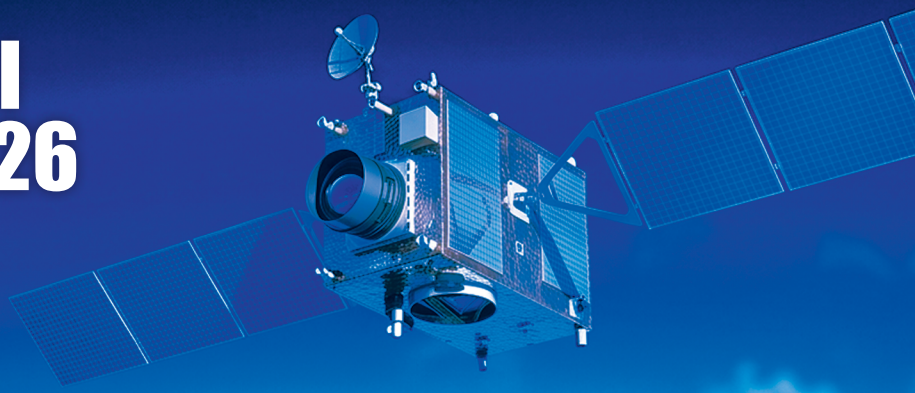
TREVOR - SAFARI Symposium 2026



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Book of Abstracts

Jointly organized by

- Trevor Platt Science Foundation, Kochi
- Chemical Oceanography Department, CUSAT, Kochi
- Marine Biological Association of India, Kochi
- ICAR-Central Marine Fisheries Research Institute, Kochi

4-6 November 2026
Venue : ICAR-CMFRI, Kochi

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…Messages…

Cochin University of Science and Technology

Cochin University P. O., Kochi - 682 022, India

(Re-accredited by NAAC with 'A+' Grade)

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It is a matter of great pleasure that the Department of Chemical Oceanography, Cochin University of Science and Technology (CUSAT), is organizing the Third International Symposium on TREVOR Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (TREVOR-SAFARI 3) on the theme "Aquatic Ecosystems Including Fisheries in a Changing World: Global Context and Tropical Perspectives", from 4 to 6 November 2026, at the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi.

Ocean observations and satellite-based remote sensing have become indispensable tools for understanding the complex dynamics of marine and aquatic ecosystems, monitoring environmental shifts, and supporting the sustainable management of marine resources. The integration of oceanographic research, satellite observations, and advanced information services offers immense potential to address emerging challenges in fisheries, aquaculture, and coastal resource management.

TREVOR-SAFARI 3 provides a timely and valuable platform for scientists, researchers, policymakers, and technology experts from India and abroad to exchange knowledge, share scientific advancements, and foster interdisciplinary collaboration. I am confident that the deliberations will promote innovative approaches to ocean observation, ecosystem monitoring, and resource assessment, while strengthening the practical application of remote sensing technologies towards sustainable fisheries, climate resilience, and the well-being of coastal communities.

I commend the Department of Chemical Oceanography (CUSAT), Trevor Platt Science Foundation, SAFARI, ICAR-CMFRI, and all collaborating institutions for their concerted efforts in organizing this important international scientific event. I extend my best wishes for the grand success of TREVOR-SAFARI 3 and trust that the symposium will lead to fruitful deliberations, meaningful collaborations, and outcomes of lasting significance to marine science and society.

Warm regards,

'erence experience.

Prof. (Dr.) M. Junaid Bushiri

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MESSAGE

It gives me immense pleasure to know that the Department of Chemical Oceanography, Cochin University of Science and Technology, is organizing the third International Symposium of TREVOR Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (TREVOR SAFARI 3) on an important theme of "Aquatic Ecosystems Including Fisheries in a Changing World: Global Context and Tropical Perspectives" during 4-6 November at the ICAR-Central Marine Fisheries Research Institute (CMFRI), Kochi, India.

Remote sensing observations are essential for studying large-scale dynamic variability in aquatic and marine ecosystems. Understanding ecological functions is needed for sustainable management of fishery resources. The themes of the symposium are pertinent in the context of the overall development of advanced remote sensing technologies for aquatic and marine ecosystem analysis. It is also crucial to adopt resource-conserving modern scientific methods to remain economically sound, socially relevant, and environmentally sustainable. This International Symposium will be a meeting point of scientific communities working in various aspects of fisheries and remote sensing from the country and abroad. This occasion will be a platform for exchanging and cultivating new theories and ideas to bring out key issues and challenges in the sector. I compliment Trevor Platt Science Foundation, SAFARI, CUSAT, ICAR-CMFRI and all the associate national and international organisations for shouldering the responsibility of organizing the symposium on satellite-based application for sustainable fisheries management and wish the programme a grand success.

30/9/2026

(J.K. Jena)

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Message



It gives me immense pleasure that the Third International Symposium of TREVOR–SAFARI (Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery) is being jointly organized by the Department of Chemical Oceanography, Cochin University of Science and Technology (CUSAT), and ICAR–Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi, from 4 to 6 November 2026. The symposium, centred on the theme **Aquatic Ecosystems Including Fisheries in a Changing World: Global Context and Tropical Perspectives**, addresses a subject of considerable scientific and societal importance.

Aquatic and marine ecosystems are undergoing rapid changes driven by climate variability, environmental pressures and human activities. Understanding these changes and their implications for fisheries and aquaculture is essential for the sustainable management of aquatic resources and the livelihoods of communities dependent on them. In this context, satellite-based remote sensing, integrated with oceanographic observations, *in situ* measurements and advanced analytical tools, offers immense potential to monitor ecosystem dynamics, understand environmental–fisheries interactions and strengthen science-based decision-making.

I am confident that TREVOR SAFARI-3 will provide a vibrant platform for scientists, researchers, policymakers and other stakeholders from India and abroad to exchange knowledge, showcase technological advances and foster interdisciplinary collaboration. The deliberations are expected to stimulate innovative research and generate valuable insights for sustainable fisheries management, aquatic ecosystem conservation and evidence-based policymaking.

