 2024 at IIT-Madras Research Park, TN

Fisheries with a special focus on Offshore Cage Culture Technology & Policy

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Subtheme I: Fisheries with a special focus on offshore cage culture technology and policy.

S. No	Title of Abstracts
1	Sea-trail of a bi-cone shaped spar type open-sea submerged fish cage system for the Indian coast
2	Seasonal and Inter-annual variability of Net Primary Productivity in the Tropical Indian Ocean
3	Ecological Dynamics of Macro- benthic Fauna within Cage Fish Farming Systems in Poora Puzha, Tanur, Malappuram District, Kerala: A Comprehensive Analysis
4	Autonomous Surface Vehicle - Optimizing Sea-Cage Aquaculture through Smart Feeding with Remote Monitoring and Algal Oxygenation
5	Effect of Spatial Distribution of Sinker Arrays on Volume Deformation in Offshore Aquaculture Cages
6	Designing, Development and Demonstration of FRP-HDPE hybrid cage for finfish farming at Pulicat Waters
7	Scientific nursery rearing practices for Asian Seabass Lates calcarifer to develop it as an ancillary sector to promote cage farming
8	Economic Viability and Economic Growth: A Comprehensive Assessment of Cage Farming in Ernakulam and Alappuzha districts, Kerala
9	Seaweed Farming for India's Blue Economy: A case study from Munaikadu Village, Palk Bay, Tamil Nadu
10	Optimizing Gracilaria salicornia cultivation: A comparative study of horizontal and vertical monoline tube nets within a cage system
11	Fuzzy Analytic Hierarchy Process based site selection for brackishwater seaweed farming: A case study in Chengalpattu district, Tamil Nadu
12	Towards Sustainable Coastal Aquaculture: A comprehensive study on seaweed distribution in Chengalpattu district, Tamil Nadu

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Sustainable Utilization of Ocean in Blue Economy

Sub Themes

Development of Tourism in Coastal State and Island & Policy.

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Subtheme II: Tourism: Development of Tourism in coastal states and islands andpolicy.

S. No	Title of Abstracts
1	Rip Current Dynamics and Beach Safety: A Multidimensional Approach to Tourism Development
2	Conservation and Livelihood in Wetland Community- Case Study of Addu City and Fuvahmulah City, Maldives
3	Development of Tourism in India's Coastal States, Islands & Offshore
4	Assessment of wave tranquility aspects for development of Passenger Terminal near Gateway of India Mumbai
5	Ocean Tourism - A rainbow policy for development of Tourism in Coastal states and Iceland through Green Sustainable Development and Economic Management
6	Environmental Performance Analysis of Coastal Tourism: A Case Study of Velankanni, Tamil nadu, India
7	Climate change impact on coastal erosion and tourism development in Digha coastal area, west Bengal, India
8	Marine Protected Areas in the Mediterranean Sea: Economic and Social Overview.
9	Tourism of an environmentally challenged island: perspectives of Mousuni, Sundarbans

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World Ocean Science Congress 2024

27ᵗʰ to 29ᵗʰ February 2024 at IIT-Madras Research Park, TN

Ocean Services : Existing & Required

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Subtheme III: Ocean services: existing and required.

S. No	Title of Abstracts
1	Operational Oil Spill Advisory Services – Existing and Required
2	WebGIS Application for Ocean Information and Advisory Services from Indian National Centre for Ocean Information Services
3	Significance of OSF & PFZ advisories in Economic improvements of fishermen of Uttara Kannada District, Karnataka
4	Ocean science and technology for offshore and coastal Industry-demanded consultancy projects/services
5	Quantifying Methane and Nitrous Oxide Fluxes in Coringa for Enhanced Climate Change Mitigation Strategies
6	Evaluation of HWRF-HYCOM coupled simulations of selected North Indian Ocean TCs from the recent past.
7	Satellite-Retrieved Long-Term Trend Analysis of Algal Blooms in Indian Coastal Waters
8	Coastal Ecosystem Services of the Coringa Mangrove Ecosystem: A Comprehensive Assessment, Valuation, and Ecosystem-Based Management Strategy
9	Operational Ocean Color Automatic Data Processing Chain for North Indian Ocean
10	Application of AI/ML techniques in improving the efficiency of potential fishing zone advisory
11	Ocean Accounting for Sustainable Development and Governance
12	Seasonal forecasting of Marine Heat Waves: Translating research to ocean services
13	Exploitation of AI in Oceanography for Naval Operations
14	Evaluating Surface Heat and Momentum Fluxes in the Indian Ocean: A Comparative Analysis of Reanalysis Products and their Temporal Trends
15	Perigean Spring Tides – the need for close monitoring along the Indian coastline

S. No	Title of Abstracts
16	Upper ocean response to tropical storm Biparjoy in the Arabian Sea based on moored buoy observations
17	Unravelling the Dynamics of Indian Mackerel Abundance: A Comprehensive Analysis of Oceanographic Influences Using GLM, GAM, and BRT Models
18	Ecological Dynamics and Predictive Factors of Crambionella orsini Jellyfish Blooms in the Western Indian Ocean
19	Navigating the Future: Advancing Fisheries Predictions with a Front-to-Fish Approach
20	Application of random forest algorithm for prediction of Hilsa (Tenualosa ilisha) catch in the north-western Bay of Bengal
21	Advancing Satellite Technology for Monitoring of Algal Blooms in the Indian Ocean
22	Atlas of Submerged Rocky Outcrops along the Indian Coastline: A Resourceful Tool for Potential Fishing Zones (PFZ) and Diverse Applications
23	Advancing Marine Ecological Services for the Indian Seas: INCOIS's Contribution
24	Detection of Sea Surface Temperature Fronts in Goa and Mangaluru Coasts By Automatic Front Detection Algorithm
25	MDART - an Interactive Oceanographic Tool for the Visualization of Moored Buoy Observations
26	Oceanic Response Captured by Moored Buoy in the Central Arabian Sea during the Passage of Cyclones between 2011-2023
27	Prevalent ocean met role for the intensification and genesis features of the ESCS Tauktae

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Ocean Observations, Process & Modelling

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Subtheme IV: Ocean observations, processes and modeling.

S. No	Title of Abstracts
1	Modeling Ocean Diurnal Cycle and its Scale Interaction to Longer Scale Climate Variabilities
2	The interplay between prolonged La-Nina events and the Indian Ocean Dipole: Role of coupled ocean-atmosphere processes
3	A thermocline dome located below the stratified waters of the northern Bay of Bengal
4	Higher-trophic fish and macrobenthos biomass models suitable for two-way coupling with lower trophic level model hosts
5	Impact of the extreme Indian Ocean Dipole 2019 on Equatorial Indian Ocean circulation
6	Mechanism of Formation of Sea Surface Temperature Fronts in the Northeastern Arabian Sea
7	Wind-driven bottom current in the equatorial Indian Ocean
8	Air-Sea interactions associated with tropical cyclones over the Bay of Bengal with special emphasis on Meso-scale Eddies
9	Investigation of tide-wave-current interactions off the east coast of India using coupled SWAN+ADCIRC modelling system
10	A review of mechanisms controlling the summer monsoon upwelling system off the Somali coast during summer monsoon
11	Implementation of Local Ensemble Transform Kalman Filter based Ocean - Atmospheric coupled data assimilation system for improved analysis quality and predictions
12	Biogeochemistry of northern Indian Ocean using Bio-Argo float data
13	Need of high-resolution oxygen profiles from the eastern Arabian Sea
14	Ocean Emitted Natural short-lived halogens exert an indirect cooling effect on climate
15	Development of a MOM6 based ocean general circulation modelling framework for the Indian Ocean

S. No	Title of Abstracts
16	Dynamical downscaling of sea level change in the Indian Ocean using ROMS
17	Statistical Analysis of generation, propagation and life cycle of Mesoscale Eddies in the Bay of Bengal using 29 years of sea level data
18	Role of local winds and remote forcing in Coastal Upwelling along the West coast of India
19	The effect of the variability of wind forcing on ENSO simulation in an OGCM: case of canonical and protracted event
20	Days to season forecasts of Indian Ocean features from daily initialized NCMRWF coupled model
21	Extreme Wind Waves simulated by Wave Watch III model during land fall of Cyclones in the Bay of Bengal
22	Rapid Intensification of Tropical Cyclone Fani (2019) over the Bay of Bengal using a Convection-Permitting Regional Climate Simulation using WRF
23	Role of ocean in recent increase in cyclone frequency over the Arabian Sea
24	Ocean Forecasting in Extended Range Prediction System at NCMRWF
25	Climate-Induced Ecological Dynamics in Coringa Mangrove Ecosystem: A Hydro-Ecological Model Analysis
26	Is Ballast Hypothesis valid in the Bay of Bengal?
27	Interannual Variability of Low-salinity Plume in the Southeastern Arabian Sea during winter monsoon
28	Impact of tropical cyclones on the wave activity in the Bay of Bengal, 1979–2019
29	Multi-band and Multi-scattering epsilon based Atmospheric Correction for EOS-06 Ocean Colour Monitor (OCM3)
30	Performance of Moored Buoy Systems during severe Cyclonic Storm Michaung in the Bay of Bengal

S. No	Title of Abstracts
31	Bay of Bengal Tropical Cyclones: Ocean Observations and Advanced Numerical Modeling
32	Genesis of Arabian Sea Mini Warm Pool using a Coupled Numerical Model
33	Physical and biogeochemical variability over a decade in an Arctic fjord, and its climate relevance
34	Monitoring and Assessment of low frequency sound in Arabian Sea
35	Summer variability in bio-optical properties and phytoplankton pigment signatures in two adjacent high Arctic fjords, Svalbard
36	How important Ocean observations for weather and Climate Predictions?
37	Application of machine learning techniques for estimating ocean mixed layer depth
38	Demarcating the long lived and short-lived eddies in the Eastern Arabian Sea
39	Assessment of the evolution of sediment plumes along the southwest coast of India using satellite observations
40	Quality control methods and analysis for Wave Rider Buoy data in the Indian Ocean
41	Analysis and Quality Control of Tide Gauge Data over the Indian Ocean
42	Projection of Physical Characteristics of Extreme Rainfall Events during the Indian Summer Monsoon Using CMIP6 Models
43	Downscaling CMIP6 Earth System Global Climate Models' winds for the Indian Ocean
44	Temporal Variability of Oceanic Fronts and their influence on Acoustic Propagation in the Southeast Arabian Seas.
45	Impact of global warming on regional ocean circulation, Air-sea interactions and cyclogenesis over the Bay of Bengal

S. No	Title of Abstracts
46	Role of physical oceanographic parameters in impacting the cyclogenesis over Indian Ocean
47	Development of pCO2 algorithm and its Spatiotemporal variability in South-east Arabian Sea using Remote sensing and In-situ Datasets
48	Drivers of the Indian summer monsoon variability: A comparison between Early Twentieth Century and Present warming periods
49	Numerical Modelling of Flood Inundation and Run-Up Along Selected River Banks of Kerala
50	Impact of river runoff and precipitation on surface pH along the Indian coastline using a high-resolution model
52	Dimethyl Sulfide (DMS) Emissions: Sea water concentration and Sea-Air Fluxes
53	Evolution of the thermohaline structure in South eastern Arabian Sea during winter
54	Annual cycle of dissolved oxygen associated with the variability of salinity and water hyacinths in the Cochin estuary.
55	Presence of eddies in the Bay of Bengal- Is it random or recurring?
56	Observed currents off the coast of Rameswaram island
57	Deep Learning techniques for the prediction of Ocean currents for underwater vehicles
58	Missing data imputation in Moored buoy data using Particle swarm optimization -ML Algorithm
59	Oceanic influence on Large-Scale Atmospheric Convection during co-occurring La Niña and IOD events
60	Influence of Atmospheric Heat-Flux in the Northern Arabian Sea surface chlorophyll Bloom
61	Long Term Prediction of Wind Power Density due to climate change using CMIP6 for Indian Coastal regions

S. No	Title of Abstracts
62	Variations in the Oxygen Minimum Zone and carbonate chemistry of the Eastern Arabian Sea since the last 15 kyr
63	Seasonal and Long-term Variability of SST in the Arabian Sea
64	Revolutionizing Ocean Observation: Advancing Oceanic Understanding and Conservation through UAV Hyperspectral Remote Sensing
65	Upper Indian Ocean Warming Trend and its Regional Variability
66	Mechanisms of the Southern Arabian Sea summer Primary Productivity weakening in response to anthropogenic forcing in Earth System Model
67	Sensitivity of simulated upper ocean thermohaline structure to diffusivity shape function in MOM5
68	Impact of Geophysical Parameters on Tropical Cyclogenesis Locations in the Bay of Bengal
69	Wave-surge-tide interactions in the Bay of Bengal
70	Comparison of adaptive methods for estimating directional spectra against 2D Fourier Transform using a fully nonlinear wave model
71	Identification and Characterization of Marine Heat Waves over the Bay of Bengal
72	Hydrography and circulation in the southeastern Arabian Sea during winter
73	Repeated Harmful Algal Blooms: Insights from continuous monitoring in the Bivalve beds of Malabar Coast, South Eastern Arabian Sea
74	Performance of SMAP sea surface salinity during extreme conditions using moored observations in the Bay of Bengal and Arabian Sea
75	Biological nitrous oxide (N_2O) consumption in coastal sediments: environmental and biogeochemical drivers

S. No	Title of Abstracts
76	Seasonal Analysis of Ocean Heat Content in the Ice-covered Arctic Ocean
77	An ensemble machine learning model for turbidity estimation using Landsat 8 OLI in Chilika Lagoon, India
78	Measurement of Microplastics Size Distribution Using a Scanning Electron Microscope
79	Ocean Acidification and The Future of Clam – Paphia Undulata – A Study on it's Characterization, Composition and Property
80	Hydrodynamic modelling of Pulicate Lake
81	Role of Surface Layer Temperature Inversion on SST Induced Variability in the Bay of Bengal
82	Wave and Current Simulations during Cyclone Tauktae and Yaas
83	Preliminary analysis on ocean acidification prediction using CO2calc and Seacarb in the chosen areas in Palk Strait, Bay of Bengal
84	Sub littoral Seaweed flora of St. Martin's Island, Bangladesh
85	Barotropic and baroclinic tides on the shelf off Svalbard and their role in shelf-fjord exchange
86	The influence of winds and tides over a lagoon and semi-enclosed estuary along the southeast coast of India
87	An analysis of the seasonal variations in sea surface temperature (SST) and their impact on the marine environment in the Bay of Bengal
88	Observations on upwelling in the southeastern Arabian Sea during the post-monsoon season
89	Decadal Variability of Coral Bleaching in the Lakshadweep Sea: Influence of Extreme Climate Events
90	Evaluation of wave parameters using moored buoy data with Satellite and ERA-5 Model datasets in the Arabian Sea

S. No	Title of Abstracts
91	The Role of Co-operation in Oceans and Marine Environments
92	Quantum-Assisted Underwater Communication: Opportunities and Challenges.
93	CMIP5 model evaluation of Wave Power over the Indian Ocean using COWCLIP 2.0 datasets
94	Prediction of Sea Level Anomaly in the Indian Ocean based on Autoregressive Integrated Moving Average Model
95	Study of long-term changes in Car Nicobar Island using DInSAR and Remote Sensing
96	Interannual Variability of Dissolved Oxygen in the Northern Gulf of Mexico Hypoxic Zone
97	Estimation of Wave Energy Potential using Remote Sensing and GIS
98	Assessment of Morphological Changes Along the Kanyakumari Coast
99	Coastal Hydrodynamics and Sediment Transport Model using MIKE 21

WOSC

World Ocean Science Congress 2024

27th to 29th February 2024 at IIT-Madras Research Park, TN

Harnessing of Marine Mineral & other Resources Exploration EIA perspectives

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Subtheme V: Harnessing of marine mineral and other resources: Exploration and EIA perspectives.

S. No	Title of Abstracts.
1	Relevance of EIA for Deep Sea mining
2	SMS & Chemical Grade Lime Mud Deposits in Indian Offshore, Carbon Credit Potential and Blue Economy
3	Evidence for two new hydrothermal fields (at 24°49'S and 24°55'S) over the southern Central Indian Ridge, near Rodriguez Triple Junction
4	Polymetallic Hydrothermal Sulphide (PMS) deposits: Geology and Exploration aspects
5	Biological Diversity Associated with the Deep-Sea Mineral Resources in the Indian Ocean
6	Cold seep induced enhanced water column methane concentrations in Krishna-Godavari basin, Bay of Bengal
7	Exploration of polymetallic sulfide deposits in the Eastern SWIR: Sediment geochemistry evidence
8	Experimental study on heating of hydraulic oil for the deep-water vehicles
9	Morphology and Molecular Phylogenetic Analysis of New Deep-sea Species
10	Image Processing and Enhancement Techniques for underwater Object detection
11	Coastal Mineral Resources of India – An Overview.
12	Distribution pattern and Provenance study of Heavy Minerals suites in different microenvironments of Gopalpur coast, Southern Odisha, East coast of India
13	Estimation of Limemud Resources Occurring in The Indian Offshore Using Professional Software Target^{TM}
14	Heavy mineral distribution pattern in the coastal tract of Kasaragod District, North Kerala, India, and inferences on the controlling factors

S. No	Title of Abstracts.
15	Strategic placer mineral exploration with mineralogical characterization in the Territorial Waters off Malud, Odisha, East Coast of India
16	Exploration of benthic biodiversity in the Central and Southwest Indian Ridges: India's commitments and contributions
17	Speciation of metals and their vertical distribution in a sediment core from southeast Bay of Bengal
18	Benthic community assessment along the polymetallic nodule region in the central Indian Ocean – An environmental and Blue Economy perspective
19	High Incidence of Vanadium and Copper in the titanomagnetite and ilmenite samples off Ratnagiri, Maharashtra, India
20	Andaman Back Arc Spreading Centre: A probable loci for Seafloor Massive Sulphide (SMS) deposits
21	Enhancing the growth conditions of the marine bacterium, Bacillus cereus, a valuable source of the biopolymer, poly- hydroxy butyrate/co-valerate at fermenter level
22	Simulation of Gas Hydrate Production in KG Basin Sediments via Depressurization
23	A new theory for the origin of the enigmatic 85°E Ridge
24	Harnessing Marine Cyanobacterial Exo polysaccharides in view of Environmental cleanup process
25	Development and optimization of seaweed-based bioplastic with enhanced durability and tensile strength using chitin derived from prawn waste
26	Comparative study of Encapsulated Peppermint & Clove oil in chitosan nanoparticles: Encapsulation efficiency, Thermal stability, Invitro release, Antioxidant activities.
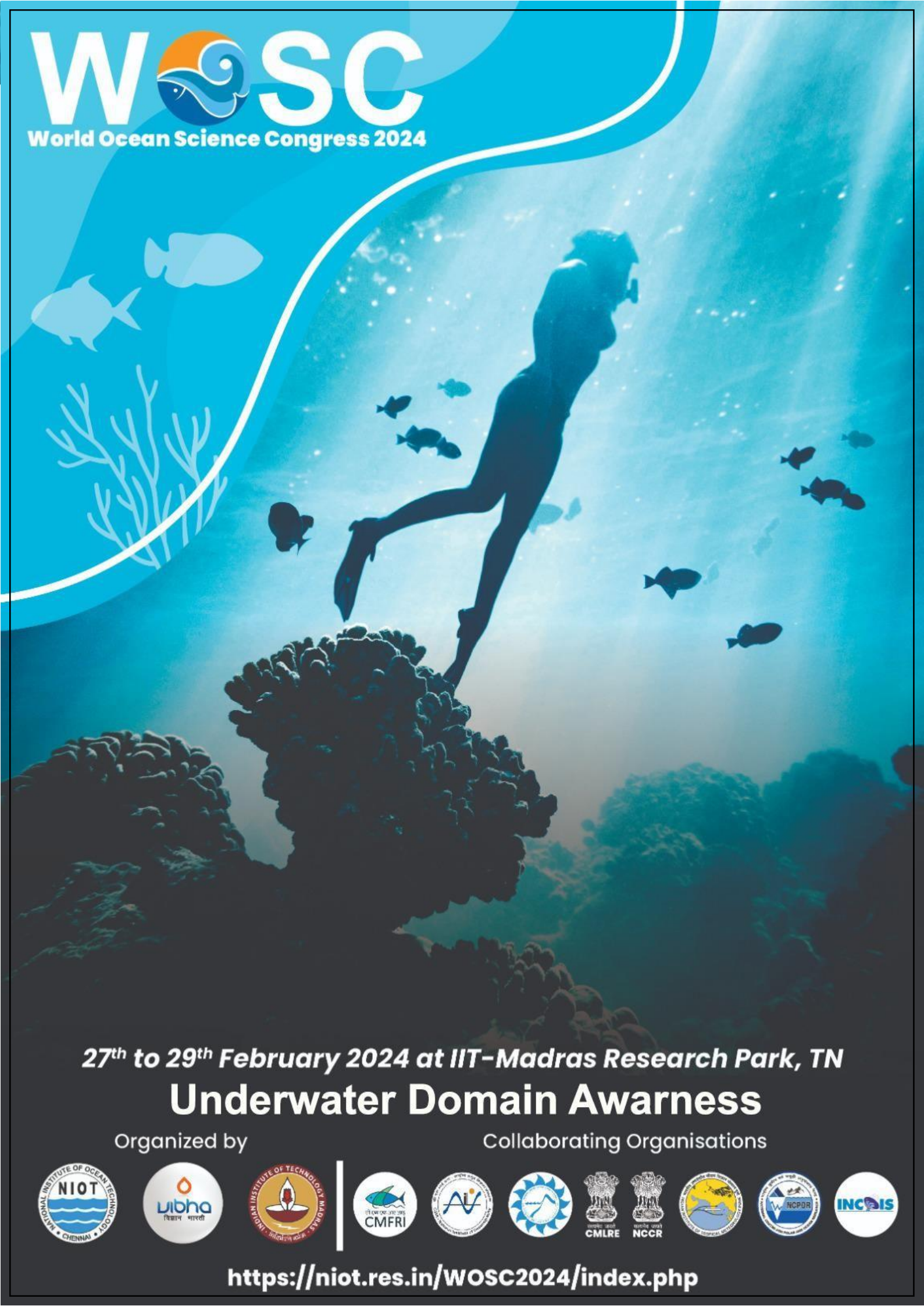
Subtheme VI: Underwater Domain Awareness.

S. No	Title of Abstracts.
1	Marine Spatial Planning (MSP), the Dynamic Digital Transformation Tool for Underwater Governance
2	Navigating the Depths: Integrating Underwater Domain Awareness for Advanced Climate Change Risk Management in the Indian Ocean Region
3	Digital Transformation for Enhancing productivity and Sustainability of Aquaculture
4	The Tyranny of Small Decisions: A Comprehensive Study of Underwater Domain Implications
5	A Comprehensive Study of Blue Economy Principles, Global Status, and Relevance in India
6	Sediment Management in the Tropical Waters of the Indo-Pacific
7	Environment Social and Corporate Governance (ESG) frameworks
8	Transforming Sri Lanka's Maritime Future: A Digital Oceans Initiative with Underwater Domain Awareness Framework

Subtheme VII: Policy requirements for sustainable utilization of ocean.

S. No	Title of Abstracts.
1	Coupling of metal speciation with sediment quality in Mandovi and Zuari rivers, estuaries, and coastal area of Goa, India: Constrains on environmental risk
2	Benefits of exploration and use of natural resources in the face of climate change conditions
3	Blue Economy
4	Mapping Species-specific Potential Fishing Zones using historic Catch-logs on "fishgram" - a super app for marine fishing community
5	Declining Marine Fish Catch: High-Time for Strategic Timeout
6	Carbonate saturation in coastal waters of Visakhapatnam, Bay of Bengal
7	Techno-Managerial Framework & Policy for Oil Spill Monitoring in India's Maritime Zone
8	Policy Framework for Sustainable Ocean Utilisation: Satellite Surveillance of Unregulated Fishing in Indian Waters
9	Evaluating Microplastic Pollution on Popular East Coast Beaches of India - Essential Insights for Informed Policies and Ocean Conservation
10	Sustainable Technology Development in Exploration and Utilisation of the Deep sea minerals
11	Marine Spatial Planning-A Policy framework for sustainable management of marine environment, Agatti Island, Lakshadweep, India
12	A Review of Existing Policies and Usage of Emerging Technologies for Sustainable Utilisation of Ocean Resources under Union Budget 2024
13	Assessment of Occupational Accidents and Role of Life-Saving Devices Among
14	Value chain of non-conventional fishery resources-Odonus niger (trigger fish) in Munamabam fishing harbour, Kerala

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Ocean Technologies for Sustainable Development

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Subtheme VIII: Ocean Technologies for Sustainable Development.

S. No	Title of Abstracts
1	A study on the hydrodynamic characteristics of a mining machine navigating over the deep-sea floor bed
2	Long Term Projection of Wind Power Density Variations Due to Climate Change Using CMIP6 for Indian Coastal Region
3	Blue-Green Revolution: Navigating the Future with Marine Algae Bio diesel
4	Study of Nonlinear Power Take-Of Mechanism for Wave Energy Conversion
5	Developing Indigenous Wave Energy based Navigational Buoy
6	Design of Lightweight Structures Using Additive Manufacturing
7	OceanEyes: A mobile app technology to enhance our understanding of marine life with citizen science approach
8	Li-Fi technology in Wireless Data Transfer for AUV charging station
9	Open Sea trail of wave energy converter at Indian coast- challenges
10	Unveiling Krishna Godavari Basin's Gas Hydrate Potential: A High- Resolution AUV Exploration
11	Two-Dimensional Instantaneous Shipping Radiated Noise Estimation for Indian Ocean Region
12	Experimental Investigation on the Maneuvering of a Container Ship in Regular waves
13	Advancing the Production of Nutritionally Rich Microalgal Species Through Large Scale Photobioreactor Cultivation
14	Instrumentation system for parametric data collection of OTEC using deep sea moored surface buoy.
15	Hydrodynamic analysis of freely floating U-OWC integrated with Π-shaped breakwater

S. No	Title of Abstracts
16	Numerical investigations of dual Wave Energy Converter (WEC) near a fully reflecting wall
17	Performance analysis of parabolic harbor wall integrated with OWC – A numerical investigation
18	Design and Implementation of Instrumentation for Monitoring Coral Reef
19	Challenges in Real Time Data Collection from Coastal and Deep Ocean Moored Buoy Platforms
20	Machine Learning in Ocean Research
21	Ballast Water Management Using MIKE21 And ARCGIS Tools
22	A Compact Design and Development of a Deep-Sea Mining Vehicle for Soft Soil Conditions
23	Literature Review on Environmental Impacts and Flocculation Dynamics in Mining Plumes for Deep Sea Mining Operations
24	India's Tidal Energy Sustainability
25	Sustainable Deployment of Ocean Wave Energy Converter (WEC) for Blue Economy
26	Performance and Techno-economic Analysis of the Helical Hydrokinetic Turbine-A Review
27	Sustainable fault-tolerant control for autonomous underwater vehicle under uncertainty and external disturbances using LMI approach
28	Development of IgY Antibody-Based Therapeutics to Combat Key Bacterial Diseases Impacting Sustainable Aquaculture Development
29	Review on Mathematical Model for Various Types of Wave Energy Converters
30	Oceanic Optical Networking: A Review of Underwater Communication
31	Designing Matched Angle Arc for Wide FOV Imaging Optics in Ocean Color Monitoring

S. No	Title of Abstracts
32	Impact of Artificial Reef Deployment on Phytoplankton and Zooplankton Communities in Coastal waters of Pulicat Region, Tamil Nadu, India
33	Geometrical modeling and control of sustainable of shore energy systems under meto-ocean environment
34	A coupled piezoelectric-magneto micro energy harvester from Ocean wave motion for ocean applications
35	Impact of ocean technology on sustainable marine ecosystems and biodiversity through coastal protection, Preservation and restoration.
36	Indigenously development of Technologies for the Ocean Observation and Ocean Technologies
37	Configurations of tracked vehicle for development of Deep-sea Mining Vehicles for Enhanced Traction in Soft Seabed
38	Floating platforms for deep ocean mining – A Review
39	Impact of Artificial Reef Deployment on Water Quality Parameters in Coastal waters of Pulicat Region, TamilNadu, India
40	Significance of Calibrating underwater electro-acoustic transducers/ Hydrophones for oceanographic applications
41	Influence of Microalgal Diets on the Mass Production of Apocyclops royi (Cyclopoida, Copepoda) and Ef icacy of A. royi Nauplii as Live Prey for First Feeding Larvae of Silver Pompano, Trachinotus blochii (Lacepède, 1801)
42	Leveraging Machine Learning for Real-Time Water Pollution Detection: A Study with Convolutional Neural Networks

Subtheme IX: Coastal protection and restoration of coasts.

S. No	Title of Abstracts.
1	Evaluation of Depth of Closure Off- Goa & South Maharashtra Coasts
2	Hydrodynamic assessment of a pair of pile-restrained H-shaped floating breakwater
3	Geotube-based dunes to protect low-lying coastal areas from inundation
4	Design of layout of suitable anti erosion bund for development of the fishing harbour
5	Coast and Wetland Protection in Kerala: 60 Years' Experience and Urgent Need
6	Nature based solutions for coastal erosion risk reduction with special refece to the indian coast – an Overview
7	Novel multi-satellite-based assessment of the coastal water quality: An operational approach for continuous monitoring
8	FEM Model for the Analysis of Ocean Wave Characteristic on Arbitrary Shaped Domain
9	Dynamics, Challenges, and Strategies for Sustainable Management of Chavara
10	Longshore currents profile generation with Forcing parameters on west coast of India
11	Mangroves as Coastal Protectors- biological solutions for the Tamil Nadu coast
12	Machine learning approach for Mapping Coastal Bio-shields Pondicherry: A Case Study
13	Coastal Bio-geo Information System for Tamil Nadu coast using Geo server (Slippy map)
14	Sustenance of Embankments in Protecting the Coastal Islands- A Case Study in Bakkhali, Indian Sunderbans
15	Comparative Analysis of Coastal Hydrodynamic Conditions and Sediment Transport with Various Coastal Protection Structures along the South West Coast of India

S. No	Title of Abstracts.
16	Coastal Restoration- A Comparative Analysis of Bakkhali and Mousuni, Indian Sunderbans
17	A study on rip current Investigation by Smartphone based camera and Numerical Model.
18	Identification and Assessment of shoreline changes using sentinel imagery and RTKGPS along Visakhapatnam-Kakinada coast.
19	Assessment of Shoreline Changes of West Bengal Coast, India
20	Studies on Coastal Erosion along Visakhapatnam Coast and the Availability of Hilsa fish along Godavari Estuary during Monsoon Season, Andhra Pradesh
21	Coastal Vulnerability Assessment along the south Maharashtra coast
22	Microplastics in the sediments along the eastern Arabian Sea shelf: Distribution, governing factors and risk assessment
23	Unraveling the land-based discharge of microplastics from sewers to oceans – A comprehensive study and risk assessment in wastewaters of Goa, India
24	A detailed investigation of macro to microplastic pollution in the Rivers Ganga and Yamuna: Unveiling the seasonal, spatial, and risk assessment
25	Comparative assessment of microplastics ingestion by pelagic, benthic and accumulation in its surrounding environment
26	Littoral Drift of Nodal Points Along the Tamil Nadu Coast
27	Assessing the coastal vulnerability of Indian cities to sea level rise under current and future climate scenarios
28	Heavy metal contamination and its ecological implications along an urbanised river-ocean continuum on the southwest coast of India.
29	Public participation in monitoring Coastal Health

S. No	Title of Abstracts.
30	Shielding the Blues: Investigating the Life of Coastal Communities of Malabar, Kerala
31	Invisible Invaders Threatening the Coastal Livelihoods: Exploring the Perceptions of Microplastics among the Coastal Communities of Malabar, Kerala
32	Concept of Sustainable shore protection through chrysopogon zizanioides (vetiver)
33	Development of WebGIS based Coastal Inundation Risk Atlas for Tamil Nadu
34	Dissolved and particulate matter-bound polycyclic aromatic hydrocarbons from Coral reef ecosystems of the Lakshadweep Archipelago: Contamination status and ecological implications
35	Microplastics Distribution in the Sediment of Pattinapakkam Beach, Chennai city, Tamil Nadu, India
36	Assessment of Shoreline Migration along Rasulpur to Subarnarekha River Mouth Area, East coast of India
37	Monitoring Geophysical Changes in Chilika Lake: A ML approach Using Global Surface Water Mapping
38	Indian coastal vulnerability: Risk assessment and mitigation plans
39	Shore protection measures along Chennai Coast using GIS and Modelling Techniques
40	Coastal vulnerability and environmental risk assessment of Chennai coast
41	Spatio-Temporal Assessment of The Muthupet Mangrove Ecosystem

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Chennai, Tamil Nadu

Marine Biodiversity & Ocean Ecosystem

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Subtheme X: Marine Biodiversity and Ocean Ecosystem.

S. No	Title of Abstracts.
1	Sea Anemone Venom: Unravelling Ion Channel Interactions for Therapeutic Insights
2	Exploring the nematode-to-copepod ratio and harpacticoid copepod as a bioindicator for monitoring metal pollution in the Netravati-Gurupura estuarine ecosystem.
3	Microbiome characterization of a marine bivalve mollusc Amygdalum sp. from Seamounts of Arabian Sea
4	Immune response of the coral, Acropora sp., from different islands of Lakshadweep
5	Exploring the seamounts of the Arabian Sea: A hub of microbial diversity and bioprospecting opportunities.
6	Preliminary Observations on the Composition and Vertical Migration of Thecosome Pteropods in the Eastern Arabian Sea
7	Biological Continuity of Copepods in the Oceanic and Coastal Oxygen Minimum Zones in the Eastern Arabian Sea
8	Bioprospecting the Potentials of Manglicolous Yeast β-Glucan: An invitro approach
9	Influence of spatial and environmental parameters on methane oxidation activity in the Eastern Arabian Sea
10	Bacteriorhodopsin producing Haloarchaea from the tide pools of Tuticorin coast.
11	Isolation of UV-protecting biomolecule microsporin-like amino acids from marine Cyanophycean algae
12	Coliform plumes along the riverine-coastal continuum in the south-west coast of India
13	Species distribution modeling of small pelagic fishery in the north Indian Ocean towards securing livelihood

S. No	Title of Abstracts.
14	A Study on Impact of Global Pandemic on Sea Turtle Nesting Along Northern Coastal Karnataka and South Goa
15	Jellyfish Biodiversity in Sabah, Malaysia
16	Evaluation of the role of Rubisco activases in activating Rubisco for fixing the atmospheric CO_2 in mangroves
17	Are Indian mackerel (Rastrelliger kanagurta) populations in the eastern Indian Ocean truly homogeneous? Insights from geometric morphometric analysis
18	Abundance of bacterial population along the Visakhapatnam coastal water during pre-monsoon season 2023
19	Impact of light levels on antioxidant activity on three centric diatom species
20	Biopolymer compounds Isolation, characterization from native Seaweed and their biological activities for Bioprospecting application
21	A Baseline Study on Comparative Marine microbial diversity in Mahatma Gandhi Marine National Park and around Port Blair municipal city, Andaman Islands usingMetagenomic approaches
22	Study on Accumulation of Pesticides and Microplastics in the Sediments of Kongsfjorden - Krossfjorden Systems of Arctic.
23	Detection of Mercury Ions in Aqueous Media Using the Polar Seaweed Mediated Green Synthesized Silver Nanoparticles
24	Enhancing Climate Resilience of India's Coastal Communities
25	Geoinformatics Based Coastal and Marine Environmental Changes Around North Male Atoll Maldives.

S. No	Title of Abstracts.
26	Insight into the perplexing metagenetic life cycle and distribution of upside-down jellyfish Cassiopea from Indian waters
27	GAN-Augmented YOLO Framework: Scaling Coral Reef Health Monitoring with Synthetic Data
28	Biodegradation of Pyrene by Piezotolerant Hydrocarbonoclastic Deep-sea Brucella anthropi IOW5
29	Carbon dioxide sequestration by marine microbial carbonic anhydrase and its application in biomineralization
30	Investigation of vocalization of bottlenose dolphin pod and a single dolphin in the northern Indian Ocean
31	Wave energy of the southwest monsoon and "Biparjoy" cyclone on the displacement and deposition of chitinous tubes of Spiochaetopterus worms along the west coast of India
32	Short-term coloration of Caranzalem beach (central west coast of India) due to diatom bloom and organic litter during the southwest monsoon
33	Dolphins of Two Seas: Unravelling the Genetic Uniqueness of Indian Ocean Humpback Dolphins
34	Arctic Ecosystems in a Changing Climate: Biodiversity Consequences and the Blue Economy's Role
35	Charting the Future of Chilika's Seagrass: Insights, Challenges, and Conservation Solutions
36	Impact of Ocean acidification by different drivers on phytoplankton in BoB
37	Biomonitoring in the Arctic Fjords employing FHHB algorithm
38	Diatoms & their associated meiofauna from off-shore sediments of Port Blair
39	Impact of Climate Change on Marine Biodiversity and Ocean Ecosystem in Indian Ocean Region: Challenges and Future Perspectives

S. No	Title of Abstracts.
40	Decadal variations in phytoplankton compositions in Southern Ocean and Global Ocean influenced by biogeochemical variables
41	Features of subsurface chlorophyll maxima and their regulators in the Arabi
42	Enhancing the growth conditions of the marine bacterium, Bacillus cereus, a valuable source of the biopolymer, poly- hydroxy butyrate/co-valerate at fermenter level
43	Silicone-chitosan mediated cross-linked composites: A biomimetic approach for antibiofilm applications.
44	Impact of deep-sea environment on methane related activities in the sediment
45	Impact of Ocean acidification on microzooplankton communities - An experimental study from the coastal waters of Bay of Bengal, India.
46	Delineating micro-phytoplankton morphometry as potential ecological indicators in the Indian Ocean: elucidation from sea surface and variable sub-surface chlorophyllmaxima
47	An account on microplastic ingestion by zooplankton community in the coral reef lagoons of Lakshadweep archipelago
48	Metagenomic Profiling of Virome Associated with the Estuarine Sediment
49	Ocean acidification influences on the health and nutritional value of tropi
50	Marine Mammal Diversity in the Eastern Arabian Sea: Insights from FORV Sagar Sampada
51	Diversity and distribution of squat lobsters in the Indian Exclusive Economic Zone
52	First quantitative assessment of acorn worm (Enteropneusta) from the deep (below 5500 m) Indian Ocean: An underwater image analysis approach along the potential PMN mining site

S. No	Title of Abstracts.
53	Coral Microbiome: An Indispensable Forefront for The Reef Ecosystems
54	Interspecific Association and Epibiosis: First Report of Peritrich Ciliate Epibiont Rhabdostyle Species on Diopatra neapolitana in Indian Coastal Ecosystem
55	Diversity and nutritional profile of Scorpaeniformes from the Arabian Sea; From underrated exploitation to sustainable utilization
56	Bacterial Diversity of Arabian Sea Sediment: Implications for Functional Significance in Phosphate Solubilisation
57	Physiochemical responses of marine bacterium exposed to different levels of polystyrene nanoplastics: Insights into oxidative stress and biofilm modulation.
58	Surface Preference and Nutrient Influences in Settlement and Development of Ulva Spores into Germlings
59	Metal substrate influence on marine diatom biofilm: unravelling physio-biological dynamics and cell-surface interactions
60	Biodiversity of halophilic bacteria from the regions of Marakkanam, Tamil Nadu and its biomedical applications
61	Elasmobranch Fish Identification using YOLO - A Deep Learning Approach
62	Advancing the Blue Economy: Building a Resilient and Sustainable Tomorrow
63	Insights into Cetacean Strandings: A Comprehensive Study of Kerala coasts of India (2022-2023)
64	High dominance of thermal tolerant Symbiodiniaceae genotypes from a marginal, turbid reef of India: A potential adaptive strategy
65	Implications of ocean acidification on trace metals and their primary biological impacts: A Review

S. No	Title of Abstracts.
66	Microplastics pollutant in marine ecosystem, its associated health hazards and its biotechnological interventions
67	Comparative Analysis of Bacterial Microbiomes from Mangrove Habitats, a Blue Carbon Ecosystem vs Terrestrial Forest using Amplicon Sequencing
68	Comparative analysis of Microbiomes and their Functional profiles from Blue Carbon Ecosystems of Goa
69	Exploration and Evaluation of Antibiotic Potential in Bacterial Isolates from Deep-Sea Sediments
70	Impact of monsoonal rainfall on the PLB (pelagic larvae of benthic invertebrates) along the coastal waters of megacity Mumbai, India.
71	Study of marine microbial diversity on micro plastics and its biodegradation effects
72	How many macrofaunal species exist in Deep-sea abyssal Indian designated polymetallic nodule site, Central Indian Ocean Basin? - A preliminary methodologicalinsights
73	Ecological Dynamics and Seagrass Biodiversity in the Andaman and Nicobar Islands.
74	Characteristics of Marine Heat Waves during the Pre-Monsoon Season and its association with Chlorophyll-a concentration in the Arabian Sea and the Bay of Bengal
75	Unravelling benthic meiofaunal community dynamics: A morpho-functional approach in Indian estuaries with variable anthropogenic influence
76	Length-weight relationships and relative condition factor of Fourteen tropical Marine fish species from Gulf of Mannar along the Southeast Coast of India
77	Occurrence, Diversity of Batoids fishes from Tamil Nadu coast, Southeast coast of India

S. No	Title of Abstracts.
78	Exploring Diversity of Pathogenic Bacteria Along the Indian Coast through Metagenomics Analysis
79	First report of three marine fish species to Indian waters; one new record of blackfin stonefish (Pseudosynanceia melanostigma) to India and two new reports of Engraulids (Thrissina gautamiensis and Stolephorus tamilensis) from the West Coast of India
80	Screening of a halotolerant Bacillus spp. for protease production and for
81	Unlocking Antimicrobial Potential: Exploring bacterial diversity in the Indian Sector of the Southern Ocean for novel drug discovery
82	Prevention of coral disease caused by pathogens using the beneficial microbial associates
83	Direct Transplantation of reef-building corals to enhance the structural complexity of degraded reefs in Palk Bay of Southeast Coast of India
84	Ghost Fishing Gear - A Multifaceted Risk to the Coral Reefs along India's Southeast Coast
85	Seasonal Variation of Chlorophyll-A as The Indicator of Climate Change
86	Underwater Optical communication method for preserving the Marine Ecosystem
87	Bioinformatic Characterization and Functional Evaluation of Thymosin (Ph-Thy) from Panulirus homarus
88	Impact of Anthropogenic Activities on the Microplastic Concentration in Copepods in the Southwestern Bay of Bengal
89	Association between pelagic fish catch and the recurrence of upwelling in monthly time lag in the Gujrat Coast
90	Ichthyoplankton abundance and distribution in the eastern Arabian Sea during the early monsoon period

S. No	Title of Abstracts.
91	Time Series Analysis of Coral Reef Area in Shallow Water Off the Coast of Ranghat Area In Andaman And Nicobar Island UsingSentinel-2 Msi Data
92	Phytoplankton composition in the seasonal subtoxic/anoxic waters of the Western continental shelf of India
93	Seasonal and spatial variation of rocky intertidal seaweeds of Konkan coast, India
94	Meso zoo plankton community of the Deep Scattering Layer in the Eastern Arabian Sea
95	Meiobenthic biodiversity of a Hydrothermally Active Seamount in Southwestern Andaman Sea
96	Island mass effect on biogeochemistry of coastal waters around Grande Island
97	Length weight relationship and note on biological observations on the bristly catshark Bythaelurus hispidus (Alcock, 1891) from southwest coast of India
98	Length Weight Relationship and Relative Gut Ecomorphology of Three Leiognathid Species from Andaman Waters
99	Ecological Status, Length-Weight Relationship and Condition Factor of Peronia Verruculata (Cuvier, 1830) Along Coastal Saurashtra, Gujarat, India
100	Upsetting intertidal food web: Implications of ocean acidification on the p
101	Distribution of Symbiodiniaceae and its effect in countering Anthropogenic
102	Heavy metal accumulation in plankton in 24-hour tidal cycle, Ganges estuary
103	Acroporidae family coral species habitat modelling for site specific manage
104	Diversity, distribution and population ecology of intertidal Asteroidea fro
105	Bioaccumulation of heavy metals and anti-oxidative changes in marine polychaete worms at Chennai estuaries, India

I.   Fisheries with a special focus on offshore cage culture technology and policy.

WOSC/2024/ABS/107

Sea-trail of a bi-cone shaped spar type open-sea submerged fish cage system for the Indian coast

Anand Kishor, National Institute of Ocean Technology

S Muthukumaravel, National Institute of Ocean Technology

Under the UN/"/gs sustainable development goals (SDG) in 2015, goal 14 talks about Life underwater. In this goal, the UN plans to regulate illegal fishing practices and develop more science-based methods to restock fish. One such technique, which has been developed recently, is the fish cage. Fishing is a major source of livelihood and business in coastal communities and islands. Placing fish cages in such areas for fish farming can improve the place's economy and livelihood. Conventionally, fish cages are made in cylindrical and spherical form, with links forming the structure's skeleton. The open areas are covered using fish nets. The conventional fish cages float on the sea surface, and thus, they are prone to wear and tear, damage due to vandalism, harsh marine environments, cyclones, etc. Due to cyclones, rain, and other bad weather conditions, fish die inside the floating fish cage. The National Institute of Ocean Technology (NIOT) has developed and tested a novel open-sea submerged fish cage design to overcome these constraints. It has a bi-cone shape with a central spar hull for buoyancy control, which will remain subsurface safely at approximately 10m depth. The durability of a submerged fish cage is more. A fish cage with a Spar hull and conical head is designed to optimise stability, drag, and strength. The structural analysis of the 10m submerged fish cage is carried out using ANSYS software, and hydrodynamics analysis is carried out using ORCAFLEX software. The testing of a 10m diameter and 6- meter length prototype with a total volume of 160 m^3, which can be used to cultivate 2Tonsof fish biomass, was successfully carried out off Ennore port, Chennai, India, for a week, and the performance was found to be satisfactory. The system has a reserve buoyancy of 1.2 Tons; in bad weather, it can be submerged by opening a solenoid valve at the bottom of the central tank to fill the desired amount of water to make the system sink. The system alters buoyancy by adding or removing the weight by pumping water in and out to the central cylinder of the cage system, thereby altering the volume. The system has a Data Acquisition System (DAS) for control, GPS to get the position details, a depth sensor to measure the system's depth, a GSM modem for remote control of the fish cage, and a solenoid valve for water entry. The entire system is powered using 24 volts of DC. Due to the self-weight of the central hull, the complete system will descend according to the command received. The fish cage can be made to ascend to the typical floating condition with half of the hull submerged by pumping water out from the central hull using a submersible pump at the bottom of the cylinder. The Data Acquisition System (DAS) is a PIC (PIC18F2520) based microcontroller that collects data from barometric pressure sensors, GPS, and depth sensors depending on the sampling interval. DAS uses GPS to update its latitude and longitude for positional information. DAS using the depth sensor makes the fish cage float or submerge depending onthe set depth or user command.

It has a sub-sea feeder system, which is designed so that feed on the surface can be conveyed up to a depth of 7-10m. This has been achieved with a water ejector-based sub-sea feeder wherein the seawater is used as a motive fluid that sucks, mixes, and conveys the feeds to the desired depth due to the ejector. The system is suitably designed for gravity and floating feeds with the available seawater resources.

<div align="center">**WOSC/2024/ABS/119**</div>

Seasonal and Inter-annual variability of Net Primary Productivity in the Tropical Indian Ocean

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Marine Net primary production (NPP) acts as the base of the marine food web. In the tropical Indian Ocean, understanding net primary production is challenging as the northern part is driven by semi-annual forcing while the southern part is driven by inter-annual forcing. This was the motivation for the present work. The North Indian Ocean (NIO) has double the primary productivity than the Southern tropical Indian Ocean. Among the North Indian Ocean region, the Arabian Sea (AS) has the highest productivity than the Bay of Bengal (BoB). The seasonal cycle of NPP showed the occurrence of enhanced NPP during the southwest and northeast monsoon periods, which were tightly coupled to the seasonal cycles of chlorophyll a (Chl-a) biomass and nitrate, and phosphate. The semi-annual enhancement inNPP was driven by the phytoplankton blooms in the Arabian Sea during the southwest and northeast monsoon seasons. The NPP, Chl-a, NO3, and PO4 showed negative correlation in major area of the domain of study with SST except the northern part of the AS and BoB. Interannual variability of Tuna catch in the Eastern and Western Indian Ocean was analyzed. However, the correlation between NPP and Tuna catch in the Eastern IO was found to be significant.

<div align="center">**WOSC/2024/ABS/160**</div>

Ecological Dynamics of Macro- benthic Fauna within Cage Fish Farming Systems in Poora Puzha, Tanur, Malappuram District, Kerala: A Comprehensive Analysis

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The current investigation was undertaken to evaluate the richness and composition of macro benthic fauna within cage fish farming systems along Poora Puzha in the Malappuramdistrict, utilizing PAST analysis. A specific cage fish farm within Poora Puzha was selected as the focal site. Sediment samples were meticulously gathered from both the cage site (Site I) and a designated reference station (Site II), positioned 100 meters away from the cage, to meticulously analyze the diversity of macro benthos. The macro invertebrates were meticulously identified to their lowest taxonomic level, and subsequent calculations were made for their abundance and diversity indices. During this study, it was observed that polychaetes (Neries Spp) were the predominant species at the reference station (Cage Site II) and were consistently present across all seasons at both sites. Notably, the abundance of polychaetes surpassed that of molluscs at the farm sites. There were conspicuous fluctuations observed in species count, diversity, and faunal abundance at the farm sites in comparison to the reference stations. Although species richness exhibited a slight decrease at the farm sites in contrast to the reference stations. The numerical abundance was notably higher at the farm sites; however, diversity indices and evenness were noticeably greater at the reference stations. The

contribution of molluscs to the average macrobenthic biomass was observed to be the highest, while the contribution of arthropods was found to be negligible, particularly atcage site I across all seasons. The Shannon-Wiener diversity index (H´) exhibited a range of variation from 2.23 (during the Pre-monsoon period at Cage Site I) to 2.473 (during the Pre- monsoon period at Cage Site II) in the present study. The results indicated that cage fish farming systems in Poora Puzha river provide habitats for various macro benthic species. The presence of certain dominant species suggests further investigation.

Keywords: Macro benthic fauna, diversity, dominant species, abundance.

Autonomous Surface Vehicle - Optimizing Sea-Cage Aquaculture through Smart Feeding with Remote Monitoring and Algal Oxygenation

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This research addresses significant challenges in the realm of fish farming, aiming to enhance both production and environmental sustainability. With an increasing global demand for fish, it's crucial to find ways to produce more without harming the environment. Common issues, like excessive algae growth and insufficient oxygen levels, can negatively impact fish farming. In response, we developed a smart boat called an Automated Surface Vehicle (ASV)that is designed to precisely feed fish and promote oxygen production. The ASV integrates technologies like Deep Learning, ROS (Robot Operating System), and 3d Depth cameras, to monitor and address potential problems in real-time. We trained the ASV to quickly identify and manage algae using YOLOv8. Furthermore, we implemented a specialized chamber within the ASV to cultivate algae, leveraging their natural ability to generate oxygen through photosynthesis. Continuous monitoring of environmental factors, such as temperature and humidity, ensures an optimal environment for algae growth and overall ecosystem health. To streamline fish feeding, the ASV features an automatic food dispenser that can be controlled on a schedule or remotely via mobile phones or computers. This innovation not only improves aquaculture practices but also contributes to better environmental management.This study explores the development, functionality, and potential impact of the ASV, emphasizing its role in advancing sustainable fish farming and ecosystem restoration. By employing these innovative technologies and strategies, we aim to revolutionize fish farming practices, making them more efficient, environmentally friendly, and capable of meeting the increasing global demand for fish.

Effect of Spatial Distribution of Sinker Arrays on Volume Deformation in Offshore Aquaculture Cages

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Studies on optimizing aquaculture cages for deep water offshore environments has gained recognition lately. Due to persistent issues of pollutant accumulation and nearshore exploitations in many other forms, investigations are conducted on gravity cages to understand how they behave in harsh sea states. Major troubles include overtopping, increased responses and cage volume deformations. Reduction in culture volume causes fish mortality in the event of a typhoon and hence an intensive study is required in this regard. The present work numerically investigates to quantify the effect of sinker position on volume shrinkage in rectangular gravity cages subjected to uniform current conditions. For the same collar draft, sinker arrays are distributed in different spatial arrangements to identify the optimum geometry for in-situ application. Numerical simulations are conducted in Orcaflex by defining mesh using segmented line elements and 3D buoys as knots for simplicity. Pinned connections are established between each link and the model confirms to a solidity ratio of 0.15. The resultant positions of net knots belonging to significant arrays in the numerical domain are projected to X-Y and X-Z planes for visualization and quantification.In addition, the influence of sinker distribution on the global hydrodynamic responses of each model is also studied through dynamic simulation in the time domain for a regular wave condition. Keywords: Offshore aquaculture, Cage volume reduction, Rectangular gravitycage.

Designing, Development and Demonstration Of FRP-HDPE Hybrid Cage For Finfish Farming at Pulicat Waters

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Fish farming is a relatively emerging phenomenon and became sunshine industry in many regions worldwide. Total aquaculture production in 2021 comprised 90.9 million tonnes of aquatic animals where farmed finfish represents the greatest proportion of this production (47.1%.) and total accumulated aquaculture production was at 126 million tonnes live weight having a value of USD 296.5 billion (FAO, 2023a). Among fish farming sector, cage-based farming is the most prominent method. Sea cages are surface-based structures holding large nets which contain thousands to hundreds of thousands of fish. The genesis of this technology came from the Atlantic salmon farms during 1960s and 1970s in Norway and Scotland,where nylon trawl nets were hung from wooden or polyethylene pipe structures. Until recently, various types of floating cages are in operation in various countries but each one hasits own advantage and disadvantage in view of operational concern. The present papernarrates the designing, development and demonstrating of FRP-HDPE hybrid cage and its performance at Pulicat open waters. The present cage system was designed to demonstrate effectiveness in providing safe and easy conditions for husbandry, monitoring and management activities such

as feeding, observation sorting, maintenance and harvesting. The farming operations were carried out using the brackish water candidate species for which breeding technologies were developed by ICAR-CIBA. The culture details of the candidate species during the crop starting from stocking to harvest are also discussed in detail. The capacity of cage's resistance to vertical top loads applied at any one of time, as well to the bottom hanging load during the operational functions is the significant advantage of this hybrid cage than other existing floating cage types. The cage's efficiency on load dilution anddistribution were also found to be on significant advantageous level during the operation.

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Scientific nursery rearing practices for Asian Seabass Lates calcarifer to develop it as an ancillary sector to promote cage farming

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Global consumption of seafood has been steadily increasing due to population growth, rising incomes and changing dietary preferences. Over exploitation of high value wild marine fish stocks has led to concerns about the depletion of natural fish populations, making finfish farming as an essential alternative to meet the increasing seafood demand. Cultivation of marine and brackish water finfishes for commercial purposes, addresses several important needs and challenges, contributing to the sustainable production of seafood. Cage farming of high value finfishes in open water bodies such as seas, oceans, lagoons, backwaters and coastal ponds offers a great scope for increasing the fish production. Finfishes such as Asian Seabass Lates calcarifer, Red snapper Lutjanus argentimaculatus, Cobia Rachycentron canadum, Pompanos, Seabreams and Groupers are highly suitable for cage farming due to their market demand and amenability for farming. However, the existing hatcheries produce and supply fish seeds of very small size, which leads to low survival rate, differential growth rate and long duration of farming to attain marketable size. Further, many nurseries rearing operators rear finfish fry in the conventional earthen ponds by feeding with low value fishes and shrimps, which is considered as an unsustainable activity. To address these issues,popularizing scientific nursery rearing practices of finfishes would help to optimize the growth, survival and health of juvenile fish during their vulnerable early stages. Readyavailability of stockable size finfish fingerlings weaned to formulated feeds would enhance the survival and growth of fishes and viability of the cage farming operations. Hence, an improved scientific rearing method has been developed by the Fish Culture Division of ICAR
– CIBA for Asian seabass Lates calcarifer fingerling production in a backwater-based nursery rearing system with formulated feed. This technology has been promoted under the Scheduled Caste Sub Plan (SCSP) programme of ICAR – CIBA to create additional livelihood avenues to the rural coastal fisherwomen. To increase the availability of scientific nursery reared seabass this model has to be promoted as an entrepreneur activity and to createit as an ancillary aquaculture activity to support cage farming. Keywords: -Asian Seabass; Lates calcarifer; nursery rearing; cage farming.

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Economic Viability and Economic Growth: A Comprehensive Assessment of Cage Farming in Ernakulam and Alappuzha districts, Kerala

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Cage farming has emerged as a pivotal segment within the fisheries sector, contributing significantly to the state of Kerala's economy. Recognizing its emerging economic importance, this study undertook a focused assessment of the economic feasibility of cage farming in the districts of Ernakulam and Alappuzha. The study used a systematic methodology, relying on primary data collected from a carefully selected sample of 60 farm units, comprising 25 from Ernakulam and 35 from Alappuzha. A pretested interview schedulefacilitated data collection through personal interviews, ensuring a comprehensive understanding of the nuances of cage farming in these regions. The findings of the study show that Asian seabass, Pearl spot, Red snappers, and Tilapia were major farmed species in Ernakulam while pearl spot and Asian seabass were in Alappuzha. The study revealedsignificant variations in average yields, with farmers in Ernakulam having reported an average seabass yield of 975 kg and pearl spot yield of 519 kg, compared to Alappuzha's average yields of 400 kg for both pearl spot and seabass. The net revenue amounted to Rs 3,53,488 and Rs. 46,627 in Ernakulam and Alappuzha district respectively showing cage farming as a financially viable technology in the state. The high benefit-cost ratio of 1.62 and
1.25 for Ernakulam and Alappuzha districts respectively indicated that revenue generated significantly outweighed the costs incurred. Thus, with the implementation of effective management strategies and continued support from governmental and other stakeholders, cage farming has the potential to emerge as a profitable avenue for fish farmers in Kerala. Keywords: Cage farming, economic viability, central Kerala.

WOSC/2024/ABS/300

Seaweed Farming for India's Blue Economy: A case study from Munaikadu Village, Palk Bay, Tamil Nadu

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Seaweed has great potential in pharmaceutical, food, cosmetic, industrial and agricultural sectors. Its farming is widely considered to be a profitable source of income and lucrative livelihood for coastal communities. This paper aims to analyze the capital incurred through seaweed farming by seaweed farmers of Munaikadu, a small fishing village on Tamil Nadu's Palk Bay coast. This paper also assesses the perception of farmers towards diversifying livelihood options, and their participation in the same. A formal household survey was conducted using a structured questionnaire to understand the patterns of income from seaweed farming and allied activities. In addition, a selected group of respondents provided inputs to explore ways to improve this livelihood option. The findings indicated that majority of

respondents combined seaweed farming with fishing, and a few were engaged in non- fishing activities as well. However, seaweed farming was found to contribute the most to household income. Inaccessibility to good quality seeds, restricted access to marketing networks, information, and communication, are the major challenges faced by seaweed farmers. To tackle these issues, the National Centre for Coastal Research (NCCR) has been offering capacity building and hands-on training programs jointly with other governmental and non-governmental stakeholders to train seaweed farmers, enhance farming techniques, and thereby increase yield. These initiatives were taken up by the Government of India as there is a need to take science to the community with regard to efficient seaweed cultivation techniques, importance of sustainability in this livelihood option, and good marketing practices. Key words: Livelihood, coastal communities, Seaweed farming, Palk Bay, NCCR

WOSC/2024/ABS/435

Optimizing Gracilaria salicornia cultivation: A comparative study of horizontal and vertical monoline tube nets within a cage system

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Seaweeds are macroscopic algae, thrive in marine environments, shallow coastal waters, and along rocky shores. These remarkable marine plants are emerging as a versatile and renewable resource, offering a wealth of possibilities in the realms of food, energy, chemicals, and medicines. Their diverse applications span nutrition, industry, biomedicine, agriculture, and personal care, positioning seaweeds as invaluable contributors to various sectors. The escalating growth of seaweed-based industries surpasses the capacity of natural seaweed stocks, compelling the imperative for systematic cultivation of these essential resources to align with industrial requirements. This study focuses on evaluating and contrasting the cultivation of Gracilaria salicornia using horizontal and vertical monoline tubenet methods within a cage system situated in a lined pond. With stocking densities of 0.5 kg vertically (6 numbers) and 0.85 kg horizontally (6 numbers), biomass density experienced a substantial increase on the 45th day, reaching approximately 2.95 kg and 8.61 kg, with corresponding Specific Growth Rates (SGRs) of 3.88% and 5.35%. Notably, the specific growth rate in the horizontal tube net was found to be significantly higher ($p < 0.05$) than thatin the vertical tube net. These results underscore the viability of implementing the horizontal application of the monotube line net method within a cage system in pond environments, ensuring the successful cultivation of Gracilaria salicornia. Keywords: Gracilaria salicornia, Seaweed Farming, Brackish water Pond, Monoline Tube Net, Cage culture.

WOSC/2024/ABS/436

Fuzzy Analytic Hierarchy Process based site selection for brackish water seaweed farming:

A case study in Chengalpattu district, Tamil Nadu

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Seaweeds are nutrient-rich resources that contribute significantly to food, employment and promoting sustainability. The escalating demand for seaweeds, coupled with the insufficiency of natural seaweed sources, necessitates the exploration of seaweed farming. Seaweed farming is being carried out only in marine ecosystems. Brackish water is a potential resourcethat can play a vital role in expansion of seaweed farming. Site selection is a crucial initial step in this process. This study aims to develop a methodology for identifying potential areas for seaweed farming in the Chengalpattu district, utilizing the Fuzzy Analytic Hierarchy Process (FAHP) method. Twenty-two representative sampling locations were identified, and water samples were collected at monthly intervals. Various criteria, namely water quality, environmental parameters, resource accessibility, and constraints, were considered in this study. Each criterion was further sub-classified and mapped in ArcGIS. The result shows the total potential area identified is 141.56 hectares, with 91.93 hectares highly potential and 49.63 hectares moderately potential for seaweed farming. This approach will help meet the growing demand for seaweeds and contribute to sustainable aquaculture practices. Keywords: Brackish water, FAHP, Seaweed farming, Sustainability, Livelihood

WOSC/2024/ABS/437

Towards Sustainable Coastal Aquaculture: A comprehensive study on seaweed distribution in Chengalpattu district, Tamil Nadu

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Seaweeds hold immense potential due to their diverse applications in food, employment, and prosperity. They are a vital source of nutrition and have a wide range of applications including the Food Industry, Cosmetics, Medicine, Agriculture, Industrial Uses, and Biofuel Production. Seaweeds provide livelihoods for coastal communities and contribute to economic growth. For expansion of seaweed farming, understanding their distribution patterns is crucial for obtaining initial seedlings for seaweed farming. Recognizing these factors, this study was undertaken to understand the distribution of various seaweed speciesin the Chengalpattu district. One-year field survey, conducted from November 2022 to November 2023, documented the prevalence and seasonal variations of species including Agarophyton tenustipitatum, Gracilaria salicornia, Ulva lactuca, Ulva prolifera, Ulva intestinalis, and Gracilaria edulis. Concurrent water quality parameters were also recorded to understand the environmental conditions influencing these species. The findings provide valuable insights into the brackishwater flora's ecological dynamics in the region, contributing to the broader goal of sustainable brackishwater resource management. This study emphasizes the importance of continuous monitoring in brackishwater ecology and has significant implications for the future of seaweed farming. Keywords: Brackishwater, Chengalpattu district, Coastal livelihood, Seaweeds, Sustainability,

II: Tourism: Development of Tourism in coastal states and islands and policy.

WOSC/2024/ABS/123

Rip Current Dynamics and Beach Safety: A Multidimensional Approach to Tourism Development

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Rip currents, prevalent along coastal regions, pose challenges to beach safety, necessitating innovative monitoring and detection methodologies. In this comprehensive study, we employ a multi-faceted approach that integrates video-based observations, high-resolution satellite imagery analysis, drifter experiments, and emerging AI technologies to enhance rip current identification and public safety measures. We utilized the Quantitative Coastal Imaging Toolbox (QCIT) on low-cost smartphones and the Video Beach Monitoring System (VBMS) to extract useful information on the existence of rip currents along RK Beach and Rushikonda beaches, respectively. Analysis of multi-temporal very high- resolution satellite imagery over several years demarcates potential rip current zones and studies their seasonal variability. This satellite-based assessment aims to prevent beach drownings by implementing measures such as restricting beachgoers in those regions or deploying lifeguards. At SAC, we developed NavIC drifters, utilizing NavIC signals to track and measure the strength of longshore and rip currents. This enriches our dataset with actual measurements, providing ground truth validation and improving the accuracy of our monitoring systems. Satellite-derived nearshore bathymetry, combined with XBeach modeling, helps us understand rip current dynamics under different wave conditions. Our ongoing work involves the development of AI-based rip current detection algorithms, leveraging machine learning to autonomously identify and predict rip currents. Additionally, we have developed a software solution capable of automatically detecting individuals in dangerous rip current zones, enhancing early warning systems and facilitating rapid response protocols. By integrating diverse data resources and cutting- edge technologies, our study not only contributes to advancing rip current science but also provides actionable insights for policymakers to ensure the sustainable development of tourism in coastal regions.

WOSC/2024/ABS/182

Conservation and Livelihood in Wetland Community- Case Study of Addu City and Fuvahmulah City, Maldives

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Mangrove wetlands, recognized as highly productive ecosystems, are intricately linked to the socio-economic fabric of local communities. This study emanates from the European Union-funded Climate Change Adaptation Project (CCAP) executed by the Ministry of Environment, Maldives. The project targeted the establishment of a community-based wetland management framework in Addu and Fuvahmulah City to advance wetland ecotourism and enhance livelihoods. Specifically, the wetlands conservation component focused on erecting a safeguarded management system for Eydhigali Kilhi and Koattey in Hithadhoo island, Addu City, and Bandaara Kilhi and Dhandimagu Kilhi in Fuvahmulah City. The objectives encompassed the protection of wetlands, biodiversity, developmentof sustainable activities, socio-economic upliftment, and the establishment of a model for protected wetland management. Employing a multistakeholder approach, management plans for these sites were formulated, eco-tourism facilities were developed, and community livelihood enhancement was facilitated – a groundbreaking initiative in terrestrial protected area management. Key project outcomes were the creation of Addu Nature Park and Fuvahmulah Nature Park, symbolizing successful wetland management models in the Maldives. The project's emphasis on training local communities, especially women engaged in wetland resource extraction, aimed at improving skills and creating market linkages for value-added products. This holistic approach integrated livelihood improvements into Nature Park management schemes, highlighting the value of wetlands and their services. The project's impact extended beyond tangible outcomes, fostering strong advocates for wetland conservation in Addu and Fuvahmulah City, effectively challenging the prevailing perception of wetlands as wastelands. Instead, the initiative showcased the economic potential of these ecosystems, transforming community perspectives and emphasizing the intrinsic benefits they offer.

WOSC/2024/ABS/228

Development of Tourism in India's Coastal States, Islands & Offshore

S.P.Rajendran, Vijnana Bharati

Introduction: India is a paradise for Nature lovers. Seashores are easily accessible for people who want to immerse themselves in mother's nature. India offers diverse segments of tourism with its abundant natural, cultural and heritage attractions. With a vast coastline, inland water bodies, forests and scenic hill stations and offers immense potential for all form of tourism. Purpose: Tourism plays a significant role in promoting the destinations and products of the coastal states. Each tourist spots explaining intricate stories from history, mythology, culture, nature, cuisine, art etc. that elicits interest and awe in the visitor about the destination. Method: ♣ Offshore islands can be safely converted into tourist destinations. ♣ Boat transport can start with small boats. ♣ Establishing boat transport from the small island to the main land. ♣ Creation of marine museum. ♣ Creating models of ruined cities along the coast and installing them on the same site. Result: ⌉ Economic benefits of residing people along the coast and

fishermen will improve. 〉 Merging Light Houses and Light Ships along the coast by Ham Radio communication. 〉 The structure of lighthouses and light ships tells their architecture is a scientific message conveyed by the colors in it. 〉 Knowledge of weather forecast and storm warning and its explanation. 〉 The operation and calibration of meteorological instruments. 〉 Development of Tourism sectors: 1)Spiritual, 2)Ancient, 3)Eco, 4)Arts & Sculpture, 5)Traditional sea food, 6)Indian scientific knowledge system, 7)Arts & Crafts, 8)Disaster management, 9)Water sports, 10)Adventure sports, 11)Beach sports, 12) Island Coast inter tourism. Conclusion: The beach has several positive features, including well maintained clean and hygiene restrooms and providing recliner chairs and lifeguard services. Enjoy the sea breeze, watching people surf and enjoying the adventure activities with the assistance of life guards. There is an entry fee for adult, vehicle parkingand Marine Museum charges may also apply. This will generate the revenue for that coastal area districts. The residence of the coastal, island area people gets awareness to keep the coastal area clean and safe.

WOSC/2024/ABS/30

Assessment of wave tranquility aspects for development of Passenger Terminal near Gateway of India Mumbai

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The essential requirements of development of Passenger terminal are the availability of; adequate area for manoeuvring of the passenger vessels and berthing place with sufficient depth, and suitable wave tranquillity, for quick embarkation and disembarkation of passengers. Among the environmental conditions of tides, waves and currents, the wave sometimes becomes the most critical parameter for deciding the location and layout of the facility. The permissible significant wave limit is 0.30m has been considered at the PassengerJetty. In the present paper, the alternative Passenger Jetty locations and layouts were assessednear the Gateway of India, Mumbai with the help of the Mathematical models like MIKE21 SW and BW. Study is carried out in two stages. In the first stage, studies for transformationof wave height and wave direction from deep water to (-) 6 m depth, using spectral wave model MIKE 21-SW. In second stage, studies are carried out for wave propagation tocompute wave heights in the proposed berthing area and in turning circle using MIKE 21– BW Model. Studies with existing condition show that without any break water protection to the berthing area for the passenger terminal, the maximum significant wave heights would be in the range of 0.8-1.2m. The downtime at the berth due to high wave conditions will be nearly 90 days in a year mostly during the monsoon season. The optimum breakwater lengthsof 500m, 550m and 600m and 920m respectively for Options-1, 2, 3 and Option 4 were evolved for providing adequate wave tranquillity conditions at the passenger jetty for safe berthing operations round the year. The reduction in the wave heights near the Gateway of India would be in the range of about 60% to 40% for Options – 1,2 and 3 respectively while for Option -4, it would be about 70% to 80%.

WOSC/2024/ABS/458

Ocean Tourism - A rainbow policy for development of Tourism in Coastal states and Iceland

through Green Sustainable Development and Economic Management

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Coastal states and Iceland have a golden chance to enhance their tourist industries through ocean tourism, which offers a rainbow strategy that integrates economic management with environmental sustainability. Making sure that more people visit oceans for vacation helps local ecosystems and communities thrive may be achieved through green sustainable development techniques. Sustainable transportation alternatives, renewable energy usage, and responsible waste management are just a few examples of how coastal states and Iceland may entice eco-conscious visitors while reducing their environmental impact. Protecting marine life is an important part of an ocean tourism rainbow policy. To safeguard delicate maritime ecosystems, such as seagrass beds, coral reefs, and varied aquatic habitats, coastal states and Iceland can impose stringent rules and restrictions. Responsible snorkelling and diving, together with marine protected zones, can help preserve undersea ecosystems and prevent tourists from negatively impacting these places' natural features. In addition, a rainbow policy for ocean tourism must include community involvement and inclusive economic management as essential components. The equitable distribution of tourism's economic advantages may be achieved by empowering local people through their participation in decision-making, the provision of training programmes, and the promotion of sustainable livelihoods. This method promotes a feeling of responsibility for the environment that is essential to the tourist industry while simultaneously improving the lives of locals. Iceland and other coastal nations can use eco-labelling programmes and certifications to encourage sustainable practices in maritime tourism. Tourists may easily find companies and sites that are committed to environmental responsibility thanks to these initiatives. Such certifications may set a business apart from competitors and appeal to ecotourists who are looking for places that really care about the environment. One of the most important parts of a rainbow strategy for marine tourism is funding environmentally friendly infrastructure. The tourist sector as a whole may benefit from the development of environmentally friendly lodgings, energy-efficient buildings, and sustainable modes of transportation. This is in line with the increasing desire for ethical and sustainable travel experiences while also reducing the environmental effect. Finally, a rainbow strategy for ocean tourism in coastal states and Iceland combines economic management with environmental sustainability in an effort to strike a compromise between the two competing goals of developing the industry and protecting the environment. These areas can become pioneers in responsible tourism by bringing in tourists looking for deep experiences without negatively impacting the environment. They can do this by adopting green practices, putting marine biodiversity conservation first, involving local communities, and investing in sustainable infrastructure. Ocean tourism has the potential to foster economic growth and environmental sustainability with well-planned initiatives.

Environmental Performance Analysis of Coastal Tourism: A Case Study of Velankanni,

Tamil Nadu, India

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India has a coastline that spans 8118 kilometers, a valuable asset for promoting coastal tourism. Velankanni, renowned for its basilica shrine, consistently draws both foreign and domestic tourists, which receives an annual influx of 20 million visitors from over the globe, with 60% of them coming during festive periods, highlighting its global importance. Nevertheless, the distinctive characteristics of the area that it relied on to attract tourists have intersected with the expansion of coastal tourism. Despite the economic advantages that coastal tourism gives to the country, the rapid and uncontrolled spread of tourism in coastal districts has led to an increasing risk of environmental degradation. Tourism has significantly impacted global warming, climate change, and other key worldwide challenges due to its extensive utilization of transportation, water consumption, waste generation, and other factors. The current study aimed to evaluate the environmental performance of tourism in the Velankanni region. The influence of tourism was categorized into four main areas: population dynamics, carbon emissions, land use efficiency, and waste generation. According to the survey conducted in the chosen area, it was found that the average amount of solid waste produced per person per day was 536 grams. Based on the findings of the carbon footprint analysis, it is projected that each tourist in Velankanni coastal tourism contributes GHG 20 emissions of approximately 48.33 kg of CO_2 eq. The analysis also reveals that transportation via roadways and electricity consumption have the greatest impact on the carbon footprint of the tourism industry in Velankanni. Furthermore, land use and land cover change (LULC) analysis reveals that there has been an expansion of built-up areas as a result of tourism activities. The study concluded by providing essential guidelines for effectively transitioning towards sustainable tourism in coastal regions. Keywords: Coastal tourism, Environmental impact assessment, LULC analysis, Sustainable tourism, Key recommendations.

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Climate change impact on coastal erosion and tourism development in Digha coastal area, west Bengal, India

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Coastal areas are the places of human pressure that affect the population and threaten the future economic development of local people. To manage this problem, we are discussed an original theoretical model representing the change in tourism and coastal erosion using a veryhigh resolution planetscope satellite Image using Python in the Digha coast, west Bengal. The resolution of the image is 3.7 meters. The data was used from the 2016 to 2023 period to find out how much area was eroded due to sea level rise and tourism activity. In Python, we calculate the NDWI for land and sea area separation and the coastal area extract using Green and NIR bands. A total of nearly 7 km of coastline was analyzed for observation of erosion frequency. The methodology comprises collecting information on quantifying coastline variation, and measuring the field to validate data using planetscope satellite data., It found Digha coast has a high density in accommodation distribution and daily rates practiced in tourism and beaches, have a high risk of erosion. Coastal erosion has affected tourismdevelopment in Digha Beach. The results indicate that there is a clear concentration of tourist accommodations in areas changed by coastal erosion. So, there is a direct connection betweenlocal tourism system income and the beaches with problems with coastal erosion. Scientific technology will be the best technology to restore the coastal area; such as beach enhancement, blue economy, solid embankment, and plantation, Proper coastal restoration strategies and policies should be applied to this highly tourist coastal area and save that area from threat and development. Keywords: Coastal erosion, coastal restoration, tourism, policy implication, Economic development, sea level rise.

WOSC/2024/ABS/457

Marine Protected Areas in the Mediterranean Sea: Economic and Social Overview

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The Convention on Biological Diversity (CBD) set a goal in 2022, requiring signing partiesto ensure effective conservation of at least 30% of the world's coastal areas and oceans by 2030. A failure to achieve this target poses a significant risk to global biodiversity. In 2020, only 8.33% of the Mediterranean Sea was officially designated as a Marine Protected Area (MPA), highlighting the need for Mediterranean governments to achieve the effective conservation of an additional 20% of the sea by 2030. Emphasizing the importance of MPAs, the research argues for their role not only in environmental protection but also in promoting development and food security. The study, evaluating the link between MPAs and the Blue Economy in the Mediterranean, reveals that as of 2022, 9.8% of the Mediterranean Sea is under protected status, a modest increase from 2020. However, the area of fully protected zones, crucial for ecological and socioeconomic benefits, is a mere 0.12%. The distribution ofprotection zones is highly uneven, with 99% located in European waters, raising concerns about the adequacy and equity of protection. The research identifies a lack of significant ecological effects in Mediterranean

MPAs due to insufficient protection and networking. Key species like the fin whale and essential fish species such as anchovy, sardines, and shad have less than 1% of their distribution fully protected, exposing them to overfishing threats. Additionally, the study highlights the economic importance of tourism over fishing and aquaculture in Mediterranean countries, with over 90% of tourists visiting the Mediterranean Sea basin. The conservation of the sea through effective MPAs is deemed vital for sustaining the regional economy.

WOSC/2024/ABS/81

Tourism of an environmentally challenged island: perspectives of Mousuni,Sundarbans

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Tourism of an environmentally challenged island: perspectives of Mousuni, Sundarbans Kamalika Mondal[1] and Kanailal Das[1] [1]Eastuarine and Coastal Studies Foundation, Howrah, West Bengal. Island tourism is an integral part of marine tourism and it is an important part of international tourism consumption. This paper takes the example of tourism in Mousuni island of Indian Sundarbans to identify the impacts on the livelihood of local people with consideration of threats from cyclone and embankment breaching. Successive cyclones of the last decade has caused salt water intrusion in the island, which limited the opportunities of agriculture that paved development of tourism in the island as a supportive livelihood for the locals. This study is based on primary data by conducting questionnaire surveys among the local people and 23 resorts authority. Secondary data are used for descriptive, cartographic method and maps were drawn using the QGIS software version 3.14 for providing the perspectives of bottlenecks of the island. The map shows that the total eroded area and accreted area of this island are respectively 3.82 sq km and 1.07 sq km. Every resort has double bed room and tent arrangement but rooms are not totally brick built. Results showsthat above 100 local people are directly engaged with resorts as labour during peak season (October to February). The per head wage of the labour is Rs 500. Many people are also indirectly engaged in some tertiary activities with the growing tourism in the island that have financially benefited the local to some extent. But the local perception also tells about a cultural conflict. The tourism practice is hindered as the island is environmentally challenged by sea level rising (3.14 mm/year), embankment breaching, devastating effect of cyclones, frequently occurence of flood. Therefore, sustainable tourism should be developed by following CRZ rules and constructing concrete embankment, creating buffer zone with mangroves, prohibiting digging sand from sea beach, and more participation of local community.
Keywords: Embankment breaching, Coastal Regulation Zone, Sustainable tourism.

III: Ocean services: existing and required.

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Operational Oil Spill Advisory Services – Existing and Required

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Abstract Oil spill advisory services play a crucial role in preventing, mitigating, and managing the impact of oil spills on the environment. Indian National Centre for Ocean Information Services (INCOIS) has an operational Online Oil Spill Advisory (OOSA) system at its workplace. INCOIS OOSA is an integrated set up of oil spill trajectory model, General Ocean circulation models, atmospheric models and Geographical Information System (GIS). OOSA v4.0 has the better representation of oil drift patterns in web map services. The user can generate the oil drift patterns within the domain 40E to 120E, 30S to 30N. The users can interpret the trajectory patterns using the video/play options provided. The quantitative status of the spilled oil pollutant is now made available for the users in the form of graphs. The users can avail this service at https://incois.gov.in/portal/osf/oosa.jsp . Apart from this, it is required to develop oil spill response strategy (OSRS) maps for the effective planning of oil spill response operations. In this paper we have explained the method of preparing OSRS maps for hypothetical oil spill events off Gujarat region. This paper emphasizes the need of OSRS maps, the required service in-addition to the existing oil spill advisory services of INCOIS. In addition a comprehensive approach to oil spill advisory services should encompass preparedness, response planning, ongoing research, international collaboration, community engagement, and the integration of advanced technologies to address both existing and emerging challenges in oil spill response management. Keywords: Spill response, oil spill, OOSA, INCOIS, Mapping.

