National Conference

on

Integrating Biogeochemistry and Ecosystems in a Changing Oceanic Environment

Book of Abstracts

Jointly organized by

ESSO - Indian National Centre for Ocean Information Services (INCOIS)
Hyderabad

&

Kerala University of Fisheries and Ocean Studies (KUFOS)
Kochi

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Preface

Warm greetings from the organizing committee of the National Conference on "Integrating Biogeochemistry and Ecosystems in a Changing Oceanic Environment", on 17-18, January, 2019.

Happy New Year to you all!!!

Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi and ESSO-Indian National Centre for Ocean Information Services (INCOIS), Hyderabad started KUFOS- INCOIS Joint Research Centre at the KUFOS main campus, Kochi on 30th May 2018. The aim was to promote collaborative research between the two organizations through research projects as well as by the exchange of faculty members and students. This conference is the first joint venture under this centre.

The two day conference will highlight theoretical as well as experimental approaches in predicting interactions among multiple changing factors that affect marine ecosystems and biogeochemical processes, including temperature, eutrophication, stratification, acidification, hypoxia, etc. and its role in affecting ocean biodiversity. It will also look into biogeochemical modeling for reliable assessments of impacts of past and likely future climate variations on biogeochemical cycles and their feedbacks in the earth system. The conference will also look into the development of ecological and biogeochemical models in local and global context and applying them to investigate the sensitivity of ecology and biogeochemistry to global change. The conference is structured around three sessions: (1) Ocean Modeling Applications in Biogeochemistry, (2) Coastal Biogeochemical Processes, and (3) Biogeochemistry and Fisheries.

We received an overwhelming response from various institutions across the country both in terms of participation as well as in terms of presentations. Total 34 abstract are selected based on the scientific merit of the abstracts covering eight oral and 26 poster presentations. In addition, 13 eminent scientists from prestigious Indian Institutes will be delivering invited talks covering the field of biogeochemistry, ocean modeling and fisheries.

We would like to acknowledge the guidance as well as the support of the leaders of the two organizations – Prof (Dr.) A. Ramachandran, Hon'ble Vice Chancellor of KUFOS and Dr Satheesh C. Shenoi, Director, ESSO-INCOIS. We are grateful to Dr. M. Rajeevan, Secretary, Ministry Of Earth Sciences, Govt. of India for his support and continuous encouragement towards successful implementation of the conference. We acknowledge the support extended by KUFOS in terms of venue, local hospitality and logistic supports. We would like to make a special mention about the support extended by Dr V.M. Victor George, Registrar of KUFOS and Dr T. V. Sankar, Director of Research, KUFOS. The support extended by the entire team of INCOIS as well as KUFOS is highly appreciated. We would like to thank all participants for their contributions to the conference program and for their contributions to this book of abstracts. *This book contains the abstracts of all the invited talks as well as the presentations coming under the oral/poster category presented during the conference.*

We wish this conference would be a good opportunity for participants from different institutions across the country to present and discuss topics in their respective research areas.

---- Local Organizing Committee

KERALA UNIVERSITY OF FISHERIES & OCEAN STUDIES

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Prof. A.Ramachandran, Ph.D.,
Post Doc. (Delft University of Technology, The Netherlands)
Vice Chancellor

FOREWORD

At the onset I would like to wish you all a healthy and prosperous New Year.

It is with deep satisfaction that I write this Foreword to the book of abstracts of the National Conference **"Integrating Biogeochemistry and Ecosystems in a Changing Oceanic Environment "during 17-18, January, 2019 which is a** joint venture of the KUFOS - INCOIScenter at KUFOS. This jointcentre has been established in KUFOS in 2018 so as to provide ocean information and advisory services to the people of Kerala in an effective and efficient manner. Under this joint venture we have several collaborative ongoing research projects and we also encourage the exchange of faculty and students between the two organizations in terms of training and research.

I understand that this conference has been widely welcomed by the research community across the nation and conference organizers have received a good number of abstracts from researchers and scholars of different organizations. I would like to appreciate the help rendered by the directors of different intuitions in terms of participation as well as presentations. The conference will encourage active interaction among research students and faculty leading to networks of researchers working at different institutions.

I trust also that this will be an impetus to stimulate further study and research in all these areas.

I appreciate the organizers of this conference from both the institutions and wish all the success for the conference .

Prof.(Dr.) A.Ramachandran

ईएसएसओ-भारतीय राष्ट्रीय
महासागर सूचना सेवा केन्द्र
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INCOIS

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डॉ एस. एस. सी. शेनॉय / **Dr S.S.C. Shenoi**
निदेशक / **Director**

Foreword Message

Warm greetings from the ESSO-INCOIS and I wish you and your family a very happy, healthy, prosperous and peaceful New Year 2019!

It is with great pleasure and satisfaction I look upon the activities of the KUFOS-INCOIS Joint Research Centre which was established at KUFOS main campus on 30 May 2018 with an objective to collaborate in research and academic activities and also to provide the ocean information and advisory services to the people of Kerala in efficient manner. I am happy to note that this joint centre is actively involved in several collaborative research projects as well as training/capacity building activities involving scientists, faculties and students not only from INCOIS and KUFOS but also from the institutions located in and around Kochi.

This National Conference "Integrating Biogeochemistry and Ecosystems in a Changing Oceanic Environment" on January 17-18, 2019 will highlight the theoretical as well as experimental approaches in predicting interactions among multiple factors that affect the marine ecosystems and biogeochemical processes. I hope that this conference will encourage the young researchers in developing ecological and biogeochemical models suitable for predicting the local and global changes due to the warming world.

I understand that this conference is structured around three scientific sessions which consist of invited lectures and contributory presentations that focus on the understanding of the marine ecosystem dynamics, the interaction of different species, and the short term prediction of marine ecosystem. I am confident that this conference would definitely enhance the knowledge and theoretical understanding of the participants in the realm of current state of marine ecosystem modeling activities.

The conference has received a very good response from marine biogeochemistry and ecosystem modeling community. A significant number of abstracts have been submitted for making contributory presentations in the conference. It would be a good opportunity for the young researchers to learn new techniques and ongoing research activities in this field of research.

I take this opportunity to appreciate the help rendered by the directors of different intuitions located in and around Kochi for extending their help for the smooth conduct of this conference.

I congratulate the team behind the organization of this National Conference form both the institutions and wish them all success.

(S S C Shenoi)
Director, INCOIS

About the Organizing Institutes

KUFOS - INCOIS Joint Research Centre was established on 30th May 2018 at the KUFOS main campus with an aim to provide the ocean information and advisory services to the people of Kerala in a fast and efficient manner. It also promotes collaborative research between the two organizations through research projects as well as by the exchange of faculty members and students. A national conference is scheduled to be held at the KUFOS-INCOIS Joint Research Centre. ESSO-INCOIS was established as an autonomous body in 1999 under the Ministry of Earth Sciences (MoES), Govt. of India and is a unit of the Earth System Science Organization (ESSO). ESSO-INCOIS is mandated to provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focused research. KUFOS is an autonomous public funded-institution established on 20th November 2010. KUFOS is the first Fisheries and Ocean Science University in the country. It provides high quality instructional programmes in Fisheries, Ocean Sciences and allied subjects.

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Invitees

Session 1: Ocean Modeling Applications in Biogeochemistry

1. Dr. G.V.M. Gupta, CMLRE, Kochi

Dr. G.V.M. Gupta obtained his Ph.D. degree on biogeochemical aspects of the Bay of Bengal in 1998. He joined as Scientist-C in Integrated Coastal and Marine Area Management (ICMAM), renamed recently as National Centre for Coastal Research (NCCR), Ministry of Earth Sciences, Chennai in 1999 and worked on many national level R&D projects on Indian coastal ecosystems, the salient among them were (i*)"Ecosystem Modeling"* studies for Cochin backwaters, Chilka Lake (Orissa), Sundarbans mangrove ecosystems (West Bengal), (ii) *"Coastal Ocean Monitoring and Predictive Systems (COMAPS),* (iii) *Integrated Coastal Zone Management Plans* for Gulf of Kachchh (Gujarat), Goa and Chennai. In 2009, Dr. Gupta, shifted to Centre for Marine Living Resources & Ecology (CMLRE), Kochi as Scientist-E and co-ordinated the national program *"Marine Living Resources of the Indian Ocean"*. Since then he is working on biogeochemistry, deoxygenation, green house gases, etc. of the estuarine, coastal and offshore coupled ecosystem of the eastern Arabian Sea. He has undertaken *Kochi Time-series (KoTS)* studies in 2012 and currently implementing the first-ever basin scale time-series, multi-institutional and multi-disciplinary collaborative project on *Marine Ecosystem Dynamics of the eastern Arabian Sea (MEDAS).* So far, he has published about 35 research publications in national and international journals and also acted as an expert reviewed many research publications from national and international journals, technical project proposals and reports, Ph.D Thesis.

2. Dr. Vinu Valsala, IITM, Pune

Dr. Vinu Valsala is Scientist-E at Indian Institute of Tropical Meteorology, Pune. He did his M.Sc. from Cochin University of Science and Technology and Ph.D. from Hokkaido University, Japan. His has a vast experience in Ocean General Circulation Models. His research interest include pCO2, biogeochemical modelling and data assimilation, Planetary wave dynamics and associated particle/tracer trajectories/pathways, Application of tracer techniques to detect variability of ocean circulation, Climate variability of Indian-Pacific Oceans, Reduced gravity layered models, Quasi-geostrophic models, Ocean Tracer Transport Model (OTTM), Ocean General Circulation Models (OGCM), Indonesian Throughflow and climate variability and Numerical Ocean modelling and development. He had receive various scholarship and awards namely Merit Scholarship Award by Cochin University of Science And Technology (CUSAT), Mitsubishi-Yamamuro Memorial Scholarship by Mitsubishi UFJ Trust Foundation, Tokyo. He is fellow of Indian National Young Academy of Sciences (INYAS).

3. Dr. P.A. Francis, INCOIS, Hyderabad

Dr. P.A. Francis acquired his M.Sc. (Meteorology) degree from Cochin University of Science and Technology, Kochi and M.Sc. Engineering (Intense Rainfall Events over the West Coast of India) along with Ph.D. (Extremes of Indian Summer Monsoon Rainfall, EQUINOO and ENSO) from IISc., Bangalore. He is presently Scientist-E and heading Ocean Modeling and Data Assimilation Group at INCOIS. His research interest is in Numerical Ocean Modeling and Indian Ocean variability and Indian summer monsoon variability. He has published 22 research papers having citation of 811. He is Student's co-ordinator at INCOIS and co-ordinator of KUFOS-INCOIS Joint Research Center. One scholar has been awarded Ph. D. under his guidance and five are continuing. He was awarded with National Geosciences Award, Certificate of Merit by MoES, Young Scientists/Visiting Fellow Award by START International Secretariat, Washington DC and C. V. Kurian Endowment prize by CUSAT, Kochi.

4. Dr. V. Vijith, CUSAT, Kochi

Dr. V. Vijith holds M.Sc. degree in Oceanography from CUSAT, Kochi and a Ph.D. degree from the Goa University. He carried out his doctoral research on "The physical oceanography of Indian monsoonal estuaries" at the CSIR-NIO under the guidance of Dr. Satish Shetye. After completing PhD, he worked as a project scientist at the IISc., Bangalore. Presently, he is Assistant Professor in the Dept. of Physical Oceanography, CUSAT. He participated in several international research expeditions, such as the first expedition of the Second International Indian Ocean Expedition (IIOE-2) and Bay of Bengal Boundary Layer Experiment (BoBBLE). Presently Dr. Vijith is managing three projects and guiding three doctoral students. In general, his research interest is in physical oceanography of coastal seas and estuaries.

5. Dr. Uma Sankar Panda, NCCR, Chennai

Dr. Uma Sankar Panda is working as Scientist-E at National Centre for Coastal Research (NCCR), Ministry of Earth Sciences, Chennai. He received his M.Sc, M.Phil. and Ph.D. in Physical Oceanography from Department of Marine Sciences, Berhampur University, Odisha. He has over 15 years of research experience in numerical modelling of coastal processes, biogeochemical interactions, coastal ecosystems, pollution and geomorphological studies. He has successfully demonstrated coupled hydro-ecological model for coastal lagoons and aquatic ecosystems along Indian coast. Presently his focus is on the prediction of coastal water quality, fate and transport of marine debris for major beaches along Indian coast. He has published about twenty-five research articles related to coastal processes, ecosystem and climate change.

Session 2: Coastal Biogeochemical Processes

1. *Dr. Aneesh Lotliker, INCOIS, Hyderabad*

Dr. Aneesh Lotliker did hid M.Sc. (Marine Science) and Ph.D. (Marine Science) from Goa University. He is presently Scientist-E at Indian Natioanl cente for Ocean Infromation Services (INCOIS), Hyderabad and serving as a In-Charge for Estuaries, Observations and Remote Sensing. He is specialized in marine optics and ocean colour remote sensing. His research interest also includes biogeochemical processes, hydro-optics modeling, oceanic bio-physical interactions, marine primary productivity, ecological indicators, phytoplankton optical properties and functional types.