I congratulate the TREVOR Platt Science Foundation (TPSF), the Department of Chemical Oceanography, CUSAT, and all collaborating national and international organizations for their efforts in organizing this important scientific gathering. It is a pleasure for ICAR-CMFRI to host and jointly organize the symposium, and I warmly welcome all participants to Kochi.

I wish TREVOR SAFARI Symposium every success and look forward to its meaningful contributions towards sustainable aquatic resource management.

Director
ICAR–Central Marine Fisheries Research Institute, Kochi

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MESSAGE

It is a pleasure to learn that the Department of Chemical Oceanography, Cochin University of Science and Technology (CUSAT), is organizing the second International Symposium on TREVOR Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (TREVOR-SAFARI 3), on the theme "Aquatic Ecosystems Including Fisheries in a Changing World: Global Context and Tropical Perspectives," from 4-6 November 2026 at ICAR-Central Marine Fisheries Research Institute (CMFRI), Kochi.

Ocean observations and satellite-based remote sensing play a vital role in understanding the complex dynamics of marine and aquatic ecosystems, assessing environmental variability, and supporting informed decision-making for the sustainable management of marine resources. The integration of satellite observations, oceanographic research, and advanced information services offers significant opportunities to improve our understanding of changing ocean conditions and their implications for fisheries, aquaculture, and coastal communities. The symposium provides an important platform for scientists, researchers, policymakers, and technology experts from India and abroad to exchange knowledge, share scientific advancements, and explore innovative approaches to addressing emerging challenges in ocean and fisheries sustainability. Such interdisciplinary initiatives are essential for strengthening the application of ocean science and remote sensing technologies in ecosystem monitoring, resource assessment, and climate-resilient marine resource management.

I commend the Trevor Platt Science Foundation, SAFARI, CUSAT, ICAR-CMFRI, and all participating national and international institutions for their efforts in organizing this important scientific gathering. I am confident that the deliberations will foster meaningful collaborations, encourage new research directions, and contribute to the advancement of satellite-based ocean and fisheries applications. I extend my best wishes for the successful conduct of TREVOR-SAFARI 3 and for the fruitful outcomes of the symposium.

(T.M. Balakrishnan Nair)

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Message

It gives me immense pleasure to learn that the Department of Chemical Oceanography, Cochin University of Science and Technology (CUSAT), in collaboration with the Trevor Platt Science Foundation, SAFARI, and the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), is organizing the Third International Symposium on Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (TREVOR-SAFARI 3) from 4 to 6 November 2026 at ICAR-CMFRI, Kochi.

The symposium theme, "Aquatic Ecosystems Including Fisheries in a Changing World: Global Context and Tropical Perspectives," addresses some of the most pressing ecological and socio-economic imperatives of our time. Earth observations and satellite-based remote sensing have evolved into indispensable capabilities for decoding complex ocean dynamics, monitoring environmental shifts, and guiding sustainable marine management. The seamless integration of oceanographic research, satellite monitoring, and operational information services offers transformative potential to enhance fisheries management, aquaculture planning, and climate-resilient coastal governance.

TREVOR-SAFARI 3 provides a timely global platform for scientists, researchers, technology developers, and policymakers to exchange knowledge, bridge state-of-the-art satellite observations with practical societal applications, and foster strong interdisciplinary partnerships. In tropical regions, where coastal communities face heightened vulnerability to climate impacts, applying remote sensing technologies is essential for safeguarding marine biodiversity, building climate resilience, and supporting sustainable livelihoods.

I commend the Department of Chemical Oceanography (CUSAT), the Trevor Platt Science Foundation, SAFARI, ICAR-CMFRI, and all partner institutions for their dedicated efforts in organizing this scientific event of global relevance.

I extend my warmest wishes for the grand success of TREVOR-SAFARI 3 and trust that the deliberations will inspire innovative solutions, catalyze international collaboration, and generate outcomes of lasting value for marine science and society.

SRNayak

(Shailesh Nayak)

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Foreword



On the eve of the TREVOR-SAFARI Symposium 2026, I find myself thinking with gratitude of all those who worked so hard to make this event a reality. When was the genesis of this symposium? A reasonable answer would be that the preparations for the symposium and the associated training events began well over a year ago. But perhaps a more accurate answer might be that it all began more than twenty years ago, with the Visiting Professorship held by Trevor Platt next door to the symposium venue, at the Regional Centre of the National Institute of Oceanography (NIO) in Kochi.

The four-month long training course was the first the first of a series of such events organised jointly by the Nippon Foundation (NF) and the Partnership for Observation of the Global Oceans (POGO), at locations around the world. It was a landmark event: the year was 2004, the year of the Indian Ocean Tsunami, which taught us all in unforgettable terms the destructive power of the sea. The tragedy that unfolded led to the establishment of the Indian Ocean Tsunami Warning System. So, it taught us that science can step up to the grand challenges posed by nature, and save lives. We also learned that friendships could save lives. If one of the trainees had not invited his friends to a Christmas dinner with his family around that fateful day, many of the trainees would have gone on a weekend trip to the seashore, risking their lives when the tsunami hit. The training was also a landmark event in the sense that many of the trainees at the visiting professorship programme have gone on to assume leadership roles themselves, and have played central roles in the organisation of the TREVOR-SAFARI Symposium, and have key roles to play in the programme ahead of us. It has been a matter of great pride and joy to see former trainees develop and grow as scientists and leaders and change the scientific landscape of India, the broader Indian Ocean region, and beyond. I also remember with sadness one of the former trainees, Satya Prakash, a brilliant mind, who left us in his prime. With the dedication that I have seen in the NF-POGO generation to build a global community of oceanographic and aquatic scientists committed to addressing existential questions that face us today regarding the fate of our planet, I feel optimistic about our future, against the odds.

These days, when there are many attractive scientific meetings worthy of our attendance, we make hard choices on which ones to attend, since we cannot attend them all. So, why did we choose this one over many other options? There are probably a great many answers to that question, but let me focus on just one. We are in India for this meeting, where the grand tradition of the *guru-shishya* (teacher-disciple) relationship has flourished over centuries, and many Indians recognized in Trevor the epitome of the *guru* in the traditional sense of the word. But he is not the only *guru* to whom we owe a great debt of gratitude that can never be repaid.