WOSC/2024/ABS/227

WebGIS Application for Ocean Information and Advisory Services from Indian National Centre for Ocean Information Services

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Geospatial technology is a vital platform for the generation, editing, analysis, visualization, and sharing of large amounts of spatial data providing a vital opportunity for decision- making and planning purposes. The augmentation of advanced ICT tools with the latest geospatial technology will enhance the capability of catering geospatial information to users more effectively. The popularity of location-based web and mobile applications is increasing day by day. The visualization of locations is relatively complicated than the tabular data. Specialized software is required to build a WebGIS application providing easy access to geospatial data to a large number of users. THREDDS Data Server (TDS) is an open-source web application integrated with Apache Tomcat web server that maintains metadata and caters to scientific datasets using a variety of remote data access protocols such as OPeNDAP, OGC WCS, WMS& HTTP. This web server supports a host of data services, including robust dataset

aggregation capabilities. This facilitates the TDS to aggregate a collection of datasets into a single virtual dataset to simplify user access to that data collection. Time series data is stored in MySQL as an object-oriented relational database management system (ORDBMS). As a tool for effective dissemination and management of information over the Internet, ORDBMS has proved to be timely and cost-effective. Web-based Geographic Information System (WebGIS) can be used for displaying spatial information and can be accessed by any user over the Internet. A graphical user interface is needed for this kind of application, which facilitates the users to identify the place of interest with a single mouse click. These free open-source software and servers can be effectively used in WebGIS technology. This paper reviews easy-to-use methodology to create a WebGIS application with basic functionalities such as pan, zoom, home, info window, measure, legend etc. It also demonstrates the versatility of these technologies in ocean information and advisory services generated by INCOIS for utilizing GIS, Remote Sensing techniques and displaying the results through a WebGISplatform.

WOSC/2024/ABS/235

Significance of OSF & PFZ advisories in Economic improvements of fishermen of Uttara Kannada District, Karnataka

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Karnataka has a coastal stretch of 320 kms and is divided in to 3 Coastal Districts namely Uttara Kannada (160 kms), Udupi (62 kms) and Dakshina Kannada (98 kms). INCOIS Hyderabad provides Ocean State Forecast (OSF) and Potential Fishing Zone advisories to fishermen of Uttara Kannada region, as of now more than 4000 fishermen are using services provided by INCOIS. Fishermen interaction meetings were conducted in major fish landing centres like: Karwar, Tadadi, Honnavar and Bhatkal from past few years, based on the feedback fishermen are of the opinion that accuracy level of services of INCOIS are more than 90%. There is increase in 30% -40% fish catch, including the early warnings of extreme ocean events like tsunamis, tidal waves and storm surges. There is more demand for PFZ advisories from Honnavar and Tadadi because they are getting good quantity of fish catch in forecasted areas. Food availability is the major factor controlling the fish production. There is a demand from fishermen for species specific advisories. A study on the food and feeding habits can shed a glow on the habit, habitat, energy intake and interactions in ecosystem, which helps in developing Ecosystem Based Fisheries Management (EBFM) models. In this direction study was undertaken to study gut content analysis of Indian Mackerel Rastrelliger kanagurta (Cuvier 1817) and analysis of plankton availability in fishing area. The periodic examination of stomach contents of Indian mackerel indicated as a planktonic feeder. In future we can establish a good advisory for Indian mackerel particularity in West coast of India.

WOSC/2024/ABS/276

Ocean science and technology for offshore and coastal Industry-demanded consultancy projects/services

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Deep understanding about ocean state in various perspectives- climatological, physical processes, nowcasting and forecasting- is of importance for better operational planning and safety of offshore and coastal industries/boards. Indian National Centre for Ocean Information Services (INCOIS) is the only institution of its kind in the Indian Ocean region to provide ocean services over two decades. Offshore industries, shipping industry, port&harbours and maritime boards, in a commercial manner, also are it's constant users/clients for last a decade. All these firms also avail oil-spill trajectory predictions, search and rescue aid tool, forecast along ship-routes, sea state forecast for port and harbours etc. The assessment of wind potential in the ONGC western offshore field was done and supplied. Projects on Inland Vessel Limits (IVL) zonation and demarcation and its dynamic versions were done for gazette purpose of five different port authorities and maritime administrations for different seasons, which in turn, helps them in enhancing their economy/business through safe port operations in the context of 'Sagar Mala' project of Ministry of Shipping. Specialised location- specific daily operational forecasts have been issued to M/S ONGC and M/S AFCONS. Ocean-met desktop studies on return period, extreme value analysis, coastal and offshore platform design parameters etc were done for ONGC. Studies on design parameters based on wave, swell, wind and on hypothetical oil-spill trajectory prediction were also executed for JNPT. A project is underway for Adani Vizhinjam port for providing them consultancy on oceanic conditions by establishing observational platforms. Clients list includes well known marine companies/clients such as L&T, Fugro, Ocean Sparkle, COWI India PVT Ltd. Periodic industry meets/workshops are conducted to fetch further user-requirements, and also to survey and collect the feedbacks on our consultancies to better refining and further developing and expanding the offshore industry-specific projects from INCOIS. Scientific aspects of such projects would be presented and discussed.

WOSC/2024/ABS/327

Quantifying Methane and Nitrous Oxide Fluxes in Coringa for Enhanced Climate Change Mitigation Strategies

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Mangroves, integral to blue carbon ecosystems, play a critical role in biomass enhancement and biodiversity enrichment. Being potential carbon sinks, mangroves also release greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), contributing significantly to the global emissions. To address potential overestimations in carbon inventories, a thorough investigation focused on CH4 and N2O emissions from sediments and creek waters in Coringa was conducted in September 2022 and March 2023. GHGs flux measurements utilized static chambers for soil assessments and bulk conc. measurements for surface waters. N_2O and CH_4 conc. in March 2023 ranged from 80.7nM to 174.5nM and 32.4nM to 596nM, respectively, whereas fluxes were lower in September 2022. The study revealed strong seasonal variations, identifying mangrove soils as a sink for N_2O but a source for CH_4. Conversely, surface waters, particularly creeks, exhibited effluxes of both CH_4 and N_2O. These findings underscore the complexity of GHG dynamics in

mangrove ecosystems, emphasizing the necessity of considering regional variations in evaluating blue carbon ecosystems. The study provides crucial insights for climate change mitigation strategies, underscoring the importance of targeted research in mangrove ecosystems and climate change. Keywords: Mangroves, GHGs, climate change, Blue carbon, Coringa.

WOSC/2024/ABS/358

Evaluation of HWRF-HYCOM coupled simulations of selected North Indian Ocean TCs from the recent past.

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North Indian Ocean (NIO) Tropical Cyclones (TCs) expose India/"/gs long, densely populated coastline to associated disasters such as strong winds, storm surges and heavy rainfalls. Rapid changes in TC intensity increase the challenges in accurately forecasting TCs in the basin. We evaluate the performance of the HWRF (Hurricane Weather Research and Forecasting) model for four intense cyclones (SuCS Kyar, ESCS Maha, VSCS Bulbul, and VSCS Vayu) that occurred in the NIO in 2019. These TCs underwent rapid intensification (RI). Validation of the track data against the Indian Meteorological Department's (IMD) best track data revealed that model runs initiated before the TC's Lifetime Maximum Intensity (LMI) had higher errors than runs started after LMI. The increased error rate in runs started before LMI is linked to the challenges in accurately predicting the timing of RI by the model. Most HWRF model runs captured the intensification trends during the RI phase, but the predicted magnitude fell short of the observed magnitudes. These RI prediction errors significantly affected the magnitude and timing of LMI. Delayed LMI timing extended the intensification phase into the weakening phase, resulting in a positive bias in the cyclone's intensity forecast during the weakening phase. We have examined the upper ocean thermal properties, such as sea surface temperature (SST), isothermal layer depth (ILD), tropical cyclone heat potential (TCHP), and depth of the 26°C isotherm (D26), from ocean component against ARGO data that showed significant improvement in SST accuracy after coupling with HWRF. The uncoupled-HYCOM and coupled-HYCOM simulations accurately represented the heat content; however, underestimation of ILD at most ARGO locations in both simulations resulted in high RMSE values. Validation of subsurface temperature profiles indicated a positive bias in the top 50 meters, which became a negative bias with increasing depth, peaking at 75 meters. Both positive and negative biases were more pronounced in the Bay of Bengal compared to the Arabian Sea. Negative biases in HYCOM SST compared to

NOAA SST were significantly reduced in areas surrounding the storm after coupling. However, positive biases developed along the storm track. These changes in SST biases after coupling in HWRF are apparently due to a positive bias in shortwave radiation in the storm's surrounding areas and a negative bias in TC intensity along the TC track. The underestimation in TC intensity led to decreased upper ocean mixing, reducing ocean cooling in response to

excessive shortwave radiation.

WOSC/2024/ABS/391

Satellite-Retrieved Long-Term Trend Analysis of Algal Blooms in Indian Coastal Waters

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The increasing recurrence and intensity of phytoplankton blooms in the Indian coastal waters result in ecological disturbances and deterioration of water quality. Understanding the long-term trend of bloom is crucial for developing effective monitoring strategies. In this context, satellite remote sensing has been proven to be valuable for the synoptic monitoring of phytoplankton blooms. This study presents a comprehensive analysis of phytoplankton blooms in Indian coastal waters using satellite data (MODIS-Aqua) spanning 2003-2023. To identify the bloom hotspots, available secondary data (literature) on phytoplankton biomass (chlorophyll-a) and abundance during algal bloom events was mined from the coastal waters of the western Bay of Bengal (BoB) and the eastern Arabian Sea (AS). The analysis resulted in the identification of nine locations as recurrent bloom sites, including Gopalpur, Kalapakkam, Gulf of Mannar, and Palk Bay on the east coast, as well as Kochi, Vizhinjam, Mangalore, and Goa on the west coast of India. A relatively high dynamic range of chl-a was observed in the coastal waters of AS (0.07−721 mg m-3) as compared to BoB (0.2−238 mg m-3). Subsequently, bloom events were demarcated from satellite-retrieved daily chl-a estimates by fixing a cut-off value of 1 mg m-3 and
1.30 mg m-3 for the east and west coasts, respectively, which were obtained through quartile analysis of the anomalies from daily climatology. The long-term analysis spanning from 2003 to 2023 revealed a noticeable upward trend in bloom occurrences for both coasts, with comparatively higher frequency on the west coast. The match-up analysis revealed efficient detection of bloom by MODIS-Aqua. Among the bloom hotspots, the coastal water of Kerala (eastern AS) is reported with higher frequency of bloom occurrences. The outcome of this analysis is of immense importance in improving operational services on algal bloom, potential fishing zones, water quality, and ecosystem trophic status.

WOSC/2024/ABS/404

Coastal Ecosystem Services of the Coringa Mangrove Ecosystem: A Comprehensive Assessment, Valuation, and Ecosystem-Based Management Strategy

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This study presents a scientific exploration of the coastal ecosystem services provided by the Coringa Mangrove ecosystem, offering a precise evaluation, valuation, and strategic framework for ecosystem-based management and nature-based solutions. The mangrove ecosystem plays a vital role in storing carbon, providing food and livelihoods for coastal communities. The benefits are not properly valued or accounted for and it is important to understand and value the services provided by coastal mangrove ecosystems for their effective management. The valuation of ecosystem services is a complex process as it includes several dimensions (ecological, socio-cultural, and economic), and not all of these can be quantified in monetary units. Employing rigorous methodologies aligned with the Millennium Ecosystem Assessment (MEA), The Economics of Ecosystems and Biodiversity (TEEB), and the Common International Classification of Ecosystem Services (CICES), the research delves into more than 40 services, including coastal protection, water quality regulation, fisheries support, carbon sequestration, and cultural and recreational values. The assessment integrates expert-based participatory approaches to quantitatively capture socio-cultural and economic dimensions. Results highlight nuanced dimensions of the ecosystem services, emphasizing the need for recalibration and recognition of their true ecological and economic worth. In considering the way forward, the study outlines a scientific roadmap for advancing ecosystem-based management and nature-based solutions. It underscores the integration of findings into policy frameworks, emphasizing sustainable practices that harmonize ecological conservation with socio- economic development.

WOSC/2024/ABS/411

Operational Ocean Color Automatic Data Processing Chain for North Indian Ocean

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Remote sensing has been proven to be a reliable data source for oceanographic research and operational oceanography. The Indian National Centre for Ocean Information Services (INCOIS) is disseminating ocean colour remote sensing based operational products on different marine ecological services to a wide array of beneficiaries and continuously researching for improved/ new products. The marine ecological services of INCOIS include the marine fishery advisory service, algal bloom information service, and coral bleaching alert system. Daily generation of these services needs a seamlessly curated ocean remote sensing data flow. To cater to the needs of the aforementioned and several other international initiatives, an Automatic Data Processing Chain (ADPC) has been developed. This study provides an overview of the INCOIS-ADPC, its capabilities and towards the acquisition of raw data from operational satellites (MODIS-Aqua, and VIIRS-SNPP), processing, and dissemination of value-added data products for near real-time generation of aforementioned marine ecological services. INCOIS-ADPC uses SeaDAS software for processing ocean colour data (Level-3 mapped products in NetCDF4 format at 1 and 4 km resolution). The key products generated by

ADPC for the North Indian Ocean region are Chlorophyll concentration, Sea Surface Temperature, Kd_490, Particulate Inorganic Carbon, Particulate Organic Carbon, Aerosol Optical Thickness, PAR, Phytoplankton group/species/size class, Total Suspended Matter, and Bloom Indices. In addition, ADPC also generates roll and anomaly products. Few products are being provided to different Indian Ocean Rim countries, such as Sri Lanka, Iran, Kenya, Maldives, Oman, Tanzania, and Thailand. Other than all the primary products, absorption (a, aph, adg using GIOP model), backscattering (bb, bbp using GIOP model), and radiance (RRS, Lw, nLw) products are also being generated for researching ocean bio-optics. The ADPC is under a continuous process of improvement in terms of performance and upgradation by including new products/satellite data.

WOSC/2024/ABS/428

Application of AI/ML techniques in improving the efficiency of potential fishing zone advisory

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Marine resources are an important component which contributes to the GDP of India. Fishery contributes to the livelihood of approximately 16 lakhs families in this country. Therefore it is essential to provide advance information on potential fishing zones (PFZ). Several studies have shown that high sea surface temperature (SST) gradient and high chlorophyll concentration in the ocean are the prospective areas for pelagic fish catch. ESSO-INCOIS provides advisories on PFZ on a daily basis using remotely sensed SST and chlorophyll-a data. However, neither this advisory gives any information about the probable quantity of the fish, nor it gives any indication about the probability of fish catch for the next few months. Our aim is to apply AI/ML techniques to improve the efficiency of PFZ advisory. Improvement of the PFZ advisory would help the fishing community by reducing search time and the exertion involved in locating fishing areas. A hybrid decision tree model is developed combining Decision tree model and Naïve Bayes method for characterizing PFZ in the Indian Ocean. If SST gradient, persistence of SST gradient and chlorophyll concentration of any PFZ are given as the input variables, this hybrid decision tree can classify the corresponding PFZ in terms of low, medium or high category of fish catch. Analyzing the available fish catch data and thermal fronts, it is seen that there are few locations in which thermal fronts are present for consecutively several months. This leads us to hypothesize that fish catch availability will be certain and more in those areas after few months. A probabilistic model is used to predict the probable fish catch from the recurrence of thermal fronts in the previous months. This model can generate an extended PFZ advisory which can predict the probability of fish catch for the next couple of months.

WOSC/2024/ABS/434

Ocean Accounting for Sustainable Development and Governance

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India, with its extensive 7517 km long coastline and with multitude of ecosystem services it provides, it is essential to frame a sustainable ocean development that balances ocean resources and health. Aligned with international statistical standards like the System of National Accounts (SNA) and the System of Environmental-Economic Accounting (SEEA), the ocean accounts framework establishes a standardized structure for compiling environmental, economic, and social information related to coastal and ocean environments. The SEEA framework not only estimates the Net Ocean Product but also the Gross Ocean Product providing a picture of the natural assets, physical and monitory accounts including fisheries, oil and gas, and other minerals. Recent estimates of Natural capital assets of the Indian coast and marine ecosystems valued 1.5 trillion, of which provisioning services account for 26 per cent, regulating services account for 44 per cent and coastal recreation accounts for 30 per cent of the total value. The estimated total coastal assets for India (Rs. 1.5 trillion) is approximately 3.2 per cent of the Net National Product (NNP) in 2012-13. However, these estimates underestimate the natural assets due to challenges in data availability, monitoring and baseline changes. To achieve these goals, it is essential to develop environmental assets, both physical and monetary accounts, understand the flow of resources to the economy, and establish ocean satellite and governance accounts linking to the ocean accounts framework. By integrating environmental, economic, and societal dimensions, this approach provides policymakers and stakeholders with valuable information for making informed decisions regarding the sustainable management and use of ocean resources.

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WOSC/2024/ABS/85

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Seasonal forecasting of Marine Heat Waves: Translating research to ocean services

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The Monsoon Mission Climate Forecast System (MMCFS) has been instrumental in providing seasonal forecasts since 2011. The forecasts include long-range forecasts of rainfall, the El-Nino and Southern Oscillation (ENSO) state, the Indian Ocean dipole, surface air temperature, etc. Marine heatwaves (MHW) are known to disrupt the marine ecosystem and can potentially impact the human population living in coastal areas. Considering an increase in the frequency, intensity and duration of MHW under a warming scenario, their reliable seasonal forecasts can be vital for risk mitigation. In this study, we assess the capability of India's operational seasonal forecast system in predicting marine heatwaves at different lead times. Using thirty-seven-year-long hindcasts from the MMCFS, it is found that the model possesses significant skill at simulating the MHW duration, intensity, and frequency. As is the case with rainfall over India, MHW skill also depends on large-scale drivers of tropical variability such as the ENSO. Sub-surface ocean heat content is identified as a possible source of MHW predictability. More research at sub-seasonal time scales is required to assess the capability of the model to forecast MHWat weekly time scales, which will possibly result in seamless sub-seasonal to seasonal MHW forecasts. Coupled model development activities, including increased ocean model resolution and improved model physics, are underway to enhance the indigenous MHW forecasting capabilities. This study paves the way for operationalizing the MHW forecasts in India. Keywords: Marine heatwaves, seasonal forecasts, coupled ocean- atmosphere modelling.

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EXPLOITATION OF AI IN OCEANOGRAPHY FOR NAVAL OPERATIONS

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The maritime domain plays vital role in global trade, transportation, and security. Understanding and predicting the ocean environment is crucial for Naval operations. Ocean parameters also play a vital role in global climate, ecosystem dynamics and human activities. Traditional in-situ methods for measuring these parameters have limitations in terms of special and temporal coverage. Moreover, long period average (LPA) is not indicative of the increased occurrences of extreme weather events. Although satellite data offers a promising solution for global and continuous monitoring, current satellite-based methods also face challenges in accuracy and resolutions. In recent years artificial intelligence has emerged as a powerful tool with the potential to revolutionise oceanography by providing insights into complex sub surface processes thereby improving decision- making capabilities. The Naval oceanographic inputs are generated using Ocean Models. However, the ever- evolving Maritime landscape demands a more robust approach as far as Naval operations are concerned. Accurate and real-time information about the ocean environment is paramount for mission success, safeguarding personnel and securing practical objectives. This concept paper explores the potential of AI and associated challenges in enhancing Ocean state forecasting capabilities in IN operations. The proposed thesis can offer significant advantages for Naval operations such as anti-submarine warfare (ASW), search and rescue (SAR), OSF etc. A comprehensive research program focused on developing and implementing AI powered solutions for operational oceanography is also proposed. The research will focus on developing improved decision-making aides/ tools for Naval Commanders. At the backend, these aids will analyse accurate and real time oceanographic information from multiple sources thereby enhancing operational effectiveness, reducing risks and increasing cost efficiency. Thus, by leveraging the power of AI, the IN can gain a significant operational advantage in the present complex and dynamic Maritime environment. This concept paper proposes a road map to unlock the transformative potential of AI for Naval oceanography contributing toa safe, secure and sustainable future for the maritime domain.

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Evaluating Surface Heat and Momentum Fluxes in the Indian Ocean: A Comparative Analysis of Reanalysis Products and their Temporal Trends.

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The global modelling community utilises atmospheric reanalysis products because of their high spatial and temporal resolution and long-term data availability. These products are necessary for carrying out model simulations, model spin-up, downscaling and even conducting an ocean state analysis. In this study, an assessment of temporal variability of air temperature (Ta), specific humidity (Qa), wind speed (WS), net shortwave radiation (SWR), net longwave radiation (LWR), momentum flux (Mo), and net heat flux (Qn) available from seven atmospheric reanalysis products (TROPFLUX (TROF), OAFLUX (OAF), NCEP/DOE AMIP-II Reanalysis (NCEP), JRA55 do (JRA), ERA5 (ERA), MERRA2 (MERRA) and NCMRWF-IMDAA (IMDAA)) has been carried out across the Tropical Indian Ocean (TIO)

against existing in-situ observations from RAMA and OMNI buoys moored at different regions of TIO. The study highlights the strengths of various datasets, over four major regions such as Arabian Sea (AS), Bay of Bengal (BoB), Central Indian Ocean (CIO), and Southern Indian Ocean (SIO). It is evident that seasonal, intraseasonal and interannual variation of surface parameters were well captured by flux datasets. The Mo value exhibited an approximate increase of ~0.047 N/m2 from AS to the SIO. Additionally, we used CCMP wind product and an experimental daily heat flux product (SatFlux) to assess the capability of reanalysis products in reproducing the spatial seasonal variability for Mo and Qn. IMDAA consistently underestimates Mo, while ERA and TROF display better correlations with CCMP wind vector data. Except IMDAA, restof the reanalysis products underestimated Qn across all seasons in the TIO. A decreasing trend in Qn is observed across most datasets, with IMDAA showing the highest annual mean value. In the context of SIO, it's worth emphasizing that the yearly mean of Qn across all datasets closely approximates zero, demonstrating periodic variations that oscillate between positive and negative values over a span of decadal scales.

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Perigean Spring Tides – the need for close monitoring along the Indian coastline

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Every year, on 6-8 occasions, the tidal range is more than normal the world over due to the perigean spring tides (when the moon perigee and full moon/new moon phases are close to each other in time) but its impact varies from place to place. India has a long coastline of around 7500m with some lowlying coasts as well as distantly located low lying islands, where there could be some possible impacts, requiring close monitoring. The most common and noticeable impact of this phenomenon is nuisance flooding causing public inconveniences, and which could also impact coastal infrastructure to some extent. This could compound the situation at such locations during the cyclones (and storm surges), swell events and southwest monsoon season, as well as cause increased wave induced rip currents at the beaches. It is thus important to study the impacts of such events along the coastline of India. The regions where this is presently happening need to be closely monitored, as they are the locations which could face the first impacts of the sea level rise, much earlier than the other locations. There are very few studies concerning perigean spring tides along the Indian coastline. The Indian National Centre for Ocean Information Services (under the Ministry of Earth Sciences) is providing 7 day predicted astronomical tides for 175 locations, along with the important moon phases such as perigee, full moon, new moon, apogee, first quarter and last quarters. INCOIS also has deployed 36 tide gauges along the coastline to improve these services as well as to monitor the sea level in real time for storm surges and tsunamis. The main users of the predicted astronomical tide services are the major/minor ports of India. These services are being constantly improved based on the close interaction with the user communities concerned.

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Upper ocean response to tropical storm Biparjoy in the Arabian Sea based on moored buoy observations

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An Extremely Severe Cyclonic Storm (ESCS) 'Biparjoy' crossed very close to moored buoy locations in the Arabian Sea during 10th-11th of June, 2023 which had a landfall on 15th June 2023 near Saurashtra and Kutch. The complete cycle of upper ocean response at different stage was examined. The significant changes are observed in the surface meteorological parameters (wind speed, sea level pressure, rainfall etc.) and oceanic parameters (wave, sea surface temperature) under the influence of ESCS by the moored buoys; AD06 and AD07 deployed by NIOT, Chennai. The analysis shows that on June 11, 2023, there was a low pressure drop of 965 hPa, a maximum rainfall of 166.7 mm/day, and a maximum wind speed of up to 90 km/h with gusts up to 153.7 km/h at the AD06 buoy position. Similarly, AD07 moored buoy also recorded maximum wind speed of 61.6 km/h on 9th June with SLP drop of 998.8 hPa on 10th June and 35.6 mm of maximum rainfall on 11th June 2023. Sea surface temperature dropped ~4°C (~2°C) under the influence of the cyclone on 12th June (10th June) at AD06 (AD07). However, The TCHP is ~120 kJ/cm2 (95 kJ/cm2) in AD07 (AD06) located in the east Central Arabian Sea which is favorable for intensification of the cyclone. The buoy AD06 (AD07) also recorded significant wave height of ~8.9 m (7.29 m) and maximum wave height of 14.6 m (11.46 m) on 12th (10th), June 2023 indicate the severity of the sea condition during the cyclone passage. The research has unequivocally demonstrated the value of the met-ocean buoy network in monitoring cyclones by providing real-time surface meteorological and oceanographic data. Additionally, this service will facilitate the integration of this data into the operational models of multiple organizations, allowing for more precise forecasting of cyclonic weather systems.

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Unravelling the Dynamics of Indian Mackerel Abundance: A Comprehensive Analysis of Oceanographic Influences Using GLM, GAM, and BRT Models

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The Indian mackerel stands as a pivotal small pelagic fish in the southeast Arabian Sea, particularly along the coast of Kerala. Despite its significant commercial value, endeavours to forecast the abundance and availability of this species in Indian waters have been notably limited. This study delves into the intricate relationship between diverse oceanographic parameters and the abundance of Indian mackerel, employing non- parametric statistical models such as the generalised linear model (GLM) and generalised additive model (GAM), alongside the machine learning methodology using the Boosted Regression Tree (BRT) model. The GLM elucidates the Poisson distribution and necessitates the conversion of dependent variables to linearity. Conversely, the GAM offers the advantage of dispensing with any predetermined assumptions regarding the functional form linking the two sets of variables, as these relationships are modelled with smooth functions. Both GLM and GAM were harnessed to delineate the relationship between species landings, the response variable, and satellite-derived parameters, serving as predictors. This modelling utilized 12 years (1995-2012) of fish catch data and environmental variables, encompassing rainfall, mixed layer depth, seawater temperature at 50 meters depth, dissolved oxygen, chlorophyll, net primary productivity, and

salinity at 50 meters depth. The analysis uncovered positive correlations between rainfall, primary productivity, and chlorophyll, while seawater temperature at 50 meters depth exhibited a negatively significant correlation with mackerel landings. Relative Importance (RI) plots highlighted primary productivity, seawater temperature at 50 meters, and mixed layer depth as the most pivotal variables in training the model. Keywords: Indian mackerel, abundance prediction, Poisson distribution, non-parametric statistical models, correlation analysis, relative Importance (RI) plots.

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Ecological Dynamics and Predictive Factors of Crambionella orsini Jellyfish Blooms in the Western Indian Ocean

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The distribution of jellyfish Crambionella orsini is mostly confined to the Western Indian Ocean, encompassing the Arabian Sea, Gulf of Oman, Persian Gulf, Red Sea, and the Strait of Hormuz. Notably, blooms of these jellyfish are frequently observed in the waters of Oman, Iran, Pakistan, and India. This study tried to find the factors affecting the jellyfish blooms and its restricted geographical distribution. The period of July to August witnesses elevated sea surface temperatures (SST) and salinity in the Persian Gulf, Gulf of Oman, and the Red Sea, creating favorable conditions for the strobilation of polyp bends releasing a substantial number of ephyrae into the Arabian Sea. Additionally, the presence of persistent warm core eddies near Lakshadweep may influence the movement of jellyfish. The wind-induced upwelling phenomena in the Arabian Sea can impact nutrient supply through advection to other areas, promoting phytoplankton development. The proliferation of artificial structures in the Persian Gulf and Gulf of Oman potentially supports polyp attachment. Juvenile jellyfish are transported to various locations by strong currents, maturing into adults during the journey. They tend to aggregate in locations with abundant food and favorable conditions. Key factors such as SST, chlorophyll levels, Ekman transport, currents, and winds could help in predicting jellyfish blooms.

WOSC/2024/ABS/375

Navigating the Future: Advancing Fisheries Predictions with a Front-to-Fish Approach

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Oceans, vast reservoirs of abundant fish and marine life, exhibit varying degrees of exploitation and utilization potential across regions. The dynamic nature of fishing grounds, influenced by factors like climate change, environmental conditions and fishing intensity, necessitates an understanding of their formation mechanisms. A comprehensive understanding of the complex interaction between environment, biology, and technology is crucial for accurately predicting fishing grounds, a key prerequisite for sustainable fisheries. The foundation of fisheries forecasting lies in discerning the relationships between fish movement, biology, and environmental conditions, enabling predictions of fishing grounds, periods and potential catch. Commonly identified fishing grounds situated along current boundaries, upwelling areas, within eddies, on continental shelves and around reef banks. The application of remote sensing technology has significantly enhanced the real-time forecasting of fisheries. It can portray environmental variables directly linked to oceanic productivity across vast expanses of the ocean effectively identifying potential fishing grounds, often manifesting as ocean fronts. Oceanic fronts usually serve as indicators of current boundaries, upwelling or eddies where optimal conditions for establishing food webs exist, characterized by rich nutrient content, high primary productivity and an abundance of bait organisms. The Indian National Centre for Ocean Information Services (INCOIS) currently offers fisheries advisories, in the form of Potential Fishing Zones, aiding fishers in locating abundant fish areas while saving on both fuel and time. INCOIS is progressing towards upgrading its services, focusing on species and catch forecasts. The approach involves tracking oceanic front persistence and studying productivity scaling over time, utilizing environmental data from remote sensing, field observations, and food web studies. Anticipated outcomes include a deeper understanding of ocean biochemical phenomena in fronts, leading to more precise predictions of fishing grounds, species and fisheries catch These advancements aim to contribute to sustainable fisheries management and promote economically and fuel efficient fishing practices.

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Application of random forest algorithm for prediction of Hilsa (Tenualosa ilisha) catch in the north-western Bay of Bengal

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Hilsa shad (Tenualosa ilisha) is considered one of the most commercially important anadromous fish species not only in India but in the entire Indo-Pacific region. Around 15% - 20% of global Hilsa catch is contributed by India of which 90% comes from the north-western part of the Bay of Bengal and the adjoining Hooghly river-estuary. It is reported that the distribution and catch of Hilsa are influenced by various oceanic and meteorological parameters. In the present study, a machine learning algorithm (Random Forest) has been applied to predict the Hilsa catch using different parameters (salinity, coastal current, wind) and their impact on the catch variability. Daily Hilsa catch data along with the aforesaid parameters were collected from 2012 – 2016 for the southwest monsoon period (June – September) only as it is considered as the peak Hilsa fishing period. Out of the total 546 data, 80% of data (n = 436) were used for model training, and the rest 20% of the data (n = 110) was used as a test dataset for model validation. The statistical indices used for model validation in the present study are the Pearson correlation coefficient (PCC) and percentage bias (PB). The PCC and PB between Hilsa catch in the test dataset and the corresponding predicted catch have been observed as 0.92 and 4.71% respectively. Analysis of the parameter importance revealed the highest importance of current speed followed by current direction and salinity on the variability of fish catch. The present study can be further used for delineating the spatial distribution of predicted Hilsa hotspots for the north-western Bay of Bengal and adjoining Hooghly estuary.

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Advancing Satellite Technology for Monitoring of Algal Blooms in the Indian Ocean

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The Indian Ocean region confronts significant challenges from Algal Blooms events, adversely impacting marine ecosystems, fisheries, aquaculture, and public health due to toxin production and water quality deterioration. This research addresses the imperative for comprehensive monitoring solutions at broad spatial and temporal scales, considering the coexistence of multiple HAB species and the complexities of optically opaque waters in the region. Indian National Centre for Ocean Information Services is the nodal institute providing algal bloom information services (ABIS) in the Indian Ocean region. The upgradation of ABIS will help differentiate bloom concerning its intensity of occurrence. The developed algorithms are validated with Satellite Ocean colour imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) data and reported algal bloom events. Despite limitations posed by cloud cover and atmospheric effects on the satellite data, the results show a promising correlation. The satellite-based algorithm advances the spatial distribution of algal blooms in

the Indian Ocean. These algorithms play a pivotal role in environmental monitoring efforts, enabling the detection of algal blooms, assessment of water quality, and monitoring aquatic ecosystems. The research outcomes are instrumental in predicting HAB transport and providing expert interpretation for generating HAB risk alert bulletins. This study contributes valuable insights for addressing the challenges posed by HABs in the Indian Ocean region, emphasizing the crucial role of remote sensing approaches in environmental management and public health.

WOSC/2024/ABS/400

Atlas of Submerged Rocky Outcrops along the Indian Coastline: A Resourceful Tool for Potential Fishing Zones (PFZ) and Diverse Applications

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Submerged coastal rocky outcrops are rocky structures connected to the land near the coast, extending into the sea with a significant portion submerged beneath the water. As these elevated, hard rocky materials under the sea bottom, posing a potential hazard to navigation, fishermen and other activities in and around the near coastal regions. In the present study, Identification and demarcation of the zone of submerged rocky outcrops along the Indian coastline was done using Naval Hydrographic Office (NHO) charts and the same was validated using high resolution optical satellite images such as Google Earth and field data of rocky zones identified by fishermen. This study serves as a crucial tool for fishermen, facilitating the identification of submerged rocky structures during fishing expeditions, while also acting as a valuable resource for applications like Potential Fishing Zone advisories. The state-wise atlases of coastal submerged rocky outcrops were primarily designed for fishermen to mitigate the problem of fishing nets tearing caused by submerged rocky structures in the sea. The distribution of rocky structures at the state level along the Indian coastline indicates whether a coastal state has a high or low occurrence of these formations. The data on these structures also serves as valuable bathymetry input for numerical modeling in regional coastal studies and various coastal structures applications.

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Advancing Marine Ecological Services for the Indian Seas: INCOIS's Contribution

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The North Indian Ocean (NIO) holds immense ecological and economic importance for the nations along its shores. However, this region experiences adverse effects from climate change, pollution, and overexploitation of marine resources. To tackle these challenges and promote sustainable ocean management and blue economy, the Indian National Centre for Ocean Information Services (INCOIS) has spearheaded efforts to establish a suite of Marine Ecological Services (MES) for the Indian Seas. INCOIS has developed key MES, including the Marine Fisheries Advisory Service (MFAS), Algal Bloom Information Service (ABIS), and Coral Bleaching Alert System (CBAS). MFAS provides forecasts and information on fishery resources, aiding fishermen in making informed decisions about fishing locations and improving catch rates. ABIS monitors phytoplankton blooms, contributing to understanding

ocean productivity, fisheries management, and early warnings for harmful algal blooms. CBAS plays a crucial role in monitoring coral reefs' health by detecting coral bleaching events, supporting conservation and climate resilience. This study also highlights the ongoing research towards developing MES on jellyfish aggregation and species-specific marine fisheries advisories. The genesis of the Jellyfish Aggregation Advisory Service (JAAS) aims to identify environmental triggers and provide information and early warnings on jellyfish swarming and beach stranding. Species- specific marine fisheries forecasts are specialized predictions that provide information about the expected abundance, distribution, and behavior of specific fish species (Hilsa, Sardine, and Mackerel) in a particular region. These forecasts are crucial for the fishing industry, as they help fishermen target their efforts more effectively and reduce the environmental impact of fishing. This study underscores the significance of MES in safeguarding the Indian Seas' diverse ecosystems and ensuring its sustainable use for current and future generations. It also highlights the potential for international cooperation in leveraging satellite technology for global marine conservation efforts in relation to the blue economy.

Detection of Sea Surface Temperature Fronts in Goa and Mangaluru Coasts By Automatic Front Detection Algorithm

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Oceanic thermal fronts delineate the boundaries between cold-water and warm-water masses in the ocean. Sea Surface Temperature (SST) fronts occurs on a variety of circumstances having the horizontal extent from a few hundred meters to thousands of kilometres and vertical extent from ten to a few hundred meters. In the thermal fronts, enrichment of nutrient occurs followed by the development of phytoplankton, zoo plankton that leads to the aggregation of fishes. In the present study, SST fronts from in the region of Goa and Mangaluru are detected using Cayyula Cornillon Algorithm with AVHRR SST product of 1.1 Km resolution for the period of 2014 - 2019. SST thermal fronts are transacted into 0.5° SST gradient and 0.3° SST gradient. Daily SST data in the NETCDF format were processed in MATLAB programming software to detect the thermal gradients for the period. The algorithm relies on a combination of methods, and operates on the data, window, and the local level. The procedure continues at the window level with the Single Image Edge Detection (SIED). Using the Algorithm techniques, the temperature distribution (histogram) in each window is analysed to determine the statistical relevance of each possible front. Notably, the most prominent fronts were observed for the months of November-March in the Arabian Sea for all the years of study. Most of the fronts are persistent up to 2-5 days, during North – East monsoon to Winter months. The results of the present study demands more comprehensive field observations within the ocean fronts, collecting information on water quality, plankton and fish samples for revealing the biogeochemical processes that responsible for the productivity in Ocean fronts. Understanding ocean processes and trophic succession in productive ocean fronts can improve Potential Fisheries Zone advisory services by INCOIS by enabling more accurate predictions and species-specific forecasts.

MDART - an Interactive Oceanographic Tool for the Visualization of Moored Buoy Observations

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The moored buoy network established by National Institute of Ocean Technology (NIOT) in north Indian Ocean has recorded more than two decades of time series measurements from more than 25 locations. The long term data set of meteorological and oceanographic parameters including sub-surface measurements of temperature, salinity and ocean currents is a wealth of information for researchers as well as engineering applications. The dissemination of such a huge dataset to various end users, prompted us to develop a user friendly software tool that can be utilized even a layman. The customized oceanographic tool titled M-DART (Moored Buoy Data Analysis and Representation Tool) is developed using approximately 50 lakh data points after stringent quality control procedures. This windows based tool, developed using Python, consists of resident data basesof met-ocean parameters and a visualization tool for contour plots, time series plots, rose plot etc. MDART provides information on actual time series and temporal averages (weekly, monthly, annual and climatic) of all parameters as well as to select the parameters/location for the selected duration. The software package materialized the dissemination of customized, user friendly information to stake holders. In nutshell; MDART is a software tool for effective utilization of buoy data for any operational purpose.

Oceanic Response Captured by Moored Buoy in the Central Arabian Sea during the Passage of Cyclones between 2011-2023

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The real-time data from Indian Moored Buoy Network during cyclones is utilized to provide Tropical Cyclone Heat Potential to IMD to provide accurate cyclone alerts, validating and assimilating numerical models to improve model forecast. The present work utilizes 13 years (2011-23) data of AD07 buoy in the central Arabian Sea (AS). Total 25 cyclones occurred out of which, 11 cyclones were having landfall on Oman/Yemen/Somalia coasts and are far from all of the NIOT buoys (Keila-2011, Murjan-2012, Chapala-2015, Megh- 2015, Sagar-2018, Mekunu-2018, Luban-2018, Hikaa-2019, Pawan-2019 and Gati-2020, Tej-2023). The tracks of 4 cyclones (Vardha-2016, Gaja-2018, Gulab-2021 & Shaheen- 2021) were extended from the Bay of Bengal to AS; were either far away from the AS buoys or located on the left side of the track and did not show countable response at AD07 location. This brings down to total 10 significant cyclones in AS, for which, response found was based on the track distance. Out of the 10 cyclones, the minimum and maximum track distances were 8 km (Nanauk-2014) and

660 km (Nilofar-2014) respectively. The performance of the AD07 buoy is ascertained based on the statistics of the observed response during cyclones. The total number of cyclones occurred in AS (Total) are segregated into 4 categories viz., cyclone signals captured (Captured), not captured as buoy is far way from cyclone track (Far), no buoy at field during cyclone (NB), & buoy not functioning (NF) even though it is in water. It is found that, all the 10 cyclones were captured by AD07 and 100% performance is achieved by AD07 buoy during 2011-2023. This success was possible because of the continuous improvements, Indigenization efforts of buoy components, following best practices and the long term field experience gained to meticulously deal with the various vagaries of the Sea.

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Prevalent ocean met role for the intensification and genesis features of the ESCS Tauktae

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In the scenario of global warming in the wake of climate change, the number of tropical cyclones is likely to increase in the North Indian Ocean due to decreased wind shear and increased warming, especially in the Arabian Sea, but a decrease in the Bay of Bengal (BOB) (Tiwari et al., 2022). In May 2021, Tauktae was an Extremely Severe Cyclonic Storm that occurred in the Arabian Sea (14-19May 2021). The present study investigates the prevalent role of the ocean atmosphere on the genesis and intensification of it, and causative ocean-met factors from a climatological and current perspective and tries to understand why it was getting intensified though it was traversed close (~ 140 km) to the coast. In general, the climatological Genesis Potential Index (GPI) is higher off the Indian west coast during the cyclone seasons, in which, low-level vorticity (LLV) and mid- tropospheric relative humidity (MTRH) have major roles to play, and same is the case for May month. SST, MTRH, CAPE, and Absolute Vorticity (ABV) have shown a rapidly increasing trend in the last decade comparing last three decades. On top of that, just before the genesis of Tauktae, SST was >29°C, tropical cyclone heat potential (TCHP) was >130 kJ cm−2, higher upper ocean heat content (UOHC), LLV and MTRH, and reduced vertical wind shear were observed, hence a higher value of GPI (>70) played a significant role in the intensification of Tauktae cyclone, which is apparent. Study on quantified role of ocean atmosphere on the intensification of Tauktae suggests a percentage contribution of 47% from the ocean and 53% from the atmosphere. The combination of La-Nina and Negative-IOD shows higher MTRH, ABV, and CAPE over the west coast of India. A notable MJO phase and substantial MJO activity (amplitude>1) are seen throughout the NIO in May.

IV: Ocean observations, processes and modelling.

WOSC/2024/ABS/100

Modeling Ocean Diurnal Cycle and its Scale Interaction to Longer Scale Climate Variabilities

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The variability at diurnal to seasonal scale in coupled models is primarily governed by surface boundary conditions (sea surface temperature (SST), turbulent heat, and momentum fluxes) between the ocean and atmosphere. Although efforts have been made to achieve the accuracy in surface fluxes and SST in observation and reanalysis products, less attention has been paid towards achieving similar accuracy in coupled model simulations. Improper diurnal phase and amplitude in intra-daily SST and precipitation are among the well-known problems in most global coupled general circulation models, including the Climate Forecast System v2 (CFSv2) model. The present study attempts to improve the representation of ocean-atmosphere surface boundary conditions in CFSv2, primarily used for India's operational forecasts at different temporal/spatial scales. In this direction, the diurnal warm layer and cool skin temperature correction scheme is implemented along with the surface flux parameterization scheme following Coupled Ocean-Atmosphere Response Experiment (COARE) v 3.0. The coupled model re- forecasts with a revised flux scheme resulted in improved characteristics in various ocean- atmosphere parameters and processes at diurnal and seasonal time scales. At the diurnal scale, the phase and amplitude of intra-daily SST and mixed layer depth variabilities are improved over most tropical Oceans. Improved diurnal SSTs helped in enhancing the diurnal range of precipitation by triggering stronger intra-daily convection. The improved diurnal ocean- atmospheric boundary state translated into a reduction in seasonal mean dry bias over Indian landmass and the wet bias over global oceans. Better simulation of El Niño–Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) related non-linearity, ENSO-Indian Summer Monsoon Rainfall (ISMR), and IOD-ISMR relation is among the most critical improvements achieved by revising the turbulent flux parameterization. The revised flux parameterization can significantly enhance India's prediction capability at short and extended range predictions for features like diurnal extreme rainfall events, monsoon intraseasonal oscillations, Madden-Julian Oscillation, etc.

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The interplay between prolonged La-Nina events and the Indian Ocean Dipole: Role of coupled ocean-atmosphere processes

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The Indian Ocean Dipole (IOD) is an important modulator of the Indian Summer Monsoon (ISM). IOD events can arise due to internal variability or can be forced by the conditions in the tropical Pacific Ocean. The frequency of consecutive La-Nina events is projected to increase in a warming world, which can intensify negative IOD-type conditions, compounding the climate risk associated with such events. In this study, we focus on the role of the Pacific Ocean state in governing the variability of the Indian Ocean. It is found that prolonged La-

Nina-type conditions can suppress the seasonal cycle of winds in the tropical Indian Ocean (TIO). As a result, large westerly wind anomalies ensue in the central equatorial Indian Ocean, strengthening the Wyrtki jets in the TIO. These jets transport warm waters to the eastern TIO and can enhance negative IOD-type conditions. Reduction in the along-shore easterlies along the Java-Sumatra coast during boreal summer and fall result in reduced wind-evaporation-sea-surface temperature feedback and weaken the mean upwelling in the eastern TIO. Suppose eastern TIO warming and a simultaneous western Indian Ocean cooling coincides with the boreal summer monsoon season. In that case, peak IOD conditions can ensue during summer, complicating the non-linear IOD- monsoon association. A better understanding of these feedbacks will help in realistic simulation of such processes in coupled ocean-atmosphere models. This will ultimately address the long-standing problem of incorrect IOD-ISM teleconnections in these models, thus leading to better forecasts of ISM and the oceanic state.

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A thermocline dome located below the stratified waters of the northern Bay of Bengal

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Thermocline domes are observed worldwide and are usually associated with a cyclonic circulation with elevated isotherms shaped like a dome. We describe the existence of a thermocline dome and cyclonic surface circulation in the northern Bay of Bengal (BoB) using historical ship-board measurements, climatological observations, and an OGCM simulation. The climatological thermal structure along 87E shows shallowing of isotherms highlighting the existence of a distinct thermal dome from May to September in the northern BoB. Further, the monthly climatology of sea-level anomaly shows a prominent area of a negative anomaly with cyclonic circulation in the northern BoB (86- 89E and 16-19N). We refer to this dome as the Northern BoB Dome (NBD). Strong near- surface stratification in the northern BoB prevents the entrainment of cooler, nutrient-rich waters to the surface from the dome and prevents the NBD from altering mixed layer temperature and chlorophyll levels. This behaviour contrasts sharply with that of the more well-known Sri Lanka Dome (83-87E and 5-10N; June to September), which is observed in the southern BoBs relatively less stratified waters. Our hypothesis on the mechanism leading to the formation of the dome is that it is related to the coastal currents in the region. We draw the insight from this study that the NBD influences the occurrence of the total number of monsoon depressions formed in this region.

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Higher-trophic fish and macrobenthos biomass models suitable for two-way coupling with lower trophic level model hosts

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An end-to-end ecosystem model (ECOSMO E2E) comprising a lower-trophic level (LTL) system with NPZD and higher-trophic level components (biomass of fish and macrobenthos; HTL) was originally developed by Daewel et al. (2019). This model is reprogrammed to separate independent fish and macrobenthos modules to facilitate two- way coupling with various LTL models through a generic coupler. The coupling is demonstrated through three distinct LTL models in a 1D model configuration, focusing on the North Sea, neglecting horizontal fish movement. Two types of fishes, a pelagic group primarily planktivorous and a demersal group exhibiting piscivorous and benthivorous feeding habits, are incorporated into the model, replicating the annual cycle of fish biomass in the North Sea reported by trawl surveys. Furthermore, the investigation explores the consequences of the two-way coupling between HTL and LTL models on the biomass dynamics of the LTL components in the North Sea. We critically examine the potential for adaptation of fish biomass models, such as ECOSMO E2E, to Indian waters and address associated challenges. These considerations are based on recent studies by Vijith et al., (2023) and Shankar et al., (2019) that showed regional variations in fish dominance, such as the prevalence of planktivorous fishes in the southern Arabian Sea and southern Bay of Bengal and the prevalence of carnivorous fishes in the northern Arabian Sea and northern Bay of Bengal. References: Daewel, U et al., 2019. Towards end- to-end (E2E) modelling in a consistent NPZD-F modelling framework (ECOSMO E2E_v1.0): application to the North Sea and Baltic Sea, Geosci. Model Dev., 12. Shankar, D. et al., 2019. Role of physical processes in determining the nature of fisheries in the eastern Arabian Sea. Prog. Oceanogr. 172. V. Vijith, et al., 2023. Assessing the geographical distribution of carnivorous and planktivorous fishes in the western Bay of Bengal, Eco. Info., 74.

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Impact of the extreme Indian Ocean Dipole 2019 on Equatorial Indian Ocean circulation

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The Equatorial Indian Ocean (EIO) plays an active role in global and regional climate change through ocean-atmosphere-coupled processes and acts as a base for many global and regional climate and weather patterns. An extreme positive Indian Ocean Dipole (IOD) event occurred in the 2019 boreal autumn, which has induced severe climate impacts around the Indian Ocean region. The ADCP observed high-frequency currents reveal that there isa strong eastward subsurface current at a depth of 50m - 150m persisting from fall 2019 to spring 2020 which is abnormal to a normal condition. Here, observational data, together with the simulations from an ocean model used to identify the processes responsible for the abnormally strong subsurface currents in the EIO during 2019/2020. The Modular Ocean Model (MOM) ocean model shows anomalous strong westward flow in the surface and strong eastward flow in the subsurface at a depth of 50m – 150m depth consistent with the observation with a good correlation. The

surface westward flow during the fall of 2019 was induced by the easterlies driven by a strong positive IOD. However, the subsurface strong eastward flow persisted in the following winter and spring of 2020 after its peak with two-fold stronger and deeper than the pIOD composites. The sensitivity experiments from a linear and continuously stratified (LCS) model reveal that an abnormal westerly wind anomaly in the western EIO is responsible for this high-magnitude subsurface currents. An anomalous westerly wind burst in the western EIO in early June generated an eastward propagating downwelling Kelvin wave, which reflected from the eastern boundary as a downwelling Rossby wave with a westward phase propagation to the western EIO. Our analysis suggests that the equatorial wave dynamics and wind anomalies on the western EIO play a dominant role in the development of an extreme IOD.

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Mechanism of Formation of Sea Surface Temperature Fronts in the Northeastern Arabian Sea

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In this study, we investigate the mechanism of formation of two long-lived Sea Surface Temperature (SST) fronts associated with the Large Marine Ecosystem in the northeastern Arabian Sea (AS), namely the West India Mid-Shelf Front (WIMSF) and West India Shelf-Slope Front (WISSF), using simulation from a high-resolution (~ 2.3 km) numerical model based on Regional Ocean Modelling System (ROMS). Both these SST fronts occur during November-April and the model simulates their variability and position realistically. Our study reveals that WIMSF is formed due to the advection of cold water (< 23 degrees C) from the Gulf of Khambhat (GoK) into the relatively warmer waters on the shelf. The formation of cold-dense water in the shallow areas of GoK is primarily caused by surface heat loss due to strong northeasterly winds during winter. The second front, WISSF, is formed along the edges of the West India Coastal Current (WICC) as it carries warm water from southeastern AS into the cooler ambient waters in northeastern AS during winter. The instabilities developed along the edges of WICC tighten the isotherms and enhance the SST gradient in WISSF. Numerical experiments show that WIMSF becomes closer to the coast in the absence of residual tidal circulation and WISSF becomes weak when the internal tide-induced vertical mixing is absent on the shelf break. Our study suggests that the position and intensity of these fronts are sensitive to tidal forcing as they control the strength of horizontal advection on the shelf and vertical mixingon the shelf break.

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Wind-driven bottom current in the equatorial Indian Ocean

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Deep ocean currents are known to be driven by differences in water density. They play an important role in the transport of water masses across the ocean basin and significantly impact climate scale processes. Nevertheless, zonal current data near the ocean bottom spanning over two decades reveal evidence of wind-driven bottom currents in the central and western equatorial Indian Ocean. The spectra of bottom currents exhibit a blue shift in dominant frequencies, with lower frequencies weakening near the eastern boundary. This frequency shift can be explained using theoretical ray paths of Kelvin waves and reflected Rossby waves. In contrast to surface circulation, the spatial distribution of intraseasonal frequencies and climate modes, such as El Niño and the Indian Ocean Dipole, near the bottom could be determined by the ray path of these large-scale waves. The downward propagation of energy by surface winds would also play a pivotal role in deep ocean biogeochemistry.

Air-Sea interactions associated with tropical cyclones over the Bay of Bengal with special emphasis on Meso-scale Eddies

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The Bay of Bengal (BoB) is an active region for the formation of the Tropical Cyclones (TCs) and accounts for about 6% of the global annual total number of tropical storms. Hence understanding the air-sea interactions associated with TC has pivotal importance for prediction. In this study, we have conducted an Ocean Mixed Layer Heat budget analysis for distinct TCs over Bay of Bengal. Further we have examined the coherence between distinct ocean mixed layer budget terms and Genesis Potential Parameter (GPP) especially over warm and cold core eddies. Through this analysis, we found that the net heat flux and entrainment terms have high correlations with GPP, with correlation coefficient value of magnitude 0.42 and 0.68 respectively and among all the parameters reported, the entrainment has highest correlation of magnitude 0.68 with GPP. It is interesting to mention that unlike the warm-core eddies the prior response (5 days before the passage of cyclone) between mixed layer terms and GPP is not observed for the case of cold-core eddies. Also, the magnitude correlation between distinct terms of mixed layer heat budget analysis and GPP is relatively less for cold-core eddies, compared to warm- core eddies. A notable feature for warm-core eddies is that the net latent heat flux dominates in influencing GPP among the terms that determines net surface heat flux, however, such dominance of net heat flux is not observed for cold core eddies, which infers that the cold core eddy regions are relatively less influential in determining/impacting cyclone life cycle, compared to the warm core eddy regions. As the latent heat flux is the major pathway between the energy exchanges from ocean to atmosphere, during active cyclone period. We have identified that the "Viyaru" is a typical one that originated in the southern BoB, propagated approximately through the middle of the bay, and made landfall over the northern BoB. The cyclonic storm Viyaru caused a basin-scale sea surface cooling of 0.35°C by increasing the mixed layer depth by 3.5 m over the Bay of Bengal. The present study could be beneficial in improving the TC models for better

prediction.

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Investigation of tide-wave-current interactions off the east coast of India using coupled SWAN+ADCIRC modelling system

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The interaction between ocean surface waves, currents, and tides has been explored in this study using the tightly coupled SWAN+ADCIRC modelling system (ADCSWAN) in some of the tide- and current-dominated areas in the Bay of Bengal. The study has been conducted during different wind regimes, including an extreme event to represent all possible weather conditions in the east coast. Several numerical experiments have been designed and carried out: 1) a control run in which the wave model is forced only with winds 2) wave model with forcing from winds and tides 3) wave model with forcing from winds and currents, and 4) wave model with forcing from winds, currents, and tides. Tide from the ADCIRC was validated against Dhamra tide gauge data, and the match was good with a correlation coefficient above 0.95. The wave parameters from the ADCSWAN were validated against waverider buoy data and the results were promising. Wave boundary conditions applied to SWAN significantly improved the wave parameter simulations. Wave parameters such as significant wave heights (Hs), mean wave periods (Tm02), and mean wave directions (Mdir) from the 4 experiments were compared to see the effect of tides and currents in the wave simulations. In the tide-dominant zone Hs and Tm02 were more influenced by tide, whereas in the current-dominant zone Hs was influenced by tide and Tm02 by current. In normal conditions, the magnitude of Hs-modulation in tide- dominated zone during spring tide was 10% higher than that of neap tide. The Hs- modulation was also impacted by the cyclone, which coincided with the spring tide. The Hs-modulations in the tide-dominant and current-dominant zones during this period were 46% and 18% respectively. Moreover, wave directions were changed in the current- dominant zones indicating the refraction of waves. The results are on par with the available literature.

WOSC/2024/ABS/166

A review of mechanisms controlling the summer monsoon upwelling system off the Somali coast during summer monsoon

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The Arabian Sea is characterized by its unique large-scale seasonal variability driven bythe seasonally reversing monsoon winds. During Southwest Monsoon the strong Findlater jet blows southwesterly across the Arabian Sea, resulting in a strong upwelling along the coast of Somalia and Arabia. However, it is important to note here that the coast of Somalia does not

exhibit classical coastal upwelling in response to the strong alongshore Findlater jets, but is much weaker than expected coastal Ekman divergence and limited in a few patches, mainly within the cold wedges of the Great Whirl and Southern Gyre. Hence, the question that needs to be addressed is why the Somali upwelling differs from the classical coastal upwelling systems. One of the early explanations suggests that the muted upwelling along the Somali coast is primarily driven by the eddies (Great Whirl and Southern Gyre) generated due to the non-linearity of the coastal currents and their offshore extension to the open ocean. Numerical experiments forced by idealized/realistic wind fields suggest that the coastal currents off Somalia is a combined response to the local alongshore winds and the remote forcing, including offshore windstress curl, Rossby waves radiating from the west coast of India, and the equatorial Rossby waves. In one of our recent research, we have shown that the upwelling along the Somali coast is mainly confined to the northern part of the coast along the cold front of the Great Whirl eddy. Whereas, in the southern and central part of the coast, downwelling Rossby waves generated by the offshore negative windstress curl oppose the wind-driven coastal upwelling. This resulted in a deepening of thermocline along the coast of Somalia and limiting the upwelling despite the increasing strength of alongshore winds with the monsoon.

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Implementation of Local Ensemble Transform Kalman Filter based Ocean - Atmospheric coupled data assimilation system for improved analysis quality and predictions

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Precise prediction of weather and short-range climate events has pivotal importance in societal and economic benefits. Incorporating the accurate state of the Earth system/"/gs components as the best initial conditions to the prediction model is imperative in minimizing forecast errors. Targeting a seamless prediction system, an ensemble-based flow-dependent coupled data assimilation system is developed for Climate Forecast System version 2 (CFSv2). Introducing the Indian Institute of Tropical Meteorology (IITM) - University of Maryland Weakly Coupled Analysis (IWCA): A coupled Ocean- Atmospheric analysis (1999-2019). The assimilation method implemented is the Local Ensemble Transform Kalman Filter (LETKF) with a weak coupling strategy. The system assimilates all the available in-situ ocean observation and atmospheric observations. The IWCA Ocean analysis shows improvement in analysis quality for SST, SSS, currents, subsurface thermal, and salinity structures, compared to the present operational IGODAS analysis and comparable to ORAS4. The tropical coupled modes of variability are well represented in the IWCA analysis compared to the uncoupled analysis, viz. IGODAS, ERA-Interim, ORAS4. By strongly projecting on the local dynamics, the Ensemble Mean better represents the background state. The high number of ensembles and implementation of coupling between Ocean and Atmosphere (weakly coupled strategy) for data assimilation is responsible for improved analysis quality compared to the uncoupled reanalysis products. Further the test runs using IWCA as Initial condition has shown improved monsoon predictions compared to CFSR reanalysis.

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Biogeochemistry of northern Indian Ocean using Bio-Argo float data

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A three-dimensional climatological product of Chlorophyll, dissolved oxygen is generated using data measured by Bio-Argo floats in the northern Indian Ocean. Nearly 9000 profiles from approximately 70 floats during 2012 to 2022 are used to generate this climatological product at various depth level ranging from 5 – 1000 meters. Well known signatures of the chlorophyll and oxygen variability on a monthly scale are represented thereby re-affirming the quality of the product. The spatial distribution of chlorophyll on a monthly scale depicted the signatures of upwelling, convective mixing in Arabian Sea (AS) and river runoff in Bay of Bengal (BoB). The depth and concentration of Deep Chlorophyll Maximum (DCM) have captured the dynamics of DCM with time. The depth- time sectional plots on meridional and zonal directions have shown the chlorophyll variability along the length and breadth of both AS and BoB, substantiating the known signatures and variability. The oxygen minimum zones (OMZ) of AS and BoB is also well captured. Depth of surface and deepest oxygen minimum were estimated using which the core and thickness of OMZ in AS and BoB was estimated. Thickness of OMZ is larger in AS than in the BoB and is observed to decrease from north to south in both basins. The spatial variations in intensity of OMZ in the BoB are observed to be governed by stratification, primary and export productions, organic matter decomposition, and eddy-driven mixing. The thick OMZ in the northeastern Arabian Sea is observed to be associated with low concentration of depth integrated Chlorophyll-a, primary production in the upper 100 m and sinking carbon fluxes at 100 m depth than other regions. Present study has shown utility of in-situ chlorophyll and dissolved oxygen observations to build good-quality gridded product that could serve as initial condition for BGC-models and a base for future data products.

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Need of high-resolution oxygen profiles from the eastern Arabian Sea

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The Arabian Sea oxygen minimum zone (OMZ) is the thickest of the three major oceanic OMZs and is responsible for 30-50% of oceanic water column nitrogen loss. It is hypothesized that OMZs will spread in the coming decades due to global climate change. In the case of the Eastern Arabian Sea (EAS), the present understanding of the dynamicsof OMZ is mostly based on model simulation due to the dearth of comprehensive observations, suggesting the importance of direct measurements. Herein, the ship-based oxygen dataset collected onboard Sagar Sampada and Sagar Kanya through repeat observations (ten times) between December 2017 and January 2019, as a part of the Marine Ecosystem Dynamics of eastern Arabian

Sea (MEDAS) programme, has been compared with the available World Ocean Atlas (WOA18) oxygen dataset. According to the MEDAS observations along the EAS, on an annual basis, the OMZ (waters with oxygen concentrations ≤22µM) occurred between ~60 and 1350m, which is nearly consistent equatorward ~10°N with the available WAO18 dataset (between ~100 and 1300m). However, the difference was maximum southward. However, the WAO18 failed to depict the information on core OMZ, the denitrifying zone (defined as DO≤5µM) that occurred between 190 and 1060m at north EAS (~22°N) and its southward expansion (upto~12°N) evident from the present study, suggesting the need of high resolution oxygen data to study the EAS OMZ and associated biogeochemical dynamics. Also, these differences in available information from reality may be considered while validating the OMZ biogeochemical models (for parameters very sensitive to low oxygen levels), as WOA climatology is widely used as a major data source for modellers. It is also taken into consideration that the open ocean BIOARGOs, which are the main source for updating the WOA, cannot capture the complexity and biogeochemical features of regions like Indian EEZ that are completely devoid of any of the floating sensors. Hence, ship-based comprehensive studies should be the data source for validating models for such a complex ecosystem.

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Ocean Emitted Natural short-lived halogens exert an indirect cooling effect on climate

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Observational evidence shows the ubiquitous presence of ocean-emitted short-lived halogens in the global atmosphere. Natural emissions of these chemical compounds have been anthropogenically amplified since pre-industrial times, while in addition, new anthropogenic short-lived halocarbons are currently being emitted to the atmosphere. Despite their widespread distribution in the atmosphere, the combined impact of these species on the Earth´s radiative balance remains unknown. Here we show that short-lived halogens exert a substantial indirect cooling effect at present (-0.13 ± 0.03 W m-2) that arises from halogen-mediated radiative perturbations of ozone (-0.24 ± 0.02 W m-2), compensated by those from methane ($+0.09 \pm 0.01$ W m-2), aerosols ($+0.03 \pm 0.01$ W m-2) and stratospheric water vapour ($+0.011 \pm 0.001$ W m-2). Importantly, this significant cooling effect has increased since 1750 by -0.05 W m-2 (61%) driven by the anthropogenic amplification of natural emissions and is projected to further change (18- 31% by 2100) depending on climate warming projections and socioeconomic development. We conclude that the indirect radiative effect due to short-lived halogens should now be incorporated into climate models to provide a more realistic natural baseline of the Earth´s climate system.

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Development of a MOM6 based ocean general circulation modelling framework for the Indian Ocean

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Accurate ocean prediction plays a pivotal role in developing coastal resilience against ocean-induced hazards and implementing an early warning system. INCOIS, being the nodal organization that provides operational oceanographic services, is actively involved in the numerical modelling of ocean circulation. As part of its unified modelling framework, under a joint collaboration between INCOIS and Florida State University, a new ocean general circulation modelling system based on Modular Ocean Model version 6 (MOM6) with Sea Ice Simulator (SIS2) is being developed. MOM6 uses a horizontal Arakawa-C grid for better mesoscale eddy simulations and an Abitrary Lagrangian Eulerian (ALE) algorithm to accommodate any vertical coordinates and an unconditionally stable model at thin layers. The system consists of a global model with uniform 1/12 degree horizontal resolution with 41 hybrid vertical layers and a nested regional model with one-way boundary conditions from the global configuration. The hybrid vertical layer uses a combination of geopotential coordinates and isopycnal coordinates to resolve the well-mixed upper water column and the stratified interior ocean. The model is currently forced with JRA55-do atmospheric forcings. The system efficiently reproduces broad features of seasonal and interannual variabilities of surface and tropical subsurface temperature quite well. Overall, the model simulations show significant improvement over MOM5 with significantly lower RMSE in SST over much of the Indian Ocean.

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Dynamical downscaling of sea level change in the Indian Ocean using ROMS

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Future regional sea level (RSL) change projections are typically based on global climate models (GCMs), which are limited in their ability to simulate spatially non-uniform sea- level rise due to their coarse resolutions. In this study, the dynamical downscaling approach was employed with regional ocean climate models (RCMs) to address these limitations in the Indian Ocean. The future regional sea level (RSL) rise in the Indian Ocean is investigated with the Regional Ocean Modeling System (ROMS) with an eddy- permitting resolution (1/12) under the highest greenhouse-gas emission scenario (RCP 8.5). To capture the spread of projections, the model used forcing fields from four different CMIP6 GCMs, selected based on a performance evaluation in the Indian Ocean domain. CMCC_CM2_SR5, EC-EARTH3, HadGEM3-GC31-LL and BCC-CSM2-MR were selected to provide climate change signals for the RCM. These signals were computed from the GCMs using time varying delta technique on both lateral open boundary and surface forcing. These bias-corrected surface and boundary forcing fields with a climatological means from reanalysis and a non-linear trend from GCMs captured the variabilities better than the original GCMs. Downscaled ocean features from the RCM historical experiment (1995-2015) show more spatial detail than the GCM, with the means and variances of parameters such as SST, SSS, and RSL more consistent with the observations in RCM than GCM. In all downscaling, the projected RSL rises in the north-eastern Indian Ocean during 2081–2100

relative to 1995-2015 is generally half or less than RSL rises in the GCMs. The discrepancies of the RSL rise in the Indian Ocean between the GCMs and RCMs are less than 10cm.

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Statistical Analysis of generation, propagation and life cycle of Mesoscale Eddies in the Bay of Bengal using 29 years of sea level data

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Mesoscale eddies are ocean features having a scale of 100km in space and a few months in time. They are commonly found throughout the oceans and are particularly noteworthy in areas of strong currents. Eddies are predominant features of Bay of Bengal (BoB), especially along its western boundary. In addition to mesoscale variability, the BoB regionis complex, influenced by monsoons, cyclonic storms, river plumes, and large-scale circulations. The examination of upper-layer circulation in the BoB reveals variations across semiannual, annual, and interannual timescales. Eddies are predominantly observed in the western part of the BoB. Previous studies emphasized the presence of eddies around the East Indian Coastal Current (EICC), attributing their formation to factors such as monsoon transition, EICC instability, and the energy transmission of westward Rossby waves and summarized the statistical properties such as intensity, life cycle, and amplitude.The mesoscale variability in the BoB was investigated using 29 years of sea level anomaly (SLA) data. A 30-year data set is considered standard in climate change studies for its balanced and reliable perspective on climate conditions. We have looked into the climatic variations in the statistical properties of mesoscale eddies such as its region of formation, life cycle, trajectory, and intensity using the py-eddy- tracker software. Mesoscale eddies are concentrated in the western BoB as seen from SLA and eddy kinetic energy (EKE) distributions. Cyclonic eddies show a preference in the northwest and south BoB, while anticyclonic ones prevail in the eastern bay. Cyclonic-anticyclonic asymmetry appears in eddy lifetime and propagation, with cyclonic eddies having longer durations and farther propagation. Westward propagation is widespread, though eastward eddies occur within EICC and the Andaman Sea. Seasonal analysis favors spring for eddy generation, with a minimum in autumn. Cyclonic eddies prevail in spring, while anticyclonic eddies dominate in summer.

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Role of local winds and remote forcing in Coastal Upwelling along the West coast of India

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The upwelling phenomenon in the West Coast of India (WCI) is significant due to it's climate and economic impact on the Indian sub-continent. This study is carried out to understand the role of alongshore wind and remote foecing in upwelling along the WCI using decadal reanalysis data (2009-2018) of satellite derived parameter. Atmospheric and oceanic parameter viz. wind, sea surface temperature (SST), sea surface height anomaly (SSHA), and chlorophyll-a concentration are used as an indicator of upwelling. Two upwelling indices, one based on wind (UIwind) and the other based on SST (UIsst) are taken into consideration. The study reveals propagation of coastal kelvin waves from East coast of India (ECI) to Arabian Sea

around Sri Lanka. CEOF analysis is used to identify the kelvin wave propagation. Furthermore, there is existence of spatiotemporal variability in this study region, where the strongest upwelling intensity is observed in the south-westtip of India (8-9° N) indicated by coincident positive Ekman Transport (ET), strong negative UIsst and negative SSHA during July/August. And towards the north of 9°N decreasing upwelling intensity is observed. According to several studies, the main driving force causing upwelling is wind, however, recent studies shows that the wind speed in the WCI has beenin a decreasing trend since the last decade (Patel et. al, 2020). With the decrease in alongshore wind speed the Coastal kelvin wave propagating from the ECI plays a dominant role in controlling coastal upwelling process along the WCI.

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The effect of the variability of wind forcing on ENSO simulation in an OGCM: case of canonical and protracted event

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This study is an attempt to understand the onset and the evolution of canonical (typical length ~ 18–24 months; CE) and protracted El Niño (> greater than 3 years; PE) compared to the normal state (NS) in an ocean model. Indo-Pacific warm pool indicates higher sea surface temperature (SST) before the onset of strong CE compared to the NS and PE. The ocean model (MOM5.1.0) used in the study shows a systematic SST bias in the Indo- Pacific Ocean with warmer (cooler) temperatures in the western (eastern) Pacific during NS, CE, and PE exhibiting La Niña–like conditions. The model also exhibits deeper thermocline depth in the western equatorial Pacific Ocean during PE and CE than NS, indicating higher heat content values. Despite higher heat content in the western Pacific before the onset of El Niño, the difference in the variability of surface wind forcing during the preceding months determines the type of El Niño. The difference in surface wind forcing among the NS, PE, and CE states without altering the ocean state can modify the subsurface propagation in the equatorial Pacific Ocean. A change in longitudinal extent of upwelling Kelvin waves from western Pacific towards eastern Pacific along with the change in surface wind forcing decides the fate of El Niño. Based on the results of model experiments for 1948–2009, observed features of the recent protracted El Niño of 2014– 2016 appear to be a blend of PE and CE in terms of ocean dynamics and surface wind forcing.

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Days to season forecasts of Indian Ocean features from daily initialized NCMRWF coupled model

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Prior information about the state of the ocean is of immense importance because of the dependency of a wide range of human activities on the oceans. The most immediate use of ocean forecasts is in planning maritime operations for search and rescue operations, fisheries, navigation, and explorations of off-shore oil reserves. Long-term forecasts of oceans help monitor the evolution of indices of major climate significance such as El-Nino and Southern Oscillations (ENSO) and also provide input in decision-making for sustainably managing marine bio-resources during a given season. Thus, forecasts ranging from a couple of days to up to a season are regularly prepared by operational centers across the world. At the National Centre for Medium-Range Weather Forecasting (NCMRWF) a seamless modeling framework

based on a coupled model has been implemented which gives forecasts of land, atmosphere, ocean, and sea ice parameters. In this study, we analyze the ocean parameters from the coupled simulations initialized using analyses produced by a 3D-Var ocean data assimilation system (ODS). The ocean model isa 75-level ORCA025 Nucleus for European Modelling of the Ocean (NEMO) with very high vertical resolution. Analysis of the simulations suggests that the model can capture the large-scale spatial variability and temporal evolution of key variables such as sea surface temperature, salinity, and upper-ocean currents reasonably well amid some deficiencies. To understand the source of errors, process-oriented studies are carried out. It is found that errors in the winds are primarily responsible for biases in SSTs across the time scales. Further, heat budget analysis shows that the SST biases are influenced more strongly by the upper ocean mixing than the surface turbulent heat fluxes. The implications of the errors in winds on the simulation of major current systems in the Indian Ocean are discussed.

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Extreme Wind Waves simulated by Wave Watch III model during land fall of Cyclones in the Bay of Bengal

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East coast of India in the North Indian Ocean (NIO) is one of the densely populated areas of the world. Bay of Bengal (BoB) in NIO experiences cyclones during pre and post- monsoon season, which are causing severe damage to the low-lying areas and coastal structures along the coastal regions. Extreme wind waves associated with the tropical cyclones are interacting with remotely generated swell waves to enhance/suppress the significant wave height and increase/decrease in the water level during the passage and landfall of the cyclones. This study focus on the understanding of the interactions between tropical cyclone generated extreme wind waves with remotely generated swellwaves by using wave model. Wave Watch III (WW3) a third generation wave model is used to predict components of the wave parameters and simulated wave data is used to understand the interaction between and wind and swell waves during the passage of cyclones in BoB. Model simulated wave components are compared with ERA5 reanalysis wave data and also validated against in-situ measurements from wave rider buoys for the cyclones formed during 2020 and 2021 in BoB. Wave Watch III model simulated wave parameters showed good agreement with reanalysis data within the uncertainties of 10 to 20% in most of the cases. Analysis of the simulations gives detailed understanding of the interactions of cyclone generated wind waves and remotely generated swell waves when cyclone approaching the coast. Detailed analysis of the study will be presented during theconference.

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Rapid Intensification of Tropical Cyclone Fani (2019) over the Bay of Bengal using a Convection-Permitting Regional Climate Simulation using WRF

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Utilizing the Convection-Permitting configuration of Weather Research and Forecasting model (Version 3.8.1), the present study investigates the dynamic and thermodynamic processes driving the rapid intensification of Extremely Severe Cyclonic Storm (ESCS) Fani (2019) over the Bay of Bengal. Our simulation unveils the intricate atmospheric interactions that contributed to the ESCS Fani's intensified characteristics. The high- resolution (~ 4 km) capabilities of the WRF model allowed for a detailed examination of key processes influencing Fani's intensification, shedding light on the underlying mechanisms. It was found that the model was skilful in capturing the trailing edge Convective Available Potential Energy (CAPE) intensification associated with the ESCS Fani. Further, the model successfully reproduced the evolution of rain-band formation, Boundary layer processes, microphysics and cloud processes, and meso-scale convective systems associated with the TC, showcasing its ability to represent fine-scale convective features crucial for understanding rapid intensification of the cyclone. This skilful representation extends our understanding of the specific thermodynamic conditions leading to Fani's intensified state. The trailing edge CAPE intensification observed in our simulations emerges as a critical factor influencing the cyclone's rapid intensification over the Bay of Bengal. The model's accuracy in capturing this phenomenon highlights its potential for improving tropical cyclone forecasting over the North Indian Ocean (NIO) region. The ability to replicate the intricate interplay between dynamics and thermodynamics, especially the trailing edge CAPE intensification, underscores the WRF model's utility in enhancing our comprehension of extreme weather events.

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Role of ocean in recent increase in cyclone frequency over the Arabian Sea

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Extreme events such as tropical cyclones are particularly dangerous for the communities living on the coastal regions. Literature suggests that recent increase in cyclone activity in Arabian Sea (AS) is related to the warming trends in the near-surface waters of the AS. Itis seen that most of the occurrences of the recent major cyclones in the AS happened during the onset phase of the Indian Summer Monsoon. However, the processes underlying these unique characteristics of recent cyclones in the AS are not well understood. In this study, we have analyzed the large scale atmospheric and oceanic conditions during two of the long lasting cyclones: Biparjoy (6-19 June 2023) and Tauktae (14-19 May 2021). It is interesting to note that the Biparjoy developed in a low vertical shear environment, but the shear increased abruptly after the genesis. This suggests that factors other than vertical wind shear played a substantial role in the intensification of the cyclone Biparjoy. It is found from the analysis of the marine heatwave index (MHW) that the sea surface temperatures (SST) in AS just before the cyclo-genesis were above the 90% thresholds. The role of subsurface warming in sustaining the cyclone over the oceanic region is highlighted by analysis of tropical cyclone heat potential

(TCHP), Brunt–Väisälä frequency (N2), and vertical shear (S2). Models are important tools in bridging data gaps particularly in the data sparse region such as the Indian Ocean. Using state of the art NCMRWF NEMO ocean model it is shown that key variables influencing the development of Biparjoy are simulated well by state-of-art ocean model even in day-7 forecast with some key deficiencies. This study establishes the role of ocean in characterizing the unique development of Biparjoy in observations and numerical model.

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Ocean Forecasting in Extended Range Prediction System at NCMRWF

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Inter-annual variability like El Nino Southern Oscillations (ENSO) and Indian Ocean Dipole (IOD) has a major impact on the ocean and atmosphere. It is essential to understand the impacts of these phenomena in the ocean and atmosphere and also to understand the air-sea interactions during the events. Sub-seasonal prediction is very useful for understanding these changes. For this, we can utilize the extended range prediction system- meteorological forecast issues issued more than 10 days up to a month in advance; which is also referred to as a sub-seasonal or extended range prediction system. This study examines the skills of the extended range prediction system of the National Center for Medium Range Weather Forecast (NERP) in predicting the different oceanic features from1993 to 2015. NERP is based on the unified global coupled model system which is implemented in the National Center for Medium Range Weather Forecast (NCMRWF). The study compares and analyzes the hindcast data with a reanalysis data system like ORAS5 of ECMWF and Tropflux data of INCOIS. The analysis shows the capability of NERP hindcast in capturing the variations of different variables like Sea Surface Temperature, Salinity, Mixed Layer Depth and net heat surface flux. The inter- annual variability like El Nino, La Nina, positive and negative IOD shows irregular weather patterns which is suitable for analyzing the hindcast data. Different methodologies are used to understand the hindcast capability like composite analysis, correlation analysis etc. From each of the analysis, we can understand that the hindcast shows overall good skills in capturing the variables during inter-annual variability in most regions of the Indian Ocean except the equatorial Indian Ocean region (10 N to 10 S and 65 E to 95 E). The study underlines the importance of the use of ERP system for ocean monitoring.

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Climate-Induced Ecological Dynamics in Coringa Mangrove Ecosystem: A Hydro-Ecological Model Analysis

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The Coringa Mangrove ecosystem located in the east coast of India has large social, economic, ecological values, contributing more than 40 provisional services. This important mangrove ecosystem faces potential ecological imbalance and alterations due to extreme climate variabilities and rising sea levels. The major impacts are on coastal processes, nutrient dynamics, biodiversity, sea water inundation, river run offs, sedimentation, and salinity intrusion in soil and groundwater. To address, a coupled hydro-Ecological is usedto assess these environmental stressors on the ecosystem. The study utilized in-situ data on physical, chemical, and biological parameters, along with measured bathymetry (100m grid) for model

simulations. The model results indicate a substantial surge in sea water inundation (~30%) into the estuary and mangrove area, primarily attributed to morphological alterations. Similarly, there is a change in the circulation pattern, with a gradual increase (+25cm/s) in surface current leading to higher sediment dispersion from Coringa and adjacent creeks. This sedimentation directly impacts phytoplankton, mollusks, crustaceans, and fish diversity. The ecological model indicates 13.7% decline in phytoplankton production due to salinity intrusion and higher turbidity. Moreover, Sea level rise effect contributes to a reduction in mangrove spatial distribution due to currents and species diversity due to micro-tidal sediment. The study identifies the zones affected by the stressor on the basis of elevation, water flow, and biodiversity index. This research provides a valuable resource for understanding and mitigating the impacts of climate-induced variability on the Coringa Mangrove ecosystem. Keywords: Mangrove Ecosystem, Climate Variability, Sea Level Rise, Hydro-Ecological Model, Biodiversity Dynamics.

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Is Ballast Hypothesis valid in the Bay of Bengal?