2. *Dr. Rajdeep Roy, NRSC, Hyderabad*

Dr. Rajdeep Roy did his Ph.D. from Chemical Oceanography Division of National Institute of Oceanography, Dona Paula, Goa. He was United States Fulbright Post-Doctoral Fellow at Woods Hole Oceanographic Institution. He is presently Scientist SE at Oceanography. He is specialized in ocean bigeochemistry and phytoplankton pigments. He participated in several international research expeditions, such as the first expedition of the Second International Indian Ocean Expedition (IIOE-2) and Bay of Bengal Boundary Layer Experiment (BoBBLE).

3. *Dr. S. C. Tripathy, NCPOR, Goa*

Dr. S. C. Tripathy has obtained Ph.D. in Marine Biology from Berhampur University/National Institute of Oceanography, India in the year 2005; and subsequently obtained D.Sc. in Earth and Environmental Sciences from Nagoya University, Japan during 2011. His major research interest is phytoplankton productivity, bio-optics and bio-physical interaction studies to understand the ocean biogeochemistry. Since 2011 he is working as a senior scientist with the Ocean Sciences Group of NCPOR, Goa. Before joining NCPOR, he was carrying out post doctoral research at Nagoya University, Japan. He has over 20 years post-M.Sc. research experience and has published his research findings in several peer-reviewed journals of national and international repute. Presently he is working towards understanding the productivity potential and biogeochemistry of the Indian sector of Southern Ocean and Arctic fjords of Svalbard by actively involving in the scientific expeditions to the polar waters. His previous research interests include study of harmful algal blooms, phytoplankton biomass/productivity, ocean color remote sensing, nutrient dynamics in estuarine and coastal environment. Dr. Tripathy is the National representative of the Scientific Standing Group-Life Sciences for the Scientific Committee on Antarctic Research (SCAR) and presently the Group Director of the Ocean Sciences Group at NCPOR.

4. Dr. Nayeem Mullungal, Qatar University

Dr. Nayeem Mullungal is a Faculty member of Marine chemistry at the Department of Biological and Environmental Sciences, Qatar University. He completed his PhD in Chemical Oceanography, from the Department of Chemistry, University Of Otago, New Zealand in 2017 with an International students Scholarship. Finished an M.Phil. in Marine chemistry with First rank from the Department of Chemical Oceanography, CUSAT in 2011 soon after M.Sc in Hydrochemistry from the same department. Major research focus is on the oceanic nitrogen cycle and use novel stable isotopic techniques for his studies. Have presented his research works in more than ten international conferences in six different countries. Have secured various international awards and supports for his work from different international agencies.

Session 3: Biogeochemistry and Fisheries

1. Dr. V. N. Sanjeevan, KUFOS, Kochi

Dr. V. N. Sanjeevan, is the former Director, Centre for Marine Living Resources & Ecology (CMLRE), Ministry of Earth Sciences, Govt. of India. He has an illustrious career spanning over 30 years. He obtained Master's degree in science from Mumbai University followed by Ph.D. from Central Institute of Fisheries Education, Mumbai and carried out Post-doctoral research on Climate Change and Fisheries at the Climate Research Unit, University of East Anglia, U.K. He is a "Fellow Academy of Science, Engineering and Technology" (FASET). He served as the Official representative of Govt. of India in various international forums such as Commission for Conservation of Antarctic Marine Living Resources (CCAMLR), Australia for 14 years, Census of Marine Life, Belgium for 3 years, Indo-US collaboration on S&T, Washington for 2 years and UN General Assembly, New York on Marine biodiversity. He was Group Leader in India's first Southern Ocean Expedition in 2004. Currently is Member, International Group of Experts on World Ocean – Assessment of Assessments. Member Antarctic Legislation Committee of Govt. of India, Member, Research Advisory Committee of CMFRI and Member Board of studies CUSAT & KUFOS. He is a recognized guide of CUSAT for Doctoral research and has more than 80 papers in international journals to his credit.

2. Dr. Kunal Chakraborty, INCOIS, Hyderabd

Dr. Kunal Chakraborty is working as a scientist in the ESSO-Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. His research interest includes ocean modeling, in particular, numerical modelling of ecosystem. Dr. Chakraborty has published more than thirty research articles apart from his thesis papers in the international peer reviewed journals having high impact factors and good number of citations. In recognition of his outstanding contributions on modeling of marine ecosystem variability in the Indian Ocean, the Indian National Science Academy, New Delhi awarded him with INSA Medal for Young Scientists 2017. Further, in recognition of his outstanding scientific contributions in the field of bio-physical coupling processes in the Indian Ocean, he was awarded with Young Researcher Award for the year 2016 by the Ministry of Earth Sciences, Govt. of India. He is a member of Standing Consultative Committee of Young Scientists, the Ministry of Science & Technology, Govt. of India and Indian National Young Academy of Science (INYAS) for five years with effect from January, 2019.

3. Dr. Grinson George, CMFRI, Kochi

Dr. Grinson George taught fisheries science for one academic year (2003) at Republic of Maldives, then joined as a Scientist in 2005 at Central Island Agricultural Research Institute, Port Blair with additional responsibilities as honorary coordinator CPR Environmental foundation and Julliete Massey Honorary fellow of World Aquaculture Society. He is currently serving as Senior Scientist at Central Marine Fisheries Research Institute, Kochi since 2012 and coordinated the prestigious Jawaharlal Nehru Science Fellow programme by Govt. of India where he collaborated with Prof. Trevor Platt FRS of PML, UK. He is working on assessment of fisheries resources using Remote Sensing, GIS, numerical modelling and oceanographic observations since 2000. Presently he is part of the National Innovation on Climate Resilient Agriculture- Marine Fisheries, two climate change related projects funded by DST and ISRO. He is in the CMFRI team dealing with Chlorophyll based Remote Sensing Assisted Indian Fisheries Forecasting System (ChloRIFFS) and GIS based fishery resources assessment in Indian Exclusive Economic Zone, and handled nearly 30 research projects in various capacities. Dr. Grinson received more than ₹40 million Indian Rupees as research grants from all major national funding agencies. Dr. Grinson is the recipient of Dr. Rajendra Prasad Puraskar, a national award in 2010 for the best book in agriculture and allied sectors by ICAR. He was awarded Dr. Hiralal Chaudhury prize and Dr. Kulkarni award at CIFE, Mumbai for his research accomplishments. He is the recipient of merit fellowships for graduate, postgraduate and doctoral programmes. He won the best PhD thesis award in his academic year from the Professional Fisheries Graduates Forum. There are twelve best paper/poster awards to his credit in various conferences and symposiums. On his expertise and global appreciation of works, he was given three foreign travel grants by various global funding agencies to visit United Kingdom, China, Thailand, Italy and Australia. 41 peer reviewed high impact research papers, 6 books, 3 edited books, 13 book chapters and more than 100 conference abstracts.

4. Dr. Anu Gopinath, KUFOS, Kochi

Dr. Anu Gopinath received Master's and Ph.D. degree from Department of Chemical Oceanography, School of Marine Sciences, Cochin University of Science and Technology. She worked as an Assistant Professor in Chemistry (permanent) at St. Teresa's College, Ernakulum for ten years from 2005 to 2015. Later in 2015, she joined Kerala University of Fisheries and Ocean Studies (KUFOS) as an Assistant Professor in Chemical Oceanography in the Department of Aquatic Environment Management. She received Young Women Scientists' Fellowship and the DST Fast Track Scheme from Department of Science and Technology. She was also awarded Commonwealth Fellowship by British Council and worked under Prof. Eric Achterberg at National Oceanography Centre, Southampton U.K. She participated in Indian Arctic Expedition thrice in 2014, 2016 and 2017. There are seven best paper/poster awards to her credit in various

conferences and symposiums. She authored five books in various disciplines of Theoretical Chemistry, Analytical Chemistry and Environmental Chemistry and two of them are currently used as the text cum reference book of C.B.C.S.S programmes of M .G University, Kottayam and Kannur University. She have twenty five publications in referred international journals as well as several conference abstracts. She also received an award for outstanding contributions in Teaching and Research constituted by Indian Society of Analytical Scientists in 2014. At present, Dr. Anu Gopinath has two major projects funded by INCOIS. She is also serving as the Nodal Officer of KUFOS-INCOIS centre at KUFOS. Presently 4 students are doing their Ph.D under her guidance and two those have been submitted under the faculty of Chemical sciences, M.G. University, Kottayam. Her research interest is in the fields of biogeochemistry of estuaries and open oceans, trace metal chemistry of mangroves and coral reefs, sedimentary organic compounds from polar and tropical sediments (characterization studies), multi-level application of green synthesized marine nanoparticles from different marine origin.

Session 1: Ocean Modelling Applications in Biogeochemistry

Marine Biogeochemistry – An overview from the northern Indian Ocean

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Abstract

Biogeochemistry of the northern Indian Ocean (NIO), represented by the Arabian Sea (AS) and the Bay of Bengal (BoB), is dynamically influenced by different physical forcing mechanisms. While the nutrients derived from the eddies and perennial rivers drive primary production in the BoB, the same is influenced by the winter convective mixing and upwelling in the AS. Primary production and community respiration are the two major processes that govern the ocean biogeochemistry and influence nutrient cycles, degree of deoxygenation and acidification. Despite being densely populated and second largest fertilizer consumption country in the world, Indian coasts are far less influenced by the mere (<10%) nutrient export fluxes from its estuaries on either side. Aerosols play a significant role; sulphate aerosols led to coastal ocean acidification while nutrient aerosols contribute to coastal fertilization. The ongoing coastal ocean acidification in the BoB is an order of magnitude lesser than elsewhere, suggesting that our systems are less impacted by anthropogenic effects. NIO harbours thickest and widest oxygen minimum zone (OMZ), its intensity is much higher in the AS compared to the BoB. The upwelling of these OMZ waters along the west coast of India during summer monsoon stimulates intense oxygen depletion and acidic conditions, which apparently converts it to one of the major hub of Greenhouse Gases (especially CO2 and N2O) production. The oxygenation/deoxygenation conditions define the nitrification/denitrification shifts and, in turn, the marine nitrogen cycle. The increase in oxygen requirements with the increase in trophic status of marine life will be impacted by the degree of deoxygenation and the anoxic conditions favour non-conducive atmosphere for coastal fishery causing their mortality.

Keywords: northern Indian Ocean, biogeochemistry, deoxygenation, oxygen minimum zone

Western Arabian Sea Acidification, seasonal variability and trends

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Abstract

Ocean Acidification is a topic of key concern to the global ocean biogeochemical community. Since the industrial revolution nearly 30% of the man-made CO_2 emitted to the atmosphere has been absorbed by the ocean. The significant uptake of anthropogenic atmospheric CO_2 into oceans leads to a reduction in pH (expressed as negative log of H+ ion concentrations) referred to as Ocean Acidification (OA) which affects the marine organisms adversely. In an acidic ocean, excess CO_2 reacts with seawater to form carbonic acid which is highly unstable and undergoes further reduction by increasing hydrogen ions (H+) which acidifies the seawater (reduces the pH). Several studies have projected a decline of upper ocean pH by 0.3-0.4 units by the end of 21st century, which has the potential to reduce oceanic biological production in the ocean. Western Arabian Sea (WAS) is a highly productive biological zone supporting several highly climate vulnerable nations and the impact of trends in pH in this region thus deserves special attention. WAS has been acidified from a pH of 8.12 (in 1960) to a pH of 8.05 (in 2010). The trend in pH over WAS is due to contributions from increased Dissolved Inorganic Carbon (DIC) and SST of 109% and 16%, respectively. The effect of Alkanility (ALK) is to buffer the existing trend in pH by -36% while Salinity contribution is only 7%. Collectively, DIC and ALK contribute up to 73% to the net pH trend. SST warming alone contributes another 16%. pH shows a decreasing trend of -0.0091 for 50 years for October to December and -0.0039 for July to August with a correlation of 0.374 and 0.244 with increasing trend in SST for the corresponding period, respectively. The study raises a red flag since this region is warming rapidly which is only exacerbating acidification.