The closest we can get is to offer that gift of learning to the next generation, by becoming mentors and teachers ourselves. That way, the gift of learning multiplies and grows, and the tradition sustains itself over generations. I believe it is that spirit of giving that has brought many leaders here to this venue today, and they have been paired with a new crop of bright, enthusiastic, early career scientists, eager and hungry for new knowledge and new opportunities. It is a powerful combination that can change the world. The spirit of competition is also an integral part of the scientific world. It is designed to promote excellence. At the same time, the three C's of Cooperation, Coordination and Collaboration are also essential to tackling complex problems that are beyond the reach of any single individual or team. They limit duplication of effort and promote faster growth and expansion. Let us allow the three C's to guide our activities during the symposium and beyond, but without compromise on excellence. Let it be our guiding spirit.

Let me take this opportunity to thank the many organisations and institutions that have joined hands with the Trevor Platt Science Foundation (TPSF) and contributed in many ways to making the symposium a grand event with over 250 registered participants from around the world. Some of them, notably the International Ocean Colour Coordinating Group (IOCCG), the Partnership for Observation of the Global Oceans (POGO), the GEO Blue Planet, the Societal Applications for Fisheries and Aquaculture of Remotely-sensed Imagery (SAFARI) and the NF-POGO Alumni Network (NANO) have all shaped by Trevor Platt, or strongly influenced by him, in their early days. This symposium is organised jointly with SAFARI, and was preceded by a workshop that brought SAFARI, GEO Blue Planet, IOCCG and POGO together, after many years. The Plymouth Marine Laboratory (PML) has been working side by side with TPSF on shared goals and vision through many avenues, of which a notable one is the Trevor Platt Science Fund set up at PML. The symposium was preceded by an online training course spread over three months, with thirteen experts from around the world contributing lectures on various approaches to investigating the many aspects of the aquatic ecosystems. This was followed by in-person training at the Indian National Centre for Ocean Information Services (INCOIS) belonging to India's Ministry of Earth Sciences. INCOIS has also had a long tradition of working with Trevor and colleagues on various initiatives, especially those devoted to training and capacity development in the Indian Ocean region, and the Global South. Trevor's legacy is alive and vibrant in these organisations, and it is fitting that they have all come together at the symposium and during the preceding training course and side events, in the spirit of the three C's. Let me also take this opportunity to thank the many organisations and institutes who have also supported the event with financial and in-kind contributions.

As an alumnus of the Cochin University of Science and Technology (CUSAT), I am happy to see the Chemical Oceanography Division of the School of Marine Sciences of CUSAT in the role of Convenor of the symposium, and organiser of the field work, which was also part of the pre-symposium training. Similarly, it is heart-warming to return to the Central Marine Fisheries Research Institute (CMFRI) where Trevor and I spent many months over multiple years, while he was the Jawaharlal Nehru Science Fellow. The Fellowship was also the occasion when our ties with NIO, the Nansen Environmental Research Centre, India (NERCI), and the Nansen Environmental and Remote Sensing Centre (NERSC), Norway, were strengthened.

The collaborations forged in those days led us to new avenues of research that have continued to grow over the years. It is uplifting to see that all these organisations, and many more, are here to support the symposium, the side events and the associated training.

In fact, training and capacity development is a common thread running through all these events. Looking back over the many years in which we have been involved in training, education and mentorship, it is evident that long-term success requires multi-decadal, sustained commitment, and the sponsors who are with us today have all demonstrated that commitment. But there is yet another ingredient to success: a succession of dedicated and committed teachers who can inspire generations to come; and we are fortunate that there are many such in our midst who have picked up that baton in the relay of learning. They understand that teaching is a two-way street: teachers are also enlightened when they teach, so it is a mutually beneficial endeavour. Let us not underestimate the value of such teachers, even in this age when Artificial Intelligence appears to have all the answers, but perhaps not all the solutions.

I have consciously avoided naming the many individuals who have worked tirelessly towards this symposium, because, if I did, the list, and this foreword, would never end. But they are in my heart, and I remember the tremendous effort, time and thinking that have preoccupied them for long months, and the attention that was devoted to planning the minutiae of the programme. I thank them all, most sincerely. But the success of the event also owes much to all of you, who have submitted abstracts and come to the event prepared to participate actively in all aspects of the programme. I thank you all.

Let me welcome you all to the TREVOR SAFARI Symposium 2026, and I trust you will find it inspiring and stimulating. Let it be the beginning of new ideas, friendships, and collaborations that will help us tackle the many scientific and societal challenges that face us today, such that the impact of the symposium will live on, long after the event has been completed.

TPSF is a small organisation with limited resources, but its members have high aspirations for promoting stewardship of our oceans and our environment. These are not idle dreams: thanks to the sincere commitment, enthusiasm and generous cooperation of TPSF members and the broader community of like-minded people, here we are, hosting the second TPSF symposium alongside the third event in the SAFARI symposium series. I hope that the shared enthusiasm and selfless spirit of support that brought us here will continue, and strengthen TPSF, enabling it to grow into a vibrant organisation that carries Trevor's vision forward and keeps his legacy alive for generations who never have had the privilege of knowing him personally.



Shubha Sathyendranath
Director, Trevor Platt Science Foundation
Chair, International Ocean Colour Coordination Group
Principal Scientist, Plymouth Marine Laboratory

…Lead Articles….

REFLECTIONS FROM POGO ON SUPPORTING NEW GENERATIONS OF SCIENTISTS TO CONDUCT THE OCEAN OBSERVATIONS OUR PLANET AND SOCIETY NEED

Sophie Seeyave[1], Lilian Krug[2] & Fiona Beckman[1]

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Introduction

The Partnership for Observation of the Global Ocean (POGO) is a consortium of almost 60 oceanographic research institutions, working together to promote and advance the implementation of global ocean observations, by supporting innovation in ocean observing, developing worldwide capacity, and advocating for the critical role of ocean observations and the need for their sustained funding. POGO has sponsored both the first and second TREVOR Symposia, in recognition of the central role that Prof. Trevor Platt played throughout the first two decades of POGO's history, particularly in the establishment of POGO's capacity development programmes and, subsequently, as Executive Director of POGO (from ~2008 to 2014).