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The ballast hypothesis involving rapid sinking of organic carbon in association with riverine mineral particles is proposed in the Bay of Bengal (BoB) in 1991. The ballast hypothesis was used intensively to explain several biogeochemical processes such as low primary production, weak oxygen minimum zone (OMZ), low bacterial respiration rates and lack of denitrification in the BoB. In contrast, the recent measurements indicated that high primary production, intense OMZ with nano molar oxygen and denitrification in the sinking particles. Hence the ballast hypothesis is re-visited using the recent experiments conducted on sinking particle flux using sediment traps, 234Thorium based particulate organic carbon export, particle back scatter, water column biogeochemistry, stable isotopic composition of carbon and nitrogen of sinking particles and surface sediment of shelf region. The isotopic data suggests the sinking organic matter is mainly contributed by in-situ production supported by dissolved organic nitrogen (DON). The amount of organic matter decomposed within the water column was higher in the north and decreased towards southern BoB and it is consistent with the spatial pattern of rate of sinking particle flux suggesting against ballast hypothesis of removal of organic matter to the sediment with weaker modifications in the water column. The higher organic carbon trapped in the middle and deep than shallow traps was observed and it is attributed to cross-shelf transport of sedimentary organic carbon as evidenced from the back-scatter of particles and isotopic composition carbon and nitrogen of shelf sediments. Despite increase in river discharge due to melting of Himalayan glacier, insignificant variability in the sinking carbon fluxes in the past three decades indicate that river discharge is not a drive force for higher sinking carbon fluxes to deep BoB than hitherto hypothesized as ballast effect.

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Interannual Variability of Low-salinity Plume in the Southeastern Arabian Sea during winter monsoon

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The sea surface temperature (SST) in the southeastern Arabian Sea (SEAS) exhibits a rapid

increase during the pre-monsoon period (April-May) as the Indo-Pacific warm pool migrates into the northern hemisphere. It has been shown that this warm water volume over the SEAS not only contributes to the onset of the Indian Summer monsoon but also influences the formation of tropical cyclones over the Arabian Sea during this period. This intensification of the SEAS warm pool is influenced by freshwater transport from the Bay of Bengal (BOB) during the winter season (December- February) through a narrow region south of the southern tips of India and Sri Lanka (3oN-7oN,75oE-82oE). In this study, we have investigated the zonal extent of the low-saline plume in the Arabian sea during January-March over the last three decades. We find that the years with extended (retracted) plumes induce negative (positive) sea surface salinity in the SEAS. Our analysis, based on reanalysis datasets and observations, indicates that this interannual variation is linked to equatorial forcing (zonal salt advection) rather than the saltwater transport from the western boundary of the BOB. The years with the extended (retracted) low salinity plumes are always preceded by weakened (strengthened) fall Wrytki Jet during the previous year. During a weaker fall jet year, the eastward advection of the western Indian Ocean's high salinity water reduces, causing a negative sea surface salinity anomaly in the eastern equatorial basin. This low salinity water then advects westward with the winter monsoon current (WMC), causing an extended low-salinity plume southwest of Sri Lanka during winter months. The processes reverse during a retracted phase of the low-salinity plume. This extended (retracted) low salinity plume contributes to the interannual variability of the mixed-layer depth and, therefore, air-sea interaction in the southeastern Arabian Sea.

Impact of tropical cyclones on the wave activity in the Bay of Bengal, 1979–2019

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The study analyzes the impact of tropical cyclones (TCs) on wave activity in the Bay of Bengal (BoB) by examining their contribution to both mean and extreme wave climatology for a period of 40 years (1979-2019).The study conducts a comparative analysis between the Climate Forecast System Reanalysis (CFSR) and Fifth generation European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalysis (ERA5) wind forced simulation and their respective filtered versions (where the signatures of the TCs are removed from the wind forcing CFSR and ERA5 datasets) using the WAVEWATCH-III model numerical simulation.This method of twin simulations enables the isolation of TC-induced waves from the general wave activity, facilitating a precise quantification of their influence. Over 200 TCs in the BoB were sampled in the simulation and the obtained modelled significant wave height (SWH) and wind speed were cross validated extensively against Indian National Center for Ocean Information Services (INCOIS) buoy observations measured for 39 TCs in the same region. TCs were identified to contribute significantly to the extreme wave heights, accounting for approximately 80% of the maximum SWH and about 40% to the highest 1%

of SWH. The geographical distribution of SWH varied across seasons and locations within the BoB. Their contribution to the mean SWH climatology during the post-monsoon season was approximately 9%, with slightly lesser impact observed during the pre-monsoon season. The northern BoB and the east coast of India experienced the most substantial TC-induced wave impact during the post-monsoon period. Conversely, during the pre-monsoon season, the eastern BoB and the coastlines of Bangladesh and Myanmar registered higher TC- induced wave influences. This comprehensive analysis highlights the significant role of TCs in shaping the wave climatology of the BoB and also emphasizes the spatial and seasonal variations of their impact. Such insights are crucial for understanding and predicting the dynamics of wave patterns in cyclone-prone regions, aiding in the development of effective risk mitigation strategies and coastal management plans. Keywords: Tropical cyclone, Ocean waves, Significant wave height, WAVEWATCH-III, Wave climate, Extreme waves, Bay of Bengal

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Multi-band and Multi-scattering epsilon based Atmospheric Correction for EOS-06 Ocean Colour Monitor (OCM3)

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Ocean color remote sensing has proven to be an effective tool for examining and overseeing marine biogeochemical properties. The objective of ocean color sensors is to ascertain the spectral distribution of visible solar radiation that is backscattered or reflected from the ocean surface, whether from above or below, and as it traverses the sea-air interface. The Top of the Atmosphere (TOA) radiance, as measured, is primarily influenced by the absorption and scattering of light by gas molecules and aerosols in the atmosphere. It is crucial to accurately model and remove these atmospheric contributions. Furthermore, adjustments are necessary to compensate for the scattering losses linked to the transmission of water-leaving radiance through the atmosphere. This entire process, referred to as atmospheric correction (AC), aims to correct for atmospheric effects and extract water-leaving radiance (Lw) from TOA radiance. The Lw obtained is then utilized to estimate chlorophyll-a concentration in water and retrieve various biogeochemical parameters, including diffuse attenuation coefficient, total suspended matter, and colored dissolved organic matter. Current AC algorithm utilizes only two bands and their ratio (epsilon) in the near infrared (NIR) to estimate aerosol reflectance and aerosol type. Moreover, it involves deriving of single scattering epsilon and then converting it into multiple scattering radiance. Latest AC algorithms are based on multi-scattering epsilon approach in which the aerosol model and optical properties determination is done in multiple scattering space. These algorithms also utilize all spectral bands in the NIR to SWIR spectral range to reduce the uncertainty in the AC process and to improve ocean color retrievals in coastal waters. This study applies the latest AC algorithm on EOS-06 OCM3,

which is having three spectral bands in the NIR to SWIR region (780, 870 and 1010 nm), to improve the AC process and retrieve better ocean colour parameters.

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Performance of Moored Buoy Systems during servere Cyclonic Storm Michaung in the Bay of Bengal

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This Study analysed the Observations from the moored buoy network during Severe Cyclonic Storm Michaung (01st to 06th December 2023) which was formed in the Bay of Bengal. The tropical cyclone intensified into a Severe Cyclonic Storm over the North Tamil Nadu and off south Andhra Pradesh on 04th December. The Cyclone made landfall near south of Bapatla between Nellore and Machilipatnam in Andhra Pradesh on 05th December 2023. The observations from the moored buoys in the Bay of Bengal and Off Chennai coast were presented. The Moored Buoys BD11& CB06 in Bay of Bengal showed significant variations in the observed datasets which are closer to the Cyclone track (285 km & 87 km respectively). The Tropical cyclone heat potential (TCHP) (in kJ/cm2) and

depth of the 26°C isotherm (D26) (in m) were computed. The met-ocean parameters cyclone were investigated. During the Cyclone period, SLP dropped upto 996 hPa in CB06 on 4th December whereas in BD11 it was observed at 998 hPa on 3rd December. The maximum wind speed, of ~19 m/s was observed at BD11 and 15 m/s at CB06, and the highest significant wave height of 5.37m was recorded on 3rd December in the BD11 location.

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Bay of Bengal Tropical Cyclones: Ocean Observations and Advanced Numerical Modeling

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Tropical cyclones significantly impact coastal communities, necessitating a focused exploration of the vital role played by comprehensive Ocean Observation in the northern Bay of Bengal. Centred on the unprecedented landfalls of Mocha, Hamoon, and Midhili in 2023, our study aims to enhance predictive capabilities in cyclone-prone regions through advanced numerical models featuring suitable microphysics schemes. The study highlights the critical need for standardized measurement techniques to improve the precision of reported wind speeds. Disclosures of uncertainties within early warning systems emphasize a persistent commitment to advancing methodologies for more accurate cyclone forecasting. An analysis of satellite data reveals the robust sea surface temperature (SST) response of the Bay of Bengal to tropical cyclones. The integration of WRF and CROCO simulations demonstrates heightened predictive accuracy compared to WRF-only simulations. Numerical models expose track and landfall time errors, indicating variabilities of 50 to 75 kilometres and 3 to 8 hours, respectively. The study emphasizesthe critical limitation arising from the absence of comprehensive Ocean Observation coverage in the northern Bay of Bengal, impeding timely forecasting of Ocean storms. This highlights the compelling need for Ocean Observation and Ocean Forecasting initiatives to safeguard coastal communities, paving the way for future research aimed at refining the accuracy and timeliness of impact-based forecasting. This holistic approach is instrumental in mitigating the potential impact of tropical cyclones on vulnerable coastal regions, emphasizing the indispensable role of Ocean Observation in revitalizing coastal resilience. Keywords: WRF, SST, Impact-based, Ocean Forecasting, coastal resilience.

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Genesis of Arabian Sea Mini Warm Pool using a Coupled Numerical Model

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The Arabian Sea mini warm pool (ASMWP), which consists of warm water patches in the southeastern Arabian Sea, is a critical element that has the potential to influence the Monsoon Onset over Kerala, a much-awaited occurrence that takes place from late May to early June. The mechanism by which ASMWP forms is independent of the tropical Indo-Pacific warm pool. Low-saline water transported by the Bay of Bengal during the winter months (December, January, and February) induces intense stratification and the formation of a thick barrier layer; this, in turn, can increase the heat content of ASMWP by impeding vertical mixing. Few studies have contested this theory and prioritized alternative variables, including wind and net heat flux. Besides that, little research has been done on how these factors can affect the ASMWP during its mature phase. Our study aimed to explore the role of the ocean and atmosphere during the mature phase of the ASMWP using a coupled ocean-atmosphere numerical model. The Model Coupling Toolkit has been used to couple the numerical models of the atmosphere, Weather Research Forecast (WRF), and the ocean, Regional Ocean Modelling System (ROMS). The coupled model is run from April 1st, 2018, through June 15th, 2018. The first month was set aside for spin-up, and the final forty-five days were devoted to our study's analysis. The major currents over the Arabian Sea, sea surface salinity, and sea surface temperature predicted by the coupled model agree well with observations. Aside from that, the numerical model accurately represents the mature and decay phases of ASMWP. This experiment is named as the control experiment. Later, to comprehend the impact of oceanic and atmospheric influence during the mature phase of the ASMWP, some sensitivity experiments on wind and salinity over the Arabian Sea were carried out.

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Physical and biogeochemical variability over a decade in an Arctic fjord, and its climate relevance

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Understanding temporal variabilities of the Arctic processes is crucial as this can influence the pace of the climate trends. The west Svalbard fjords are influenced by the Arctic amplification and the warm-saline North Atlantic Water (AW) inflows. In this study, we used decade-long observations since 2011 and a high-resolution fjord model coupled with biogeochemistry to decipher and explain the physical and biogeochemical variability in a west Svalbard fjord-Kongsfjorden. The observations show that the fjord water column underwent a 0.5-1.0oC warming compared to the last decade. The fjord AW layer shows a temperature rise of 0.09oC/yr, associated with the increase in the West Spitsbergen Current. The reanalysis data show that the North Atlantic Oscillation (NAO) in its positive phase shifts the storm tracks northward enhancing AW flows to the Arctic. The winter NAO is found to influence the AW entry into Kongsfjorden from summer to autumn. Besides NAO, the highest winter sea-ice

coverage in 2011 limited the summer AW entry resulting in the lowest temperature, salinity, and thinnest AW layer. Contrarily, only 11.6% fast ice coverage and the subsurface AW inflows compensating for the surface freshwater outflow by local south easterlies led to enhanced AW intrusion and the highest temperature and salinity in the summer 2014. Thus the observations and simulations show that a combination of the above processes resulted in warmer and colder fjord environments. During the warmer years, the spring subsurface chlorophyll was observed higher than in the colder years. Nitrate showed a general pattern of decline, coinciding with high chlorophyll values; the decline was lesser during the cold years when the chlorophyll was lower compared to the warmer years. The enhanced chlorophyll in Kongsfjorden during the warm years indicates the shifting of the fjord into a more productive ecosystemin an ongoing Arctic warming scenario.

WOSC/2024/ABS/90

Monitoring and Assessment of low frequency sound in Arabian Sea

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Sound is the highly efficient means of communication underwater and is the primary way many species use for navigation and localization. High noise levels can reduce the ability of animals to communicate and hence, it is essential to understand the baseline state of ambient noise levels. Measurements from a Passive Acoustic Monitoring (PAM) system deployed in Arabian Sea are used to understand the acoustic field. The Essential Oceanographic Variable (EOV) Ocean Sound and the derived products Sound Pressure Level (SPL) has been compared with supporting variables such as AIS Marine traffic data, Sound Speed Profile (SSP) and Sonic Layer Depth (SLD). The measurements as well as post processing of the data were subject to standardized procedures, quality control and signal processing routines. 1/3 rd octave band of 63 Hz and 125 Hz along with 2 kHz is used to strengthen the ecological relevance. Propagation modeling studies with respect to the seasonal changes in the acoustic environment brought out specific features such as ducts, leakage, Minimum Cutoff Frequency, Transmission Range etc. This work focuses on the natural and anthropogenic sound due to activities such as shipping, which shows an increasing trend over the years. The data was sampled at 32 kHz for 12 minutes every 30 minutes attaining 40% duty cycle. Data retrieved is processed and spectral analysis carried out, and the acoustic metrics are reported for octaves in the low frequency band. Variationin SPL from Nov 2018 - Nov 2019 for the octave frequencies from 63 Hz to 2 kHz is examined and is seen to follow SLD that spans 100 m from surface, and varies with SLD deepening. The derived SPL in the range 85 to 110 dB in the lower band is typical of the receiver position relative to the surfaceduct and the soundscape in the region.

WOSC/2024/ABS/92

Summer variability in bio-optical properties and phytoplankton pigment signatures intwo adjacent high Arctic fjords, Svalbard

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Arctic fjords are sensitive to the enhanced climate warming-induced glacial meltwater discharge that influences its hydrography and biology. This study explains the impacts of the underwater light environment and nutrient limitation on the phytoplankton biomass, composition, and light absorption in the sunlit zone of the Kongsfjorden (KG)- Krossfjorden (KR) twin fjord ecosystem during summer when the meltwater discharge is at maximum. Observations in two phases in each fjord revealed pronounced spatial hydrographic variations between the phases and among the fjords. The intrusion of warm Atlantic water into fjords and subsurface chlorophyll maxima was observed. Meltwater- induced higher concentrations of optically active constituents in KG resulted in a shallower euphotic zone than KR. Nitrate and silicate limitation was evident in both fjords. Higher phytoplankton light absorption coefficient (aph, m-1) and chlorophyll-a in KR implied its higher productivity potential. However, the light-absorption efficiency of surface microplankton was affected by the "pigment-package effect". Phytoplankton pigments analyses revealed an inter-fjord difference in surface phytoplankton composition predominated by microphytoplankton followed by nano and picoplankton. The average diversity index for the phytoplankton group (H/"/g) was higher in KR (0.71) than KG (0.55), which was possibly controlled by microzooplankton grazing. This study reveals that environmental settings in both fjords were quite different, which drives their productivity potential and species diversity. Thus, an increased warming climate can have impacts of varying magnitude on these fjord ecosystems despite their close geographical proximity. Keywords: Arctic fjords, bio- optics, glacial meltwater, light attenuation, nutrient limitation, phytoplankton.

WOSC/2024/ABS/93

How important Ocean observations for weather and Climate Predictions?

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The Tropical Atmosphere Ocean (TAO) and Triangle Trans-Ocean Buoy Network (TRITON) buoys deployed in the tropical Pacific play a significant role in monitoring tropical Pacific conditions such as El-Niño/La-Niña in real-time. Similarly, the Indian buoy observations are crucial for monitoring Indian Ocean conditions such as Indian Ocean Dipole and Indian Ocean Warming. Earlier studies have illustrated the importance as well as irrelevance of moored buoy observations towards the prediction of sea surface temperature in the tropical Pacific Ocean. With the advent of Argo floats, have these moored buoy observations become redundant? In the present study, we address this question in the context of Indian summer monsoon rainfall (ISMR) prediction. The extreme monsoon year of2018 was selected to test the above hypothesis. Without moored buoy observations being assimilated, the oceanic initial conditions and the seasonal forecasts had large oceanic temperature errors and forecasted a normal monsoon instead of a below-normal monsoon during 2018. Therefore, moored buoy observations are essential and should be assimilated to get realistic Pacific Sea surface temperature (SST) and accurate ISMR predictions.

WOSC/2024/ABS/299

Application of machine learning techniques for estimating ocean mixed layer depth

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The mixed layer depth (MLD) of the ocean is a significant variable that acts as an interface between the ocean and atmosphere influencing the climate and the marine ecosystem. Argo floats are commonly employed for sampling this layer, yet their spatial and temporal coverage remains insufficient for comprehending the variability of the MLD in the northern Indian Ocean. The lack of in-situ sub-surface data necessitates for alternative methods to calculate these sub-surface variables. In this context, we examine machine learning (ML) approaches to derive MLD based on remotely sensed surface variables in the two basins of the Northern Indian Ocean (NIO); Arabian Sea (AS) and Bay of Bengal (BoB). Utilizing Argo data, we illustrate the application of multiple ML techniques, such as artificial neural network (ANN), support vector machine (SVM), and random forest (RF), for the estimation of MLD and assess their comparative capabilities. While the ANN method has previously been used to estimate MLD in basins beyond North Indian Ocean, the model skills of SVM and RF has not yet been established. In both basins, our findings demonstrate marginal superiority in the performance of SVM compared to ANN and RF. The results also indicate that estimation errors are more pronounced for deeper MLD (>50 m) compared to shallower depths (<50 m). In the BoB, sea surface salinity (SSS) significantly influences MLD estimation, while it shows no significant impact in the AS. Other significant predictors for both basins include latitude, month, sea surface temperature (SST), and sea level anomaly (SLA). The results of our study indicate that ML approach exhibits significant potential and should be considered for predicting a range of sub-surface oceanic variables.

WOSC/2024/ABS/111

Demarcating the long lived and short lived eddies in the Eastern Arabian Sea

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Eddies are omnipresent in the different basins of the global ocean. The present study utilises long-term reanalysis data to comprehend the dynamics of short and long-lived eddies in the Eastern Arabian Sea. The global ocean physics reanalysis (GLORYS12V1) data for the 28-year period (1993-2020) is used to identify and track eddies using the geometry- based PyEddy tracking algorithm based on Sea level anomaly. The tracked eddies are further categorised into short (< 15 days), medium (15-180 days) and long-lived (> 180 days) eddies based on their lifetime. The average characteristics of each type of classification are studied in detail. A case study on the generation of eddies is also dealt with in detail.

WOSC/2024/ABS/113

Assessment of the evolution of sediment plumes along the southwest coast of India using satellite observations

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Sediment plumes are regions influenced by riverine freshwater and significantly impact the physical, biological, and geochemical processes of the continental shelf. Monsoonal rains feed the rivers during the southwest monsoon (June–September), and a huge volume of sediment debouches onto the continental shelf. There are no studies addressing the extent of the sediment plume on the west coast of India. The satellite observations are limited by extensive cloud cover during the period. Consequently, previous investigations of plumes from Indian Ocean regimes were primarily focused on large rivers and relied on modelling approaches. This study employs satellite observations, specifically remote sensing reflectance (Rrs) to represent sediment plumes from the Periyar River on the southwest coast of India. We selected Rrs wavelength at 670 nm from the high-resolution Sentinel-3 from 2018 to 2022. Using harmonic analysis, we created a new gap-free climatology by incorporating 15 frequencies of the annual cycle. The sediment plume boundary is identified from the climatology, with a threshold Rrs of 0.0015 Sr-1 established through maximum correlation with river discharge from the Periyar. Notably, climatology based on arithmetic averaging is inadequate for understanding the plume area because of the presence of gaps in the data due to cloud cover. The southwest India (Kerala) experienced exceptionally high rainfall from June to August 2018, leading to severe flooding. We present a case study of the evolution of the sediment plume from the Periyar River during this intense flood event. To understand the flood plume's evolution, we created a daily snapshot based on harmonic analysis from the available cloud-free images from 22 August to 30September 2018. The study reveals that plume signals extend up to 40m depth contours. Additionally, we show the nature of wind and geostrophic currents during the event and speculate their roles in the plume's evolution.

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Quality control methods and analysis for Wave Rider Buoy data in the Indian Ocean

M Anuradha, INCOISTVS Uday Bhaskar; Venkat R Shesu; E. Pattabhi Rama Rao

Quality control ensures the accuracy of oceanographic and meteorological data, which allows the researchers to draw valid and reliable conclusions from their research. Precise data is fundamental for understanding marine processes, ecosystems, and climate dynamics etc. The quality of wave measurements is crucial for validating wave forecasting models, calibrating and validating satellite wave sensors, comprehending wave physics, monitoring climate conditions, designing ships and offshore installations, conducting effective sea operations, and conducting studies on climate trends and variability (Magnusson et al 2021). Wave rider buoys (WRB), also known as wave buoys or wave rider systems, are specialized oceanographic instruments designed to measure and record various parameters related to ocean waves. Understanding wave height, period, and direction helps in predicting storm surges, coastal erosion, and potential hazards for marine activities. A network of 16 Wave rider Buoys has been established along strategic locations of the Indian coastline by Earth System Science Organization – Indian National Centre for Ocean Information Services (ESSO-INCOIS) to monitor the wave conditions along the Indian coast, as well as for validation of the models. The quality control methods are developed and applied upon on the delayed mode data from 14 years WRB data. On an average the quality control pass percentage of significant wave height is about 90%. In the total data, 10 percent of the data is flagged as bad data due to

quality control.

WOSC/2024/ABS/138

Analysis and Quality Control of Tide Gauge Data over the Indian Ocean

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Abstract: Observation is way of gathering data by watching behaviour, events, or noting physical characteristics in their natural setting. Observations can be overt (everyone knows they are being observed) or covert (no one knows they are being observed and the observer is concealed). The benefit of covert observation is that people are more likely to behave naturally if they do not know they are being observed. The present paper describes data processing and quality control of time series water level data by using Tide gauges. A network of state of-the-art 36 tidal gauge stations has been established by Indian National Centre for Ocean Information Services (INCOIS) along strategic locations of the Indian coastline to monitor progress of tsunami waves, as well as for validation of the model results. This study describes the data processing and quality control of the hourly tide gauge data particularly for the Chennai, Cochin, Nagapattnam, Visakhapatnam and Kakinada stations. And then validated the observed data with the predicted tide data. We also got good agreement with the observed data. The quality of the data with the help of quality control procedures and dissemination of data. This study provides the details about the real time quality control procedures on tide gauge data. Keywords: Tide gauge, observation, quality control, Time series, validation.

WOSC/2024/ABS/153

Projection of Physical Characteristics of Extreme Rainfall Events during the Indian Summer Monsoon Using CMIP6 Models

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We identified a group of models from the Coupled Model Intercomparison Project 6 (CMIP6) that effectively simulate the observed mean Indian summer monsoon and extreme rainfall events (EREs) and their corresponding interannual variability. Subsequently, we assessed the projected changes in EREs based on these models across four climate change scenarios viz., Socioeconomic Pathways (SSP) 1-2.6, 2-4.5, 3-7.0, and 5-8.5 defined using percentile thresholds. Across all scenarios, we observed increased mean rainfall, increased amounts of extreme rainfall, and increased variability, including a notable rise under SSP5-8.5. Towards the end of the 21st century, the spatial variability of both mean and extreme events was found to be most pronounced under the warmest scenario, with very extreme rainfall exhibiting six times greater variability compared to mean rainfall. This implies a substantial vulnerability for water resource management. The intensity and frequency of very extreme rainfall events (vEREs) were projected to increase, although with considerable variability among models. The relationship between atmospheric water holding capacity and changing temperature, as indicated by the Clausius Clapeyron (CC) relation, exhibited near CC scaling,

particularly over the north Indian region. We identified the physical characteristics of extreme events to discern any alterations in the relationship between EREs and air temperature. This regional-scale information will be valuable for assessing regions prone to heavy rainfall in the future.

WOSC/2024/ABS/155

Downscaling CMIP6 Earth System Global Climate Models' winds for the Indian Ocean

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As a popular renewable energy source, wind has great potential to reduce carbon emissions globally. Following the 'carbon neutral' strategy, wind power can replace fossil fuels in India. Therefore, it is necessary to assess the changes in the wind potential of the Indian coastal areas in the near and far future. Downscaling is an approach to obtain fine-scale weather and climate information. In this study, we downscaled three Coupled Model Intercomparison Project Phase 6 (CMIP6) Earth System Global Climate models' winds with reference to the European Centre for Medium-Range Weather Forecasts Reanalysis 5 (ERA5) winds to construct bias-corrected regional winds for the Indian Ocean. The CMIP6 winds data spans over the historical period from 1980–2014 and future scenarios (SSP585) from 2015–2100. Here it is to be noted that the selected CMIP6 models (GFDL, UKESM, and CNRM) cover 80% of CMIP6 models' projected changes of the Indian Ocean's physical and biogeochemical states. We employed five downscaling approaches such as Quantile Mapping (QM), Quantile Delta Mapping (QDM), Linear Scaling (LS), Variance Scaling (VS), and Time-Varying Delta (TVD) methods to construct bias-corrected downscaled winds for the Indian Ocean. This study reveals that the TVD method performs relatively better than the other methods in producing bias-corrected winds. Further, the climatological mean and interannual variance indicate that the bias-corrected winds are of better quality compared to the individual CMIP6 models. Hence, the bias-corrected winds can be used to examine changes in winds pattern, a limitation of CMIP6 models in providing the realistic changes. Additionally, the bias-corrected downscaled winds will be extremely useful to force the regional models.

WOSC/2024/ABS/156

Temporal Variability of Oceanic Fronts and their influence on Acoustic Propagation in the Southeast Arabian Seas.

Hasna Kunjumon, National Institute of Ocean Technology; M.C. Sanjana

Acoustic propagation in seawater is highly influenced by the dynamic nature of water mass and oceanic fronts. This study uses CTD data collected during November 2018 to November 2019 in the South East Arabian Seas (SEAS) to investigate these influential factors. The variation in temperature, salinity and density across the water mass affect the sound speed profiles, directly affecting the SONAR detection performance, underwater communication and marine mammal behavior. Oceanic fronts, characterized by transition zone between the water

mass properties, resulting in the complexities in acoustic transmission through phenomena like refraction, reflection, and scattering. Firstly, the temporal variability of water mass was studied. The Arabian Sea high salinity water mass (ASHSW) was observed as subsurface high salinity core. Persian gulf (PGW) and red sea water mass (RSW) was also observed. The dynamic processes such as down welling, upwelling, intrusion of low saline waters, affects the spreading of this water mass. The temporal variability is observed in the water mass which shows diverse variations across varying depths during different seasons, consistently reflecting difference in both thickness and core value throughout the study period and its presence shows the difference in the sonic layer depth (SLD) and hence influence on the sound transmission. Secondly, the oceanic front in our study region is detected using canny edge detection algorithm and we could observe the presence of frontal region in our study location. The datasets were usedto calculate the number of categories of sound speed profiles by clustering method so that typical sound speed profile structure of various categories in different seasons were obtained. The sound propagation across the fronts was studied to evaluate the effect of frontal system on propagation loss.

WOSC/2024/ABS/168

Impact of global warming on regional ocean circulation, Air-sea interactions and cyclogenesis over the Bay of Bengal

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The occurrence of cyclones in the Bay of Bengal has significant meteorological and socio-economic impacts on the surrounding countries and plays a crucial role in shaping the biogeochemistry, circulation patterns, and physical oceanographic characteristics of the ocean. Recent studies, such as Roxy et al. (2020), have reported rapid warming in the Indian Ocean during recent decades. As a vital part of the North Indian Ocean, the Bay of Bengal has witnessed a notable increase in the frequency and intensity of tropical cyclones in recent years. Therefore, the objective of this study is to understand the impact of Indian Ocean warming on the changes in the regional circulation patterns, air-sea interactions, and subsequently, cyclone formation activity in the Bay of Bengal. This study focuses on the physical characteristics of the Bay of Bengal, such as sea surface temperature (SST), mixed layer depth, Isothermal layer depth, D20, sea surface height (SSH), sea surface salinity, zonal and meridional currents during global warming episodes in the past and present decades. The study reports the prominent changes in Bay of Bengal circulation and physical oceanographic characteristics with respect to global warming, also elucidates the causative factors responsible for these changes and its impact on cyclogenesis over Bay of Bengal. Keywords: Global warming, regional circulation changes, upper ocean variability, cyclogenesis, ocean circulation.

WOSC/2024/ABS/179

Role of physical oceanographic parameters in impacting the cyclogenesis over Indian Ocean

Anuj Gupta, University of Hyderabad; Pentakota Sreeniva, University of Hyderabad

Tropical cyclones form over tropical regions in both hemispheres (the Northern and Southern Indian Oceans). Till now, sea surface temperature (SST) is known as the only important parameter for cyclogenesis in oceanic point of view. Oceanic Rossby and Kelvin waves are

the factors that control the variability of different parameters. The Indian Ocean produces a lot of cyclogenesis each year, which have wide social and economic impacts on the Indian subcontinent. The motive of this work is to understand different physical oceanographic parameters and their impacts on tropical cyclones in the tropical Indian Ocean. In the northern Indian Ocean, downwelling kelvin waves (dKw) manipulate the thermal structure of the ocean by affecting the thermocline depth. Due to dKw propagation, the thermocline depth increases, warms up the sea surface, and increases the oceanic heat content. It impacts the sea surface salinity (SSS) as well, which eventually drives the density to change. Both warm SST and high oceanic heat content induce cyclogenesis, though SSS does not have too much importance in cyclogenesis. A positive sea level anomaly (SLA), which is mainly influenced by downwelling Rossby waves (dRw), influences cyclogenesis by deepening the thermocline depth from October to December. The Rossby wave pattern is not clearly visible in sea surface temperature, but during August and September, a coastal kelvin wave is propagating, which is influencing cyclogenesis, We found that, in the southern Indian Ocean Westward propagating dRw significantly controls different oceanic parameters and eventually controls the cyclogenesis over this region. Further the impact of different oceanic parameters on cyclogenesis over Bay of Bengal is reported in this study.

<center>WOSC/2024/ABS/187</center>

Development of pCO2 algorithm and its Spatiotemporal variability in South-east Arabian Sea using Remote sensing and In-situ Datasets

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The sea surface partial pressure of CO2 (pCO2) is a critical parameter in climate change, ocean acidification, and carbon flux studies. Monitoring pCO2 levels helps assess carbon dioxide sources and sinks, including human activities and natural processes. This study focuses on deriving sea surface pCO2 using an empirical algorithm based on chlorophyll a (Chl-a), sea surface temperature (SST), and sea surface salinity (SSS) from MODIS Aqua and OISSS datasets. Monthly Chl-a, SST, and SSS images were generated over the South- east Arabian Sea from 2012 to 2022, and their inter-annual and intra-annual variability were analyzed. Six regional and global water algorithms were used to derive pCO2, resulting in different ranges of estimates with some algorithms underestimating and others overestimating pCO2. To determine the most accurate algorithm for our study area, validation with in-situ data was performed. The Zhu et al., (2009) two-parameters algorithm (SST and Chl-a) showed the correct trend in the correlation plot, with an R^2 value of 0.80 and RMSE of 15.52. Utilizing this algorithm, composite images of pCO2 were generated, and the pCO2 values ranged between 380 – 540 μatm. This range demonstrated better accuracy when compared with in-situ data. Also inter-annual and intra-annual variability of pCO2 also generated for our study area, The findings highlight the importance of selecting an appropriate algorithm for accurate pCO2 estimation. The study contributes valuable insights into the dynamics of pCO2 in the South-east Arabian Sea, providing a basis for further research and understanding of carbon dynamics in this ecologically significant region. Accurate estimation of pCO2 is crucial for assessing the impact of human activities and natural phenomena on marine ecosystems and global carbon cycles. Continuous monitoring and refinement of pCO2 algorithms are essential for advancing our knowledge of climate change and ocean acidification, enabling effective management and mitigation strategies for these critical environmental issues.

<center>WOSC/2024/ABS/188</center>

Drivers of the Indian summer monsoon variability: A comparison between Early Twentieth Century and Present warming periods

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Drivers of the Indian summer monsoon variability: A comparison between Early Twentieth Century and Present warming periods Suchithra Sundaram*1,2 and G. Latha1 1 Ocean Acoustics, National Institute of Ocean Technology, Chennai 2 Department of Science and Technology (WOSA), India Corresponding author*: suchithrasundaram@gmail.com Abstract: It is a fact that, compared to the late nineteenth century, the early twenty-first century is approximately 0.8 °C warmer, and a further rise in temperature is predicted. Our current understanding of Earth's rising temperatures indicates that it can lead to longer and hotter heat waves and cold waves, more frequent droughts, extreme precipitation events, an increase in the frequency of hurricanes, faster sea ice melting, Sea level change, and many other natural calamities. However, past investigations illustrate that the surface air temperature after the Industrial Revolution did not increase continuously. Instead, between warm periods, there were less warming or slack temperature periods known as warming hiatus (eg., 1945-1970). It is intriguing to note that, during the first half of the twentieth century (1910 to 1940), there existed a significant warming period known as the Early Twentieth Century Warming (ETCW) period when the Greenhouse gas concentration (GHG) was nearly four times lower than today. The significance of ETCW is that it had similarities with the current warming period, particularly increased surface air temperature anomalies of comparable magnitudes of the present day in the high latitudes of the northern hemisphere. This study aims to understand the drivers behind the precipitation variability of the Indian summer monsoon (ISM, June– September) during ETCW and compare it with the present warming period. Preliminary analysis of All India Summer Monsoon Rainfall data from the India Meteorological Department from 1901 to 2022 (122 years) shows that despite the difference in the GHG concentration, both periods show a similar trend in the rainfall variability during the peak phase of the warming. Further research is needed to comprehend the influence of the atmosphere- ocean-sea ice interactions and teleconnections during both epochs in causing such similarities other than the GHG. Keywords: Indian Summer Monsoon, Ocean, Sea Ice, Teleconnection, Surface temperature

Numerical Modelling of Flood Inundation and Run-Up along Selected River Banks of Kerala

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The state Kerala was in the shadow zone of numerous natural disasters like the tsunami of 2004, Ockhi 0f 2017, Floods of 2018, replicated floods in 2019. Prior to 2004 the term disaster was a matter of strange things for the Keralites which were happening on the other side of the world. But the disasters like tsunami, Ockhi, repeated floods, few landslides and landslips revealed our vulnerability. These disasters were an eye opener to the Keralites. Immediately after each disaster the research and development gained momentum to mitigate the impact of disasters. The state of Kerala is engrossed in establishing a flood warning system due to the repeated

flooding. The main component of a flood warning system is the prediction of flood inundation and run-up pattern along the banks of rivers and it is also helps to identifying the vulnerability of the flood. The prediction of flood characteristics can only be done with the help of an effective numerical model. So this paper is an investigation to numerically model the flood inundation and run-up pattern along three prominent river banks pertaining to South, North and Central Kerala. As real time data collections are considered to be laborious, tedious and time consuming. satellite data sets with the support of an open source model - HEC RAS was selected for this investigation. The model results predicted that Kerala is not at all vulnerable to floods for normal and moderate modes of rainfall. But significant inundation will arise for heavy rain fall and extreme rainfall events like the hypothetical mode of rainfall envisaged under this investigation. The simulation studies also showed that external discharges like dam discharge and tidal reflections can also lead to increased run-up and inundation levels along these river banks. Keywords: inundation, run up, HEC RAS, flood, Ockhi

Impact of river runoff and precipitation on surface pH along the Indian coastline using a high-resolution model

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Surface ocean pH is a critical parameter affecting marine ecosystems and carbon cycling, and its spatio-temporal variability, which is influenced by various natural and anthropogenic factors. In the coastal waters of India, river runoff and precipitation play crucial roles in modifying surface pH by altering the distribution of dissolved inorganic carbon (DIC) and associated biogeochemical processes. For this study, we employ MITgcm coupled with the DIC biogeochemical module to investigate the impact of river runoff and precipitation on surface pH at high spatial resolution. The physico-chemical parameters of the model are validated against available observational data to ensure its accuracy. The DIC biogeochemical module is integrated within the model framework, considering multiple DIC sources and sinks, including air-sea CO_2 exchange, biological production, and carbonate mineral dissolution. We aim to accurately capture the spatio- temporal distribution of DIC and its subsequent impact on surface pH. A series of sensitivity experiments are conducted to understand the individual and combined impact of river runoff and precipitation on simulated carbon parameters. The model's response to varying freshwater DIC fluxes and precipitation patterns could explain their relative contributions to surface pH variations. Additionally, the role of physical processes such as coastal upwelling and mixing are investigated in modulating the riverine signal and its propagation into the open ocean. Our study contributes to a better understanding of the drivers of surface pH variability in the region and their potential implications for marine ecosystem management and conservation efforts.

A Study on Evaluation of the Occurrences of Submarine Slope Failure-Induced Tsunamis in the Andaman Sea

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Tsunamis can result in devastating consequences, causing significant loss of life and destruction of coastal areas. While most tsunamis are triggered by submarine earthquakes, they can also be generated by other natural events such as volcanic eruptions, island collapses, and

massive landslides on marine margins. The current study focuses on tsunamis caused specifically by slope failures. A comprehensive review of past literature employing diverse methodologies in tsunami wave modelling has facilitated our enhanced understanding of the phenomenon and its underlying causative factors and also helped us monitor the potential for slope failure-induced Tsunamis in the Andaman Sea Region. We have employed a methodology centred on the analysis of water level data from buoy data sourced from NOAA – NDBC across the Andaman Sea Region, investigating for Tsunami signals. Additionally, Tsunami travel times have been computed utilizing a Python wave propagation model based on the hazard data obtained from the National Centers for Environmental Information (NCEI). Also, we aimed to scrutinize signals to assess their alignment with predicted signals generated by the tsunami wave propagation model and finally categorise these signals based on their conformity, distinguishing them into those with known causes and those with undetermined causes. The study intends ultimately to emphasize the importance of ongoing research, monitoring, and a multidisciplinary approach in advancing our understanding and readiness for tsunamis caused by slope failures, which is crucial for minimizing their devastating consequences.

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Dimethyl Sulfide (DMS) Emissions: Sea water concentration and Sea-Air Fluxes

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Dimethyl sulfide (DMS) is a naturally occurring trace gas which affects the Earth's radiation budget by changing radiative forcing through the formation of sulfate aerosols. Considering the spatial and temporal variability of seawater DMS, various climatologies have estimated the global distribution of DMS. In this study, the differences between estimations of seawater DMS, based on observation- based interpolation (Hulswar et al., 2022) (H22)) and proxy-based parameterization methods ((Galí et al., 2018) (G18) and (Wang et al., 2020) (W20)) are analyzed. Compared to the parameterization- based methods, interpolation-based methods show higher DMS concentration but no mesoscale variability. The parameterization-based methods also suggest positive significant long- term trends in seawater DMS (6.94 ±1.44% decade-1 for G18 and 3.53 ±0.53% decade-1 for W20). However large differences, often more than 100%, are observed between the different estimations suggesting that sea-air fluxes and hence the impact of DMS on the radiative budget will be sensitive to the estimation used. Further the total flux to the atmosphere in models is calculated using a seawater DMS concentration climatology anda sea-air flux parameterization. To calculate DMS flux seven flux parameterization methods ((Liss and Merlivat, 1986; Erickson, 1993; Nightingale et al., 2000; Ho et al., 2006; Goddijn-Murphy et al., 2012; Wanninkhof, 2014) (LM86, E93, N00a, N00b, Ho06, GM12, W14)) are used. After taking seasonal mean of calculated fluxes, the most used flux parameterization (N00b) is compared with other parametrizations to identify differences in absolute values and spatial distribution. In-situ flux observations are used to validate calculated fluxes of all parameterization and it is observed that emissions in current models overestimate the total sea-air DMS flux but underestimate the higher range when it can significantly impact new particle formation and growth. We also observed that there are regions where uncertainty in DMS flux is driven by uncertainty in seawater DMS concentration but in other regions, the choice of the flux parameterization will drive absolute flux values.

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Evolution of the thermohaline structure in South eastern Arabian Sea during winter

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The dynamics and thermodynamics of the south eastern Arabian Sea (SEAS) are influenced by both local and remote forcing. Active atmospheric convection, development of mini warm pool, thermal inversion, formation of barrier layer, and freshwater intrusion all make the SEAS an active area of research. The West Indian Coastal Current (WICC), the primary current on the west coast, reverses its direction in response to wind and thermodynamic forcing. The intrusion of freshwater from the Bay of Bengal modifies the thermohaline structure and mixed layer at SEAS. This study makes use of ten years of ocean and atmospheric data to examine the evolution of processes at SEAS. Local freshwater fluxes, river runoff, and advection of low saline water from the Bay of Bengal were analyzed for the salinity variation during the winter season. December to February is found to be the time of minimum salinity extending to a depth of 70m. Salinity at SEAS is found to be less affected by local freshwater forcing but more by advection. The high SSTat SEAS is a result of the combination of positive net heat flux and a shallow mixed layer.

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Annual cycle of dissolved oxygen associated with the variability of salinity and water hyacinths in the Cochin estuary.

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The Cochin estuary on India's southwest coast experiences pronounced seasonal changes due to the Indian Summer Monsoon. Beyond the better-known seasonal variations, there are Intra-Seasonal Oscillations (ISO), including the Monsoon Intraseasonal Oscillation (MISO) with a 30-60-day cycle of northward-moving rain-forming cloud bands from the equator. This study, utilizing a time-series measurement of salinity, temperature, sea level and dissolved oxygen from December 2019 to May 2021, reveals year-round ISO in the estuary. In the dry season (December to April), salinity averages around 30 PSU, with ISO amplitudes of 3 to 5 PSU. During the wet monsoon season, ISO amplitudes vary from 5 to 10 PSU. Notably, wavelet spectrum analysis highlights a 30-60-day variability in salinity during July, August, and September. The Outgoing Longwave Radiation (OLR) over the Indian Ocean shows a

northward propagation of cloud bands associated with MISO. The investigation establishes a connection between the variability in salinity and temperature in the shallow waters of the Cochin estuary and the MISO indices. We have also carried out the analysis of dissolved oxygen and the distribution of water hyacinth to investigate the water quality of the estuary. The percentage of this salt-intolerant aquatic vegetation cover in the estuary is depicting a decreasing trend after the closing of the Thanneermukkom saltwater barrage in December, whereas there is an increasing trend from May, which must be due to the opening of the barrage. A similar pattern is observed in the dissolved oxygen, where the value is observed to be very low (<3mg/l) during the dry season, which must be due to the decaying of water hyacinths caused by the increase in salinity. After the opening of the saltwater barrage in May 2020 and the onset of the summer monsoon, the time series of the dissolved oxygen increased.

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Presence of eddies in the Bay of Bengal- Is it random or recurring?

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Eddies play a crucial role in moving energy and matter through the ocean, impacting mixing processes in the ocean's surface layer. The Bay of Bengal, one of the most dynamic regions of the world's oceans, is also famous for the occurrence of lots of mesoscale eddies, so concentrating on recurring ones in view of ASW oceanography. The presence of eddies has detrimental as well as conducive effects on underwater sound transmission, sonarperformance and the detection and localization of underwater targets. Investigating recurring eddy characteristics is crucial for enhancing underwater situational awareness and defence capabilities. The identification and tracking of the eddies were done by utilizing a Python module named py-eddy-tracker with altimeter data (CMEMS - Absolute Dynamic Topography and surface geostrophic currents from 2000 to 2020). Only those eddies having alifespan of 28 days are considered for the study. There are 902 anticyclonic and 1068 cyclonic eddies originating in between regions 80 °E -100 °E and 5 °N - 25 °N during the period. The radius of anticyclonic eddies ranges from 23.81 km to 217.99 km and cyclonic eddies range between 23.22 km to 222.97 km. Among these, the number of recurring eddiesin 2° x 2° grid boxes in each four seasons was identified, and those grids with a recurrence rate of > 40 % were selected. The characteristics of such recurring eddies in each season wereanalyzed. Characteristics of one such anticyclonic eddy around Andaman Nicobar Island is: amplitude variability between 0.0058 m and 0.110 m; radius ranges from 31.32 km to 148.19 km with propagation speed variates between 0.578 m/s to 0.411 m/s having short (33 days) tolong lifespan (118 days).

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Observed currents off the coast of Rameswaram island

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We present the observed current data obtained from Recording Current Meters deployed in the periphery of Rameswaram island (Tamil Nadu, India) during 2010-2011. The island is

sandwiched between Palk Bay (PB) and the Gulf of Mannar (GoM) which lie to the north and south respectively. The ocean of this region is ecologically important as it harbours diverse corals and many sensitive fauna. The data used was part of the Sethusamudram Shipping Channel Project undertaken by the Government of India. Observations of raw currents indicates a seasonally reversing current, distinctly visible at location near channels, with a strong northeastward (southward) current seen at Pamban Pass in March to September (October to February). A Northward (Southward) transport of 587 m3/s (819 m3/s) during the JJAS (DJF) at Pamban Pass is seen where the annual mean current is ~27 cm/s. However, the annual net transport is northward. The effect of wind on current is evident from the correlation of reanalysis wind data with observed current. This leads to 6-hour resampled cross- shore (along-shore) currents at Adam's Bridge and Pamban Pass to have a correlation value of 0.67 (-0.53) significant at a 1% level. Residual currents are similar to the raw currents iN seasonality and current strength. A local scale circulation is observed around the island during summer monsoon. Tidal analysis reveals that the M2 tidal constituent is strong at Adam's Bridge and PB, but we also notice S2 (at Pamban Pass) or K1 (at GoM) emerging as the strongest tidal constituent. We present evidence that a minor shift in deployment location can lead to dramatic shifts in raw current for shallow water locations. Inertial currents were found to be of negligible strength compared to tidal currents. The bathymetry of this region plays a major role in determining the strength and direction of raw current as well as the tidal and residual currents.

WOSC/2024/ABS/287

Deep Learning techniques for the prediction of Ocean currents for underwater vehicles

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Real-time dynamic ocean currents dramatically impact the precise navigation of underwater vehicles. Conventional approaches for estimating and forecasting ocean currents, such as the Navier–Stokes equations, are computationally intensive and require enormous amounts of historical ocean data to construct numerical models. Therefore, this paper employs Deep Learning techniques, which rely on simpler and more readily implemented convolution methods, to determine the most effective model for predicting ocean currents. Additionally, a comparison was made between the implemented convolution methods using the R2 score, Mean Absolute Error (MAE), and Mean Square Error (MSE). The DL method-based Long Short Term Memory (LSTM) performed the best among all others, achieving 88% accuracy with minimal error. The analysis of qualitative performance involves the visualisation of data correlation and the generation and comparison of heat maps. Keywords: Ocean Currents, Deep Learning, Convolution Models, Underwater Vehicles.

WOSC/2024/ABS/292

Missing data imputation in Moored buoy data using Particle swarm optimization -ML Algorithm

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One of the primary tools used for collecting ocean observation data is the deep ocean buoy. The accurate collection and analysis of moored buoy data are critical for understanding ocean dynamics, climate patterns, and ecosystem health. Deep sea instrumented moored buoy data plays a pivotal role in advancing our understanding of the dynamic and complex marine environment, with far-reaching implications for ocean science, climatology, and the prediction of natural disasters such as tsunamis and cyclones. The Moored buoys deployed in the deep ocean transmit data to the shore station through satellite. The satellite communication between the buoy and shore station may get interrupted at times, sensor failure or malfunction, vandalism which leads to data loss. Since the buoy data is of great importance for forecasting weather, the missing data needs to be filled so that the analysisor studies relying on these data does not become in-consistent and void. To fill the data gaps in the buoy data we have built a model that employs Artificial intelligence along with a machine learning algorithm called Particle Swarm optimisation (PSO). Particle Swarm Optimization (PSO) stands as a powerful metaheuristic algorithm inspired by social behaviour observed in nature, particularly the collective movement of bird flocks and fish schools. PSO has since gained widespread popularity for its simplicity, efficiency, and versatility in solving optimization problems across various domains. The model that was built using PSO was able to fill the missing data with different accuracies depending on the variable training data Thus the maximum accuracy of greater than 95% was achieved when 5 days of missing data was filled with 60 days of buoy data input data. When the input number of days were reduced the corresponding model output accuracy has also got reduced. The model's result and performance has been validated using corelation plot tofind the distribution of data across all the use cases that has been tested. The corelation plot also shows that the predicted data is consistent with the actual data.

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Oceanic influence on Large-Scale Atmospheric Convection during co-occurring La Niña and IOD events

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The Indian Summer Monsoon Rainfall (ISMR) profoundly impacts the lives of over a billion people across the region. Historically, its extremes have been linked to the El Niño/Southern Oscillation (ENSO) and modulated by the Indian Ocean Dipole (IOD). Notably, the monsoon rainfall during June to September 2022 displayed intriguing spatial patterns: above-normal precipitation over the south peninsula and central India, normal over Northwest India, and below-normal over East and Northeast India. In 2022, La Niña conditions associated with a negative Indian Ocean Dipole (nIOD) (hereafter co-occurrence years), were prevalent over the equatorial Pacific and Indian Ocean. This study investigates the often-overlooked Oceanic subsurface contribution to large-scale atmospheric convection over the tropical Indian Ocean. By undertaking a comprehensive analysis of the observed and reanalysis datasets, we find that

strong equatorial westerly wind anomalies prevailed over the equatorial Indian Ocean during co-occurring years generating eastward propagating downwelling Kelvin waves which deepens the thermocline in the eastern equatorial Indian Ocean. The Kelvin waves then propagates into Bay of Bengal and gets reflected from southern tip of India as westward propagating Rossby waves deepening the thermocline and causing low level wind convergence in the northern Arabian Sea. We identify two centres of low-level wind convergence, one over Northern Arabian Sea and another over Maritime Continent during co-occurrence years. These wind convergence centres play a pivotal role in channelling moisture towards their core, in addition, significantly deepen the oceanic thermocline, increase the Ocean heat content and thus maintaining warmer SSTs over area of conversions. Together, these interrelated factors create an environment that is conducive for enhanced convective activity over the zone of convergence, enhancing and sustaining the convective conditions. This study underscores the significant contribution of ocean dynamics in shaping large-scale atmospheric convection during the co-occurrence years. Beyond the conventional focus on SST, our findings highlight the significance of considering broader Oceanic variables in comprehending and forecasting monsoonal variability.

WOSC/2024/ABS/308

Influence of Atmospheric Heat-Flux in the Northern Arabian Sea surface chlorophyll Bloom

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The northern Arabian Sea is renowned for the winter surface chlorophyll (Schl) bloom induced by winter monsoon winds. During this season, convective mixing enhances the mixed layer depth, increasing nutrient availability in the euphotic zone. As spring arrives, reduced cooling and gentle winds lead to a shallower mixed layer depth (MLD), promptinga Schl bloom. Recent investigations challenge the conventional explanation tying phytoplankton biomass to a shallow MLD by revealing an early surge in Schl during the fag end of winter. This study delves into the root cause of the noticeable Schl surge in early spring, as captured by satellite images. Our findings suggest that the rapid Schlgrowth coincides with the transition from atmospheric cooling to atmospheric heating. To substantiate this claim, our analysis utilizes chlorophyll data from ESA Ocean Color Climate Change Initiative (ESA-OCCCI) merged satellite products spanning the past two decades (1998 to 2022). We incorporate heat flux and surface wind data from ERA5 reanalysis. The results provide enhanced insights into the dynamics of surface blooms in the northern Arabian Sea.

WOSC/2024/ABS/311

Long Term Prediction of Wind Power Density due to climate change using CMIP6 for Indian Coastal regions

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There is a world-wide interest on renewable sources of energy, due to the ill-effects of global warming as a result of man-made greenhouse gas emissions and solar and wind energy take a predominant lead in replacing fossil fuels. The global wind power generation should increase to 36% by 2050 in order to limit the atmospheric temperature rise to 1.5^{o}C. Large capacity onshore and offshore wind farms are being installed around the world and India stands in fourth position in global wind and solar power generation. There exists a vulnerability to wind energy production and safe operation due to variability in atmospheric temperature, wind velocity and direction, sea-level rise, humidity, aerosol in atmosphere, etc. More importantly, due to both natural and anthropogenic climate change, weather patterns are changing, hence it is imperative to know the future changes and likely potential areas of wind energy and their capacities. Large fluctuation in wind velocity and direction is reported from different regions across the globe and in certain cases it is up to +150%. Long term prediction of wind power density is not only important from an economic point of view, but also from the safety of turbines. In this study, climate projections from different Coupled Model Intercomparison Project-Phase (CMIP) models are analysed for climate scenarios SSP4.5 and SSP8.5-one realistic case and another extreme case- to study the variation of wind power generation for future forecasting (Near term, Mid Term and Lond Term) over the Indian region specially for coastal states like Tamil Nadu and Gujarat where exists great wind power potential. The study can help future wind power installations for its economic analysis and safety considerations.

WOSC/2024/ABS/317

Variations in the Oxygen Minimum Zone and carbonate chemistry of the Eastern Arabian Sea since the last 15 kyr

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The Arabian Sea features a persistent Oxygen Minimum Zone (OMZ) that results from monsoon-driven upwelling, leading to increased biological productivity and organic matter sinking to intermediate depths (300-1000 m). Given the global warming and rising ocean hypoxia concerns, it is very important to understand the OMZ conditions and associated oceanographic processes. This study investigates the impact of atmospheric and oceanic circulation on the carbonate chemistry of the OMZ using proxies, primarily $CaCO_3$(wt.%) and planktic foraminifera (Globigerinoides ruber) shell weight. Core SK-376/(GC)-02 retrieved from the OMZ (water depth 614 m) of the Eastern Arabian Sea reveals variation in the $CaCO_3$(wt.%) over the past ~15.5 kyrs. The $CaCO_3$(wt.%) fluctuated between 21%- 79%. During the Bølling-Allerød (B-A) period (~15-12.7 kyr), lower $CaCO_3$(wt.%) levels suggest reduced carbonate preservation in the water column, possibly indicating intensified summer monsoon strength. Simultaneously, increased surface water primary productivity (Singh, 2007) is linked to significant oxygen depletion in intermediate waters, leading to elevated CO_2 levels and an intensified OMZ during the B-A. During the Younger Dryas period (~12.7-11.5 kyr), there is a decline in $CaCO_3$(wt.%), possibly influenced by strengthened winter monsoon winds. Concurrently, surface water primary productivity and the OMZ remained weak during this period (Singh, 2007). The $CaCO_3$(wt.%) shows a consistent trend in the early to the beginning of the Late Holocene (~11.12– 4 kyr) but decreases in the later stages, while G. ruber shell weights gradually decreased throughout the Holocene. The OMZ intensity is likely to have intensified during the early to mid- Holocene (Joshi et al., 2021). The decreasing trends in shell weight and $CaCO_3$(wt.%) maybe linked to calcite dissolution in bottom waters due to varying OMZ intensity or the rise in atmospheric CO_2 concentrations throughout the Holocene (Joshi et al., 2021). However, more comprehensive proxy data are essential to delineate OMZ redox conditions precisely, and the sources of water masses involved to record past changes in the OMZ intensity.

Seasonal and Long-term Variability of SST in the Arabian Sea

Pavas Kumar, Alagappa University

This study investigated the long term warming of the Arabian Sea (AS) in both Seasonal and Long Term (1940-22) time scale and the associated variation in Sea Surface Chlorophyll. Arabian Sea is one of the most biologically productive regions of the world ocean, mainly due to the processes occurring in the Arabian Sea such as coastal upwelling along the coast of Somalia, Arabia and south- west coast of India during summer monsoon (south-west) and winter cooling and convection during winter monsoon season (north- east). It has been reported that northern Indian Ocean is warming at a higher rate compared to Pacific and Atlantic Ocean hence the present study aims at understanding seasonal as well as long- term warming of the Arabian Sea from 1940 to 2022. Towards this a suite of ocean atmospheric parameters were analysed in the Arabian Sea domain (40- 78oE and 0- 30oN). The above parameters were used to create seasonal climatology in the Arabian Seaas well as sub- domain within the Arabian Sea. The seasonal cycle of Sea surface temperature (SST) showed a semi-annual variability in the Arabian Sea as well as sub- domains of the Arabian Sea. The highest

SST was seen in the south-eastern box while northern Arabian Sea box showed lowest SST. Similarly other atmospheric parameters also showed differing variability in different parts of the Arabian Sea. The long -term SST showed differential rate of warming in different parts of the Arabian Sea. The highest rate of warming was seen in the South-eastern Arabian Sea while lowest was seen in the Arabia region. The linear correlation as well as spatial correlation analyses showed different atmospheric parameters play significant role in controlling the oceanic variabilityin different sub-domains within the Arabian sea.

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Revolutionizing Ocean Observation: Advancing Oceanic Understanding and Conservation through UAV Hyperspectral Remote Sensing.

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In an era where understanding and safeguarding our oceans is imperative, driven by environmental challenges like climate change and marine pollution, this study introduces a revolutionary method in marine science. Utilizing Unmanned Aerial Vehicles (UAVs) equipped with hyperspectral remote sensing, this research presents a versatile and efficient alternative to traditional in-situ ocean observation methods. This technology represents a significant shift in marine research methodologies, offering a broader, less intrusive, and more comprehensive approach to understanding oceanic processes. The study primarily aims to refine UAV hyperspectral remote sensing to address limitations of traditional ocean observation methods, including spatial and spectral inconsistencies in water- leaving radiance and remote sensing reflectance. By optimizing UAV flight paths, sensor viewing angles, and incorporating advanced atmospheric correction methods, significant issues like sun glint and atmospheric path radiance are effectively mitigated. This enhances the accuracy and reliability of the data collected. This technology's utility extends to monitoring various marine pollution forms, such as oil spills and macro plastics, and conserving marine ecological areas, including coral reefs. The effectiveness of this method is validated by capturing detailed spectral signatures of these targets and comparing them with in-situ measurements. Moreover, the research explores the potential of UAV hyperspectral data to replace traditional in-situ and other ocean observation systems. Comparative analyses indicate that UAVs provide a more expansive and non-intrusive means of acquiring oceanic data, especially beneficial in remote or sensitive marine areas where human presence is limited. The deployment of UAV hyperspectral remote sensing has emerged as a formidable tool in ocean observation, greatly enhancing our understanding of marine ecosystems. By offering a sustainable and efficient alternative to traditional methods, this technology sets a new standard for the effective monitoring and management of marine resources, which are essential to the blue economy. Its implications are significant, making a notable contribution to global environmental servation efforts and the crucial battle against climate change.

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Upper Indian Ocean Warming Trend and its Regional Variability

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The subsurface temperature data from Met Office Hadley Centre was used to study the upper Indian Ocean warming for the period 1960 to 2020. The Ocean Heat Content (OHC) was estimated at each grid and integrated for different depth ranges (0-100m, 100-300m, 300-700m, and 0-700m). The OHC was averaged for each region such as Arabian Sea (AS) (50:78E, 8:25N), Bay of Bengal (BoB) (78:100E, 8:25N), Western Equatorial Indian Ocean (WEIO) (38:64E, 10S:10N), Eastern Equatorial Indian Ocean (EEIO) (64:100E, 10S:8N), Northern South Indian Ocean (NSIO) (30:120E; 30S:10S) and Southern South Indian Ocean (SSIO) (30:120E, 50S: 30S) to study the regional variability of heat content. The monthly heat content was then used to obtain the anomaly. A linear regression analysis was conducted to assess the long-term trends in OHC and to obtain the spatial distribution of the warming trend. The results show that the average heat content of the Indian ocean was increased by 0.6×10^9 J/m2 during this period of 61 years at a rate of 0.098×10^9 J/m2 per decade and also showed interannual and decadal variabilities. Signals of OHC variations that are assumed to be associated with global warming, have been found up to a depth of 700 m. On a regional scale, the OHC showed an increase in all regions with a higher increasing trend at AS and SSIO.

WOSC/2024/ABS/352

Mechanisms of the Southern Arabian Sea summer Primary Productivity weakening in response to anthropogenic forcing in Earth System Model

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The Arabian Sea (AS) relies on its strong primary productivity (PP) to support fisheries, playing a crucial role in bolstering the economies and food security of nearby nations. This study investigates the future response of AS summer PP to climate change under unmitigated scenarios from the Coupled Model Intercomparison Project (CMIP). Analysis of both CMIP5 (16 models) and CMIP6 (14 models) indicates a significant projected decline in summer PP across three climatologically productive upwelling regions in AS by 2100, particularly notable around Somalia and the southern tip of India upwellings. Contrary to earlier studies, our findings suggest that changes in wind-driven nitracline depth, rather than increased upper-ocean thermal stratification, are primarily responsible for driving this future decline. The projected slowdown of the Walker cell further strengthens equatorial easterlies in the Indian Ocean, leading to deeper thermocline and nitracline depths in southern AS, resulting in a consequent decrease in PP. Moreover, biases in present-day equatorial winds may have led to an underestimation of present-day southern AS PP in CMIP models, impacting future projections. It is recommended that addressing uncertainties and reducing wind biases within climate models is essential for improving the reliability of biogeochemical projections.

WOSC/2024/ABS/367

Sensitivity of simulated upper ocean thermohaline structure to diffusivity shape function in MOM5

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The Oceanic surface boundary layer (OSBL) is the outer layer of the ocean which is mostly responsible for the air-sea interaction. The air-sea heat and momentum fluxes are passing through this layer. OSBL is the gateway for contacting with the interior ocean to the atmosphere. The oceanic mixing happening in this layer is through buoyancy driven processes and mechanical mixing. In general, K profile parameterization scheme overestimates mixing in upper ocean. The model used for this study is Modular Ocean Model version 5 (MOM5). MOM5 is developed by National Oceanic and Atmospheric Administration, Geophysical Fluid Dynamics Laboratory has been used with horizontal resolution x and with 50 vertical levels. 50 years MOM5 spinup has been done with coordinated ocean ice reference experiment (CORE) climatological forcing. Afterwards, control run has been done with Japanese Reanalysis (JRA55-do) interannual forcing by changing the shape function from the default cubic to a six degree polynomial from 2007 to 2023. JRA55-do is the Japanese Reanalysis dataset for driving ocean models. It's horizontal resolution is .5 and temporal resolution is 3 hour. Furthermore, vertical structures of bias and errors for temperature, salinity, density and seasonal variability have been studied for upper 200m to see how these are deviating with changed shape function. The study region has been divided into four sub regions, Arabian Sea (52E-75E, 6N-25N), Bay of Bengal (80E-100E, 6N-25N), Equatorial Indian Ocean (40E-100E, 5S-5N), and Southern Indian Ocean (30E-120E, 0S-30S). Study period is divided in four seasons spring (March- April-May), summer (June-July-August-September), fall (October-November) and winter (December- January-February). Parameterization is required in the mixing scheme for better representation of the sub grid scale processes like Langmuir turbulence, stokes drift effect. The main equation for the KPP mixing scheme depends on the tracer and momentum diffusion equation which is controlled by the diffusivity. The tracer diffusivity is dependent on shape function. The shape function is a cubic polynomial by it's default set up in MOM5. The shape function is been changed to six degree polynomial and, it is seen that the vertical temperature bias is reduced for both surface(cold) and subsurface(warm) by almost 20% in all over the regions mostly in JJAS season.

Impact of Geophysical Parameters on Tropical Cyclogenesis Locations in the Bay of Bengal

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Tropical cyclones (TCs) are considered as one of the most extreme weather hazards with significant impact on the coastal regions. The North Indian Ocean receives its fair share of TCs every year, non-uniformly distributed between its two sub-basins, Bay of Bengal (BoB) and Arabian Sea. Even though cyclogenesis over the Bay has been previously observed to be decreasing during recent years, studies on the spatio-temporal changes in the cyclogenesis locations are limited. The current work focused on identifying the spatio- temporal changes in cyclogenesis locations and evaluating the impact of geophysical factors (sea surface temperature, tropical cyclone heat potential, upper ocean heat content, relative vorticity, vertical wind shear, mid-tropospheric relative humidity and convective available potential energy) on such changes over the BoB during 1991 to 2021. K-means clustering technique was adopted to characterise the spatio-temporal changes in cyclogenesis locations over the Bay, while empirical orthogonal function (EOF) and random forest (RF) regression techniques were used to assess the impact of geophysical factors. Cluster analysis resulted in identifying

three optimal clusters of cyclogenesis locations, with a shift in active cyclogenesis locations from the south-eastern to northern BoB. Although vertical wind shear was decreasing over higher latitudes and increasing near the equatorial belt, all other parameters were found to be increasing over a major part of the Bay. This made the Bay conducive to cyclogenesis in the higher latitudes, while making the lower latitude regions slightly inhibiting, resulting in the northward shift in cyclogenesis locations post-2005. RF regression model showed dominating impacts of vertical wind shear, relative vorticity and tropical cyclone heat potential on modulating cyclogenesis over the basin during the study period. The resulting northward shift of active cyclogenesis locations may pose a serious threat to coastal populations in terms of more landfalls in the eastern coast of India.

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Wave-surge-tide interactions in the Bay of Bengal

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We employed a coupled wave-hydrodynamic model covering the entire east coast of India and the head Bay of Bengal (BoB) region to simulate realistic storm surges and waves induced by 15 tropical cyclones (TCs) between 2010-2020. The selection of these TCs was based on the availability of tide-gauge water level data, as well as wind and wave measurements obtained from buoys. Our unique approach involved consistent model settings, including the same domain, mesh, bathymetry, atmospheric and tidal forcings, and parameterization schemes for all 15 TC cases, contrasting with previous individual TC cases based or location specific studies that exhibited variations in model specifications and forcing datasets. This uniform framework allowed us to investigate tide-surge-wave interaction processes and their relative contributions across all the TCs consistently. Our model experiments reveal that wave setup can contribute significantly, up to ~50% - 100% of tide-removed water level amplitude, depending on TC intensity, tidal phase, bathymetric features, and proximity to landfall. Whereas tide-surge interaction proves crucial only for TCs making landfall in the head BoB region.

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Comparison of adaptive methods for estimating directional spectra against 2D Fourier Transform using a fully nonlinear wave model

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The directional wave spectrum (DWS) is widely used in ocean engineering and naval architecture for analysis of the characteristics of ocean waves. Traditionally, it is estimated by an array of sensors or with remote sensors. In the former the directional spectra is gleaned from point measurements which yields uncertainty in the accuracy of spreading estimations. Using remote sensors, the whole sea surface can be used to estimate the DWS but has limited resolution in high wavenumbers/frequencies. Advancements in numerical modeling and higher-resolution measurements using stereo imaging techniques have enabled more accurate assessment of spectral properties. This study aims to assess the accuracy of estimating the spreading distribution of DWS based on point measurements. We employ spectral estimation methods, including the Maximum Likelihood Method (MLM), Maximum Entropy Method (MEM) and the wavelet Directional Method (WDM), in comparison with results obtained from applying the 2D Fast Fourier Transform (2FFT) to the water surface data. This is done with numerical simulations of the water surface for different sea states using a 3D fully

nonlinear phase resolving model with a broad range of Fourier modes. Our analysis revealed that DWS obtained from MLM are statistically 15% broader than those derived from 2FFT. Conversely, DWS using MEM were 5% narrower and using WDM 3% narrower compared to those obtained with 2FFT.

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Identification and Characterization of Marine Heat Waves over the Bay of Bengal

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Extended stretches of abnormally high sea surface temperatures are known as marine heat waves (MHWs). MHWs are observed all around the world and climate change is expected to increase the frequency and intensity of the catastrophes. These anomalous instances of elevated water temperature have several negative repercussions, including alterations to species distribution, localized extinctions, and significant financial implications for the seafood industry. Notable effects include the reduction of important fishery species and the effects on aquaculture. Furthermore, MHWs can cause changes in marine ecosystems, which would impact a region's total productivity and biodiversity. This study focuses on the detection of MHW over the Bay of Bengal (BoB) from 1982 to 2022. The intensity of MHW events was observed to be high during the southwest monsoon period (June, July, August, and September: JJAS) in the northern part of the Bay. The percentage of days with high-intensity MHW was also notable in these months. The trends of frequency, intensity, and duration during this period were significant at 95% confidence level. The intensity of MHW and the percentage of MHW heatwave occurrence days in the BoB were found to increase with time, moving from north to south. MHWs with durations longer than 80 days were observed to be prevalent in the 2003-2022 period, as compared to the 1982-2002 period. Further analysis is being carried out to identify MHW systems combining the spatiotemporal extents of individual MHW events, which is expected to yield better characterization of MHWs using sea surface temperature data.

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Hydrography and circulation in the southeastern Arabian Sea during winter

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The southeastern Arabian Sea is a unique oceanic region due to the presence of seasonally reversing monsoon current. This region plays a critical role in the onset of SW monsoon in the Indian subcontinent. We conducted a field campaign during February 2023 to understand the hydrography and circulation in this region. The results from two CTD transects along 9.5 N and 10 N and ship ADCP are presented. The vertical structure of temperature and salinity shows that the sea surface temperature ranged around 28°C and a sea surface salinity ranging between 33 - 33.5 psu. The mixed layer depth observed is ~80
m. We further identified the presence of three water masses; Bay of Bengal Water mass, Arabian Sea High Salinity Water mass and Persian Gulf Water mass. The currents from ship ADCP data reveals a northwest current. In order to understand the spatial features of the currents, OSCAR data is utilised. Analysis shows the presence of a cyclonic eddy in the region.

We further used regional ocean modelling system (ROMS) simulation outputs to understand the observed variability. Preliminary analysis shows the presence of eddies and its role in hydrography and circulation in the region. Key words: southeastern Arabian Sea, ship ADCP, SW monsoon.

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Repeated Harmful Algal Blooms: Insights from continuous monitoring in the Bivalve beds of Malabar Coast, South Eastern Arabian Sea

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A comprehensive study conducted from January to December 2023 delves into the physico-chemical drivers triggering harmful phytoplankton blooms in Thikkodi coastal waters in the bivalve beds of Malabar Coast, South Eastern Arabian Sea (SEAS). Recurrent blooms, notably of Gymnodinium species, were observed during the study period, marked by a reddish-brown color change in late August and a reoccurrence on November 30th 2023. In-situ analysis during bloom events revealed a temperature of 23.36°C and a chlorophyll concentration of 12.62 mg m-3, providing crucial insights into the environmental conditions conducive to Gymnodinium proliferation. Ocean colour data monitoring indicated low water temperatures in August, suggestive of an upwelling phenomenon, enriching surface waters with nutrients and fostering favorable conditions for phytoplankton blooms. A similar bloom on November 30th further emphasized the persistence of Gymnodinium species. Thikkodi coastal waters, renowned for biodiversity of seaweeds, gastropods and molluscs, face potential consequences from these recurrent blooms. Gymnodinium species, known for producing Brevitoxins, also pose a threat to human health through paralytic shellfish poisoning, as these toxins accumulate in edible bivalves. This study underscores the urgency of ongoing research to unravel the intricate interplay of environmental factors leading to Gymnodinium blooms. Addressing these concerns is paramount for the sustainable management of the marine ecosystem in the region and the protection of human health. Continuous monitoring and proactive measures are recommended to mitigate the impact of harmful algal blooms on coastal waters.

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Performance of SMAP sea surface salinity during extreme conditions using moored observations in the Bay of Bengal and Arabian Sea

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The NASA Soil Moisture and Active-Passive (SMAP) mission provides sea surface salinity by measuring the brightness temperature using L-band microwave radiometer. This mission was launched in January 2015 and provides global products of soil moisture on land and surface salinity in the ocean. Many studies have compared the sea surface salinity from SMAP with in-situ measurements such as Argo profilers, moored buoy systems, and sail drones etc. This SMAP sea surface salinity is often biased with systematic errors on larger temporal, spatial scales and random errors on short-time and length scales. The Bay of Bengal experiences

tropical cyclones during the pre-monsoon (April- May) and post-monsoon (October-November) periods. Cyclone induced mixing and upwelling cause an increase in sea surface salinity and the brightness temperature measurement by SMAP is affected due to rough sea surface and high winds. In this study, the SMAP sea surface salinity is compared with time-series data from deep ocean moored buoy systems, and the results will be discussed in this paper.

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Biological nitrous oxide (N_2O) consumption in coastal sediments: environmental and biogeochemical drivers

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Nitrous oxide (N_2O) is an important greenhouse gas, and additionally an ozone depleting gas in the stratosphere. Coastal sediments are biogeochemically dynamic regions in terms of production and consumption of N_2O. We present experimental evidence of N_2O consumption in sediments of a shallow coastal lagoon (Pulicat on the south-east coast of India). Sediment N_2O uptake rates ranging between -2.03 µmol N_2O m-2 d-1 and -0.26 µmol N_2O m-2 d-1 are observed. This is coupled with observations and analysis of the sediment microbiome. Established understanding of biological N_2O consumption dictates that largely N_2O is microbially reduced to N_2 via N_2O reductases. This process is quantified in this study through the use of acetylene, that specifically inhibits the reduction of N_2O to N_2. N_2O consumption occurs at a rate of 1.27 µmol m-2 d-1, when the dissolved oxygen concentration in the overlying water column is <2%. Low water column salinity (12-28.3 ppt) and temperature (26-27 °C) conditions prevalent in the lagoon during our sampling period (December-January, 2022/23) impact N_2O uptake processes as they shape the sediment microbial community. Organic carbon content is low (range: 0.17- 0.23%). It is the autochthonous nature of OC in Pulicat, however, that is a more important driver of N_2O flux/uptake. The sediment microbiome is explored through 16S amplicon sequencing. Paracoccus, Pseudomonas, Bacillus and Halomonas are genus of bacteria encoding N_2O reductases or nitrite reductases, observed during our sampling period. A framework of N_2O cycling at the sediment-water interface of this lagoon is illustrated.

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Seasonal Analysis of Ocean Heat Content in the Ice-covered Arctic Ocean

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Ocean heat content (OHC) explains the amount of internal heat energy accumulated in an oceanic column and is a precise parameter to assess the sea ice melting in the Arctic Ocean. Estimation of OHC and its spatial distribution over the Arctic Ocean is critical in understanding sea ice freezing and thawing annual cycles. Recently, Vijay and Shanmugam (2022) has made

a successful attempt by overcoming the challenges associated the insufficient in-situ CTD data in the ice-covered Arctic ocean and developed an artificial neural networks (ANN) model to estimate OHC stored in an oceanic column ranging from the snow or sea ice surface to a stipulated depth by relating ongoing changes in OHC to sea ice thermodynamics parameters. In the current study, satellite-based daily OHC estimates of 700 m depth (0.25° spatial resolution) were generated by employing the ANN model developed by Vijay and Shanmugam (2022) and analyzed the seasonal distribution of OHC over the ice-covered Arctic Ocean by computing seasonal mean OHC over the period of 2006-2015. It is observed that OHC distribution followed a seasonal cycle in both the Eurasian and Amerasian basins in the central Arctic, but the weak halocline and increased warm Atlantic water intrusion led to higher OHC accumulations in the Eurasian basin compared to the Amerasian basin. Further, all the ice-covered Arctic sub-basins were exposed to warming based on their proximity to the point of Atlantic water influx (Fram Strait). The observed maximum OHC (Autumn season) over the Nansen basin, Amundsen basin, Makarov basin, Canada basin, and the Beaufort Sea are 787.78 GJ m^(-2), 787.51 GJ m^(-2), 785.94 GJ m^(-2), 784.62 GJ m^(-2), and 784.76 GJ m^(-2), respectively. In contrast, relative cooling was observed in the northern parts of Greenland and the Canadian archipelago due to the formation and accumulation of thicker ice.

<div align="center">**WOSC/2024/ABS/453**</div>

An ensemble machine learning model for turbidity estimation using Landsat 8 OLI in Chilika Lagoon, India

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Accurate estimation of coastal and inland water quality parameters is essential for informed decision-making in water resource management. Turbidity, a critical water quality indicator, plays a vital role in assessing the health of aquatic ecosystems. Chilika Lagoon, one of Asia's largest coastal lagoons, requires precise and timely monitoring of turbidity levels for effective environmental management due to its vast and dynamic nature. Although various machine learning (ML) models have been developed for turbidity estimation using remote sensing data, their performance is uncertain when applied at regional scales. This study presents a robust approach to turbidity estimation in Chilika Lagoon by employing an ensemble machine learning model subsequently applied to Landsat 8 Operational Land Imager (OLI) data. The proposed ensemble model combines multiple ML algorithms, leveraging the strengths of individual models to enhance overall prediction accuracy. The incorporation of diverse data sources and the use of an ensemble approach contribute to the robustness of the turbidity estimation model, allowing it to accommodate the complex and variable conditions of Chilika Lagoon. The results demonstrate the effectiveness of the ensemble ML model in accurately estimating turbidity levels across different spatial and temporal scales in Chilika Lagoon. The model was implemented to generate seasonal (pre and post-monsoon) time-series turbidity maps of Chilika Lagoon covering six years (2017-2022). Notable seasonal and inter-annual variations in turbidity distribution were observed in different sectors (northern, central, and southern) of the lagoon. Sector-wise analysis revealed a seasonal pattern in turbidity, with higher values during the post-monsoon season and lower values during the pre-monsoon season. The findings of this study may have significant implications for water resource management, particularly in regions where sediment dynamics play a crucial role in aquatic ecosystem functioning.

<div align="center">**WOSC/2024/ABS/456**</div>

Measurement of Microplastics Size Distribution Using a Scanning Electron Microscope

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The identification of microplastics in the environment, notably in oceanic waters, is essential to mitigate the impacts on marine ecosystems, biota, climate dynamics, and human health. Microplastics will enter the marine ecosystems as primary particles through direct discharge (rivers, lakes, estuaries, and waste waters, etc.) or as secondary particles (weathering of macroplastics due to waves, currents, tides, and sunlight, etc.). The estimation of the size distribution of microplastics is essential for mitigating marine pollution through laboratory methods. To address this, a novel laboratory measurement method utilizing the scanning electron microscope (SEM) was used. SEM is a microscopic technique that generates high-resolution images by scanning the surface of solid specimens. The operational principle of SEM involves a high-energy electron beam interacting with the sample's surface, producing signals related to the surface topography and composition. The microplastics considered in the present study comprise polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC) and these are non-conductive. For SEM imaging, specimens must either be conductive or rendered conductive through the sputter coating phenomenon, involving the application of a thin layer coating. The high-resolution images are captured with SEM and the mean size diameter ($D\mu$) of the microplastic particles is measured. The $D\mu$ of the PE samples are in the range of 2 to 5 µm and similarly, the $D\mu$ of the PP samples are in the range of 10 to 15 µm. In the case of PS samples, the $D\mu$ is in the range of 2 µm to 3 µm, whereas PVC samples show the $D\mu$ µm is in the range of 0.5 µm to 2 µm. This SEM analysis gives a comprehensive understanding of microplastic behavior in oceanic waters and is useful for the detection and quantification of microplastics through remote sensing techniques.