Keywords: Ocean Acidification, CO_2, pH, Western Arabian Sea, DIC, Alkanility

Structure and Dynamics of the Under Currents Along the East Coast of India

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Abstract

East India Coastal Current (EICC) is a western boundary current system in the Bay of Bengal (Bay) with characteristic reversal in the direction of flow north of 10oN. Major driving forces of EICC are the winds blowing parallel to the shore all along the boundries of the Bay, the Ekman pumping in the interior Bay as well as the remote forcing from the equatorial Indian Ocean. While there is a fairly good understanding on the variation as well as the forcing mechanisms of the surface EICC, the subsurface structure of EICC and its variation were not well studied until recently due to the nonavailability of long timeseries data on currents at different vertical levels in the coastal waters. But, availablity of continuous timeseries data from coastal (shelf/slope) Acoustic Dopler Current Profilers (ADCP) in the recent years significantly enhanced our understanding on the vertical variation of EICC. These observations helped us to carry out more detailed study on the previously reported undercurrents in EICC. It has been observerd that the undercurrents in the southern parts of the coast (eg. Cudallore), which are observed in shallower depths (~100-250 m), are relatively strong and organized, with large variation in intraseasonal time-scale. However, the inability of the numerical circulation models to simulate these undercurrents limited further studies on the spatial structure as well as the dynamics of these undercurrents. In this study, we present the simulations from a very high resolution ocean general circulation model, which reproduced the observed coastal under currents in the EICC with good accuracy. We also present our analysis of these simulations to explain the structure and dynamics of coastal undercurrents, especially in the south-eastern coast of India, where the under currents are found to be most prominent. We show that very small-scale subsurface eddies originate from the instabilities in the EICC are responsible for the undercurrents observed by the ADCP deployed in the slope off-Cudallore and its high-frequency variation. In order to discuss possible biogeochemical implications of these subsurface eddies off the coast of Cudallore, we draw analogue to the Peruian current system, which also has similar under currents due to the formation subsurface eddies.

Keywords: East India Coastal Currents, undercurrents, Acoustic Dopler Current Profilers, oceanic subsurface eddies

On the winter phytoplankton bloom in the northeastern Arabian Sea

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Abstract

The northeastern Arabian Sea (NEAS), having two phytoplankton blooming seasons, is one of the most productive regions in the north Indian Ocean. The first seasonal bloom occurs during the summer monsoon (June–September), when the climatological winds are southwesterly. The second occurs about a month later, during the winter monsoon (November–February), when the winds reverse and blow from the northeast. The winter bloom is attributed to entrainment of nutrients, owing to deepening of the mixed layer (ML) forced by convective cooling at the surface of the ocean. The winter blooming period also experiences downwelling forced by coastal Kelvin waves. At the same time, the West India Coastal Current (also associated with the Kelvin waves) transports low-salinity waters of the Bay of Bengal into the Arabian Sea. As the current takes the waters poleward along the west coast of India, the contrast between salinity of the waters of the current with ambient waters has an impact on mixed-layer physics. This impact in the NEAS was discussed by Shankar et al. [2016]. They showed that the inhibition of ML deepening in the south of the NEAS is forced by the advection of low-salinity water by the poleward-flowing WICC. In a sequel paper by Vijith et al. [2016], we set up a coupled physical-biological model (based on MOM4p1- TOPAZ) to investigate the consequences of the inhibition of ML in the NEAS. The model is able to simulate the spatio-temporal variability of physical and biological variables in the NEAS. We show that the chlorophyll integrated to 200 m depth from the surface is lower in the southern NEAS than in the northern NEAS. The inhibition of mixed-layer deepening in the south can affect the size- based distribution of small and large phytoplankton, nutrient limitation terms and growth rate, and their elemental composition, as seen in the model. In short, we give an example of how a coastaltraped Kelvin wave affects the biology of the north Indian Ocean.

Keywords: Arabian Sea, phytoplankton, bloom, Kelvin waves, TOPAZ

Modelling biogeochemical processes in the coastal waters off Chennai

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Abstract

To illustrate the important biogeochemical processes and their interaction in a coastal ecosystem, a coupled hydrodynamic-water quality model is configured. The high resolution model based on finite volume technique is developed for complex and dynamic coastal environment where significant spatial and temporal variation of physical, chemical and biological variabilities are prevailing. Events such as sewage influx, phytoplankton blooms, sea foaming and effect of flooding and storms also affect the coastal waters. The model demonstrated for the coastal waters off Chennai, a metropolitan city with a population of 4.65 million, is a major industrial hub facing threats due to domestic and industrial effluents brought through Cooum and Adyar rivers, Ennore creek and Buckingham canal. The coast supports a number of beaches viz. Marina, Elliot and Thiruvanmiyur visited by large number of tourists. Bed resistance, eddy viscosity, wind friction and heat exchange coefficients are calibrated for the hydrodynamic and advection-dispersion model. In water quality model, 13 state variables and 83 rate constants /coefficients for process equations were derived and calibrated. The model successfully demonstrated the capability to simulate the hydrodynamics and water quality scenarios in the coastal waters. A web based forecasting of water quality parameters is designed to as public information system for the coastal communities and beach goers. These predictive model and web forecasting is helpful for better beach management and policy makers.

Keywords: coastal water quality modelling; web-based forecast system, Chennai coast

Simulation of Nutrient Dynamics in coastal environment at Tarapore, Mumbai, Maharastra

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Abstract

The coast is in of the most environmentally dynamic states in the world. It separates the marine part of the world from the continents. It separates the salt-water communities from fresh water communities. It separates land life from water borne life but amphibians live in both the environments. Some of the marine organisms move towards estuary with less water salinity for reproduction. The nutrients are very much essential in the coastal communities. Hence an attempt has been made to understand the nutrient dynamics. The simulation of nutrients such as ammonia, phosphate, nitrate and oxygen concentrations would be carried out in Tapapore, industrial coastal area in Maharashtra State. Predictive model simulation was carried out in the study area using MIKE21 HD and ECOLAB Two Dimensional mathematical to examines the nutrient plume behavior in the vicinity of the study area. The present paper describes in the coastal environmental parameter such as the distribution and concentration of the nutrients in the study area. The hydrodynamic model was calibrated for field observed tidal variation and current speed. The ammonia concentration was extracted from the four locations in the domain from the existing outfall location. The Phosphate concentration was also extracted from the four locations in the domain from the existing outfall location. The nitrate concentration over the period of simulation is examined in model domains. It is concluded that the nutrients plumes are always attached with the dynamics of the current speed for example if the current speed is north direction, the plume also towards north direction. However, they are demises as thus move out from the source.

Key words: Nutrient Dynamics, BOD, DO, Phosphate, Ammonia , Nitrate, MIKE21HD

Development & Implementation of a multi-component ecosystem model with linkage between lower & upper trophic levels for the Northern Indian Ocean (NIO) & its applications

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Abstract

Ocean exhibits highly variable and diverse ecosystems governed by the complex physical and biogeochemical interactions within it. All biogeochemical processes and interactions between living and non-living components of the ecosystem cannot possibly be explained by sparse observations alone. Here the importance of ecological models comes into picture. Models are very useful for simulating and analysing the long-term balance of physical and biogeochemical interactions in the ocean and thereby giving a detailed account of ecosystem processes. In this study, we attempted developing an intermediate complex model for two stations in the Northern Indian Ocean (NIO) namely 65.5 ^{0}E 21 ^{0}N (hereinafter North) and 70 ^{0}E 19 ^{0}N (hereinafter South) for the year 2009 in-order to match with two observation instances happened during this time, along three Argo tracks in the Northern Indian Ocean, and along three ship tracks (3 cruises FORV Sagar Sampada Cruice No. 262 11 th to 25 th February 2009, FORV Sagar Sampada Cruice No.263 27th February to 14th March 2009, FORV Sagar Sampada Cruice No.264 18th to 30th March 2009). The model has 51 vertical levels with 5 meters resolution. The inspiration for our work is the adaptation of a lower trophic ecosystem model known as NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) developed by PICES CCCC MODEL Task Team which is reported to be successful in simulating the temporal evolution and dynamics of the north pacific nutrients, phytoplankton spring blooms and marine food web (Kishi et al.,2007). The model has 15 state variables with nitrate (NO_3) as the major currency along with calcite, silicate and carbon cycle. Among the plankton community a functional classification 1based on size (small, large and predatory) has been implemented. In this study we have coded this model and tuned for the Indian Ocean. The physical model is a 1-D mixed layer model based on Mellor and Yamada (1982) mixing module. The model is forced ECMWF atmospheric forcing and WOA-2013 initial conditions. Vertical advection and exchange of nutrients with subsurface ocean are provided by profiles of predefined vertical velocity taken from ECCO re-analysis data. Model is simulated for 8 years and by this time it achieved a balance

physical and biogeochemical variable. Major features of plankton community are as follows. The model is able to capture the subsurface chlorophyll maxima present in Arabian sea. And reasonably reproducing the winter and summer bloom of chlorophyll in the study region, an apparent lag between phytoplankton bloom and zoo-plankton predatory are also captured by the model. The seasonal cycle of nutrients is well captured by the model. The model is further planned to be expanded for Indian Ocean and end-to-end study of lower trophic to upper trophic marine ecosystem and food web.

Keywords: Northern Indian Ocean, Argo, NEMURO, nitrate, bloom, trophic

A comparative study of physico-chemical parameters of Cochin Estuary and Chilika lagoon.

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Abstract

NCCR/ICMAM-PD has been monitoring different types of marine ecosystems like estuaries, backwaters, lagoons etc. and undertaking various ecological assessment studies. Under this scheme, detailed investigation on the Chilika lagoon, and Cochin backwater was conducted in previous plans as these system host a diverse range of bio-chemical processes driven by physical forcings. In the present study, these two different types of marine ecosystems are compared in terms of their physical, chemical and biological characteristics to understand the variability in their dynamics. The result indicate a clear zonation in both the Cochin backwater and Chilika lagoon with characteristics difference in the north, south and central sectors due to interaction with the river flux and the flushing of the water through the inlets. Though the systems are physically different owing to the difference in the tidal characterstics in the inlets, the variability of chemical and biological parameters has a strong connection to tides. The results clearly indicated that both the system contains heavy levels of nitrogen owing to the influx from the river system. In Cochin backwaters, the nitrate content varied from .92 to 19.16 mmol/l in post-monsoon and 5.25 to 11.8 mmol/ l in pre-monsoon whereas in Chilika lagoon, it varied from 0.019mmol/l to 0.15mmol/l annually. Also it is noted that the Chilika lagoon is characterised by highly productive photosynthetic activity which is not nutrient limited. Even variation in the dominating species along the north, central and southern sector was evident. Overall nutrient cycling in both the system exhibit clearly the effect of physical forcing in the system.

Keywords: Chilika Lagoon, Cochin estuary,Physical parameters, Nitrate

A comparative nutrient dynamics of an open and semi-enclosed estuary on the East coast of India.

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Abstract

The variation in macronutrients (Nitrogen, Phosphorous and Silica) concentrations of an open estuary (Dhamra) and a semi-enclosed, mangrove dominated estuary (Matla) is studied during the pre-monsoon and monsoon season of 2016. The hydrological characteristics of the river Matla is dominated by the tidal flow from the sea and the run-off from its catchment area. Matla estuary has lost its connection from the upstream source, but Dhamra estuary gets continuous freshwater flow from the Mahanadi river. The concentration of DIN (dissolved inorganic nitrogen), phosphorous and silica increases from the upstream to downstream of the Matla and Dhamra during both the seasons, but in case of Dhamra estuary an increase in nitrogen concentration in the mid-estuary is observed during the monsoon. The silica concentration from the upstream to downstream in Dhamra estuary during monsoon and pre-monsoon ranges between 165.91 μM to 118.23 μM and 98.31 μM to 27.84 μM respectively whereas in case of Matla estuary, it ranges between 17.32 μM to 32.20 μM and 45.96 μM to 43.99 μM. The observed high silica concentration in the Dhamra estuary is due to the freshwater discharge into the estuary from Mahanadi river and also owing to its weather pattern of rocks in the catchment areas. To assess the control of nutrients on biological productivity, we have taken into consideration the nutrient ratios (Si:N and N:P). The Si:N ratio ranges between 1.34 (pre-monsoon) and 2.72 (monsoon) for Matla and 3.2 (pre-monsoon) and 6.63 (monsoon) for Dhamra. The Si:N ratio is more than the critical ratio of 1 suggesting that the estuaries are not eutrophic. The N:P ratio is 28.04 for Dhamra estuary and 18.24 for Matla estuary. N:P ratio is more than the Redfield ratio (N:P=16). Inspite of high N:P ratio in the Dhamra estuary, the concentration of phosphate ranges between 0.24 μM to 0.14 μM. This indicates that phosphorous is a limiting nutrient for phytoplankton production in Dhamra estuary during monsoon.

Keywords: Matla and Dhamra estuary, Nitrogen, Phosphorous, Silica, Nutrient ratio

Time-depth evolution of chlorophyll in the Arabian Sea - A description based on model and Argo data.

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Abstract

The Arabian Sea is one of the most productive regions among the world oceans. Temporal and spatial variations in phytoplankton biomass exist in the Arabian Sea at all scales from the diurnal to the seasonal, and from fine to large scale. We use bio-Argo data and a biogeochemical model to investigate the time-depth evolution of chlorophyll in the Arabian Sea during monsoons and inter-monsoon periods. It is still unknown what physical and biological conditions trigger the bloom conditions in the water column, because comprehensive time series of the vertical distribution of phytoplankton biomass and nutrients are lacking. To understand Bio-Physical relations, we investigate budget of nitrate in the mixed layer using the model.