Sustained ocean observations are required to understand aquatic ecosystems in a changing world, and to inform policy and decision-making in support of environmental stewardship and sustainable development. However, some of the largest geographical gaps in the coverage of ocean observations are in the tropics, Indian Ocean, and around the coasts of under-resourced nations. POGO supports projects and activities that are seeking to address these gaps, and which are relevant to many of the 2nd TREVOR Symposium sub-themes – for example, through professional training, citizen science, and low-cost technology development.

This article will focus on the links between ocean observations and societal applications, such as fisheries, water quality, and extreme events, and on the importance of capacity development, which was central to much of Trevor's life and career, forming a significant part of his legacy, which is being continued by POGO to this day.

The Role of Ocean Observations in Supporting Fisheries, Water Quality Monitoring, Climate Resilience, and Monsoon Dynamics & Extreme Events

Ocean observations provide the foundation for understanding and managing marine and coastal environments. Through networks of satellites, research vessels, buoys, autonomous vehicles, tide gauges, and coastal monitoring systems, scientists and other stakeholders collect data on ocean temperature, salinity, currents, sea level, biogeochemistry, and other relevant information on marine ecosystems. These observations are increasingly important as climate change, population

growth, and economic development place growing pressures on marine resources and coastal communities. Ocean observing systems support a wide range of societal applications, particularly fisheries management, water quality monitoring, climate resilience planning, and the prediction of monsoon dynamics and extreme weather events.

Fisheries depend on healthy marine ecosystems and a thorough understanding of the environmental conditions that influence fish distribution, abundance, and productivity. Ocean observations provide critical information on ocean temperature, currents, dissolved oxygen, chlorophyll concentrations, and habitat conditions, all of which affect fish populations. Over the last two decades, satellite observations have been successfully used to identify productive fishing grounds by tracking ocean fronts, upwelling regions, and areas of high biological productivity, as well as providing real-time environmental data to help fishers improve operational efficiency, reduce fuel consumption, and target sustainable fishing areas.

Coastal and marine water quality directly affects public health, tourism, fisheries, aquaculture, and ecosystem health. Ocean observations play a central role in detecting pollution, harmful algal blooms, nutrient enrichment, hypoxia, and other threats. Continuous monitoring systems measure key water quality parameters such as temperature, salinity, turbidity, dissolved oxygen, pH, nutrients, and chlorophyll. These observations provide early warning of environmental degradation and support rapid response. For example, harmful algal bloom events can threaten fisheries, aquaculture operations, and human health through toxin production and/or oxygen depletion. Both ocean colour remote sensing and *in situ* observations (e.g. phytoplankton biomass, detection of target species using biomolecular techniques, and/or toxin detection using immunoassays) are used for routine testing at fixed sites or from autonomous platforms. Ocean biogeochemical observations are important for tracking ocean acidification, a growing threat to shellfish industries and marine biodiversity. Early detection through ocean monitoring allows authorities to issue advisories and mitigate economic losses.

Ocean observations are fundamental to understanding climate variability and provide the evidence base needed for climate adaptation and resilience planning. Measurements of sea surface temperature, ocean heat content, sea-level rise, and changing ocean circulation patterns allow us to monitor climate trends and improve climate models. Sea-level observations are particularly important for coastal resilience: tide gauges, satellite altimetry, and coastal monitoring systems provide information on rising sea levels, storm surges, and coastal flooding risks. Such information supports the design of coastal defences, flood risk management plans, and disaster preparedness strategies. Ocean observations also contribute to nature-based solutions for climate adaptation. Monitoring coastal wetlands, mangroves, seagrass meadows, and coral reefs helps assess their condition and effectiveness in providing coastal protection, carbon sequestration, and habitats/nursing grounds.

Sea surface temperature patterns influence the exchange of heat and moisture between the ocean and atmosphere, which in turn affects monsoon development and intensity. Observing systems in

the Indian Ocean, Pacific Ocean, and other tropical basins collect data on temperature, salinity, ocean currents, and air-sea interactions that feed into weather and climate prediction models. Ocean observations improve seasonal forecasting by helping us to understand large-scale climate phenomena such as the El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), both of which have significant impacts on monsoon rainfall. Better forecasts support agricultural planning, water resource management, and disaster preparedness.

In addition to seasonal prediction, ocean observations are critical for forecasting extreme weather events such as tropical cyclones, marine heatwaves, storm surges, and heavy rainfall. Ocean heat content observations help determine the amount of energy available to fuel cyclones, while coastal observing systems support storm surge forecasting and emergency response. Marine heatwaves, which are becoming more frequent and intense under climate change, can have devastating effects on fisheries, coral reefs, and coastal ecosystems. Continuous monitoring enables early detection and supports impact assessment and adaptation planning.

POGO's role in supporting ocean observations for societal benefit

POGO has always focused strongly on the application of ocean observing beyond the realm of science, to benefit broader society. Much of this focus originates in POGO's involvement with the Group on Earth Observations (GEO), which was established following the 2002 World Summit on Sustainable Development.

The Societal Applications in Fisheries and Aquaculture using Remotely Sensed Imagery (SAFARI) project was initiated during the early years of POGO's involvement with GEO, under the leadership of Trevor Platt and Shubha Sathyendranath, with funding from the Canadian Space Agency. The Indian National Centre for Ocean Information Services (INCOIS) is a recognised leader in the use of satellite remote sensing to produce Potential Fishing Zone maps and other real-time alerts and bulletins for fishers, available in local languages and sent directly to their mobile phones. The GEO Blue Planet Initiative, which Trevor founded during his tenure as Executive Director of POGO, continues to focus (among other topics) on fisheries applications of ocean observations (mainly from satellite remote sensing), and it is very appropriate that the 3rd SAFARI Symposium is being held in conjunction with the 2nd TREVOR Symposium, in Kochi.