Ocean Acidification and the Future of Clam – Paphia Undulata – A Study on it's Characterization, Composition and Property

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This study delves into the multifaceted impacts of ocean acidification on Paphia undulata shells, elucidating the interconnected consequences of increased Carbon dioxide (CO_2) emissions. As a major driver of climate change, CO_2 is absorbed by the ocean, inducing a chemical transformation termed ocean acidification. The altered seawater chemistry affects the alkalinity of the ocean and leads to a decline in the concentration of Calcium carbonate in

Paphia undulata shell powder, impacting the calcination process in bivalves. Therefore, this study aims to analyze oceanic parameters including temperature, pH, dissolved carbon dioxide, dissolved oxygen (DO), and alkalinity, comparing them with secondary data to better understand ocean acidification. Findings indicate a rise in ocean temperature, a decrease in seawater pH below standard levels, reduced levels of dissolved oxygen due to increased dissolved carbon dioxide, and lowered seawater alkalinity as a consequence of ocean acidification resulting from atmospheric carbon dioxide absorption by the ocean. SEM analysis reveals a reduction in the size of Paphia undulata shell powder. GCMS analysis identifies pharmacologically important compounds, such as Thymol-TMS and Demelcolcine in the shell biomineral. XRD analysis demonstrates changes in crystallinity due to ocean acidification. Additionally, the biomedical properties of powdered Paphia undulata shells offer valuable insights for developing alternative antiviral drugs. The comprehensive findings underscore the far-reaching consequences of ocean acidification on the thickness, strength and integrity of economically and ecologically vital Paphia undulata shells, emphasizing the urgency of addressing this environmental challenge. Embracing sustainable practices, adopting circular economy models and minimizing carbon emissions are emphasized as crucial steps in averting further ocean acidification and preserving marine environments.

WOSC/2024/ABS/73

Hydrodynamic modelling of Pulicate Lake

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A tidal inlet serves as a narrow passage enabling the ingress of water into the land, establishing a vital link between the ocean and surrounding features such as bays, lagoons, marshes, and tidal creeks. Pulicat Lake, positioned on the border of Tamil Nadu and Andhra Pradesh, stands as India/"/gs second-largest brackish water lagoon. This lake interconnects with the sea through three distinct tidal inlets—Tupilipalem, Raidoruvu, and Pazhaverkadu. Historically, Pulicat Lake spanned approximately 461 sq.km in the 17th century, but over time, it has diminished to 281 sq.km. Simultaneously, the lake's depth has decreased from an average of 3m to 1m. Numerous threats, including wetland degradation, rapid siltation, and industrial pollutants, jeopardize the lake's ecosystem. The fisherfolk's livelihoods and the lake's ancient existence face challenges due to migration patterns and inlet closures. The lake's salinity, a significant concern, exhibits variations based on internal water flow, ranging from 0 to 52ppm. During the pre-monsoon period, the lake becomes hypersaline due to rapid evaporation. This study concentrates on observing hydrodynamic and physical parameters within the lake and employs numerical modeling to evaluate water level fluctuations. Various scenarios were modeled to enhance water flow, with results indicating that the three tidal inlets operate independently. Interestingly, changes in one inlet do not impact the others. The modeling suggests that altering or dredging existing inlets has minimal influence on the overall water flow within the lake.

WOSC/2024/ABS/77

Role of Surface Layer Temperature Inversion on SST Induced Variability in the Bay of Bengal

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The Bay of Bengal, renowned for its heightened cyclonic activity, witnesses an annual occurrence of approximately four to five cyclones, inflicting substantial damage upon coastal

regions. Particularly during the winter season, the phenomenon of surface layer temperature inversion (SLTI) manifests, characterized by the ocean's surface exhibiting ower temperatures than the underlying layers, thereby influencing cyclonic dynamics. Extensive meteorological research underscores the pivotal role of SLTI in shaping cyclones and impacting their intensity and trajectories. However, the intricate relationship between SLTI and the variability in sea surface temperature (SST) induced by cyclones necessitates further investigation. Our study relies on comprehensive data from the Ocean Moored Network for the Northern Indian Ocean (OMNI) buoy network, specifically measuring key oceanic parameters such as temperature and salinity. Critical sea surface temperature data is extracted from the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA5 reanalysis dataset, while cyclone trajectory information is sourced from the International Best Track Archive for Climate Stewardship (IBTrACS), a repository curated by the National Hurricane Center (NHC) and the National Oceanic and Atmospheric Administration (NOAA). By dissecting the intricate interplay among SLTI, cyclones, and SST variability, our research aims to advance the comprehension of cyclonic dynamics in the Bay of Bengal. The anticipated outcome is an improved foundation for cyclone prediction models, enhancing early warning capabilities, and fortifying coastal communities against the adverse impacts of cyclones. Ultimately, this study represents a substantial stride towards bolstering our meteorological preparedness in the Bay of Bengal.

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Wave and Current Simulations During Cyclone Tauktae and Yaas

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Our research highlights the crucial role of current as a significant parameter for predicting extreme wave conditions accurately. Utilizing the WAVEWATCH III model, we conduct comprehensive simulations focused on the cyclones Tauktae and Yaas, elucidating the nuanced behavior of coastal waves influenced by varying currents. Our findings emphasize the substantial impact of wave-current interactions on coastal regions, particularly Gopalpur and Kanyakumari, during cyclonic events. This study not only provides novel insights into the role of current in shaping extreme wave conditions during cyclones but also validates the accuracy of wave and current simulations. By advancing our understanding of these complex interactions, the study significantly improves our ability to forecast and respond to extreme events with greater precision. The research holds particular relevance for disaster preparedness and management.

WOSC/2024/ABS/151

Preliminary analysis on ocean acidification prediction using CO2calc and Seacarb in the chosen areas in Palk Strait, Bay of Bengal

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The aim of this study is to analyze the carbonate chemistry parameters of Palk Strait, Bayof

Bengal using CO2calc and Seacarb software package. The CO2calc and Seacarb was performed for understanding major carbonate chemistry parameters specifically total inorganic CO2 (TCO2), either fugacity (fCO2) or partial pressure of CO2 (pCO2), carbonate and bicarbonate concentrations by using TA, pH, Temperature as input constant data from different locations. From this result, carbonates parameters from different location are variable at different seasons. Multivariate statistical analysis clearly revealed correlations between the different carbonate parameters of different locations at different seasons. The current investigations depicted the changes of carbonate parameters mainly reduction of calcification and pH of selected locations which maybe increasing the vulnerability of the marine ecosystem in selected areas. Keywords: Ocean acidification, Palk Strait, Bay of Bengal, Carbonate Chemistry, CO2calc, Seacarb.

Sub littoral Seaweed flora of St. Martin's Island, Bangladesh

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Investigation on the sublittoral seaweed flora collected from 0.5 to 10 m depth during late March and April of 2013 from six localities around the St. Martin's Island, Bangladesh has revealed the presence of 39 seaweed taxa, 12 under Rhodophyceae,11 under Chlorophyceae,16 under pheophyceae. Of these, Avrainvillea amadelpha (Montagne) Gepp et Gepp (green) Pocockiella variegata (Lamax.) Papenfass, Spatoglossum asperum J.Ag., Spatpglossum variable Figari etc De Notaris and Sargassum Pallidum (Turner) C. Agardh (browns) are new records for Bangladesh.

Barotropic and baroclinic tides on the shelf off Svalbard and their role in shelf-fjord exchange

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The Arctic Ocean is considered a weak vertical mixing regime due to the weak internal wave activity that cannot break the strong stratification at these latitudes. However, recent studies have shown the enhancement of vertical mixing driven by internal waves, particularly in shallow regions of the Arctic, such as the continental shelf, slopes, and inside fjords. This study shows the characteristics of barotropic and internal tide activity on the shelf off Svalbard using the current velocity data from the Acoustic Doppler Current Profiler (ADCP) and numerical model simulations. Spectral energy shows elevated peaks in semidiurnal and diurnal

frequencies in barotropic and baroclinic currents. Barotropic tidal currents in the semidiurnal (diurnal) band reached ~10 cm/s (~3 cm/s). The amplitude of the semidiurnal (diurnal) internal tides reached ~9 cm/s (~4 cm/s) during the observation period. The baroclinic tide followed the first mode throughout the period by ~30%. A high- resolution (~500 m) numerical model, the Regional Ocean Modeling System (ROMS), is set up with realistic forcing and tides to better understand the spatial distribution of barotropic and internal tide energy and its generation mechanisms. Model simulations show that the topography features in the shelf and slope regions are likely the generation regions triggered by strong barotropic forcing across the topography. The role of tides in modulating low-frequency currents and water column structure is further studied using an experimental run without tidal forcing in the model. The difference between simulations with and without tide shows that the tide can influence the low-frequency circulation pattern on the shelf. The tide-induced residual circulation on the shelf increases volume transport to the adjacent Kongsfjorden by ~10%. However, the vertical hydrography simulations with and without tide do not vary significantly on the shelf, indicating that the tidal energy may not be sufficient to mix the water column in the region.

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The influence of winds and tides over a lagoon and semi-enclosed estuary along the southeast coast of India

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Tide monitoring and management in lagoons and closed water boundaries are crucial for restoring water quality and positively impacting ecosystems and biodiversity. The restoration of lagoon water dynamics offers a comprehensive understanding of regional water circulation patterns and their impact on water quality through sensitivity experiments. This study explores the dynamics of water mass exchanges in a lagoon and a semi-closed estuary, focusing on the artificial impact of open-closed intertidal operations and variation in geographical characteristics of two domains. For this study, a high- resolution hydrodynamic model is used to perform a set of sensitivity experiments to understand the impact of tidal forcing on the lagoon and semi-enclosed estuaries. Out of M2, S2, K1, and O1 tidal constituents, M2 is the major contributor, and the maximum elevation at the tidal inlet was about 0.67m. The study shows that tides dictate the exchange of water mass exchange between the lagoon and open ocean and its flushing is controlled by the characteristics of the opening channels. Further, the physical characteristics and flow patterns of these shallow basins are studied using the model setup. This study contributes to our understanding of how tides and winds impact the circulation within these coastal water bodies and how it controls the exchanges of physical tracers along with nutrients and sediments in these waters.

WOSC/2024/ABS/283

An analysis of the seasonal variations in sea surface temperature (SST) and their impact on the marine environment in the Bay of Bengal

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An important factor in determining ocean-atmosphere interaction is sea surface temperature (SST). In this study we focused on understanding sea surface temperature signature for considering the marine environmental impact such as cyclone occurrence, rainfall, and marine organism's survival trend due to temperature variation, it concentrated on studying the behavior of the SST anomaly that predominated in the Bay of Bengal region. The observed SST anomaly data used in this study were obtained from NOAA Coast-watch by combining global and regional methods. Using SAGA-GIS and MATLAB, we created SST anomaly maps, with an average temperature range of 25.46°C to 28.15°C observed over a century. Notably, marine organisms exhibited adaptability to varying temperature zones. Our investigation revealed a seasonal shift, with the largest temperature change of 0.65°C in May and the smallest change of 0.06°C in September, influencing seasonal rainfall and the formation of low-pressure zones. In 2021, we compared climatological SST with AVHRR SST data for the Bay of Bengal, finding an average monthly deviation of 0.7°C, except in June and October. Interestingly, the SST anomaly peaks at the end of September and vanishes entirely in October, suggesting a strong correlation between SST and various environmental factors, making it a key factor in understanding marine organism consistency.

WOSC/2024/ABS/340

Observations on upwelling in the southeastern Arabian Sea during the post-monsoon season

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The southeastern Arabian Sea (SEAS) under the influence of monsoonal winds exhibits variability in the hydrography and circulation. The seasonal coastal current and associated

monsoon season due to the upwelling process. The upwelling in the SEAS during 2013- 2020 is examined utilizing the Ocean Moored Buoy Network for the northern Indian Ocean (OMNI) at two locations 8.2 °N, 73.3 °E (AD09) and 10.3 °N, 72.6 °E (AD10) deployed by National Institute of Ocean Technology (NIOT). The OMNI buoy measures both surface met-ocean and subsurface oceanographic parameters. The temperature data at discrete depths (0.5 m, 1 m, 5 m, 10 m, 15 m, 20 m, 30 m, 50 m, 75 m, 100 m, 200 m, and 500 m) available at hourly intervals from 2013-2020 is primarily used for this study. In general, the upsloping of isotherms started in March and shoaled to a minimum in October at both AD09 and AD10. The upwelling at both locations shows distinct interannual variability specifically during the post-monsoon season (October-November). The depth of 26°C (D26) isotherm observed was ~20 m in October and it was minimal during 2016 and 2017. The role of local wind stress and remote forcing from equatorial wind is also examined. In addition, the sea level anomaly is utilized to understand the role of propagating waves and mesoscale eddies and the sea level variability associated with upwelling.

WOSC/2024/ABS/371

Decadal Variability of Coral Bleaching in the Lakshadweep Sea: Influence of Extreme Climate Events

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Rapid climate change poses a threat to highly productive marine ecosystems like coral reefs, especially during extreme occurrences like El Nino Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). These events elevate sea-surface temperatures (SST), intensifying thermal stress on coral reefs. A significant coral reef area in India, Lakshadweep is vulnerable to bleaching because of strong oceanic anomalies. This study examines coral bleaching in the Lakshadweep Sea over the past two decades (2000-2020), emphasizing the strong El Nino event in 2015-2016. According to the literature, the threshold temperature for coral bleaching is 28.5°C – 28.92°C. The initial months of 2016 witnessed an average SST of approximately 30°C, representing a remarkable deviation of nearly one degree above the 10-year average. The recurrence of events exceeding the established threshold temperature emphasises the importance of additional investigation. In response to this context, our study pioneers an analysis of changes in key environmental parameters, including Salinity, Dissolved Oxygen (DO), pH, and Chlorophyll-a (Chl-a), over the past two decades in areas where significant changes have occurred. These parameters, known to impact coral health, contribute to the heightened vulnerability of the Lakshadweep Sea. It is imperative to acquire site-specific insights into these environmental parameters to formulate effective strategies for the conservation and resilience of coral reefs in the Lakshadweep Sea. Keywords: Coral Bleaching, Lakshadweep Sea, El Niño Southern Oscillation, Indian Ocean Dipole, SST, Chlorophyll, Conservation.

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Evaluation of wave parameters using moored buoy data with Satellite and ERA-5 Model datasets in the Arabian Sea

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The understanding of ocean waves and their temporal and spatial variability is important for several defence and civilian uses. Also planning structures and shipping routes requires wave data collected during extreme conditions. Further, the summer monsoon and wind conditions in the North Indian Ocean have a major influence on the waves along the west coast, however, studies on waves in the Arabian Sea are quite scarce. Hence this present work aims to investigate the wave parameters such as significant wave height, mean wave direction, and zero crossing wave period for the year 2019, in order to know about the sea state conditions over the Arabian Sea. The datasets from different platforms (i.e.) NIOT moored buoys@ three locations (AD06, AD07 & AD09), ERA-5, and AVISO satellite were collected and utilized in this study. The comparison of significant wave height between Buoy and ERA-5 shows good correlation than the Aviso satellite data. The correlation coefficients for AD06- 0.99;(0.97), AD07- 0.99;(0.98), AD09- 0.98;(0.97) are estimated for ERA-5, (AVISO). The maximum significant wave height during 2019 is 6.38m in AD06, 4.93m in AD07, and 3.72m in AD09 due to the southwest monsoon and extreme events in the Arabian Sea. In addition, the waves during the extreme events were also studied.

WOSC/2024/ABS/388

The Role of Co-operation in Oceans and Marine Environments

Sivaraman, Institute of Ocean Management

Interaction with neighboring countries is crucial for oceans and marine environments. It is essential for shared resources, environmental conservation, disaster response, security, scientific research, trade and economic opportunities, policy harmony, and cultural and social ties. Oceans are interconnected, and pollution or degradation in one country's waters can affect neighboring nations. Collaborative efforts are necessary to address transboundary issues like marine pollution, habitat destruction, and climate change impacts. Maritime security is a shared concern, and shared research initiatives can lead to comprehensive data and insights. Consistent policies and regulations can help manage marine resources effectively. Strengthening cultural and social ties can create a conducive environment for collaboration on shared challenges. Co-operation fosters a sense of shared responsibility, enabling countries to jointly address environmental, economic and security challenges to the benefit of all involved. Hybrid interaction involves combining traditional in-person and virtual interactions, allowing for global participation and adaptability to changing circumstances. This model allows for direct communication, networking, and global participation, enabling diverse and geographically dispersed audiences. It also incorporates technology tools for enhanced communication and information-sharing, making the Ocean Summit more resilient and accessible.

WOSC/2024/ABS/393

Quantum-Assisted Underwater Communication: Opportunities and Challenges.

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With over 70% of Earth's surface covered by oceans, the need for advanced underwater communication is clear. The integration of quantum technology into underwater communication, specifically Quantum Key Distribution (QKD), holds immense promise. This abstract delves into the revolutionary potential of QKD, highlighting applications in RF communication among satellites, ships, and submarines, as well as optical communication between submarines. The advantages lie in enhanced security and noise resistance, addressing challenges posed by underwater turbulence. Traditional methods like RF and acoustic channels for underwater communication face limitations. Underwater RF communication requires ELF or VLF frequencies and cumbersome antennas, while the acoustic channel lacks stealthiness. Recognizing these challenges, the abstract underscores the importance of robust and secure communication for naval forces engaged in seaborne missions. The feasibility of underwater quantum communication is explored through a variety of QKD protocols, considering line-of-sight, non-line-of-sight, and free- space to underwater channels. Despite being a nascent field, quantum cryptography proves to be a practical solution for secure communication in challenging aquatic environments. This analysis sets the stage for a transformative shift in underwater communication, using quantum technologies to overcome existing limitations and usher in a new era of secure and efficient communication beneath the Earth's oceans.

WOSC/2024/ABS/394

CMIP5 model evaluation of Wave Power over the Indian Ocean using COWCLIP 2.0 datasets

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Embracing renewables reduces dependence on finite, polluting sources, addressing climate change. This study aims to evaluate the capabilities of 32 Coupled Model Intercomparison Project Phase 5 (CMIP5) models provided by Coordinated Ocean Wave Climate Project Phase 2 (COWCLIP 2.0) in simulating wave power (WP) over the Indian Ocean (IO). The assessment is based on their historical simulations spanning from 1979 to 2014 during JJA with regard to ERA5 reanalysis as observation. A range of skill metrics, including bias, root mean square error (RMSE), interannual variability skill (IVS) score, M-Score, and total ranking, is employed to assess the CMIP5 models/"/g accuracy across three clusters CSIRO, JRC, and IHC over IO. Climatology assessment findings suggest that the CSIRO cluster and the Multi-Model Ensemble (MME) models demonstrate more substantial alignment with ERA5 reanalysis data, characterized by reduced biases and RMSEs, compared to the remaining clusters. The findings indicate that CMIP5 models demonstrate a reasonable ability to replicate the observed WP conditions. Keywords: Wave power, CMIP5 models, RMSE, IVS, M-Score, Indian Ocean.

WOSC/2024/ABS/397

Prediction of Sea Level Anomaly in the Indian Ocean based on Autoregressive Integrated Moving Average Model

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Sea level rise poses a threat to coastal habitation, serving as corroborating evidence for global warming and endangering densely populated areas along the Indian coastline and low-lying islands while causing disastrous impacts on coastal and offshore structures. In this study, the seasonal climatology and variability of sea level anomaly (SLA) are examined in the North Indian Ocean (NIO) region (65°E–92.5°E, 4.5°N–25°N). Additionally, trend analysis has been conducted at six different locations along the Indian coastline using the Archiving, Validation, and Interpretation of Satellite Oceanographic (AVISO) SLA dataset spanning 27 years from 1993 to 2019. This paper introduces a prediction methodfor sea level anomaly, employing the Autoregressive Integrated Moving Average (ARIMA) model. From the spatial data, a time series of sea level anomaly is obtained by averaging the values within a 20 x 20 grid size at key locations as along the east and west coast of India. Subsequently, predictions for future sea level anomalies are conducted. Measurement of results is assessed using the root mean square error (RMSE) method. Based on the analysis, the most and least susceptible locations are identified, and predictions of sea level anomalies at each location are presented.

WOSC/2024/ABS/473

Study of long term changes in Car Nicobar Island using DInSAR and Remote Sensing

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Differential Synthetic Aperture Radar Interferometry (DInSAR) is a widely used for the surface deformation monitoring. The study area Car Nicobar Island is between Little Andaman and Nancowry and is almost flat terrain island with maximum elevation of about 70 m suffer from natural disasters like Tsunami, etc., Car Nicobar Island is formed on the base with marine sediments surrounded by reefs. The island receives an average rainfall of about 2900 mm on both North-eat and south-west monsoon. The geomorphology of study area is surrounded by shallow sea and coral reefs and has small cliff in the north consist of coralline diluvium. This study presents the use of DINSAR technique to measure the surface deformation using 32 Sentinel-1A datasets acquired from 2017 to 2020 and calculate shoreline change using Sentinel-2 datasets from Google Earth Engine. The results of the findings are mapped using Geographic Information Systems. The results give the understanding of the Car Nicobar Island and their changes with respect to long-term coastal process and the global climate Change.

WOSC/2024/ABS/484

Interannual Variability of Dissolved Oxygen in the Northern Gulf of Mexico Hypoxic Zone

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The concentration of dissolved oxygen, less than 2-3 milligrams per liter of water, referred to as hypoxia, occurs worldwide. In the United States, the hypoxic zone with an area of 22,000 km2 is identified in the Gulf of Mexico west of the Mississippi River. Previous scientific literature attributed this world's second-largest hypoxic zone to the influx of nutrients, mainly Nitrogen and Phosphorus, from the agricultural fields in the Midwest United States. Additionally, the Mississippi River provides fresh water, the second crucial element that promotes the formation of the hypoxic zone. The warm waters and the availability of nutrients increase the primary productivity; phytoplankton and the organic carbon from zooplankton sink to the bottom and utilize the oxygen, resulting in oxygen-deficient zones. This study tries to understand the interannual variability of dissolved oxygen in the Texas-Louisiana continental shelf hypoxic zone using National Oceanographic and Atmospheric Administration (NOAA) Hypoxia Watch CTD station data during 2010-2021. Besides, the present research focuses on the factors affecting the interannual variability in dissolved oxygen concentration in the hypoxic zone.

WOSC/2024/ABS/58

Estimation of Wave Energy Potential Using Remote Sensing and GIS

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Waves occur by the force of the wind which blows over surface water, transferring its energy and causing the water to move in a circular motion. The rise and fall of water molecules create a wave that moves in the direction of the wind. The wave transports energy, not water. Wave energy is a form of renewable energy that harnesses the kinetic energy generated by the movement of ocean waves. This energy can be converted into electricity, providing a sustainable and clean power source. The wave energy potential varies depending on geographic location, as it is influenced by factors such as wind patterns, ocean currents, and the overall wave climate. Over the past two decades, researchers have developed various robust techniques for harnessing energy from natural sources like solar radiation, oceans, and winds. This investigation focuses on harnessing wave energy through synthetic aperture radar (SAR) along the Chennai coast during different monsoon periods. To achieve this, the nonlinear velocity bunching algorithm is employed to extract information on ocean wave spectra parameters, including significant wave height, directions, and energy levels. The study also illustrates how satellites, specifically SAR, can offer precise and dependable data, contributing to a more comprehensive and realistic assessment of energy potential. Keywords: Wave energy, Remote Sensing, SAR, Bunching algorithm.

WOSC/2024/ABS/64

Assessment of Morphological Changes along the Kanyakumari Coast

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The interface between the land and sea keeps changing its shape and position continuously due to various environmental conditions. These changes in shoreline are primarily associated with waves, tides, winds, periodic storms, sea level change, and the geomorphic processes of erosion and accretion and anthropogenic activities. Observing and quantifying changes along vulnerable coastlines is essential for coastal managers and policymakers regulating coastal development. This includes monitoring both extreme and subtle variations in oceanographic forcing. This study concerned the assessment of shoreline changes along the coastline of Kanyakumari using the Coastsat. Coastsat – a Python toolkit will be used to distinguish the boundaries between land and water. This toolkit utilizes the functionalities of Google Earth Engine to effectively retrieve Landsat and Sentinel-2 images cropped to any user-defined region of interest, enhancing efficiency in the process. The resulting images are pre-processed to remove cloudy pixels and enhance spatial resolution, before applying a robust and generic shoreline detection algorithm. This innovative method for shoreline detection integrates supervised image classification and sub-pixel resolution border segmentation, enabling the mapping of shoreline positions with a precision of approximately 10 meters. Using the results obtained, infrastructure or habitats vulnerable to changes will be identified and strategies will be proposed to mitigate them. Keywords: Shoreline changes, Landsat, Sentinel, Coastsat, Python toolkit.

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WOSC/2024/ABS/69

Coastal Hydrodynamics and Sediment Transport Model using MIKE 21

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Sanjeeve J, Anna University; A. Ponmozhi; Dr. M. Krishnanveni 2. Teaching Fellow, Anna University Chennai 3. Professor And Director, Institute for Ocean Management Anna University Chennai

Overview of coastal engineering. Study of wave hydrodynamic and coastal processes. To know the basic about the coastal process and sediment transport. Overview of MIKE 21 software and its relevance to coastal hydrodynamics and to implementation of MIKE 21 for hydrodynamics. Application of MIKE 21 for sediment transport simulations. Basic of the software used for mathematical modeling MIKE 21. By using the MIKE 21 to create a Hydrodynamic module by knowing the basic set up and know how the model run and relate to the real world conditions. The west coast of India was choose for the finding the hydrodynamics model and the mike 21 software is used to find the sediment transport over the area and the sediment rate to be calculate for the west coast of India.

V: Harnessing of marine mineral and other resources: Exploration and EIA perspectives.

WOSC/2024/ABS/109

Relevance of EIA for Deep Sea mining

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Deep Sea Mining is a very challenging task to be carried out in open oceans. An Environmental Impact Assessment studies need to be carried out in high seas to assessthe effects of mining operation being done. A proposal was made to deploy a surface mooring and three long sub-surface moorings in the central Indian Ocean to provide the Environmental Impact Assessment baseline and for metocean data with requisite sensor suite to fulfill our requirement. The measurements by these sensors will help us gauge the environmental conditions in which the mining system has to operate. A surface buoy was deployed in the Indian Ocean at the mining site Latitude: 13° 32.0865' S Longitude: 75° 41.7979' E to measure the metocean data of the ocean. The buoy was equipped with sensors like Wind sensor, precipitation sensor, Humidity and Temperature sensor, Air Pressure sensor, wave sensor, CT sensor and INMARSAT modem to transmit the real time data to the shore station. The received data is being monitored to know the environmental conditions at Indian mining site which will aid the launching and retrieval of the mining machine. A sub-surface mooring is deployed 500 m below the ocean surface in Central Indian Ocean having depth of 5000- 5500 m. Three long sub- surface deep sea mooring of approx. 4800 m length has been successfully deployed at Central Indian Ocean at three different locations. The sensor suite on these mooring is CTD-turbidity sensor, Sediment traps, single point Current meters and Acoustic Doppler Current profiler, mounted at various depths as standalone sensors throughout the mooring length. The data from the surface and sub-surface mooring will provide helpful information to design the mining scheme and assess the after effects of mining operation.

WOSC/2024/ABS/16

SMS & Chemical Grade Limemud Deposits in Indian Offshore, Carbon Credit Potential and Blue Economy

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Limemud occurs in the western Indian offshore which is compositionally $CaCO_3$, amorphous, homogeneous, creamy white, soft and non-sticky sediments mainly consisting of ooids. The chief mineral constituent of limemud is aragonite. Limemud mainly occurs within water depths between 80m and 100m and at a distance of about 100km in the Gujarat offshore. Bench scale beneficiation and agglomeration studies for limemud foundit may be used in steel, filler, pharmaceuticals, food and cement industries. It is pertinent that though India has huge deposits of cement grade limestone, for high grade limestone the country depends on imports mainly from UAE, Oman, Egypt etc. In 2021 alone, India imported high grade limestone worth more than $ 500 million. The physical and chemical properties of limemud suggest that the limemud may be a suitable raw material for the production of 'stone paper' which can be termed as 'green paper' as well. There are several advantages in manufacturing stone paper in

comparison with that of wood pulp paper especially in the consumption of water and emission of CO2e. A difference of about one- ton CO_2 emission is estimated in the production of one ton paper between the two methods that may acquire one carbon credit depending up on the Indian Carbon Market. The World,at present is facing a critical threat with climate shift. At this juncture, replacement of wood-pulp paper with stone paper in a phased manner may be considered. The properties of limemud make it highly mobile in nature and hence pumping out by means of pneumatic or eddy pumps may be a better option than dredging, in view of sustainable mining. Offshore mining can play a key role in boosting India's Blue Economy. To facilitate this, the Offshore Areas Mineral (Development and Regulation) Amendment Bill, 2023 was recently passed by the Rajya Sabha in India. The bill aims to introduce crucial reforms in India's offshore mining sector.

WOSC/2024/ABS/203

Evidence for two new hydrothermal fields (at 24°49'S and 24°55'S) over the southern Central Indian Ridge, near Rodriguez Triple Junction

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Hydrothermal vent fields, hosted by mantle-derived ultramafic rocks, are rich in precious metals (gold and silver) and are recognized as future marine mineral resources alternate to land. Further, these vent fields leave their foot print in the deep waters by providing enormous amount of chemical constituents in dissolved and particulate forms. Water column physico-chemical studies were conducted over the southern Central Indian Ridge (CIR) between 24°44'S and 25°15'S, for the exploration of seafloor hydrothermal sulfide mineralization. Helium (3He), methane (CH4) and 13C-CH4 were studied in seawater samples collected from deep waters along with the physical characteristics. Maximum turbidity anomalies were observed between 2320-2650 m during several CTD stations. An elevated helium values (3He= 88%), and CH4 concentrations (up to 250 nmol/kg) confirms the presence of hydrothermal plume emanating from high temperature hydrothermal vent (Field 1 at24°49'S). To the south of this vent field, another hydrothermal plume between 2900-3250 m was identified. Elevated concentrations of dissolved methane (up to 21 nM), 3He values (up to 21%), along with high turbidity values confirm the presence of another hydrothermal plume in deep waters and provide evidence for second field (Field 2 at 24°55'S). The stable isotope ratios of methane (13C-CH4) in hydrothermal plumes of both these fields show that heavier isotopes are enriched (from -12.9‰ to -14.7‰) when compared to background seawater (13C= -33‰) and are similar to vent fluids on the global mid-oceanic ridges. The geochemical characteristics of plumes from both these fields, CH4/3He (59-97x106) indicate that there is excess methane possibly because of serpentinization of ultramafic rocks.

WOSC/2024/ABS/207

Polymetallic Hydrothermal Sulphide (PMS) deposits: Geology and Exploration aspects

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Seafloor massive sulfide (SMS) deposits, found in diverse hydrothermal settings at varying depths, are gaining attention as a potential future alternative to terrestrial resources and a global metal supply. These deposits form through the interaction of seawater with sub- seafloor

magma, typically occurring at active volcanic centers like mid-ocean ridges. Cold seawater enters seafloor cracks, reaching depths of several kilometers, and undergoes chemical reactions, resulting in a hot, slightly acidic, reduced fluid enriched in dissolved metals and sulfur. This process yields deposits rich in base metals (iron, zinc, copper, and lead), sulfides, and various elements such as calcium, gold, silver, arsenic, and platinum. At intermediate to fast-spreading MORBs, high-temperature venting primarily occurs in the axial zones associated with basaltic volcanism. In slower spreading ridges, long-lived detachment faults may divert fluid flow, leading to sulfide deposits located kilometers away from the ridge axis. Studies indicate that hydrothermal fields, both active and inactive, are found at many Oceanic Core Complexes (OCCs) associated with detachment faults, and are exceptionally favourable conditions for their generation. However, geological and tectonic influences impact the composition of hydrothermal fluids. These differences are related to variations in source-rock composition as well as variable input of magmatic volatiles and metals into the hydrothermal systems. A systematic exploration effort by NCPOR in CIR led to the discovery of a hydrothermal sulphide mineralisation site far off- axis associated with OCC. Global estimates suggest modern volcanic zones in the ocean contain around 6×108 tonnes of massive sulfide deposits, with approximately 3×107 tonnes of copper and zinc. Ongoing discoveries are expected to increase these estimates. Notably, larger deposits may exist on the seafloor, and emerging technologies are being developed to explore areas away from the ridge axis and under sediment cover.

WOSC/2024/ABS/210

Biological Diversity Associated with the Deep-Sea Mineral Resources in the Indian Ocean

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The deep Indian Ocean is currently the focus of global scientific attention due to the estimated rich mineral resources it holds. However, the region is also one of the least explored and scientifically neglected, particularly in terms of its biological diversity. The mineral resources include large deposits of polymetallic nodules in the abyssal plains, cobalt crusts deposited on some seamounts, and massive hydrothermal sulfide deposits along the Indian ridge systems. These deep-sea regions are home to numerous known and unknown benthic communities that live in association with the mineral deposits. The deep-sea habitats are considered stable and sensitive to anthropogenic disturbance, and the benthic fauna associated with a particular mineral resource is also specific. For example, the fauna associated with polymetallic nodules is dominated by burrowing forms (holothurians, polychaetes, crustaceans), while colonies of sessile fauna (corals, sponges, molluscs, and crinoids) are found associated with cobalt crust. The vent-specific chemosynthetic communities (bacteria, shrimps, crabs, gastropods, mussels, barnacles, and tube worms) are known to be associated with hydrothermal sulfide. Given the limited benthic sampling in the deep Indian Ocean and the potential impact of future commercial mining, it is critical to sample and study the faunal abundance, diversity, distribution, adaptations, endemism, and connectivity of deep-sea fauna linked with specific mineral resources. Moreover, the least explored deep-sea benthic habitats of the Indian Ocean may harbor numerous unknown species. Generally, the representatives of megafauna are large, long-lived, slow-moving, and reproduce seasonally under limited food supply. The small- size macro- and meiofauna, on the other hand, have a short life cycle, and they produce in response to the seasonal supply of phytodetritus fluxes to the sea floor. Accordingly, the technologies used to mine the deep- sea mineral resources will have to

consider these factors to ensure that commercial mineral mining causes minimal damage to the benthic environment.

WOSC/2024/ABS/217

Cold seep induced enhanced water column methane concentrations in Krishna- Godavari basin, Bay of Bengal

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Active cold seep sites associated with shallow gas hydrates, methane gas flares in the water column, and cold seep ecosystem were reported from the Krishna Godavari (K-G) basin, the eastern continental margin of India. The ecosystem comprises various chemosymbiont benthic organisms such as Bathymodiolus, Acharax, and several heterotrophs (Mazumdar et al., 2019). An autonomous underwater vehicle (AUV OEM-6000) survey was conducted during December 2023 at two cold seep locations (KG-1, water depth: ~1750 and KG-2, water depth: ~1000 m) of the Krishna-Godavari basin, to understand the water column methane concentrations along with seabed survey by means of photographic studies. The results of the study show that the KG-1 comprises of surface methane hydrates, the bubbling of methane gas, and a large ecosystem extending to several square meters in area. The dissolved methane concentrations range from ~ 0.002-1.45 µmol/L. Very high dissolved methane concentrations may be attributed to gas bubbling from the cold seeps. Venting of methane bubbles may be attributed to excessive pore pressure and low solubility because of enhanced pore water salinity resulting from methane hydrate crystallization. The ecosystem is predominantly populated with Bathymodiolus species along with the presence of tube worms (possibly Lamellibrachia Sp.), goose barnacles etc. Although enhanced water column methane concentrations (2-500 nmol/L), and surface hydrates coupled with carbonate crusts are observed at KG-2, benthic megafauna were not observed. Absence of benthic community may be attributed to recent methane seepage activity. References: Mazumdar, A., Dewangan, P., Peketi, A., Gullapalli, S., Kalpana, M.S., Naik, G.P., Shetty, D., Pujari, S., Pillutla, S.P.K., Gaikwad, V.V., (2019) The first record of active methane (cold) seep ecosystem associated with shallow methane hydrate from the Indian EEZ. Journal of Earth System Science, 128(1), 1-8. Acknowledgments: We sincerely thank Director NIO, NIOT, and MoES, Gas hydrate program, NIOT.

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Exploration of polymetallic sulfide deposits in the Eastern SWIR: Sediment geochemistry evidence

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Hydrothermal vent incidence is proportional to the spreading rate of the mid-oceanic ridges (MORs). However, the ultra-slow spreading Southwest Indian Ridge (SWIR) is unique and has a relatively higher incidence of hydrothermal vent fields compared with other ultra-slow spreading ridges. We have carried out geochemical studies of surface sediments from the eastern part of the ultra-slow spreading southwest Indian ridge (SWIR) 63°E - 69°E. The sediment samples were collected from two regions, 63°E to 64.5°E (block A) and 67°E to 68.5°E (area north of the ridge axis – block B and the area south of the ridge axis – block C). Calcium carbonate (55– 85%) is the dominant phase in theEastern SWIR sediments. A comparative study of the sediments having similar carbonate content suggests that the sediments from block C are most metalliferous, followed by block B sediments, while block A sediments are least metalliferous with the highest detrital content.The metalliferous nature and negative Ce and positive Y anomalies in the shale- normalized rare earth element (REE) pattern of the bulk sediments, as well as the leached fraction, reflect the presence of hydrothermal inputs to most of the sediments. It is also observed that with increasing depth, the metalliferous nature of the sediments decreases. The residual fraction is dominated by mid-oceanic ridge basalt (MORB) derived components in addition to serpentinizedperidotite and terrigenous material. Among the studied sediments, sample E-3-16 from Fuji Dome has high zinc concentrations, possibly of hydrothermal origin, indicating the possibility of a new vent field in the near vicinity. High Cu content indicates that the incorporation of sulfide debris in sediment sample C- GC-16(0-1cm) has enriched the Cu content. Subsequently, the oxidation of sulfide triggered the reduction of U, Mo, V, and As and their uptake from the water column.

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Experimental study on heating of hydraulic oil for the deep-water vehicles

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Self propelled remotely operated deep-water vehicles like underwater mining machine, remotely operable vehicle, etc., are mainly consisting of hydraulic system, electric motor and instrumentation system. The fluids used in the hydraulic system will be subjected to a high pressure and low temperature of the deepsea ambient conditions. The hydraulic oil viscosity will be high at the deepsea ambient conditions. The cold start of the hydraulic system at high ambient pressure would cause the system failure due to the high viscous of the oil. It is essential to have a heating system to maintain the temperature around 20-25 deg C to have a desirable viscosity of the oil. For the sizing of the heating system, an experimental study was carried out on the 12 nos of 10 W (total power of 120 W) PTC heating element to ascertain the heating capability at higher pressure and low temperature, simulating deep sea ambient conditions. An electro-thermal analysis was done to choose the sizing of heating elements

capacity to avoid localized heating of oil. The heater elements were placed in a pressure compensated enclosure with hydraulic oil (Viscosity grade:32) and heated up the oil in hyperbaric conditions up to 600 bar pressure. It has been observed that the specific temperature coefficient of the oil was more at higher pressure and low temperature compared to the standard temperature pressure (STP) conditions which cause more heat energy required to raise the temperature of the hydraulic oil. Based on the experimental results the heating system was sized more than10% of the STP for the deep-sea ambient conditions. Key words: Deepwater vehicles, hydraulic oil, heating system, deep sea ambient.

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Morphology and Molecular Phylogenetic Analysis of New Deep-sea Species (Oct

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Deepsea corals are important habitats for creatures in the deep-sea environment, often providing habitat for other marine species. So far, no deepsea coral species belonging to the family Victorgorgiidae Moore, Alderslade, and Miller (2017) have been reported from the Indian Ocean. Here, we present the first documented complete mitogenomes of the new deep-sea coral Victorgorgia sp. nov., and its systematic position within the family Victorgorgiidae. A benthic sledge was used to collect samples of the megabenthic populations from depths between 2032 and 2507 m. It is included in an assessment of the benthic ecology and baseline environmental conditions. Using molecular phylogenetics and morphological comparison, we present a new octocoral species based on integrative taxonomic techniques. The new species tentacle sclerites are mainly josephinae clubs, small flat rods, straight clubs, tuberculate sticks, the point, and collaret sclerites are tuberculate spindles and sticks of similar sizes; medulla sclerites are mainly tuberculate sticks, and spindles. Molecular phylogenetic analyses (mitochondrial mtMutS) are evidence for CIR new species as more closely related to V. flabellate, and V. iocasica from the Western Pacific Ocean within genera Victorgorgia. These descriptions increase our understanding of the Central Indian Ridge octocoral species diversity and contribute to the ongoing project work of the Deep Ocean Mission. Keywords: Octocoral, new species, molecular phylogenetics, deep-sea coral, Victorgorgiidae, CIR,

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Image Processing and Enhancement Techniques for underwater Object detection

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In the recent years, an exploration of deep sea has attracted more attention as the underwater environment contains vast and diverse range of living and non-living resources which includes minerals like polymetallic nodules and other marine organisms. Mapping and detecting those resources in underwater through underwater vehicles, AUV's, etc., is difficult as it has poor visibility because light is exponentially attenuated and the images are poorly contrasted and hazy. Underwater resource detection utilizing image processing approaches has attracted substantial interest using imaging technologies. This paper discusses the effect of the image processing and enhancement techniques to detect and quantify the presence of Polymetallic Nodules, Flora and Fauna in the focused area which would help in identifying the new species of organisms if any. Respective images are gathered and datasets were prepared by categorising as per the underwater resources to detect the concern objects by discarding the false-positives using Haar-Cascading Machine Learning Algorithm and image enhancement

techniques such as histogram, histogram equalization and CLAHE. A python based in-house desktop application is developed to detect and process images. In this application real-time object detection can be done without any additional hardware components other than underwater cameras. Hundreds of positive and negative datasets are created using images from different sources, in various lighting conditions. The images are compared in realtime and 70-80 % accuracy was achieved in detecting the object. This algorithm can help in detection of all types of mineral resources, flora, and fauna after training it with appropriate positive and negative datasets. Quantification of the underwater resources will help in effective planning of utilizing these resources.

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COASTAL MINERAL RESOURCES OF INDIA – AN OVERVIEW.

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India's coastal area is bestowed with immense mineral potentials like heavy minerals, sand, vanadium etc. The heavy minerals mainly include Ilmenite, Sillimanite, Garnet, Rutile, Zirocn, Monazite etc. All these minerals are of utmost economic importance as they are used for different industrial products. The silica sand is mainly concentrated to coastal parts of Kerala and Karnataka whereas carbonate sands are reported from off Gujrat coast. Heavy minerals are found extensively throughout West Coast and East Coast of India and their concentrations are mainly at Kerala and Odisha coasts. Sand resource of 750 million tonnes has been reported in the Territorial Waters off Kerala by GSI and sand percentage varies from 80 to 96%. This sand can be useful for construction purpose once salt contentis removed by repeated washing. The total Heavy minerals in the West Coast varies from 0.03% to 43.8% and in the East Coast, it varies from 0.51 to 20.81%. At Southern part of Kerala, near Ambalappuzha, the HM wt% goes up to 80% in the beach sand and they consist mainly Ilmenite (82%) followed by Sillimanite (15.8%). The total Heavy Mineral resource in the nearshore areas of India is 79 million tonnes up to a depth of 1m. Vanadium mineral is recently reported by GSI on the coastal part of Gulf of Kutch in titano-magnetites in coastal parts of Gujrat. The average Vanadium content reported is 2552 ppm and Vanadium varies from 1224 ppm to 3271 ppm. In Bulk sediments, average Vanadium content is 455 ppm. Key words- Sand, heavy minerals, vanadium, kerala, odisha etc.

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Distribution pattern and Provenance study of Heavy Minerals suites in different microenvironments of Gopalpur coast, Southern Odisha, East coast of India

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The placer/heavy mineral (HM) analysis is a significant tool to infer the provenance, mode of transportation of the fluvial, continental- dune-beach and marine terrigenous sediments . As the on-land natural resources are fast depleting, the future of global economy in general and national economy in particular shall have to fall back on the offshore resources and national policy on offshore resources is required to be in place for both near shore and deep sea sectors. Their easy availability, chemically resistant to weathering, durability and low cost mining gives good profit to the country. Odisha coastline, East coast of Indiais endowed with a number of multi-mineral placer deposits of beach and dune sand origin. The present study was carried out along Gopalpur to Sonapurpeta sector, southern Odisha, East coast of India on the HM distribution in different onshore and offshore microenvironments, which reveals that the onshore and near shore sediments of the sector laden with high concentration (>3 wt%) of the economic heavy minerals. The bulk (THM) heavy mineral concentration is 7.12 wt % and 14.03 wt % in the near shore and onshore regions respectively, represent a promising heavy mineral concentration zone. It is observed that their values gradually decrease from land to seaward due to various geological processes. This average value itself is indicative of high incidence pattern of HM in the present study area. The THM content at the onshore beach sediments varies between 1.35 and 30.53 wt%, with an average value of 14.03 wt.% and at the near shore (0-10 m isobaths) region varies between 0.55 and 21.30 wt%, with an average value of 7.12 wt.%.The heavy mineral suite with Ilmenite, Garnet and Sillimanite as major constituents followed by Rutile, Zircon, Monazite as economic mineral, others area Hornblende, Pyroxenes, Epidote and minor amounts of Kyanite and Tourmaline. Based on heavy minerals assemblage, it can be concluded that the heavy minerals in the study area might have been derived originally from different high grade metamorphic rocks, acid and basic igneous rocks, reworked sediments and the low rank metamorphic rocks of Eastern Ghat Mobile Belt (EGMB) (like migmatites, khondalite, charnockites, granite gneiss, pyroxene granulites). Rivers, such as, Devi, Harchandi, Behuda and Mahanadi draining through the rocks of EGMB have contributed these minerals to the nearshore to offshore. The minerological study also depict the sediments were mainly transported from crystalline EGMB terrain by fluvial and aeolian processes and subsequently deposited in the marine environment. The distribution pattern exhibited by opaque, garnet, zircon and rutile suggest that difference in specific gravity, settling velocity and differential transportation have played a major role in their distribution pattern at different micro environments under the study. Gopalpur is a wave dominated area. Normally wave and fluvial dominated areas are more pronounced for HM deposits than tide dominated areas, due to sediment input by high energy wave influx.

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ESTIMATION OF LIMEMUD RESOURCES OCCURRING IN THE INDIAN OFFSHORE USING PROFESSIONAL SOFTWARE TARGET™

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The mid-outer continental shelf of north western India is characterized by the presence of limemud which is soft, creamy white homogeneous, calcareous material with major mineral phase aragonite followed by calcite. Limemud occurs as basin/depression fill deposits. Limemud may be suitable for steel, cement and filler industries. As per IBM data, India resort to imports of large quantity high grade limestone to meet the requirements. The Offshore Areas Mineral (Development and Regulation) Amendment Bill, 2023 was recently passed by the Rajya Sabha in India aiming at major thrust in the offshore mineral exploration and mining. At this juncture, the estimation of limemud resource using professional software like TargetTM is of paramount importance. Reconnaissance survey carried out by GSI in the Gujarat-Maharashtra offshore covering more than 75,000 sq.km area with sporadic core sampling and systematic Sub-Bottom Profiling (SBP), estimated inferred resource of about100 billion tonnes and delineated potential area about 12,000 sq.km and about 3,500 sq.km area highly potential where the overburden thickness is less and grade ($CaCO_3$%) is more. Close Grid Mineral Exploration (CGME) was planned in 160 sq.km area falling within the high potential zone as a part of cruise SR-053 onboard RV Samudra Ratnakar recently off Porbandar, Gujarat. The area was profiled at 1km interval using SBP to bring out the sub-surface continuity of the limemud and sampled at 2km x 2km grid interval generating 44 cores of 3 to 5.84m length. The inferred resource of limemud with higher level of confidence was estimated following triangulation method of wireframing using Target software that is built on Geosoft® Oasis montaj™ platform brought out 179.6MMT of Impure Limemud (Grade: ILM with 70-80% $CaCO_3$), 735.7 MMT of Limemud (Grade: LM, with 80-90% $CaCO_3$) and 524.4 MMT of High Grade Limemud (Grade: HLM, with >90% $CaCO_3$).

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Heavy mineral distribution pattern in the coastal tract of Kasaragod District, North Kerala, India, and inferences on the controlling factors

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The coastal tracts of Kerala State are well known for their economically important heavy mineral placer deposits. An interesting pattern in the heavy mineral distribution has been identified during a short-term and long-term morphological study conducted on the coastal area between Chandragiri and Karingote River mouths, Kasaragod District, Kerala. A structurally weak plain defined by an offshore fault and a minor river Chittari on the landward side divides the area into two sectors with unique characteristics with respect to geology, geomorphology, and sediment transport. Total Heavy Mineral (THM) concentration in sector-1 varies from 2.9 to 18.59%, averaging 7.38% with an economic heavy mineral (EHM) concentration of 0.9 to 12.64 % (average 3.564%). In secor-2, the wt% of THM ranges from 4 to 37.16% averaging 13.65% with EHM concentration from 1.28 to 23.81% (average 7.67%). Having all the characteristics of a submerging coast, the northern part of the Chittari River (sector-1) manifests erosion while the southern part(sector-2) with characteristics of an emerging coast exhibits accretion. Shallow seismic reflection studies and gravity data picked up several structural faults and lineaments which can be inferred as the control of geomorphic difference. The iso concentration map prepared for THM reveals that sector-2 is more enriched with heavies where the seasonal to millennial data show a shoreline advancement when compared to sector-1. Lithologically, Quartzo felspathic Gneiss is the major litho unit of sector-1 whereas sector - 2 has Archaean Charnockite as the major crystalline litho-unit. The mineralogy of heavy mineral suite changes from ilmenite-garnet-sillimanite in sector-1 to the garnet-ilmenite- sillimanite in sector-2. On examination of the plausible controlling factors for the uniqueness in the distribution pattern of the heavies in the two sectors, it has emerged that coastal geomorphology plays a pivotal role in the distribution and concentration of heavy mineral placers in the area.

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Strategic placer mineral exploration with mineralogical characterization in the Territorial Waters off Malud, Odisha, East Coast of India

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Systematic close grid placer mineral exploration in the inner shelf zone off Malud, Odisha coast was carried out in the coastal vessel of GSI, RV Samudra Kaustubh. Bathymetric study implies, the study area is very smooth and gently sloping towards the south with isobaths parallel to the present-day coastline. A total of 64 vibrocore samples and 3 water samples were collected from water depths of 19.60 m to 32.15 m. Core length varies from
0.29 m to 1.79 m. Textural analysis of the surface sediment shows that coarse sand dominates the majority of the seafloor. CM Plot indicates most of the samples fall under the beach environment of deposition and the main mode of transport for their deposition was by rolling associated with or without bottom suspension. The fining downslope and downcore pattern of the sediments may represent facies shift due to regression in the past. Bulk placer mineral percentage in the study area for top 1m sediment varies from 0.58 to
13.97 wt% with an average of 3.40 wt%. Ilmenite, Leucoxene were the predominant minerals followed by Garnet and Sillimanite, Magnetite, Monazite, Zircon and Rutile. Other non-economic heavy minerals identified are Pyroxene, Amphibole, Spinel, Kyanite, Mica etc. Resource estimation was carried out using Arc GIS 10.8.2 software, bulk heavy mineral resource evaluated is about 3.2471 million tons with mean bulk HM of 6.217% from 54.7696 million tonnes of placer mineral bearing sand. Geochemical study of placer minerals in the sediments show high concentrations of $Fe_2O_3\%$ in the sediments of the area varying from 18.88% to 27.42% followed by $TiO_2\%$ varies from 10.14% to 21.84% and $Al_2O_3\%$ ranges between 9.30% and 21.69%. Major oxides such as Fe_2O_3, TiO_2, and Al_2O_3 in the sediments show strong affinity to terrigenous-derived materials. Total REE values vary from 2201 ppm to 3296 ppm with an average of 2485 ppm.

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Exploration of benthic biodiversity in the Central and Southwest Indian Ridges: India's commitments and contributions

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Mid-ocean ridges are being prospected for seabed mining, as they harbour massive sulphide deposits associated with hydrothermal venting activity. The International Seabed Authority (ISA) is mandated to regulate the exploration (and exploitation) of marine mineral resources beyond national jurisdiction and to develop measures for environmental protection for the proposed mining activities. A pre-requisite for such environmental protection is the generation of comprehensive data on seafloor biodiversity, which is particularly vulnerable to the physical disturbances that may arise due to seabed mining; and this is emphasised in the ISA's guidelines and initiatives (e.g. sustainable seabed knowledge initiative, SSKI). As part of India's commitments to the ISA, the NCPOR has been conducting extensive benthic biodiversity surveys in the Indian contract areas along the Central and Southwest Indian Ridge systems, using an integrated taxonomic (i.e. both molecular and morphological) approach. This has also led to the description of four new species of sponges, three new species of deep-sea corals and two new species of squat lobsters as well as numerous new records for the region. The list continues to grow and more potential new species are being identified,

particularly among corals and brittle stars. Apart from contributing to baseline environmental data before seabed mining, these efforts are filling gaps in knowledge about the biogeography and connectivity of deep-sea fauna, and highlight the value of deep-sea biodiversity exploration.

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Speciation of metals and their vertical distribution in a sediment core from southeast Bay of Bengal

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Benthic community assessment along the polymetallic nodule region in the central Indian Ocean – An environmental and Blue Economy perspective

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Polymetallic nodules are mineral deposits found on the ocean floor that contain valuable metals such as copper, nickel, cobalt, manganese etc. These nodules are of great interest to the blue economy, which refers to the sustainable use of ocean resources for economic growth and improved livelihoods while preserving the health of the ocean ecosystem. However, the effects of polymetallic nodule mining on the environment are likely to be long-term. The Central Indian Ocean Basin (CIOB) have been designated for commercial polymetallic nodule (PMN) mining in commercial interest and is considered among the viable components of India's Blue Economy program. Therefore, understanding environmental impact assessment is required before extracting nodules from the CIOB. Benthic communities that live on the sea floor (inside or on the seabed) and are attached to the PMN are the primary organisms to be affected due these activities. Therefore, assessment of these communities is crucial. We have investigated the benthic community structure (meio, macro and nodule-associated fauna) from the past three cruises (2019, 2020 and 2021) data to understand the community pattern along the proposed mining zone (IRZ), preserved zone (PRZ) and one reference site (BC-20). The macrofauna diversity was found to be more in box core samples than the multicore. A total of 11 taxa found in the meiofaunal community were found along the three areas. Silty sediment texture and organic carbon showed positive relation to the benthic community. IRZ was found

to be a more benthic community present than other areas. The biological activities and nodule-associated fauna were recorded higher at PFZ areas than IRZ and BC-20. The biological activities like tubes, mobile and sessile were dominant with <20mm class size of nodules. Our preliminary results showed that nodules act as habitats and are sheltered for benthic organisms in the study area. However, more sampling efforts are required to understand the community pattern before starting mining activities along the PMN areas in CIOB. Therefore, an environmental impact assessment of the benthic community is necessary to understand the potential impacts of deep-sea mining on the benthic fauna and the upper reactive sediment layer and to develop environmental guidelines for the assessment of the possible environmental impacts from the exploration for polymetallic nodules in areas beyond national jurisdiction.

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High Incidence of Vanadium and Copper in the titanomagnetite and ilmenite samples off Ratnagiri, Maharashtra, India

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During the Cruise-SD-307 of Geological Survey of India, samples containing heavy minerals were collected off the coast of Ratnagiri, Maharashtra. These minerals were subsequently separated at the IREL Research Centre, Kollam, India. A total no of eight ilmenite and titano magnetite samples representing eight bays of the study area were analysed for major oxides and trace elements concentration by XRF method. The analysis of major oxides and trace elements in ilmenite samples revealed varying concentrations: Fe_2O_3 ranged from 35.82% to 42.97%, TiO_2 from 21.64% to 45.66%, and Vanadium from 1429ppm to 1816ppm, averaging 1592 ppm. In titanomagnetite samples, Fe_2O_3 ranged from 45.69% to 53.78%, TiO_2 from 17.91% to 24.42%, and Vanadium from 3392ppm to 4442ppm. Notably, both ilmenite and titanomagnetite samples exhibited higher concentrations of Copper. Cu values for ilmenite samples ranged from 345 ppm to 1166 ppm, averaging at 628 ppm, while titanomagnetite samples showed Cu values from 743 ppm to 1030 ppm, averaging at 943 ppm. A ternary composition diagram showing solid solution series of Iron and Titanium oxide minerals (After deer et.al 1992) was prepared by using EPMA data of titano magnetite grains. Ternary diagram of TiO_2, FeO and Fe_2O_3 indicates that all the titano magnetite samples fall in titanomagnetite field. From the ternary diagram, it is interpreted that the higher concentration of vanadium in the samples are contributed by titanomagnetite in the survey area, which is reported from the Decan basalt present in the hinterland. The EPMA study unveiled exsolution lamellae of ilmenite within titanomagnetite and vice versa. Titanomagnetite is a significant phase in the high titania basalts (average TiO_2 2.55%) a portion of copper is bound to be with that phase (Pramod O. Alexander. & Harel Thomas,2011). The strong positive correlation observed between Cu and V further supports the provenance of titanomagnetite from the Deccan basalt. Vanadium holds a pivotal status as a critical raw material, particularly in strategic domains like defence and aerospace. These findings offer valuable insights into vanadium presence and distribution in the studied mineral samples, providing crucial data for further research and resource assessment in the region.

WOSC/2024/ABS/72

Andaman Back Arc Spreading Centre: A probable loci for Seafloor Massive Sulphide (SMS)

deposits

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Backarc basins, much like the Mid-ocean Ridge system, are known for their potential to contain Seafloor Massive Sulphide (SMS) deposits. Recent research in the Andaman Back Arc Spreading Centre (ABSC) has revealed the presence of SMS in the form of volcanic rocks with vent-like features, broken chimney structures, and rock containing metal sulphides. In addition, the occurrence of pyrite mineral along with basaltic rock provide further evidence of the presence of SMS in this region. The Fe-Mn crust samples collected from the area show a high Mn/Fe ratio, poor enrichment of trace metals, and high $\sum$REE, indicating their hydrothermal origin. Evidence of recent hydrothermal activity in the region is also seen in the high incidence of Mn in the top sediment, the occurrence of montmorillonite clay, and in-situ unaltered glass shards. All these geological findings suggest that the ABSC is a potential location for SMS. However, in slow-spreading ridges like the ABSC, long- lived detachment faults may divert fluid flow away from the ridge axis, resulting in sulphide deposits being found several kilometers away from the ridge axis. Therefore, exploration for SMS should not be restricted only to the active spreading centre.

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Enhancing the growth conditions of the marine bacterium, Bacillus cereus, a valuable source of the biopolymer, poly- hydroxy butyrate/co-valerate at fermenter level

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Increasingly environment friendly sources of durable materials become very much important in day today life in the context of shrinking oil reserves for which sustainable alternatives to petroleum- derived products, such as bio-polymers, can be derived from renewable materials such as microorganisms found in unique diversity in the marine environment. They are adapted to diverse conditions of nutrient availability which enable them to produce a wide variety of polyhydroxy alkenoates, including polyhydroxy butyrate co-valerate (PHBV), under diverse conditions of nutrient availability. Bacillus cereus, a marine bacterium capable of producing PHA from the industrial waste, glycerol as substrate, was isolated at the National Center for Aquatic Animal Health, Cochin University of Science and Technology. The commercial production of PHBV from B.cereus requires understanding of the growth kinetics, culture conditions, and production kinetics of the organism under consideration. We investigated the growth kinetics of B.cereus in 5L fermenter and traced its growth kinetic parameters as well as different phases of growth. As the organism is a spore producer, spore formation has also studied in lab- scale fermenters and investigated the impact of mixing parameters, specifically agitation and aeration, in order to optimize and scale up the production of biomass and biopolymer in pilot and industrial fermenters. Keywords: Poly hydroxy alkanoates (PHAs), Poly hydroxybutyrate co valerate (PHBV), Bacillus cereus, agitation, aeration

WOSC/2024/ABS/273

Simulation of Gas Hydrate Production in KG Basin Sediments via Depressurization

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Gas hydrates, resulting from hydrocarbon gases trapped within water molecule structures due to specific high-pressure and low-temperature conditions, hold significant promise as a future energy source. These formations occur naturally in advantageous settings, like permafrost areas at depths ranging from 130 to 2000 meters and deep-water sediments spanning depths of 800 to 3000 meters. Despite this potential, the technology for extracting methane gas from these reservoirs is still under development. While various nations have conducted trial tests, achieving commercial viability remains a considerable hurdle. Depressurization emerges as a leading method for gas hydrate dissociation, yet it continues to undergo refinement. In this context, numerical simulations play a pivotal role in understanding the intricate production processes before embarking on real-world field experiments. Using TOUGH+ HYDRATE, a specialized simulation software, a study modelled a 100 meter cubic reservoir with parameters similar to the sediment conditions in the KG basin. The simulation aimed to replicate production processes employing depressurization techniques that align with the specific in-situ thermodynamic conditions of the KG basin. Exploring a range of pressure drops (ΔP) from 10 to 90 bar, the study sought to assess their impact on methane gas production. The results revealed a notable trend: higher production volumes were evident at ΔP values of 90 and 80 bar. Methane gas output showed a direct correlation with increased pressure drops. At a 70-bar pressure drop, production levels reached 4.9 million m3. However, a substantial spike occurred at pressure drops of 80 and 90 bars, where production surged impressively to 50 million m3. Therefore, based on this comprehensive study, it is proposed that pressure drops of 80 bar and higher offer an economically feasible method for methane gas production within the KG basin's reservoir setting. This observation may drive further advancements and considerations in the pursuit of effective gas hydrate extraction methods.

WOSC/2024/ABS/312

A new theory for the origin of the enigmatic 85°E Ridge

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The subsurface 85°E Ridge (85ER) in the Bay of Bengal is characterised with up to 200 km width and a typical gravity low. Numerous studies have been done on this ridge till date but there is no consensus on its mode of origin, extent and nature. We have attempted an integrated study of gravity, magnetics and seismic data along the 85ER to understand the origin of the ridge in the light of new results on the complex tectonics of the surrounding crust. This study examines three aspects about the existence of the 85ER to propose a new theory: 1. nature of the pre-existing crust on which the ridge formed, 2. time of emplacement, 3. source of the ridge structure. The seafloor spreading that occurred between India and Antarctica during Early Cretaceous was affected when the eastern segment of the spreading center jumped northward to the Kerguelen plume. The transform fault (TF) along which the spreading center jumped forms the northern segment of the 85ER. Clockwise rotation of the spreading center during the Middle Cretaceous coupled with left lateral offsets resulted in transpression towards south. This transpression along a TF forms the southern segment of85ER which is also the northward continuation of the 86°E fracture zone. Further, our study suggests that the emplacement of 85ER over a TF boundary explains its typical low gravity. Its considerable width can be attributed to the changes in plate motion occurring during the Middle Cretaceous.

The ridge has emplaced rather rapidly during the Middle Cretaceous period due to fractured nature of the TF crust. The source of volcanism is probably the Kerguelen plume via a new conduit, though the role of the Crozet hotspot cannot be ruled out. Dense geophysical datasets including deep seismics along the ridge are entailed to validate this theory.

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Harnessing Marine Cyanobacterial Exo polysaccharides in view of Environmental clean up process

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Oceans, covering two-thirds of our planet, house vital biological, mineral, and energy resources with applications in various sectors. Responsible exploitation requires a thorough understanding of potential environmental consequences. Harnessing marine resources within sustainable practices ensures a harmonious coexistence between human activities and delicate ocean ecosystems. Marine cyanobacteria, unique photosynthetic prokaryotes, are recognized for producing abundant Exopolysaccharides (EPS). Comprising polysaccharides, lipids, proteins, and heteropolymers, these substances find diverse applications in textiles, detergents, adhesives, oil recovery, wastewater treatment, brewing, downstream processing, cosmetology, pharmacology, and food additives. Recent exploration of EPS as biosorbents offers an eco-friendly alternative to traditional methods, addressing contaminants like textile dyes, heavy metals, and petroleum hydrocarbons that contribute to ecological crises. With the spotlight on efficient biomass usage, the study focuses on the holistic approach of extracting and characterizing marine cyanobacterial polysaccharides, emphasizing their applications in environmental concerns. Keywords: Marine cyanobacteria; Exopolysaccharides; bio sorbents; Applications.

WOSC/2024/ABS/447

Development and optimization of seaweed based bioplastic with enhanced durability and tensile strength using chitin derived from prawn waste

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The world produces around 350 million tonnes of plastic waste each year (OECD report, 2023). The environmental crisis caused by plastic pollution demands sustainable alternatives to traditional, non-biodegradable plastics. Plastics derived from renewable biological sources, represent a promising and environmentally sound alternative. This project focuses on developing biodegradable bioplastics using natural resources like seaweed (Kappaphycus alvarezii) and chitin from shrimp shell waste. Annually, the world generates approximately 6 to 8 million tonnes of waste from crab, shrimp, and lobster shells (Yam and Chen, 2015). Bioplastics derived from seaweeds emerge as a sustainable solution to the plastic pollution.

The study aims to create an eco-friendly biopolymer blend as an alternative to conventional plastics. The objectives include extracting and integrating carrageenan from Kappaphycus alvarezii and chitin from shrimp shell waste, and characterising the resultant bioplastic. The study aims to enhance and compare the bioplastic's mechanical strength, durability, and biodegradability to confirm its practical utility. Preliminary work includes the isolation of carrageenan from seaweed through alkaline treatment and the extraction of chitin from prawn shells. Further studies aim at refining the bioplastic's properties, and exploring commercial applications, aiming to significantly contribute to sustainable materials science and mitigate plastic pollution. The socio-economic impact is significant as India's extensive 7516 km coastline, particularly the southeast coast, Gujarat coast, Lakshadweep Island, and Andaman and Nicobar Islands, are rich in seaweed, promising ample raw material for bioplastic production. It also enables recycling the tonnes of crustacean waste discarded. Advancements in this sector could greatly benefit coastal families, particularly women, by enhancing employment and providing new source of income. Thus, harnessing India's abundant seaweed resources can markedly enhance bioplastic production, substantially boosting economic growth and empowering coastal communities. Keywords: Bioplastic, plastic pollution, shrimps, seaweed, chitin.

Comparative study of Encapsulated Peppermint & Clove oil in chitosan nanoparticles: Encapsulation efficiency, Thermal stability, Invitro release, Antioxidant activities.

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Essential oils have gained remarkable attention due to their suitability as green additives which could efficiently substitute synthetic food additives with their inherent side effects. They have the potential of improving the shelf life of food as a result of their antimicrobial properties (Abel Inobeme and Charles,2024). Esssential oils like Clove and Peppermint oil contain many phenolic compounds like eugenol with many biological properties that can act as antioxidants and antimicrobials. Because of its poor solubility and rapid oxidation, it cannot used efficiently in food packaging, pharmaceuticals. Nanoencapsulation of these essential oils in chitosan enable its controlled release, maintain the stability and increase its effectiveness. Chitosan is second most abundant biopolymer in nature, found in fish scales, cell walls of crusteaceans, mushroom, fungi etc. Chitosan being a biopolymer has many applications in the field of food and agriculture as a clarifying agent, antioxidant, seed coating, antimicrobial agent. Fish and seafood processing industries generate large quantities of waste, which are at the origin of several environmental, economic and social problems. Fish scale being a food waste can be utilized in production of chitosan feasibly by three chemical treatment steps namely demineralisation, deproteinization and depigmentation. Preliminary work includes extraction of chitosan from fish scales followed by its encapsulation. Ionic gelation method is most commonly used method for the preparation of encapsulated chitosan nanoparticles with the help of tripolyphosphate (TPP). The chemical structure and success of encapsulation is checked using Fourier transform infrared (FTIR)spectroscopy and X-ray diffraction (XRD). Scanning electron microscopy (SEM) results gives images of the shape of nanoparticles. Physiochemical properties, invitro release studies and antioxidant activities is evaluated using UV spectroscopy. A comparative study of both encapsulated essential oils is performed. This technique has its application in food industry as an active packaging material, pharmaceuticals and pest control. Keywords: Essential oils, Nanoencapsulation, Chitosan, Nanoparticles.

VI: Underwater Domain Awareness.

Marine Spatial Planning (MSP), the Dynamic Digital Transformation Tool for Underwater Governance

Shridhar Prabhuraman, Maritime Research CenterJay Pinjarkar; Arnab Das; Romit Kaware

The global community, under the United Nations (UN) Decade of the Ocean Sciences for Sustainable Development, prioritizes Marine Spatial Planning (MSP) for enhanced Ocean Governance. Investigating MSP in tropical waters becomes a compelling research problem due to sub-optimal sonar performance for acoustic surveys and the potential environmental impact of exploiting rich biodiversity and underwater mineral reserves. Given the real climate change risk, effective risk management across water bodies is crucial for ecosystem well-being. MSP, a spatio-temporal mapping tool, allows nuanced policy and technology interventions, as well as capacity building in underwater domains, considering marine and freshwater systems. This work introduces a unique AI-based MSP tool for nuanced governance in varied underwater applications, utilizing inputs from above-water databases for real-time predictions. Experimental validation at select locations, based on Modeling & Simulation efforts, minimizes sensor deployment. Unlike resource-intensive conventional MSP, the tool is designed for tropical waters and is demonstrated with features and backend Digital SignalProcessing (DSP) and Data Analytics efforts. The presentation highlights the tool's applicability for sustainable development in the global south.

Navigating the Depths: Integrating Underwater Domain Awareness for Advanced Climate Change Risk Management in the Indian Ocean Region

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The Indian Ocean, pivotal for geostrategic interests, connects West Asia, Africa, Southeast, and East Asia, hosting 35% of the world's population and 16.8% of global oil reserves. Faced with escalating climate threats, a vital need arises for an advanced Climate Change Risk Management (CCRM) strategy in the Indian Ocean Region (IOR). This abstract suggests integrating Underwater Domain Awareness (UDA) into CCRM for real- time climate impact data. UDA monitors oceanographic, meteorological, and ecological parameters, providing decision-makers with predictive capabilities. In the IOR's vulnerability, UDA in CCRM identifies underwater-specific impacts like ocean acidification and coral reef degradation. By incorporating UDA into climate models, stakeholders gain insights for targeted mitigation and adaptation measures.UDA's utility extends to early warning systems for extreme weather events, facilitating timely evacuations and reducing human and economic losses. The abstract underscores collaborative efforts among IOR nations to establish a transcendent UDA network, promoting effective data sharing and coordinated responses to climate challenges. Integrating UDA with advanced CCRM strategies becomes a transformative approach for resilience in the face of evolving climatic conditions. The abstract advocates for proactive and collaborative deployment of UDA technologies, ensuring sustainable development in the Indian Ocean Region.

WOSC/2024/ABS/490

Digital Transformation for Enhancing productivity and Sustainability of Aquaculture

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Aquaculture, with its potential to revolutionize local economies, requires sustainable growth practices to minimize environmental impact. The forthcoming digital tool employs machine learning for comprehensive farm monitoring, prioritizing productivity over increased land usage. By extracting vital environmental parameters influencing organism growth, the tool offers insights to enhance productivity without expanding land footprint. The framework integrates evidence from literature into a mathematical model, utilizing probability and machine learning concepts to predict organism growth rates based on environmental conditions. This robust framework maximizes returns for farmers, aids stakeholders in identifying high-productivity locations, and reduces organism mortality rates by maintaining optimal farm conditions. The digital integration serves as a proactive measure to mitigate climate variability impacts, enhancing aquaculture's sustainability and resilience. Additionally, the transformation acts as a governance tool for diplomatic decisions and investments in the aquaculture field, strengthening data-driven insights- based development in the Indian Ocean Region. This approach not only boosts economic benefits but also minimizes risks, contributing to a more sustainable and resilient industry.

WOSC/2024/ABS/491

The Tyranny of Small Decisions: A Comprehensive Study of Underwater Domain Implications

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This research investigates the "Tyranny of Small Decisions" in diverse environmental contexts, analyzing cases like the Aral Sea catastrophe, Acoustic Habitat Degradation, Overfishing, Plastic Pollution, Coastal Communities versus Development, Urban Flooding, Freshwater Management, Groundwater Mismanagement, Traditional Practices versus Development, and Wetlands Management. The Aral Sea case illustrates how seemingly rational decisions can lead to disastrous environmental consequences, emphasizing the need for a comprehensive framework like Underwater Domain Awareness (UDA). Acoustic Habitat Degradation highlights the complex relationship between human activities and underwater ecosystems, proposing mitigation strategies such as noise regulation and advanced vessel technologies. Overfishing exposes the interplay of corporate interests, technological advancements, and regulatory gaps, advocating responsible fishery practices globally. Plastic Pollution in the Indo-Pacific region exemplifies the "Tyranny of Small Decisions," emphasizing the UDA framework for data-driven policy decisions to combat marine plastic pollution. The study on Coastal Communities and Development explores the balance between economic growth, environmental conservation, and social welfare, proposing an integrated framework of UDA and community- based participatory research for informed decision-making and sustainable development.

WOSC/2024/ABS/493

A Comprehensive Study of Blue Economy Principles, Global Status, and Relevance in India

J Cathrine, Maritime Research Center, PuneArnab Das

This study examines the global and Indian-specific aspects of the Blue Economy, analyzing sectors like deep-sea mining, fisheries, aquaculture, shipping, coastal transportation, and inland waterways. It explores the Blue Economy's connection with the energy transition, focusing on sustainable practices in ocean energy and offshore wind. Emphasizing a vision for a Sustainable Blue Economy, the study addresses the integration of economic growth with environmental conservation, proposing strategies for inclusive growth and resilience in coastal and riverine communities. The study also covers sustainable marine tourism, safe diving practices, and the economic benefits of ecotourism. In tropical waters, it explores capacity building and capabilities amid unique challenges. The transformative potential of digital technologies in ocean governance, particularly Marine Spatial Planning, is highlighted, underscoring the role of digital tools in responsible Blue Economy governance. Throughout, collaborative efforts involving government officials, industry professionals, environmentalists, students, researchers, and entrepreneurs are emphasized as crucial for comprehensive and responsible Blue Economy development, ensuring sustained benefits for current and future generations.

WOSC/2024/ABS/487

Sediment Management in the Tropical Waters of the Indo-Pacific Romit

Rajendra Kaware, Maritime Research Center, Pune; Arnab Das

The Indo-Pacific region, a focal point for global strategic interaction, draws attention due to geopolitical dynamics and security concerns. Leveraging the economic and political potential in this area is imperative. Comprising the tropical waters of the Indian and Pacific oceans, this region poses unique challenges in sediment management with profound implications for floods, erosion, transportation, fisheries, aquaculture, sustainability, and underwater resource extraction. Despite India's commitment to sustainable development through initiatives like Sagarmala, Bharatmala, Gati-Shakti, Jal Jeevan, and Inland Water Transport, challenges persist, particularly in addressing siltation and erosion in tropical waters. Climate change intensifies risks like floods and cyclones, emphasizing the need for erosion prevention.Tailored sediment management is crucial for site-specific challenges in tropical waters.Marine Spatial Planning (MSP) emerges as a transformative solution through digital transformation in the underwater domain. The Underwater Domain Awareness (UDA) Framework by the Maritime Research Centre in Pune offers real-time insights, enabling well-informed policy interventions. This research explores the UDA framework's application in addressing unique sediment management needs, proposing policy and technological interventions, enhancing acoustic capabilities, and addressing challenges and opportunities for decision-makers and stakeholders in the region. The UDA framework has collaborative potential among regional nations, discouraging external interference.

WOSC/2024/ABS/492

Environment Social and Corporate Governance (ESG) frameworks

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ESG and ESG frameworks have gained significant traction in the recent years as the demand for sustainability in organization operations has increased. There is a need for organizations to integrate their Environment, Social and Governance (ESG) operations. This paper aims to discuss the evolution of ESG frameworks, ranging from traditional non- financial reporting standards such as the Global Reporting Initiative (GRI) to more specialized frameworks like the Task Force on Climate-related Financial Disclosures (TCFD) and the Sustainability Accounting Standards Board (SASB). The paper will further discuss different sectors where ESG frameworks have been applied, and will discuss the potential benefits of adopting ESG frameworks on organizational performance. Additionally, it introduces major ESG databases and rating agencies involved in ESG data analytics, emphasizing the critical importance of ESG data for informed decision-making. However, there are also certain limitations with the existing literature on ESG frameworks and measurements. In light of these limitations, the paper advocates for future research endeavors aimed at gaining deeper insights into the implementation of ESG frameworks within corporate settings, and for the consistency and accuracy of major ESG rating systems.

WOSC/2024/ABS/495

Transforming Sri Lanka's Maritime Future: A Digital Oceans Initiative with Underwater Domain Awareness Framework

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Sri Lanka, with its rich maritime heritage spanning 5,000 years, possesses a valuable maritime culture crucial for its island nation status. This study explores the seamless realization of the Digital Oceans construct for Sri Lanka, propelled by the Underwater Domain Awareness (UDA) framework. Leveraging the UDA framework, the Digital Oceans initiative incorporates tools for Living Resources Management, Underwater Radiated Noise Management, and addresses Tropical Littoral Challenges. Sri Lanka's sustainable blue economy, guided by UDA, aims to foster conservation, development, and diverse economic activities for inclusive growth. The Indo-Sri Lankan Relations take on a new perspective with UDA, facilitating transparency, confidence building with the international community, and effective governance. The proposed 4-step implementation, driven by the UDA framework, includes seminars, workshops, and interactions, engaging students and professionals, initiating projects for policy and technology interventions, and establishing research, academic, skilling, incubation, and strategy centers. This Center of Excellence, supported by collaborative efforts and resource pooling, optimizes Science & Technology development and research. The UDA framework recognizes site-specific challenges and opportunities in the Indian Ocean Region, providing a nuanced perspective for Indo-Sri Lankan relations.

VII: Policy requirements for sustainable utilization of ocean.

WOSC/2024/ABS/161

Coupling of metal speciation with sediment quality in Mandovi and Zuari rivers, estuaries, and coastal area of Goa, India: Constrains on environmental risk

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This study was conducted to assess the variability of bulk loads and speciation of toxic metals in surface sediment in relation to the basic sediment characters along the fresh-water and estuarine zones of the rivers Mandovi and Zuari, and adjacent coastal areas of Goa, India. For that, the distributions of sediment parameters like texture, organic carbon (TOC), total nitrogen (TN), heavy metals (e.g. Cu, Ni, Cr, and Pb) contents and their speciation were investigated. The results showed marginal elevated concentrations of those metals in TOC-rich estuarine sediments; as compared to those found in fluvial and coastal sites. This indicates excess inputs of metals through anthropogenic activities around both the estuaries. Furthermore, it has also been found that most Cr and Ni concentrations in sediments at both estuaries and coastal sites exceed the optimal limits of several international sediment quality guidelines. To assess the possible ecological risks, the speciation of those metals was investigated, and it showed the majority (50 to >80%)of total metals were associated with residual silicic fraction of all sediment samples. This suggests the silicic materials in sediments; which usually originate through erosion of terrestrial rocks in the catchment areas could be the main host of those toxic metals. Due to the immobile nature of metals; trapped within silicic structures; the dominant fractions of these sedimentary toxic metals would not be exchangeable with water or easily bioavailable and likely impart very limited impacts on the aquatic environment. Therefore, even the bulk contents of toxic metals in sediments exceed the optimal limits of standard quality guidelines; the relative association of toxic metals with different sedimentary components is an important factor for ultimate toxicity assessment.

WOSC/2024/ABS/190

Benefits of exploration and use of natural resources in the face of climate change conditions

Dr. PAMARTHI AMARENDRA, Advanced Marine and Atmospheric Research Agency (AMARA)

At present, all the people around the world are facing many severe weather conditions and continue to live in many miserable conditions. There is a huge availability of natural resources that can provide a lot of relief to the people. The best adaptive way forward is to actin a way that mitigates natural calamities by judiciously utilizing the available resources. Climate change is becoming more serious due to many mistakes in pollution control. The way of life followed by people all over the world can also be considered as a major reason for the acceleration of these climate change processes. However, it is a fact that climate change isto be tackled effectively if it is done in a systematic manner with a number of strongmeasures. Keywords: Climate Change, Life, Planet, Policy, Pollution control and Natural resources.