Keywords: Arabian Sea, phytoplankton, bio-Argo, inter-monsoon, model

Study of Ocean pH variability from 1961-2010 in Indo-Pacific ocean using paleo-ocean pH records from boron isotope ratio and model

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Abstract

Increasing anthropogenic CO2 emissions since the industrial revolution and its consequences are responsible for decreasing ocean pH. Ocean Acidification is causing threat to the Marine Ecosystem, especially marine calcifying organisms. Several model studies have projected a decline of upper ocean pH by 0.3 – 0.4 units by the end of 21st century. Oceans act as net sinks of atmospheric CO2 and play a key role in carbon transformation and sequestration. Ocean Acidification is further reducing the natural carbonate ion concentration in the seawater. The longest instrumental records of past pH are available only from two stations i.e. Hawaiian Ocean Time Series (HOTS) and Bermuda Atlantic Time Series (BATS) stations in the Pacific and the Atlantic oceans respectively. However, these records are available only for the past three decades. So we have to depend on proxy records which are comparable to instrumental records of ocean pH. We are trying to compare model output with reconstructed values of paleo-pH obtained from Boron isotope ratio.

Boron proxies were obtained from New Caledonia (22°21′47 S, 166°15′29 E) location and using coral based seawater pH calculations, reconstructed pH was obtained which was then correlated with model pH anomaly. Correlation shows significant positive response with model output in the region of interest. It also explains influence of El-Nino in the Pacific Ocean. The model simulated pH is able to capture long term variability of pH. Through this study we will be able to understand what are the main drivers which are responsible for regional pH variability from 1961 to 2010 in Indo-Pacific Ocean and understand how ocean acidification is being accelerated due to increasing atmospheric CO2 from man-made climate change.

Keywords: Ocean Acidification, Boron proxies, interannual variability

Qualitative & Quantitative relationship assessment of Upwelling dynamics, Productivity and pelagic catch by satellite data of Southwest coast, India

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Abstract

The study has been made to understand the influence of coastal oceanic processes on major pelagic fish catch especially Indian oil sardine (Sardinella longiceps) and Indian Mackerel (Rasrelliger kanagurta) along the south-west coast of India. Ekman mass transport derived from the meridional component of wind is used as Coastal Upwelling Index (CUI). Sea Surface Temperature (SST) and Chlorophyll-a concentration was also used to deduce a possible relationship between environmental parameters and Oil Sardine and Mackerel fishery along the south-west coast of India. Indian oil sardine and Mackerel landings data were collected from CMFRI for the period 1998 to 2015. The present study revealed the specific influence of Ekman mass transport on chlorophyll-a variability along the south-west coast of India during the summer monsoon. Multi Correlation analysis shown the significant influence of coastal ocean dynamics and environmental parameters on fish landings data along the SW coast of India.

Keywords: Upwelling, chlorophyll_a, Pelagic catch, Ekman mass transport

Assessment of the ROMS simulated biogeochemical dynamics in the Indian coastal waters

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Abstract

The ecosystem models are developed to simulate the underlying physical, chemical and biological processes, towards determining the relative influence of the processes. The objective of this study was to understand upper ocean biogeochemical variability in the northern Indian Ocean. Water temperature, salinity and chlorophyll-a data simulated by a biophysical model configured using ROMS, in-situ data collected under the SATCORE project implemented in the INCOIS and physico-chemical observations carried out onboard FORV Sagar Sampada during February,2015 were used in this study. The validation results of ROMS simulated model and SATCORE water temperature showed best correlation in both Arabian Sea (R2=0.72, N=238) and Bay of Bengal (R2=0.76, N=292). In the case of salinity, model showed better trend in Bay of Bengal (R2=0.87, N=278) compared to Arabian Sea (R2=0.39, N=116). Whereas, chlorophyll showed better trend in Bay of Bengal (R2=0.82, N=314) and was found to be underestimating for Arabian Sea (R2=0.71, N=167). Similarly, Dissolved oxygen (DO) showed better trend but model data was overestimating. The oxycline and oxygen minimum zone were well captured by the model. The model confirms the presence of oxygen minimum zones in the Arabian Sea below 100 meter depth. The deep chlorophyll maximum was well captured by the model. The model simulated mixed layer depth, isothermal layer depth and D23 isotherm was shallower compared to the in-situ cruise data.

Keywords: ROMS, Biogeochemistry,North Indian ocean, Chlorophyll-a.

CDOM – An Optical tool to assess the Biogeochemical cycling in the Estuary

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Abstract

The export of terrigenous matter into an estuary alters the biogeochemistry of the ecosystem. Coloured dissolved organic matter (CDOM) serves as an excellent tracer of the extent of input of riverine water into an estuary. In the present study, the variations in CDOM in a tropical estuary, Vembanad Lake, will be assessed on a seasonal scale. The relation between CDOM and salinity, which is temporally and spatially variable would be estimated. The results will give an idea about the source of the CDOM, influence of sunlight and the complex circulation patterns and dynamics in coastal regions. Input of CDOM in a water body is found to be accompanied by the input of nutrients and the preference, if any, of particular phytoplankton types to elevated CDOM will be examined. The above parameters would be checked based on the CDOM concentrations in the fresh water, estuarine and marine regions of the estuary in monsoon as well as post monsoon season of 2018. Understanding of the complex characteristics and environmental interactions of the CDOM pool would provide valuable insight into a variety of biogeochemical processes occurring in estuarine and coastal waters.

Key words: Vembanad Lake, biogeochemistry, coloured dissolved organic matter, salinity

The influence of increased warming on the dissolved oxygen concentration in the eastern Arabian Sea: A modeling approach

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Abstract

The oxygen minimum zone (OMZ) present in the central Arabian Sea is the second-most intense OMZ in the world's tropical ocean, with near-total depletion of oxygen at depths from 200 to 1000m. The oceanic dissolved oxygen (DO) concentrations are constantly affected by physical processes such as diffusion and aeration, and biological processes such as photosynthesis and respiration. Studies have shown that the DO concentration decreases with increase in global warming in the recent years (eg. Bopp et al. 2002, Matear and Hirst, 2003). We have used a one-dimensional configuration of the European Regional Seas Ecosystem Model (ERSEM) coupled with the General Ocean Turbulence Model (GOTM) to study the influence of tropical Indian Ocean warming on the dissolved oxygen concentration at a selected location in the eastern Arabian Sea. The ERSEM model that we have used in this analysis has been advanced by including denitrification processes. We have also looked in to the influence of variability of sub-surface temperature and salinity on the DO. The increasing warming and the resultant expansion of the OMZ has implications on the modeled primary productivity in the region.

Keywords: OMZ, Arabian Sea, global warming

Time series analysis of the recurring bloom in North Eastern Arabian Sea

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Abstract

The current warming scenario has profound impact on the biological system and the responses between various components of the ecosystem are always chaotic in nature. The thermodynamic, and biochemical settings of the physiology of organisms are drastically changing over the past decades. The phytoplankton groups, which are the major primary producers over the global ocean, mostly vulnerable to changes, and so it is important to assess its variability in the current scenario of change. The intensification observed in the winter-spring blooming of Noctiluca due to warming as reported by Lotliker et al. (2018) and Gomes et al. (2009) from the North Eastern Arabian Sea (NEAS) has been considered as the focal theme of the present analysis to explain the change in temperature and its impact on these tiny organisms. Remote sensing data of Chl-a/florescence and SST for NEAS (17-25N; 64-72E) from Aqua MODIS are used for the analysis. March being the ideal period of peak bloom, time series analysis of Chl-a and SST for the month are taken care of for the years 2003 to 2017. Derived indices on the time series profile to explain the peak, the amplitude/intensity and the persistence/duration, applying the algorithm developed, in R language, and the co-occurrence of the same with SST pattern shows a curious inverse relation explaining the response of blooming and its frequency to the change in temperature. Preliminary analysis shows dominant role of temperature, especially the temporal variations, in regulating surface chlorophyll patterns. As the present analysis could bring out the temperature driven growth kinetics in a wide temporal extend of a tropical system, this have a large scope on the studies related to the changing climate.

Keywords: Bloom, NEAS, remote sensing, SST, Chl-a

Dynamics of Phytoplankton based carbon in Cochin Estuary

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Abstract

Cochin backwater is one of the productive estuarine systems in India, perhaps the most intensively investigated aquatic system in the country during the last five decades. Phytoplankton community is ecologically very significant as the entire renewable resources in aquatic ecosystems are either directly or indirectly generated by virtue of their capacity of synthesizing organic matter. The magnitude and even the type of the fishery are influenced by the distribution, diversity and abundance of micro phytoplankton species which fluctuate with time and space. Phytoplankton samples were collected monthly over period of one year (2015-2016) from seven stations in the Cochin estuary. Total density of phytoplankton ranged from 56556 cells L-1 to 137492 cells L-1 constituting 76 species. Diatoms were the dominant micro phytoplankton and the maximum cell density was contributed by Chaetoceros curvisetus, C. lorenzianus during pre- monsoon, Coscinodiscus centralis and Spirogyra sp. during monsoon and Cyclotella striata during post-monsoon season. Higher values of chlorophyll a were observed during post monsoon season (17.37 ± 32.67 mg). The minimum carbon content of phytoplankton was 6.64 mg C m-3 (July 2015) and maximum of 11577.5 mg C m-3 (January 2016). Similarly, the primary productivity was maximum during pre-monsoon; this could be due to high inorganic nutrient inputs received from river discharge, that also enhanced phytoplankton production. Productivity also showed significant positive correlation with phosphate, silicate, nitrate and nitrite. The study thus provides current insights on the changes in micro phytoplankton community structure and its production trends in the Cochin estuary.

Keywords: Phytoplankton, Cochin estuary, Carbon

Sediment dynamics, composition and distribution along the Port Blair coast, India

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Abstract

Coastal geomorphology and hydrogeography are governed by variety of physical forces. Detail analysis of sediment texture, grain sizes and composition (organic matter and CaCO3) are proxy measures of paleological history of shoreline, depositional and relict environments. Understanding the geomorphological and sedimentological processes are becoming increasingly important for the management of coastal resources. A total of 210 sediment core samples (appr. 200 gm, 5cm internal diameter, 10cm depth) were collected and analyzed for two years (2013-2015), from the Port Blair bay (PBB) and adjacent area. Result showed that, the sedimentary habitats along the Port Blair coast are of sandy substratum where sand textural class was dominant (mean 84.6% to 96.4%). However, the majority of sites were of fine particle size (128 micron to 239 micron) except JG where very fine sand class was observed (114 micron). % organic matter was observed highest at locations having urban proximity and showed direct association with relatively high silt and clay contents. While CaCO¬3 distribution pattern were opposite and found highest in faraway location where high percentage sand was observed. PERMANOVA result showed significant variation ($p < 0.05$) at all the factorial level (location, season and year) and further confirmed by B-C similarity matrix visual. In conclusions, the results of sediment quality parameters described the overall environmental degradation resulting from human activities making the bay system highly vulnerable, posing potential threats to the human wellbeing and paving the way for coastal health degradation. An integrated and holistic approach for the assessment and carrying capacity of the island ecosystem are highly recommended.

Phytoplankton size classes in coastal waters of northwestern Bay of Bengal using in situ and satellite data

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Abstract

The unicellular micro-organism, phytoplankton, plays a critical role in the modulating aquatic ecosystem. They are the primary producers and foundation of the aquatic food chain and play a critical role in global carbon budget. Although most phytoplankton are intimately linked with all of the aforementioned processes, certain groups of phytoplankton have distinct physiological and biogeochemical attributes that make them specialized functional roles. Many biogeochemical processes are closely linked to phytoplankton size classes and there is growing recognition that satellite maps could provide a useful measure of ocean ecosystem state and function. The size classification method involves partitioning into different size groups namely microplankton (>20 μm), nanoplankton (2 - 20 μm) and picoplankton (<0.2μm). The present study is focused on understanding the variability of phytoplankton concentration in various size classes using in situ and satellite (MODIS-Aqua) data. The study compares the results at two coastal sites (Gopalpur and Visakhapatnam) along north-western Bay of Bengal. The former being influenced by Rushikulya river and later by port and urban discharge. The spatial distribution of phytoplankton concentration, in different size classes, were estimated using regionally tuned model three component "abundance" model of Sahay et al. (2017). The model was validated with the in situ data generated onboard ORV Sagar Manjusha during May 2007, October 2007, January 2008 and November 2008.The model was then applied to MODIS-Aqua data to generate synoptic images. The results depicts that micro-plankton dominates very close to the cost. However, the dominance of pico-plankton increases towards offshore. The outcome of the study could be efficiently used to understand the phytoplankton functional types from space and linking it further with the community composition.