In situ biological observations have long been more challenging to implement globally, since they cannot readily be made in the synoptic manner offered by satellite remote sensing. To address this issue (which both Trevor Platt and Shubha Sathyendranath were instrumental in highlighting within POGO and other international fora since the early 2000s), POGO led the creation of the Ocean Biomolecular Observing Network (OBON), a UN Ocean Decade Programme endorsed in 2021. OBON now brings together over 30 projects and is developing a global hub for biomolecular measurements to support sustainable development, including fisheries and aquaculture. The programme is working on data and metadata standardisation, sharing of protocols, capacity development, technology readiness, improving reference libraries, and advancing the policy readiness of biomolecular observations, such as eDNA. In Sept 2025, a workshop was held at the

UN Food and Agriculture Organisation (FAO) headquarters in Rome, which led to the establishment of a Working Group on Quantitative eDNA for Fisheries Stock Assessments (QefSA). The WG aims to expand adoption of eDNA analytics for fisheries applications by increasing the capability to create indices of eDNA abundance, initially through the development of a series of simple, concrete training modules for fisheries managers.

Another area strongly supported by POGO, which can be traced back to Trevor's leadership, is passive acoustics. POGO's involvement in this area was initiated when, in 2009, Jesse Ausubel highlighted that ocean sound had not been properly addressed as an element of global change, and that decreasing anthropogenic sound in the ocean could help us learn more about the effects of sound on marine organisms [1]. The Sloan Foundation subsequently provided seed funding for what was to become the International Quiet Ocean Experiment (IQOE), co-sponsored by POGO and the Scientific Committee on Oceanic Research (SCOR). This decade-long programme was to focus mainly on the effects of anthropogenic sound on marine animal populations – however passive acoustics emerged during the decade as a powerful tool for monitoring biodiversity, with increasing numbers of taxa being discovered to be soniferous, including fish species. As a result, passive acoustics monitoring is increasingly recognised as a potential tool to support fisheries management [2].

Since 2017, the Nippon Foundation-POGO Alumni Network for the Ocean (NANO), established in 2010 under Trevor's leadership, has been supporting a global network of time-series stations, called "A global study of coastal Deoxygenation, Ocean Acidification and Productivity at selected sites" (NANO-DOAP) [3]. Almost in its tenth year, this project is building a valuable time-series of coastal observations. Several citizen science initiatives (C4CEM [4], SAGITTA and FVON Pilot Projects) have also emerged under NANO's umbrella, which are working with fishing communities to gather data on temperature, salinity, fisheries, and plastic pollution in coastal waters. Together, these efforts provide valuable information to monitor changes in the physical, chemical and biological properties of coastal waters around the world and link them to climate change and other human impacts. A NANO Projects Workshop is being held back-to-back with the TREVOR Symposium to discuss the projects' results and to plan future activities, and many NF-POGO alumni will be attending and contributing to the Symposium.

Trevor Platt and POGO: A legacy spanning generations of ocean scientists

Arguably the largest contribution Trevor Platt made to POGO was through his tireless efforts to help train the next generation(s) of ocean scientists. He was the first Nippon Foundation-POGO Visiting Professor (2005), hosted numerous POGO-SCOR fellows for training visits of up to 3 months at both Bedford Institute of Oceanography in Canada, and Plymouth Marine Laboratory in the UK, and organised and/or taught on countless training courses in countries all over the world. This drive to support capacity development was one of the original objectives of POGO, and has been a continuous thread of POGO's evolving strategy for nearly three decades. As a result, POGO has provided training to nearly 1,500 early-career scientists from 102 different countries, has a

thriving network of alumni conducting research and observations all over the world, and has a growing membership of institutions working together to fill gaps in our capacity to observe the global ocean.

Conclusion

Ocean observations form an essential component of modern environmental management, climate science, and sustainable development. By providing reliable and continuous information about the state of the ocean, observing systems support sustainable fisheries, safeguard water quality, strengthen climate resilience, and improve understanding and prediction of monsoons and extreme weather events. But global capacity to conduct these observations is unevenly distributed, and funding for ocean observing in most parts of the world is insufficient and/or under threat, due to competing priorities and economic pressures. Guided by Trevor's original vision, POGO continues to work on developing the work force, improving accessibility of equipment and infrastructure, and facilitating the sharing of data that are desperately needed for ocean observations to become truly global.

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THE AQUATIC ECOSYSTEMS IN A CHANGING WORLD: FOOD SECURITY, MULTIPLE PRESSURES AND SUSTAINABLE OCEAN GOVERNANCE

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Oceans under multiple pressures

The world oceans are indispensable to food security, livelihood and ecosystem functioning, yet they are under increasing anthropogenic pressures from climate change, overfishing, pollution, plastic wastes, tourism, maritime transport, aquaculture, offshore energy development and competing demands for marine space. Although the ocean covers approximately 70.8% or 361 million square kilometres of the earth's surface, its most productive coastal waters and their resources are finite. Ocean space is limited, particularly in the coastal areas! Hence, effective integrated cross-sectoral management of marine ecosystems are essential to foster social and sustainable value creation and growth. Though one must ask: is it possible to achieve consistent governance while balancing these various, often competing, uses and needs?

Aquatic food security

Hunger and malnutrification is a global reality for 673 million people, representing 8.2% of us in 2024 (FAO, 2026), either due to lack of available, accessible or more frequently also affordable food. Rapid increasing global population, projected to reach 8.5 billion by 2032, will further increase the need for food proteins. Aquatic food provides high-quality protein and essential micronutrients to billions of people worldwide. Fisheries and aquaculture production constitutes 15-17% of the global animal proteins supply, however reaching as high as 50-75% in several regions in Asia and Africa. However, increasing demand cannot be met indefinitely by expanding wild capture fisheries, whose production has remained relatively stable over recent decades. Sustainable aquaculture, improved fisheries management and the protection of aquatic habitats must form complementary elements of future food systems.