WOSC/2024/ABS/220

Blue Economy

Dr. Prashant Kumar Srivastava, Ministry of Earth Sciences

Blue Economy Vision: "Sustainable utilization of Blue Economy resources for economic growth of the country ensuring health, safety and diversity of ocean ecosystem" The "Blue Economy" is defined as sustainable use of ocean resources for economic growth, improving livelihoods and employment especially for those who depended upon it while preserving the health of ocean ecosystem. The blue economy comprises a range of economic sectors and related polices that together determine sustainable use of ocean resources based on sound scientific knowledge and technological capabilities. As India aims to become a high growth economy and simultaneously enhance its capabilities to shape the geo-strategic environment in its immediate and extended neighborhood, its ability to play a consequential maritime role will be a critical factor. The potential of marine resources (living and non-living) has not been explored and harnessed to its optimal capacity. The size of the Blue Economy in India has been estimated to be about 4% of the Gross Domestic Product. The Blue Economy should be viewed as an important growth and employment multiplier which would promote creation of a pool of experts in different maritime domains in businesses, merchant shipping, fishing and aquaculture sector, research institutes, Universities, tourism etc. and widen opportunities for investments in marine construction, fishery infrastructure, renewable energy sector and deep-sea mineral exploration thus leading to direct and indirect employment generation over a period of time. The Blue Economy framework aims to significantly enhance the lives of coastal communities, preserve our marine ecosystems and maintain the security of our marine areas. Today, the Blue Economy holds the promise of being the next multiplier of economic growth and well-being, provided that the strategy places sustainability and socio-economic welfare at the centre stage.

<div align="center">WOSC/2024/ABS/284</div>

Mapping Species-specific Potential Fishing Zones using historic Catch-logs on "fishgram" - a super app for marine fishing community

Parag Ramteke, Captain freshZubair Ahmed, Captain fresh; Ganesh Nakhwa, West Coast purse seine fishing Welfare Association

The urgent need for sustainable fishing practices and effective marine resource management has prompted the application of machine learning (ML) and statistical methods to identify species-specific Potential Fishing Zones (PFZs). Refer: Fishgram, a comprehensive super app for the marine fishing community, designed to improve fishing operations and promote sustainability. Fishgram features PFZ Maps powered by INCOIS, enabling fishermen and boat owners to search for fishing hotspots. The app also offers navigation features like bathymetry depth, weather features such as ocean state forecasts, and catch log capabilities for recording catch details. Our proposed framework utilises ML algorithms and statistical models to analyse diverse data sources, including satellite imagery and oceanographic data such as ocean surface temperature, wind patterns, atmospheric pressure, surface ocean current patterns. Historical catch logs are also integrated into the analysis sourced from fishgram. By combining these datasets, the framework predicts the occurrence of specific species and identifies targeted areas that exhibit similar geophysical parameters. The workflow utilises a Multimodal Machine Learning approach, to layer the embeddings from each data source to identify species specific PFZ mappings. To begin with, the paper will focus on a few of the high value marine species such as Cephalopods (Squids, cuttlefish, octopus), Tuna, Indian Mackerel, Groupers to analyse for their catch locations and migratory patterns. Our stakeholders include West Coast purse seine fishing Welfare Association and Karanja Fishering Cooperative Society Limited who are invested in giving feedback on the PFZ service and validating the catch logs and catch quantity.This framework allows for the redefinition of PFZs with potential species tagging,

aiding fishermen and businesses in targeting high-value species and tracking catch logs. By leveraging ML algorithms and ocean observation, Fishgram contributes to sustainable marine resource management and the preservation of our oceans' biodiversity.

WOSC/2024/ABS/302

Declining Marine Fish Catch: High-Time for Strategic Timeout

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It is evident based on the global fish catch data that marine catches are at declining trend and it is accelerated in the last decade. Worldwide, more than 85% of the fish population are overfished. In India, there are about 3205 fish species, where exclusively 1555 are marine fishes, 936 freshwater and 15 belong to brackishwater ecosystems. While, 392 species found in both marine as well as brackishwater (Brachi-marine), 108 fishes found in freshwater to brackishwater (Bracki-fresh) and about 199 species found in all three ecosystems (Universal fishes). Though, the estimated potential marine fish resource in is about 4.41 mt, for the last five years, the landings are stagnated and fluctuating between 3.7 mt to 4.1 mt. Though overall landings remains constant and catch in weight is the same, more than 60% of the boat owners are not making profits, because of the reduced catch of fish and increased cost of fishing operations. This is the time to have a 'Strategic Timeout' to review our fishing efforts,fishing gears, mesh sizes, fishing ban periods and fisheries policies. Though fisheries is a state subject, it is the time to have common consensus to have "One Country-One Policy" for marine fisheries management. This review paper discusses about the management strategies of vast ecosystems through continuous monitoring and stock assessment programs, 'Evolved Management Strategies (EMS)' involving all the stakeholders. It is an effort to connect the diverse perspectives, experiences, and expertise that can assist inform decision-making, drive innovation, and improve outcomes. Key Words: Overfishing, Stock Assessment, Fish Stocks.

WOSC/2024/ABS/305

Carbonate saturation in coastal waters of Visakhapatnam, Bay of Bengal

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Calcium carbonate solubility equilibrium is highly important in water chemistry. In surface supply reservoirs, photosynthesis removes CO_2, leading to an increase in pH. In the Vishakhapatnam coast, this has been observed to cause spatial variability in the pH and saturation states (Ω) of coastal waters for two biologically significant calcium carbonate minerals: aragonite and calcite. During pre- monsoon analysis of water samples from 11 stations along the Visakhapatnam, the values of the environmental variables recorded during the spring and neap tides varied from 6.12 to 8.14 for pH,11.86 to 34.07 for salinity, 0 to 5.88 mg/l for Dissolved oxygen (DO), 1.01 to 26 mg/l for Biological oxygen demand (BOD), 5.36 to 43.89 μM for dissolved inorganic nitrogen (DIN), 0.54 to 37.73 μM PO4, 2.71 to 122.52 μM SiO4, 0.18 to 16.41 mg/m3 Chl-a, 1066 to 2765 μM/kg for alkalinity, 909 to 2419 μM/kg for DIC, 159 to 27048 μatm for pCO2, 0.06 to 6.54 for calcite (Ωca), and 0.04 to4.32 for aragonite (Ωar). The lowest DO and salinity was recorded in spring low tide while pH in neap low tide. BOD, nutrients, Chl-a were found highest in low tide of spring and neap may be due to anthropogenic input from neighbouring areas. Saturation state of calcite and aragonite were calculated from measured values using pH, salinity, nutrients and Total alkalinity (TA). The variation of pH in the low and high tides was 0.16 with more carbonated

saturation (>1). So the system was supersaturated, and carbonate saturation is under control. Therefore, our findings indicate that, the Visakhapatnam coast is unlikely to become under-saturated in relation to calcite and aragonite. Present study becomes a bench mark for better understanding and prediction of the carbon cycle and the response of marine life to future coastal ocean acidification.

WOSC/2024/ABS/315

Techno-Managerial Framework & Policy for Oil Spill Monitoring in India's Maritime Zone

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Oil spills are a global concern and often refer to marine oil spills, where oil is released into the ocean. As India has a long coastline of 7500 kms along with major oil installations along the coast line and growing maritime trade across major and minor ports; oil spill management is a major national requirement of the day. Realizing the importance of oil spill management, the Government of India took a few initiatives like formation of Oil Spill India and National Oil Spill – Disaster Contingency Plan. However, continuous monitoring of oil spills and concerted efforts for environmental and economic priorities can be achieved only through operational services on a 24x7 basis. For this, the combination of advanced technologies like Remote Sensing, GIS and GPS/IRNSS can be used and more importantly the power of their convergence can be tapped for delivering 'right information' to the 'right people' in 'right time'. Some of the international success stories in satellite based oil spill monitoring include PROMED in Mediterranean seas, INSTOP in Canada, ScanEx RDC for North Caspian Sea etc., Agencies like European Maritime Safety Agency (EMSA) achieved Clean seas/ Safe seas in Europe. EMSA generates near real time alerts for oil spills and has successfully identified the polluting vessels. The availability of Satellite based Imaging in Microwave SAR (RISAT-1) and optical bands and positional information from IRNSS has expanded the scope for improving the efficiency of oil spill detection and monitoring. Also India has Bhuvan / NICES GeoPortals of ISRO, and INCOIS centre involved in oceanic studies. Hence, India has the need with long coast and all potential technologies for delivering the services. The pertinent need is a Techno- Managerial Framework for the Indian Maritime Zone to realize such an end-to-end solution. Coupled with various elements like oil & gas production/infrastructure data, oil spill signatures along with location information, the various Stake holders can be alerted for prevention, mitigation and management of oil spills. The paper will present need and roadmap for establishment of such a techno-managerial framework for an operational service involving a long term policy for the commitment and roles & responsibilities of

multiple stake holder for environmental sustainability and synergy in oil spill response; as it will pay rich dividends to the nation also.

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Policy Framework for Sustainable Ocean Utilisation: Satellite Surveillance of Unregulated Fishing in Indian Waters

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This research addresses the issue of Illegal, Unreported, and Unregulated (IUU) fishing activities, particularly in the North Indian Ocean. The study proposes a policy-oriented methodology to mitigate IUU fishing by using data from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day and Night Band (DNB) onboard three satellites. The goal isto detect illicit nighttime fishing activities within Indian maritime boundaries, especially those that use lighting while disabling the Automatic Identification System (AIS). The VIIRS DNB data can register low-light signals, enabling the precise identification of fishing vessels' location, quantity, and movement. The findings reveal numerous light fishing vessels operating nightly within the Indian Exclusive Economic Zone (EEZ) and state territories. This data is valuable for policy-making bodies to manage unregulated fishing activities. Cross-referencing VIIRS boat detections with AIS data can identify boats operating illegally in Marine Protected Areas and seasonally restricted fishing grounds. It can also detect potential incursions of foreign fishing boats across EEZ lines and locate boats exceeding wattage limits placed on lighting. Daily temporal satellite data can track shifts in fishing grounds and identify stationary ships that may be storage boats collecting catch from a group of fishing boats. Implementing this system across India's vast coastline presents challenges, especially with the recent emergence of LED fishing that hampers AIS detection. This necessitates robust classification algorithms and collaborative efforts from the fishing industry and authorities. Limitations in VIIRS sensor capabilities during dense cloud cover require further investigation. Despite these challenges, the potential of VIIRS DNB data for combating IUU fishing in India is substantial. The study underscores the need for future research and development to address classification complexities and sensor limitations, paving the way for effective policymaking for sustainable management of India's fisheries and the protection of traditional fishing communities.

Evaluating Microplastic Pollution on Popular East Coast Beaches of India - Essential Insights for Informed Policies and Ocean Conservation

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Microplastics (MPs), plastic particles measuring less than 5 mm, have emerged as a global environmental concern, particularly for their potential impacts on marine ecosystems. Despite their significance, data on MPs in the Indian coastline are limited. To address the gap, herein we present the findings regarding occurrence and abundance of MPs from a preliminary assessment study conducted on popular beaches along the Eastern Indian Coastline (EIC) during two seasons (Pre-monsoon and post-monsoon). Using a systematic sampling approach, shore sediment samples were collected from various locations. Different types, sizes, and colours of MPs, including fibres, fragments, microbeads, and films, were identified through visual inspection (stereozoom microscopy), following a chemical pretreatment procedure. Polymer characterization using the ATR-FTIR technique revealed prevalent polymers, such as polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), and polystyrene (PS), with PE being the most common. The minimum concentration of MPs recorded was about 1350 particles/m2. Considering the necessity for assessing the level of microplastic pollution in coastal India, the study stresses the need for effective mitigation techniques and enhanced awareness among beachgoers. The findings of the study add to the broader issue about coastal microplastic pollution and highlight the importance of sustainable waste management strategies for conserving the ecological integrity of these unique seascapes.

Keywords: Microplastics, (MPs), EasternIndian Coast (EIC), pollution, marine ecosystems, preliminary, assessment.

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Sustainable Technology Development in Exploration and Utilisation of the Deep sea minerals

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The oceans comprise valuable resources that can be effectively utilized by mankind. Ocean consists with the mineral deposits such as sulphides, cobalt, and polymetallic nodules, presenting niche opportunities for extraction. India and other contemporary countries are working to explore these minerals with their innovation techniques. The current paper presents the ongoing efforts of countries, including India, to explore and harness these minerals through innovative techniques. The focus is on establishing sustainable methods for exploration and utilization, with the potential to significantly contribute to the economic growth and development of nations. The focus is on establishing sustainable methods for exploration and utilization, with the potential to significantly contribute to the economic growth and development of nations. Currently, the Blue economy constitutes 5% of India/"/gs Gross

Domestic Product (GDP), and with advancements in deep-sea mineral exploration, this contribution is anticipated to rise to 5-8%. A comparative analysis with the 1970s reveals a shift in GDP valuation, emphasizing economic activities derived from marine resources such as fisheries, offshore oil, and gas. To ensure effective and sustainable technology, attention must be directed towards refining the mining license code, diversifying technological approaches to minimize ecosystem impact, and implementing optimized and effective metallurgy processing methods. These measures are essential for the prolonged growth and success of deep-sea mineral extraction technologies. With mining activities already underway, the paper highlights the long-awaited progress in exploring these minerals, positioning India at the forefront of advancing this technology. This research contributes to the discourse on sustainable practices in deep-sea mineral extraction, emphasizing the importance of responsible mining for the overall benefit of the economy and the marine ecosystem.

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Marine Spatial Planning-A Policy framework for sustainable management of marine environment, Agatti Island, Lakshadweep, India

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In recent decade, zonation of ocean has become an essential step towards realizing ecosystem-based sea use management. Initially, the concept was primarily sparked by the need to create marine protected areas in the European seas. In the very recent, concern has focused on the need to conserve nature, especially ecologically and biologically sensitive areas in the context of multi-use planning of ocean space. Marine Spatial Planning (MSP) emerges as a crucial strategy to achieve both economic and ecological sustainability, departing from sectoral management approaches. In an effort to understand the value of MSP in India, a MoU has signed with Norway during 2019 under the Indo-Norway International Ocean Management and Research Initiative for a period of 5 years as a partof Blue Economy. Further, integrated ocean management is identified as an area of mutual interest for future cooperation. Though India's policy on coastal zone management is prevalent, MSP seeks to improve decision-making and manage human activities through an ecosystem-based approach. This study presents the MSP framework by performing case study from one of the ecologically sensitive area with coral ecosystem in Lakshadweep group of islands; and further illustrates the importance of sustainable development in Indian marine environment. The findings of this study will serve as a reference for the better management of maritime regions of Lakshadweep Islands.

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A Review of Existing Policies and Usage of Emerging Technologies for Sustainable Utilisation of Ocean Resources under Union Budget 2024

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The ocean has been the backbone for the survival of humans with its purposes ranging from import & export, fishing, natural resources, offshore communication, etc. Hence, governing bodies of the world have introduced several sectors and policies to utilise and preserve the ocean. The UNEP (United Nations Environment Programme) is the leading global authority on the environment and has safeguarded the ocean by the introduction of several regulations and policies like the Barcelona Convention (1976) for the protection of the Mediterranean Sea against pollution. In India, the government and the Coast Guard of India have taken steps to support the cause such as the introduction of the Wild Life Protection Act of India in 1972 for legal protection of the marine ecosystem. This paper presents the historical data of such policies and their implementation. This paper also studies the future scope for implementation of such policies in the context of the Union budget (2024). The paper also proposes sustainable methods of energy generation by making use of ocean thermal energy and ocean waves. Both are emerging technologies that are heavily researched and were not a viable solution in the past due to their lack of data to support their implementation, cost of infrastructure and feasibility. The end goalis to maximise the utilisation of the various resources that the ocean has to offer sustainably.

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Assessment of Occupational Accidents and Role of Life-Saving Devices Among

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Fishing is widely recognized as one of the most dangerous occupations in the world, with fishermen operating smaller crafts facing increased vulnerability to the unpredictable nature of the ocean, Impactful Sea currents, and wind speed. direction, wave heights, and other climate-related factors contribute to various accidents at sea. Additionally, lack of awareness regarding life safety gadgets (LSGS) and their ineffective utilization further intensify the risks associated with life at sea. Moreover, the absence of physical boundaries increases the likelihood of fishermen unintentionally straying into areas beyond Exclusive Economic Zones (EEZ) and other countries' territorial waters, highlighting the urgent need for research in this area. This study aims to identify the major occupational accidents and analyse the role of life safety gadgets among small-scale motorised fishermen in the southernmost coastal regions of India; Thiruvananthapuram, Kollam, and Kanyakumari. Qualitative study and survey-based analytics were employed to collect data. Data analysis involved content analysis and statistical measures such as the arithmetic mean, standard deviation, standard error, and an effective five-point Likert-scale mean score method. Among the seven identified occupational hazards, physical hazards emerged as the most prominent (mean score: 172.8), followed by environmental hazards (mean score: 112.44) and psychological hazards (mean score: 101.14). Communication devices, such as Very High-Frequency Wireless Sets (VHF), were found to be the most useful for obtaining weather information at sea, with satellite phones being in high demand for deep-sea communication purposes. It was observed that a significant portion of the active fishermen population in the study areas still lacked a reliable and effective boat-to-shore communication network. The findings of this study have implications for the amendment of fishery policies and the implementation of effective fishery management in India. By shedding light on the prevalent occupational hazards and the role of life gadgets,

this research provides valuable insights that can contribute to enhancing the safety and well-being of small-scale motorised fishermen in India's southernmost coastal regions.

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Value chain of non-conventional fishery resources-Odonus niger (trigger fish) in Munamabam fishing harbour, Kerala

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Kerala is one of the major marine fish producers in the country. This has been incurred due to the acquaint of technology and changes in the fishing operations over the years, plays a crucial role in the country's economy contributing significantly to food security, employment, and foreign exchange earnings. The study was focused on one of the major landing centres, Munambam fishing harbour which is located on Vypin Island of Ernakulam district of Kerala. Trawl fisheries of mechanised sector contributes major landings in the centre over a period of time. Over a period of time decreasing catch per unit effort (CPUE) increases cost of fishing has led to the utilization of different by catches which were only discarded. The by catch was brought to the landing centre on account of the prices and uses across the secondary and tertiary sectors. The study identified that trawl catch constituted both commercial and low value by- catches, in which Odonus niger of Balistidae family, locally called as 'Klathi' grabbed the major position in by catch landings. The value chain of Odonus niger indicates that it is mainly transported to fishmeal factories in Mangalore and Tamil Nadu and utilized for fishmeal production and fish oil due to its thick-skinned and high oil content. It has been used for surumi preparation, especially in Gujarat and Karnataka and being used for domestic consumption in southern parts of Tamilnadu and Kerala. Besides they are also used in biomedical and pharmaceutical applications. On some occasions, it has been continuous as mainly catch due to the unavailability or low volume of commercial fishes. This study portrays that it is necessary to document the importance and utilization of by catch which further helps to reduce the impacts of discarding. Keywords: Bycatch, trawl fishery, fishmeal, fish oil.

VIII: Ocean Technologies for Sustainable Development.

A study on the hydrodynamic characteristics of a mining machine navigating over the deep-sea floor bed.

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Deep-sea mining has emerged as an industry with the goal of extracting minerals from the ocean floor. To explore and extract mineral resources from the profound ocean depths, specialized vehicles designed for deep-sea mining operations are required. This research focuses on investigating the hydrodynamic characteristics of these vehicles, aiming to comprehend the intricate interactions between the submerged equipment and the seabed floor at different Reynolds numbers. To explore the evolution of the hydrodynamic performance and flow field characteristics near the seabed, this study employs numerical simulations using the computational fluid dynamics (CFD) method. The simulations consider various seabed topographies and angles of attack to predict hydrodynamic parameters such as drag, pressure, and skin friction coefficients. These parameters are analyzed to gain insights into the hydrodynamic performance of the mining machine under different conditions. During the vehicle's movement, the fluid separates around it, leading to the formation of low-pressure areas behind the machine. Velocity distribution, pressure distribution, and turbulent kinetic energy are thoroughly examined for all operational conditions. The research also delves into the influence of hydrodynamic forces on the stability of the mining vehicle during seabed material collection and also to offer insight that contribute for the advancement of underwater mining technology. The findings of this study inform design and operational strategies, guiding the development of robust and high-performance mining vehicles capable of navigating the demanding and ever-changing deep-sea environment.

Long Term Projection of Wind Power Density Variations Due to Climate Change Using CMIP6 for Indian Coastal Region

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There is a world-wide interest on renewable sources of energy, due to the ill-effects of global warming as a result of man-made greenhouse gas emissions and solar and wind energy take a predominant lead in replacing fossil fuels. The global wind power generation should increase to 36% by 2050 in order to limit the atmospheric temperature rise to 1.5oC. Large capacity onshore and offshore wind farms are being installed around the world and India stands in fourth position in global wind and solar power generation. There exists a vulnerability to wind energy production and safe operation due to variability in atmospheric temperature, wind velocity and direction, sea-level rise, humidity, aerosol in atmosphere, etc. More importantly, due to both natural and anthropogenic climate change, weather patterns are changing, hence it is imperative to know the future changes and likely potential areas of wind energy and their

capacities. Large fluctuation in wind velocity and direction is reported from different regions across the globe and in certain cases it is up to +150%. Long term prediction of wind power density is not only important from an economic point of view, but also from the safety of turbines. In this study, climate projections from different Coupled Model Intercomparison Project-Phase (CMIP) models are analysed for climate scenarios SSP4.5 and SSP8.5-one realistic case and another extreme case- to study the variation of wind power generation for future forecasting over the Indian region specially for states like Tamil Nadu and Gujarat where exists great wind power potential. The study can help future wind power installations for its economic analysis and safety considerations.

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Blue-Green Revolution: Navigating the Future with Marine Algae Bio diesel

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Marine microalgae emerge as a promising solution for sustainable biofuel generation and environmental conservation, owing to their abundant availability, rapid growth rates, and carbon dioxide fixation capabilities, coupled with their adaptability to thrive in harsh environments. This study explores the potential of marine green algae, Picochlorum sp., by utilizing LTDS Ossein Effluent and Formulated Low cost Seawater based Medium Using fertilizer grade analar nutrient at outdoor conditions in an open condition for energy feedstock production. The investigation is pivotal in uncovering their viability as a renewable energy source and optimizing solar energy harnessing through photosynthesis across various cultivation modes. Extensive research evaluates the impact of environmental factors on the growth and productivity of marine microalgae in outdoor settings, including light availability, temperature, nutrient availability, salinity, CO_2 availability, and Total Organic Carbon content. The study aims to maximize biomass production and lipid accumulation, critical for essential for sustainable biofuel production in an economical manner. Results indicates that the formulated low-cost Seawater-based Medium, in comparison to the lab-defined medium (ASN), yields a higher lipid content of 19%, signifying a relative increase in lipid production. Additionally, the Ossein effluent proves to be an effective microalgal growth medium, significantly reducing water and nutrient footprints while achieving an impressive 36% lipid content. Continuous cultivation facilitates the development of large-scale microalgal technology, leveraging effluent composition to mimic necessary algae nutrients and providing alternatives to conventional nutrient uptake processes. Supporting evidence from biochemical traits and total carbon analyses reinforces the viability of these marine microalgae for bioremediation and cost-effective biodiesel feedstock production. This research underscores their potential in minimizing environmental impact, emphasizing the substantial role of marine green algae in steering towards a greener and more sustainable future for biofuel production. Keywords: Green Energy, Biomass, Bioenergy, Carbon content, Effluent.

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Study of Nonlinear Power Take-Off Mechanism for Wave Energy Conversion

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Wave energy converters (WECs) play a crucial role in the renewable energy sector, offering distinct advantages such as the predictability and stability of wave energy. Among the variety of WECs available, Salter/"/gs duck, specifically the WEC rotor, stands out as exceptionally efficient in harnessing power from 2D regular waves, making it a primary focus of the present study. The success of any WEC device hinges significantly on the Power Take-Off (PTO) system, responsible for converting the relative motion of the WEC device into usable electricity. Given the oscillating nature of waves in both frequency and amplitude, extracting wave power through a PTO system becomes inherently unpredictable. The challenge lies in maximizing wave absorption, which hinders by the absence of adequate theoretical control strategies in a nonlinear wave environment. While direct drive methods can transform the mechanical motion of the WEC into usable energy, they often necessitate a substantial increase in the size of the WEC device to accommodate the requisite PTO loads. An alternative, more viable approach involves employing hydraulic PTO loading, where the motion of the WEC is converted into fluid flow. This method offers inherent advantages and can be seamlessly integrated on both theoretical and practical fronts. The hydraulic PTO system, implemented through Coulomb damping, proves to be particularly advantageous. Thecurrent study delves into the implementation of one-way and two-way PTO damping, specifically applied to the WEC rotor. The primary focus of the research revolves around a numerical model based on weakly nonlinear potential flow theory. The study aims to optimize this model by incorporating elements such as nonlinear restoring moments and PTO mechanisms into the WEC rotor. This comprehensive exploration seeks to address the complexities of maximizing wave energy conversion in a nonlinear wave environment.

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Developing Indigenous Wave Energy based Navigational Buoy

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NIOT has been developing wave energy devices since its advent in 1994. The first wave energy plant in India was set up in Vizhnijam, Kerala, on the Southern coast. This OWC- based fixed wave energy plant powered a 10000 litres/day reverse osmosis (RO) plant. Following its successful demonstration, a few floating OWC-based wave energy devices were developed and demonstrated, one of which was a wave energy-based navigational buoy, which was developed for seakeeping in ports and harbors and later transferred to industry. This article presents the development of an indigenous product, a wave-powered navigationalbuoy, and the structural analysis carried out to check the structural integrity of the buoy. Here, the buoy was modelled in ANSYS APDL using the SHELL181 element. The buoy material was selected as mild steel. Appropriate boundary conditions were applied, and the load conditions corresponding to extreme sea states were applied to decide the thickness of the buoy and determine the number of stiffeners required. Upon getting the elements' stress and

deformations, the values were compared to the yield strength of the selected material. The thickness of the shell, shape and number of stiffeners were accordingly optimised.

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Design of Lightweight Structures Using Additive Manufacturing

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The Northern Indian Ocean moored data buoy systems are designed, developed, and deployed by the Ocean Observation Systems (OOS) group of the National Institute of Ocean Technology (NIOT). These buoys are designed to offer continuous measurements of surface meteorological and oceanographic parameters at these specific locations. As demand for innovative engineering solutions continue to grow, NIOT has embarked on a groundbreaking initiative to explore the application of Additive Manufacturing (AM) in the design and fabrication of lightweight strcutures and underwater components. Due to freedom in design it offers a high potential for weight saving in underwater applications. This research aims to leverage the unique capabilities of AM technologies, such as 3D printing, to create structurally efficient and lightweight components. AM offers new available categories of geometries to be built in 3D printing. Functional features are designed and analyzed with the use of AM processing knowledge and numerical simulation. Key aspects of the study include the identification of optimal design configurations, material selection, and manufacturing parameters that maximize strength-to-weight ratios while ensuring durability and reliability in challenging marine conditions. The existing components used in marine applications, such as buoyancy floats and sensor housings, deal with a range of material densities, sizes, and shapes, presenting significant challenges as depth increases. In response to these challenges, NIOT focuses on material selection, manufacturability, and studying its behavior through various testing methodologies. This approach aims to develop materials that exhibit anti- corrosive properties and excel in both high-pressure and low-temperature conditions. The structural design emphasizes hydro profiles with pressure-withstanding capabilities, incorporating water-tight mechanisms crucial for deep-sea resilience. Additionally, the harsh and corrosive environment demands innovative surface finishes and coatings to enhance durability. This research contributes to NIOT's continuous endeavors towards cost effective production of deep-sea components through Additive Manufacturing (AM) and evaluate its potential for the future.

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OceanEyes: A mobile app technology to enhance our understanding of marine life with citizen science approach

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OceanEyes, an innovative mobile application developed by the Centre for Marine Living Resources & Ecology (CMLRE), serves as a pivotal tool for contributing data to the Indian Ocean Biodiversity Information System (IndOBIS). India has a vast coastline of approximately

7517 km, covering both mainland and islands, monitoring the marine life across this expanse is challenging by any single individual or institution. OceanEyes emerges as a solution, strategically integrating technology and citizen engagement to enhance our understanding of marine life within the Indian Exclusive Economic Zone (EEZ). OceanEyes is structured majorly on three core modules, real-time observations by users, a data verification mechanism by curators and admins, and data visualization. This user-friendly appempowers individuals to actively participate in documenting marine species and their habitats. The app questionnaire was adopted based on international biodiversity data standards (DarwinCore) which are maintained by TDWG (Taxonomic Data Working Group).The app allows users to record observations offline, with data syncing automatically once network coverage is available. To ensure data accuracy, the information generated through this app undergoes validation and curation by experts in the backend. The data, verified by curators and approved by admins, is visualized using geospatial technology, and mapping observations to get valuable insights into the spatial distribution of marine species. OceanEyes is more than a mobile app; it's an example of how technology can drive sustainable ocean utilization by harnessing the collective efforts of citizens, scientists, and policymakers. Through a blend of technology, education, and community collaboration, the verified data from this app becomes an invaluable asset for understanding migration patterns, identifying biodiversity hotspots, and monitoring the impacts of climate change on marine life.

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Li-Fi technology in Wireless Data Transfer for AUV charging station

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Abstract: Wireless communication in underwater presents unique challenges, especially in the context of AUV charging station where high data rate and reliability are essential. This research article explores the application of Li-Fi technology as a transformative technique in underwater wireless AUV charging station. AUV is an unmanned, underwater autonomous robotic vehicle designed for underwater exploration and data collection. Although AUVs can explore the ocean autonomously, they need to be launched and recovered for power and data transfer which is time consuming and increases operation expenses. Instead, we propose a seafloor charging station which can transfer data and power effectively. Li-FI is a wireless communication method that uses visible light to transmit data. It relies on LEDs to modulate light signals, which can be detected and decoded by light sensitive receivers such as LDR, photodiodes, phototransistor. This contains a transmitter (AUV) and receiver (Charging station) part. The transmitter includes a strong LED which emits modulated light signals that carry data. Optical components like lenses and reflectors are used to efficiently focus and direct the light underwater. Arduino is used to control and coordinate the Li-Ficommunication and encode data. A modulation scheme like OFDM is chosen for its efficiency and ability to handle multipath fading. The receiver side consist of photodetector for data reception, optical components, Arduino and Demodulation (OFDM) to reverse the modulation applied by the transmitter. The proposed method provides high data rate, low latency, no electromagnetic interference with a higher efficiency.

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WOSC/2024/ABS/243

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Open Sea trail of wave energy converter at Indian coast- challenges

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A major challenge of ocean wave energy converter (WEC) development is to deploy it in the ocean. This article reports how a point absorber (PA) WEC, Sindhuja-1, was developed and tested in the ocean. The WEC was developed from concept, numerical modelling, and laboratory testing. The test site was the VOC Port in Tuticorin, India. The WEC consisted of a buoy, a spar, and a power take-off mechanism. The diameter of the buoy was considered 0.75m and the spar length was 10m. The whole designing and preliminary testing were done at the wave basin at IIT Madras. The system was transported to the site, and an initial test was conducted at the harbour area, where the water is calm and has a depth of more than 10m. A hired fishing boat pulled the system over the ocean surface to a location having a water depth of 20 m, a distance from the coast of 6 km, and wave heights of 0.5-0.8 m. The electrical and electronics components were insulated and covered by a cylindrical acrylic jacket to avoid water splash or rain damage. The system operated vertically and generated power of about 100W

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Unveiling Krishna Godavari Basin's Gas Hydrate Potential: A High- Resolution AUV Exploration

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Ocean Mineral Explorer (OMe-6000) is India's first 6000-metre depth rated Autonomous Underwater Vehicle (AUV), realised by National Institute of Ocean Technology (NIOT), MOES(GOI), India, developed by M/s Kongsberg Maritime, Norway as per NIOT's requirements for deep sea exploration with all types of scientific payloads. OMe-6000 AUV deployed in the Bay of Bengal at Krishna Godavari Basin for the exploration of gas hydrates at a water depth of 1750m. The OMe-6000 is a fully augmented hydrographic and geophysical exploratory tool with a variety of scientific and survey payloads for deep ocean research. AUV-based high-resolution bathymetry and optical images from the gas hydrate region in the KG basin are examined in detail to understand the distribution of gas hydrates and associated features. Gas hydrates, a promising energy resource, have gained significant attention in recent years. This study presents the results of a comprehensive exploration at theKrishna Godavari Basin, utilizing state-of-the-art Autonomous Underwater Vehicle (AUV) technology. The mission focused on acquiring high-resolution data, including photos, synthetic aperture sonar (SAS) bathymetry, sub- bottom profiles and environmental parameters in the region. The AUV, equipped with advanced sensors and imaging systems, successfully captured detailed imagery of the seafloor, providing unprecedented insights into the geological features of the Indian Basin. The synthetic aperture sonar bathymetry facilitated precise mapping of the underwater terrain, revealing intricate structures and potential gas hydrate accumulations. Our study emphasizes the remarkable data quality achieved by the AUV, showcasing its capability to deliver fine-scale images and bathymetric data. The sub-bottom profiles further enhance our understanding of the sedimentary layers, contributing to a comprehensive geological interpretation. Key findings include the identification of distinct gas hydrate signatures and their spatial distribution within the basin. The presented data not only enhances our understanding of KG Basin's geology but also holds implications for the broader field of gas

hydrate exploration. In summary, the high- resolution data obtained through AUV technology at the KG Basin provides a valuable resource for advancing our knowledge of gas hydrate reservoirs. This abstract outlines the methodology, data quality, and initial findings, setting the stage for in-depth analysis and future exploration endeavours. High-resolution geophysical data collected with AUV fromthe area shall be explained in detail in the conference.

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Two-Dimensional Instantaneous Shipping Radiated Noise Estimation for Indian Ocean Region

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Estimation of radiated noise from marine vessels has become an important research challenge, both for military and non-military applications in the 21st century. Shipping noise is the single ubiquitous source of ambient noise in the ocean and it is the dominant low frequency noise component of the overall ambient noise spectrum. The Indian Ocean Region (IOR) has emerged as the most critical sea area in the 21st century both for economic as well as geo-political reasons. The shipping traffic due to the merchant marines and the naval deployments have seen a manifold rise in the IOR [1]. The enhanced shipping traffic directly translates to significant increase in the low frequency ambient noise levels and impacts the Acoustic Habitat Degradation in the region [2]. The marine species are known to depend on sound for multiple biologically critical functions like foraging, communication, navigation, finding mates for breeding and more. The creased ambient noise interferes with the perception of their environment causing serious acoustic habitat degradation. The navalwarships need to evade detection by their adversaries and thus have a critical requirement for acoustic stealth. Thus, capability for dynamic estimation of low frequency ambient noise levels in a frequency range of 100 Hz – 500 Hz is an important requirement both for assessment of acoustic habitat degradation and vulnerability with regards to acoustic stealth. Precise estimation of the radiated noise from marine vessels will contribute towards the acoustic capacity building, particularly in the strategically important IOR and go a long way in ensuring, effective realization of the Underwater Domain Awareness (UDA) framework. Similar work has been undertaken by Christine Erbe et.al [3] in Vancouver region. In this work, we have created a framework for dynamic two-dimensional spatio-temporal low frequency ambient noise map for a part of the Indian Ocean Region, surrounding the Indian Subcontinent (0.125o S - 60.125o E to 25.125o N –90o E). The map is a quarter degree gridded manifestation of ambient noise levels, i.e., receiver points have been placed throughout the area with a distance of 0.25o between subsequent receiver points and noise levels at these receiver points have been captured and mapped. Automatic Identification System (AIS) data, for our area of interest has been used to extract the shipping traffic information. Our machine learning model, trained on data generated using Wittekind model (which takes Marine Traffic data [4] and the data from other registries as input parameters) and Real World recorded data clubbed together after proper validation, has been used to calculate the source spectra of the ship. Further, a Neural Network model trained for Indian Ocean Region [5] has been used to compute transmission loss between each pair of sender (ship) and receiver points. Our aim in this paper is two-folds. Firstly, using machine learning models – we desire to create a framework that can instantly generate instantaneous ambient noise map for a specified region with reduced time complexity as compared to existing mathematical models and train models on real world datasets to reduce the ambiguity of approximations that is produced by mathematical models. The final

instantaneous two- dimensional noise map in terms of Sound Pressure Level [SPL dB re 1μPa] at the receiver points is displayed for frequencies of 100 Hz - 500 Hz, enabling us to visualize the intensityof noise in the particular area. The synthetic maps generated using established modelling algorithms as discussed above, have been validated with limited real experimental data offthe Goa Coast. The validation matches closely with the proposed work and also with similar efforts undertaken by G V Frisk[6] at a macro global scale. Such efforts can go a long way in generating effective Underwater Domain Awareness (UDA) across stakeholders. All low frequency underwater systems can be deployed effectively using this map. Keywords: AIS, Low Frequency, Ambient Noise Mapping, Acoustic Habitat Degradation, Passive Surveillance Systems REFERENCE [1]Das, A. (2019). Acoustic Habitat Degradation Due to Shipping in the Indian Ocean Region. In Changing Ecosystems and Their Services (p. 49). IntechOpen. [2]Wenz, G.M., 1962. Acoustic ambient noise in the ocean: spectra and sources. The Journal of the Acoustical Society of America, 34(12), pp.1936-1956. [3]C. Erbe, A. MacGillivray and R. Williams, "Mapping cumulative noise from shipping to inform marine spatial planning", The Journal of the Acoustical Society of America, vol. 132, no. 5, pp. EL423-EL428, 2012. [4] Knudsen, V.O., Alford, R.S. and Emling, J.W., 1948. Underwater ambient noise. J. Mar. Res., 7, pp.410-429. [5] R. Patra, S. Prabhuraman and A. Das, "AI & ML based Implementation of the Underwater Channel Model in the Tropical Littoral Waters of the Indian Ocean Region (IOR)," OCEANS 2022 - Chennai, Chennai, India, 2022, pp. 1-8, doi: 10.1109/OCEANSChennai45887.2022.9775296. [6] Farcas, A., Powell, C. F., Brookes, K. L., & Merchant, N. D. (2020). Validated shipping noise maps of the Northeast Atlantic. Science of the Total Environment, 735, 139509.

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Experimental Investigation on the Maneuvering of a Container Ship in Regular waves

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Human life and aquatic environment are closely interconnected since ancient times in which marine transport has major role in developing human dependency on the sea. Hence it is very important to ensure navigational safety, primarily for surface ships through which majority of marine trade is transported. Poor controllability of a surface ship is considered as a major cause for most of the marine accidents, which may result in loss of life and property. With theaim of achieving minimum safety of Ocean going vessel, International Maritime Organisation(IMO) has set some standards for ship maneuverability with minimum performance requirements for turning and course keeping ability. Traditionally, assessment of ship maneuvering characteristics is carried out in calm water conditions, thus ignoring the effectof the wave on the ship hydrodynamic behaviour hydrodynamic forces acting on it, resulting in the change of ship steering and control characteristics. In the present study, free running model tests on turning maneuver are conducted on a container ship in calm water and also in regular waves at the Seakeeping and Maneuvering Basin (SMB) facility of Naval Science andTechnological Laboratory (NSTL), Visakhapatnam. The turning tests on the self-propelled model are conducted in calm water and in regular head sea waves with different heights and length to understand the effects of wave parameters on the turning characteristics of the vessel. Turning and course changing qualities of a vessel can be estimated by conducting turning circle test. Turning circle tests are conducted in still water and in regular head sea waves. Tests are carried out for different model wave heights such as 0.013m, 0.019m and

0.026 m and also for different wave lengths such as 1.5m, 3m, 4.5m, 6.0m and 7.5m (λ/L=0.5,1,1.5,2,2.5.). Estimated steady turning radius is increased by 10.1% and other parameters like transfer and tactical diameters also increased by 2.31% and 1.35% respectively and advance is reduced by 21.8 % in head waves compared to still water condition. Compared to the trajectory in calm water, vessel trajectory in waves are found to drift towards the direction of wave propagation and the vessel drift increases with height of first order wave. Wave length also has a considerable effect on maneuvering. Longer waves has less effect on turning characteristics of the ship.

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Advancing the Production of Nutritionally Rich Microalgal Species Through Large Scale Photobioreactor Cultivation

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Marine microalgae are nutritionally rich and are the natural food source of larval stages of many aquaculture organisms, considering only few species being used in aquaculture and therefore the development of new marine microalgal species is essential for fish seed production and the diversification of aquaculture. In this context, the effects of ten different marine microalgal cultures isolated from east and west coast of India on the growth, survival and reproduction of the copepod Oithona rigida. Preliminary morphological screening was carried out to check the compatibility with zooplankton feeding size followed by molecular identification and biochemical composition analyses of the selected microalgae in terms of carbohydrates, proteins, minerals and amino acids. In addition, the nutritional characterization of the microalgal strains were performed which included analysis of amino acids, fatty acids profiling (analysis by Fatty acid Methyl esters) and elements employing different techniques like Reverse-Phase HPLC, GC-MS and Inductively coupled plasma massspectrometry (ICP-MS) respectively. Based on nutritional segregation of selected microalgae and feeding trials with copepod Oithona rigida, new isolates of marine microalgal species Nannochloropsis oceanica MACC 24, could be identified as potential candidates as live feedsin aquaculture. Morphological characterization of these marine algal isolates was performed together with the SEM analysis of the algal species. The indigenously designed 50L photobioreactor has been scaled up to 500L, for marine microalgal mass production. These achievements paved way for the development of readily available concentrated microalgal biomass for aquaculture applications which comprises the different nutritionally rich marine microalgal species to replace fish meal in support of sustainable recirculating aquaculture production. Finally, this will lead to development of cost-effective models of microalgal massproduction systems for aquaculture application through optimized bioprocess and the photobioreactor production system for biomass production of the selected microalgal isolates for use as live feed in aquaculture.

WOSC/2024/ABS/321

Instrumentation system for parametric data collection of OTEC using deep sea moored

surface buoy.

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Ocean thermal energy conversion (OTEC) is a clean form of ocean energy and one of the best sources for mitigating electrical power demand in islands of tropical countries like India. The National Institute of Ocean Technology (NIOT) is establishing an open cycle OTEC-based desalination plant at Kavaratti, Lakshadweep. It will be a first-of-its-kind plant worldwide. These OTEC plant installations have various challenges. The operation of the OTEC plant depends essentially on the temperature gradient available between the surface seawater and deep seawater, which varies seasonally. Also, offshore OTEC components, such as inlet and outfall pipes, are a major challenge as they highly depend on the sea conditions. Thus a prolonged investigation of oceanographic parameters will be beneficial for optimizing the design and suitable installation of offshore OTEC plant components. After a suitable assessment of the site and location, a first of kind deep-sea moored surface buoy observatory system was deployed at Kavaratti Lakshadweep to study the oceanographic parameters. This paper explains the novel methodology implemented in the deep sea moored surface buoy instrumentation system and data logging system with subsea sensors up to a depth of 1000m for in-situ measurement of temperature and water current profiles for OTEC application. The data logging system architecture has been designed with several modes of redundancy communication system to collect and transfer the measured data with a high sample rate and handle the large-size data without interruption. A real-time IoT platform-based mobile application was also developed and implemented. This specially designed deep sea observatory surface buoy system can be implemented in each OTEC plant site as a value addition. KEYWORDS: OTEC, Deep Sea moored buoy, Current meter, Ocean energy, offshore instrumentation system

WOSC/2024/ABS/333

Hydrodynamic analysis of freely floating U-OWC integrated with Π-shaped breakwater

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Oceans hold enormous amounts of energy which can be potentially harnessed to reduce the dependency on rapidly depleting fossil fuels. Ocean wave energy is probably the most rapidly growing form of renewable energy nowadays. Various pilot plants and full-scale power plants have been deployed around the world employing different types of ocean wave energy conversion devices. However, research and investment in this sector is still at a very nascent stage. The power density on shores is far less than that of deep offshore region, so floating offshore wave energy devices are considered in the deep-water regions. In the present study, a freely floating U-shaped Oscillating Water Column integrated with a Π-shaped breakwater is analysed using Boundary Element Method. The integrated system is considered free to move in three degrees of freedom, namely heave, roll, and sway. The performance of the device is evaluated on analysing the theoretical maximum efficiency, radiation conductance and susceptance coefficients of the U-OWC, and the heave, roll and sway RAOs of the system. The

effect of varying different geometrical parameters such as the "U" channel width, chamber width and draft of U-OWC is studied. The study observed that increasing the "U" channel width impaired the energy conversion efficiency while increasing the chamber width and draft of U-OWC improved the efficiency. Moreover, increasing the geometrical dimensions resulted in increased motion responses, as is intuitively expected. The study will be helpful to scientist and engineers for designing the integrated WEC-breakwater device in the offshore region. Keywords: Π-shaped breakwater; U-OWC; Boundary Element Method; RAO; Efficiency.

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Numerical investigations of dual Wave Energy Converter (WEC) near a fully reflecting wall

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The evolution of the Blue Economy strengthened the development of coastal infrastructure including breakwaters. In the pursuit of a sustainable Blue Economy, opting for wave energy production is a prudent decision. By integration of the wave energy converters with coastal structures especially breakwaters is expected to improve the performance of the wave energy device and also aid in the protection of coastal barriers from explicit wave impacts. Based on Airy's theory the hydrodynamic performance of a submerged dual different-sized cylindrical buoy wave energy converter (WEC) in front of a fully reflecting vertical wall is carried out. Both buoys are constrained to a single degree of freedom of heaving motion in a completely submerged condition. The numerical analysis was carried out using the well-known multi-domain boundary element method (MDBE) to estimate the added mass coefficient, radiation damping and wave excitation force. The study focused on influencing parameters namely the size of the cylinder by keeping the same volume ratio, cylinder spacing, wall-cylinder distance and at different submergences particularly to examine the notable energy capture performance ratio (Cp) using the trapezoidal method. Additionally, to understand the resonance behaviour of buoys the response amplitude factor (RAO) and heave forces, surge forces, and damping ratio are analysed in front of fully reflecting walls. Interestingly, it was found that the performance of the wave energy converter improved up to 74% in the presence of a fully reflecting wall than in the open sea domain. The study will further help to identify the dynamics of WEC with coastal structures which in turn improves the sustainable technologies for utilisation of Ocean in Blue Economy.

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Performance analysis of parabolic harbor wall integrated with OWC – A numerical investigation

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Ocean energy can be harnessed from various sources, including tides, currents, and waves. Among these wave energy sources are reported to be predictable and accessible. In order to capture energy from waves, many technologies have been invented. Amidst those technologies, the oscillating water column (OWC) is one of the well-established wave energyconverters (WECs) with few or almost no moving parts that are less prone to failure. But, the OWC technology still suffers higher costs than well-established wind turbines and solar panels technologies, which have achieved commercialization level. However, the implementation of wave focusing techniques at specific locations can significantly boost the wave power at the focal point, resulting in increased overall efficiency of wave energy devices. The objective of present work is to enhance the effectiveness of the OWC by integrating it with parabolic harbor walls. This integration aims to magnify the wave height inthe vicinity of the device, thereby improving its overall efficiency. A numerical study is carried out using an open-source CFD solver called REEF3D to investigate the performance of an OWC by measuring the air pressure (Pair) and wave elevation (A) inside the chamber. The accuracy of the numerical model is validated by comparing the time histories of these parameters with experimental data. Evaluating the performance of OWC with parabolic and straight harbor walls revealed that the parabolic design exhibited increased air pressure at d/L
$= 0.131$ for Hi $= 0.03$ m, with slight improvements at other frequencies. In contrast, the wave amplification factor exhibited an opposing trend. Consequently, marginal variations in overall performance are anticipated for both configurations. Notably, at lower wave frequencies, the OWC with a parabolic harbor wall demonstrated superior performance.

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Design and Implementation of Instrumentation for Monitoring Coral Reefs

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Coral reefs, the most species-rich marine ecosystem is composed of diverse andinterconnected colonies of coral polyps whose structures are built over time by the calcium carbonate secreted to form hard skeletons. Found in shallow, warm waters, typically intropical and subtropical regions, these play a significant role in the life cycle of one quarter ofall marine fish species and also act as a wave breaker. Overtime, surveys have vindicated thatcoral reefs have been undergoing significant direct and indirect anthropogenic pressures, providing a sensitive indicator of coastal ocean health, climate change, and ocean acidification, with associated implications for society. Monitoring of coral bleaching events, disease outbreaks and osteoporosis of the sea by observing certain water quality parameters combined with live feed transmission will be essential in the next decade to mitigate the impacts on coral reefs, particularly in the context of the Sustainable Development Goals. This review provides a comprehensive analysis of methodologies proposed to address the above. The review begins by outlining the vitality of coral reefs, and the challenges associated with their monitoring using traditional methods. It then explores the evolution of UAVs and AUVs, respective findings and limitations faced. The technique of usage of a combination of sensors integrated with the now advancing AI, and the system being deployed using either a suspended weight or a customised robotic fish which serves the necessity of automation is a suggestive conclusion

which is primarily discussed. By analyzing current research trends, approaches, and challenges, this review provides valuable insights for researchers, government agencies, global communities and future generations, as the collaboration ofthese groups is crucial for developing and implementing effective strategies to protect and sustain coral reef ecosystems.

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Challenges in Real Time Data Collection from Coastal and Deep Ocean Moored Buoy Platforms

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The moored data and tsunami buoy system deployed and maintained by the Ocean Observation System (OOS) group of the National Institute of Ocean Technology (NIOT) in the northern Indian Ocean for more than two decades with wide range of sub-surface, surface and atmospheric parameters in the oceans. Natural disasters such as storms, cyclones, hurricanes and tsunamis have pushed the scientific community, weather forecasting agencies, disaster warning agencies, and governments to work towards effective and timely communication methodologies at national, regional, and global levels to improve preparedness and response. The initial OOS data buoys relied on INMARSAT and GPRS communication systems whereas the GPRS communication is used only for the coastal buoy and INMARSAT in deep sea buoy but the INMARSAT has the drawbacks of high costs and power requirements. The alternative approach was to use INSAT communication systems as an economic solution but it has the limitations of fixed communication intervals, high power requirement and the inability for two-way communication. To address these issues, IRIDIUMtelemetry was integrated into the buoy system. This move aimed to overcome the limitations of the INMARSAT system by reducing costs, minimizing power requirements, and decreasing data latency. For the first time in India, the buoy system has integrated with IRIDIUM telemetry and a GPS receiver to accurately determine buoy positions. This article underscores the crucial role of satellite communication in advancing ocean observational platforms, detailing the progression from GPRS and INMARSAT and eventually, the integration of cost-effective and efficient IRIDIUM telemetry.

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Machine Learning in Ocean Research

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Machine learning, deep learning, and computer vision have experienced exponential growth in the realm of oceanography and marine sciences, presenting promising outcomes and innovative solutions to intricate marine phenomena in recent years. Their applications span a diverse array of domains, encompassing the identification of climate patterns, prediction of sea level changes, simulation of wind and waves, automated detection and tracking of underwater objects, monitoring coastal waters, identification of oil spills and pollution, and estimation of geoacoustic parameters. This comprehensive review endeavours to provide an exhaustive overview of the current state of machine learning (ML) applications, undertaking the synthesis and analysis of a diverse range of literature. Within the scope of ocean sciences and technology, various ML techniques and algorithms address specific challenges. Supervised learning

facilitates model training using labeled datasets for accurate predictions, while unsupervised learning unveils inherent structures in unlabeled datasets, ideal for clustering tasks (eg K-means, DBScan) or anomaly detection like monitoring coastal waters, identification of oil spills and pollution. Reinforcement learning, tailored for sequential decision-making, finds application in autonomous systems. Deep learning techniques such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs) excel in handling complex data types like images and time series, enhancing capabilities in tasks such as underwater object detection and climate pattern recognition, simulation of wind and wavesand estimation of geoacoustic parameters. The application of these diverse ML techniques underscores the adaptability of the field to various challenges within ocean sciences, offering a nuanced understanding of marine phenomena. Through a critical examination of existing literature, the review identifies prevailing trends, challenges, and opportunities at the intersection of ML and ocean sciences. It underscores the profound significance of ML in enhancing predictive capabilities, refining data-driven decision-making processes, and fostering innovation in marine research. This detailed analysis offers insights into the various applications and methodologies employed in leveraging ML for advancing our understanding of oceanic systems. This review emphasizes the vital importance of future directions, stressing the necessity for interdisciplinary collaboration and the seamless integration of emerging technologies to effectively address the ever-evolving complexities of oceanic systems serving as a valuable resource, this review not only imparts crucial insights but also extends an invitation for further investigations by researchers, practitioners, and policymakersexploring the burgeoning landscape of machine learning applications in the field of ocean sciences.

Ballast Water Management Using MIKE21 and ARCGIS Tools

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Ballast water management is a critical aspect of maritime transportation, aimed at preventing the spread of invasive species and safeguarding the marine environment. This abstract presents a novel approach that combines the Geographic Information System (GIS) capabilities of ArcGIS and the powerful hydrodynamic modeling of MIKE 21 HD softwareto enhance the effectiveness of ballast water management practices. ArcGIS is utilized for spatial data management, mapping, and visualization, allowing for the integration of various geospatial datasets, including port locations, environmental conditions, and regulatory boundaries. MIKE 21 software, on the other hand, provides advanced hydrodynamic modeling tools to simulate the transport and dispersion of ballast water discharges, making it possible to assess potential environmental impacts. The integration of these two technologies enables the creation of a comprehensive decision support system for ballast water management. By incorporating real-time data, vessel tracking, and environmental conditions, stakeholders can make informed decisions about ballast water exchange areas, treatment facilities, and discharge locations. The system also assists in compliance with international and regional regulations, such as the International Maritime Organization's (IMO) Ballast Water Management Convention. These abstract highlights the potential of combining ArcGISand MIKE software to streamline and enhance ballast water management efforts, contributingto the protection of ecosystems and biodiversity in our oceans and seas. The approach demonstrates the power of synergizing geospatial intelligence with advanced hydrodynamic modeling to address critical environmental challenges associated with maritime transportation. Keywords- Ballast water

management, ArcGIS analysis, numerical modelling mike 21.

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A Compact Design and Development of a Deep-Sea Mining Vehicle for Soft Soil Conditions

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India has been at the forefront of developing technology for deep-sea mining to harvest polymetallic nodules from depths ranging between 5000 - 6000 meters in the Central Indian Ocean Basin (CIOB). The seabed in this region comprises water-saturated, soft cohesive clay with shear strength typically less than 2 kPa. The deep-sea mining vehicle must adeptly position, maneuver on the soft soil seabed, and efficiently collect the polymetallic nodules. The design and development of this vehicle are pivotal, emphasizing machine supportability and streamlined vehicle deployment operations. The development of compact structures for deep-sea mining was a prerequisite to minimize the overall underwater weight and volume of the mining machine, ensuring reliable underwater operations. Utilizing commercially available tools, a Finite Element Analysis (FEA) was performed on the mining machine structures with various loading conditions and subsystems. This analysis aimed to identify stress distributions and concentrations, facilitating the transformation of the compact vehicle design and the reduction of overall weight. Subsequently, the entire system underwent simulation in Multi-Body Dynamic (MBD) analysis, considering various soil strengths and operating conditions. The simulation results played a crucial role in the design and development of a compact deep-sea mining machine. This paper presents the compact design of the deep-sea mining machine, along with FEA and MBD analyses. It further covers the load testing of structures and functional prototype testing of the deep-sea mining machine in alaboratory setting, subject to various operating conditions. Additionally, the paper discusses the performance of the subsea mining machine, particularly its locomotion in deep-sea soil in the Central Indian Ocean Basin at a depth of 5270 meters. Keywords— Deep Sea Mining Vehicle, MBD, FEM, Soft soil, CIOB.

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Literature Review on Environmental Impacts and Flocculation Dynamics in Mining Plumes for Deep Sea Mining Operations

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The International Energy Agency (IEA) predicts that India will surpass the European Union (EU) in global energy consumption by 2030. Meeting the growing demand for renewable energy and electric vehicle technologies necessitates substantial metal quantities, leading to an increased focus on deep-sea polymetallic nodule mining due to depleting terrestrial deposits. This study explores the burgeoning research trend on deep-sea mining plumes, crucial for sustainable practices. The deep sea mining process involves seafloor vehicles collecting minerals, utilizing a vertical system for transport, and extracting ore on surface vessels. Plumes generated by deep-sea mining categorized into collector and mid-water discharge types, undergo three phases: discharge, buoyancy-driven, and passive transport. Comprising dissolved materials and suspended particles, plumes raises environmental impact. Understanding plume behavior is vital for ecologically acceptable deep-sea mining equipment. Dissolved materials move inseparably with water, while particle settling varies based on size, influencing seabed distribution. Elevated suspended sediment concentrations pose challenges,

emphasizing the need for responsible deep-sea mining. Depending on the chosen mining pattern, the ratio between the characteristic advection timescale and the collector motion timescale can vary significantly. This variation may result in processes such as plume stretching, plume accumulation, or other nontrivial phenomena. The study comprehensively reviews conceptual and methodological advancements in monitoring and controlling Deep Sea Mining Plumes (DSMP) and introduces a MATLAB-based numerical investigation on flocculation effects. This research not only contributes to DSMP knowledge but also outlines key areas for exploration, emphasizing responsible mining practices. The numerical investigation enhances precision and applicability by quantifying the impact of flocculation on sediment plumes. In summary, with the demand for metals on the rise, deep- sea mining emerges as a crucial alternative. However, understanding and mitigating environmental impacts, especially those stemming from mining plumes, is imperative for promoting sustainable practices in the commercial mining processes within the deep-sea environment. This study insights, highlights research areas and introduces a quantitative approach, reinforcing the importance of responsible deep-sea mining.

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India's Tidal Energy Sustainability

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India is positioned for noteworthy population growth projected to attain 1.5 billion by the year 2030, coinciding with a 21% surge in the demand for electricity. With the nation targeting 50% of its energy needs from renewables by 2030, there's a crucial need for additional electricity generation. India possesses a total electricity capacity of 388 GW, distributed as follows: 25.94% from renewable energy (RE), 11.96% from hydroelectric sources, 1.75% from nuclear power, and the majority share of 60.35% from thermal power plants. To achieve its ambitious 2030 target of 450 GW of RE, India plans to heavily rely on solar (300 GW), wind (140 GW), and 10 GW from other sources. However, meeting this target would require a substantial land area, between 165,000 and 375,000 km2, posing a significant challenge. To address this constraint, the focus turns to marine renewable energy, leveraging India's extensive 7,500 km coastline, including regions like the Gulf of Kutch, the Gulf of Khambhat, and Sundarbans. Tidal energy, considered predictable due to gravitational effects between the sun, moon, and Earth, offers a solution. An Indian Renewable Energy Development Agency (IREDA) report estimates a harvest potential of about 12.5 GW of tidal energy in India, with the Gulf of Kutch showing a kinetic energy potential of nearly 2 GW. This article envisions the development of a tidal stream farm in the Gulf of Kutch, assessing kinetic energy availability and bathymetric conditions. The study suggests that a tidal farm with 642 turbines in the Central Gulf could harvest approximately 353 MW of tidal energy. Notably, the use of bottom-mounted Horizontal Axis Tidal Turbines (HATT) demonstrates a significant reduction in capital costs compared to previous estimates. The detailed site study underscores the promising potential of the tidal stream farm in this location, offering a viable and sustainable solution to India's growing energy demands.

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Sustainable Deployment of Ocean Wave Energy Converter (WEC) for Blue Economy

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The sustainable utilization of ocean resources is becoming increasingly imperative in the context of the Blue Economy. This article delves into the development and deployment of a point absorber (PA) Wave Energy Converter (WEC), named Sindhuja-1, and its successful testing in the ocean waters off the Ports in Tuticorin and Vishakhapatnam, India. The Sindhuja-1 WEC evolved through a comprehensive process, starting from conceptualization, and numerical modeling, to rigorous laboratory testing. The designing and preliminary testing phases were conducted at the wave basin at the Indian Institute of Technology (IIT) Madras. The WEC comprises a buoy, a spar, and a power take-off mechanism, with specific dimensions of a 0.75m diameter buoy and a 10m spar length. The deployment site, Tuticorin and Visakhapatnam Ports, were chosen strategically for its conducive conditions. Initial tests were carried out in the calm waters of the harbor area, where the water depth exceeded 10m. Subsequently, the system was transported to a location 6 km from the coast, featuring a water depth of 20m and wave heights ranging from 0.5 to 0.8m. The transportation was facilitated by a hired fishing boat, underscoring the practicality and adaptability of the deployment process. The Sindhuja-1 WEC operated in a vertical manner and demonstrated its capacity to generate approximately 100W of power. This successful power generation marks a significant milestone in the development and deployment of ocean wave energy converters. The utilization of a point absorber design allows for flexibility and efficiency in capturing wave energy, contributing to the overall sustainability goals of the Blue Economy. The oceanic trials validate the viability of Sindhuja-1 as a sustainable and efficient source of power in diverse marine conditions, emphasizing the potential for harnessing oceanic resources in an environmentally friendly and economically viable manner.

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Performance and Techno-economic Analysis of the Helical Hydrokinetic Turbine-A Review

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Hydrokinetic turbines harness the kinetic energy of water flowing in a river, tidal currents, and many other natural or artificial passages. These turbines can be employed in the perennial river stream and the vast coastline. This helps national interest in self-reliance in the energy sector, as these sources are freely available and have minimal environmental effects. Vertical axis turbines are the most preferred choice as they are more stable and have lesser structural noise than horizontal axis turbines. A helical hydrokinetic turbine (HHKT) is a type of vertical axis turbine with helical airfoil or twisted blades that ensure a constant torque on the blade, thus reducing the power fluctuation at the generator end. However, it can extract a maximum power of 59.23% from free streams of about because of the Betz limit. This paper presents the various design parameters that affect the performance of the HHKT and the techno-economic analysis proposed for the same.

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Sustainable fault-tolerant control for autonomous underwater vehicle under uncertainty and external disturbances using LMI approach

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Autonomous underwater vehicles (AUVs) represent a category of unmanned submersibles designed to provide researchers with a cost-effective, long-range and timely response capability for collecting underwater environmental data. However, controlling an AUV is a complicated task due to its nonlinear and unpredictable behaviour. AUVs necessitate a robust control technique to mitigate the impact of actuator failures and environmental disturbances. Futhermore the system's performance may degrade, and instability may arise from unforeseen environmental factors such as sea currents and natural calamities. Therefore, there are two primary reasons for considering a sustainable fault-tolerant control system. Firstly, during underwater missions, it should have the capability to handle fluctuations in control performance caused by external disturbances, sensor noises, and oscillations in AUV dynamics. Secondly, the designed control system should be capable of adapting itself to parametric variations. The main objective of this study is to develop a sustainable fault- tolerant control system for the uncertain Multi-Input and Multi-Output (MIMO) model of an AUV to regulate its various motions. The proposed control technique helps to stabilise the AUV's motion and prevent large accidents in either direction even in the presence of actuator faults, external disturbances and uncertainties. Thereby, Lyapunov stability theory is employed in the context of linear matrix inequalities to establish a set of criteria ensuring the system's asymptotic stability. Finally, the proposed control for various AUV motions involves a combination of physical techniques and robust control methods that adjust the orientation of the body to prevent excessive oscillations. At last, the numerical results for the considered AUV model are illustrated to show the effectiveness of the proposed sustainable fault-tolerant control technique.

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Development of IgY Antibody-Based Therapeutics to Combat Key Bacterial Diseases Impacting Sustainable Aquaculture Development

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Specific avian egg yolk antibodies (IgY) has recently been attracted considerable attention to the international scientific community as an alternative to antibiotics for bacterial infection control in aquaculture. Six bacterial pathogens, Vibrio harveyi, Aeromonas hydrophila, Edwardsiella tarda, Mycobacterium smegmatis, Streptococcus iniae and Streptococcus agalachiae were formalin-inactivated and used as whole-cell antigen for immunizing chicken under standard conditions. For immunization and egg production, twenty one BV-380 hens (20-weeks-old) were collected and kept in individual cages with ample feed and water and divided into control and test groups. Triplicates were maintained for each pathogen. Each hen received intramuscular injections (1 mg/ml) of the antigen suspension along with Freund's complete adjuvant at two different sites. Three booster injections (antigen + Freund's incomplete adjuvant) were administered intramuscularly at 3 and 6 and 9 weeks. Eggs were collected every day during the immunization period. IgY was purified from egg yolks of

immunized chicken following PEG precipitation method. Purity up to 80-85% can be obtained by dialyzing the extracted IgY against PBS. The quality of the final preparations was confirmed by Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS- PAGE). The molecular weight patterns for the heavy and light chains, were consistent with the predicted molecular masses such as 65 and 27 kDa respectively. Bradford's Protein estimation assay was performed to find out the concentration of purified antibody and it ranges between 39.2- 23.8 mg/ml. Production of specific antibody was confirmed by dot blot assay. Passive oral immunization using these specific IgY as vaccines are highly useful as compared to the conventional vaccine as it can be delivered orally and it is more convenient for the application in aquaculture. Moreover, offers promising future avenues for developing novel prophylactics and treatment options against infectious diseases.

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Review on Mathematical Model for Various Types of Wave Energy Converters

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Ocean waves globally offer a substantial energy potential of 2 terawatts (2TW), presenting a significant opportunity for sustainable power generation. The coastlines worldwide boast an annual energy potential of 8 million terawatt-hours ($8 * 10^6$ TWh), providing an alternative to current carbon-intensive energy sources responsible for 60% of electricity generation and contributing to global warming. The increases the global emphasis on wave energy in many part of the world which has led to the exploration of various techniques for capturing this energy. The assessment of available ocean energy employs the linear wave theory, examining metrics such as energy per meter, energy per area, power per meter, and power per area. Researchers actively investigate mathematical models for diverse wave energy converters, encompassing point absorbers, oscillating water columns, overtopping devices, and more which helps to understand building efficient and robust wave energy extractor with an optimised design to deliver these at low cost. This paper comprehends the various methods followed by various types of wave energy convertors to create a comparable understanding on these mathematical models. This also describes the Equations of motion derived from Newton's second law which are pivotal in comprehending the combined effects of ocean environmental conditions (wave velocity and acceleration) and system parameters (mass, added mass coefficient, damping factor, spring coefficient, and hydrodynamic coefficients). This paper underscore brief review on various aspects that should be understood before selecting and starting to design wave energy convertors through providing a crucial knowledge on environment and operations, of wave energy convertors, in mathematicalformat and, the critical importance of, understanding and optimizing the performance of wave energy converters in the broader context of shaping a sustainable energy future.

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Oceanic Optical Networking: A Review of Underwater Communication

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Underwater Wireless Optical Communication (UWOC) presents a promising solution for high-speed data transmission in aquatic environments. This paper explores the challenges and

advancements in image transmission over UWOC systems. The unique properties of light propagation in underwater settings are considered, along with the impact of water turbidity, attenuation, and scattering on the fidelity of transmitted images. Various modulation techniques, encoding schemes, and signal processing methods tailored for efficient image transmission in UWOC are discussed. The paper also highlights recent technological developments, such as adaptive optics, multiple-input multiple-output (MIMO) systems, and deep learning-based image processing algorithms, aimed at enhancing the reliability and speed of image transfer. Furthermore, practical applications and future research directions in underwater image transmission via optical communication are outlined, emphasizing the potential for underwater exploration, surveillance, and scientific endeavours.

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Designing Matched Angle Arc for Wide FOV Imaging Optics in Ocean Color Monitoring

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Ocean Colour Monitor (OCM) are small constellation of satellites in space. Currently, ISRO has launched a third generation of OCM payload in Earth Observation Satellite (EOS-6) to monitor ocean in different spectral bands. OCM is an Electro Optical (EO) imaging payload consisting of thirteen optical bands imaging in visible and NIR region with spectral bandwidth ranging from 8nm to 40nm. The refractive optics assemblies exhibit tele-centricitybetter than 1° with twelve optical elements to cover wide swath of 1590km at an altitude of 732.5km requiring full field of view (FOV) of 87°. The radiometric non-uniformity is required to be <18% with matched image format across all the 13-bands. At wide FOV, anti- reflective coating (ARC) on optical elements suffers shift in spectral band towards lower wavelength and drop in transmittance due to S and P rays splitting. Thus the transmission efficiency of individual lenses and hence the lens assembly results in severe non-uniformity across the image format. This paper discusses the concept of matched angle technique to mitigate the drawback of conventional design to meet the transmittance targets at normal and extreme AOI (87°/2 = 43.5°). The matched angle design technique compensates the band shift by adding additional thickness to the stack (designed for 0° to 43.5° operation) compared to conventional stack. Meticulous controlling of process parameters during e-beam coating yields minimal absorption of S and P rays address the impeding drop in transmittance. Common thin film stacks for closely spaced spectral bands were designed to increase the coating production throughput and further the ARC design and process were space qualified. Lens assemblies exhibited higher transmittance levels and non-uniformity less than 15% thereby significantly contributing to better SNR at system level. The matched angle ARC designs, ARC process, space qualification tests and performance of lens assemblies are presented in this paper.

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Impact of Artificial Reef Deployment on Phytoplankton and Zooplankton Communities in Coastal waters of Pulicat Region, Tamil Nadu, India

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The present study investigated the qualitative and quantitative variations in phytoplankton

and zooplankton communities before and after deploying an artificial reef in Pulicat Lagoon, India. Prior to deployment, phytoplankton diversity ranged from 17 to 21 taxa, with densities between 1×10^4 and 1.38×10^4 cells/L. Zooplankton diversity ranged from 11 to 14 taxa with density varied from 61 to 80 Nos/ litre. Post-deployment, phytoplankton species richness dramatically increased, reaching 72 taxa, while densities ranged between 4.8×10^4 to 1.28×10^5 cells/L, Zooplankton exhibited similar trends, with 58 species recorded and densities ranging from 90 to 541 individuals/L. These findings suggest that artificial reef deployment positively influences both phytoplankton and zooplankton communities in Pulicat Lagoon. The increased diversity and abundance may be attributed to improved habitat complexity, enhanced food availability, and potentially modified hydrodynamics around the reef. Further research is warranted to elucidate the underlying mechanisms and long-term ecological implications of these changes.

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Geometrical modeling and control of sustainable offshore energy systems under meto- ocean environment

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This paper systematically presents a theory for controlling nonlinear dynamics of guyed platforms supporting wind turbines. Offshore wind turbines supported on guyed towers are inherently complex and respond nonlinearly under wind and wave loading. The motions on the top of the towers structures may be considerably high in severe environamental conditions and therefore they need to be controlled for operational as well as maintenance. Moreover, as they are exposed to combined wind and wave loading and are themselves mechanisms, therefore they manifest chaotic behaviour owing to the parametric nonlinearities. In this paper, the response of a model guyed platform subjected to wave forces only is investigated which is analogous to survival condition. Only the first-order forces due to the waves have been considered. The undesired chaotic motions are eliminated using the geometrical control methods and thereby the behaviour is synchronized. A 5MW NREL wind turbine is considered for the study. To keep the response in safe operating regime, the controlled response of offshore structure is essential. The focus of this paper is to develop a robust control technique so as to regulate the vibration and synchronization of support structures for an offshore wind turbine. The work is restricted to understanding the nonlinear motions of guyed platforms, due to slackening of a guylines and thereby controlling the motions for safe operations. The restoring force of the multiple guylines is idealized as a nonlinear spring whose stiffness changes depending on the position of the structure. In particular, a control mechanism based on backstepping method is being proposed. The performance of the algorithm is illustrated in this paper by designing the controllers for controlled response of the structures supporting guyed wind turbines in the chaotic regime which can be modelled asa Duffing-van-der-Pol equations.

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A coupled piezoelectric-magneto micro energy harvester from Ocean wave motion for ocean applications

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There is an increase in oceanographic researches which involves deploying data buoys and underwater sensor networks in the recent years. Batteries and conventional renewable energy converters exploiting the wind, solar and wave energies are bulky and costly. Owing to this there is a paradigm shift toward MEMS energy harvesting technologies involving piezoelectric, tirboelectric, and electromagnetic principles to harness energies from low frequency ocean wave motion. When these technologies are coupled together it increases the amount of energy harnessed. This research focuses on coupling the principles of piezoelectric and magnetic transduction to enhance the amount of energy generated. The coupled piezoelectric diaphragm with the electromagnetic energy harvester is designed and analyzed using Finite Element Analysis simulation on ANSYS. The harvester setup consists of acopper coil winded tube like structure with a freely moving magnetic ball placed inside the hollow. The movement of the magnetic ball inside the tube changes the magnetic flux of the coil thereby producing power. Piezoelectric diaphragms are placed at both the ends of the tube. They are impacted by the moving magnetic ball inside the tube along one face which produces power along the face perpendicular to it. Simulations are performed for different scenarios considering the diaphragm and electromagnetic harvester separately and then comparing the results with the piezoelectric-magneto hybrid model. It can be seen thatcoupling both the piezoelectric and electromagnetic technology gives a maximum output of

29.41 mW. This setup is very compact in size and can easily be accommodated inside the buoy cavity or allowed to float on the surface of the water in the case of sensor networks to power the microelectronic devices.

<div align="center">**WOSC/2024/ABS/459**</div>

Impact of ocean technology on sustainable marine ecosystems and biodiversity through coastal protection, Preservation and restoration

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In order to safeguard ocean ecosystems and promote the sustainable growth of marine biodiversity, ocean technologies are crucial. Innovative technology offer practical solutions to reduce the effects of increasing sea levels and severe weather events, which is a major contribution in the field of coastal protection. Seawalls, man-made reefs, and offshore breakwaters are some of the technological solutions that have proven effective in protecting coastal areas, populations, and ecosystems from erosion and storm surges. Both human settlements and various maritime environments are protected by these measures. Repair of damaged coastlines caused by human activity or natural calamities relies heavily on ocean technology. In order to determine the state of coastal ecosystems and pinpoint regions that require restoration, marine conservation projects frequently employ state-of-the-art technologies like underwater drones and sensors. Important coastal ecosystem components including seagrasses, coral reefs, and mangroves may be planted as part of restoration efforts. By making restoration efforts more efficient and precise, these technologies help ecosystems recover and thrive with less ecological disturbance. Sustainable fisheries management is one of the many benefits of ocean technologies, which also help restore and protect coastlines. The use of data analytics and satellite-based tracking allows authorities to keep tabs on fishing, identify illicit behaviours, and put fisheries management measures into action. These

technologies promote sustainable fishing methods, which aid in maintaining marine species' health and abundance. This benefits both ecological balance and populations who rely on fisheries for their livelihoods. Sustainability initiatives are taken to the next level with the incorporation of renewable energy technology into marine and coastal ecosystems. The example of offshore wind farms is their ability to produce clean energy by utilising the force of the ocean's winds. For marine ecosystems' long-term survival, this helps mitigate climate change while simultaneously decreasing dependence on fossil fuels. Further, there is a lot of hope for developing marine energy technologies like wave and tidal power to provide sustainable power sources with less environmental effect. Nevertheless, it is critical to recognise that there are obstacles to the implementation of ocean technology, such as possible consequences on the ecology and ethical concerns. The future of marine ecosystems depends on our ability to find a middle ground between reckless technological development and careful environmental management. We can help achieve the larger objectives of sustainable development and environmental protection by resolving these issues and pushing forward with responsible and sustainable ocean technology, which will strengthen and protect our oceans.

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Indigenously development of Technologies for the Ocean Observation and Ocean Technologies

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Ocean Electronics group has indigenously developed many technologies for oceanobservation like Ocean Drifter, Design and developement Autonomous Underwater Profiling Drifter floats for the various depth like 500m, 2000m and 4000m, Design and developement Autonomous Ocean glider, Design and developement of PCM based buoyancy engine,Design and developement of PCM based thermal engine for the power generation and other various Ocean Technologies like Design and developement Open sea spar type submerged fish cage for the sustainable aquaculture, Design and developement of Open sea water ejector based fish feeder for open sea floating cages and submerged cages, Design and developement of AI/ML based fish bio-mass system for fishes in cage and other aquaculture ponds, Design and developement Autonomous Wireless based expendable CTD for the profiling the ocean at particular place,Design and developement Non-contact type CTD for ocean profilingsystem These development of indigenous system will not only enahnce the strength of Ocean Observation in India but also reduce dependancy on foreign country system and cost. Also these development can help in making sustainable Ocean Observation system in a better way due to availablity of indigenous Technology readily in India. These Indigenous technology has a good advantage that no foreigner can indulge himself in it.

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Configurations of tracked vehicle for development of Deep-sea Mining Vehicles for Enhanced Traction in Soft Seabed

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The National Institute of Ocean Technology (NIOT), India, has been actively involved in developing technology for a deep-sea mining machine designed to extract polymetallic nodules

from depths ranging between 5000 and 6000 meters in the Central Indian Ocean Basin (CIOB). Specifically engineered for collecting these nodules from the soft seabed, the project focuses on a crawler-based mining machine. Maneuvering and providing support in extremely soft soil with shear strength less than 2 kPa present significant challenges. This paper conducts a study to determine the optimum track configuration, crucial for enhancing the traction of the vehicle under deep-seabed soil conditions. In the study, a MultiBody Dynamic (MBD) analysis was executed using ADAMS/ATV software. This involved developing a soil-machine interaction environment and simulating various track configurations with seabed soil parameters. The research specifically compares the efficacyof dual tracks and four tracks configurations on soft soil. To assess the traction performanceof the tracked vehicle, drawbar pull simulations were performed on different configurations under varying operational conditions. The MBD results were then integrated into a Finite Element Analysis (FEA) to determine permissible stress and permissible deformation, aiding in the finalization of the prototype design. Based on the MBD and FEA results, the final design was crafted using 3D modeling software. The next step involves fabricating a prototype for testing in Bentonite soil, evaluating its performance under various traction conditions. This comprehensive approach, encompassing simulation, analysis, and physical testing, ensures the development of a robust and effective deep-sea mining vehicle capable of navigating and collecting nodules in challenging soft seabed environments. Key words:Crawler, Tracked vehicle, Deep sea mining, MultiBody Dynamic, Finite Element Analysis (FEA), Bentonite, Soft soil.

Floating platforms for deep ocean mining – A Review

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Deep ocean mining is a process of obtaining valuable minerals, including but not limited to polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts. In concern with the recent commercial interest of deep sea mining the technical challenges associated with it are widespread. However, these can be broadly classified under a fewmajor domains that include collection or extraction methodology, transportation or lifting system and the supporting floating platforms including ore transportation. Research activities and pilot projects are being carried out in international waters in a wide range of floating bodies. These fixed or floating structures are demanded to satisfy the operational requirementof the overall mining configuration. Each system is designed and developed as per the handling capacity of the vessel. The parameters considered with respect to the selection of platform are size and displacement of the vessel, payload, static and dynamic stability, seakeeping, dynamic positioning system, launching and recovery system of heavy machines, high power requirement, equipment handling system, natural period and response spectrum of the platform, sea states. Vessel identification is a vital part of the system requirement. This study gives a broad understanding and insight on one of the major aspects of ocean mining which is the identification of suitable floating platform at different stages of mining operation considering the above factors. It also brings out the potential viability of certain range of vessels for mining. The paper discusses the existing usage of floating platform by the mining companies its significance and challenges during operations. It also presents a method to look out the ocean mining operation as a complete system of work well ahead of starting the project. It can be used as a comparative study to formulate a regulatory framework inchoosing the nature of floating bodies for the further development of deep sea miningtechnology. Keywords:

Deep sea Mining, floating platforms.

Impact of Artificial Reef Deployment on Water Quality Parameters in Coastal waters of Pulicat Region, Tamil Nadu, India

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Artificial reefs were installed in four sites along the coastal waters of pullicat region to provide additional habitat that enhances fishery resources. The impact of artificial reef (AR) deployment on water quality parameters in Pulicat Lagoon, India, was investigated by analyzing pre- and post-deployment water samples. Physico-chemical parameters like temperature, pH, salinity hardness, alkalinity, ammonia, Nitrate, nitrite, TS, TDS, TSS, DO, COD, BOD, phosphate and EC were assessed. Soil parameters pH, organic carbon, Available nitrogen and available phosphorus were assessed. Remarkable season wise fluctuation in the physico-chemical parameters could be recorded during the study especially during monsoon season. Salinity decreased up to 31 during pre-deployment (2021-22) and up to 28 ppt during post deployment (2022-23), indicating potential freshwater influence. Notably, totalsuspended solids decreased significantly, with pre-deployment values (0.4-35.2 g/L) droppingto post-deployment levels (0.01-0.11 g/L). Nutrient concentrations followed a similar trend, with reductions observed across all measured parameters. Ammonia decreased from 0.009- 0.41 mg/L to 0.002-0.05 mg/L, nitrates from 0.062-0.499 mg/L to 0.07-0.86 mg/L, and phosphates from 0.12-1.6 mg/L to 0.12-0.62 mg/L. These reductions suggest enhanced nutrient uptake and improved water clarity potentially due to increased filter feeder activity surrounding the reefs. In contrast, chlorophyll-a concentration, an indicator of phytoplankton biomass, increased after AR deployment, ranging from 0.06-0.38 mg/m3 before to 0.45-0.81 mg/m3 after. This rise could be attributed to enhanced primary productivity in the vicinity of the reefs, providing additional food sources for higher trophic levels. This study highlightsthe potential of ARs for improving water quality in coastal ecosystems, while emphasizing the need for continued monitoring and assessment of their ecological effects.