Keywords: Phytoplankton size classes, MODIS-Aqua, absorption coefficient

Climate change impact and forecasting the vagaries of primary production in the Eastern Arabian Sea

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Abstract

Climate change is a biggest environmental challenge causes significant impact on marine ecosystem and primary production in the world oceans. The influence of extreme weather events such as El Niño, La Niña, IOD and cyclone on chlorophyll-a (chl-a) concentration is evident from the recent studies. In this context, the present study made an attempt to understand the variability in chl-a concentration triggered by extreme climatic events and also to forecast the chl-a biomass of the eastern Arabian Sea, which is one of the most biologically productive oceanic provinces in the Indian Ocean. An extensive use of both remote sensing and model data were incorporated in the present study to examine the variations in chl-a and also the variability for the upcoming years. The chl-a data from OC-CCI provides a time series of 20 years (1998- 2017) by merging all the available data from different platforms. The CMIP5 model data under IPCC representative concentration pathway (RCP) scenarios provides time series of various geophysical variables including chl-a for the period 2006 to 2100. The results showed significant variability in chl-a biomass in the study region during the extreme climatic years. Also the analysis of CMIP5 model data revealed that the primary production will be reduced in the future years and it may affect the food web of marine ecosystem, related fishery economy, food and livelihood. Suitable mitigation, adaptive countermeasures, implications of ecosystem conservation and management policies will be helpful to reduce the climate change impact on primary production.

Keywords: Climate Change, IPCC, RCP, chlorophyll-a, Eastern Arabian Sea

Session 2: Coastal Biogeochemical Processes

Optical Characterization of Indian coastal Waters - Influence of biogeochemical processes

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Abstract

Ocean is a habitat of single-celled organisms called phytoplankton. Phytoplankton, is an intrinsic division of aquatic food cycle and are also known to play an important role in sequestering carbon dioxide, via process of photosynthesis. The abundance and variability in phytoplankton population is greatly influenced by various physical and biogeochemical factors in the water column they live in, and can be used as indicators of environmental change. Light, temperature and nutrients are essential factors driving temporal and spatial changes in the phytoplankton community. Freshwater input from rivers can transport both coloured dissolved organic material (CDOM) and suspended particulate material (SPM) to the coast, reducing both water transparency and phytoplankton growth. In addition, re-suspension of sediments from the sea floor may also reduce available light. The long-term trend in the distribution of phytoplankton has been useful for discovering the patterns of variability, which could be potentially used to assess health of the ecosystem. With advancement in the technology, satellite remote sensing has proven its ability, to detect phytoplankton pigment, chlorophyll-a (chl-a), from space at synoptic scale. The advantage of this technique is to have long term, cost effective, continuous data, which is difficult to generate with the manual sampling. However, this technique has limitation in the coastal waters, in terms of accuracy, due to the optical complexity. The standard bio-optical algorithm often fails in coastal waters due to interference of chl-a signal with other optically active substances (OAS) such as Coloured Dissolved Organic Matter (CDOM) and Total Suspended Matter (TSM). The standard algorithm takes the ratio of Remote Sensing Reflectance (Rrs) in blue and green bands and assumes that the peak reflectance shifts to longer wavelength with increase in chl-a concentration. For better accuracy of satellite retrieval of chl-a it is necessary to test this hypothesis. The study presents optical characterization of Indian coastal waters using 191 quality checked in-situ hyperspectral Remote Sensing Reflectance (Rrs). Based on spectral variability of Rrs, Indian coastal waters could be classified into four water types. The geographical distribution showed that Type-1 water encountered farthest (38±21 km) whereas Type-4 was closest (6±3 km) to the coast. The spectral pattern of Rrs could be clearly attributed to the variability in concentration of OAS, the distribution of which depends upon the physical and biogeochemical processes. The pattern and distribution of Rrs and OAS indicates the primary source of physical, optical and biogeochemical parameters affecting the Rrs is from land discharge and / or coastal processes.

Keywords: satellite, chlorophyll, optically active substances, coastal waters, reflectance

Some aspects of volatile halogenated organic compounds (VHOC) from coastal eastern Arabian Sea

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Abstract

Halocarbons released from oceans are important in atmospheric processes as it increase breakdown of ozone in marine boundary layer. Their abundance in seawater is influenced by water column conditions and phytoplankton community. In the present attempt, halocarbon abundances together with pigment composition were monitored in the coastal waters of the central eastern Arabian Sea. Variability in pigments was used to understand the influence of phytoplankton community composition on halocarbon concentrations in this region. Halocarbons and phytoplankton pigments showed strong short-term variability, with maximal values generally associated with southwest (summer) monsoon high productivity. Decreased chlorocarbon abundances in subsurface layers indicate their possible consumption under oxygen deficient conditions, particularly during the summer monsoon and fall-intermonsoon periods. Halocarbon abundances were in the order CHCl3, CH2Br2, CHBr3 and CCl4. The CHCl3 along with the brominated compounds showed significant positive relationship with chlorophyll and marker pigments such as fucoxanthin suggesting the importance of diatoms and prymnesiophytes in the Arabian Sea and rising the possibility of satellite based retrieval based on empirical models.

Keywords: Halocarbons, marine boundary layer, phytoplankton

Role of Southern Ocean in global climate change: Salient findings from Indian Southern Ocean Expeditions

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Abstract

The Oceans play a major role in shaping the Earth's climate, and each oceanic region has different significance in influencing the global climate change scenario with their potential for drawing-down the atmospheric CO2. In this context, the Southern Ocean (SO), being the world's largest high-nutrient low-chlorophyll (HNLC) regions, plays a significant role as a sink for atmospheric CO2 via its solubility and prevailing biological pumps. It thus plays a pivotal role in the global carbon cycle and climatic regulations through biogeochemical fluxes of carbon, nutrients etc. from the ocean surface to the deep interior. The efficiency of the biological pump depends on a range of environmental and biological factors (such as type of phytoplankton/zooplankton inhabiting), which in turn are influenced by climate change. It is observed that the productivity in SO regions is closely related to the hydrodynamics across the fronts and convergence zones, thereby varying the phytoplankton, the prey-predator relationship and food-web structure and biogeochemical cycle. Scientific insight gained from physicochemical and biological studies performed during Indian Southern Ocean Expeditions (ISOE) in the last decade highlights some interesting findings and emphasizes India's research activities in the SO region for better understanding of the SO processes, biogeochemical cycles, marine productivity and global climate change scenario. Under the aegis of Ministry of Earth Sciences (MoES), Government of India, concerted efforts are put in place by NCPOR to carryout research in the Indian sector of the SO since 2004, with a primary focus to comprehend the role (response) of the SO in (to) regional and global climate variability. This talk would include some of the salient findings of ISOE which highlights: causal mechanisms of variability in phytoplankton community structure and productivity among frontal regions [i.e., Subtropical Front (STF), Sub-Antarctic Front (SAF) and Polar Front (PF)], patterns of phytoplankton biomass distribution within and among the fronts, role of diatoms in deciphering environmental change, food-web dynamics, bio-optical characterization of water column etc. in this lesser-understood region in the SO.

Keywords: Southern Ocean, productivity, physical forcings, biogeochemistry, climate change

Arabian Sea and Nitrous Oxide; a stable isotope story

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Abstract

Nitrous oxide is an atmospheric trace gas, which was first identified as an agent in stratospheric ozone depletion and later classified as an important greenhouse gas with a global warming potential 300 times that of CO_2 on a molecular basis. Its concentration of 275 ppbv (pre-industrial period) in the ambient air has increased to the current value of 325 ppbv and oceans account for 25-30% of global N_2O emissions. Marine N_2O sources and processes are poorly understood due to the paucity of data. There is a lack of detailed study in/to the role of nitrous oxide in oceanic nitrogen cycle and global warming. In the ocean, N_2O is majorly produced through nitrification and denitrification; however, there exist uncertainties about the major pathways responsible for its production. In the coastal waters of Southwest Arabian Sea, N_2O was highly concentrated at the surface as compared to the other oceanic waters especially in the upwelling regions. Sea-to-air N_2O flux measurements shows an existence of N_2O source. Stable isotopic study of N2O including δ15Nbulk, δ 18O, δ 15Nα and its site preference (SP) were also conducted for the first time in this oceanic regions to study the production pathways. The dissolved oxygen, nutrients and stable isotope results suggest that the nitrification process (through NH_2OH followed by NO oxidation) are mainly responsible for the N_2O production.

Keywords: Nitrous oxide, CO_2, nitrification, denitrification

Export of dissolved inorganic carbon to the Northern Indian Ocean from the Indian monsoonal rivers

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Abstract

Rivers are strong source of dissolved inorganic carbon (DIC) to the coastal waters and account for ~38% of the total fluvial carbon transport to the global oceans. The major processes that are controlling the riverine export of DIC include, chemical weathering of carbonate and silicate rocks, decomposition of soil organic carbon in the basin, dissolution of atmospheric carbon dioxide (CO2) and exchange with the ground water in rivers. The aim of this study is to identify the major sources of DIC in the Indian monsoonal rivers and to estimate their export fluxes to the north Indian Ocean. Samples were collected from a total of 27 estuaries along the Indian coast during the wet period. DIC and δ13CDIC were measured using Coulometer and Isotope Ratio Mass Spectrometer attached to Gas Bench, respectively. Total export flux of DIC from each river was estimated by multiplying the mean concentrations of DIC in the freshwater region of an estuary with the mean annual discharge. DIC concentrations in Indian estuaries widely varied from 3.4 to 73.6 mg l-1 due to significant variability in the size of the rivers, precipitation pattern and lithology in the catchments. The range of δ13CDIC (-13.0 to -1.4‰) indicates that DIC is largely contributed by weathering of silicate and carbonate minerals. Indian monsoonal estuaries annually export ~10.4 Tg of DIC to the northern Indian Ocean and account for 2.5% of the total DIC export by the world major rivers to the global ocean. Our study demonstrates that significant spatial variability of the hydrological, lithological and environmental conditions in the catchments and in-stream processes (autotrophic production and heterotrophic decomposition of organic matter) strongly controls the DIC in the Indian monsoonal rivers.

Keywords: dissolved inorganic carbon, sources, export flux, Indian rivers, Indian Ocean

Distribution of associated biogeochemical parameters of carbonate system and air-sea exchange of CO_2 in the east equatorial Indian Ocean

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Abstract

The reversal of surface winds and associated surface circulation twice a year along with Indian Ocean Dipole (IOD) and Indonesian through flow (ITF) from the western equatorial Pacific Ocean makes the equatorial Indian Ocean highly biogeochemically vibrant zone. However, lack of equatorial divergence makes the equatorial Indian Ocean least productive region in comparison with equatorial Pacific and Atlantic. Moreover, eastern equatorial Indian Ocean (EEIO) being a part of the Indo-Pacific warm pool is an area of intense air –sea coupling and in turn influencing regional and global climate variability. Two multidisciplinary cruises were undertaken wherein intense sampling carried out during July-August 2016 and Nov-Dec 2017 in the EEIO covering meridional (5˚N to 8.4˚S along 100˚E) and zonal (100˚E-88˚E along 8.4˚S) sections. Our aim was to cover the distribution of hydrographic and biogeochemical features during boreal summer and winter. In this study, we made an attempt to understand the distribution of seasonally varying associated biogeochemical parameters of carbonate system like pH, DIC and pCO2 along the both transects while highlighting the temporal variability of air-sea exchange of CO2 in EEIO. The surface pH values ranged between 8.085-8.052 (total scale) in the meridional section and 8.073-8.031 in the zonal section during winter where as during summer it varied between 8.1-8.05 in the meridional section and 8.092-8.04 in the zonal section. Less pH values (7.0-7.3) were observed in the oxygen minimum zone between 200-800m in meridional sections (5˚N-2˚N) during both the seasons, which indicates higher rate of oxic-degradation at these depths. TCO2 values ranges between 1820-1940µM in the surface waters and 2250-2400µM in the deeper waters (1000m). In the meridional sections asymmetric distribution of TCO2 was observed compared to the zonal sections, may be due to the highly dynamic physical processes along the meridional transects. From the pCO2 values (Average surface pCO2 ranged between 423 ±12.37 µatm and 414 ± 15.24 µatm in meridional and zonal sections respectively), it can be inferred that EEIO is acting as a source for the atmospheric carbon dioxide during both the seasons.