According to the UN Food and Agriculture Organisation (FAO) report the State of the World Fisheries and Aquaculture (SOFIA) reports (FAO, 2026), global fisheries and aquaculture production reached a new record of 235 million tonnes in 2024, an increase of 5.2 % since 2022. Capture wild fisheries have largely stabilized at about 92 million tonnes (in 2024) and have remained within the 86–94 million tonnes range since the late 1980s. This may be due to that some stocks have reached their ecological limits and/or adequate fisheries management, and fishing restrictions have been enforced. The importance of both inland and ocean aquaculture will be increasingly important for our food supply.

The aquatic food systems contribute to the livelihoods of 600 million people all over the world, including India. ICAR–Central Marine Fisheries Research Institute (CMFRI) estimated India's total marine fish landings, including the Andaman and Nicobar Islands, at 3.47 million tonnes in 2024, approximately 2% lower than in 2023. This year-to-year decline highlights the variability of capture fisheries and the need for continuous stock assessment and adaptive

management. India's seafood exports further demonstrate the economic significance of aquatic resources. The Marine Products Export Development Authority (MPEDA) reported exports of approximately 1.70 million tonnes, valued at ₹62,408 crore (US$7.45 billion), in 2024–25. These benefits must be balanced against the need to conserve fish stocks, protect critical habitats, reduce pollution and strengthen the resilience of fishing communities to climate-related and economic shocks.

Changing ecosystems

The director of the Norwegian Institute of Marine Research opens his annual 2026 State of the Ocean Speech with the fact that the Norwegian cod stock that was record high at 3,7 million tons in 2013 (only 13 years ago!) has now declined to its absolute minimum recorded ever reported. These and several other examples are dramatic changes in a vulnerable marine ecosystem that will have in increasing important role for our future food supply. Such developments underline the limitations of relying on historical trends or individual environmental indicators to predict ecosystem responses.

Effective management must therefore be based on sustained observations, rigorous analysis and regular reassessment. Scientific understanding is strengthened when long-term monitoring is combined with ecological knowledge, fisheries data and information on environmental variability. Even well-established models and assumptions must be tested against new observations as ecosystems respond to changing climate and human pressures.

Remote sensing and emerging technologies in ocean observation

Knowledge must be supported by observations and data to support our analysis and increase human wisdom. Earth-observation satellites, research vessels, drifting and moored buoys, autonomous floats and *in situ* sampling provide complementary information on the state and variability of aquatic ecosystems. Satellite observations are particularly valuable for monitoring sea-surface temperature, ocean colour, chlorophyll concentrations, coastal change and indicators of ecosystem productivity. The legacy of the several decades of development correction and retrieval algorithms for satellite data, ocean dynamics and ecosystem modelling, that the scientific community have developed is the foundation for the future knowledge-based ocean management.

Europe’s Copernicus Marine Services (CMEMS) and the European Space Agency Climate Change Initiative (ESA-CCI) are comprehensive sources for consistent global data sets about our oceans. India also has a substantial ocean-observation and information infrastructure. The Indian National Centre for Ocean Information Services (INCOIS), under the Ministry of Earth Sciences, integrates observations from *in situ* platforms and satellites and provides oceanographic information for research and operational applications. Its activities include ocean-observation networks, Argo profiling floats, drifting and moored buoys, and the management of oceanographic data. During 2023–24, INCOIS reported deploying 44 Argo floats in the tropical Indian Ocean, including four biogeochemical Argo floats.

Other important Indian institutions include the National Institute of Ocean Technology (NIOT), which develops and operates ocean-observation technologies, and the National Centre for Polar and Ocean Research (NCPOR), which supports oceanographic research and sustained

observations in polar and other oceanic regions closer to the Indian sub-continent. Together with INCOIS, ICAR-CMFRI, the Ministry of Earth Sciences and other national research organisations, these institutions contribute to understanding ocean dynamics, marine resources and climate-related change. *Samudrayaan* - the Deep Ocean Mission, National Coastal Mission (NCM 2.0) and the National Action Plan for Climate Change (NAPCC) including the *Mausan* mission are some relevant national Indian initiatives.

AI and Digital Twins of the Oceans are emerging tools that makes us better to assess the state and the variability of our oceans. Their reliability, however, depends on the quality, continuity and representativeness of the underlying data. Still the ocean itself is highly under-sampled, particularly in deeper waters and in ecologically sensitive coastal areas. Strengthening sustained observations and improving data sharing are therefore essential priorities.

OceanEye and international co-operation

The Ocean Eye International Alliance, launched by the European Commission during the UN General Assembly High-Level week this year, seeks to strengthen sustained ocean observations through international co-operation, investment and improved co-ordination. This will be achieved by taking a major part of the global market for ocean observation technologies, developing Digital Twins of the Oceans that combines "all" real time data, utilizing AI and advanced modelling to simulate and predict the ocean ecosystem conditions. Ocean Eye will combine public, commercial and scientific development and engagement, enhancing the political awareness about the oceans and its roles. Its four pillars will contribute to improve the *governance of the oceans*, form *international alliances* to close the observational gaps in many the regional seas' worldwide, support *innovations and commercial technological development* and finally connect people and assure *societal engagement* in the oceans. Its success will depend on sustained contributions from governments, research institutions, technology developers and the private sector. Participation by countries bordering the Indian Ocean would help strengthen regional observing capacity and improve understanding of shared ocean processes, including monsoon variability, marine heatwaves, ecosystem change and fisheries productivity.

Norway-India co-operation for sustainable ocean planning

Norway has one of the longest coastlines in the world, stretching for over 25,000 kilometers along the North Atlantic Ocean and the Barents Sea. Narrow and deep fjords meet the open ocean and the Norwegian Coastal Current, setting up complex ocean current systems, which in turn make these waters rich in marine living resources. Although the Norwegian coastline is twice as long as Indias, the Exclusive Economic Zones are comparatively large being ranked respectively the 17th and 18th in the world, covering more than 2,3 million square kilometres each.