Significance of Calibrating underwater electro-acoustic transducers/ Hydrophones for oceanographic applications

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Significance of Calibrating underwater electro-acoustic transducers/ Hydrophones for oceanographic applications Shabeer A, Preyenga V, A. Malarkodi and G. Latha National Institute of Ocean Technology, Pallikaranai, Chennai, India. Underwater acoustic sensors and instruments play a significant role in oceanographic applications, and their Calibration is crucial for deriving fruitful results. Underwater systems such as acoustic modems, acoustic pingers, transponders and acoustic monitoring systems are widely used in ocean technology applications. Data quality, especially in underwater scenarios, is the ultimate factor in deciding the success of the measurement system. Transducers performing outside their intended specification requirements leads to measurement of false data. Before using the data for any

analysis application, the data quality must be established categorically. Calibration is fundamental for accurate measurements and to estimate the characteristics of hydrophones. Calibration establishes the relationship between the measured value and the value realized by the reference standard under specified conditions. This is usually established by comparison of its uncertainty with the allowable limits for the specified application. If the uncertainty is within the acceptable range, then the data is considered good quality. Otherwise, it is considered poor quality and results in incorrect decision-making. Absolute uncertainty can never be achieved; Hence, the uncertainty range is estimated with a traceability chain with reference to national or international standards. Instruments and transducers intended to be used as reference standards for Calibration shall be checked for fitness. This is generally established by verifying the performance metrics claimed by the manufacturer with the requirements of the intended purpose. Some performance metrics for the instruments include accuracy, resolution, Signal-to-noise Ratio (SNR), and channel-to-channel isolation. Similarly, for the transducers, receiving sensitivity, transmitting voltage response, directivity, resonant frequency, bandwidth of flat response, electrical impedance, conductance, susceptance, acoustic source level, and directivity are the few significant parameters looked into. The instrument's fit for purpose is also established by comparing results obtained with its equivalent alternative. Transducer sensitivity is measured from the instrument already established as the reference standard. The scope is to show the importance of the Calibration of underwater electro-acoustic transducer/Hydrophones used for the above applications, as Calibration is the only way to ensure the quality and reliability of the results.

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Influence of Microalgal Diets on the Mass Production of Apocyclops royi (Cyclopoida, Copepoda) and Efficacy of A. royi Nauplii as Live Prey for First Feeding Larvae of Silver Pompano, Trachinotus blochii (Lacepède, 1801)

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This study explores the impact of three microalgal diets (Chloroidium saccharophilum, Chlorella vulgaris, and Nannochloropsis oculata) on the population growth and nutritional composition of Apocyclops royi, a crucial copepod in marine finfish larval rearing. Under optimized water quality conditions, mass culture of A. royi with the C. saccharophilum diet exhibited higher survival and ovisac production compared to the other microalgal diets, reaching a density of 12,700±454 individuals/L on the 21st day. The fatty acid profile of A. royi fed C. saccharophilum showed significantly elevated levels of saturated and polyunsaturated fatty acids, including eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and arachidonic acid (ARA) ($p < 0.05$). Additionally, the amino acid profile revealed significantly higher content of essential amino acids, such as Glycine, Alanine, Aspartic acid, Glutamic acid, Threonine, and Histidine, compared to the other diets ($p < 0.05$). This emphasizes the suitability of the C. saccharophilum microalgal diet for mass culture, enhancing copepod productivity and nutritional value as live prey for marine finfish larvae. The short generation time (6-7 days) and small nauplii, along with high nutritive value, make A. royi suitable for mass culture and aquaculture. To assess its potential as a live feed for silver pompano (Trachinotus blochii) larvae, A. royi nauplii were experimented with during the critical first feeding stage. Feeding experiments from 3 to 7 days post-hatch using A. royi nauplii and Brachionus plicatilis (S-type rotifers) diets revealed superior growth in T. blochii

larvae fed A. royi nauplii compared to the rotifer diet. The A. royi nauplii-fed group exhibited significantly higher lengths (p < 0.05), specific growth rate, and pigmentation, highlighting its suitability as a valuable live prey source for the initial feeding phase of T. blochii larvae and contributing to improved growth and pigmentation during this critical developmental stage.

<div align="center">**WOSC/2024/ABS/494**</div>

Leveraging Machine Learning for Real-Time Water Pollution Detection: A Study with Convolutional Neural Networks

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Water pollution poses a significant threat to public health and ecosystems in India, necessitating effective early warning systems for timely intervention. This study explores the utilization of machine learning techniques, specifically Convolutional Neural Networks (CNNs) and Multi-Layer Perceptrons (MLPs), for real-time detection of water pollution events. Leveraging real-time monitoring data, the proposed model aims to provide timely alerts to communities and authorities, enabling proactive measures to mitigate the impacts of pollution. A comprehensive dataset comprising 2000 images annotated with pollutant information was utilized, sourced from previous research. CNNs were trained to detect pollutants through bounding boxes which mapped the pollutants, achieving real-time inference capability in under 20 milliseconds. Comparison with MLP models highlighted the superior performance of CNNs, attributed to their ability to capture spatial relationships within images. The study also investigated the prevalence and distribution of pollutants within the dataset, identifying concentration patterns that inform model training strategies. Additionally, measures were taken to address data similarity issues through augmentation techniques and to optimize model deployment on resource-constrained devices using TensorFlow quantization. Results demonstrated a 91% reduction in model size while retaining accuracy, essential for practical deployment in remote locations. Looking forward, future work aims to enhance model generalizability through diverse data augmentation methods and explore the incorporation of additional machine learning algorithms. Transfer learning and experimentation with hyperparameters are also proposed for further performanceoptimization. Overall, this research underscores the potential of machine learning in combating water pollution and fostering sustainable water resource management in India. By empowering communities and authorities with timely and accurate information, this approachhas the potential to play a crucial role in safeguarding public health and protecting vulnerable ecosystems.

IX: Coastal protection and restoration of coasts.

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EVALUATION OF DEPTH OF CLOSURE OFF- GOA & SOUTH MAHARASHTRA COASTS

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Depth of closure is a point at which the seaward limit of an active zone where the least sediment transportation occurs; in other words, it is the seaward limit of the morphological changes. So it is important to know the sediment transport limit, for the planning and management of coastal structures. Also, it is a vital parameter in the calculation of the sediment budget and in locating of the offshore limit for wave-induced coastal sediment transport. This paper focuses on the evaluation of the depth of closure along the coast of Goa and South Maharashtra using two methods. The first method includes the Hallermier formula and the second method utilizes measured bathymetry profiles wherein the apparent convergence points in the profiles indicate the depth of closure. Measured bathymetry data collected during pre- and post- monsoon for three consecutive years off North Goa, South Goa and South Maharashtra were used. The depth of closure at different locations is estimated using 50 years of wave data in the Hallermier equation, and compared with the depth of closure derived from the bathymetry profiles. Key words: Depth of closure, Sediment transport, nearshore structures, Coastal management

WOSC/2024/ABS/233

Hydrodynamic assessment of a pair of pile-restrained H-shaped floating breakwater

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Floating breakwaters serve the basic purpose of countering the depleting mooring spaces in the busy harbour and operate as an offshore protection measure in deep water regions. Floating breakwaters always offer an efficient solution for weak sea beds, supported by mooring or piles. Lower fabrication, transportation, and installation costs compared to fixed breakwaters make floating structures popular for wave attenuation and WEC integration. Research works performed in recent years have shown the effectiveness of the porous floating breakwaters towards reducing reflected wave amplitude. Studies from recent times demonstrate the ability of porous floating breakwaters to maximize the reflected waves and reduce transmission. Cost-effective alternatives to conventional massive breakwaters are emerging in the form of innovative floating structure configurations optimized for deep-water energy trapping and dissipation. In the present study, a pair of interconnected H- shaped stratified floating porous structures supported by piles is modelled numerically using the Multi-Domain Boundary Element Method (MDBEM) based on small amplitude wave theory. The numerical model developed using MDBEM approach is validated with the results from previous literature. The hydrodynamic response of waves interacting with a pair of pile-restrained H-shaped floating breakwaters is investigated by analyzing wave reflection, transmission, and dissipation coefficient along with wave force coefficient on the structures. The present study investigates the effect of varying structural parameters on the efficiency of consecutive floating structures for both normal and oblique incident waves. The analysis considers various relative

submergence depths and relative structural widths examines efficiency across different water depths and the influence of Bragg resonance through changes in relative spacing. The study reveals that the two H- shaped structure configuration is mostly effective in the intermediate water region. The study indicated that, on increasing the number of structures and reducing the spacing between the structures the wave reflection can be enhanced due to the presence of breakwater system. Further, the leeside structure experiences the maximum wave impact irrespective of the number of structures. In addition, the seaside structure of a two-H shaped structure is more vulnerable to wave impact than the three-H shaped structures considering under intermediate water depth region. Keywords: Multiple breakwaters; H- shaped structure: Reflection and Transmission Coefficients, Multi-Domain Boundary Element Method (MDBEM); Wave force coefficient.

Geotube-based dunes to protect low-lying coastal areas from inundation

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Coastal erosion and inundation have emerged as a critical global concern, with far-reaching environmental, social, and economic implications. Its impact extends beyond specific sectors, significantly affecting economies on a broad scale. As per the shoreline change atlas by the National Centre for Coastal Research, about 46% of Kerala coast is subjected to coastal erosion and 62% of the coast is covered with coastal structures. Only a few pristine beaches are available in Kerala and these need to be protected considering the alarming situation. Valiyaparamba, located in Kasargod district of Northern Kerala has an 18 km long pristine beach sandwiched between the Arabian Sea and Valiyaparamba backwaters. As the coastal areas are very low-lying, they are subjected to inundation and flooding during monsoon season displacing many coastal communities. Shoreline analysis carried out using satellite images from 1990 to 2022 shows significant erosion at a few stretches. Seasonal shoreline analysis indicates loss of beach during monsoon and regaining the same after monsoon. So, a dune system is designed at the vegetation line by integrating the Geotubes, Nourishment and Vegetation to minimize inundation and protect coastal communities during Monsoon. Considering the soft nature of the solution, the beach will be regained post-monsoon as usual. The functional configuration of the dune is arrived at, by considering the wave transmission over the dune and the design is carried out by considering the hydro-geotechnical aspects and the material properties of the Geotube. Similar concepts can be used to protect coastal communities from flooding and extreme events at pristine beaches along the Indian coast.

Design of layout of suitable anti erosion bund for development of the fishing harbour

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Fisheries business is an important sector in coastal states in India. The development of any fishing harbour generally encounters problems due to excessive wave exposure and alongshore drifts. The mouth of a fishing harbour in Mulgoan, Shrivardhan Maharashtra has been chocking specially in fair weather due to the prevailing alongshore drift and thus making navigation of fishing boats very difficult. In the present paper, the solution to this problem was suggested with the help of mathematical model studies. A suitable anti sea erosion bund was recommended and a training wall as well, to arrest the prevailing drift and for providing

necessary wave tranquillity, near the entrance. Offshore wave data from IMD was used for present studies. Wave transformation studies carried out with help of MIKE 21 –SW, Further Boussinesq wave model (MIKE 21 –BW) was used for predictionof the wave field due to combined refraction, diffraction of directional random waves in a harbour. The MIKE 21 BW simulations with proposed training bund and anti sea erosion bund of length 1500m and with dredged channel at -2.0m indicate that the wave heights would be within limits near the existing jetty and at the entrance. Littoral drift studies indicate that the net transport in a year is of the order of 0.034 million cum and is towards South and gross transport is of the order of 0.083 million cum. LITLINE studies indicate that the accretion will occur at north of the bund upto about 225 m and after 6 years, it will be almost stabilized. Studies indicate that the proposed bund of length 1500m reaching upto the depth of (-)1m with 80m wide dredged channel to (-)2m, will provide required tranquillity for fishing operations throughout the year and the creek mouth will remain open for entire year with minimum maintenance.

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Coast and Wetland Protection in Kerala: 60 Years' Experience and Urgent Need

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Sixty years ago the senior author undertook a study of coast erosion in Kerala and documented it. (Modern Methods of Beach Protection",1963 and "Coast Erosion in Kerala: Its Causes and Control",1964). The conclusion was that sand dune stabilisation, artificial nourishment of littoral drift, sand bypassing and natural vegetation were the preferred modern methods of beach protection. But the old practice of unnatural and temporary measures such as sea walls and groynes without application of appropriate new technology and ideas continued to destroy the environment. Satellite photographs showed continuing erosion and extensive loss of coastal lands and homes. In addition, indiscriminate harbour development and large-scale sand removal also continued to worsen the situation. Of late, large-scale mineral sand mining has been destroying the coastal sand barrier very rapidly. Toxic waste discharge from sand mining and removal is affecting the people and fish population. Sand trapping and removal in the guise of harbour clearance, is also taking place in Thottappalli. Greivances of local people who lost homes and livelihoods, against unscientific mining and removal of sand remain ignored leading to their struggle with satyagraha for more than 3 years and court cases up to the Supreme Court. The urgent need is to stop mining and removal of sand immediately, re-establish the natural flow of river systems, backwaters and sea for coastal sediment balance, and to start modern methods of beach protection. These measures will accomplish the following for the entire area: 1. End the large-scale erosion of the coastline which is threatening the coastal communities with loss of homes and means of livelihood at an alarming rate. 2. The National Waterway functioning naturally without locks, inland of the sand barrier along the coast will remain safe. 3. Stop the salinity intrusion and protect the fresh water sources. 4. The world heritage Ramsar site of Kuttanat unique with its "below-the-sea level farming" now under threat of submersion, will be protected. 5. Toxic waste discharge affecting the health of people and fish population will end. 6. The deteriorating security of homes and liveability in Kuttanat will be saved from further threat. 7. The potential loss of farmlands through sea water intrusion and threat to food security will be prevented. 8. Damage to coastal vegetation will be prevented and natural disaster barrier will be preserved. 9. The natural Blue Carbon sequestration in the coast and wetlands will be unhampered. 10. The rapidly diminishing sand barrier caused by sand removal will be protected.

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Nature based solutions for coastal erosion risk reduction with special refece to the indian coast – an Overview

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The coastal zone is very dynamic in nature because of continuous interaction between land, ocean and atmosphere taking place there. The coastal area is an old settlement zone and contributes to the economy of nations. The coastal area is thickly populated with about 40 % of world population living there within 100 km. Many of the large cities and urban agglomerations exist along the coast in several countries. The coastal area also has several strategic infrastructure related to ports, air ports, defence establishments, industries, mining of sand and minerals, drilling for hydroccarbon, fishing, fish processing units, aquaculture, agriculture, tourism, power plants, several institutions and various other developments, apart from settlements. The coastal zone comprises of various geomorphological components such as coastal plain, coastal terrace, sandy beaches, cliffs, rock outcrops, muddy shores /mud flats, rocky shores, sand dunes, barrier beaches, lagoons, etc. The coastal area is mainly a lowlying area. It is also home to various important and productive ecosystems with diverse array of habitats providing goods and services of different kinds. The coastal zone is prone to several natural hazards such as tsunami, cyclones, storm surges, earth quakes, rogue waves, sea level rise and climate change per se. The disasters arising from these hazrds make drastic impacts on the life and property, livelihood and economy, environment and ecosystems leading to displacement / migration of coastal population. Coastal flood and coastal erosion arising from these hazards are main disasters. Coastal flooding is the inundation of sea water mainly cuased by tsunami, storm surges, rogue waves and sea level rise. Coastal erosion and submergence take place due to both natural hazards and anthropogenic activities (in the coastal area & hinterland). The coastal erosion along with other factors like population growth, reclammation, urbanization, increase in infrastructure and degradation of ecosystems enhances the vulnerability. According to the Intergovernmental Panel on Climate Change (IPCC) sea level rise could reach 60-110 cm by 2100. The total length of the coastline of india consisting the mainland, Lakshadweep Islands and Andaman & Nicobar Islands is about 7500 km. The Indian coast is home to about 170 million of the country's 1.4 billion people. They will be affected by the flooding due to the natural hazrds. The Indian coastline is at high risk for impacts of climate change related to sea-level rise. Sea levels along the Indian coast have risen by8.5 centimeters during the past 50 years and India will witness an increased flooding. Nature has always been our first and strongest defence system. Mangroves, seagrass meadows, coral reefs, forest& non-forest coastal vegetation, salt marshes, sand dunes, rocky outcrops, rocky cliffs, barrier beaches, muddy shores, nearshore barrier islands, nearshore / offshore sand bars, tidal wetlands (estuaries, backwaters, inland islands), peatlands and other habitats are some of the ecosystem components acting as disaster risk reducing buffers. Indian coast is also endowed with such bioshield and buffers. Currently artificial structures like seawalls, groynes, shore based breakwaters, offshore breakwaters, submerged breakwaters, embankments, dykes, bunds etc. are constructed to protect the coast from flooding and erosion. These sructures themselves act as cause at times. Recently other options like sand filled geotubes, submerged reef and beach nourishment are also being implemnted at some locations. Efforts are being made to restore and conserve ecosystems like mangroves, sand dunes and coral reefs. Casuarina and other plantations are grown as wind breakers along the coast at some locations especially on the east coast of India. Prevention of natural hazards is not possible. The feasibility of continuing with conventional grey infrastructures is fast deminiishing. Hence, it is time to harness the power of nature itself. In this context, the feasibility of Ecosystem-based Disaster Risk Reduction (Eco-DRR) is to be explored with due concern. It is a recent and proactive approach for limiting and reducing the impact caused by natural hazards because it is a convenient and critical tool. Nature based Solutions (NbS) as part of ECO-DRR are increasingly accepted and being implemented to address the risk reduction. There is a need to unlock the full potential as well as the uncertainities and to develop a global standard for

better implementaion and acceptance. This paper presents an overview of the coastal flooding and erosion, coastal environment, and its uniqe ecosystem services providing coastal defence against the coastal hazards. The role of ecosystems in DRR and NbS including the current pracices in the ecosysem restoration and rehabilitation is briefly reviewed. The need and perspectives for Eco-DRR
- NbS and Integrated Coastal Zone Mmanagement (ICZM) will be emphasized with special refernce to the Indian coast.

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Novel multi-satellitembased assessment of the coastal water quality: An operational approach for continuous monitoring

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The increasing levels of anthropogenic activities and rapid industrial development have led to a significant degradation in the coastal water quality. Remote sensing techniques make it possible to have spatial and temporal view of surface water quality parameters and more effectively and efficiently monitor the coastal water systems and quantify the water quality issues. Most of the studies have focused on optically active variables, such as chlorophyll-a (chl-a), Total Suspended Solids (TSS), and Coloured Dissolved Organic Matter (CDOM) which provides a comprehensive understanding of water quality. This research investigates coastal water quality monitoring through the application of high-resolution optical satellite data incorporating high-resolution multi-satellite data for the identification of water quality cells. By leveraging advanced satellite technology, the research aims to provide real-time insights into diverse water quality parameters influencing coastal water quality. This study uses the optical satellite data for the identification of fine-scale variations, enabling a comprehensive understanding of factors such as sedimentation, algae blooms, and pollutants. The focus extends beyond general monitoring to specifically identify and characterize water quality cells, allowing for targeted management strategies. These results are critical for monitoring and assessing the quality of surface waters in coastal environments and enabling water resources managers to formulate and implement management plans for a variety of water bodies cost-effectively. This innovative approach enhances the precision and efficiency of water quality management, fostering a proactive response system for sustainable coastal environment.

FEM Model for the Analysis of Ocean Wave Characteristic on Arbitrary Shaped Domain

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A finite element numerical model is presented considering the effect of refraction, diffraction, and energy dissipation by breakwater. As wave move from deep to shallow water coastal regions, wave parameter changes as a result of depth variations, presence of irregular shore boundaries, and wave reflections from the coastline. Therefore, to understand the wave transformation phenomenon near the coastal region, mild slope equation is solved using the finite element method. The numerical model is validated against the experimental and numerical results available for the rectangular domain and applied to a real coastal Paradip port in Odissa (India). The wave height is computed at the selected key stations in the port. From the simulated results, it is observed that the present numerical model with dissipation parameter is an efficient and useful tool for the analysis of water surface wave problem in realistic domains.

Dynamics, Challenges, and Strategies for Sustainable Management of Chavara

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The coastal area of Chavara in the Kollam district of Kerala, India, undergoes continuous changes influenced by both natural elements and human activities. Factors such as alterations in wave patterns, ocean currents, and climate conditions, coupled with practices like sand mining, have presented challenges, particularly related to coastal erosion. In response to these challenges, various coastal protection measures have been implemented over the past five decades along the Kollam coast. Assessments of the effectiveness of these structures have been conducted using satellite imagery, and a detailed analysis of current status of coastal erosion has been carried out through shoreline analysis using remote sensing and GIS techniques. To gain a comprehensive understanding of offshore wave dynamics and nearshore wave transformation, numerical wave modelling, specifically utilizing the Spectral Wave module, has been employed. The outcomes of this modelling have been used to estimate the sediment budget along the coast, employing the LITPACK module. This study results highlight a prevalent northern sediment transport pattern for a significant portion of the year. These insights are crucial for informed decision-making regarding sand mining activities along the Chavara coast and the development of effective coastal protection strategies. By understanding sediment drift patterns, stakeholders can make sustainable choices for coastal management and development.

Longshore currents profile generation with Forcing parameters on west coast of India

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The characteristics of surfzone, such as longshore currents (LSC), rip currents, and sediment dynamics, have been extensively studied. Generation mechanism of the longshore currents and rip currents were earlier studied (Shepard and Inman 1950; Inman and Quinn 1951) with numerous experts by estimating longshore current based on theoretical equations using different assumptions (e.g., Galvin1963; Longuet-Higgins. 1970). Studies based on comparison of measured and estimated currents were carried out in different scenarios throughout the world. In the context of the Indian coastline, Yadhunath et al. (2014, 2022) measured longshore current using sophisticated instruments on meso- tidal beaches and evaluated the performance of theoretical equations. These studies allowed for comparison of LSC estimation using equations and the combined effect of wave breaker height, breaker period, breaker angle, wind and beach slope parameters on LSC estimation. Longuet-Higgins (1970) established a theoretical LSC profile shape similar toa Rayleigh profile. Yan et al. (2023) studied LSC instabilities on a mild slope plane beach through a wave basin study and identified different LSC profile shapes and their significance. The present study aims to understand the influence of waves, tides, winds, and combinations of these processes on LSC instabilities using the advanced hydrodynamic model Delft3D and measurements. Yadhunath et al. (2022) previously used Delft3D to model rip current occurrences and prevailing conditions along an 8 km beach stretch in Goa. The study region's bathymetry was derived from measurements and hydrographic charts. An array of three current meters was deployed at locations C1, C2, and C3 in Candolim at a depth of 1.1 m to validate the LSC over a period of 96 hours (Figure 1b). This study provides valuable insights into the prevailing LSC profile shape, which is significant for understanding littoral drift and changes in coastal morphology. Keywords: Longshore current, surfzone, Delft3d, Wave.

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Mangroves as Coastal Protectors- biological solutions for the Tamil Nadu coast

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Coastal protection translates to safeguarding resources and ensuring a sustainable blue economy. The Tamil Nadu coastline, second longest of all Indian states, is exposed to natural disasters like floods, cyclones, storm surge, and seismic activity that could result in tidal waves. It is also subject to erosion, accretion and impacts of climate change like sea level rise and ocean acidification. Grey structures like sea walls and groins are indeed an immediate solution to protect coasts. However, such infrastructure is not eco-friendly and, in the long run, could have detrimental effects on biological, physical and chemical aspects of the coast. An eco-friendly solution lies in unique natural vegetation and coastal ecosystems that play the role of coastal protection. These natural coast protectors, otherwise nick-named, 'Bioshields' are being lost due to growing anthropogenic pressureon our coasts. Often, mangroves are considered as forerunners in coastal protection, especially after the 2004 tsunami. The study ponders if mangroves can truly defend coasts against natural hazards. Bioshields can dampen waves, stabilize coastlines, restrict salt water intrusion, and even help combat coastal pollution. A strategic revival of such ecosystems, namely coral reefs, seagrasses, mangroves, sandy shore vegetation, and natural structures like sand dunes, has great potential to protect

our coasts. Such exercises demand an in-depth understanding of mangroves and coastal ecosystems, their interaction with physical features of the coast and predicting changes over time, keeping in mind effects of climate change. This study attempts to incorporate features of coastal protection, ecosystem services, coastal vulnerability and climate change to enable informed choice of bioshields in a given region. A review of previous studies that has helped suggest bioshields for Tamil Nadu is used as a case study and as the backbone to design bioshield solutions for other locations as well.

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Machine learning approach for Mapping Coastal Bio-shields Pondicherry: A Case Study

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Coastal regions are vital ecosystems that provide numerous ecological, social, and economic benefits. Among these, coastal bio shield plays a pivotal role in safeguarding the resilience and sustainability of these regions. This study aims to employ remote sensing technology to map and assess the coastal bio shields along the Pondicherry coast in India. The research employs a multi-sensor remote sensing approach, integrating data from satellite imagery and LiDAR technology. These datasets are processed and analysed using advanced geospatial techniques to identify and characterize various components of coastal bio shields, including mangroves, Sand dune and other coastal vegetated habitats. The emerging techniques in the remote sensing domains, like machine learning and the Google Earth Engine (GEE) cloud platform were used for image processing in the present study. Random Forest (RF) algorithm used to extract the coastal plantation along the coastline. The findings of this study provide valuable insights into the distribution, extent, and health of coastal bio shields along the Pondicherry coast. Additionally, the research highlights the importance of these ecosystems in terms of shoreline protection, carbon sequestration, biodiversity conservation, and recreational opportunities. The mapping of coastal bio shields using remote sensing data not only contributes to our understanding of the region's ecological dynamics but also informs sustainable coastal management and climate adaptation strategies. This information is crucial for policymakers, environmentalists, and local communities to make informed decisions regarding the conservation and restoration of these critical coastal ecosystems. Moreover, the methodology developed in this study can serve as a valuable template for similar assessments in other coastal regions worldwide, promoting the conservation of these essential ecosystems for generations to come. Keywords: Mangrove, Sand Dune, Coastal Plantation, Remote Sensing, ALTM

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Coastal Bio-geo Information System for Tamil Nadu coast using Geo server (Slippy map)

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This study delves into the implementation of web mapping technology to bolster the Coastal Bio-Geo Information System (CBIS) initiative in Tamil Nadu, India, the first of its kind of work, with a focus on leveraging GeoServer as a robust geospatial platform. CBIS, a comprehensive database for the conservation of biodiversity and protection of ecosystems, requires advanced tools for monitoring, analysis, and decision-making. Web mapping, as facilitated by GeoServer, emerges as a pivotal solution to meet these requirements. The case study unfolds the integration process of GeoServer into the existing infrastructure, enabling

efficient management and dissemination of geospatial data. Leveraging open-source technologies, the study demonstrates the cost-effectiveness and accessibility of GeoServer, making it an ideal choice for regions with resource constraints. The web mapping application serves as a dynamic interface for stakeholders, providing real-time access to diverse datasets related to biodiversity, land use, and environmental parameters. The study highlights the customization capabilities of GeoServer, allowing for tailoring the web-mapping interface to the specific needs of the CBIS initiative. Through a user-friendly interface, decision-makers can visualize, analyze, and interpret complex geospatial information, fostering informed decision-making in biodiversity conservation efforts. Furthermore, the study explores the scalability of the GeoServer solution, emphasizing its adaptability to accommodate future expansions and technological advancements. The integration of spatial analytics tools within the web- mapping environment enhances the capability to derive meaningful insights from the wealth of geospatial data, aiding in the formulation of evidence-based conservation strategies. In conclusion, the case study presents a successful implementation of GeoServer in the context of the CBIS initiative in Tamil Nadu, illustrating its potential as a versatile and scalable solution for web mapping in biodiversity conservation. Keywords: CBIS, Geo server, Open Source, Biodiversity, Web Mapping.

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SUSTENANCE OF EMBANKMENTS IN PROTECTING THE COASTAL ISLANDS- A CASE STUDY IN BAKKHALI, INDIAN SUNDERBANS

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India loses hectares of land every year due to coastal erosion. West Bengal has the highest percentage of eroding shoreline (36%) followed by Odisha, Kerala and Andhra Pradesh. Coastal islands of Indian Sundarbans have faced severe cyclonic effects of Bulbul (2019), Amphan (2020) and Yaas (2021) triggering embankment breaching and salt water intrusion hampering livelihoods. Bakkhali, a coastal tract of West Bengal lies next to Bay of Bengal. The assessment is to examine the suitability of embankments in protecting the coasts and restoring the coastal islands of Bakkhali. Quantitative methods such as measuring the embankments using clinometer, assessing the embankment design scenario, geo-spatial techniques to detect the areal changes were undertaken. A beach profiling was done to observe the effects of coastal erosion on beach with the help of dumpy level. Qualitative study in the form of interview was undertaken on residents (N=50) regarding the sustenance of embankment. Concrete embankments at Kargil beach with slope 13.5o towards sea and 4.3o towards land whereas concrete with earthen embankment (geojute) was found to be 11.5o towards sea and24.5o towards the land. The coastal configuration of Bakkhali shows an interesting erosion and accretionary behavior at two adjacent sections unlike the other islands of Indian Sundarbans. An area of3.32sq.km has been eroded due to erosive actions of wave and storm surges. Proper structural concrete embankments are demanded by the locals. Armored concrete embankment protected by vegetative wall (made of mangrove and Acacia nilotica, commonly known as Babla tree) will be beneficial to cope up with the coastal erosion and further studies also need to be conducted in restoring the coastal islands. Keywords: - Coastal erosion, cyclonic disturbances, erosion-accretion, embankment design

WOSC/2024/ABS/86

Comparative Analysis of Coastal Hydrodynamic Conditions and Sediment Transport with Various Coastal Protection Structures along the South West Coast of India

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The southwest coast of India, particularly the Kollam-Trivandrum-Kanyakumari coasts, over the years, have undergone significant changes in the shoreline (mostly negative) and this is attributed to the changes induced in coastal hydrodynamics due to both natural and anthropogenic factors. Of the various factors, the human-driven stresses on the coast which have been progressively increasing due to various reasons such as the introduction of hard structures for purposes such as coastal protection without proper scientific study, development of port and harbours, inet stabilization and also other activities such as beach sand and river sand mining have adversely affected the coast thereby altering the coastal processes of the region as well as the sediment availability. A review of the performance of the hard protective measures adopted such as groynes, seawalls, jetties etc present along the Kollam-Thiruvananthapuram-Kanyakumari stretch clearly indicates that the structures like groins/breakwaters which are provided at a particular location or coastal stretch has triggered erosion on the adjacent coasts mainly because of the changes in coastal geomorphodynamics and this, in turn, has often resulted in the adoption of similar hard measures to protect the adjacent coast with the trend continuing. The present study highlights the changes in coastal morphodynamics (including the sediment transport pattern) that the coastal stretch selected for the study has witnessed particularly during the last decade and the factors responsible have been delineated. Changes in shoreline position (both short and long-term) are studied by comparing muti-dated satellite images whereas for the changes in the coastal morphoodynamics the available site-specific data which includes wave measurements, beach profile measurements, bathymetry data, sediment characteristics, etc. have been used. In addition, numerical model studies also have been carried out to understand the changes and also to substantiate the findings.

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WOSC/2024/ABS/87

Coastal Restoration- A Comparative Analysis of Bakkhali and Mousuni, Indian Sunderbans

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Coastal erosion is the process by which coastal landmasses are eroded by the action of destructive waves at a rate of 4 feet/year. Cyclonic disturbances in the coastal islands of Indian Sundarbans like Bulbul (2019), Amphan (2020) and Yaas (2021) has affected in rupturing of embankment hampering livelihoods. A comparative study was done between Mousuni and Bakkhali, part of Indian Sundarbans facing Bay of Bengal in the Southern part of Ganges delta. The objective of the study was to assess the suitability of embankments in combatting the vulnerability of coastal erosion in Mousuni and Bakkhali. To observe the beach morphology both quantitative and qualitative approaches were undertaken. Quantitative methods such as measuring the design of various embankments (mainly permanent concrete embankment and temporary geojute), dumpy level was used to observe the effects of coastal erosion on both the beaches. Qualitative methods such as questionnaire survey was done to understand the people's perception regarding the sustenance of embankment. Mousuni island faced a land reduction of about 3.82km2 along western bank (1979 - 2011; Das,2022) whereas coastal stretch of about 2km from Bakkhali in the east to Fraserganj in the west was eroded (Das,2022). A comparison of Mousuni and Bakkhali shows that the south of Mousuni experiences striking effects of coastal erosion at Baliara demolishing the geojute embankments and resorts. Unlike Mousuni, Bakkhali shows an aerial change in erosion as well as accretion scenario along the coasts. Well- structured concrete embankments are demanded by the local residents in case of both the islands. Mousuni, being more vulnerable due to its location gets eroded faster than Bakkhali losing more land. Site specific mechanisms with proper embankment design covered plant species (mangrove) is required to cope up with the coastal retreat of these two islands. Keywords- Coastal retreat, coastal erosion, vulnerability of cyclones, embankments

A study on rip current Investigation by Smartphone based camera and Numerical Model.

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Rip currents, characterized as swift, narrow, jet-like cross-shore water currents, manifest in the surf zone and extend beyond the breaker. Within the surf zone, feeder currents converge, contributing to the development of rips from both sides, resulting in wave radiation stress due to differential wave dissipation over shallow bars. Numerous studies have been conducted to understand rip current dynamics, proposing various approaches for rip hazard assessment. The primary objective is to equip authorities and lifeguards with knowledge and tools for effective rip current risk prevention. This study specifically focuses on the detection and analysis of rip currents using a Smartphone-Based Beach Monitoring System (SBMS) and numerical models such as Xbeach. Videos, each spanning 20 minutes, were collected during the period from July 2022 to July 2023, and an open-source QCIT toolbox was employed to process these videos. Rectified Timex images were utilized to identify rip current patterns, concentrating on the identification of the strongest rip currents. The study introduces an efficient methodology for evaluating rip current hazard and risk, grounded in probability theory, and the analysis indicated that rip currents occur in the study area under moderate wave conditions ($0.5 \leq Hs \leq 2.0$ m; $3.5 \leq Tp \leq 14.0$ s; (Dir°, θ) 120° to 180°). The surveyed beach topography and bathymetry interpolated for the numerical modelling. However, as it was not sufficient, a new method was attempted to extract satellite derived bathymetry (SDB) from the Sentinel 2 images during the study period. A total of 659 test scenarios were conducted, exploring variations in wave parameters from Hs 0.2 to 2.5 m, Tp 2 to 25 s, and Dir (° θ) 100 to 200. The occurrence of rip currents mainly depends on wave direction and wave heights were observed.

Identification and Assessment of shoreline changes using sentinel imagery and RTKGPS along Visakhapatnam-Kakinada coast.

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Extraction of shorelines using satellite imagery is an effective method because customary digitization is a long and hectic process. This study focuses to extract and detect shoreline changes from Sentinel imageries of the Visakhapatnam - Kakinada coast along the east coast of India using an object-based approach. An object-based approach for the automatic detection of coastline from sentinel imagery using the Feature Extraction Workflow by Normalized Difference Water Index (NDWI) method. The resulting vector polyline is smoothened for every 100 m using ArcGIS software. Delineation of multi-temporal satellite images was performed by visual interpretation from 2014 to 2019 to detect the shoreline changes. Different available techniques and methods are employed to observe shoreline changes. In addition to this, The Shoreline information simulated by satellite remote sensing is in fair agreement with RTK GPS observations. The observed and remote sensing shoreline changes help to identify the areas of accretion and eroding zones over the long term. During this study, erosion and deposition changes were observed along R K beach, Rushikonda beach, Uppada beach, and Kakinada beach. The spatial variation rates were calculated using the statistical methods of the Digital Shoreline Analysis System (DSAS) during specific periods. The maximum observed shoreline accretion and erosion rates at Kakinada are 5.3m/year and -4.35m/year indicates slight accretion. The maximum

observed accretion and erosion rates at Uppada beach are 3.8m/year and -6.78m/year respectively indicating erosion. Similarly, at R.K Beach the maximum observed shoreline accretion and erosion rates are 3.68m/year and -3.68m/year respectively indicating the beach is in a stable state. At Rushikonda beach, the maximum observed shoreline accretion and erosion rates are 2.24m/year and -3.04m/year respectively indicating erosion. Keywords: Shoreline, RTK- shoreline, Satellite imageries, DSAS.

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Assessment of Shoreline Changes of West Bengal Coast, India

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Assessment of coastal dynamics is an important task that can be applied in various fields such as, hazard zoning, erosion-accumulation studies, regional sediment budgets, and the development of conceptual or predictive modelling of coastal morphodynamics. This study uses geospatial techniques to track the long-term (1962–2023) shoreline changes along the coast of West Bengal, India. The coastlines have been extracted by the 1:250,000 toposheets (1962), Landsat series of satellite and Indian Remote Sensing Satellite (IRS) sensor's e.g., MSS, TM, ETM+, OLI & TIRS and LISS-III (1975 to 2015) and Sentinel-2, MSI sensor (2017 onwards) imageries using automatic shoreline detection method (histogram smoothing and an adaptive thresholding techniques). The High Water Line (HWL) is considered as the coastline identification by the Modified Normalized Difference Water Index (MNDWI) method and repetitive field survey have been conducted to observe the actual scenario of sediment transportation path of this region. The delineated shorelines have been analyzed using Digital Shoreline Analysis Systems (DSAS) to detect shoreline changes along the Kanthi coastal plain of West Bengal coast between 1962 and 2023. The measurement of shoreline variation is mainly described for four zones: zone-I, Digha; zone-II, Sankarpur; zone-III, Mandarmoni; zone- IV, Junput. Four statistical parameters that function in the DSAS automatically quantify the rates of shoreline changes in the form of accretion and erosion patterns. These parameters are as follows: End Point Rate (EPR), Net Shoreline Movement (NSM), Linear Regression Rate (LRR), and least median of squares. Long-term analysis of changes in the coast is important for the management of coastal areas and for planning the future development of the coastal zone. Keywords: Shoreline changes; Geographic Information Systems (GIS); Digital Shoreline Analysis Systems (DSAS); Coastal dynamics; Erosion-accretion.

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Studies on Coastal Erosion along Visakhapatnam Coast and the Availability of Hilsa fish along Godavari Estuary during Monsoon Season, Andhra Pradesh

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Visakhapatnam is a Coastal city of Andhra Pradesh with a coastline of about 48 km from Bheemunipatnam to Yarada. This entire stretch of Coastline is continuously subjected to intense erosion throughout the SW Monsoon season. The rate of erosion along this entire coastal stretch was delineated by carrying out Beach Profiles at 10 stations. The profiles were taken bimonthly (twice a month) at these locations during the Monsoon season of 2023. At each location volumetric change in beach sand was quantified for 50 meters stretch on either side of the profile (a total of 100 meters). Analysis of Beach Profiling data had revealed during Monsoon time from June to September that the amount of erosion along the Visakhapatnam Coast is thrice to the rate of accretion. During SW Monsoon time, the southern part of city coast from Yarada to South of Submarine was eroded to a greater extent (ranging from 22029 m³ to 724 m³ based on base profile of Mid March) with the maximum Net erosion localized along RK Beach and South Yarada. In contrary to the Southern coast, the northern coast of Visakhapatnam from North of Submarine to INS Kalinga was subjected to minor accretion (ranging from 10827 m³ to 624 m³ based on base profile). Hilsa is a common tropical fish species common in Northern Indian Ocean and Bay of Bengal that migrates into the freshwater rivers (Anadromous) of east coast of India during the Monsoon time. It is most commonly sought fish in the Indian sub continent with high market demand. The availability of Hilsa fish along the Godavari estuary is studied by analyzing the various biogeochemical parameters (Chlorophyll, pH, Alkalinity, Temperature, Nutrients, Turbidity etc :) of Godavari estuarine river waters. Hilsa fish catch data collected from local fishermen was also compared with the river water discharge data of Dowleswaram barrage. Studies showed during periods of Peak discharge and minor fluctuation in estuarine water temperature availability of Hilsa fish is significantly high.

WOSC/2024/ABS/309

Coastal Vulnerability Assessment along the south Maharashtra coast

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The south Maharashtra coast, particularly the districts of Ratnagiri and Sindhudurg, is potentially vulnerable to erosional hazards, frequent rehabilitation of land, and accelerated sea-level rise. In recent years, the evidence has shown erosional threats and gradual submergence along the creeks and lowlands of Ratnagiri. To determine the vulnerability of these hazards, vulnerability ranking was assigned using a coastal vulnerability index (CVI) using five geophysical parameters, including shoreline change, coastal slope, geomorphology, tidal range and significant wave height. The datasets were obtained from the satellite data of theLandsat series from the years 1992, 2002, 2012 and 2022 to derive the shoreline changes along the coast. Digital Shoreline Analysis System has been implemented to demarcate the baseline and shorelines from the series of Landsat data. The tidal variations were extracted from the Windows Unix program for Tides 32. The coastal slope was determined using GEBCO gridded data, and a geomorphologic map was prepared using supervised learning techniques. Significant wave height was estimated from the measured wave height data off Vengurla and Ratnagiri. The CVI is used in the categorisation of the coast in the classes of High Risk, Moderate Risk and Low Risk based on the Shoreline Analysis for the Coast. The study identifies and delineates vulnerable areas from low to high-risk vulnerability. The CVI determines that 23% (89 km) of the coastline is under High Vulnerability, 35% (136 km) under Moderate Vulnerability and41% (160 km) under Low Vulnerability which necessitates the implementation of preventive measures to reduce the loss of coastal land, cropland, and displacement of the population. Keywords: Coastal Vulnerability Index (CVI), Significant wave height, General Bathymetric Chart of Ocean (GEBCO)

WOSC/2024/ABS/328

Microplastics in the sediments along the eastern Arabian Sea shelf: Distribution, governing factors and risk assessment

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Despite the omnipresence of microplastics (MPs), the studies around the western continental shelf of India i.e. Eastern Arabian Sea (EAS) are uncovered and understudied. Thus the present study was focused to understand the spatial distribution, characterization and risk assessment of MPs in sediment across seven coastal transects (10 to 50 m) all along the EAS shelf. The highest MPs concentration (MPs/kg d.w.) was detected in the northern EAS (NEAS; 2260±1050) followed by central (CEAS; 1550±1012) and southern (SEAS; 1300±513) shelves. Among all distinct locations, the highest concentration of MPs (2500±1042) was detected in the north coastal sediments off Mumbai, followed by off Mangalore (1480±1169) in the center and off Kochi (1350±212) in the south. MPs were found in the form of fibres, fragments and films with a predominance of fibres (~70–80%). Approximately 74.6 % of the total MPs were in the size range of 300μm to 5mm. The surface of detected MPs was rough, irregular, and mechanical weathering features such as pits, grooves also observed and spotted with bacterial community structures. Polypropylene (PP; 34%), polyisoprene (PIP; 19%), butyl rubber (18%), and low-density polyethylene (LDPE; 13%) were dominant polymers. The pollution load index highlighted minor risk while the polymer hazard index exhibited a hazard level of V. Litter discharge, fishing activities, and active marine navigation are among the many high-risk sources of plastic contamination in this region. Due to the prevailing winds, currents, low sea surface height, and high precipitation, the conditions in the EAS are favorable for the accumulation of both sea-based and land-based particles. Hence, this study provides novel insights into the potential risks posed by MP to the IO rim and associated marine ecosystem which will enhance our knowledge of the ecological implications and consequences of MP pollution, ultimately aiding in developing effective management and mitigation strategies.

WOSC/2024/ABS/329

Unraveling the land-based discharge of microplastics from sewers to oceans – A comprehensive study and risk assessment in wastewaters of Goa, India

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Owing to their pervasive dispersion in the environment and their potential ramifications on both marine life and human health, microplastics (MPs) are of increasing concern. However, there is still a lack of research on the release of MPs from different land-based pathways like creeks, drainage outfalls, and conduits into coastal water systems in India. This study represents comprehensive research into the attribution of MPs in the estuarine system, specifically those emanating from wastewater sources in Panjim City, Goa, India. Urban wastewater collected from different locations in and around Panjim City exhibited values ranging from 79 ± 21 to 338 ± 7 MPs/L, with a prevalence of fibrous and black MP particles. The size range of the MPs at all sampling sites was 100-300 µm. Analysis byµ-FTIR revealed 35 distinct polymeric compositions in wastewater, with a dominance of polyacrylamide (PAM), polyvinyl chloride (PVC), and polyamide (PA). Additionally, primary and secondary MPs were studied to unravel the contributions from land-based sources. This included the quantification of MPs in ten samples from personal care products (PCPs) and twenty samples from washing machine effluents (WMEs). MPs in PCPs ranged from 1.8 to 1554 MPs/g. Microfibres and fragments were predominant in WMEs (3986 to 4898 MPs/L). This study suggests a strong relation between polymers found in wastewater effluent and those present in PCPs and WMEs. The identified polymers showed high polymer hazard indices (IV and V), posing a significant threat to the ecosystem and a potential risk to human health.

WOSC/2024/ABS/335

A detailed investigation of macro to microplastic pollution in the Rivers Ganga and Yamuna: Unveiling the seasonal, spatial, and risk assessment

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Microplastics (MPs) are apparent to be as disquieting as global pollution due to their ubiquity in the environment and possess a detrimental impact on ecosystems. It is widely established that riverine systems are contaminated with MPs, but limited studies are comprehended concerning how their concentration diverges with different seasons and places. Over the past few years, numerous inquiries and concerns have been raised about the escalating levels of plastic pollutants in India's most sacred river Ganga. Thus, the present study is the first trailblazing investigation for the seasonal and spatial abundances of MPs in the surface water, water column, and sediments of the river Ganga and Yamuna. For that, 4 major cities were selected (Haridwar, Agra, Prayagraj & Patna) and samples were collected in each city at three different point sources (upstream, downstream & drainage/midstream). Along with the MPs, macroplastics were also collected at different location in order to understand the probable source of solid waste in the river Ganga and Yamuna. The estimated plastic flux calculated based on the depth weighted MP concentration in the water samples were high in the wet season compared to the dry season. The results revealed that the wet season accounted elevated concentration of MPs compared to the dry season. Among all, >300µm sized fibre-shaped black and blue colored MP particles were dominant. PAM, PVP, PVC, PA and PIP were the most profound polymer types detected in all matrices, seasonally. The pollution load index (PLI) determined the low- risk level, while the polymer hazard index (PHI)

signified extremely high hazardous risk associated with MP in the sediments of river Ganga and Yamuna. Undoubtedly, the acquisition of real-time data for the MPs study in the Ganga and Yamuna rivers posed numerous challenges that demanded meticulous planning and the implementation of adaptive sampling techniques. Hence, this study represents the pioneering effort to comprehensively investigate the levels of plastic pollution in the Ganga and Yamuna rivers, incorporating both water and sediments combined with the effect of seasonal inputs. Therefore, implementing appropriate strategies and an approach for preventing toxic contamination in the river systems needs to be developed and implemented into observance.

WOSC/2024/ABS/336

Comparative assessment of microplastics ingestion by pelagic, benthic and accumulation in its surrounding environment

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This comparative study examined the presence of MPs in commercially important pelagic (Rastrelliger kanagurta) and benthic (Arius jella) species from off Goa coast, India. In addition, surrounding environment samples (water and sediment) were also scutinized for the enumeration of MPs. All the isolated particles were characterized using stereozoom microscopy and μ-FTIR for their morphology and polymeric composition respectively. The results of the study indicated that the GIT of pelagic fish (mackrael) had an average of 2.3 ± 1.4 MPs/g, whereas benthic fish (catfish) showed an elevated MPs accumulation of 10.1 ± 4.7 MPs/g. The mean abundances of MPs recorded in water samples were 120 items/L and 2055 items/kg dry weight (DW) in sediment samples. Fibrous MPs manifested across all the four compartments (pelagic, benthic, water and sediment). Interestingly, smaller-sized MPs in the range of 20-300 μm were found in all studied matrices. The prevailing hues of MPs encompassed blue, red, and black colours, with instances of discoloration indicative of their environmental degradation. The μ-FTIR identified diverse types of polymers in all four matrices which are mainly of commercial importance. Among these polyamide (PA), polyacrylamide (PAM), polyvinyl chloride (PVC), polyethylene (PE), and ethylene vinyl alcohol (EVOH) were the most abundant. A noteworthy finding has highlighted a similarity in polymer compositions between pelagic fish and the surrounding water. Similarly, a consistent pattern was identified between benthic fish and sediment, indicating a direct association between species-specific polymers and the introduction of polymers from their respective environments. The overarching anthropogenic sources in the investigated region are likely attributed to activities such as fishing activities, untreated sewage discharge, and tourism-related operations. Consequently, it is recommended to incorporate reporting on plastic abundance in the GIT as a reliable method for monitoring MPs contamination in fish. Despite the common practice of gut removal in culinary processes, concerns arise regarding the potential transfer of minute plastic particles and associated harmful contaminants, such as persistent organic pollutants (POPs), into consumable tissues, thus raising issues related to human exposure.

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Littoral Drift of Nodal Points Along The Tamil Nadu Coast

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Littoral drift refers to the phenomenon of movement of sand in wave breaking zone in coast parallel (alongshore) and coast perpendicular (onshore-offshore) direction existing as a continuous chain of transport along the sandy coastline. In general, this continuous littoral transport is taking place all along the Indian coastline extending from Gujarat in the west coast to West Bengal in the east coast. The state of Tamil Nadu is situated on the southernmost part of the Peninsular India adjoining the Bay of Bengal to the east and the Indian Ocean to the south. The length of the coastline is reported as1076 km starting from Neerody on the west coast to the mouth of Pulicat Lake along the east coast. The stretch of the coast is unique by its varied morphological formation and a kind of exposure to either Indian ocean, Gulf of Mannar, Palk Bay or Bay of Bengal. The classification shows that it comprises of about 57% sandy beach, 38% mudflats and 5% rocky coast. The estimated littoral drift for the coastline from Neerody to Pulicat for every 10 km distance shows that the littoral drift values are higher along Mahabalipuram to Thiruvanmiyur stretch. The littoral drift values are lower along Tuticorin to Mandapam stretch. In Palk Bay, i.e., between Mandapam and Vedaranyam, the geomorphological formation, wide intertidal flats, presence of dense mangroves, silt & clay deposits at nearshore and absence of wave action make the stretch not vulnerable to littoral drift. The annual net drift is almost negligible considering the nodal point along the stretch between Nagapattinam and Thirumullaivasal. The authors have made an attempt to understand these nodal points and their respective littoral drift patterns which is crucial for coastal management, erosion control and restoration of coasts. This understanding of the coastal process and the pattern of littoral drift will help to protect and restore the coastlines against the increased adverse events like erosion, sea level rise etc.

<center>**WOSC/2024/ABS/350**</center>

Assessing the coastal vulnerability of Indian cities to sea level rise under current and future climate scenarios
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Sea Level Rise (SLR) is the most serious threat that the world faces today and in the future. The Intergovernmental Panel on Climate Change (IPCC) projects high-emission global mean SLR of 1.3 to1.6 meters in 2100. SLR is a major hazard to coastal cities all over the world, including Indian cities. In order to develop appropriate adaptation and risk reduction strategies, information on inundation due to SLR is required. This study attempts to prepare a portfolio of SLR inundation maps for selected Indian coastal cities. The observed SLR data from the PSMSL tide gauge stations, as well as the projected ensemble model of IPCC AR6 Shared Socioeconomic Pathways (SSP) climate scenarios were used for SLR assessment. Observed SLR for the historical period during 1987 to 2022 were analysed and plotted in combination with future SLR scenarios till 2100. Then, elevation-based inundation area mapping was done using ALOS PALSAR DEM of 12.5 m for future SLR scenarios to estimate the possible future inundation area under SSP scenarios SSP2-4.5, and SSP5-8.5. At last, present land use land cover maps were prepared and inundation areas are quantified and spatially mapped. Historically, alarming SLR was noticed in a majority of the cities in both the west and the east coast of India. Climate models project that the SLR will continue until the end of the century under all scenarios. While the changes, per year increase, SLR inundation area and affected LULC varies across cities. The high risk hotspot mapping done by this study is an useful resources in developing appropriate adaptation and risk mitigation strategies to reduce the effects of SLR, protect coastal communities, and promote sustainable coastal development in the face of climate change.

<center>**WOSC/2024/ABS/36**</center>

Heavy metal contamination and its ecological implications along an urbanised river-ocean

continuum on the southwest coast of India.

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This study examined the contamination levels and ecological risks of heavy metals in the riverine-coastal continuum on the southwest coast of India. Surface sediments were collected from the New Mangalore Port area, Nethravati and Gurupura rivers, and adjoining estuaries and coastal regions and analysed for heavy metals. The sediments were rich in Fe (0.26-3.96 %), a common feature of the southwest coast of India. Mn was 57.98-494.60 µg/g and did not display much variation in the study region. Ni and Cu ranged from 9.04 to 180.54 µg/g and 0.27 to 3.14 µg/g, respectively. Co ranged from 1.36 to 26.18 µg/g and Zn from 24.60 to 203.77 µg/g. Cr and Pb exhibited slightly higher concentrations in sediments that ranged from 25.41 to 291.89 µg/g and 9.36 to 306.18 µg/g, respectively. The risk assessment study in sediment reveals that Pb emerges as the predominant contaminant in the region, while Cu, Mn, and Fe remain categorized as uncontaminated in the study area. The enrichment of metals in the study area follows the order Pb > Ni > Cr > Zn > Co > Mn > Cu. The pollution intensity order for trace metals was as follows Pb > Ni > Zn > Cr, primarily concentrated in the coastal and riverine zones. The findings indicate that the level of metal contamination in the sediment is concerning, with anthropogenic inputs mostly coming from adjacent urban areas. River metal concentrations are higher compared to the port due to runoff and silt transfer. The findings from this study can provide valuable insights into the dynamics of trace metal contamination in similar riverine-coastal environments and aid in formulating sustainable management strategies for safeguarding both environmental integrity and human well-being. Keywords: Heavy metals, estuary, river, risk assessment.

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Public participation in monitoring Coastal Health

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Introduction Public awareness and engagement are key to the preservation of the environment. Citizen Science is an emerging concept where the public is involved in collecting and recording ecological data and uploading onto a public database which is freely accessible to the lay public and scientists. Highly motivated individuals can monitor observable changes in earth and ocean landscapes, and this data could contribute to local decision making or academic work. Technology can be used for this purpose, however there is only limited awareness amongst the public and scientific community about the apps available for use. Citizen Science and costal monitoring Environment-related citizen science apps were searched online and sixteen were assessed in depth. The apps measured water level (n=3), water quality (litter, water colour and nitrate levels) (n=2), biodiversity (algae growth, butterfly count, bee count, rare arable flower numbers) (n=8), fishing (n=1), changes in costal landscape (n=1), dynamic changes in sand dune habitats and species (n=1), soil health (n=2). The data collected could be used by researchers, or by the public to raise awareness about potential socioenvironmental risks in their community. Limitations of the apps included unclear instructions (n=3), need for paid subscription (n=1), inability to register

an account (n=2) inaccessible on android phones (n=5). The uploaded data quality is user dependent. Three apps pertaining to costal protection were included: CoastSnap (monitors changes to coastal landscapes by uploading serial photographs), Dynamic Dunescapes (monitors sand dune habitats and species) MyCatch (monitors fish stock). Instructions were straightforward and comparative images were provided. This data is useful to demonstrate coastal recession, and inform potential property owners about potential flood risks. Conclusion Citizen science encourages public involvement in monitoring changes in coastal landscapes and can involve individuals enthusiastic about contributing to science and learning about their local environment. This project illustrates the importance of encouraging local initiatives in monitoring coastal and environmental changes.

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Shielding the Blues: Investigating the Life of Coastal Communities of Malabar, Kerala

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Oceans are a bottomless pit of opportunities and these enormous prosperities account for the Blue Economy worldwide. According to the University of Cambridge, 38% of the world population is coastal dwellers. Clean drinking water is still an unattainable dream among coastal communities across the globe. The present study delves into the Sustainable Development Goals (SDG) 6: Clean Water and Sanitation emphasizing the public awareness of Clean Water, Sanitation, and Hygiene (WASH) and its impact on the Blue Economy. The study is carried out among the communities of the Malabar coast in Kerala. A sustainable investigation is done by incorporating the survey-taking tool, Kobo-Toolbox. A sample size of 150 was considered from each district under study. The investigation findings point out the lacuna between the system and the people. The existing regulations, like Coastal Regulation Zone (CRZ) rules, make these marginalized classes groundless for availing rightful support from the authority. Far relocation sites from the water are a significant barrier to acceptance among villagers who rely on the sea for their livelihood and identity. Another finding drawn from the survey is the prevalence of Open Defecation (OD) in the Open Defecation Free Plus (ODF+) announced zones. Apart from the lack of basic infrastructure, an unrelenting attitude of coastal villagers towards OD is a reason for this situation. These conditions seek attention from the Government and other agencies for building awareness about the hygiene practices of coastal villagers. The coastal population shows a sense of responsibility towards pollution-free waste management/ disposal by joining hands with Government schemes. As Kerala beaches are hotspots for tourism, prompt actions are advised to be taken by the authorities to maintain the serenity and beauty of our beaches by filling the voids in the life of the place-based people. Keywords: Blue Economy, Coastal Villagers, Open defecation, WASH, Waste management.

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Invisible Invaders Threatening the Coastal Livelihoods: Exploring the Perceptions of Microplastics among the Coastal Communities of Malabar, Kerala

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For coastal communities, the ocean holds both sustenance and a siren song. But beneath the shimmering surface lies a growing threat of microplastics. Unquestionably, the growth of microplastics in coastal areas has an impact on human health and marine ecosystems, making it a global environmental concern. The present study delves into the perceptions of the coastal communities towards the omnipresent issue of plastic pollution, its insidious manifestation as microplastics, and the fragile future of Blue Economy as coastal tourism. A quantitative study is carried out among the Northern districts of Kerala. The findings regarding the perceptions of the coastal community on microplastics are sparse. This term is unfamiliar to a large mass of coastal communities. The community comprising fishing villages, tourist destinations, and ports, are closely tied to the marine environment and dependent on its resources, making them vulnerable to the consequences of microplastic pollution. Initiatives by governments, like Kerala/"/gs Haritha Karma Sena, have the potential to promote effective waste disposal measures. The majority of respondents expressed support for government initiatives aimed at improving their quality of life and securing their livelihoods. Approximately 60% of households actively engage in segregating and storing plastic waste. Unfortunately, a certain percentage of this non-degradable waste in coastal areas often ends up being burned or dumped openly, exacerbating the environmental challenges associated with its disposal. Efforts to reduce single-use plastics, improve waste disposal practices, and promote environmental education among coastal communities are vital steps toward addressing this issue. Additionally, collaboration between government, industries, and community stakeholders is crucial in implementing sustainable measures for the protection and preservation of coastal ecosystems. By taking decisive action, it is possible to safeguard the future of coastal communities and ensure the sustainable growth of coastal tourism for generations to come. Keywords Blue Economy, Coastal Villagers, Microplastics, Waste management

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Concept of Sustainable shore protection through chrysopogon zizanioides (vetiver)

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Coastal protection is an important parameter which is meant for protecting coastal structures from Environmental parameters such as Waves, Currents, Storm surge and Tsunami. For preventing or protecting human beings, infrastructure during extreme events is mandatory for providing adequate coastal protection measurements like Breakwater, Seawall, Sea dikes, Revetments and Geotextiles.But the Coastal protection measures with the help of above said measures like Breakwater and Seawall construction will become more expensive. In order to achieve the Shore protection in a techno economic feasible manner, we will be going for sustainable measure like vegetation. In this paper, Shore protection with the help of vegetation will be described for better understanding of ecofriendly shore protection measure which safeguard the Shore without

disturbing the Shore. The Stiffness property of vegetation plays a crucial role in preventing the shore from preventing wave overtopping, erosion on coastal structure. In this paper, Shore protection is carried out by Vetiver plant (Chrysopogonzizanioids). Laboratory Experiments on Tensile strength test for vetivergrass. Based on experimental results of Tensile strength test, graph done for Tensile strength verses Diameter. In addition to that Slenderness ratio derived from Tensile strength test will be base for check its suitability against wind speed. Field study done for vetiver growth in saline environment and Coastal sand at Thalankuppam, Northeast coast in Chennai and Rameswaram. Vetiver'sresistance against ocean waves were checked with Field studies and Laboratory Study at Thiruvotriur and Department of Ocean engineering, Indian Institute of Technology, Madras. Flow resistance test done for vetiver to check its adequacy against disasters like Tsunami as well as Storm surge.

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Development of WebGIS based Coastal Inundation Risk Atlas for Tamil Nadu

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Climate change induced sea level rise is one of the most significant effects in the recent decades. Recent studies highlighted that over the end of the century, the low elevated regions of Indian coast will get inundated due to the alarming increase in sea level. In addition to this, Tamil Nadu faces several coastal hazards such as Tsunami, cyclone and flood that impacted life and property. Coastal communities are at high risk to the hazards since the elevation range of few coastal areas are almost flat. Taking this into consideration, risk assessment of coastal areas due to natural hazards is the need of the hour. Understanding the importance of providing proper management strategies for coastal inundation, a Web-GIS based platform for the Coastal Inundation Risk Atlas has been developed village wise to help coastal communities for preparedness and managing the impacts of hazards. This platform is aimed to provide user friendly GIS operations and facilitates to process spatial data and perform spatial analysis using interactive maps up to cadastral level. This will assist policy makers to frame adaptation strategies, building a disaster-resilient infrastructure and implement better hazard management plans in the near future. Key words: Climate change, Vulnerability, Risk, WebGIS

WOSC/2024/ABS/55

Dissolved and particulate matter-bound polycyclic aromatic hydrocarbons from Coral reef ecosystems of the Lakshadweep Archipelago: Contamination status and ecological implications

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Coral reefs are generally considered a pristine ecosystem, free from anthropogenic disturbances because of their remoteness. However, coral reefs are now threatened by both global and local stressors. The degree of organic pollution and its ecological implications in the coral reef regions like the Lakshadweep Archipelago are unknown. This study investigates the levels of polycyclic

aromatic hydrocarbons (PAHs) in the Lakshadweep Archipelago's ambient environment. Water and particulate matter were collected from four coral islands (Agatti, Kavaratti, Perumal Par and Bangaram) of the Lakshadweep during January and December 2022 and analysed for dissolved and particulate matter-bound PAHs. The 15 PAH priority pollutants were quantified, ranging from 2.77 to 250.47 ng/L and 0.44 to 6469.86 ng/g in the dissolved and particulate form, respectively. The coral ecosystems of Lakshadweep showed relatively lower levels of PAHs compared to available datasets of coral reef ecosystems worldwide. Principal Component Analysis (PCA) and source apportionment indicated that mixed sources of pyrogenic, low-temperature combustion and petrogenic were the main contributors of PAHs in the water column. The risk quotient (RQ) values revealed moderate to severe ecological risk to aquatic organisms in both dissolved and particulate forms by PAHs. Keywords: Polycyclic aromatic hydrocarbons, Source apportionment, ecological risk, coral reef, Lakshadweep Archipelago

WOSC/2024/ABS/68

Microplastics Distribution in the Sediment of Pattinapakkam Beach, Chennai city, Tamil Nadu, India

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Microplastics are currently regarded as emerging pollutants where their presence is not commonly monitored in the environment but it has been already detected in the environment and causes known or suspected adverse impacts on the ecological system and human health. Microplastics are the small tiny plastic pieces less than 5 mm in size such as pellets, microbeads fibres, films, foam, and fragments. Therefore, this study intends to analyse the distribution of microplastics in the mid-intertidal zone sediments from Pattinapakkam Beach, Chennai, Tamil Nadu. Datasheet was prepared before heading to the sampling location. Tansect and point intervals were determined and plotted at the study area (Pattinapakkam Beach) using Google Earth Pro. The sampling was planned on a New Moon Day, where there will be high tide and low tide on the day. The physical properties of the microplastics were recorded in the datasheet such as colour and type. Analysing microplastics distribution in beach sediment samples using FTIR spectroscopy. Finally, for the microscopic examination of microplastics distribution in the sediment sample after the oxidation removal and density separation processes, the microscopical techniques (i.e., dissect, polarized, fluorescence, scanning electron, and atomic force microscopy) are one of the most used identification methods for micro/nanoplastics, but they have the limitation to produce incomplete results in analyses of small particles. At present, the combination with chemical analysis (i.e., spectroscopy) overcome this limit together with recently introduced alternative approaches. The development of new analytical instruments coupled with each other or with conventional and innovative microscopy could solve the current problems in the identification of micro/nanoplastics. Key words: Microplastics, Sediments, sampling, Analysis and microscopic examination.

WOSC/2024/ABS/117

Assessment of Shoreline Migration along Rasulpur to Subarnarekha River Mouth Area, East coast of India

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Coastlines may advance or retreat in response to eustatic sea level changes or regional tectonics or seasonal weather changes. These changes result in changes of rate of shoreline shift from centimeters to several meters per year. Human interventions also play a major role on it. Digha coastal region in the northeastern part of the Bay of Bengal is potentially vulnerable to erosional hazard has become a matter of concern in the recent past and frequently gathered media attention. The present study assessed the coastal erosion vulnerability along 65 km long coastal stretch located between Rasulpur (East Midnapur, West Bengal) and Subarnarekha (Balasore, Odisha) River mouths estuarine complex during the last four decades (1932 – 2020), using SOI Toposheets, Landsat imageries with the aid of ArcGIS software, to evaluate different coastal processes vis-à-vis stability of the beach for a long sustainable coastal zone management. From the change detection study of the relative position of shorelines both advance and retreat nature has been recorded with the dynamic behavior of shoreline with different events of erosion and accretion at different time intervals. The entire terrain extending between Bankiput-Birampur, Mandarmani and Digha up to Talsari is under the threat of rapid erosion. Significant amount of loss of land is observed largely south of Rasulpur River to Birampur, Mandarmani up to Sahapur area due to the sediment erosion from the banks because of complex interactions between river flow, waves and tides. The analysis reveals that the maximum erosion has been taken place from Bankiput to Birampur with a shoreline retreat of approximately 448m to 786m. The entire stretch of Mandarmani up to Sahapur area, where the shoreline receded approximately 360m to 1km towards land, represent most vulnerable zone of erosion due to accelerated rate of coastal erosion. The Baguran to Rasulpur River mouth area is differing from the other sectors to the SW side. The net changes in the sector indicates a SW sediment movement with bank erosion on the SW side of the River mouth and accretion on the NE side along a NE-SW trending coastline, probably because of the local reversal in the sediment movement under the influence of the Hoogly River Delta. The Champa River Estuary (separates Digha from Shankarpur) has changed it's course in the inland area mostly because of the influence of sea. Here the shoreline retreat on both sides of the Digha Mohona indicating nil sediment inputs from the Champa River. Due to the NE- SW alignment of the coast, the NE part of the Subarnarekha River mouth recorded sediment accumulation at the expense of sediment from the SW part. The shoreline advance in this area is around360m-470m. It is observed that the Jalda inlet near Mandarmani- Tajpur and Digha inlet shifted approximately 0.8km and 1.35km southerly. The 6.78 km long spit from Talsari to Subarnarekha River mouth with few isolated islands (Subarna Island) migrating seaward side in the last few decades. The area has suffered many cycles of erosion and deposition.

WOSC/2024/ABS/120

Monitoring Geophysical Changes in Chilika Lake: A ML approach Using Global Surface Water Mapping

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Chilika Lake, the largest brackish water lagoon in Asia, has undergone significant geophysical and geomorphological changes influenced by both natural events and anthropogenic interventions. It is designated as a Ramsar site in 1981 and listed in the Montreux records (wetlands under threat). To systematically identify alterations in the lake's landscape from 1984 to 2022, this research employed a change detection analysis utilizing the JRC Global Surface Water Mapping Layers dataset (v1.4) obtained from Landsat 5, 7, and 8 scenes. The dataset, comprising 4,716,475 scenes, was processed through the Global Surface Water Explorer platform, acting as a virtual time machine with a 30-meter resolution. The pixels of the dataset were individually classified into water / non-water using an expert system and the results were collated into a monthly history for the entire time period and

two epochs (1984-1999, 2000-2021) for change detection. The dataset was retrieved through Google Earth Engine (GEE) using Machine Learning (ML) approach. GEE is an open-access cloud computing platform which works on the basis of java script. The findings indicated that, over the 38 years study period, 63.7 % of Chilika's area consistently observed water for more than 9 months annually. Moreover, the comparative analysis between 1984-1999 and 2000-2021 revealed notable reduction in occurrence of water by 25 % over 657.92 sq.km area of Chilika, whereas an increase by 50 % was observed over 100 sq.km area. Overall, a reduction in occurrence was identified over 873.26 sq.km out of the total area (973.92 sq.km). So, to mitigate these adverse impacts, the study recommends enhancing hydrological regimes, maintaining coastal inlets, and adopting a balanced water allocation strategy for both human and ecological needs. The primary drivers behind this occurrence reduction were identified as siltation of the lake basin at its outer channels, restricted sea water exchange, eutrophication, and weed infestation. Therefore, this research underscores the importance of continuous monitoring and adaptive management strategies to ensure the sustained health and resilience of Chilika Lake, emphasizing the need for collaborative efforts between stakeholders, policymakers, and local communities.

WOSC/2024/ABS/181

Indian coastal vulnerability: Risk assessment and mitigation plans

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Coastal regions have become more significant due to a variety of factors, including the high productivity of the ecosystem, dense population, industrial friendliness, transportation, and tourism. However, during recent past these areas are at risk due to global climate change and human activities. The present study identifies the places that are susceptible to disturbances resulting from coastal hazards such as coastal storms, sea level rise, and erosion. The process of identifying an issue, measuring it, and determining the risk rate in order to create development plans that lower risk and vulnerabilities is known as vulnerability assessment. This study assesses coastal vulnerability based on physical variables, that are primarily used in Coastal Vulnerability Index (CVI), viz. the sea level rise and shoreline change rate, coastal geomorphology, elevation and slope, wave height, etc. The Indian Coast requires prompt implementation of appropriate planning and protection measures by the Coastal Management Agency to protect the coastal environment and people/"/gs lives. In this study Coastal vulnerability data of locations collected by using Remote sensing and GIS methods. These findings are useful to reduce the impact of coastal disasters and mitigation purposes.

WOSC/2024/ABS/66

Shore protection measures along Chennai Coast using GIS and Modelling Techniques

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The coastal region of Chennai, with its pristine beaches and diverse ecosystems, faces imminent challenges related to shoreline erosion, climate change impacts, and human activities. Coastal protection and restoration strategies are crucial to ensure the resilience and sustainability of this ecologically significant area. It experiences erosion exacerbated by factors such as sea-level rise

and increased storm activity. Conventional measures like seawalls and groins, though effective in protecting the shoreline, fall short in restoring the lost beaches. Therefore, a comprehensive approach is necessary to address both protection and restoration. Innovative coastal protection initiatives tailored to Chennai unique characteristics involve a mix of engineered and nature-based solutions. Seawalls, groins, and beach nourishment counter erosion, while the restoration of mangroves and dune ecosystems enhances natural defenses. In conclusion, the coastal protection and restoration strategies for the Chennai coast presented herein advocate for a balanced, adaptive, and community-centric approach, aiming to preserve Chennai environmental and cultural heritage for current and future generations. Keywords: Coastal protection, Coastal Restoration, Erosion, Remote Sensing, GIS, Erosion Modelling.

WOSC/2024/ABS/70

Coastal vulnerability and environmental risk assessment of Chennai coast

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This research focuses on the 120-kilometer coastal stretch within the Chennai district of Tamil Nadu, located on the southeast coast of India. Encompassing tourist resorts, ports, hotels, fishing villages, and towns, this area faces a range of threats, including storms, cyclones, floods, tsunamis, and erosion. The primary objective of this study is to establish a Coastal Vulnerability Index for the Chennai coast, employing the analysis of remotely sensed data and geographic information system tools. The procedure involves incorporating diverse parameters, including geomorphology, Land Use and Land Cover (LULC), significant wave height (SWH), rate of sea level rise (SLR), shoreline change (SLC), bathymetry, elevation, and coastal inundation. The study categorizes vulnerability zones to coastal natural hazards into high, medium, and low magnitudes, visually presenting the results on a map. This map serves as a valuable resource for state and district administrations engaged in disaster mitigation and management planning. Additionally, it functions as a tool for designing new facilities and holds significance for insurance purposes.

WOSC/2024/ABS/71

SPATIO- TEMPORAL ASSESSMENT OF THE MUTHUPET MANGROVE ECOSYSTEM

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Mangroves exhibit remarkable adaptability, strategically positioning themselves to thrive in diverse coastal settings, effectively adjusting to the dynamic natural conditions that unfold over time and space. Functioning as a natural buffer or bio-shield, they offer protection against coastal hazards such as wind, tidal waves, and erosion. This study employs remote sensing techniques and various vegetation indices, leveraging digital analysis of multi-temporal Landsat satellite data. The primary focus is on assessing changes in Muthupet mangrove extent, species composition, and key indicators of mangrove health from 2000 to 2023. Over the past two decades, health metrics like Leaf Area Index (LAI), Enhanced Vegetation Index (EVI), and Normalized Differential Vegetation Index (NDVI) have exhibited a consistent linear decline, particularly noticeable in the areas of the mangrove forests facing the sea. This decline in health indicators appears to be attributed to elevated salinity levels, increased temperatures, and siltation. The findings underscore a spatial shift in mangrove area and health, presenting a critical challenge for the Muthupet mangroves. This predicament is further exacerbated by the looming threats of climate change and rising sea levels, collectively posing an existential crisis for these mangroves.

X: Marine Biodiversity and Ocean Ecosystem.

WOSC/2024/ABS/102

Sea Anemone Venom: Unravelling Ion Channel Interactions for Therapeutic Insights

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Sea anemones (Cnidaria: Actiniaria) are marine benthic invertebrate predators that produce a myriad of venom peptides with remarkable bioactivity. These peptides, while traditionally associated with their predatory nature, have emerged as compelling molecular tools in biomedical research due to their interactions with ion channels. This research paper delves into the exploration of research dedicated to understanding the profound interactions between sea anemone venom peptides and ion channels and their potential implications. Sea anemone venom peptides exhibit an extraordinary diversity of functional properties, notably their interactions with ion channels, crucial membrane proteins that regulate the flow of ions across cellular membranes. These peptides exhibit specificity in modulating various types of ion channels, including voltage-gated sodium, potassium, and calcium channels, as well as ligand-gated channels. Their selective targeting of specific ion channels offers promising avenues for drug development, particularly in the treatment of neurological disorders, pain management, cardiovascular conditions, and cancer, thus demonstrating potential as pharmacological tools and therapeutic leads. This research paper synthesizes the current state of knowledge regarding sea anemone venom peptides and their intricate modulation of ion channel activity. It highlights the potential of these peptides as valuable tools for both understanding ion channel physiology and developing innovative therapeutic interventions, offering new insights into the realms of drug discovery and targeted therapeutics. Keywords: Sea anemone, Venom peptides, Ion channels, Drug discovery, Marine natural products.

WOSC/2024/ABS/104

Exploring the nematode-to-copepod ratio and harpacticoid copepod as a bioindicator for monitoring metal pollution in the Netravati-Gurupura estuarine ecosystem.

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The Nematode/Copepod (N/C) index, introduced by Raffaelli and Mason (1981), with a threshold value of 100, to monitor the effects of organic pollutants in sandy beaches, has subsequently undergone refinement, enhancing its sensitivity. Warwick (1981) proposed a threshold value of 40 for coastal environments and 10 for moderately sandy bottoms. In the context of monitoring metal pollutants in diverse aquatic environments, Lee et al. (2001) suggested a more comprehensive approach, combining the N/C index with the mean density of harpacticoid copepods. In the present study, we investigated benthic meiofauna in relation to heavy metal pollutants in the Netravati-Gurupura estuary and adjacent coastal waters, along the west coast of India. The N/C ratio and mean density of harpacticoid copepods (HC) have been used, to test their potential use as bio-indicators in a tropical estuarine-coastal system. Nematodes exhibited highest abundance in all zones, while other groups (copepod, polychaetes, oligochaetes, molluscs, and foraminiferans, fish larvae) were meagerly represented. Notably, in the Netravati, the N/C index ranged from 8 to 15, while in the Gurupura, it varied from 4 to 4.9. In the coastal zone, copepods were absent in a few stations,

leading to a high variation in the ratio (1–99). Mean density of copepod was 7±4, 14±10 and 1±1 ind·10 cm –2 in the Netravati, Gurupura and coastal zones, respectively. The elevated levels of heavy metals such as Pb, Cr, Zn, Ni, indicated significant contamination in sediment. This may be the reason for the high N/C index and low mean density of harpacticoid copepods in the Netravati and coastal zones. No significant relation was found between the organic content load with the N/C index. The study indicates that the N/C ratio and mean density of harpacticoid copepods together can serve as potential bio-indicators of metal pollution in tropical estuarine-coastal ecosystems. Key words: meiobenthos, marine ecology, estuarine ecosystems, pollution status, heavy metals.

WOSC/2024/ABS/122

Microbiome characterization of a marine bivalve mollusc Amygdalum sp. from Seamounts of Arabian Sea

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Each organism has a unique microbiome which contribute significantly to their existence and understanding that is important for defining their ecological significances. This is especially important in deep ocean ecosystem characterized by the existence of several unique biogeochemical conditions. Amygdalum sp. is a bivalve mollusc which has the capabilities to survive in oxygen minimum zones of deep ocean. In the current study, we report the microbiome of Amygdalum sp. collected from the seamounts of Arabian sea. The microbiome generated using nanopore sequencing technology were analysed in EPI2ME Labs software provided by Oxford Nanopore using wf-metagenomics workflow. The microbiome of Amygdalum sp. showed the existence of a diverse group of bacteria (Shannon index = 5.85, Simpson index = 0.98, Pielou's evenness = 0.71), which were dominated by Proteobacteria (51%), followed by Bacteroidota (18%), Planctomycetota (8%), Mycoplasmatota (4%) Firmicutes (8%), Actinobacteria (3%) and Spirochaetes (3%). Gammaproteobacteria (39%) were the dominant class followed by Bacteroidia (12.5%), alphaproteobacteria (9%), Planctomycetia (7%), Flavobacteriia (4%) and deltaproteobacteria (2.5%). The Pseudomonas sp. was the dominant genus of bacteria associated with Amygdalum sp. Current study forms the first report on the microbiome of benthic organisms from the seamounts of Arabian Sea. Further studies on the isolation and functional aspects of these microorganisms are ongoing and are required for shedding more light on the role of microbiome on supporting the existence of Amygdalum sp. in oxygen minimum zones of deep ocean and exploring their biotechnological potentials. Keywords: Microbiome, deep ocean, microbial diversity, seamounts, benthic, bivalves

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Immune response of the coral, Acropora sp., from different islands of Lakshadweep

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There are multiple ways through which the aquatic animals respond to the external stressors, and the response of corals to pollution and indicators of climate change are a topic of recent research. The stress factors induced by pollution and indicators of climate change triggers the immune systems of aquatic organisms, but that of corals are least studied. Corals are devoid of a well-developed immune system, and various microorganisms also support their wellbeing. In the current study, we discuss the immune responses of Acropora corals collected from four different islands namely Kavaratti, Agatti, Bangaram and Perumalpar of Lakshadweep Islands, India. The abundance of associated bacteria ranges from 6×10^4 to 1×10^8 gene copies per nanogram of DNA. The H_2O_2 scavenging activity varied between Acropora sp. collected from different islands and maximum (2.2×10^{-4} units min^{-1}) and minimum (6.1×0^{-5} units min^{-1}) activities were found in samples from Agatti and Bangaram respectively. Peroxidase activities varied from 9.8 to 0.15 $\times 10^{-3}$ units min^{-1}, with minimum and maximum values in Acropora sp. collected from Agatti and Bangaram respectively. Preliminary analysis showed that the hydrographic variables also influenced the difference in the expression of immune parameters in corals. Overall, the study indicates the importance of monitoring the immune parameters in analysing the impact of pollution and indicators of climate change on the health status of corals.