Key words: Equatorial Indian Ocean, Air-Sea Exchange, Carbonate System

Study on the variation of dimethylsulphide and associated compounds in the coastal waters of Goa, West coast of India

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Abstract

The concentration of dimethylsulphide (DMS), an important gas with implications to the radiation balance of the Earth generally depends on the concentration of dimethylsulphoniopropionate (DMSP), an osmolyte in algal cells. Eutrophic coastal and upwelling zones are generally observed to have higher concentration of DMSP and DMS in comparison to oligotrophic open ocean waters. We present time series data on total DMSPt, DMS and total DMSOt at a coastal time series station off Goa (CaTS-G5). The seasonal and inter-annual variation of DMS and associated compounds is discussed in the light of changing environmental and biological conditions, and finally, an estimate of the DMS flux is presented. Concentrations of DMSPt, DMS and DMSOt were measured from Sep 2009 to Dec 2013.DMSPt varied between 0.35 and 252 nM (avg. 24±32.3 nM) and DMS varied from 0.5 to 442 nM (avg. 22.5±48.3 nM). DMSPt, DMS and DMSOt showed high spatial and temporal variability with maximum concentrations observed during the southwest monsoon (SWM; Jun to Sep), fall inter-monsoon (FIM; Oct), and during the spring inter-monsoon (SIM; Mar – May). Also, 2010 and 2011 was relatively less productive in terms of DMSPt and DMS as compared to 2009, 2012 and 2013. Highest DMS concentration (442 nM) observed during the study period was seen to be associated with seasonal anoxia during September 2009. DMSOt distribution closely resembled that of DMSPt and DMS with an overall variation from 0.56 to 185.9 nM (avg. 27.8±30.1 nM). Though in general, DMSPt profiles followed the Chlorophyll a (Chl a) pattern, the relation between the two was weakly positive. The high concentration of DMSPt and DMS during SWM and FIM may be attributed to the abundance of phytoplankton (diatom and dinoflagellate), whereas during SIM to Trichodesmium and mixed diatom bloom. Average surface DMS during the study period was 18.5 nM, whereas average DMS flux was estimated to be 20.9 µmol S m-2 D-1.

Keywords: DMS, DMSPt, DMSOt, Arabian Sea, anoxia, phytoplankton.

Nitrous oxide contribution from Mangalavanam coastal wetland, Kerala

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Abstract

Continuous monitoring has been carried out in Mangalavanam coastal wetland to elucidate the role of a tropical pristine mangrove ecosystem in contributing greenhouse gas - N2O to the atmosphere. The study confirms that the ecosystem hold significant amount of carbon and nitrogen in water and sediment. Higher nitrogen (5.71±3.70 mgL-1) along with carbon (47.00±17.44 mgL-1) concentrations has slightly lowered C: N ratios (9.58±2.77). A strong positive correlation exist between organic carbon and nitrogen ($r = 0.916$, with $\rho = 0.000$), suggesting the association of nitrogen with organic carbon and can be considered as a measure of organic nitrogen in the system. Despite of high nitrogen concentrations, low dissolved N2O (3.78±0.99 nM) were observed during the study. This has also led to lower water to air N2O fluxes making the wetland a weak source of N2O to the atmosphere. Any disturbance to such pristine ecosystems is likely to upset its carbon-nitrogen balance, may releases N2O as emission which is likely to contribute to global warming and climate change. Therefore, it is more important to conserve our existing pristine mangroves for their greater potential in storing carbon and nitrogen.

Keywords: wetland, carbon, nitrogen, nitrous oxide

Environmental interaction of Gelatinous Zooplankton swarm in the pelagic food web of Sundarbans

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Abstract

The study addressed the impact of Ctenophore Swarm on the distribution, abundance, biomass and community structure of Mesozooplankton in the coastal waters of Sundarban and its impact on the pelagic fisheries. The swarm stations of Sunderbans experienced high Sea Surface Salinity of 24.37 psu and low Sea Surface Temperature (SST) of 18.89°C compared to other stations. The average dissolved oxygen (DO) in the surface waters of swarm stations (5.42ml/l) was found to be lower than in the non-swarm stations (6.32 ml/l). The average surface nutrient concentration (NO3- 3.26 µM, NO2- 0.35 µM, PO43- 3.56 µM, SiO4- 7.17 µM, NH3 0.36 µM) in the swarm stations differed significantly with those of non-swarm stations (NO3- 5.57 µM, NO2- 0.63 µM, PO43- 3.61 µM, SiO4- 11.25 µM, NH3 0.33 µM). Mean surface zooplankton biovolume (22.42 ml/m³) and numerical abundance (5366.17ind/m³) were highest in the swarm stations due to ctenophore swarm. Low chlorophyll ranged from 0.66-0.73 µg/l in the swarm stations. Generally, Copepoda forms the dominant mesozooplankon taxon but in the swarm stations Ctenophora was dominant, followed by Cnidaria. In the non-swarm stations a notable shift in community structure was observed with Copepoda being the dominant group followed by Chaetognatha. The Ctenophore swarm was mainly due to Pleurobrachia pileus. In addition Pleurobrachia globosa, Beroe ovata and Beroe gracilis were present sporadically. Dominant zooplankton present in the swarm stations were Clytia lomae, C. hemisphaerica, C. discoida, Ectopleura sp., Diphyes dispar, Lensia subtilis, Lensia subtiloides, Bassia bassensis and Sulculeolaria sp. whereas the non-swarm station comprised of Acartia danae , Oithona similis, Acrocalanus longicornis , Acrocalanus gibber and Belzebub hanseni. Our result points to a link between ctenophore swarm and eutrophication that leads to sudden outburst of ctenophore swarm and decreased tertiary productivity associated with them.

Keywords: Ctenophore swarm, Pleurobrachia pileus, Pleurobrachia globosa, Eutrophication.

Temporal variations in the concentration of metals in Vembanad Lake in relation to 2018 flood

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Abstract

The massive flood affected the South Indian state of Kerala in August 2018, due to unusually high rainfall during the monsoon season. It has been declared as a calamity of severe nature. This study is an attempt to compare the total metal concentrations in the Vembanad Lake on a temporal basis-comparing the pre & post flood metal concentrations in the water samples. Water samples were collected from 21 stations of Vembanad Lake extending from Thevara Ferry to Aroorkutty and were analyzed using the standard procedure (APHA 2005). Eleven metals,viz.Cadmium,Lead,Chromium,Aluminium,Vanadium,Calcium,Titanium,Magnesium, Zinc,Cobalt,Copper,Iron & Nickel have been analysed. Some of the metals showed an increase in concentration in the post flood sampling while others remained almost similar to the pre flood concentrations. Concentrations of important heavy metals like Cd, Pb & Cr showed a slight increase in the post flood samples. Concentration of Al decreased in the post flood samples .V, Ca, Ti, Mg, Zn, Co & Co showed an increase in concentration in the post flood samples when compared to the pre flood samples. The concentrations of Fe & Ni remained almost similar for both the sampling periods.

Keywords: Metals, Vembanad Lake, Flood

An unusual occurrence of Trichodesmium bloom in the lagoon of Minicoy Island, Lakshadweep

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Abstract

An unusual occurrence of algal bloom belong to Cyanobacteria, Trichodesmium erythreum was observed in the lagoon waters of Minicoy Island, Lakshadweep, during May 2018. Water quality parameters such as temperature,salinity,pH,nitrates, nitrites and phosphate were recorded. A significant reduction in nitrate concentration was noticed during the bloom period, whereas, relatively high concentration of phosphate was observed. Around 4808 filaments of Trichodesmium were observed. Trichodesmium density was measured to the tune of 3.09×10^7 cells l^{-1}.

Keywords: Cyanobacteria, Algal bloom, Trichodesmium, lagoon, nutrients, oligotrophic

Bulk Organic Matter Profile in a Tropical Mangrove Ecosystem of Cochin, Kerala, Southwest Coast of India

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Abstract

Background: Mangrove ecosystems are considered to be highly productive and have an inevitable role in regulating the biogeochemical cycles of the coastal environment. Hence, the present study aims to understand the sedimentary organic matter dynamics of core sediment in a tropical mangrove ecosystem, Cochin region, Southwest Coast of India. Methods: Core sediment was collected from Malippuram, Cochin region (10001'12"N- 76012'55"E) on March, 2018. Pipette analysis was adopted to determine the texture of the sediment. Total organic carbon (TOC) was estimated by TOC analyzer (VARIO TOC SELECT-Elementar). Total Carbohydrates (CHO), Protein (PRT), Lipid (LPD), Tannin and Lignin (TLN) and Pigments in the sediment samples were analyzed spectrophotometrically. Results: Textural analysis reveals a predominance of sand (39.58% -98.45%), followed by silt (0.27%-41.80%) and clay content (0.08%-18.62%). TOC of sediment samples ranged from 0.08% to 18.61% with maximum value recorded at the surface and minimum observed at 80 cm depth. The total CHO, PRT and LPD concentrations varied from 1.53 mg/g to 31.85 mg/g, 0.23 mg/g to 46.65 mg/g and 0 to 2.43 mg/g, respectively. The TLN varied between 4.09 mg/g and 360.47 mg/g. The current study reveals low PRT/CHO ratio towards the bottom of the sedimentary column (20-90 cm depth) and high PRT/CHO ratio is observed in the upper 20 cm depth. The study area is characterized by large content of pigments and its degradation products in the surface layer and a significant decrease towards the bottom of the core. Conclusion: The study revealed that organic matter contents are enriched in the surface layers of mangrove core sediments. The relative distribution of organic matter followed the order: PRT > CHO > LPD with maximum values obtained at the surface and minimum towards the bottom. The results suggests that mangrove ecosystems can act as an efficient sink for organic carbon burial and its preservation in the sediments.

Key words: Mangrove ecosystem, organic matter, core sediment, carbon sink

Mapping vulnerability of coastal villages of Karnataka towards sea level rise

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Abstract

The coastal zones have always been a place of attraction for human settlement and living. Climate change induced sea level rise can cause catastrophic events in the coastal area. Increased rate of sea level rise in 21st century compared to the past also increased the vulnerability of coastal zone. The elevation of coastal zone is a major variable which is used for defining the vulnerability of coastal zone. This study analyses the proportion of the land area and population distribution in the Low Elevation Coastal Zone (LECZ) in different villages along Karnataka. The areas of LECZ have been estimated using Digital elevation maps from NOAA. The interpolated maps of coastal population are made by GRUMP project data for the urban-rural population. The village wise estimates of LECZ area and the population have been categorized using boundary files from DataMeet project which also has been verified by digitizing the maps of the village boundaries from various sources. The GIS based maps are produced by Arc GIS 10. The results highlight the villages with a high degree of exposure to coastal flooding due to the sea level rise in Karnataka. The information helps to provide essential mitigation and adaptive plans for the coastal villages.

Keywords: coastal zones, Low Elevation Coastal Zone

Marine Ecosystem exploration near shipwreck location at Baruva coast by 'ROV SONIYA'

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Abstract

Marine ecosystem is a largest aquatic system in the world covering more than 70% of the planet extending from the shore to the dark sea floor. It includes tidal zones, estuaries, the mangrove forest, the sea floor and coral reefs. Marine eco system is very important because marine life is protected from predators. It supports marine life such as tiny planktons, fish, crustaceans, reptiles to survive. In this paper I am mainly focusing to explore naturally formed eco system at shipwreck location. Mostly shipwreck leads to formation of artificial reef, providing habitat and shelter for many living marine organisms. Tiny fragile animals called coral polyp's lands and form lime stone skeletons on the hard surface of wreckage. Not only shipwreck is an artificial reef, there are some other types of artificial reefs such as tyres, 3-D printed structures, concrete structures, submerged temples etc., To explore this shipwreck eco system, I have selected a shipwreck location at Baruva coast nearby Baruva village in Sompeta mandal, Srikakulam district, Andhra Pradesh 532263 located coordinates 18.53o N 84.35o E elevated at 10m. Baruva coast was used seaport in the era of British colonial rule in India up to 1948. In July 1917, a ship carrying goods sank in the coast of Baruva. Now I have taken an initiation to explore this shipwreck with help of remotely operable underwater vehicle named ROV SONIYA. A continuous videos and photos footage of shipwreck is collected at different time intervals in day and night time to capture the eco system. By using ROV SONIYA we can explore this artificial reef more safely when compared to human exploration. There will be no disturbance to eco system when compared to human exploration.

Keywords: ecosystem, ROV SONIYA, shipwreck

Microzooplankton community structure in response to an event of gelatinous swarm in the coastal waters of Sundarban mangrove

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Abstract

The present study highlighted the effect of Ctenophore swarm on the species composition, abundance and biomass of microzooplankton community in the coastal waters of Sundarban Mangrove region of Eastern India. A total of 40 species of microzooplankton were identified from the three study stations (which experienced swarming caused by Pleurobranchia pileus) out of seven study stations. The maximum diversity (65%) was observed in dinoflagellates, followed by ciliates, which contributed 30%, and foraminiferans, which made up 5% of the total microzooplankton community. Among the dinoflagellates in the swarm stations, genus Protoperidinium was the most dominant. Protoperidinium depressum was found to be the most abundant species in this group followed by Tripos furca, Noctiluca scintillans, Tripos trichoceros, Protoperidinium conicum and Protoperidinium leonis. Among the ciliates, loricate tintinnids were more abundant than aloricate ciliates. Tintinnopsis and Leprotintinnus were the two most prominent genera among the ciliates. Leprotintinnus simplex, Leprotintinnus nordqvistii, Tintinnopsis butschlii, Tintinnopsis gracilis, Favella ehrenbergii were some of the major species of ciliates present in the swarm areas. Significant variations of physico-chemical parameters were observed between the swarm stations and non-swarm stations. High Salinity (24.37 psu) and low sea surface temperature (18.89 °C) values were obtained compared to non-swarm stations. The mean dissolved oxygen (5.42 ml/l) in swarm stations was significantly lower than the dissolved oxygen (6.32 ml/l) in the non-swarm station. The mean surface water nutrient concentration of nitrate (3.26 µM), nitrite (0.35 µM), phosphate (3.56 µM), silicate (7.17 µM), and ammonia (0.36 µM), were recorded from the swarm stations. A low chlorophyll range (0.66-0.73µg/l) in the swarm stations from surface to sub-surface depths of water maybe due to the sloppy feeding nature of the gelatinous zooplankton that caused the swarm.