Norway's marine and coastal regions have seen developments in several sectors, including oil and gas exploration, fishing, aquaculture, shipping, tourism, coastal infrastructure development and renewable energy, to name a few. These activities provide substantial economic benefits but also create competing demands on marine space. Norway's experience with integrated, ecosystem-based marine management demonstrates the importance of combining scientific

assessments with coordinated planning across sectors. The Norwegian government state in their last assessment report: "*Current and future sea-based value creation is dependent on good environmental conditions and a rich natural diversity in Norway's coastal and marine areas, safeguarding the sea as a food dish, and ensuring sustainable use of the sea's resources. Through the previous management plans for each individual sea area, comprehensive frameworks and measures for the sustainable use and conservation of the ecosystems have been laid down. With this notification, the government continues and renews the system of comprehensive and ecosystem-based management plans for the Norwegian marine areas».*

India faces similar challenges along its extensive coastline, where fisheries, ports, shipping, tourism, coastal development, conservation and emerging marine industries intersect. Scientific evidence and inclusive governance are essential to reconcile these demands while safeguarding ecosystem services and coastal livelihoods.

The India-Norway Task Force on Blue Economy for Sustainable Development was launched in January 2019 to foster bilateral cooperation in marine resource management, green shipping, deep-ocean technology, and sustainable aquaculture. Building on this relation, the project *INOSOP: The India-Norway Sustainable Ocean Planning* (2026 – 2030) was launched in cooperation between the Norwegian Embassy in Delhi, the Norwegian Ministry of Foreign Affairs and the Ministry of Earth Sciences, Government of India. INOSOP brings together Norwegian and Indian partners to advance knowledge-based marine spatial planning and sustainable ocean management, with National Centre for Coastal Research (NCCR) being the lead Indian institution. The initiative can support the integration of observations, scientific assessments and planning approaches to address competing uses of marine space.

Summary

The future of aquatic food security depends not only on increasing production but also on maintaining the ecological processes that sustain aquatic resources. Sustainable fisheries, responsible aquaculture, climate adaptation and marine spatial planning require reliable observations, robust models and interdisciplinary scientific assessments.

The TREVOR–SAFARI community can contribute through high-quality observations, innovative remote-sensing applications, ecosystem modelling and international knowledge exchange. Integrating these efforts with long-term monitoring and effective governance will strengthen our ability to detect environmental change, assess risks and inform management. Ultimately, ocean science must translate knowledge into decisions that sustain aquatic ecosystems, food security and human well-being.

Contents

Theme: Aquatic Ecosystems Including Fisheries in a Changing World: Global Context & Tropical Perspectives

Sub Theme 1 Biogeochemical Cycles and Processes		
Abstract ID	**Title**	**Page No.**
TSS/BGCP/01	**Monsoon-Driven Reorganization of Phytoplankton Seasonality in the Indian Ocean: Implications for Biogeochemical Cycling** *Aditi Modi, Himanshu Saxena, Roxy Mathew Koll, Prajeesh A.G., Subimal Ghosh, Marina Lévy & Suvarna Fadnavis*	42
TSS/BGCP/02	**Nutrient-Driven Response on Phytoplankton Community Structure, Dominance and Primary Production in the Coastal Arabian Sea** *Bhaskara Rao Dokala & BSK Kumar*	43
TSS/BGCP/03	**Ecogeographic Variability and Trophic Role of Microzooplankton in the Eastern Arabian Sea** *Sambit Singh, C.R. Asha Devi, I. Anandavelu & Hani Mohandas*	44
TSS/BGCP/04	**Primary Production in the Iceland Basin: Influence of Bio-Optical and Photosynthetic Parameterisation on *In Situ* and Satellite Estimates** *Harish Kumar Kashtan Sundararaman, Miao Sun & Heather A. Bouman*	45
TSS/BGCP/05	**Habitat Heterogeneity of Myctophid Species Assemblages in the Western Indian Ocean** *Meera K. M., Smitha B. R., V. N. Sanjeevan & Hashim M.*	46
TSS/BGCP/06	**Assessment Of Deep Chlorophyll Maxima Variability in the Northern Indian Ocean Using Bio-Argo Floats** *Minu P., Rupam Kalita & Aneesh Lotliker*	47
TSS/BGCP/07	**Potentially Toxic Metals in The Coral Reef Ecosystems of the Lakshadweep Archipelago** *Vignesh E.R., Mrinalini V., Gireeshkumar T. R., Ramzi A. & Snigtha*	48
TSS/BGCP/08	**Nitracline Variability in the Eastern Arabian Sea: Insights from Bio-Argo Float Observations** *Princy M. John, K. Nandakumar & Aneesh A. Lotliker*	49
TSS/BGCP/09	**Seasonal Variations in the Water Column and Optical Properties from the Ecologically Sensitive Hooghly-Sundarban Estuarine System** *Rajdeep Roy, Chiranjivi Jayaram, Ranith Rajmohan Pillai, M. V. Anand, Manohar Pullata, Neethu Chacko, Yara Srinivas & K. Ajith Joseph*	50