Exploring the seamounts of the Arabian Sea: A hub of microbial diversity and bioprospecting opportunities.

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Seamounts creates distinctive habitats characterized by unique hydrography and topography. Seamounts generally harbour higher biomass and have been frequently considered as "hotspots" of the marine life. The study of the microorganisms that thrive in such habitats may provide insights into the nature, resilience and ecology of the environment. The present study is an investigation of the bacterial diversity in the Arabian Sea sediments from various twilight zones, which is also referred to as the mesopelagic zone. The nine sediment samples obtained from seamount and continental shelf regions are processed in different growth media to obtain axenic culture. The bacterial community structure assessed by 16S rRNA gene sequencing and analysis of 135 isolates showed that dominant phyla comprised of Proteobacteria (57%), Firmicutes (25%), Bacteroidetes (9%) and Actinobacteria (9%). The community level metabolic profiles showed high utilization of polymers, carboxylic acids and carbohydrates substrates. The unique catalytic properties of bacteria were observed for lipase, urease, amylase and gelatinase. Potential novel isolates sharing ≤ 98.6 % similarity with type strains of the genera Acinetobacter, Oceanobacillus, Pseudoalteromonas,

Oceanisphaera were identified. The extracellular polysaccharides (EPS) were extracted from different bacterial strains which exhibited antibiofilm activity against Staphylococcus aureus, Pseudomonas aeruginosa and Escherichia coli. The EPS formed stable emulsions in coconut oil and benzene resulting in an emulsification index of 95% and 90%, respectively. The results from this study provides a holistic understanding of seamount bacterial diversity and their functional attributes. The insights gained have implications for pharmaceutical targets, environmental remediation, and the exploration of novel biological applications.

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Preliminary Observations on the Composition and Vertical Migration of Thecosome Pteropods in the Eastern Arabian Sea

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Pteropods are zooplankton, which are popularly known as "sea butterflies" or "sea angels" because of their astonishing appearance and elegant swimming style. Thecosomate pteropods are vulnerable to rising ocean acidity and hence they are considered the bioindicators of ocean acidification. Vertical migration is a fascinating phenomenon among almost every zooplankton, where they show synchronised vertical movement both upwards and downwards in the water column over a fixed interval of time. In the current study, the composition and diel migration of the pteropod community in the eastern Arabian Sea was analyzed based on plankton pump samples from discrete depths in the upper euphotic column (5m, 10m, 20m, and 30m) collected during the day and night from 15 locations. The occurrence of pteropods showed significant diel variations, with a preponderance of Heliconoides inflata, Limacina bullimoides and Creseis conica in both day and night samples. The overall abundance of pteropods in the surface waters of the eastern Arabian Sea increased during the night. Several pteropods are identified from the study area which include Creseis conica, Heliconoides inflata, Limacina bullimoides, Clio pyramidata, Clio convexa, Peracle reticulata, Pneumoderma heronensis, Cavolinia sp., Diacavolinia sp., Styliola sp., Hyaloclis sp., Cuvierina sp., Telodiacria sp., Diacria sp., Creseis sp., Limacina sp., Peracle sp., Clione sp., and Desmopterus sp.. They showed characteristics such as (a) living in the subsurface with marginal vertical migration, (b) living in the subsurface during the day and surface during the night with active migration and (c) non-migrants with little to no diel migrations and residing always in subsurface layers. This forms the baseline information on vertical migration of pteropods from the Indian waters.

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Biological Continuity of Copepods in the Oceanic and Coastal Oxygen Minimum Zones in the Eastern Arabian Sea

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The highly productive eastern Arabian Sea (EAS) harbours two distinct oxygen minimum zones (OMZs): a perennial one located north of 10°N at intermediate depths and a seasonal one along the west coast of India during the Southwest Monsoon (SWM). The seasonal OMZ over the Western Indian Shelf arises from the upwelling of oxygen-depleted waters from the perennial OMZ. These OMZs significantly impact the vertical distribution of pelagic organisms. They restrict diel migration depths, increase predator susceptibility, confine the available habitat, and ultimately lead to community reorganization. Notably, no previous studies in the EAS have examined zooplankton samples exclusively from the entire OMZ depth range (150-1000 m). Hence this study presents the results of a stratum-wise vertical sampling during SWM at nearshore (50m) and offshore (1000m) depths along the Indian Coastline, using a Multiple Plankton Net. This study aimed to investigate the composition, abundance, and distribution of copepods within both the perennial and seasonal OMZs of the EAS. Key findings are: (a) large-sized calanoids belonging to the families Metridinidae, Lucicutiidae, Eucalanidae, Paracalanidae, Augaptilidae, Scolecitrichidae, and Heterorhabdidae dominated the oceanic OMZ, (b) the calanoid species Lucicutia grandis served as an indicator species for the OMZ, (c) the sex ratio of copepods within the OMZ displayed a near-equal number of males and females, a deviation from the typical female-skewed community, which attributed to the stable environment of the OMZ, with abundant food and lack of visual predators. It was also observed that during the SWM, the coastal OMZ along the Indian western shelf displayed a dominance of calanoids, including species such as Pleuromamma indica, Lucicutia flavicornis, Lucicutia paraclausii, Eucalanus elongatus, Subeucalanus pileatus, Subeucalanus subcrassus, and Clausocalanus furcatus. These species include members found in the oceanic OMZ, highlighting a significant similarity between the two zones along the west coast of India during the SWM.

<div align="center">WOSC/2024/ABS/169</div>

Bioprospecting the Potentials of Manglicolous Yeast β-Glucan: An invitro approach

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βeta-glucans, one of the important constituents of yeast cell wall have received much attention in past few years. Nowadays, these biomacromolecules have been extensively used in pharmaceutical, food and cosmetic industries. Although some physiological functionalities of these sustainable polymers have been confirmed, the bioactive potential of Manglicolous yeast β-glucan remain unexplored. Mangrove is one of the rare and distinctive ecosystems that offers numerous microhabitats with the potential of harbouring yeast communities. The present study was aimed to determine the bioactive potential of β-glucan from mangrove yeast isolates available in the laboratory. β-glucan extracted from 100 isolates were initially screened for α-amylase inhibition using plate assay. The β-glucan from the potent isolates were further examined for various pharmaceutical potential such as antioxidant, antimicrobial, anti-diabetic and anti-inflammatory activity. The yield of β-glucan extracted by an acid-base method varied depending on isolates (100-500mg/g of cells). Among the 100 isolates the β-glucan from 7 isolates (PV5, PV12, PV21, PV28, PV56, PV60, PV62)

were identified as potent as they exhibited complete inhibition of α-amylase enzyme. Further, this was confirmed quantitatively by α-amylase inhibition assay, in which PV62 showed an inhibition of 75.8±0.02%. These β-glucan samples also exhibit scavenging potential against DPPH and ABTS radicals and maximum activity was observed for PV28. A significant antibacterial activity against various pathogens were exhibited by β-glucan from PV21 sample. However, these β-glucan samples does not express any anti-inflammatory and α-Glucosidase inhibition potential. Thus, the findings of study suggests that manglicolous yeasts too are a value source of β-glucan which have potential to be applied in fields of nutraceuticals, food and pharmaceuticals.

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Influence of spatial and environmental parameters on methane oxidation activity in the Eastern Arabian Sea

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Coastal waters are one of the major contributors of methane emissions to the atmosphere. Methanotrophs play an important role as a sink by significantly mitigating this process. This study examines the abundance and activity of methanotrophs to understand their role in biologically driven ocean processes in 3 different ecosystems; offshore waters of Lakshadweep Island, near shore waters of Kochi and a coral reef ecosystem of Angria Bank along the southwest coast of India. The spatial and depth wise influence of the physicochemical and biological parameters on the methane related processes was investigated. The methane-oxidizing bacteria (MOB) and average methane-oxidation activity (MOA) followed the trend of Kochi > Lakshadweep > Angria bank. Higher rates of MOA were accompanied by higher bacterial load at Kochi station as compared to Angria bank. This may be due to the proximity of the Kochi station to the near shore as compared to that of comparatively pristine waters at Angria bank. Besides, at Angria bank and Lakshadweep which had comparatively deeper stations than Kochi, the microbial abundance and activity decreased with depth. The environmental parameters at the three stations significantly correlated with the MOA, MOB and total counts (TC). At Kochi, TC correlated with MOB while at Angria bank, it had a negative influence on MOB. Also, in the case of Angria bank and Lakshadweep, turbidity had a positive and negative influence on MOB respectively. This is suggestive that the same environmental parameters can have varying influence on the microbial population and its activity in spatially different sites.

WOSC/2024/ABS/183

Bacteriorhodopsin producing Haloarchaea from the tide pools of Tuticorin coast.

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Marine microorganisms thriving under extreme conditions are a promising source of unique metabolites that are of wide industrial applications. Haloarchaea are salt tolerant species capable of producing industrially important compounds such as Bacteriorhodopsin, carotenoids, lipids, and

proteins. They are present in a wide range of hyper saline habitats including salt pans, tide pools, and salt marshes which are least explored for bioprospecting. In this study, we isolated ten species of halo archaea from the intertidal pools along Tuticorin coast. These isolates were identified using 16s rDNA sequencing and assessed for their ability to produce Bacteriorhodopsin and carotenoids under optimum lab conditions using UV-Vis spectroscopy. Of these 10 isolates, three species including Halococcus sp., Halococcus salifodinae and Halophilic archaeon produced both carotenoids and Bacteriorhodopsin and only these three species were considered for further analysis to estimate the Bacteriorhodopsin yield and photocurrent activity. H. salifodinae produced a maximum of 184 mg /liter of cultured lysate compared to H. archaeon and Halococcus sp. which produced 127 mg and 65.6 mg/liter of cultured lysate, respectively. However, none of the isolates showed photocurrent activity. Our results demonstrate that tide pools are an important source Bacteriorhodopsin producing haloarchaea and these isolates can be critical for large scale production of Bacteriorhodopsin and it's related technological applications.

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Isolation of UV-protecting biomolecule microsporin-like amino acids from marine Cyanophycean algae

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Cosmetic products derived from biomolecules of natural sources have gained momentum in recent days. One such natural source is microsporine-like amino acids (MAA), a biomolecule with enormous potential for being developed as sunscreen. MAA is a diverse group of water-soluble compounds distributed in algae and fungi. Marine microalgae especially marine cyanophyceans which inhabit diverse extreme environments have established their relevance as an important source of these wonder biomolecules with multiple health benefits inclusive of high antioxidant activity. Despite the potential of MAA being developed into a natural sunscreen the existing downstream processes for extraction are less than sufficient for industrial applications. So there exists a greater need for the development of innovative extraction processes for MAA extraction. Hence, the present investigation explored the isolation, quantification, and optimization of process parameters for MAA extraction. MAA production potential was evaluated in cyanophycean algal species (Spirulina major, Phormidium tenuii, Synechocystis pevalakii, Nostoc punctiforme and Trichodesmeium thiebautii) isolated from diverse marine environments using HPLC (High pressure liquid chromatography) and UV spectrometry. A series of single-factor and orthogonal experiments were carried out in which the effects of solvents (25% ethanol, 50% methanol, 25% methanol, 50% methanol), the solid–liquid (S:L ratio 1:10 to 1:100 g/mL) ratio, the time of extraction (30 to 180 min), and the extraction temperature (25 to 50 °C) on the MAA yield were determined. Three major MAA viz, Shinorine (absorption maxima 332nm), Porphyra 334 (absorption maxima 334nm), and microsporine glycine (absorption maxima 312nm) were isolated and quantified from these marine cyanophycean algae. The content of MAA ranged from 500 to 700 µg/g before optimization and the content augmented to 2083 to 3340µg/g after optimization. The isolated MAA was purified and characterized.

WOSC/2024/ABS/209

Coliform plumes along the riverine-coastal continuum in the south-west coast of India

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Coastal and estuarine environments of world are exposed to increased anthropogenic activities, which deteriorate water quality if the effluents and sewage are discharged bypassing treatment systems. Microbial quality of estuarine and coastal ecosystems is an emerging concern as as they contribute to the spread of water associated diseases and antibiotic resistant genes. Surveillance of coastal waters for microbial and chemical quality is a global agenda relevant to sustainable development goals 6 (Clean water and sanitation) and 14 (Life below water). Current study discusses the microbial and chemical quality of water collected from the Netravati and Gurpur rivers (7 stations) and its adjacent coastal waters (12 stations) along south-west coast of India. The stations located at the confluence of Netravati and Gurpur rivers recorded high concentration of silicates (113 + 11.6 µM) and coliform bacteria (>11 - 4.6 MPN index/ml). The faecal contamination extended towards the Arabian sea in a zonal direction, while their meridional distribution was restricted by weak coastal currents. Our results indicate significantly higher (p<0.05) abundance of Vibrio spp. in riverine waters (6.9 x 104 + 5.3x104 copies/ml) compared to the coastal waters (1.3 x 104 + 1.94 x 104 copies/ml) in the study area.

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Species distribution modeling of small pelagic fishery in the north Indian Ocean towards securing livelihood

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A new small-pelagic fish habitat-suitability model focusing especially northwestern Bay of Bengal is represented in the work. Hilsa shad (Tenualosa ilisha) habitat was studied from the catch data and oceanic/ecological indicators, derived from an operational biophysical model, using generalized additive model and geographic information system. We used Regional Ocean Model System (ROMS), developed by Indian National Centre for Ocean Information Services (INCOIS), simulated sea surface temperature (SST), sea surface salinity (SSS), surface current speed and direction as predictor variables. Our coupled biophysical model has been validated against a wide range of observational data and has demonstrated considerable capability in reproducing marine ecosystem dynamics at synoptic and seasonal time-scales in the Indian Ocean. Several generalized additive models were constructed with Hilsa shad catch per unit effort (kg h−1) as a response variable for the study period (2012-2016). Best-fit model was selected based on the significance of model terms, reduction in Akaike's Information Criterion and increase in cumulative deviance explained. The selected model has been used to predict catch per unit effort of Hilsa shad using predictor variables and the model was validated using a linear model. Out of four predictor variables, SST and salinity have significant role in Hilsa shad habitat selection. Additionally, surface current

direction showed dominant influence during summer monsoon breeding migration towards coast/estuary. Probability maps of predicted habitat with no fishing zone information are generated using geographical information system for the Hilsa fishing community for further validation. Key words: Hilsa, Prediction, Habitat suitability Model, biophysical model, fishing zone.

A STUDY ON IMPACT OF GLOBAL PANDEMIC ON SEA TURTLE NESTING ALONG NORTHERN COASTAL KARNATAKA AND SOUTH GOA

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Study on Olive Ridley nesting during global pandemic (COVID-19) was conducted during the year 2020-21 across the coastline of South Goa and northern coastal Karnataka. It was observed that percentage of the eggs laid had comparatively increased during the pandemic as the tourism related activities, fishing activities, human interference on beaches was almost nil. Approximately 10-15% increase in eggs laid across western coastline was seen. The number of turtle visits also increased considerably. Because of increased tourism activities the beaches are highly polluted with variety of litters. The beaches are flooded with huge number of lights and continuous activities like birth day parties, anniversary parties etc. disturbing the turtle nesting activities. Fishermen are of the opinion that earlier days Olive Ridley turtle use to come to the beaches for laying eggs. In Honnavar region the number of pits observed were 11, 6 and 18 during the year 2018-19, 2019-20 and 2020-21 respectively. The number of eggs laid were 1331, 724 and 1740 for the year 2018-19, 2019- 20 and 2020-21. Similarly 3 pits with 322 eggs at Galgibag and 19 pits with 2242 eggs at Agonda beach of Goa was observed during the year 2018-19. At Galgibag 6 pits with 723 eggs were observed during the year 2019-20, at Agonda beach 12 pits with 1314 eggs were noticed. From the present observations it can be stated that anthropogenic activities and habitat destruction are directly threatening turtle nesting grounds across observed beaches of Karnataka and Goa. Attention needs to be given to promote eco-friendly tourism activities and periodic cleaning of beaches for plastic and other non-degradable materials.

Jellyfish Biodiversity in Sabah, Malaysia

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Medusozoan jellyfish (Cnidaria) represent an important part of the ocean's ecosystem, and despite their wide-ranging impacts to human activities, relatively little knowledge is currently present on their population within the state of Sabah. In order to determine the species biodiversity and the impact that these jellyfish have to human health in the state, an assessment of jellyfish biodiversity was carried out. Historical records from 1870-1970 show that more than 150 species of were

previously recorded in Sabah, Malaysia. The large difference between the number of jellyfish species recorded in the present day compared to that in historical records suggest that the current records of jellyfish biodiversity in the state is highly underestimated, especially in the classes Hydrozoa and Cubozoa. Since 1991, there have been about 36 cases of serious jellyfish envenomation in the state, with six resulting in fatality of the sting victim. Children are most at risk of developing serious symptoms. Cases of jellyfish stings were reported from all parts of the state. Sting events are more common from November to January; however, stings were reported year-round. Among the species known to occur in the state is the deadly box jellyfish Chironex yamaguchii Lewis & Bentlage, 2009, which has been implicated in multiple serious jellyfish stings and fatalities. Through this study, a list of jellyfish species which could occur in the state has been produced, as well as a checklist of jellyfish species currently known to occur within the state, with physical samples collected deposited for future reference. It was also found that harmful jellyfish pose a threat to coastal human populations throughout the state. More research on jellyfish needs to be prioritized, not only to determine the true biodiversity of jellyfish in the region and to identify and prepare for harmful jellyfish species, but also to raise public awareness of jellyfish-related risks and proper safety seeking attitude in order to reduce the risk of jellyfish-human conflicts.

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Evaluation of the role of Rubisco activases in activating Rubisco for fixing the atmospheric CO2 in mangroves

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Blue carbon, or carbon fixation by green ecosystem can reduce man-made CO2 emissions, whereas capacity of mangroves to sequester and retain organic carbon is five times higher than tropical or terrestrial land plants. Ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco), the enzyme is among the most important targets for improving the photosynthetic efficiency. However, Rubisco can also be inhibited by a range of sugar phosphates. The release of the inhibitory sugar molecule is mediated by the AAA+ protein Rubisco activase (Rca), which couples hydrolysis of ATP to the structural remodeling of Rubisco. Rca enzymes are found in the vast majority of photosynthetic organisms, from bacteria to higher plants, with diverse in sequence and mechanism, suggesting their convergent evolution. The Rca enzymes and their activation role of Rubisco in mangrove carbon sequestration process is not much studied. The present study will aim in understanding the Rca enzymes for their role in activating Rubisco in varied stress conditions. Thus, the results may provide new insights in understanding the active carbon fixation of mangroves.

WOSC/2024/ABS/307

Are Indian mackerel (Rastrelliger kanagurta) populations in the eastern Indian Ocean truly homogeneous? Insights from geometric morphometric analysis

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The boundaries of Indian mackerel (Rastrelliger kanagurta) populations/stocks in the three Large Marine Ecosystems (LMEs) in the eastern Indian Ocean (Arabian Sea, Bay of Bengal, and Andaman Sea) are not clearly discriminated or delineated, resulting in conflicting population boundaries. Inherent limitations of the methodologies adopted could be the major reason behind this lack clarity in the population boundaries boundaries. Geometric morphometric analysis (GMA) using landmarks has been found to be the most appropriate approach under these conditions. Thus, the present study aims to differentiate between the populations of R. kanagurta in the eastern Indian Ocean (Arabian Sea, Bay of Bengal, and Andaman Sea) by employing GMA of body shape. The results indicate significant differences in body shape between the populations of R. kanagurta inhabiting the eastern Indian Ocean. The variations are primarily observed in the relative sizes of body depth, head, dorsal and anal fins, and the position of eyes, mouth, pectoral, anal, and dorsal fins. The Bay of Bengal populations were mainly characterized with a deeper body, large heads, dorsally oriented eyes, posterior pectoral fins and longer anal and second dorsal fin. Andaman populations were characterized with a more streamlined body, anterior pectoral fins, ventral eyes and shorter anal and second dorsal fins. Arabian Sea population possess an intermediate shape between Bay of Bengal and Andaman populations. These observed variations confirm that R. kanagurta constitutes a discrete population in the eastern Indian Ocean. This study provides valuable information on the population structure of R. kanagurta in the Arabian Sea, Bay of Bengal, and Andaman Sea, which can be useful in fisheries management and conservation efforts.

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Abundance of bacterial population along the Visakhapatnam coastal water during pre-monsoon season 2023

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The escalating urbanization, industrialization and tourism in the Visakhapatnam region have indeed led to significant environmental challenges, particularly in terms of water pollution in the coastal areas. Release of untreated or inadequately treated domestic sewage introduces various contaminants, including nutrients, pathogens, and organic matter into the coastal waters. In the present study, a total of 44 water samples from 11 stations designated as VC-1 to VC-11 delineated

into 3 zones i.e. Jalaripeta (VC-1 to VC-3), R.K. Beach (VC-4 to VC-8) & Fishing harbour (VC-9 to VC-11) of Visakhapatnam coast were collected in both high (HT) and low tides (LT) and analysed for bacteriological study during the spring and neap tides in the month of May, 2023. The values of Total Viable Count (TVC) ranged from 0.6 x 109 CFU/ml (VC-6, LT) to 12.95 x 109 CFU/ml (VC-9, LT) and 0.3 X 109 CFU/ml (VC-8, HT) to 7.25 x 109 CFU/ml (VC-4 LT) during spring and neap tides respectively. All the bacterial groups were recorded high in during the spring low tide except the Vibrio group (TV, VPLO, VCLO). In the present study, the Vibrio group showed more abundance in high tide than low tide. Groups of indicator bacteria (TC, FC, ECLO, SFLO) and pathogenic bacteria (SHLO, SALO, KLO, PALO) had shown more abundance in the neap tide than spring tide. The proportion of Faecal Coliform (FC) and Streptococcus faecalis (SFLO) was used to calculate the Pollution Index (PI). The value of PI ranged from 0.05 (VC-11) to 5.82 (VC-1) and 0.07 (VC-3) to 5.45 (VC-1) in spring and neap tides respectively. Among the four samplings, VC-1 recorded the highest PI value in 3 instances where the Dissolved Oxygen values were comparatively lesser (0.00 to 3.62 mg/l) may be due to the influx of untreated sewage.

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Impact of light levels on antioxidant activity on three centric diatom species

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Abstract: The demand of natural product isolated from microalgae has increased considerably especially in the case of natural anti-oxidants from marine microalgae. Microalgae have become a good source of natural anti-oxidants because of their biochemical composition such as carbohydrates, peptides, lipids, vitamins and carotenoids contents. Three centric diatom species such as Odontella aurita, Odontella sinensis and Thalassiosira decipiens were isolated and in different laboratory condition. These diatom species were cultured at different light intensities and their effect on antioxidant capacity was studied. Total phenolic content (TPC) was estimated and the antioxidant property of these diatom species was assessed by 1, 1-diphenyl-2-picrylhydrazyl (DPPH) assay. The result showed that the free radical scavenging (FRS) property of these diatoms was considerably higher at 80 µmol/m2/s light levels whereas radical scavenging activity was lowest at 20 µmol/m2/s light level in all the three species. Furthermore, the effect of light on pigment concentration showed that fucoxanthin, diadinoxanthin and chlorophyll a were the major pigments. The concentration of fucoxanthin, diadinoxanthin and chlorophyll a were also significantly higher at the 80 µmol/m2/s light intensity. This study showed that light significantly affect the light significantly affected the antioxidant property and pigment concentration. Key word: Antioxidants; centric diatom; free radical scavenging; light levels, pigments

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Biopolymer compounds Isolation, characterization from native Seaweed and their biological activities for Bioprospecting application

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Alginate are an outstanding biomaterial and a naturally occurring polysaccharide obtained from marine seaweeds sources. In the field of drug delivery, alginate is extensively investigated as an excipient. In the present study, the content and spectroscopic characterization (1H and 14C NMR FT-IR, UV spectroscopy and Flame spectroscopy) of the sodium alginates were investigated in a native seaweed harvested from the Pulicat Lagoon Wetland ecosystem of Tamil Nadu, East Coast of India. By applying various advanced techniques, such as NMR spectroscopy, FT-IR, HR-MS and UV spectroscopy used to study verified the homogeneous distribution of the cross-linking ions in the alginate and the high degree of ion exchange. The 1H and 14C NMR spectroscopy indicated that the extracted alginates have a high content of β-d-mannuronic (M) than α-l-guluronic acid (G) with M/G ratio values ranging from 1.04 to 4.41. The FT-IR analysis data elucidated that the IR spectra of the extracted alginates exhibited significant similarities to the commercial alginate. Further conformation study in Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray (EDX) Analysis were used to provide elemental identification and quantitative compositional information of studied alginate. Bioprospecting of Pulicat lagoon native seaweed species. has potential activities in antimicrobial, and anticancer observed from this study. The Present study enumerated 15 microbial strains against the studied species alginate observed. From this study observed that three alginates has high potential bioprospecting of wound-healing bacteria research in near future. Further human cancer cell line studies using breast cancer against isolated alginate from study site. It was observed that, has IC50 values of 3.991 µg ml-1. This information might help investigators develop future studies in deep sciences on wound healing activities against seaweed algina. This is the first-ever attempted from Pulicat lagoon native seaweed species alginate has high calibre on bioprospecting approaches.

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A Baseline Study on Comparative Marine microbial diversity in Mahatma Gandhi Marine National Park and around Port Blair municipal city, Andaman Islands using Metagenomic approaches

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Marine microbiome is complex and least-understood habitats on Earth, even play significant role for potential long-term controls on global biogeochemical cycles. The present study reported the culture-independent assessment of microbial diversity of Mahatma Gandhi Marine National Park and Port Blair municipal city, South Andaman sediments based on metagenome sequence analysis using 16S rRNA geneV3–V4 region. Four surface sediments samples collected from four different locations across South Andaman Islands. Our study obtained 21, 371 reads, of which 19, 726 high

quality 16S rRNA geneV3–V4 sequences were subjected to diversity analysis. The study elucidated that the microbiota classified into six phylum: more abundant phylum Bacteroidetes, Fimicutes, Actinobacteria, Nitrospirae, Cyanobacteria, Planctomycetes and fewer Proteobacteria, which was largely represented with the family bacillaceae and Psychrobacter pulmonis (25.55 – 27.53%), Halomonas sp. (15.23 – 11.51%) The microbial metagenomics was an eight-fold higher diversity in Jolly Buoy Island, Mahatma Gandhi Marine National Park. The subsequent Principal Component Analysis (PCA) explained 99.53% variance suggesting a highly distinct microbial abundance at Jolly Buoy Island, Marine National Park sampling location compared to other sites. The present research data provided the first preliminary marine microbiome comparison between the pristine environment of Marine National park and Port Blair municipal limit of the South Andaman Island. Further extended studies are essential to understand functional diversity in detail from the Andaman and Nicobar Islands marine sediments.

WOSC/2024/ABS/353

STUDY ON ACCUMULATION OF PESTICIDES AND MICROPLASTICS IN THE SEDIMENTS OF KONGSFJORDEN - KROSSFJORDEN SYSTEMS OF ARCTIC.

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The emerging era has been facing wide array of immense pollution since the past few years. The Arctic region is not an exception to this and being continuously exposed to a long range atmospheric and oceanic pollutions due to a vast range of irresponsible anthropogenic activities, which in turn resulting in the deterioration of the Arctic marine ecosystems. The sources through which Arctic have been polluting, include pesticides, chemical and waste release from human settlements and industries, excessive use of plastics and increased commercial fisheries besides the over exploitation of aquatic resources. The present study aims to focus on this aspect and pertains to assess the impact of major pollutants viz., pesticides and microplastics in the Arctic sediments. Samples have been collected from the five stations from Kongsfjorden - Krossfjorden systems of Arctic region. The sedimentary parameters such as Total Organic Carbon (TOC), Total Organic matter, CHNS, particle analysis was analyzed and correlated with pesticides and microplastics. It has been observed that the pesticides detected in the region has a high positive correlation with TOC as well as texture and thus proves that highly significant. Diuron, the urea pesticide has been detected in the station with the increased percentage of nitrogen which corroborates the correlation of pesticides with CHNS. The quantity of microplastics detected were high especially in the sediments collected near the open ocean stations. The study validated that the sediments serve as a major sink for the hazardous pollutants such as pesticides and microplastics. The study would definitely aid in constructing the framework for mitigating the high pollution levels in Arctic systems, thus protecting the aquatic ecosystems.

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DETECTION OF MERCURY IONS IN AQUEOUS MEDIA USING THE POLAR SEAWEED MEDIATED GREEN SYNTHESIZED SILVER NANOPARTICLES

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Definitive and delicate methods to examine and monitor the levels of mercury is particularly important for the protection of environment as well as for safeguarding the health of living beings. The potential and environment friendly method for the detection of mercury ions using the green synthesized nanoparticles. The seaweed mediated green synthesized silver nanoparticles (AgNPs) stand out to be the distinctive colorimetric sensor for the discerning detection of Hg^{2+} in aqueous media. In the present study, the stabilized spherical silver nanoparticles have been biosynthesized in a green and cost-effective manner from the aqueous extract of Fucus gardeneri which is one of the polar seaweeds. The biosynthesized AgNPs were clearly characterized using UV-Visible spectroscopy, Fourier transform infrared spectroscopy (FTIR), Selected area electron diffraction (SAED), Energy dispersive X-ray analysis (EDAX), High resolution Transmission electron microscopy (HR-TEM), and X- ray diffraction (XRD) and techniques. It has been observed that the green synthesized silver nanoparticles were yellowish-brown in colour due to the surface plasmon resonance. In the presence of Hg^{2+} ions, the brown silver nanoparticle solution turned to colourless, accompanying the disappearance of absorption maximum at 410 nm. The selectivity and sensitivity of biogenic AgNPs towards Hg^{2+} ions were also studied and the limit of detection was found to be 1µM.Besides the sensing studies, the antimicrobial activity has also been tested for the silver particles which would aid in validating the extent of the silver nanoparticles in environmental applications.

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Enhancing Climate Resilience of India's Coastal Communities

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The Indian coastline extends along both its western and eastern sides, crafting a spellbinding narrative of nature's grandeur, cultural splendor, and timeless history. Two hundred and fifty million people who live within 50 kilometers of the coast call this their home. Since ages these landscapes, marked by coastal fields, river deltas, and vast oceans, have served as the essential foundation for agriculture, fishing, and various forms of livelihoods, providing millions of people with food, income, and prosperity. Now, the vibrant life in these coastal areas, such as the State of Odisha, is at risk as they face the impacts of global warming and climate change. According to a latest report of the Intergovernmental Panel on Climate Change, coastal areas will continue to experience sea level rise throughout the 21st century. Extreme climatic events, which previously occurred once every 100 years, could now take place almost every year by the end of this century. Through a systematic thought process and multi-stakeholder approach, Government representatives, Climate and Biodiversity Advisors, Environmentalists, Community Mobilizers, Sectoral Experts in coastal ecosystems, Scientists in the field of marine, brackish, and freshwater aquaculture, and above all,

coastal communities, have joined hands in the pursuit of preserving ecosystems and local well-being. The forefront of this effort is the "Enhancing Climate Resilience of India's Coastal Communities" (ECRICC). a project funded by the Green Climate Fund (GCF) and led by the Ministry of Environment, Forest, and Climate Change, Government of India, in partnership with the State Government of Odisha and the United Nations Development Programme. This initiative is expected to act as proof of concept for the National Action Plan on Climate Change- 2008, the Odisha State Action Plan on Climate Change, India's NDCs and the G20 Chennai High Level Principles for a Sustainable and Resilient Blue Economy- 2023.

<div align="center">WOSC/2024/ABS/382</div>

GEOINFORMATICS BASED COASTAL AND MARINE ENVIRONMENTAL CHANGES AROUND NORTH MALE ATOLL MALDIVES.

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Climate change refers to a long-term shift in global weather patterns, caused by an increase in atmospheric carbon dioxide levels. The carbon dioxide will be Trap the heat from the atmosphere which is cause the glacier and polar ice will be melt rapidly. Due to the melting of glacier will cause the sea level rise. The Maldives most popular island country for tourism and world's lowest lying area. The average elevation of Maldives is 1m, the height of the island is about only 2.4m above MSL. Since the 1950s, sea level in and around the Maldives has been rising at a rate of 0.03–0.06 inches (0.8–1.6 millimeters) per year. Because of the Maldivian topography, small changes in sea level translate into extensive land inundation. The Maldives island have highly affected by the flood due to the sea level rise. The sea level rise will cause the shoreline erosion, coral degradation. From Landsat, Sentinel 2A data the shore line and SAM (spectral angular mapper) will used for coral identification and mapping. By using these software ArcGIS, Envi, DSAS to asses impact of climate change on both coastal and marine environment. The shore line changes both erosional and accretional will be happed. Erosional will caused by the sea level rise and coastal flooding, the accretion will be caused due to the Maldives Government will create a lot of artificial Island for habitation and urbanization purpose. The Maldives is volcanic basement which is present in the Chain of Sunken mountains ridge which is formed the result of massive eruption over Western India in the Late Cretaceous period. The coral present in the top of underwater volcanoes, the coral atoll will be product the lagoons and island act as a barrier for the island. From geomorphology 1997& 2023 map the land adaptation due to sea level will be analyzed, people are created the artificial island on the coral island so the coral island will be reduced. The sea level rise will gradually increase in worldwide but the Maldives will highly vulnerable to the rise of sea level because the low lying area, the IPCC will report the future sea level rise, in the end of decades the entire island will be submerged or uninhabited. Due to sea level rise the shore line will be eroded and the coastal flooding will highly be occurred due to the flooding the coral cover will be bleached due to high turbidity concentration. The sea level rise will cause the saline water intrusion on the fresh water bodies. So that the Maldives Island will be uninhabited in the end of decades. The sea level rise from 1997 to 2023 the rise rate is 0.01m will be increased annually. The future rise of sea level and inundation will be predicted by using NASA sea level projection tool.

<div align="center">WOSC/2024/ABS/429</div>

Insight into the perplexing metagenetic life cycle and distribution of upside-down jellyfish Cassiopea from Indian waters

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The scyphozoan upside-down jellyfish Cassiopea is an ecologically essential species in marine and coastal ecosystems with distribution worldwide. Estimating the Cassiopea metagenetic life-history straits and reproductive potential is a cue for determining the distribution abundances and fluctuations of natural populations. Samples taken from different parts of India and further macro-morphological and molecular studies show that two species are present: Cassiopea andromeda and C. xamachana. However, earlier reports do not show that C. xamachana is found in Indian waters, wherein both species exhibit different colour morphs, i.e., red, brown, white, green, blue, and purple, in the wild and captive-reared C. xamachana. The present study also attempts to hint at the key oceanological parameters affecting the reproductive pattern of Cassiopea under indoor laboratory and outdoor natural conditions. The adults of the genus Cassiopea medusa are raised in the Cnidarian Laboratory of ICAR-CMFRI in Thoothukudi under controlled conditions. C. xamachana can reproduce both asexually and sexually; however, C. andromeda fails to respond; in adult animals, it exhibits complete bleaching of zooxanthellae, resulting in bluish-white to whitish-coloured shrunk animals. The study documented the sexual and asexual reproduction of C. xamachana and the meta- genetic life cycle stages, such as planula larva, benthic polyp, juvenile ephyra, and adult medusa, under different environmental regimes. This study provided insight into the critical parameters for the reproductive pattern of Cassiopea, which is essential to understanding its swarming behaviour in the wild. The results of adaptive ability in various environmental conditions for the Cassiopea meta- genetic life cycle are detailed in this paper.

WOSC/2024/ABS/75

GAN-Augmented YOLO Framework: Scaling Coral Reef Health Monitoring with Synthetic Data

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This paper explores the utilization of machine learning methodologies to monitor and safeguard the health of coral reef ecosystems. The methodology involves the application of the latest YOLO (You Only Look Once) algorithm, which offers high precision in detecting the status of coral reefs, distinguishing between bleached and healthy colonies, and identifying prevalent diseases. The primary objective is to proactively address potential coral bleaching by identifying affected colonies and implementing timely measures to mitigate the impact. One of the pivotal challenges in coral reef health assessment is the high cost and logistical complexities associated with acquiring

comprehensive datasets. To address this, the paper integrates the latest Generative Adversarial Network (GAN) architecture. This innovation enables the augmentation of the training dataset for the YOLO algorithm. By generating synthetic coral reef images, it alleviates the cost-intensive nature of physically capturing images from deep-sea locations, significantly expanding the diversity and volume of the training dataset. Consequently, this approach enhances the accuracy and robustness of the YOLO model in detecting various coral reef conditions. This early detection empowers conservationists and policymakers to take timely and targeted actions, such as relocating bleached colonies or implementing specific interventions to prevent widespread bleaching. The outcomes of this study promise to revolutionize coral reef conservation efforts by providing a cost-effective and efficient means of monitoring reef health on a large scale. The fusion of YOLO algorithm and GAN architecture presents a scalable solution that can be instrumental in preserving these invaluable marine ecosystems. This paper serves as a pioneering step towards establishing an effective framework for continuous surveillance and management of coral reef health, fostering sustainability and resilience in marine environments.

WOSC/2024/ABS/79

Biodegradation of Pyrene by Piezotolerant Hydrocarbonoclastic Deep-sea Brucella anthropi IOW5

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Pyrene a polycyclic aromatic hydrocarbon (PAH), which is a ubiquitous environmental pollutant, poses a significant threat due to its persistence and toxicity. Understanding the microbial degradation of Pyrene in deep-sea environments is crucial for environmental remediation and ecological preservation. This study investigates the biodegradation of pyrene, by piezotolerant hydrocarbonoclastic deep-sea bacterium. About 10 strains were isolated from deep-sea water of the Indian Ocean using enrichment techniques that were designed to specifically target bacteria with pyrene degrading capabilities. Out of these 10 strains Brucella anthropi IOW5 a hydrocarbonoclastic bacterium was found to degrade pyrene maximum at a concentration of 250 mg/L. The strain was observed to utilize several classes of polyaromatic hydrocarbons (PAHs) as a sole carbon source. The strain showed luxurious growth on various hydrocarbon substrates such as anthracene, light crude oil, toluene, tween 80, petrol, bilge oil and kerosene. The growth and degradation of the strain IOW5 was tested in the presence of different concentration of NaCl ranging from 1to 8% (w/v) and different pH ranging from 4.0 to 10. In which the optimum growth and higher rate of degradation was found at 2% NaCL and at a pH 7.0. The effect of immobilization was carried out with different carrier materials like wheat bran, rice bran and algae, in which the maximum growth and degradation of pyrene about 84%, was observed for algal immobilized biomass. Harnessing the biodegradative potential of Piezotolerant Hydrocarbonoclastic Brucella anthropi could offer sustainable management of hydrocarbon pollutants in deep-sea environment.

WOSC/2024/ABS/83

Carbon dioxide sequestration by marine microbial carbonic anhydrase and its application in biomineralization

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Global CO2 emissions are estimated to be about 48 gigatons per year. It has been proposed to reduce the emissions by less than 5 gigatons per year by 2050 so as to limit the global temperature rise to 2 °C by 2100. Marine microbial carbonic anhydrases (CAs) are promising targets which can facilitate rapid enzymatic conversion of CO2 to stable compounds. The present study is aimed to screen bacterial CAs from seamount sediments samples and characterize them for their application in biomineralization process. A total of 65 strains were screened for esterase activity using p-nitrophenyl acetate as substrate and five were found to be CA positive strains. The isolate NIOT28 was identified as Bacillus sp and selected for further study based on its CA activity of 500 U/mg protein. Carbonic anhydrase protein was purified and the activity was confirmed by zymogram analysis using saturated carbondioxide. The molecular weight of CA was found to be 22kDa. Further, the potential of CO2 mineralization was tested using saturated carbon dioxide, 100 ug of purified β-CA and 25mM of calcium chloride and 50 mM of Glycine-NaOH buffer. After 12 hrs, the sample was filtered and weighed. Calcium carbonate of about 32 mg was produced in the mineralization process. Formation of CaCo3 crystals were confirmed by SEM and XRD analysis. The characterized enzyme would be of potential source in CO2 sequestration.

WOSC/2024/ABS/91

Investigation of vocalization of bottlenose dolphin pod and a single dolphin in the northern Indian Ocean

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Acoustic monitoring, a powerful non-invasive research tool, is increasingly used to assess the presence of marine mammals and study their activity. Here, in this study, we provide an initial analysis of the vocalization of the pod of bottlenose dolphins and a single dolphin in the free-range marine environment in the northern Indian Ocean. Data with overlapping of bottlenose dolphin whistles and the single bottlenose dolphin whistles considered for comparison are collected as part of a long-term study, in which acoustic recording and behavioural observations are made year-round for free-ranging bottlenose dolphins. Data is sampled at a rate of 25 kHz. The data with vocalization signal are high-pass filtered to remove the background anthropogenic noise such as the boat propeller, engine, etc. All the analysis is carried out using Matlab software. The results inspected by the trained and experienced passive acoustic monitoring (PAM) operator highlighted the multiple concurrent whistles from several dolphins and a single dolphin in the spectrogram of respective

data. Although future studies are required, our results suggest that a significant emission of signature whistles characterizes the difference in vocal behaviour for the group and single dolphin. The observation from the data reveals that overlapping whistles represent more frequent vocalization, which may be linked to cooperative foraging strategies that attract more dolphins and protect them against predators like sharks and other predators. Thus, the vocal behaviour of dolphins could help develop an acoustic monitoring practice capable of identifying their activities like group cohesion, aggression, foraging, etc, from audio recordings.

WOSC/2024/ABS/147

Wave energy of the southwest monsoon and "Biparjoy" cyclone on the displacement and deposition of chitinous tubes of Spiochaetopterus worms along the west coast of India

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Present study investigates the impacts of wave energy generated by the southwest monsoon (2022) and the combination of the SWM and the cyclonic storm "Biparjoy" (2023) on the displacement and deposition of chitinous tubes of the polychaete Spiochaetopterus sp. This tube-building worm lives in the inter- and subtidal flats of the coasts by secreting chitin-like substance and constructing the translucent tubes (cellophane). Field observations and sampling were conducted fortnightly along the central west coast of India (Goa beaches) from mid-May to July 2022 and mid-May to late-June 2023. One-time observation was conducted along the beach stretches of Kochi (Vypin and Njarackal) and Mumbai (Versova) during both years in mid-June. The sea was calm during both sampling years in May (significant wave height 1.2 ± 0.2 m). However, there was a noticeable increase in significant wave height in the first half of June in 2022 (1.7 ± 0.3 m) and extremely high waves along the shores of the west coast of India during the cyclone (Biparjoy) pass in 2023 (3.2 ± 0.1 m). During the SWM of 2022, we found the deposition of chitinous tubes only along the central west coast of India (<0.49 kg/m²). However, a significant amount of tubes was deposited in 2023 (>2.6 kg/m²), particularly following the cyclone. Post-cyclone observations along Kochi beaches showed abundant tubes, however, such tubes were not observed along Mumbai shores. Noticeably, during both years there were no such tubes observed during pre-SWM along central west coast of India. We have analyzed the wave parameters to understand the depth and distance of sediment churn up, which resulted in the release of even longer tubes (~15 cm). This correspondence offers a fundamental comprehension of the effects of powerful waves on the displacement of subtidal tube worm Spiochaetopterus sp., along the west coast of India.

WOSC/2024/ABS/154

Short-term coloration of Caranzalem beach (central west coast of India) due to diatom bloom and organic litter during the southwest monsoon

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Through in-situ observations and physico-chemical and biological measurements from Caranzalem beach of Goa located in the central west coast of India (eastern Arabian Sea), we present

the reasons behind the short-term peculiar coloration of the beach stretch, for the first time. We have conducted field observations and sampling during the southwest monsoon 2023 (SWM) along the Caranzalem- Miramar beach stretch (~2.5 km distance) of Goa. The above beach borders the eastern side of Mandovi estuary. It has a wider inter-tidal region (~150 m) due to mildest slope which exposes a large area during low tides (~0.34 km²). Though we have frequently (alternate days/weekly) observed the beach, here we present peculiarly colored beach condition only. The inter-tidal area of the beach was usual in color with slightly blackish and turbid water during the early stage of the SWM (Mid-July). Noticeably, the beach color was changed as bright gold during the late SWM (4th week of August) and also the water found to be amber/golden in color. Remarkably, the southern section of the beach (~1 km) and the water over was blackish in color. The microscopic observations of surface sediment and water samples evidenced that the cause of golden color of water and inter-tidal zone beach was due to the dense occurrence of a diatom Navicula spp. (abundance=$35.41\times10\text{-}6$ cells/L), which formed the bloom in water and mat-like layer on the beach surface-sediment. Similarly, the black coloration was formed due the deposition of litter-derived organic particles, could be the semi- degraded mangrove and other vegetative materials brought into the estuary due to the SWM rainfall and river runoff. We presented the suitable hydrographical conditions to the formation of diatom blooms in the estuarine region.

WOSC/2024/ABS/196

Dolphins of Two Seas: Unravelling the Genetic Uniqueness of Indian Ocean Humpback Dolphins

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The Indian Ocean Humpback dolphin, declared endangered by the IUCN, faces dwindling numbers despite being recognized as a separate species (Sousa plumbea) only in 2014. This understudied dolphin thrives in coastal waters from South Africa to southern India. A first-ever analysis of the complete mitochondrial genome (16, 387 bp) and control region (~400 bp) from 15 stranded individuals in the Arabian Sea and Bay of Bengal reveals intriguing insights. Compared to its closest

relative, the Indo-Pacific Humpback dolphin (Sousa chinensis), S. plumbea/"/gs mtDNA is 98.4% identical. Yet, Bayesian analysis confirms their distinct positioning within the Delphininae subfamily, alongside the Sousa genus. Further comparison with published Sousa sp. sequences unveils genetic differences between the Arabian Sea and Bay of Bengal populations and their neighbors. Strikingly, S. plumbea populations from Southern Arabian Sea & Bay of Bengal, South Africa, and Bangladesh population form three separate lineages, mirroring similar patterns in Australia (S. sahulensis) and China (S. chinensis). This genetic uniqueness hints at local ecosystem adaptations and holds crucial implications for conservation efforts. The researchers suspect more distinct populations or even species complexes within the Indian Ocean, emphasizing the need for wider geographical studies and continuous eDNA monitoring.

<div align="center">**WOSC/2024/ABS/198**</div>

Arctic Ecosystems in a Changing Climate: Biodiversity Consequences and the Blue Economy's Role

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The Arctic region is undergoing accelerated warming, surpassing global warming rates. This escalation is inducing profound changes in both terrestrial and marine Arctic ecosystems, notably impacting bird and mammal species. Terrestrial disturbances, like increased winter temperatures and "rain-on-snow" occurrences, are detrimental to local flora and fauna. Such changes result in ice formations that hinder herbivores' food access and alter predator-prey dynamics. Conversely, marine environments witness temperature hikes and diminishing sea ice, destabilizing the food chain and influencing marine birds' and mammals' behaviors. While some species in the Arctic thrive amid these changes, many endemic species suffer. The intricate interplay between marine and terrestrial ecosystems underscores the urgency for sustained monitoring to grasp their trophic dynamics and prioritize conservation strategies. Furthermore, global obligations demand safeguarding Arctic biodiversity, underscoring its intrinsic value and global significance. Integrating these insights, the Blue Economy advocates for a holistic economic approach, emphasizing long-term environmental valuation over transient market-driven objectives. Historically, the Arctic has faced intensified environmental pressures, now amplified by its economic allure. As the region opens up for commercial ventures, it's pivotal to strike a balance between economic potential and ecological preservation, especially with a surge in proposed infrastructure projects. The world would be immeasurably diminished without this unique biodiversity and its invaluable contributions. Protecting polar biodiversity underscores our dedication to acknowledging and preserving the irreplaceable value of global biodiversity.

<div align="center">**WOSC/2024/ABS/291**</div>

Charting the Future of Chilika's Seagrass: Insights, Challenges, and Conservation Solutions

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Despite the diverse geographical distribution of seagrass in the country, a substantial 74% of scientific publications originate from Palk Bay and the Gulf of Mannar in Tamil Nadu. Chilika, recognized as the largest lagoon in Asia, houses the second-largest seagrass meadow in India, constituting 22% of the total. This lagoon serves as a potential repository of blue carbon and plays a crucial role in supporting diverse floral and faunal biodiversity. Chilika's seagrass patches, spanning 155 sq. km, host a total of seven recorded species. However, the precise significance of seagrass in this distinctive lagoon ecosystem remains inadequately understood. Despite the absence of reported declines, it is crucial to acknowledge the possibility of stressors impacting Chilika's seagrass beds.

Additionally, the lax enforcement of existing legislation and a general lack of awareness among stakeholders regarding the ecosystem services provided by seagrass pose significant obstacles to their conservation. Urgent and targeted research on Chilika's seagrass, particularly in the context of changing climate regimes, is essential in the current scenario.

Impact of Ocean acidification by different drivers on phytoplankton in BoB

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Atmospheric CO_2 is increasing at the rate of 1.5 to 2 ppm annually due to increase in anthropogenic activities. The dissolution of CO_2 in the surface ocean decrease pH at the rate of 0.0015 to 0.0022 per year. In addition to CO_2, increase in pollutant levels in the atmosphere and its deposition over ocean further acidify the ocean. A decade long time-series observations in the coastal Bay of Bengal (BoB) revealed that occurrence of rapid acidification, by 2 to 4 times, was observed compared to elsewhere in the global ocean in the similar latitudinal belt. Such high acidification rate is attributed to increase in atmospheric pollutants such as sulphates, nitrates and organic acids. The impact of ocean acidification on phytoplankton composition and biomass is evaluated based on CO_2 dissolution micro or mesocosm experiments. Since acidification in the BoB is driven not only by CO_2, such experiments may not yield accurate results as dissolution of CO_2 does not change carbonate alkalinity whereas sulphates and nitrates modify both pH and alkalinity. In order to examine the impact of ocean acidification on phytoplankton in the coastal waters, microcosm experiments were conducted by manipulating the pH using CO_2, H_2SO_4, HNO_3 and HCl and its response was monitored for 5 days. Significant differences in response of phytoplankton biomass, composition and uptake rates were observed due to manipulation of pH by different acids. Significant increase in concentration of particulate organic carbon and nitrogen associated with depletion in d13C and d15N and enrichment in d13C of dissolved inorganic carbon (DIC) was observed in all treatments with C/N ratio close to 6.6 suggesting that increase in plankton biomass due to acidification. A significant decrease in nitrate and ammonium uptake rates were observed associating with decrease in primary production and increase in heterotrophy was observed in all treatments, except in HNO_3 and H_2SO_4 treated samples. Increase in perdinin, Chlorophyll-b, Fucoxanthin and Chlorophyll-a was observed in HNO_3 and HCl added samples whereas it was decreased in other treatments. Though microzooplankton abundance was increased in all treatments, it was higher in the HNO_3 and HCl added samples. These experiments suggested that the response of phytoplankton biomass to ocean acidification is different in the BoB from that of traditional experiments conducted using CO_2 alone. Since the time-series observations suggested that about 50% of the acidification is driven by CO_2 and other by atmospheric deposition, the pH manipulation must be conducted using both CO_2 and acids (HNO_3 and H_2SO_4) in future in order to obtain accurate response due to ocean acidification in the Bay of Bengal.

Biomonitoring in the Arctic Fjords employing FHHB algorithm

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The ill effects of climate change have caused a poleward shift in the distribution of species due to the rapidly rising water temperatures. Studies report that the region is invaded intensively by new species and many native species are moving towards extinction. Marine ectotherms that thrive in latitudinal ranges based on their thermal tolerance, are reported to diminish at the equatorward boundaries and swell at the polar boundaries owing to global warming. This calls for an immediate need to assess and document the extent of climate change-driven animal migrations occurring in the Arctic waters. However, the extreme climatic conditions and the remoteness of the region makes biomonitoring tedious in the Arctic ecosystem. The present study puts forward a deep learning-based analysis of a large underwater video dataset that was captured from the Arctic region. The dataset was acquired using underwater cameras mounted on custom-made stainless-steel frames; collected over a period of 26 days from the Kongsfjorden- Krossfjorden twin Arctic fjords in Svalbard, Norway, as part of the Summer Indian Arctic Expedition 2023. The collected data sets are used to train Fire Hawk Honey Badger (FHHB) based Deep Maxout Network (DMN) for automated detection of the organisms. The FHHB model employed for the study integrates a Deep Convolutional Neural Network (CNN) for species detection, trained using the FHHBA and subsequently employed DMN and was found to be very efficient in classifying the underwater images captured from the region. The algorithm optimally fine-tunes the classifier, contributing to the effectiveness and robustness of the system. The model attained a superior value of mAP, precision. The ultimate aim of the present study is to introduce an innovative framework for species type classification, emphasizing the integration of the FHHB Algorithm and DMN that holds potential for advancing the field of underwater object recognition, specifically in automating species detection and classification in diverse and challenging underwater environments.

<div align="center">WOSC/2024/ABS/53</div>

Diatoms & their associated meiofauna from off-shore sediments of Port Blair

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Benthic diatoms are microscopic organisms belonging to the class Bacillariophyceae and have been reported to be abundant in marine, brackish and fresh water environments. They play an important role in the organic carbon fixation and ecosystem productivity. Only limited number of studies have been conducted from the off-shore sediment samples of Andaman Islands. We collected sub-littoral sediment samples at a depth of 15-20 metres from 3 different locations for 6 months from the South Andaman Sea. A Van-Veen grab of 25 cm2 was used to collect the samples in situ and sub-samples (56 no's) were taken by a PVC corer of 8 cm diameter. A total of 41 species of benthic diatoms belonging to 28 genera were identified. Along with them, 10 other meiofaunal groups were identified up to the possible smallest taxonomic level. Triceratium favus and Coscinodiscus radiatus were the most abundant diatom species and Psammodictyon sp. was the least abundant. Foraminifera, nematode, copepod, pteropod, polychaete, kinorhyncha, ostracod, halacarid mite, gastrotricha and Sipuncula were the other meiofaunal groups reported in the study. The diatom diversity was found to be the least in the Carbyn's Cove station with finely textured clayey sediment and lower dissolved oxygen values (DO) which partially prevents diatom growth and colonization. In the other 2 stations diatoms were more abundant and diverse. The amount of silt and sand were higher than clay in their sediments along with preferential temperature, D.O, pH, OC and salinity values. Univariate and multivariate analysis was conducted using primer-e software and the PCA (Principal component analysis) also showed sediment composition and dissolved oxygen as the main factors that influence

the faunal distribution.

WOSC/2024/ABS/80

IMPACT OF CLIMATE CHANGE ON MARINE BIODIVERSITY AND OCEAN ECOSYSTEM IN INDAIN OCEAN REGION: CHALLENGES AND FUTURE PERSPECTIVES

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Climate change is adversely affecting our planet. This research focusing on how eustatic sea level change, ocean acidification, rise in sub-surface level ocean temperature is impacting the marine biodiversity and ocean ecosystem in areas around Indian Ocean Region. In this study, while analyzing past trends of instrumental period based on United Nation Environmental Programme (UNEP) data we find that the rare occurring events of Indian Ocean Region such as positive and negative Indian Ocean Dipole are now occurring in an unsteady way since last 50 years. This could be due to rise in ocean sub-surface level temperature and increasing low pressure areas. In addition with this, affect of anthropogenic activity on the marine biodiversity in the upcoming years and its trends analysis is depicted in this research work. According to Intergovernmental Panel On Climate Change (IPCC) report titled 'Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities' oceans has taken up between 20-30% of total anthropogenic Carbon Dioxide emissions since the 1980s which leads to further ocean acidification. Among others, factors such as eutrophication and harsh anaerobic conditions are leading to increasing coral mortality and bleaching. These entire phenomenons posing existential threat to flagship flora and fauna of Indian Ocean such as dugong seals, eelgrass, phytoplanktons. Lastly, preventive measures in keeping the Indian Ocean Region ecosystem intact from the negative affect of climate change and anthropogenic activities are presented with result as shown by them and more ways toward sustainable utilization of Indian Ocean Region and marine biodiversity are discussed.

WOSC/2024/ABS/98

Decadal variations in phytoplankton compositions in Southern Ocean and Global Ocean influenced by biogeochemical variables

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The global environmental variations owing to natural and anthropogenic influences are challenging the structure and functioning of the ocean ecosystem. The complex processes interacting within the physical, chemical, and biological environment at different spatio-temporal scales and their impact on the ocean ecosystem processes are yet to be investigated. A long term trend on phytoplankton biomass in terms of Chlorophyll-a concentration (Chla), phytoplankton compositions and the processes that control the variability is required for understanding the ocean ecosystem. This study investigated decadal trends (2002–2015) of phytoplankton composition and biogeochemical parameters over the Global Ocean (GO), Southern Ocean (SO), and the Arctic Ocean (AO) using ocean color remote sensing and assimilated data from the National Aeronautics and Space Administration (NASA) Ocean biogeochemical model. The results revealed the dominance of larger cell phytoplankton mainly diatoms throughout the SO and AO; however, the coccolithophores dominate in the remaining part of the GO. Analysis of nutrients showed that nitrate is not a limiting

factor for the variability of phytoplankton biomass in the SO and AO. The low nitrate concentration influenced in the rest of the GO. The photosynthetically available radiation (PAR) limiting the phytoplankton biomass and composition in the SO and AO. Although the SO is known as the high nutrient low chlorophyll (HNLC) region of the GO, the low iron concentration along with the PAR co-limits the growth of phytoplankton biomass. Trend analysis showed that an increase in Chl-a and diatoms in the SO and AO. In contrast, it declined significantly in the other regions of the GO, in response to the consistent increase in sea surface temperature. The results indicated that, shifting of phytoplankton community from regional to global scale have a greater implication for climate change and marine ecosystem.

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Features of subsurface chlorophyll maxima and their regulators in the Arabian Sea

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It is important to characterize the vertical distribution of chlorophyll a in the oceanic water column to ensure the precise estimation of depth-integrated ocean primary production. Arabian Sea (AS) is one of the most productive regions of the world ocean. Reversal of winds during the summer monsoon**.**

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Enhancing the growth conditions of the marine bacterium, Bacillus cereus, a valuable source of the biopolymer, poly- hydroxy butyrate/co-valerate at fermenter level

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Increasingly environment friendly sources of durable materials become very much important in day today life in the context of shrinking oil reserves for which sustainable alternatives to petroleum-derived products, such as bio-polymers, can be derived from renewable materials such as microorganisms found in unique diversity in the marine environment. They are adapted to diverse conditions of nutrient availability which enable them to produce a wide variety of polyhydroxy alkenoates, including polyhydroxy butyrate co-valerate (PHBV), under diverse conditions of nutrient availability. Bacillus cereus, a marine bacterium capable of producing PHA from the industrial waste, glycerol as substrate, was isolated at the National Center for Aquatic Animal Health, Cochin University of Science and Technology. The commercial production of PHBV from B.cereus requires understanding of the growth kinetics, culture conditions, and production kinetics of the organism under consideration. We investigated the growth kinetics of B.cereus in 5L fermenter and traced its growth kinetic parameters as well as different phases of growth. As the organism is a spore

producer, spore formation has also studied in lab- scale fermenters and investigated the impact of mixing parameters, specifically agitation and aeration, in order to optimize and scale up the production of biomass and biopolymer in pilot and industrial fermenters. Keywords: Poly hydroxy alkanoates (PHAs), Poly hydroxybutyrate co valerate (PHBV), Bacillus cereus, agitation, aeration

Silicone-chitosan mediated cross-linked composites: A biomimetic approach for antibiofilm applications.

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Biofilm-associated challenges lead to a major substantial threat in diverse fields, incorporating the necessity for the development of advanced biomaterials with robust antibiofilm properties. This study investigates the synergistic antibiofilm activity of surfaces with different polymeric compositions in comparison with the negative polymeric replicas that are attained through soft

lithography. PDMS serves as the base material, as it is known for its biocompatibility and flexibility. It is further combined with chitosan and PEG as it is attributed to antibacterial and antibiofilm capabilities. The composite materials were systematically characterized to confirm the successful integration of PEG and chitosan within the PDMS matrix, followed by the evaluation of antibiofilm efficacy against the common biofilm-forming bacteria using the established biofilm assays. The combined action of PEG and chitosan demonstrated a multifaceted approach, disrupting early biofilm formation and effectively inhibiting bacterial adhesion, concurrently eradicating the mature biofilms. It also revealed a sustained and controlled release profile, ensuring prolonged efficacy over time. This comprehensive study exhibited the antibiofilm performance of the integrated components towards the developed polymeric composition. This development holds significant promise for applications in marine, medical devices, industrial equipment and other relevant domains where biofilm-related challenges persist. The insights gained from this research pave the way for the design and optimization of biomaterials with enhanced antibiofilm properties, addressing a critical need in the ongoing battle against biofilm-associated infections. Keywords: Biofilm, Polymeric compositions, Antibiofilm, Biocompatibility, Lithography.

WOSC/2024/ABS/167

Impact of deep sea environment on methane related activities in the sediment

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The deep-sea is characterized mainly by physical variables like hydrostatic pressure, temperature, salinity and oxygen. In the deep sea environment, the diverse micro-faunal activity is influenced by in situ conditions. In an attempt to characterize the microbial environment with reference to methane activity and to elucidate the influence of in situ conditions on the related bacterial groups in the deep sea sediment, samples from 3 distinct stations in the Central Indian Ocean Basin were investigated. The rates of methane activities and the influence of pressure on the methane activities were studied. The rate of methanogenesis ranged between ND (not detectable) to 5.795 nmol g-1d-1. The zone of maximum methane production of 5.79 nmol g-1d-1 was seen at the nodule rich station BC-9 at a depth of 0-2 cm. The predominantly oxic sediments of the CIOB surprisingly produced, 9x higher values of anaerobic methane oxidation ranging from ND to 14693.51 nmol g-1 d-1 as compared to aerobic methane oxidation which ranged from ND to 2427.55 nmol g-1 d-1. Under pressurized conditions of 473.7 atm there was a 2x reduction in methane production while, aerobic and anaerobic oxidation increased by 7x and 3x respectively. These results suggest that pressure acts synergistically with low temperature to reduce the methane production and enhance the oxidation of methane activity.

WOSC/2024/ABS/202

Impact of Ocean acidification on microzooplankton communities - An experimental study from the coastal waters of Bay of Bengal, India.

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The impact of Ocean acidification (OA) on microzooplankton (MZP) communities from the coastal waters of the Bay of Bengal (Off Vishakhapatnam) was studied by pH manipulation microcosm experiment through an acid addition (October 2022). The nutrient (nitrate, phosphate, and silicate) concentrations were increased from the initial/ first day to the fourth day, and a declined in concentration was recorded on the last day of the experiment. In contrast, the phytoplankton biomass decreased from the initial to the fourth day, and increased on the last day of the investigation. The total abundance of phytoplankton and micro zooplankton (MZP) communities varied from 36, 594 to 277, 408 Cells. L -1 and 60 to 364 Cells. L -1, respectively, and a significant difference in phytoplankton and MZP abundance were found between the initial and final day of the entire experimental samples (Control and acidified). The initial seawater sample was dominated with diatom Dactyliosolen fragilissimus (Centric; 82%) species and shifted to Amphora sp (Pennate; 80-94%) at the end of the experiment (all acidified and control samples). The initial MZP community composition consisted of four different groups (LC: Loricate ciliates, ALC: Aloricate ciliates, HDS: Heterotrophic dinoflagellates and Copepod nauplii) and at the end of the experiment, it was shifted entirely to the dominance of heterotrophic dinoflagellates (67-100%) in all the samples (control and acidified). The MZP showed a significant inverse relation with phytoplankton biomass, phytoplankton abundance, and heterotrophic bacterial counts in all the samples (control and acidified). Moreover, statistical analysis revealed that the LC showed a weak correlation with Chl-a, and the HDS showed a significant correlation with phytoplankton biomass, abundance and bacterial counts (Autotrophic and heterotrophic). These results indicate that the impact of Ocean acidification on the MZP communities could vary with different species and groups due to their food availability (Indirect effect) and individual competence (Direct effect) to sustain in low pH conditions.

WOSC/2024/ABS/216

Delineating micro-phytoplankton morphometry as potential ecological indicators in the Indian Ocean: elucidation from sea surface and variable sub-surface chlorophyll maxima

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The present study uses a morphological trait-based approach to investigate the morphometric adaptations of the micro-phytoplankton community from the sea surface and SCML of the Indian Ocean (IO). Data from two oceanographic cruises covering 38 stations, i.e., AS (10 and 4 in

oligotrophic and OMZ), BoB (4), Equatorial (9) and STIO (up to 30oS; 11) were utilized. The simple elongated phytoplankton geometric shapes PGSs (e.g., Cylinder, Elliptic Prism, Prism on parallelogram) were common across the IO. The dominance was broadly similar in the sea surface and SCML and between the sea surface and SCML of deep (>100m); however, the shallow (20-50m) and intermediate (50-100m) SCML showed differences in the dominance. The surface-to-volume ratio (S:V) and greatest axial linear dimension (GALD) varied significantly among the bioregions (sea surface and SCML) and with varying SCML depths. The environmental conditions (quantity and quality of light and nutrients) influenced the Cylinder (Cyl) more than the Elliptic prism (ElliP) and Prism on parallelogram (PoP). Interestingly, the dominant PGSs were well adapted to conserve the S:V (i.e., GALD changed very minimally), and the degree of change was even less for the SCML than for the sea surface. For the sea surface, Cyl showed dominance in the northern than the southern IO, whereas ElliP showed an opposite trend. The complex PGSs (Ellipsoid, 2Cones, and Elliptic prism+4cones) primarily present in the oligotrophic regions of the IO showed a sporadic distribution. Among the SCML, the intermediate SCML harbored more PGSs and taxa than shallow and deep, with the percentage contribution of simple PGSs gradually decreasing and the complex PGSs gradually increasing with the increasing SCML depth. Thus, the present study confirms that environmental variabilities are robustly reflected in the morphological attributes of simple PGSs; therefore, S:V and GALD can be used as ecological proxy in the oligotrophic pelagic system.

An account on microplastic ingestion by zooplankton community in the coral reef lagoons of Lakshadweep archipelago

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Spatial-scale observations were made in the four major coral reef lagoons (Agatti, Kavaratti, Bangaram and Perumalpar) and open waters of Lakshadweep Archipelago for studying microplastic (MP) ingestion by zooplankton community during January 2022. The mean concentration of ingested MPs was higher in non-crustacean taxa (av. 0.23 ± 0.23 piece/individual) than the crustacean taxa (av. 0.04 ± 0.02 piece/individual). Concerning the size of the ingested MPs, copepods retained a smaller size (av. 53 ± 44 μm) compared to the non-crustaceans, i.e. hydrozoans (av. 411 ± 287 μm), chaetognatha (av. 255 ± 413 μm) and siphonophores (av. 218 ± 339 μm). FTIR analysis revealed that these MPs were mostly of polyethylene, alkyd resin, and polypropylene in origin and presumed to be originated from the fishing gears as a result of the prevailing active fishing in the lagoons and also the disposal of land-based single-use plastic consumer items. The maximum encounter rate of MPs/zooplankton was observed in the Kavaratti lagoon (av. 0.2 ± 0.28 pieces/individual) and the minimum was in the Bangaram lagoon (av. 0.04 ± 0.04 piece/individual). Since the zooplankton community is recognised as a vital energy source for the whole higher trophic organisms in the coral lagoon ecosystems, the main risks due to the accumulation of MPs in zooplankton identified in the study are likely to affect not only the zooplankton community directly but also the organisms that rely on them for sustenance. Even though the Lakshadweep Archipelago is an oceanic coral reef island system comprised of several inhabited and habited islands with lagoons of rich biodiversity, the results of the present study revealed the drastic influence of plastic pollution. Since the coral reef lagoons of Lakshadweep

islands are identified as significant ecological hotspots because of the great diversity of coral reefs and associated fauna, these lagoons should be protected from the contamination of MPs.

WOSC/2024/ABS/249

Metagenomic Profiling of Virome Associated with the Estuarine Sediment

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Viruses are immensely diverse and abundant organisms in aquatic ecosystems. An understanding of their vast diversity and the significance of the roles played by them still lingers in the shade. Viral metagenomics paves the way for unravelling the details of the various aspects, with next-generation sequencing being the efficient and suitable method. The present study has looked into the metavirome composition of the sediments of the Cochin Estuarine backwaters. The viral particles were concentrated and purified from the sediment by centrifugation, filtration and flocculation. The flocculate was subjected to whole genome amplification using Illumina, thus generating the metavirome. NGS analysis revealed bacteriophage dominance, with the Aeromonas phage being the most abundant. Cyanophages and the Megaviridae family members were present in significant numbers. Tilapia lake virus was the major viral pathogen detected. Phages play an essential role in the biogeochemical cycle of the Cochin estuary as they can control the abundance of bacteria by lysis and exchange genetic material following a viral attack. The presence of Cyanophages and Megaviruses, which affect the phytoplankton, also indicate their roles in controlling the primary production. Hence, the results show that metagenomics is a valuable tool that helps explore and understand the viral community associated with the estuarine environment. Thus, the data generated in this present work can be of importance in accelerating further studies to fully understand the roles and significance of the viral organisms of the estuarine and other aquatic systems.

WOSC/2024/ABS/25

Ocean acidification influences on the health and nutritional value of tropi

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We know that seaweeds have immense ecological and economic value. Hence, it is important to understand how climate change stressors will affect them? Most studies on acidification, another outcome of increasing concentrations of atmospheric CO2, and seaweeds have analyzed only a few response variables, mainly photophysiology. Therefore, we examined in detail the response of some tropical fleshy seaweeds to acidification. We investigated response of two red seaweeds Gracilaria foliifera and G. debilis, to carbon dioxide-induced acidification of seawater (pH 7.7) in a controlled laboratory experiment over two weeks. As response variables, we measured growth, productivity, redox state, primary and secondary metabolites. In brief, the results showed that both species will have advantages under acidified condition as the growth rate and productivity increased. Acidification influences the nutritional values of algae as a general increase in the amino acids, and fatty acids were observed. Besides, we also found improved antimicrobial activities of acidified algal extracts against several bacterial and fungal food pathogens.

Marine Mammal Diversity in the Eastern Arabian Sea: Insights from FORV Sagar Sampada

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Diversity of marine mammals in the eastern Arabian Sea is not well documented due to the limitation in infrastructure availability with the different institutes. The Centre for Marine Living Resources & Ecology with its primary mandate of documenting the Marine Living Resource assessment has been conducting shipboard visual surveys to document cetaceans using long-range binoculars. Results of the opportunistic visual surveys carried between December 2017-October 2020 is given below. The surveys covered 10, 976 nautical miles of transects in the eastern Arabian Sea. Ten species of cetaceans were identified and 57 sightings were documented during these surveys, among which the most frequently sighted were Stenella longirostris, Stenella attenuata and Tursiops aduncus. Results demonstrated high cetacean diversity and abundance in the Indian part of the Arabian Sea, coinciding with areas of high biological productivity during summer and winter seasons. Stenella longirostris was most frequently sighted in the entire eastern Arabian Sea between 10°N and 22°N latitudes. Blue whales were observed in the deeper waters off Gujarat. Survey effort focused on the continental slope revealed that most mammal sightings were associated with depths between 500 to 1000m. Lack of information on the status of marine mammals, and the ever-increasing threats warrant periodic surveys for scientifically assessing these vital resources and further estimating the ecosystem services rendered by these keystone species.

Diversity and distribution of squat lobsters in the Indian Exclusive Economic Zone

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Abstract: Crustaceans of the anomuran superfamilies Chirostyloidea and Galatheoidea (except the family Porcellanidae). Published literature was restricted to surveys in a few coastal regions and those of the RIMSS Investigator, Valdivia, Galathea, the International Indian Ocean Expedition, the FORV Sagar Sampada and ORV Sagar Kanya. The present work summarizes data from literature (60 sampling sites) and observations from the FORVSS surveys (66 stations). The consolidated data revealed a total of 89 species, including 14 chirostyloids in five genera of three families, and 75 galatheoids in 19 genera of three families. Munidopsis Whiteaves, 1874 was the most speciose genus (32 species), followed by Galathea Fabricius, 1793 (10) and Uroptychus Henderson, 1888 (8). Among the biogeographical regions in the Indian Exclusive Economic Zone, the highest number of species (18) were recorded in the Andaman and Nicobar Ridge province, followed by the South West Indian Slope Province (9), and North West Indian Slope and Coromandel Slope provinces (6 each). The munidid squat lobster Gonionida andamanica was the most widely distributed species recorded from five bioregions each, followed by the munidopsid squat lobster Munidopsis scobina (four bioregions), and Munidopsis regia (three bioregions). Analysis of the bathymetric distribution of taxa recorded in the present study revealed that exclusively deep-water species (> 200 metres depth)

accounted for 54% of the total diversity, followed by shelf water species (< 200 metres depth; 37%); only 9% were recorded from shelf and deep waters. Out of the 378 specimens examined, 40 were observed to be infected with rhizocephalan barnacles (67.5%) and bopyrid isopods (32.5%). Despite their vast geographical extent, the Indian waters are scantily surveyed, thereby necessitating extensive systematic surveys to unravel the squat lobster diversity and prevalence of parasites across this region. Keywords: Galatheoidea, Chirostyloidea, Distribution, Parasite, India.

WOSC/2024/ABS/324

First quantitative assessment of acorn worm (Enteropneusta) from the deep (below 5500 m) Indian Ocean: An underwater image analysis approach along the potential PMN mining site

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Enteropnuests (Acorn worms) are an important component of the deep-sea benthic environment, as they play a major role in surficial bioturbation and nutrient cycling. Knowledge about their distribution, abundance, and behaviour in deep-sea environments is sparse around the world. Prior to this study, there is no quantitative information available about this organism from the Indian Ocean. In this study, we analysed seafloor imagery data taken from the central Indian Ocean basin (CIOB) by an autonomous underwater vehicle (AUV). 0.5 km2 area was surveyed, which was divided into 130 transect lines. Only 64 alternative transects were used to avoid the overlap between the adjacent lines. Fiji software was used to analyse the images to obtain the data for the number of trails, the area covered by trail, poop width, in-between poop width, length of the poop and size morphometrics of the enteropnuests, which includes the total body length, main body length, lip width, mean body width, proboscis length, and body area. 2, 969 trails were observed, among which 12 trails had enteropnuests present in them. The trails were classified on the basis of shape into five categories, i.e., spiral (S), switchback (SB), spiral switchback (SSB), meandering (M), and spiral meandering (SM) and on the basis of rotation into three categories, i.e., clockwise (CW) and counter- clockwise (CWW). The trails were also classified on the basis of mean, area and intensity density into four categories, i.e., New, Medium, Old, and Very old. Spiral trails were dominant, with 2, 683 observations, and there was no significant difference in the rotation category. The maximum trials were in the medium category, with 1, 020 observations. It is the first quantitative study of enteropneusts from the Indian Ocean, which will add to our knowledge of the ecosystem functioning in the deep sea, especially in the potential PMN region in the Indian Ocean. Keywords: PMN region;

Acorn Worm; Deep-sea; CIOB; Image analysis

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CORAL MICROBIOME: AN INDISPENSABLE FOREFRONT FOR THE REEF ECOSYSTEMS

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Coral microbiome and their associations have a pivotal role in stabilizing the homeostasis of the coral reef ecosystems. These microbiomes are considered to be highly significant for this ecosystem because of their wholesome participation in every bit of processes towards maintaining the health of the coral reefs. The microbiome of the coral covers a wide array of microbes including dinoflagellates, bacteria, viruses, and fungi in which, these in advantageous interaction with the hermatypic corals possibly provides the defensive elements of natural significance against the ecological stressors, thus maintaining the well being of the coral reefs. Either the increase or decrease in the number of microbes, or the specific changes in the structure of the microbiome serves as the bioindicators of the threats for the reef ecosystem. The initiation of bleaching of the corals can be well exhibited by the modifications occurring within the microbiome. They are additionally basic to the procurement and cycling of fundamental and essential nutrients like carbon, nitrogen, phosphorus, and sulfur. The coral microbiome was by and large accepted to display enormous variety and host particularity, though the emerging investigations have demonstrated so far that the microbiome have found to have unique physiology, morphology and ecological functions and can also typically differ based on the microhabitat inside the coral tissues, skeleton or the mucus present on the surface of the corals. The quality of the water has a huge impact on the microbiome as it can increase the probability of risk for the booming of diseases. Moreover, the analysis of the prokaryotes with respect to fecal pollution can reflect the state of water quality of the coral reef ecosystem. Therefore coral reefs being one of the most necessitous and prodigious ecosystem for maintaining the diversity as well as sustainability of the aquatic life and the stability of the reefs in turn would be maintained by the coral microbiome. Thus the deep investigations on the coral microbiome would aid in taking the conservatory steps for safeguarding the entire coral reef ecosystems.

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Interspecific Association and Epibiosis: First Report of Peritrich Ciliate Epibiont Rhabdostyle Species on Diopatra neapolitana in Indian Coastal Ecosystem

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Diopatra neapolitana Delle Chiaje, 1841, has been representative of the estuarine and coastal waters

of India. Raut et al. (2005) demonstrated that the Coringa mangrove ecosystem was a prominent habitat for the dominance of D. neapolitana (Annelida: Onuphidae) benthic assemblage. In the present study, as part of the ongoing Ecosystem Service Project, benthic polychaetes were collected from 27 locations in coastal waterways, coringa mangrove creeks, and Kakinda Bay during March - 2023. Our study findings suggest that ciliate epibionts affixed to surface of living substratum (i.e. onuphidae polychaetes), and these basibionts lodge and constitute a support for the epibionts, the existence of this association between two organisms is known as epibiosis. The examination of the present study using light microscopy and SEM analysis revealed that polychaete species were infested by the peritrich ciliate epibiont Rhabdostyle species. The Rhabdostyle species were mainly found at intersegmental furrows, close to parapodial bases, and on the dorsal surface of D. neapolitana. This is the first report of a peritrich ciliate epibiont Rhabdostyle species found on D. neapolitana. Understanding the distribution and diversity of ciliates in benthic-pelagic biota and how environmental variables affect interaction between epibionts and basibionts will require further research. Key words: Suctorian ciliate, basibionts, Polychaete, Kakinada mangroves, Protozoa Reference: Raut, D., Ganesh, T., Murty, N.V.S.S. and Raman, A.V., 2005. Macrobenthos of Kakinada Bay in the Godavari delta, East coast of India: comparing decadal changes. Estuarine, Coastal and Shelf Science, 62(4), pp.609-620.

Diversity and nutritional profile of Scorpaeniformes from the Arabian Sea; From underrated exploitation to sustainable utilization

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Being the fourth largest order, Scorpaeniformes exhibit immense diverse in both morphology and habitat, making them one of the most difficult groups for taxonomists to classify due to taxonomic ambiguities and collection difficulties. They are regarded as one of the major groups caught during demersal trawling operations targeting deep-sea shrimps in the Arabian Sea. A total of 31 species belonging to nine familes viz. Apistidae, Dactylopteridae, Platycephalidae, Peristediidae, Scorpaenidae, Setarchidae, Synanceidae, Tetarogidae and Triglidae were collected from Sakthikulangara fishing harbour in Kerala, India from September 2021 to December 2022 as trawl bycatch at depths ranging from 200 to 420 m. Among them Dactyloptena tiltoni were new record to the northern Indian Ocean and 4 species viz. Dactyloptena papilio, Scalicus orientalis, Richardsonichthys leucogaster, Peristedion riversandersoni were new record to the Arabian Sea. Deep sea fishes are a valuable and relatively unexplored resource with potential applications in food and nutraceutical sectors. Despite the limited availability of detailed biochemical composition data for many deep fishes, they are currently being utilized for the preparation of feed, fertilizer and

various other purposes. We examined proximate composition of eight dominant deep sea scorpaeniform fish species, focusing on protein, fat, ash, and mineral content, to evaluate their suitability for food applications. The results revealed a promising protein profile, with an average content ranging from 10-16 % across the species analyzed. Additionally, the fish exhibited favorable mineral compositions, including significant levels of essential elements such as calcium, sodium, potassium, phosphorous and magnesium. These findings indicate that deep sea scorpaeniform fishes could serve as a valuable source of protein and essential minerals for food and nutraceutical applications. Limited knowledge on these resources is restricting the harnessing and utilization which have which have a high scope for food related industries. The findings may have implications for fisheries management, conservation efforts, and guiding strategies for sustainable exploitation and promoting the responsible utilization of deep-sea fish species.