Keywords: Microzooplankton, Ciliates, Dinoflagellates, Ctenophore swarm, Sundarbans

Humification rate in Kerala Mangroves – Assessment of Spatial and Temporal variations using UV-Visible Spectroscopy

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Abstract

Knowledge about the organic matter humification process are essential for understanding the carbon biogeochemical cycles. The aim of this study is to analyze relationship between the properties of humic acids and extent of humification in mangrove sediments using UV-Visible spectroscopic technique.Sediment profiling has been done on Kerala mangroves by making a geographical differentiation in to Northen ,Central, and Southern parts of Kerala. The temporal variations (pre-monsoon and monsoon) in humification was also attempted in the study area. The UV-Visible absorbance of isolated humic subatances were measured at wave lengths of E(205,250,260,280,360,465,472,665,600,670,nms).The E465/E665(Esquven ratio) decreases with increasing molecular weight and condensation of aromatic constituents and is believed to serve as an index of humification. All stations except the sample from the core sample of Asramam pointed out higher humification and low degree of aromatic condensation and infers the presence of relatively large proportion of aliphatic structures.The E280/664 or E472/664 ratios also supported this.Less intense bands are obtained at 205 nm and 250 nm and these showed the presence of polar functional groups such as hydroxyl, carbonyl, carboxyl and phenolics . High E270/400 and, E280/472 (range at7.5 to 8.5 nm) ratios showed the degradation of phenolic/quinoid core of humic acid as well as proportion between the lignin and other materials at the beginning of humification. The quantity of isolated humic acids was higher for pre-monsoon than monsoon season.

Key Words: UV-Visible spectroscopy, humic acids, Sediments, humification

A study on the biochemical composition of Arctic Kongsfjorden sediments

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Abstract

Kongsfjorden is a glacial fjord which is influenced by the Atlantic and Arctic water masses. The spatial variability of the biochemical composition of the fjord sediments was studied during July 2016. The presence of the sedimentary Proteins, Carbohydrates and Lipid components was analyzed and studied with the support of Biochemical Indices and Elemental Ratios. The Kongsfjorden sedimentary system was dominating with the carbohydrate concentration in comparison with proteins and lipids. The labile fraction was maximum towards Open Ocean influenced by Atlantic water mass and minimum near to the glaciers. The fjord sediments were found to be with aged and less degradable organic matter with a low quality of labile organic matter.

Keywords: Kongsfjorden, Sediments, Biochemical Composition

Spatial variations of non-algal particles and CDOM in the coastal and open ocean waters off Kochi, South Eastern Arabian Sea: Implications for light absorption budget of the water column and biogeochemistry

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Abstract

The characterizations of optical properties in different portions of the ocean are necessary steps for using optical measurements, performed by in situ and remote platforms as tools for biogeochemical studies. This study characterizes the optically active substances and their coupling to hydrographic conditions in the poorly studied waters off Kochi. The samples were collected onboard FORV Sagar Sampada 371 cruise from off Kochi. The coastal samples were collected from 10m to 50m bathymetric region and open ocean samples were from 100m to 2000m stations. The slope of the Colored Dissolved Organic Matter (CDOM) absorption spectrum varied within a short range around 0.0065 nm−1 (SD = 0.0028 nm−1). When data from coastal and open ocean waters were considered, the relationship between phytoplankton absorption and chlorophyll a concentration was generally similar to the previously established for pre-monsoon season waters. Our coastal data, show that significant departures from the general trend may occur due to phytoplankton composition, pigment packaging and cell size. The absorption budget at 440 nm was highly variable with a relative contribution of non-algal particles at coastal station ranged between 5–60% and open ocean station ranged between 1–5%. Higher turbidity (Avg. 0 .823 ± 0.98 NTU) even during pre-monsoon at coastal stations waters were observed. CDOM and non-algal particles relative absorption ranged more than 50% in the coastal waters, which makes serious implication on the bio-geochemistry of the region. The relative contribution of the non-algal particle absorption was decreasing from coast station to the offshore stations as expected. A detailed time series investigation is required to study the effect of on these non-algal particles and CDOM on the water column light absorption budget and its effect on the biogeochemistry of the coastal waters off Kochi.

Keywords: Pre-monsoon, non-algal particle absorption, CDOM, light absorption budget, Coastal waters off Kochi.

Cyclone induced Chlorophyll-a bloom in the Arabian Sea in 1997—2015

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Abstract

Tropical cyclones are weather systems that alter the dynamical processes in the oceans. The strong winds associated with cyclone bring in subsurface nutrients into the surface and thus enhance the Chlorophyll–a (i.e. Chl-a bloom) after the cyclone passage. In the North Indian Ocean, Arabian Sea experience fewer numbers of cyclones as compared to that over the Bay of Bengal and the cyclones occur primarily during the post-monsoon period. A comprehensive analysis of cyclone induced chlorophyll-a bloom over the Arabian Sea for the period 1997–2015 is made using Ocean Colour Climate Change Initiative version 3.1 data. The mechanisms that trigger the cyclone-induced Chl-a bloom are also studied using Ekman Pumping Velocity and Translational speed. Our analysis suggests that the Chl–a is generally enhanced in five days after the cyclone passage, and was highest for the cyclones Gonu (2007), Onil (2004) and Mukda (2006) and was about 1.2—1.8 mg/m3.

Keywords: cyclone, Gonu, Chl-a, bloom

Session 3: Biogeochemistry and Fisheries

The Biogeochemistry behind recruitment success in Fishery.

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Abstract

Post-recruits of most fish stocks exhibit broad tolerance limits to environmental conditions like temperature, salinity, dissolved oxygen, pH etc., and therefore these fishes have wide distributional range and better resilience to climate variations. Unlike this, early ontogenic stages of most fishes have only narrow tolerance limits to environmental variables and accordingly have limited distributional range restricted mostly to the pelagic waters. Hence early stages of fish are more susceptible to environmental perturbations. Recruitment success essentially is an additive process to the fishery is dependent on the success in spawning and early ontogeny, whereas loss in fish biomass occurs through predation and fishing. The spawning seasons of most fishes are delicately adjusted through pheromone controls to commence few weeks prior to the onset phase of productive seasons. However, recruitment success/ failure are dependent on aggregation/dispersal of fish eggs and larvae under the influence of prevailing environmental conditions, over which the fish has no control. This explains the inter-annual fluctuations in fishery especially those in small pelagic fish stocks with short life-spans. Several physical, chemical, biological and geological factors influence and modulate larval growth and recruitment success in fishery. Fish in their early stages of ontogeny depend on optimum environmental conditions for survival and growth as explained by the Optimum Window Concept and therefore even subtle deviations in one or more environmental factors from the optimum range will negatively affect the year-class strength. Aggregation of fish eggs and larvae in productive waters under the influence of upwelling, convective mixing, river plumes, cold-core eddies etc., promote larval survival and growth rates whereas strong surface currents, offshore Ekman transport, turbulence etc., results in dispersal of eggs and larvae to less favourable grounds leading to heavy mortality. Further, phenotypic plasticity in swimming and manoeuvring abilities and feeding (mouth gape) of the newly hatched larvae, pre-flexion, flexion and post-flexion stages of ontogeny largely determine the suitability of the spawning and nursery grounds of fishes. Coastal upwelling areas characterized by strong new production are the most preferred grounds (peak spawning) for larvae with good swimming abilities but having restriction on food (size class) selection. They can make use of the microbial loop that exists in the coastal oligotrophic waters prior to the onset of upwelling to tide over the feeding limitations and then effectively feed on the diatoms, copepods and dinoflagellates that succeed with advancement of the upwelling process. Secondary peaks in spawning are mostly associated with regenerated production mediated through bacterial degradation of sinking organic matter. Important physical and biogeochemical processes that influence the fishery along the south-west coast of India, an Eastern Boundary Upwelling System (EBUS) are discussed here.

Keywords: fish stocks, recruitment, Eastern Boundary Upwelling System

Demonstration of a coupled biophysical model for the prediction of potential fishing zones

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Abstract

The operational Potential Fishing Zone (PFZ) Advisory by the ESSO-Indian National Centre for Ocean Information Services has a significant impact on the livelihood of the coastal community of India. The advisories are provided to the fishermen on a daily basis utilizing remotely sensed sea surface temperature (SST) and chlorophyll-a (Chl-a) data from NOAA-AVHRR and MODIS-AQUA and/or Oceansat-2 satellites respectively. Sometimes it becomes a major challenge to retrieve SST/Chl-a data from satellite images, particularly during the extensive cloud coverage. To overcome this operational difficulty, the satellite data was replaced by coupled physical-biogeochemical model data capable of simulating the ocean features leading to PFZs. The use of model data provides additional advantage of transforming the existing service from advisories to forecast. The seasonally varying ocean features from satellite retrieved high resolution SST/Chl-a were compared with model simulated high resolution SST/Chl-a data. In comparison, the average length of PFZs identified from satellite (model) data (2010-2016) for off Gujarat is 27.80 ± 7.2 km (33.07 ± 3.2 km) whereas for off Andhra Pradesh, it is 28.27 ± 10.9 km (52.48 ± 8.7 km). Considering the capability of model in identifying PFZs, the existing advisory service can be transitioned into a short term PFZ forecast. In the future direction, the implementation of a fully-coupled individual-based end-to-end model for small pelagic fish has been initiated to explore the environmental conditions associated with interannual and intraseasonal modes which are believed to be the driving force, controlling variability in fish populations.

Keywords: PFZ, ROMS, Satellite image, SST, Chlorophyll-a.

Surrogate datasets addressing the challenges in marine ecosystems: specific case studies on larval movement, fishing grounds, inter annual fluctuations and distribution in fishes and coral reef bleaching

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Abstract

The advent in satellite remote sensing and modelling applications have paved way for spatial and temporal synoptic scale datasets often at high resolutions. These datasets are looked upon as proxies or surrogates for data deficient marine ecosystem related research problems. In this lecture, the applications of such data sets in identifying the essential fish habitats, such as spawning grounds, nursery grounds and fishing grounds, as explained in the Cushing's triangle is explored. Further the analysis and inferences made out of such datasets are utilized to infer and explain the inter-annual variability and distribution of small pelagic fishes and their demersal counter parts. The widely used Sea Surface Temperature (SST) data sets have given some remarkable observations related to coral reef bleaching in the Andaman Sea. The major environmental variables affecting marine ecosystems and the possible forecasts made for such variables and the impact these variables will have on the marine ecosystems in a climate change scenario is deliberated upon.

Keywords: data deficiency, climate change, prediction, fish habitats, demersal, pelagic, satellite remote sensing, modelling

Hypoxia and Its Consequences in the coastal waters off Kochi – An overview of the new project initiative under KUFOS-INCOIS center

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Abstract

Coastal hypoxia is defined as the natural and/or anthropogenic dissolved oxygen (DO) depletion in coastal waters to a certain level (< 30% saturation or < 2 mg/L = 62.5 µM) which has been recognized as a world –wide phenomenon since the late 1960s. The occurrence and extent of coastal hypoxia has risen over the last century from ~ 20 sites before 1950 to ≥ 400 sites at the beginning of this century, due to increased anthropogenic discharges of nutrients and organic matter. Similarly, there is are also evidences for hypoxic events in shelf systems, mainly in areas subject to upwelling and is potentially linked to regional climatic variations of physical forcing factors. Kochi is the second largest city along the west coast of India and one of the finest natural harbours in the country. In recent years, great concern has been expressed with regard to deterioration of Cochin backwaters and consequent loss of supportive functions of this wetland system, especially due to urbanization, industrialization and agricultural activities. Considering the economic importance of Kochi, these activities are expected to increase in future. The resultant increased marine transport of nutrients and other toxic metals through the backwaters are likely to upset the coastal ecosystem. Moreover, the Arabian Sea, which has been identified as one of the highly vulnerable region following its mid-depth oxygen deficiency and associated denitrification, is bordering this coast. Located between these two environmentally sensitive zones, the coastal waters are vulnerable to the changes in the backwaters as well as the Arabian Sea. Thus, the coastal waters necessitate a critical evaluation of the nature and quantum of inputs to the Arabian Sea as well as their assimilative capacities.