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Bacterial Diversity of Arabian Sea Sediment: Implications for Functional Significance in Phosphate Solubilisation

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Arabian Sea is a highly productive ocean which hosts an active bacterial community that takes part in the phosphorous cycling of ocean sediments. In the present study, microbes from bottom M-ASM3B (900m) and top M-ASM3T (400m) of the Arabian Sea mounts were extensively screened to isolate and compare number of phosphate-solubilising bacteria (PSB) with total microbial diversity and phosphate concentration in the sediments. Soil extract media was used to screen for PSBs by tri-calcium phosphate solubilisation method wherein 15 bacteria showed positive results with visible dissolution halo zones. Diversity analysis showed that PSB obtained from the Arabian Sea sediments was found to be lower than the total microbial diversity. Interestingly, molecular identification of total microbial diversity revealed various genera Oceanobacillus, Pseudomonas, Chryseomicrobium, Halopseudomonas, Shouchella, Bacillus, Pscychrobacter, while the identified PSBs belonged to Bacillus, Pseudomonas, Enterobacter and Priestia, which are well-known phosphate solubilisers. Comparative analysis showed that the total phosphate concentrations slightly increased with depth, peaking at 900m (2.98µM) compared to 400m (2.26µM). Similarly, the number of PSBs was also found to be high in the bottom sediment indicating their phosphate solubilisation potential. Out of 15 PSBs, four potential bacteria were selected for optimisation studies which showed that these PSBs were found to be metabolically active in upto 4M (23.4%) NaCl indicating their halotolerant potential for maximum solubilisation. Among them, two strains were found to solubilise maximum phosphate atalkaline pH suggesting the production of alkaline phosphatase enzyme, which was identified as Priestia megaterium and Bacillus velezensis. On the other hand, the other two strains from Bacillus spp. showed optimum solubilisation at acidic pH

indicating the synthesis of acid phosphatase. These Halotolerant strains from Arabian Sea sediment with efficient phosphate solubilisation could be used as bio-inoculants for natural fertilizer towards enhancing plant growth under saline stress and thereby promote sustainable Agriculture.

WOSC/2024/ABS/143

Physiochemical responses of marine bacterium exposed to different levels of polystyrene nanoplastics: Insights into oxidative stress and biofilm modulation.

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Large amounts of discarded plastics in the environment can be aged into microplastics and nanoplastics, which are not easily removed, posing potential nonnegligible risks to the ecosystem and human health. Biofilm formation is an essential feature of marine bacteria. They can adapt to various extreme environments by the production of extracellular polymeric substances (EPS) and play an important role in biogeochemical cycles. Although limited studies have revealed that nanoplastics have detrimental impacts on microorganisms, the potential response mechanisms of marine biofilm bacteria toward nanoplastics are still lacking. In this study, biofilm synthesis, and physiochemical responses of marine bacterium Pseudomonas sp. BFB-4S to different levels of polystyrene nano plastics (PS NPs) exposure was evaluated using multi-staining fluorescence microscopic, spectroscopic (fluorescence excitation-emission matrix, 2D-Fourier transform

infrared correlation spectroscopy, FT-NMR), multi-marker based oxidative stress and genotoxicity assessment. The results showed that PS NPs had dual effects on BFB-4S, and different concentrations of PS NPs demonstrated different effects on the growth, biofilm synthesis, extracellular polymeric substances modulation (EPS), and oxidative stress of BFB-4S. All levels of PS NPs had no obvious biocidal effect on BFB-4S. In addition, biochemical composition in EPS varied differently in response to increased NP exposure, as the ratio of polysaccharide/protein/lipid. Additionally, spectroscopic annotation revealed obvious heterogeneities in biochemical component variations in response to MPs, as the carbonyl, carboxyl, and amino functional groups and glycosidic bonds in the EPS preferentially responded. Further analysis of the toxicity mechanism of PS-NPs indicated that they could induce reactive oxygen species production, DNA damage, and modify antioxidant enzyme activity. Our findings would provide new insights into the interactions between environmental bacteria and PS NPs, thereby enhancing our understanding of the potential risks of PS NPs to microbial ecosystems and public health.

WOSC/2024/ABS/145

Surface Preference and Nutrient Influences in Settlement and Development of Ulva Spores into Germlings

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Ulva, a versatile intertidal green macroalgae standout as the predominant macroalgal biofouler globally. The Ulva life cycle involves critical phases, including the production and settlement of motile spores on substrata. Understanding the ecophysiological responses to variation in surfaces and nutrient parameters during the early life stages is crucial for comprehending the initial developmental processes. In this study, we explored the growth of Ulva from spores to germlings using different substrates and nutrient concentrations. We examined five commonly available commercial polymer surfaces- Polyethylene terephthalate (PET), Polypropylene (PP), High-density polyethylene (HDPE), Low-density polyethylene (LDPE), and Polyvinyl chloride (PVC). Additionally, four distinct nutrient concentrations of nitrate and phosphate were investigated. Spore settlement assessments were conducted 48 hours post-inoculation. Additionally, the elongation of individual cells into filaments was systematically monitored throughout the experimental period. Nutrient concentrations were manipulated, with N1 0.4mm, N2 0.8mm, N3 1.2mm, N4 1.6mm for

nitrate and P1 0.05mm, P2 0.10mm, P3 0.15mm, P4 0.20mm for phosphate. Continuous monitoring of development revealed significant changes in elongation length and the time taker for it. Spore size peaked at approximately 1.4-5mm across all substrates. Initial settlement rates were notably higher in PET, PP, PVC, and HDPE, with LDPE exhibiting comparatively lower settlement. Subsequent development revealed that PP and PVC had a higher number of germlings in N3 and P2, while the spore count gradually decreased. In the following days, development diminished on other substrates with intermediate nutrient concentrations. The decline in spore settlement and subsequent growth could be attributed to surface characteristics and the availability of essential nutrients. Keywords: Ulva spp., Polymer surfaces, Nitrate, Phosphate, Spore settlement.

Metal substrate influence on marine diatom biofilm: unravelling physio-biological dynamics and cell-surface interactions

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Biofilm formation by marine diatoms is a complex process influenced by various factors and parameters. In this study, we investigated the biofilm formation abilities of marine diatoms (Amphora coffeiformis-COR-D1 & Nitzschia microcephala-COR-D2) on different metal substrates. This study focuses on the physio-biological interaction of the diatoms on various substrates in biofilm formation process. The experiments were conducted at various time intervals to evaluate the temporal dynamics of biofilm development. Surface characterization data played a crucial role in understanding the biofilm formation process. Contact angle measurements provided insights into the wettability and surface hydrophobicity of the substrates, while surface energy calculations helped evaluate the interaction between the diatoms and substrates. The analysis involved assessing the percentage adhesion, quantifying extracellular polymeric substances (EPS) and employing Alcian blue staining. Additionally, thermodynamic approaches were used to quantify the biofilm formation process. Biofilm fluorescence signatures on different substrates were

evaluated through epifluorescence microscopy, spectroscopy (excitation-emission matrix) and 2D-FTIR correlation spectroscopy. The results demonstrated that the biofilm formation by marine diatoms varied depending on the substrate and the duration of exposure. EPS extraction and quantification provided information on composition of the extracellular matrix produced by the diatoms, contributing to biofilm formation and stability. Alcian blue staining facilitated the visualization and assessment of transparent exopolymer substances (TEP).The thermodynamic approaches enabled the quantification of the biofilm formation process based on surface free energy calculations. This allowed for a deeper understanding of the thermodynamic interactions between the diatoms and substrates, shedding light on the driving forces behind biofilm formation. The combination of surface characterization techniques along with physio-biological quantification enhances our understanding of the biofilm formation process and facilitates the development of strategies for managing biofouling, bioremediation, and biotechnological applications in marine environments.

Biodiversity of halophilic bacteria from the regions of Marakkanam, Tamil Nadu and its biomedical applications

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Development of biocompatible, ecofriendly and bacteriorhodopsin-based bio sensor to detect an infectious disease using the membrane proteins of halophilic bacteria that thrive in extreme hypersaline environment up to 4M salt concentration is a challenging and cost effective. These bacteria possess characteristic features of tolerating low and high pH, high temperature, limited nutrient source and low oxygen level. This study focusses on isolation, characterization and optimization of the halophilic bacteria from extreme hypersaline regions of Marakkanam, Tamilnadu (12°18'69.52" N, 79°92'78.95" E) for maximum production of bacteriorhodopsin. Among 11 isolates, SM1 strain found to produce more yield up-to 0.4mg/ml. Enhancement of bacteriorhodopsin production was achieved by formulating a modified mineral media using low-cost carbon and nitrogen sources (dairy effluent, distillery spent wash) and elicitors (EDTA and $MnCl_2$). This mineral media was used to carry out scale up study in 10 L photo bioreactor. The biomass was processed to extract the Intracellular transmembrane protein, bacteriorhodopsin by following freeze thaw and bead mix methods, among which freeze thaw method shows more yield. Utilising the purified form of isolated purple membrane protein for amending with a conducting biopolymer such as PVA and chitosan making bacteriorhodopsin as a suitable transducer in sensor to detect the antigen antibody interactions. The characterisation of the coated bR-ITO glass was achieved by ATR and NMR. The ability of the isolated protein to produce photocurrent activity was also observed. Key Words: Haloarchaea, Bacteriorhodopson and biosensor.

Elasmobranch Fish Identification using YOLO - A Deep Learning Approach

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In the face of global environmental challenges, the conservation of marine biodiversity has emerged as a critical imperative. Elasmobranch fishes hold a special ecological significance. Elasmobranchs are vital apex predators that helps to maintain oceanic ecosystem balance. However, their populations have been significantly threatened by human activities, leading to alarming declines in many species. Traditional methods for elasmobranch fish identification and diversity monitoring are laborious, time consuming and often inadequate for large-scale conservation efforts. In response to these challenges, this research introduces a conservation-centric approach: YOLO a deep learning tool for elasmobranch fish identification. YOLO, known for its efficiency and real-time object detection capabilities, is adapted to address the unique demands of image analysis and species recognition. The proposed model consists of two components. One is designed for the feature extraction process based on the ResNet-50, wherein, the second component is designed for the detection of Elasmobranch fish based on YOLO v2 which Individually identify fish based on their morphological patterns. The data was collected from different locations of Gujarat coast, India and Dataset split into two parts 80% training images, and 20% testing images. The model was trained on a data set of 80 % images focusing on the fish body with a labelled bounding box approach. The final performance show value of accuracy, sensitivity and F1 score is close to 1. So, the model is reliable and underperformed. So, this study conclude that YOLO object detection improves fish identification, conservation, and ecosystem protection by enhancing monitoring precision and efficiency. Keyword: Elasmobranch, YOLO, Identification, Deep Learning

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Advancing the Blue Economy: Building a Resilient and Sustainable Tomorrow

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Amid urgent environmental challenges, marine habitats and species face increased risks, amplified by issues such as oceanic contamination, global warming, and excessive marine resource exploitation. Regions along the coastlines are especially at risk, contending with rising ocean levels and more frequent severe storms. With the ocean's vast economic value—generating roughly USD 2.5 trillion globally and sustaining the livelihoods of over 3 billion people—countries are exploring new sectors like marine science and sustainable ocean energy. The concept of the Blue Economy stands out as a pivotal approach, promoting both sustainable development and the conservation of marine life. This strategy is in line with the objectives of the UN's Sustainable Development Goals, notably SDG 14 centered on marine protection. However, fully harnessing the Blue Economy's benefits requires significant financial backing and a united global push, closely linked with environmental and climate targets. Nations such as India are at the forefront, enacting policies to safeguard marine ecosystems and encourage eco-friendly approaches. The deep ocean, which encompasses over 90% of the Earth's habitable space, is undergoing increased human activities like fishing, mining, and tourism, all aimed at fostering a blue economy. Despite its vast biodiversity and crucial roles in climate regulation and fisheries, these activities pose threats to deep-sea ecosystems. For instance, overfishing in areas like Tasmania has nearly wiped out species and caused lasting damage to coral ecosystems. Given the deep ocean's importance to global health and societal well-being, there's an urgent need for informed and sustainable management. To address this, we must prioritize equitable and cautious approaches, ensuring that our actions align with the long-term preservation and health of the deep ocean. As international dialogues evolve, it's essential for all

key players—be they governments, global organizations, or businesses—to emphasize and invest in advancing

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Insights into Cetacean Strandings: A Comprehensive Study of Kerala coasts of India (2022-2023)

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Documenting marine mammal strandings provides important information needed to understand the occurrence and distribution patterns of species. In this report, we document the stranding events of cetaceans along the Kerala (n = 10) shores of India, systematically observed from 2022 to 2023. The documented strandings involve eight Indian Ocean humpback dolphins (Sousa plumbea), one Indo- Pacific finless porpoise (Neophocaena phocaenoides), and a baleen whale (cranium of Balaenoptera spp). The taxonomic identification of the stranded carcasses was confirmed through morphometric features and thoroughly documented with photographs. The determination of the cause of death involved an on-site investigation, including a necropsy that entailed examining the body externally for signs of traumatic injuries, parasites, or any anomalies on the body surface. Subsequently, samples of various organs (skin, blubber, muscle, heart, lung, liver) from each specimen were extracted and preserved in 70% ethanol. These samples were stored at -20˚C and submitted to the Marine Mammal Tissue Repository (MMTR) at CMLRE for molecular and future analysis. The information obtained from these stranding events provides novel insights into the presence of marine mammals along the southeastern Arabian Sea of the Kerala coast in India. Moreover, it emphasizes the need for proactive conservation and sustainable management policies aligned with the Wildlife Protection Act of 1972 and the IUCN Red List of Species.

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High dominance of thermal tolerant Symbiodiniaceae genotypes from a marginal, turbid reef of India: A potential adaptive strategy

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Climate change-induced rise in sea surface temperatures has led to an increase in the frequency and severity of coral bleaching events, ultimately leading to the deterioration of coral reefs, globally. However, the reef-building corals have an inherent capacity to acclimatize to thermal stress on pre-exposure to high temperatures by "switching" or "shuffling" their symbiotic dinoflagellate-Symbiodiniaceae community towards a thermal tolerant composition. This reorganisation may become an important tool in coral's resilience to rapid environmental change. Therefore, it is crucial to delineate the Symbiodiniaceae community in our reef to predict their resilience capacity. Our study aims to analyse the symbiont community associated with common reef corals in a heat-stressed, marginal turbid reef of Palk Bay, India. We employed next-generation sequencing-based high-resolution analyses of internal transcribed spacer two (ITS2) amplicons within the SymPortal framework to examine the diversity and organization of Symbiodiniaceae communities. The results revealed a dominance of heat-tolerant Durusdinium (D1-D4) and Cladocopium (C15) across coral species (A. cytherea, A. digitifera, F. abdita, and P. lobata) and reef environment (seawater, and reef sediment), with the presence of 18 ITS2 type profiles in our sample. To our knowledge, this is the first comprehensive study to delineate Symbiodiniaceae communities at fine scale resolution (ITS2 type profile) from scleractinian corals of India and provides a baseline for future work in a marginal reef ecosystem of India. Several studies have highlighted the importance turbid reefs as prospective climate refugia. Therefore, this study is crucial for researchers, scientists, stakeholders, and policymakers to identify reef sites and coral species with resilience capacity for devising future reef restoration and management strategies.

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Implications of ocean acidification on trace metals and their primary biological impacts: a review

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This review has been undertaken to understand the importance and present state of knowledge of ocean acidification on trace metal chemistry and the possible impacts of metal species on marine biota, considering the strategies and objectives of ocean acidification risk assessment. The increasing CO_2 concentration significantly alter the pH of ocean waters which will have definite effects on the chemistry of trace metals. The major conclusions of the study can be described as

follows: Ocean acidification will slow down the oxidation of Fe(II) thereby retarding Fe(III) formation and subsequent hydrolysis/precipitation leading to an increase in iron bioavailability. Further, the increased primary production sustains enzymatic bacteria assisted Fe(III) reduction which enhances the formation of Fe(II) and subsequently the binding of weaker ligands favours the dissociation of free Fe(II) ions, thus increasing the bioavailability. The reduction of Fe(III) mediated by pH changes can steadily generate Fe(II) from iron oxyhydroxides, Fe(III) organic ligand bound complexes, etc. On contrary, the strong complexation by dissolved organic matter (DOM) may decrease the bioavailable iron concentration even though the dissolved iron concentration increases with the solubility of Fe(III) species. The increasing pCO2 condition increases the bioavailability of copper ions by decreasing the availability of free CO_3^{2-} ligand concentration. In the coastal ecosystem, the results of ocean acidification, together with increasing bioavailable metals directly impacts the phytoplankton community structure and henceforward the occurrence of toxic algal blooms. To reveal the interaction of phytoplankton with essential metals, studies should be carried out with dominant species in the ocean waters strongly affected by ocean acidification conditions. To conclude, ocean acidification affects the bioavailability of trace elements in the sea water, henceforward the studies on uptake rates of these elements by phytoplankton should be assessed so that the positive/negative contribution of ocean acidification to bioavailability can be sorted out.

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Microplastics pollutant in marine ecosystem, its associated health hazards and its biotechnological interventions

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Microplastic pollution in marine environment has become a widely discussed phenomenon which is impacting the plants, animals and humans. They originate from various sources including breakdown of larger plastic debris, release of plastic fibres from textiles, fishing gears and microbeads commonly used in personal care products. They not only act as vectors by carrying pathogenic microorganisms, they also absorb pollutants and bioaccumulate them in marine organisms. This continuous exposure of this detrimental pollutants is causing various health hazards and metabolic disorders in marine animals and humans. Thus, there is an ardent need to review the potential effects, exposure pathways, and toxicity of microplastic toward human health. The prevailing types of microplastics, their abundance and geographical distribution needs to be discussed in details. This paper also deals with microplastic characteristics, chemical interactions, and properties of microplastic. To reduce the pollution there is a need for effective wastewater treatment method to remove microplastic particles. Although several physical and chemical methods are available including filtration and sedimentation and subsequent degradation. However, these methods are costly, low efficiency and generate secondary pollutants. In order to manage these pollutants effectively, further research and development of effective and efficient methods for removing microplastics is necessary. Microbial mediated degradation of MPs using combinations of microorganisms, such as bacteria, fungi, bacterial consortia, and biofilms can serve as a good alternative for degradation. Furthermore, role of different hydrolytic enzymes in degradation of MP and its corresponding structural changes and changes in functional groups in MPs were noted. Finally, the prospects of biodegradation of microplastics were discussed in details.

Comparative Analysis of Bacterial Microbiomes from Mangrove Habitats, a Blue Carbon Ecosystem vs Terrestrial Forest using Amplicon Sequencing

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Mangrove ecosystems are vital coastal Blue Carbon Ecosystems (BCE) playing a significant role in carbon sequestration and storage. These ecosystems are pivotal in preventing climate change and global warming. The ability of Mangrove BCE to function as carbon reservoirs is majorly determined by their belowground soil microbiome. These microorganisms play a crucial role in deciding the extent of carbon that is either stored or released back into the atmosphere. This study delves into comparing the sediment bacterial communities from two mangrove habitats (Chorao and Cortalim) with two terrestrial ecosystems (Mhadhei and Netravali) of Goa, to understand the overall bacterial community profiling in both the habitats and to delineate their differential potential in carbon sequestration. We used 16S V3-V4 amplicon sequencing to understand the bacterial taxonomic composition of these habitats. The community structure revealed the varying bacterial communities at both habitat types. Predictive functional profiles of bacterial communities were obtained using PICRUSt and KEGG databases. Predictive functional diversity elucidated the carbon sequestration and storage pathways in bacterial communities of terrestrial and mangrove ecosystems. Our findings highlight the potential role of sediment mangrove bacterial communities in carbon sequestration and climate change regulation and maintaining the ecosystem balance. Understanding the microbial functioning in the mangrove BCE uncovered significant insights into the microbial breakdown of organic substances. This process is intricately linked to the primary productivity of mangrove plants within these ecosystems. Furthermore, the study illuminated the vital role played by mangrove microbiota in the enzymatic remineralization of complex, high-molecular-weight organic matter. These microorganisms serve as critical regulators in the marine carbon cycle, acting as key players in controlling essential biogeochemical processes. This includes the decomposition of Blue Carbon, highlighting their indispensable role in the overall health and balance of these coastal ecosystems and their significant influence on the global carbon cycle. Keywords: Mangrove microbiomes, bacterial dynamics, functional profiles, next-generation sequencing, blue carbon ecosystem

Comparative analysis of Microbiomes and their Functional profiles from Blue Carbon Ecosystems of Goa

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Vegetated coastal and marine ecosystems are commonly referred to as blue-carbon ecosystems. The inorganic carbon taken up and transformed into organic form in these habitats is what is termed "blue carbon". Marine ecosystems representing natural blue carbon sinks, play a vital role in the global carbon cycle. With their unique blend of high salinity, organic richness, and vigorous nutrient recycling, these habitats are thriving homes for a diverse array of microbes that help uphold the ecosystem's functionality. This study undertakes a comparative analysis of the microbial diversity and metabolic pathway of the bacterial community inhabiting two such bustling blue carbon ecosystems: mangroves and seaweed, aiming to identify key microbial players and their functional profiles based on cultivable and metagenomic approach. Sediment samples collected from dense mangrove vegetation in Chorao and seaweed beds in Dona Paula were screened for investigating the heterotrophic activity of bacteria via substrate utilisation assays specific to mangrove (lignin, xylan) and seaweed (agar, carrageenan, ulvan) habitats. The identification of the taxonomic and functional diversity composition was facilitated by NGS based on 16S amplicon sequencing targeting the V3-V4 regions through Illumina technology. The results show that the heterotrophic activity to utilize the substrates was widespread in the morphotypes from both the blue carbon ecosystems. Metagenomic analysis also shows terrestrial influence and increased pathogenic forms in the mangrove habitats compared to the seaweed beds, which could be due to the sediment characteristics and its retention capacity. The findings from this research contribute valuable foundational insights into the microbiome of blue carbon ecosystems that are focal for evaluating the effects of anthropogenic interferences on these pristine ecosystems. Keywords: Blue carbon ecosystems, Mangroves, Seaweeds, Heterotrophic activity, Goa.

Exploration and Evaluation of Antibiotic Potential in Bacterial Isolates from Deep-Sea Sediments

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Antimicrobial resistance (AMR) poses a global health threat, being the leading cause of deaths attributed to infectious diseases worldwide. The rapid development of resistance in bacteria underscores the urgent need for the discovery of novel antibiotics. The deep-sea environment represents an extensively unexplored reservoir of microbial life, offering the potential for discovering novel bioactive compounds. In light of this, the present investigation aims to explore and evaluate the antibiotic potential present in bacterial isolates obtained from the depths of Central Indian Ocean sediments. A total of 108 isolates were obtained from the sediment samples by serial dilution and spread plate method. Out of these bacterial cultures, 45 isolates were further selected for antibacterial screening. Crude extracts of these isolates were prepared by ethyl acetate extraction method and tested against Staphylococcus aureus, Escherichia coli, Bacillus sp. and Pseudomonas sp. by Agar well diffusion method. Preliminary findings revealed promising antimicrobial activity of 19 bacterial isolates against selected pathogens. The bacterial isolates showing promising activity were identified by using 16S rRNA gene sequencing. Further characterization and elucidation of the bioactive compounds from these isolates could contribute significantly to the development of new antibiotics to combat emerging drug-resistant microbes. Keywords: Antimicrobial resistance, Deep-sea bacteria, Bioactive compounds, Antibiotics, Marine Natural Products

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Impact of monsoonal rainfall on the PLB (pelagic larvae of benthic invertebrates) along the coastal waters of megacity Mumbai, India.

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The coastal water varies considerably depending upon regional environmental factors such as rainfall, freshwater inflow, tidal incursion and various biological activities. High river discharge during monsoon creates a strong hydrographical cline between marine and fresh waters, acting as physical barrier on planktonic community in coastal ecosystem. Several studies have investigated the vulnerability of Mumbai due to positive trend of rainfall extremes could increase the risk of severe flooding in the present and future climatic scenarios. Present work was designed to unravel the impact of that elevated monsoonal precipitation on density and diversity of pelagic larva of benthic invertebrates (PLB). Benthic larval sampling was conducted during before and after monsoon and the changes in their population dynamics recorded along with associated environmental factors. The density of PLB was recorded as lower before monsoon (150-970 ind.100m-3) compared to after monsoon (197-2368 ind.100m-3). Altogether, 14 types of different larvae were identified with bivalve (family Mytilidae) and barnacle nauplius larvae (subclass Cirripedia) dominated during before and after monsoon respectively. PLBs like Polychaete larva, Ophiopluteus larva of echinoderms, Brachyuran crab megalopa are only documented during pre-monsoonal period, conversely penaeid shrimp larva are only observed during after monsoon period. A combination of

multivariate cluster analysis, biotic indices, and canonical correspondence analysis revealed noticeable alterations in the PLB community structure across the spatio-temporal scale. Furthermore, significant intra-monsoonal changes (ANOSIM, 49.47% dissimilarity, global R= 0.974, p ≤ 0.01) in larval population correlated with several environmental factors (temperature, salinity, turbidity and phosphate-P) were clearly noticed. Regarding larval composition, the present study depicts that monsoonal water quality plays an important role in the seasonal sharing of different PLBs. Henceforth, a long-term monitoring of PLB population is required in this urbanized coastal ecosystem, considering its role in ecosystem functioning and biodiversity conservation. keywords: Monsoon, Benthic larvae, Multivariate analysis, Environmental factors, Mumbai coast

<p style="text-align:center">**WOSC/2024/ABS/347**</p>

Study of marine microbial diversity on micro plastics and its biodegradation effects

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What lies in the abyss of the sea, holds the solutions to plethora of problems on the land. India, being surrounded by Arabian Sea in the Southwest, Bay of Bengal in the Southeast and Indian Ocean in the south, witnesses major tourism activities along its coast. Due to this a foremost problem of plastic pollution has surfaced the water bodies. The plastics litters are degraded through physical, chemical, photochemical and biological agents. The degradation results in breaking down of larger plastics into smaller (micro, Nano) plastics, which are engulfed by aquatic lives and ultimately enters into food chain. Presence of micro plastics in human bodies has already been reported where they act as oncogenic agents and causes cancer. The current plastic waste management method further elevates the environmental threats by causing soil pollution in case of landfills and air pollution in case of incinerations. A sustainable method to combat the issue is microbial degradation resulting in organic by-products. In the study conducted in CSIR-NIO on the samples of partially submerged plastic litters collected from Vasco Jetty, the presence of two major bacterial communities, Psychrobacter and Pseudoalteromonas was found. These marine microbes are not widely reported for biodegradation in Indian marine environment. The degradation study by the two colonies was conducted on virgin HDPE plastic sample over a period of 6 weeks in which about 5.19% weight loss was observed in samples exposed to Psychrobacter and 6.67% weight loss in ones exposed to Pseudoalteromonas. Images through Scanning Electron Microscopy (SEM) showed formation of holes and floral structures resulting from degradation activity from these colonies. On the basis of this preliminary study, a further explorative study is planned to investigate the marine microbes in Western Coast and Arabian Sea capable of degrading plastics and isolate the responsible enzyme in pure form. The success in the study could lead to mapping the blueprint of plastic waste treatment plants where plastics could be biodegraded, an alternative sustainable approach to current plastic litter management.

How many macrofaunal species exist in Deep-sea abyssal Indian designated polymetallic nodule site, Central Indian Ocean Basin? - A preliminary methodological insights

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Abyssal plains exhibit astounding marine life and all faunal species cannot be studied using camera technologies. However, the diverse methodologies used in investigating fauna are a downside of benthic explorations and ecology; for example, in sampling gears (Multi corer, Box corer and grabs), sieve size etc., differences can make quantitative comparisons between studies difficult. The present study focuses on the Indian-designated polymetallic nodule site, Central Indian Ocean Basin (CIOB), which may support significant biodiversity but has remained unexplored and is considered the most homogeneous environment as basins/plains are knowns worldwide. Therefore, this provides an ideal setting to examine the difference in the sampling gear types and predict the species richness using rarefactions curves. Further, to test whether a Multicorer may show the highest density and diversity over box corer can generate bow waves and disturb the environment. We examined the distribution of macrofauna (> 300 µm) from three different locations separated by approx. 100 Km distance. In total, 117 individuals were collected in box corer, and 220 in multi corer individuals were extracted from the top 10cm sediment from nine replicates of core liners and six box corers. Macrofaunal abundance (Mean ± SE) was reported in 1889.62 ± 210.18 and 78.1 ± 14.71 ind.m⁻² based on multi− and box corer sampling types, respectively. Overall, the community structure did not differ between the sites (Permanova; $p = 0.54$). The temporary meiofaunal taxa out of 18 higher taxa were captured mainly by multi-corer, contributing 85.39% of total macrofauna abundance, and box corer captured relatively low (59.82%) of their respective densities. Only nine taxa occurred in both the sampling gear rest were unique to the sampling gears. Only multi-corer samples were appropriate to compare the diversity and densities of small-sized fauna (> 300 µm) between the

sites. However, rarefaction analysis showed box corer is convenient for finding more species, and the highest predicted existence could have more than 150 benthic species in the IRZ area. Rarefaction suggested that more sampling efforts are required for more accurate inferences.

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Ecological Dynamics and Seagrass Biodiversity in the Andaman and Nicobar Islands.

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In the Andaman and Nicobar Islands, seagrasses, such as Thalassia hemprichii, Enhalus acoroides, and Halodule spp., play a crucial role in coastal ecosystem formation, providing essential habitats for diverse marine life. Recent research emphasizes the ecological significance of these seagrasses, elucidating their impact on seawater carbon chemistry and their role in coral reef resilience against ocean acidification. The vulnerability of the Andaman and Nicobar Islands to global seagrass threats necessitates urgent conservation efforts, particularly for key species like Thalassia hemprichii and Enhalus acoroides. Extensive studies in the South Andaman Islands reveal insights into seagrass distribution patterns, bed widths, and shoot densities across diverse substrata, with a focus on sand composition. Conservation priorities are identified to protect seagrass meadows from anthropogenic pressures, including sewage inflow and solid waste disposal. Comprehensive management strategies, including aquaculture integration and marine protected zones, tailored to the region, are crucial for preserving seagrass meadows and their rich biodiversity. This amalgamation of findings underscores the necessity for adopting customized conservation approaches aligned with the unique biological context of the Andaman and Nicobar Islands. Understanding these ecological dynamics is paramount for sustaining the health of coastal ecosystems and safeguarding the invaluable contributions made by seagrasses, especially as the global seagrass crisis unfolds.

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Characteristics of Marine Heat Waves during the Pre-Monsoon Season and its association with Chlorophyll-a concentration in the Arabian Sea and the Bay of Bengal

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Indian Ocean has experienced rapid warming in recent years, which increases the likelihood of Marine heatwave (MHW) occurrences in its basins. MHWs are extreme warm ocean surface conditions and are defined here when the sea surface temperature (SST) exceeds the 95th percentile value for three or more consecutive days. This study focuses on the MHW events occurred in the Arabian Sea (AS) and the Bay of Bengal (BoB) during the pre-monsoon season (April–May) from 1982–2021, examining their impact on Chlorophyll-a (Chl-a) and net primary productivity (NPP) in these oceanic regions. Throughout the study period, there were 42 MHW events occurred in AS and 68 in BoB with significant positive trends of about 8.1 and 6.3 MHW days per decade. Also, a strong relation between the MHW duration and the dominant climate modes is identified in this study. An evident decrease in Chl-a concentration was observed during MHW in both basins, especially for medium (7–14 days) and long duration (> 14 days) events. On an average, chl-a concentration has been reduced approximately 10% in AS and 2% in BoB. In general, AS and BoB have witnessed more frequent and long-lasting MHWs in the past few decades (2002–2021), which have substantially reduced the primary productivity of the north Indian Ocean. Keywords: Marine heatwaves; Net primary productivity; Pre-Monsoon; Chlorophyll-a; SST; NIO

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Unravelling benthic meiofaunal community dynamics: A morpho-functional approach in Indian estuaries with variable anthropogenic influence

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Estuarine ecosystems, acting as pivotal transition zones between terrestrial and marine environments, exhibit a distinctive mixing of salinities, giving rise to a brackish water milieu that fosters a diverse range of organisms. Despite their ecological significance, the benthic meiofaunal dynamics in Indian estuaries, particularly through a morpho-functional trait approach, remain inadequately investigated. This study seeks to bridge this gap by delving into the intricacies of benthic meiofaunal communities, focusing specifically on marine nematodes. Our objective is to discern whether the functional attributes of nematodes can serve as pertinent metrics for understanding their fluctuations in response to environmental influences. By exploring the morpho-functional traits of these faunal communities, we aim to unravel the nuanced interplay between estuarine ecosystems and the inherent characteristics of their resident nematode communities. Two tropical estuaries, Ulhas and Shastri, were selected to demonstrate the method of amalgamation of multiple functional traits of nematodes that would effectively mirror the functioning of the marine ecosystem method while also documenting variance in meiofaunal populations spatiotemporally. In the Ulhas Estuary, both overall density and biomass values were consistently highest across seasons. Notably, pre-monsoon periods exhibited greater faunal production in both estuaries. The Shastri Estuary, characterized by a relatively pristine environment, displayed higher values for the number of taxa (24 taxa) and other diversity indices compared to the anthropogenically influenced Ulhas Estuary (13 taxa). Gastrotrichs, kinorhynchs, pycnogonids, tardigrades, and rotifers are among the intriguing taxa that identified along the Shastri. Salinity, organic enrichment, and sediment texture have been demonstrated to be the key drivers of nematode adaptation of traits such as the buccal cavity, amphid, and tail shape. The trophic guild types 1A and 1B were predominantly represented

in higher percentages in the zones with silty and clayey sediment. A substantial number of the 2A type of buccal was found in the sandy sediment. Smaller amphids appeared in zones with high organic (TOC%) enriched sediments. Additionally, it was noted that conico-cylindrical tails predominated more in zones with sandy sediment ahead of conical ones. This study establishes a linkage between meiofaunal communities and the functional characteristics of nematodes, emphasizing their efficacy as reliable markers for discerning environmental differences within the two tropical estuarine ecosystems under investigation.

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Length-weight relationships and relative condition factor of Fourteen tropical Marine fish species from Gulf of Mannar along the Southeast Coast of India

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The quantitative aspects of length-weight relationships (LWR) and relative condition factors play a crucial role in assessing the growth, overall health, and fitness of fish in marine habitats. This study focused on estimating LWRs for fourteen species collected from the Gulf of Mannar along the southeast coast of India during September 2022 to December 2023. The findings revealed that the exponents (b) in the length-weight relationship, ranged from 2.515 to 3.224. Negative allometric growth was observed in seven species (sardinella albella, scarus rubroviolaceus, Sphyraena obtuse, Nemipterus zysron, Scarus ghobban, Nemipterus japonicas and Siganus canaliculatus), while five exhibited isometric growth (Lutjanus fulviflamma, Lutjanus fulvus, Lutjanus Kasmira, Sphyraena jello and scolopsis bimaculatus), and one, Ephinephalus aerolatus, displayed positive allometric growth. Kn values ranged from 1.008 to 1.108, suggesting good overall well-being for these fish populations. This study provides vital baseline data on LWRs and Kn for Gulf of Mannar fish species, crucial for establishing a robust monitoring and management system for their sustainable conservation. Keywords: Gulf of mannar, Length-weight relationship, Allometric, Isometric, condition factor

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Occurrence, Diversity of Batoids fishes from Tamil Nadu coast, Southeast coast of India

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Abstract: The batoid fishery (Ray and Skate) in India is important resource for the livelihood of fisherman, and there is vast scope for food both at national and international markets. The present study emphasize batoids species diversity and its catch rates was assessed based on random sampling during August 2019 to September 2023 from different landing centers viz., Tuticorin, Kanyakumari, Colachel and Vizhinjam in Tamil Nadu, Southeast coast of India. Totally, 69 species belonging to 5 orders and 14 families of batoids were recorded in the area. These included 25 species belonging to family Dasyatidae, 6 to family Mobulidae, 5 to family Rhinidae and Narcinidae. Neotrygon indica, was the most dominant species followed by Narcine timley, Aetobatus ocellatus., R. javanica, Gymnura poecilura, Brevitrygon imbricata, Himantura uarnak, Maculabatis gerrardi, Pateobatis bleekeri and Pastinachus ater were observed in all seasons. The numbers of species recorded was higher during the post-monsoon followed by summer, pre-monsoon and monsoon. The result on the taxonomic and phylogenetic diversity details using the PRIMER v7 software was elucidated in the paper. The conservation of batoids and the management measures to be followed along the Tamil Nadu Coast also were discussed in this paper. Key words- Elasmobranchs Batoids, Tamil Nadu, Marine Biodiversity, PRIMER-V7

Exploring Diversity of Pathogenic Bacteria Along the Indian Coast through Metagenomics Analysis

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Contamination of coastal waters with human pathogens has been well documented. The higher bacterial abundance in the coastal waters is mainly attributed to river discharge and the input of domestic and industrial sewage. There are only a few detailed studies on the genetic diversity and population structure of pathogenic bacteria in the coastal sediments of India. The development of molecular methods like metagenomics is gaining popularity as these techniques facilitate a thorough investigation of microbial communities in environmental samples. In the present study, surface sediment samples were collected from seven sites along the coast of India (Paradeep, Vishakhapatnam, Chennai, Mangalore, Goa, Mumbai, and Veraval). Metagenomic analysis was used to evaluate the presence and distribution of bacterial genotypes in different marine areas subjected to different anthropogenic activities. Further, to understand if these sediments could be a potential reservoir of pathogenic bacteria that could be a risk to human health. The taxonomic data reveals that the bacterial abundance ranged from 65.92% to 72.62% at all the sites except Mangalore, where it is substantially lower at 11.83%. The phylum Proteobacteria was identified as the most prevalent in all the samples, with the class Gammaproteobacteria being the most abundant. The sediments from Goa exhibited the highest amount of bacterial diversity at the genus level, while Mumbai had the highest diversity of pathogenic bacteria. The pathogenic genera Vibrio, Pseudomonas, and Acinetobacter were found in all the sampling locations. Among the sites, Legionella, Aeromonas, Enterococcus, Escherichia, Streptococcus, Staphylococcus, and Campylobacter were among the top ten most abundant pathogenic genera. The pathogenic bacterial genes distribution varied from the lowest number of genes (585) in Mangalore, while Mumbai had the highest number of genes (8249). The present study serves as a baseline for future studies aiming to unravel the relationships between pathogenic bacterial diversity and ecosystem health in coastal regions

First report of three marine fish species to Indian waters; one new record of blackfin stonefish (Pseudosynanceia melanostigma) to India and two new reports of Engraulids (Thrissina gautamiensis and Stolephorus tamilensis) from the West Coast of India

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The present study records the occurrence of three fish species to the Indian waters, including one new record of blackfin stonefish Pseudosynanceia melanostigma to India and two new reports of Engraulids, Thrissina gautamiensis and Stolephorus tamilensis from the West Coast of India. The studied specimens were collected from landing centres and bycatch collections from the west coast of India (from Gujarat & Goa) as part of an ichthyofaunal study programme of ZSI, Kolkata. The presence of branchiostegal membranes broadly fused to the isthmus, the number of dorsal fin spines and the number of segmented pelvic fin rays, the general colour pattern of species, the presence of a large black spot distally on the anterior part of soft dorsal fins, caudal fin with two broad dark bars were the key features identified the species Pseudosynanceia melanostigma. The presence of a maxilla which terminates before the pectoral fin base, Body Depth, presence of enlarged teeth in both upper and lower jaws, number of gill rakers and number of anal fin rays were used as the key features to differentiate the Thrissina gautamiensis from the similar species under this genus, whereas the characters like presence of concave pre-opercular margin, absence of pre-dorsal spine and double-pigmented line behind the dorsal fin, absence of scattered melanophores between dorsal fin and caudal peduncles and the number of gill rakers were confirmed the species Stolephorus tamilensis. The present study suggests the need of more focus on the taxonomy and ecology of the least studied fish groups of Indian waters.

Screening of a halotolerant Bacillus spp. for protease production and for

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Uncontrolled anthropogenic activities like urbanization, industrialization, modern agricultural practices and habitat destruction are root cause for generation of pollutants in unprecedented levels. These pollutants are acting as mutagens and teratogens causing environmental as well as health hazards. Bacteria as a result of its distribution in various habitats including extremophilic environments evolved their metabolic ability to utilize pollutants and release nonhazardous and useful products in to surroundings by productions of different classes enzymes like laccases, proteases, lipases, hydrolases, dehydrogenases and dehalogenases. In the present study, a mesohalotollerant (6-8%) Bacillus was isolated from Kali estuary by screening on skimmed milk agar media. The identified species was Bacillus vietnamensis. The protease activity was tested

against different inducers like peptone, tryptone, milk, groundnut cake and pongamia cake. Among all substrates, peptone showed to be highest inducer of the protease and of the crude protease activity with peptone was showed to be 772.75 U/ml. Based on present work it can be concluded that protease is highly promising for environment clean up, food industry and industrial applications.

Unlocking Antimicrobial Potential: Exploring bacterial diversity in the Indian Sector of the Southern Ocean for novel drug discovery

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Exploring the bioactivities of organisms remains a valuable approach for developing new pharmacological products. Despite advancements in drug synthesis, screening natural compounds directly from organisms continues to yield a high percentage of new medicinal compounds. The Southern Ocean, rich in microbial diversity, holds promise for discovering novel biologically active substances. The marine environment, with its vast microbial diversity and unique ecological conditions, is estimated to host 106–108 bacterial species. Marine organisms thriving in extreme conditions such as pressure and temperature produce a diverse array of secondary metabolites, including polysaccharides, polyunsaturated fatty acids, antioxidants, sterols, proteins, pigments, and compounds with antimicrobial properties. This study presents novel insights into the microbial diversity of the Indian sector of the Southern Ocean, focusing on bacterial isolates with potential antimicrobial properties. Water and sediment samples were collected, and Bacillus spp., Pseudomonas spp., and Actinomycetes spp. were identified through cultural and morphological characteristics. 16S rRNA sequencing and phylogenetic analysis confirmed eight bacterial organisms, paving the way for taxonomic classification in this region. The isolated bacteria were mass-cultured, and their extracts exhibited varying levels of antibacterial activity. This suggests their potential as sources of bioactive compounds. Ongoing experiments with purified fractions aim to elucidate the chemical nature and mechanism of action of these compounds. The significance of these findings lies in the urgent need for new antimicrobial agents amid increasing antibiotic resistance. The study contributes to the understanding of microbial diversity in the Southern Ocean, shedding light on the role of microorganisms in marine ecosystems. The identified bacterial isolates hold promise for the development of novel drugs to combat bacterial infections. This research aligns with global efforts in drug discovery and underscores the importance of exploring marine bacteria as valuable reservoirs for biotechnological advancements.

Prevention of coral disease caused by pathogens using the beneficial microbial associates

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Many studies have focused on antibiotics to cure the infected corals. However, the researchers do not advocate using this tactic with corals in the ocean, as excessive antibiotic use can create antibiotic- resistant microbes and superbugs. Alternatively, coral-associated beneficial bacteria are known to produce antimicrobial compounds that prevent the growth of potential pathogens and invading microbes. Hence, beneficial bacteria associated with coral Porites lutea were isolated and antimicrobial protein and bioactive secondary metabolites were extracted and tested for their

antimicrobial activity against putative prokaryotic and eukaryotic coral pathogens. Bioactive secondary metabolites exhibited remarkable antagonism against various coral pathogens such as Serratia marcescens, Vibrio spp. and Aspergillus sydowii. Besides, the metabolites of Cobetia marina, Cobetia amphilecti, Pseudoalteromonas neustonica, and Virgibacillus halodenitrificans manifested notable inhibition against the protozoan ciliates (Uronema marinum, Holosticha diademata, Cohnilembus verminus, and Euplotes vannus) and zooplankton that are known to be involved in the secondary pathogenesis in coral diseased lesion progression. Thus, the present study may benefit in controlling the coral disease using the coral-associated beneficial bacteria caused by microbial pathogens.

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Direct Transplantation of reef-building corals to enhance the structural complexity of degraded reefs in Palk Bay of Southeast Coast of India

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Coral transplantation via asexual propagation of coral colonies has been used to restore the structure and function of degraded reefs in Palk Bay on the southeast coast of India. Successful restoration programs in India are rare. Therefore, this study aimed to implement a coral outplanting method at two different locations (Thonithurai and Munaikadu) in Palk Bay, India. Twenty iron frames and 800 cement slabs were used to make artificial substrates to install 800 small coral fragments, and the installation was performed in two sets to understand the variation in the growth and survivability of corals. The branching corals Acropora muricata, Acropora hyacinthus, Montipora digitata, and Pocillopora damicornis were used in this study. After 3 years of coral transplantation, there was significant growth observed between the coral species whereas, the growth difference between Thonithurai and Munaikadu was not significant. The average monthly growth rate of A. muricata (0.94cm/month) was the highest among all studied species, whereas A. hyacinthus, M. digitata, and P. damicornis had monthly growth rates of 0.44cm, 0.47cm, and 0.18cm, respectively. The survival rate for each species was calculated, and the survival rate for A. muricata (>60%) and A. hyacinthus (>50%) was the highest, whereas that for P. damicornis was the lowest at both sites (<35%). A large number of fish assemblages dominated by Terapon jarbua (grunter fish), Pomacentrus trilineatus (damsel fish), and Siganus javus (rabbitfish) were recorded from the sites after 9 months of transplantation and regular monitoring on fish abundance are also carried out. The results indicated that the coral out-planting method could be an effective tool for coral restoration in Palk Bay, and branching coral species can be considered promising contributors to artificial reef formation. Long-term restoration and multispecies transplantation approach can enhance the reef diversity in Palk Bay.

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Ghost Fishing Gear - A Multifaceted Risk to the Coral Reefs along India's Southeast Coast

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Fishing gear lost or abandoned by the fishermen intentionally or due to some unavoidable situation or damage is left within the sea bottom which continues to kill marine organisms including fish, macro-benthic fauna and marine vertebrates often referred to as Ghost Fishing or Derelict Fishing Gear (DFG). Ghost fishing is claimed to be the most prominent threat on marine animals and ecosystems, posing considerable ecological and socioeconomic challenges. Indian reefs are also threatened by the impacts of ghost nets and several incidents of coral species mortality were encountered from the four regions of Palk Bay reef on Southeast coast of India during routine coral reef monitoring survey. We looked at a total of 28 coral colonies, 13 of which were branching corals (Acropora sp.) and 7 of which were massive corals (Porites sp. and Goniastrea sp.) that were either totally or partially impacted by entangled fishing gear. The eight remaining colonies showed obvious signs of damage from fishing traps left on the living reefs, although they lacked tangled fishing lines. Acropora corals in shallow water reefs are the major contributors to the structural complexity of the reef and also attract coral-fish interaction to maintain the ecological integrity of the reef. Therefore, ghost fishing affects such habitat complexity, which supports high biodiversity and complex biological interactions. Present study reports photographic evidence of the damage caused by DFG and also discusses the possible measures at different levels of work to reduce the risk of ghost nets in shallow reef environments.

<p align="center">**WOSC/2024/ABS/240**</p>

SEASONAL VARIATION OF CHLOROPHYLL-A AS THE INDICATOR OF CLIMATE CHANGE

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The present study aims to understand the dynamics of Chlorophyll-a (Chl-a) variability comprehensively in the seasonal timescales using both numerical simulation and observation datasets. The study provides many new contributions toward our understanding of the seasonal variability of Chl-a. The results have been shown from the climatological simulation with ROMS, the NPZD model. The regions of Chl-a maximum with their associated mechanism during summer and winter monsoons have been analyzed in the Bay of Bengal (BoB). The monsoonal reversal of winds, seasonal expansion of oceanic currents, and cyclonic eddies are responsible for pronounced biogeochemical variability over the basin. The summer and winter monsoonal winds are responsible to some extent for Chl-a enhancement in the BoB. North-east and southwest monsoon seasons have a strong influence on the spatiotemporal variability of biogeochemical parameters in the BoB. In the central Bay of Bengal, during the south-west monsoon, the high Chl-a region occurs due to strong cyclonic eddy activity which showed shoaling of thermocline and doming of subsurface chlorophyll maximum. Southwesterly winds were unable to break the stratification resulting in shallow mixed layer depth. During the northeast monsoon, the northeasterly winds are moderate enough to break the stratification which drives mixing that deepened mixed layer depth. The mixed layer is shallow during the eddy activity and passage of the cyclones. Through this study, it is also suggested that the variation of temperature is related to Chl-a concentration. This study suggests that the seasonal variation of Chl-a is controlled by air-sea interaction, eddies, winds, ocean circulation, and temperature changes. Keywords: Chlorophyll-a, Seasonal variability, ROMS model

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Underwater Optical communication method for preserving the Marine Ecosystem

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Nowadays, there is increasing concern about Marine Biodiversity, and for that many strategies are ruled. One such method that enables focus on the marine system is the Underwater Optical Communication (UWOC). The UWOC process generally confines the range of covering the distance using optics or photons under the water surface. Using this method in clearing or identifying the pollution caused in the ocean, we can maintain the marine ecosystem in a better manner. The optical system uses a diode for radiating light and we try to incorporate the Avalanche Photodiode (APD) as this is opted as an efficient one comparing various light emitting sources. The APD source can radiate for over 10 meters underwater and can be designed in complex circuitry. The normal Optical system communicates the received signal to the receiver which is termed to be the user end with the light absorbing material. Underwater, communication happens by providing high internal gain with high quantum efficiency. Quantum efficiency is determined using the thickness of the source. The channel is open which needs to be protected as the collected information is confidential which carries the information of the species across the water body along with the necessary details. When we can bring this system to identify the pollutants affecting marine life and find out about the different species based on the available databases, we can establish a better Marine Biodiversity across the country, and worldwide. Thus, designing an Optical Communication unit specializing in underwater purposes can monitor the life in the ocean ecosystem in a simple and encrypted manner.

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Bioinformatic Characterization and Functional Evaluation of Thymosin (Ph-Thy) from Panulirus homarus

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The present study highlights the first-ever report of Thymosin (Ph-Thy) from an Indian Spiny Lobster, Panulirus homarus. The gene sequence analysis revealed that the gene contained an open reading frame (ORF) spanning 378 nucleotides, encoding a peptide consisting of 126 amino acids. The bootstrap distance tree calculated for the Ph-Thy nucleotide and amino acid sequences confirmed that it was more similar to other thymosins from P.monodon. When characterized in silico at the molecular level, the peptide sequence revealed a molecular weight of 13.91 kDa, with a net charge of +1.25 and predicted 16 anticancer motifs. These results emphasize the capacity of Ph-Thy as a marine peptide and advance our understanding of immune reactions and protective mechanisms in Panulirus homarus.

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Impact of Anthropogenic Activities on the Microplastic Concentration in Copepods in the Southwestern Bay of Bengal

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Plastic is being widely known as a major environmental contaminant. Plastics being sturdy get fragmented into microplastics (MP) which are spread in various compartments of the environment (water, air, and soil). Among these, the study of MP in the aquatic ecosystem has greater importance as this could be a possible pathway to the human body through the aquatic food web. The mesozooplankton (copepods) play a key role in the marine food web by transferring the energy from primary producers (phytoplankton) to the higher trophic marine organisms. MP are readily bioavailable for the copepods to ingest, since the size of the microplastics overlay with the size of the phytoplankton. The present study investigates the concentration of MP in copepods in selected regions (Chennai, Tuticorin, and Nagapattinam) during different seasons (dry and wet) of the southwestern Bay of Bengal. The mean MP ingested by copepods in Chennai (avg. 0.103 ± 0.04 No./individual), Tuticorin (avg. 0.11 ± 0.07 No./individual) and Nagapattinam (avg. 0.036 ± 0.01 No./individual) during dry season is high compared to wet season [(avg. 0.07 ± 0.03 No./individual), (avg. 0.08 ± 0.03 No. /individual), and (avg. 0.03 ± 0.01 No./individual)] respectively. The ingestion of MP by copepods are high in the metro cities of Tuticorin and Chennai, where there are more anthropogenic activities than Nagapattinam region. Though the results were compared with the past studies, the MP concentration in copepods were slightly higher during the dry season. Therefore, management strategies are suggested to limit the problematic plastics and stop additional plastic pollution in the coastal regions endangering aquatic life and human health.

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Association between pelagic fish catch and the recurrence of upwelling in monthly time lag in the Gujrat Coast

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Upwelling is known to be a primary indicator of the potential fish availability in the ocean. INCOIS provides potential fishing zone (PFZ) advisory by detecting thermal fronts in the Exclusive Economic Zone (EEZ) of the Indian Ocean. Thermal fronts are the boundaries between two water masses with disparity in sea surface temperature (SST). Thermal fronts are generated by Cayula Cornillon Algorithm with threshold values 0.3 0C, 0.4 0C and 0.5 0C. Each thermal front is reflected as a line, known as the PFZ line. The objective of this study to show a causal relationship between fish catches data and the recurrence of PFZ lines in monthly time lag. Daily fish catch data at different locations of EEZ are collected from INCOIS. For each fish catch point, a buffer region of 10 km. is created for considering the number of PFZ lines. Analyzing the available fish catch data and PFZ lines in the Gujrat coast from 2002 to 2014, it is observed that there are few locations in which PFZ lines are present for consecutively several months. Moreover, fish catch is higher in those areas where PFZ lines are present for the previous months.

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Ichthyoplankton abundance and distribution in the eastern Arabian Sea during the early monsoon period

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The responsible fishery is utmost important towards the sustainable use of fishery resources and monitoring of ichthyoplankton abundance and distribution in the marine ecosystem is one of the requirement to reach this goal. The maritime states along the west coast of India have higher marine fish catch than their eastern counterpart and hence, the study of ichthyoplankton in the eastern Arabian Sea gets more significance. Hence, our study was designed to investigate the abundance and distribution of ichthyoplankton in the eastern Arabian Sea during the early monsoon period of 2023. Concurrent observations on physicochemical parameters (temperature, dissolved oxygen, salinity, nutrients) and biotic variable (chlorophyll-a) were carried out to evaluate their potential influence on ichthyoplankton distribution. The study was carried out from 8° N to 20°N along different transects separated by 1° latitude gap. In each transect, ichthyoplankton sampling was carried out in the surface water from coastal location characterized from 10 m to offshore location with a depth of 500m. Although, fish egg and larvae were observed along all transects, their abundance was relatively higher in the southern part (8°-15°N) compared to the northern part (north of 15°N). Signatures of upwelling was prominent in the southern part extending up to 11°N (Off-Kozhikode). The distribution of nutrients (nitrate, nitrite, phosphate, and silicate) also exhibited spatial variation with relatively higher values at the southeastern Arabian Sea and the occurrence of upwelling in that region might have contributed to that. The higher nutrient concentration in the southern part supported the higher phytoplankton biomass in that region. The food rich environment of the south-eastern Arabian Sea was favorable for the spawning of fishes resulting in higher ichthyoplankton abundances. Key words: Ichthyoplankton; Abundance, distribution, eastern Arabian Sea

WOSC/2024/ABS/296

TIME SERIES ANALYSIS OF CORAL REEF AREA IN SHALLOW WATER OFF THE COAST OF RANGHAT AREA IN ANDAMAN AND NICOBAR ISLAND USING SENTINEL-2 MSI DATA

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Coral reefs are one of the most diverse marine ecosystems, commonly called the "Rainforests of the Sea". Though they only occupy less than one percent of the ocean floor, they are home to fourteen percent of marine species by supplying food and shelter. The Status of Coral Reefs of the World 2000 report estimates that 27 percent of the world's coral reefs have been effectively lost due to human activities and climate impacts (Wilkinson 2000). Regular surveillance and conservation measures must be taken for this ecosystem to survive in a healthy state. To gather data Surveys are conducted underwater in shallow water (0–30 meters) to gather data are then used by scientists and coastal

managers to assess coral reef and fish population management strategies, catalogue threatened or invasive marine species, and support regional monitoring efforts. However, in-situ field studies are very costly and time- consuming, so optical remote sensing can be an effective alternative to finding and monitoring coral habitats. Due to its superior characteristics, the Sentinel-2 mission has promising uses in coral reef mapping. Using remote sensing reflectance, a K-mean classification was performed to classify the coral and sea grass pixels from the deep-water pixels. From the Remote sensing reflectance, the bottom reflectance has been derived using a Quasi analytical algorithm which is used to do another classification using a threshold of 0.005 on the Bottom Reflectance at 560 nm. Both classifications have been applied to the subsetted atmospheric corrected data of Sentinel-2 imagery over the study area in order to perform the time series analysis of the coral reef area off the coast of Ranghat region which comprises the middle Andaman where coral bleaching is quite high. This also helps for easy research on coral reef habitat for the instants where in situ field surveys are not possible.

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Phytoplankton composition in the seasonal suboxic/anoxic waters of the Western continental shelf of India

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We studied the abundance and composition of phytoplankton community at a shallow (27m) station over the Western Indian Shelf (CaTS site, off Goa), during suboxic/anoxic events of the late southwest monsoon (SWM; September-October) from 2020 to 2023. We observed that the water column (0-27m depth) experienced seasonal suboxia/anoxia (0-63μM O_2, 18-27m) with presence of H_2S in the bottom waters during late SWM of the years 2021, 2022 and 2023. The stratified deoxygenated bottom waters were cold (24.1± 1.7°C), high saline (35.01 ± 0.54 SD) and with low nitrate (<1μM). While the upper layer of the water column (<18 m) retained warmer temperatures (28.7 ± 0.68°C) and well-oxygenated conditions, exhibiting relatively lower salinity (32.4 ± 1.14). Interestingly, higher phytoplankton abundance (46.5-976.732 × 103 cells/L) found in the anoxic waters (>18m) was dominated by diatoms 91.4% especially the pennate forms (58.8%) in the dark zone (low photosynthetically active radiation (PAR; <1 µE m-2 s-1). In September 2022, characteristic coexistence of multiple algal blooms were found in the dark hypoxic waters especially pennate diatoms of smaller chain forming Fragillariopsis oceanica (>60 µm) and the larger Pleurosigma elongatum (>200 µm). Other dominant phytoplankton in the low oxic waters were Pseudonitzschia haemii, Thalassionema nitzschioides, Navicula transitrans, Meuniera membranacea, Thalassiosira sp. and Rhizosolenia sp. The phytoplankton abundance of the oxic surface waters that ranged between 13.3-857.6 × 103 cells/L were also dominated by diatoms (73.5%) but chiefly contributed by the centric diatoms (56.29%) such as Skeletonema costatum, Guinardia sp. Leptocylindrus sp. At times, oxic surface waters were also dominated by dinoflagellates such as Gymnodium sp. (September 2023). However, dinoflagellates were relatively less abundant in low oxygen waters (12.8%) in the study area. In the climate change scenario, future studies are required to understand the expansion and magnitude of the deoxygenation zones in the coastal waters and its effect on phytoplankton in the dark suboxic/anoxic waters in the Eastern Arabian Sea.

Seasonal and spatial variation of rocky intertidal seaweeds of Konkan coast, India

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A spatial and temporal investigation was conducted to scrutinize and examine the diversity of seaweeds in the rocky intertidal zone of the Konkan coast from February 2022 to May 2023. The study encompassed four consecutive seasons: pre-monsoon 1 (February-May 2022), monsoon (June-September 2022), post-monsoon (October-January 2022), and pre-monsoon 2 (February-May 2023). A total of 105 seaweed species were identified along the Konkan coast, with red algae comprising the highest proportion (42%), which was followed by green algae (30%) and brown algae (28%). Comparative analysis across all four seasons revealed a higher abundance of seaweed species and diversity indices during the post-monsoon and pre-monsoon periods, while lower values were recorded during the monsoon months. This study identified 17 species that were commonly found in all seasons, while 36 species were found with restricted occurrence in particular seasons. Sargassum species showed the highest diversity with 12 species, which is followed by Ulva, Caulerpa, and Hypnea with 7 species each, and Cladophora (6 species) and Chaetomorpha (5 species). Among all the surveyed stations, Alibaug and Sandkhol exhibited the maximum number of species (n = 47 each), while Shrivardhan recorded the least (n = 1). Five seaweed species were abundantly present across all the studied locations, including Centroceras calvulatum (916), Gelidium pusillum (884), Gracilaria corticata (499), Ulva lactuca (462), and Hypnea spinella (404). All three diversity indices unequivocally indicated greater seaweed diversity in Alibuag and Sandkhol stations. Thus, this study will contribute to a greater understanding of how seasonal changes impact the distribution and diversity of seaweed populations across different rocky intertidal habitats along the Konkan coast. Keywords: Seaweeds, intertidal, Konkan coast, spatial variation, Seasons.

Mesozooplankton community of the Deep Scattering Layer in the Eastern Arabian Sea

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Mesozooplankton of the Deep Scattering Layer (DSL) is inadequately addressed despite their irreplaceable contribution in sequestering carbon to the deeper layers of the ocean. The present investigation is an attempt to delineate the community composition of mesozooplankton in the DSL of the eastern Arabian Sea (EAS). Using Acoustic doppler Current Profiler (ADCP) assisted techniques, samples were systematically collected from the DSL at four different stations in the EAS during October 2021. Additionally, samples from the surface layers (0-120m) and the intermediate layer between surface and the DSL were also collected. DSL across all the stations were associated with an increased abundance of swift swimming mesozooplankton like Myctophid larvae and Euphausiids. The prevalence of various species of copepods like Acrocalanus gibber, Euchaeta rimana, Paracalanus spp. etc in the intermediate layers can be attributed to the reduced swimming capabilities of these organisms. This reduced mobility is particularly evident in the present investigation due to the temporal regimen of the sampling. Furthermore, a declining trend was observed towards north in the abundance of various groups of mesozooplankton (Eg: Chaetognaths), particularly in the DSL, which indicates the influence of the Oxygen Minimum Zone

(OMZ) of the northern Arabian sea on the mesozooplankton community of the DSL. The present study is a comprehensive approach to systematically locate, characterise and identify the defining factors of the DSL.

Meiobenthic biodiversity of a Hydrothermally Active Seamount in Southwestern Andaman Sea

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Seamounts are marine topographical features that rise from the sea floor to a height of >1000 m. They harbour highly biodiverse communities and can be sites of high endemism. In this study, we studied the meiobenthic biodiversity on a seamount in the southwestern Andaman Sea (CSM13). Sediment samples were collected using a UNSEL box corer at 4 stations along the seamount. The chemical and biological parameters were analysed from the collected sediment. The results showed high abundance and biomass of meiobenthos on the seamount. The high abundance and biomass of meiofauna, 2714 ind./100 cm2 and 410.23 µg/100 cm2 respectively, were recorded at the summit. The eastern flank station also had a high abundance and biomass of meiobenthos, 1629 ind./100 cm2 and 310.37 µg/100 cm2 respectively. The abundance and biomass were significantly lower in the western flank and basin stations. Nematodes were the most dominant group of meiobenthos at all the stations followed by other groups such as copepods, ostracods and nauplius. Desmodorinae sp. and Microlaimus sp., bacterivore groups known from other hydrothermally active sites, dominated the nematode abundance at the summit. The family Desmoscolecidae, also bacterivores, dominated all the other stations. Results from recent scientific investigations have revealed signatures of active hydrothermal activity including gas flares and chemosynthetic symbionts such as Bathymodulus sp. on the CSM13 seamount. Our results also corroborate these findings and suggest active hydrothermal activity on CSM13, with the presence of nematodes previously reported from hydrothermal vents. These results show a highly diverse community of meiobenthos community thriving on a seamount, in a very poorly understood region. Future studies can help elucidate other questions such as the origin of organisms currently inhabiting the seamount and the connectivity among the other seamounts in the region.

Island mass effect on biogeochemistry of coastal waters around Grande Island

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Coastal oceans are highly dynamic regions of ecological and economic importance that are vulnerable sites to different stressors. We studied the spatial and temporal variation in the biogeochemistry of the coastal waters surrounding an archipelago in the northeastern Arabian Sea. Seawater was collected from six stations (S1-S6) around the Grande Island archipelago, located off Goa coast, during late Southwest monsoon (SWM, September-2022), Fall-inter monsoon (FIM, November-2022), Northeast monsoon (NEM, January-2023) and Spring-inter monsoon (SIM, April-2023). We also sampled station G3, off Goa during similar time points, as a station away from the island. The bottom water was cold, highly saline, low pH, and had hypoxic to anoxic conditions during SWM. These harsh conditions were reduced as the winds reversed during FIM and further to NEM, and by SIM, the water column was well mixed with high-temperature, oxic, and highly saline seawater that had a pH of roughly 8.0. A comparison of the Chl-a concentration around the island to the G3 station indicated that the waters surrounding the island were more productive which is possibly due to the nutrient input from the landmass and active physical forcing around the island. There was a significant difference in biogeochemistry between the two sides of the island, facing the coast and open ocean. This difference was pronounced during SWM which could be due to upwelling in the inner shelf towards late SWM aggravated by the productivity caused by the island mass. Therefore, we conclude that an island mass effect has a role in altering the biogeochemical conditions around the island and in the coastal seas which in turn can impact the highly sensitive organisms dwelling in these waters such as coral reefs, and other benthic organisms.

Length weight relationship and note on biological observations on the bristly catshark *Bythaelurus hispidus* (Alcock, 1891) from southwest coast of India

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Bythaelurus hispidus belongs to family Scyliorhinidae of order carchariniformes, are very small, slender and elongated deep sea sharks which occurs only as bycatch. This study presents the length weight relationship (LWR) of 26 specimens of B. hispidus collected from bycatch deep sea shrimp trawlers operating at an average depth of 200-450 m at sakthikulangara fish harbour, Kollam, southwest coast of India during the month of November 2023. Females were abundant in landings than males with the sex ratio of females to males being 1.6:1. The total length (TL) ranged from 26.5 to 34.5 cm (mean ± S.E = 31.8 ± 0.4) for females and 27.4 to 33.2 cm (29.93 ± 0.6) for males. The b exponent estimated is 3.9539 which indicates a positive allometric growth. The average k value estimated is above 1 which states that the well being of this species is positively good. Apart from LWR estimation, about twenty numbers of individuals were dissected to have an observation on their reproductive biology and stomach contents. Almost half (50%) with empty stomach, 25% with

trace elements and rest 25% with half full. Bythaelurus hispidus are ovoviviparous species where female give birth to young ones in uterus. In this study a total of 10 females were found pregnant, contained either one or two embryo or one fertilized egg in each uterus. A total of 7 males were in developing stage having clasper length ranging from 1.7 to 2.2 cm. This species is known only from Andaman seas, Kerala coast, Gulf of Mannar, Sri Lanka, Thailand and Oman. The IUCN Red list of Threatened species list the status of Bythaelurus hispidus as Near Threatened under criteria A2d.

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Length Weight Relationship and Relative Gut Ecomorphology of Three Leiognathid Species from Andaman Waters

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The Length Weight Relationship and relative gut ecomorphology of three species of Leiognathidae family Aurigequula fasiata, Gazza achlamys, and Deveximentum insidiator; captured from the coastal waters of Andaman and Nicobar Islands were studied. Fishes were caught monthly basis by artisanal fishermen from December 2022 to April 2023 during the present investigation. With the use of linear regression analysis (least-squares method) the length-weight relationship (W= aLb) was estimated. The r2 values for all the three species analysed in this study were high (primarily > 0.89). The slope values (b) of the linear regressions were 3.005 (p>0.05) for A. fasciata, 3.270 (p>0.05) for G. achlamys, and 2.982 (p>0.05) for D. insidiator; indicating an isometric growth pattern for all three cases. The relative condition factor (Kn) values were 1.002±0.062 for A. fasciata, 1.003±0.071 for G. achlamys, and 1.004±0.095 for D. insidiator, signifying well-being of the three species in their habitat. The gut content analysis revealed a dominance of planktons in both A. fasciata (66.24%) and D. insidiator (52.16%), whereas fish and cephalopod remains were most abundant in G. achlamys. However, A. fasciata also showed the presence of benthos (28.94%). There was a dominance of partially digested matter and debris in A. fasciata and D. insidiator. The Tube length- Head length ratio (Tul/HL) was the greatest for D. insidiator (0.721±0.013) followed by G. achlamys (0.639±0.031) and lowest in A. fasciata (0.619±0.036).

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ECOLOGICAL STATUS, LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR

OF PERONIA VERRUCULATA (CUVIER, 1830) ALONG COASTAL SAURASHTRA, GUJARAT, INDIA

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Peronia verruculata is a shell less Gastropod, which exhibits a steady population in the intertidal zone. P. verruculata is quite common molluscan species and has a uniform distribution pattern throughout the year in the intertidal substratum of coastal Saurashtra. Being dominating species, fluctuation in physical condition hardly brings any change on their distribution. Standard quadrate sampling was done throughout the year to investigate population ecology of P. verruculata. Distribution values did not show any definite trend at the sites. It was evident that there was no significant difference in the population abundance existed between the sites as well as among the seasons. Along with this Lenght-Weight relationship (LWR) of P. verruculata was examined from coastal Saurashtra. A total of 360 specimens were collected at low tide and systematic measurements (length and weight) were taken to quantify its size. The LWR of P. verruculata was estimated using the formula $W = aL^b$. The growth pattern varied at different locations. The length-weight relationship expressed allometric growth. The Fulton's condition factor was measured and the obtained condition factor along all the study sites was >1. Thus, the study showed correlation between length -weight, condition factor and significant difference among ecological conditions along study sites. Keywords: Peronia verruculata, distribution pattern, Lenght-Weight relationship, condition factor.

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Upsetting intertidal food web: Implications of ocean acidification on the p

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Ocean acidification has become increasingly severe in coastal areas. It poses emerging threats to the coastal organisms and influence ecological functioning. Donax faba, a dominant clam in the intertidal zone of Bay of Bengal, plays an important role in coastal food web. This clam has been widely consumed by the local communities and also acts as a staple diet for the shore birds and crustaceans. In this paper, we investigated how acidified conditions will influence the physiology, biochemical constituents and energetics of Donax faba. Upon incubation for 2 months in lowered pH 7.7 ± 0.05 and control 8.1 ± 0.05 conditions, we found a delayed growth in the acidified conditions followed by decreased calcium ions in the clam shell. Although not significant, we found the digestive enzymes showed a downward trend. Total antioxidant is significantly increased in the acidified condition compared to control. The expression level of MDA and antioxidant enzymes such as SOD, CAT, GST, GPX, and APX showed increasing trend in acidified conditions compared to control. Among nutrients such as amino acids and fatty acids there is no significant difference, however, showed a downward trend in the acidified conditions compared to control. Among, minerals

iron and zinc showed significant increase in the acidified conditions. The above results suggest that the clam growth, and physiological energetics may have deleterious effect if exposed for longer duration at lowered pH conditions thereby affecting the organisms involving in the coastal food web.

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Distribution of Symbiodiniaceae and its effect in countering Anthropogenic

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The coral ecosystem, provides significant ecological and economic value to the community. The foundation of coral reefs depends on the mutualistic bond between the photosynthetic dinoflagellate of the family Symbiodiniaceae and the host. The predominant rise in anthropogenic effect has led to hindrances in the coexistence of Symbiodiniaceae within the host. The current study focused on examining the ecological role of Symbiodiniaceae in the coral reef, their interaction with the host, and the molecular aspect of the relationship. The molecular diversity of Symbiodiniaceae was examined within two Sea anemones and in one Zoanthus species: Anthopleura elegantissima, Stichodactyla gigantea and Zoanthus SP, showed an overall high abundance of Cladocopium, Symbiodinium and Durusdinium species. The uncultured Symbiodiniaceae genera within the relevant organism were sequenced using the Illumina Miseq platform with targeted metagenomics. The distribution of Symbiodiniaceae in A. elegantissima, was found with Symbiodinium (37%), Cladocopium (35%), unclassified Symbiodiniaceae (24%) and Durusdinium (4%). In S. gigantea the Cladocopium (50%) was found to be more dominant than other species. About 33% of species in Zoanthus were Symbiodinium and Cladocopium, followed by unclassified Symbiodiniaceae (23%) and Durusdinium (11%). The general distribution of Durusdinium in all three species exhibits a promising bleaching recovery with the temperature hikes. The present study also characterised the occurrence of the microbiome in association with Symbiodiniaceae. Thus understanding intercommunication between symbionts will help to uncover their resilient nature and further help to preserve their integrity and unique biodiversity.

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Heavy metal accumulation in plankton in 24 hour tidal cycle, Ganges estuary

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The heavy metal accumulation in the lower food web of Indian estuaries received attention in literature owing to the rapid industrialisation and urbanization of coastal regions. A study of the variability of heavy metal accumulation (e.g., Zinc, Chromium, Lead and Arsenic) among plankton in 24 hours tidal cycle is globally rare. Such a study was conducted on a macro-tidal connecting creek of the Muriganga, Ganges estuary (18 and 19th June 2023from 11.00 hrs to next day 11.00hrs). Hourly in-situ data of the water-depth, salinity, water-temperature, pH, dissolved oxygen (DO) were recorded. The plankton were collected separately for quantitative and metal analysis. The plankton and water samples were analyzed for heavy metal using Atomic Absorption Spectrophotometer. The water- depth ranged 1.5 and 5.3 m, salinity 12.54 to 17.55 psu, water-temperature 31.2 to 31.7

C and DO 4.92 – 5.92 mg/L during the 24 hours tidal cycle. The phytoplankton biodiversity is significant made of diatoms followed by dinoflagellates and the zooplankton were mostly dominated by the calanoidfollowed by the cyclopoid copepods. The heavy metal concentrations in the water, phytoplankton and zooplankton followed a similar trendi.e., Cr>Zn>Pb>As. The metal concentrations (μg/L) in the surface water were Cr (9.30 – 32.08), Zn (7.25 – 59.78), Pb (0.76 – 19.76) and As (Not Detectable – 0.05).The metal concentrations(μg/g)of the phytoplankton and zooplanktonranged Cr (2.12–20.3), Zn (13.7–56.7), Pb (3.52–11.72) As (Not Detectable – 0.009) and Cr (21.7–194.3), Zn (225.7–1670.9), Pb (10.6–97.5), As (0.003 – 0.010), respectively. The bioaccumulation factor was formulated which revealed significant variation within the hours. This study suggested that 24 hours tidal cycle brings variability in heavy-metal accumulation process in an estuary so shall not be overlooked while conceptualizing management plan of an estuary.

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Acroporidae family coral species habitat modelling for site specific manage

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Habitat modelling is an essential method for conservation practices. The present study carried out an Acroporidae family habitat survey modelling from April 2017 to March 2020 in the Palk Bay coral reef ecosystem using MaxEnt and environmental parameters (CDOM, sum_SST, optimal_SST, PAR, Kd (490), turbidity, DO, salinity, total alkalinity, NO3, NO2, NH4, IP, pH, and MODIS). The study observed that 11 coral species occurrences in Palk Bay belong to the Acroporidae family, such as Acropora digitifera, Acropora gemmifera, Acropora humilis, Acropora hyacinthus, Acropora intermedia, Acropora muricate, Acropora sp, Montipora aequituberculata, Montipora digitate, Montipora sp, and Anacropora forbesi. Shannon diversity index (H') showed a mean of 1.402 and was high at the VDK (1.689) reef site, while it was low at the PAM (1.073) site. The species richness mean was 5.29, and it was high in the VDK and OLK reef sites, while it was low in the PAM reef site. Evenness was found with a mean of 0.886, and it was low (0.790) at the OLK reef site and high (0.977) at the PAM reef site. The Pearson correlation plot showed that PAR, optimal_SST, sum_SST, Chla, NO3, NO2, and IP were strongly positively correlated with each other. Turbdiity, Kd (490), and NH4 had a strong positive correlation with each other, while they were strongly negatively correlated with salinity and alkalinity. MaxEnt revealed that OLK and VDK reef sites were highly suitable for Acroporidae family habitat, while MND and PAM reef sites were not suitable. Total alkalinity, PAR, and nutrients were associated with highly suitable sites, while turbidity contributed to not-suitable reef sites. The present study might be helpful for future research to understand the optical and environmental constituents of the Acroporidae family habitat suitability for Palk Bay and the policy made for coral conservation management. Keywords: Palk Bay coral, Acroporidae, diversity, Environment, Habitat modelling, MaxEnt

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Diversity, distribution and population ecology of intertidal Asteroidea fro

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Present study was aimed to evaluate the basic ecological status of intertidal Asteroidea from the rocky shores of Gujarat. In this study, eight rocky shores viz., Okha, Shivrajpur, Dwarka, Mangrol, Veraval, Dhamlej, Simbor, and Diu of the Gujarat coastline were selected and surveyed extensively from January to December 2021. Though the shores studied are situated along a continuous coastline, significant spatiotemporal variations in the diversity, distribution, and density of the intertidal Asteroidea were observed. Four intertidal Asteroidea Echinaster purpureus, Anthenea rudis, Aqulionastra lorioli, and Aqulionastra burtoni were identified and studied further. A total of 12 color morph of A. lorioli was reported from all the studied areas. The present study revealed that the species diversity and density of Asteroidea varied over annual and diverse spatial scales. Diversity indices suggested lower community stability and species richness with moderate species evenness at all the studied sites. All four Asteroidea species were found to be vertically distributed in the middle and lower intertidal zones of the selected coastline. The index of dispersion suggested a general uniform and random distribution pattern. The distribution pattern of different asteroid species was also found to be varied in the rocky shores studied. We have noted that on the Gujarat coast, Asteroidea mostly preferred microhabitats like the space underneath a rock, rock pools, shallow pools, flat rock caves/crevices, and pool/puddles. It is possible that along with the prevailing climatic conditions of the study period and the intertidal faunal composition therein, coastal structure and various microhabitats might have played a vital role in the observed differences. Empirical data provided in this study offers a better understanding of intertidal Asteroidea and provides the baseline for future field and experimental studies on predation, interspecific and intraspecific competition, and coexistence in intertidal communities. Keywords: Asteroidea, intertidal, rocky coast, spatiotemporal, Gujarat

Bioaccumulation of heavy metals and anti-oxidative changes in marine polychaete worms at Chennai estuaries, India

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Concentration levels of chromium (Cr), zinc (Zn), copper (Cu), cadmium (Cd), iron (Fe), and lead (Pb) were ascertained in polychaete species Marphysa madrasi, Laonice cirrifera, and Namalycastis jaya captured in Kovalam, Ennore, and Adyar estuaries on the Chennai coast, India. Three different worms were found abundant in the respective estuaries and bioaccumulated a harmful amount of lead (Pb) in Ennore (L. cirrifera) and Kovalam and Adyar stations contaminated with Pb and Iron (Fe) in their tissues, compared to other heavy metals such as chromium (Cr), zinc (Zn), copper (Cu), cadmium (Cd). The association between water characteristics, heavy metal accumulation, and abundant species of each location was revealed by the canonical correspondence analysis (CCA) of polychaete species with other water parameters and heavy metal variables. The findings of this research showed that metals observed in Ennore estuaries were absorbed by L. cirrifera via nutrition, water, and sediment and that their metal concentrations were high despite their antioxidant biomarkers GST (Glutathione-S-tramferases), CAT (Catalase) and LPO (Lipid Peroxidation) being significantly higher in level due to lead contamination. and other two species also might act as effective bioindicators of heavy metal contamination throughout the Chennai coast of India. By combining sediment characterization and bioaccumulation results, it was possible to identify both polluted sites and the potential causes of sediment toxicity.

Metal Accumulation in Different Molluscan Species Collected From Southern Palk Bay, India

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Metals accumulation is considered as one of the reason for the degradation of marine ecosystem resulting in reduction of species diversity. It put major impacts on food chain by accumulating in the marine organisms, especially in gastropods and bivalves. In the present study, metals such as Cd, Cu, Pb and Zn concentration were analysed from the marine tissue of eight gastropods and seven bivalves collected from three locations along Palk Bay of Southeast coast of India. For the analysis of metal, acid digestion method was followed and was determined using atomic absorption spectroscopy. Among the various molluscan species, Cu ha higher concentration among the study areas whereas Pb was found below detectable level. According to the guideline of FAO permissible level of metals in molluscs are 1.00 ppm for both lead and cadmium. In the present study, the accumulation of cadmium in the analysed species is higher than the permissible limit, whereas accumulation of lead is below permissible level. Therefore, the bioaccumulation of metals in this area is to be monitored continuously to protect the coastal and marine environment. Key Words: MetalsAccumulation, Palk Bay, Cadmium, Lead, Mollusc