The proposed project is focusing on the seasonal variations in upwelling and hypoxia in the coastal waters off Kochi up to a depth of 100m (6 selected stations and sampling was done at 0, 5,10, 20, 30, 50 and 75 m depths). The water column variations in general hydrography, chlorophyll, dissolved oxygen, nutrients, TOC and hence the associated nitrification/denitrification status of the study area is examined in detail. Based on these combined physico – chemical observations we will also correlate it with the community structure of phytoplankters as well as benthic organisms. Two samplings were completed in the months of November and December, 2018. The concentration range was Ammonia 0.011 – 0.349 μmol/L , Nitrite 0.55 - 0.694 μmol/L , Nitrate 15.447 – 29.479 μmol/L , Phosphate 0.014 - 2.511 μmol/L and Silicate 0.984 – 6.68 μmol/L . The DO level varied from 4.15 - 5.34 mg/L and TOC varied from 0.96-5.63mg/L. The study in general showed an increase in nutrient concentration towards the coastal stations than the off shore ones.

Key words: Hypoxia, coastal waters, nutrients, nitrification/denitrification

A study on the effect of Astaxanthin in fresh water ornamental fish Koi Carp using Erythrocyte count (rbcs) before and after stress.

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Abstract

The determination of hematological parameters of freshwater fishes gives an idea of their physiological status and influence of various environmental factors (Ramaway and Reddy, 1978). Ornamental fish keeping forms an important commercial component of aquaculture. Shrimp waste is one of the important natural sources of carotenoid (Shahidi, et al., 1998,). This experiment involves the collection of shell of deep sea shrimp, extraction of astaxanthin, preparation of astaxanthin incorporated feed and feeding of Koi Carp. To get 10 ppm, 25 ppm and 50 ppm astaxanthin in feed, 7mg, 17.5mg and 35mg astaxanthin was added, respectively, in 700 g of powdered feed. The experimental animals were divided into four groups. T1 T2, T3 and T4 as control, 10 ppm, 25 ppm, and 50 ppm astaxanthin incorporated feed respectively. At the end of the feeding trial, fishes were systematically captured for blood sample collection. Blood samples were transferred at 4°C to laboratory for analysis. Blood was collected from the two fishes and pooled to obtain one replication Erythrocytes count (RBCs) was carried out .The value was expressed in number of red blood cells in million per mm^3. Before stress mean RBCs of different treatments (T1= 2.315 ± 0.1567, T2= 2.277 ± 0.1300, T3= 2.505 ± 0.1456, T4= 1.8700 ± 0.0876). Upon exposure to stress, mean RBCs count decreased intreatments T1, T2 and T3 (T1= 1.495 ± 0.0812, T2= 1.512 ± 0.0632, T3= 1.807 ± 0.0554) while it marginally increased in T4(T4= 1.882 ± 0.1060). There was significant difference in mean RBCs count among treatments after stress. The highest difference in the mean value of the erythrocytes count was obtained in T1 and lowest in T4.The rate of reduction in RBCs count due to stress was maximum in T1 whereas it marginally increased in T4.

Keywords: Astaxanthin, hematological parameters, Shrimpshell, Koi carp.

Real time Physical, Chemical and Biological data collection by "SAGAR AVALOKAN 2" at near shore upwelling and Gosthani river run off at Bheemunipatnam coast to validate fish accumulation

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Abstract

Near Shore Upwelling (NSU) occurs when wind push surface water away from shore and surface water is replaced by the sub-surface colder and rich nutrient water. This upwelling improves productivity near shore and leads to formation of potential fishing zones (PFZ). River mouth or river run off region is the area where river water will combined and mix thoroughly with sea water, due to this process it transports rich nutrients into sea. Both upwelling and river mouth improves fish productivity and shows different individual characteristics in formation region. Then intensity of PFZ formation varies in both upwelling and river mouth area, health of productivity is also varies in both regions. The present study it to identify different individual characteristics (DIC) at both regions to validate fish accumulation at these regions. To validate these regions, I am going to collect DIC such as physical, chemical and biological oceanographic data at near shore upwelling region and river mouth region. Water samples at different layers will be collected in these regions to validate what kind of process favouring to formation of healthy and un-healthy PFZ. Physical oceanography parameter like temperature, salinity and density, chemical oceanography parameter such as dissolved gasses and biological parameter like plankton types in these two regions. To validate this, here I am implementing an automated platform named "SAGAR AVALOKAN 2" which is unmanned robotic measuring platform (URMP), a second version of SAGAR AVALOKAN it is floating platform, which collected sea surface temperature at various locations at Andaman Sea. Now SAGAR AVALOKAN 2 collects required data such as physical, chemical and biological oceanography at near shore upwelling zone and river mouth area. This robot reaches NSU portion based on satellite derived location through GPS, after reaching to this location it start collecting physical, chemical and biological oceanographic data at spatial and temporal scale. Simultaneously the same operation will be performed by URMP at river mouth region. A comparison study is going to be done between these two regions to find out favourable and un-favourable conditions for formation of PFZ. This URMP is economically efficient way of data collection at these portions; multiple data will be collected at multiple locations without influencing ecosystem and PFZ's. URMP is very useful to collect continuous data accumulation when compared to the human operated platform and we can accesses very remote location at both near shore upwelling (NSU) region and river mouth portion.

Key words: Near Shore Upwelling (NSU), potential fishing zones (PFZ), different individual characteristics (DIC), unmanned robotic measuring platform (URMP)

Evaluation of satellite based potential fishing zone at Visakhapatnam coast by "MATSYA ANVESHIKA" platform

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Abstract

Potential fishing zones (PFZ's) are formed when continuous wind blows parallel to coastal line leads to formation of upwelling zones. This upwelling zone brings rich nutrients colder water from sub-surface to surface and helps to grow primary food producers (PFP) know as phytoplankton. This plankton is primary food for fish and accumulation of fish expands on spatial and temporal scales. Satellite based PFZ is identified based on less sea surface temperature (SST) and phytoplankton pigment (chlorophyll a) over an area. Mostly PFZ forms near fronts, currents, eddies, meanders and gyres region. We cannot complete assurance that every upwelling process can leads to occurrence of PFZ. Most of fishing activities takes place at PFZ location and amount of fish catch is very satisfactory when compared to Non-PFZ location. Since Indian Ocean is highly influenced by Indian monsoon wind patterns effects time and spatial distribution of PFZ. At present mostly Catch per Unit

Effort (CPUE) is one of the method used for evaluation for satellite based PFZ. This type of approach is fully based on probability of PFZ, sometimes CPUE is more and less based on upwelling phenomenon and involves more cost. There should be a cost effective and appropriate evaluation of PFZ. This present study introducing cost effective, appropriate and robust evaluation techniques to measure intensity of PFZ based on satellite data. Here I am introducing an Autonomous Floating Platform (AFP) named "MATSYA ANVESHIKA" which means "fish exploration" at PFZ to validates satellite data. This AFP consists of eco sounder which estimates the fish schools at PFZ location. AFP is an autonomous robot, which reaches to PFZ location based on satellite data by GPS. On reaching to location it measure the intensity of fish cloud and also measure migration of PFZ intensity area also. Measured data is send through by satellite link. We can get continuous and live data of fish cloud at PFZ, this type of approach is very useful when compared to CPUE. At present this paper shows satellite based fish cloud intensity at PFZ and real time measurement using eco sounder by AFP. Parallely we can access in-situ oceanography data at PFZ during measurement. This type of robotic platform should be encouraged to validate the PFZ. It is very useful when compared to CPUE methods and we can estimate in real time migration of PFZ and behaviour of fish cloud without disturbing fish cloud.

Key words: Matsya Anveshika, Potential fishing zones (PFZ's), primary food producers (PFP), sea surface temperature (SST), Phytoplankton Pigment (chlorophyll a), Catch per Unit Effort (CPUE), Autonomous Floating Platform (AFP).

Current status of research on species distribution modeling of marine species

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Abstract

Over time, the importance and development of statistical tools like species distribution modeling (SDM) are at a rapid pace. The paradigm shift from basic logistic regression tools to a diverse range of advanced analytical approaches shows the advancement in this line of research. The species distribution model is an important conservation tool which can forecast the future distribution shift of a species due to alterations in their environmental predictors. In marine environments, hundreds of literature were published with goals as conservation strategies, assessing the impacts of climate change, and understanding the relationships between marine organisms, their physio-chemical environment, the spread of invasive species and so on. This work analyses the bibliometry and reviews the research works till date in this area. Data from the scopus database is used for the bibliographic search and R package biblioshiny has been used for the analysis. Here we analysed the power of SDM in marine species and the different ways which can be recommended for further research in this field. SDM is now a hot tool used to gain ecological and evolutionary insights and to predict distributions across sceneries and helps conservators to be prepared for expected environmental changes. This work will help the novice and ecologists to stand on the shoulders of giants in SDM.

Keywords: species distribution modeling, ecological

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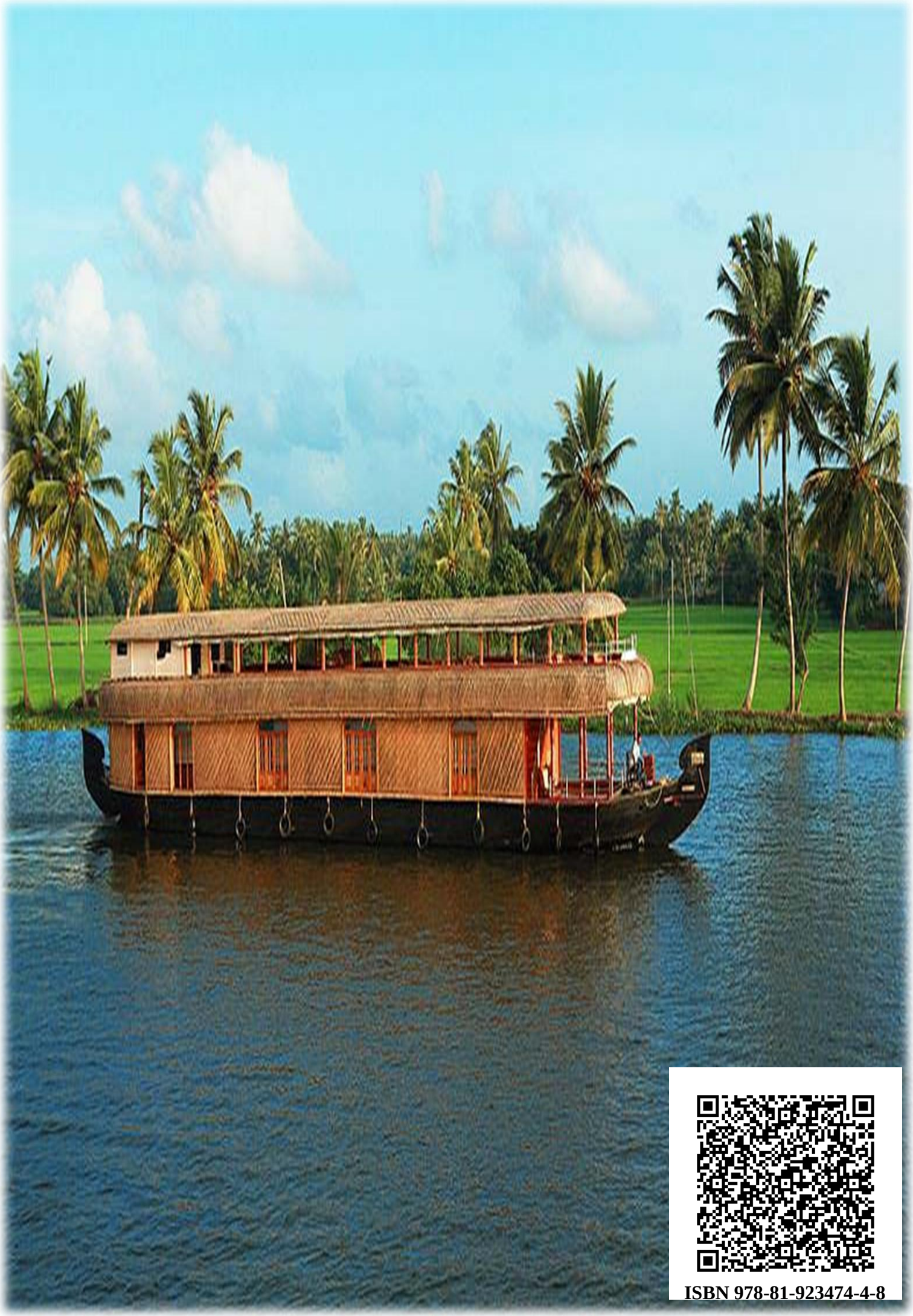

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