TSS/BGCP/10	**Long-Term Variability of Sedimentary Polycyclic Aromatic Hydrocarbons in the Cochin Estuary: Responses to the 2018 Kerala Flood and Covid-19 Restrictions** *Ramzi A., Gireeshkumar T. R. & Habeeb Rahman K.*	51
TSS/BGCP/11	**Monsoon-Driven Variability in Nitrous Oxide Production and Emissions Along the Southeast and Southwest Coasts of India** *Snigtha, Gireeshkumar T.R., Emil John C.R., Sanyo P.S., Vignesh E.R., Muhammed Nishad T. & Arya K. S.*	52
TSS/BGCP/12	**Variability Of Coloured Dissolved Organic Matter (CDOM) in the Coastal Waters of the Western Bay of Bengal** *Souda V. P., Minu P., Sanjiba Kumar Baliarsingh & Aneesh A. Lotliker*	53
TSS/BGCP/13	**Distribution and Polymer Characteristics of Microplastics in the Southern Ocean: Evidence From ISESO-2025** *Anamdasu Yasaswi, Anu Gopinath, Shaju S. S., Jijo Lukose, Arya P. Kumar & Abel Varghese*	54
TSS/BGCP/14	**Comparative Analysis of Air–Sea CO_2 Fluxes Across Different Coastal Regimes Along the East and West Coasts of India** *Anju Kumari, Abhinav Gummalla, Haritha M., Mohammed Suhail & P. V. Nagamani*	55
TSS/BGCP/15	**Integrating Sub-Surface Biogeochemistry and Community Succession to Understand Winter *Noctiluca scintillans* Bloom Dynamics in the Northern Arabian Sea** *S. Ayana & Sanjiba Kumar Baliarsingh*	56
TSS/BGCP/16	**Characterization And Source Identification of Fatty Acid Biomarkers in the Cochin Estuary, Kerala** *Ragi A. S., George Snijin, Anjana Vijayaraghavanunni, Muhsina Thasni M. M. & Shaju S. S.*	57
TSS/BGCP/17	**Living At the Edge: Diel Vertical Organization of Mesopelagic Communities Across a Tropical Oxygen Minimum Zone** *Sahina Akter, Hashim Manjebrayakath, Meera K. M. & Purbali Saha*	58
TSS/BGCP/18	**Satellite-Based Assessment of Phytoplankton Carbon Dynamics in the North Indian Ocean** *Haritha M., Abhinav Gummalla, Anju Kumari & P. V. Nagamani*	59
TSS/BGCP/19	**Microplastics in Antarctic Coastal Sediments: Occurrence, Distribution, and Polymer Characterization** *Nisha R., Anamdasu Yasaswi, Fazil Rahiman, Arya P. Kumar, Femi Anna Thomas, Jijo Lukose, Sangeeth K. & Anu Gopinath*	60
TSS/BGCP/20	**Comparative Nutrient Regimes Under Distinct Bloom Conditions of the North Eastern Arabian Sea** *Soorya Mohan, Vimal Kumar K.G. & Smitha B. R.*	61
TSS/BGCP/21	**Seasonal Variability in Carbon Dynamics in a Monsoon-Driven Tropical Estuary** *Swatilekha Baksi & Syed Hilal Farooq*	62

TSS/BGCP/22	**Interannual Variability in Nutrient Cycling and Phytoplankton Biomass in the Cochin Estuary from Consecutive Pre-Monsoon Observations of 2025 And 2026** *Ardra K. R., Soumya K. P. & Shaju S. S.*	63
TSS/BGCP/23	**Seasonal Emergence of Diazotrophic Pathways: Diatom–Diazotroph Symbiosis and Trichodesmium in Coastal Waters off Paradip** *Baisakhi Pattnaik & Suchismita Srichandan*	64
TSS/BGCP/24	**Aerosol–Chlorophyll Coupling in the Coastal Northwestern Bay of Bengal: A 22-Year Modis-Aqua Analysis off the Gopalpur Coast** *Chinmaya Pradhan, Suchismita Srichandan & Amit Kumar Mishra*	65
TSS/BGCP/25	**Dynamics of Particulate Organic Carbon Flux in the Mesopelagic Zone Insights from the Continental Slope off Karaikal, Southeast Coast of India** *Gomathi Sankar K. & Pavithra Balamurugan*	66
TSS/BGCP/26	**Development And Application of a Multi Species Numerical Model for Small Pelagics in the Indian Ocean EEZ and their Trophic Level Interactions** *Harikrishnan N., Vinu Valsala & Faseela Hamza*	67
TSS/BGCP/27	**Trends in Nitrogen and Phosphorus Inventory in Contemporary Ocean** *Mansa Singh, Shreya Mehta & Arvind Singh*	68
TSS/BGCP/28	**Diurnal Variability of the Deep Chlorophyll Maximum in the Bay of Bengal** *Pavithra Balamurugan, Alexkirubakaran Augustinraj & Saravanakumar Ayyapan*	69
TSS/BGCP/29	**Adaptive Marine Biogeochemical Prediction through Observation-Constrained Parameter Estimation and Hybrid Physics–Ai Modelling Framework** *Deep Banerjee, Jerry Blackford, Gemma Kulk, Shubha Sathyendranath, Jorn Bruggeman, Bolding & Bruggeman ApS, Elin Meek & Heather A. Bouman*	70
TSS/BGCP/30	**Top-Down Cascading Effects Counteract De-Eutrophication Efforts in Coastal Ecosystems** *Shubham Krishna*	71
TSS/BGCP/31	**Phytoplankton Biomass and Biodiversity Climate Change Initiative (Phyto-CCI)** *Gemma Kulk, Victor Martinez-Vicente, Marco Bellacicco, Consiglio Nazionale delle Ricerche, AstrID Bracher, Robert Brewin, Ana Brito, Vanda Brotas, Andrei Chuprin, Sarah Conners, Alexander Hayward, Lianne Jackson, Lekshmi Krishnakumary, Peter Miller, Plymouth Marine Laboratory, Emanuele Organelli, Consiglio Nazionale delle Ricerche, Graham Quartly, Ralf Quast, Brockmann Consult, Salem I. Salem, Shubha Sathyendranath, Xuerong Sun & Hongyan Xi*	72

TSS/BGCP/32	**Are Global Oceans Reaching a Tipping Point? Remotely Sensing Phytoplankton Extremes** *John A Gittings, Iason Theodorou, Eleni Livanou, Giorgio Dall'Olmo, Sezione di Oceanografia, Borgo Grotta Gigante, Trieste, Robert J. W. Brewin, Francesco Nencioli, Nicolas Cassar, Shubha Saythendranath, Devon & Dionysios E. Raitsos*	73
TSS/BGCP/33	**ESA Ocean Colour Climate Change Initiative (OC CCI) Project: Recent Developments and Community Applications** *Steve Groom, Salem Salem, Shubha Sathyendranath, Dan Clewley, Elin Meek, Carsten Brockmann, Dagmar Muller, Ralf Quast, Samantha Lavender, Francois Steinmetz,Vittorio Brando, Jamie Pitarch, Frederic Melin & Sarah Connors*	74
TSS/BGCP/34	**Phytoplankton Size Structure in the Northwest Weddell Sea** *Bob Brewin, Bethany Wilkinson, Xuerong Sun, Giorgio Dall'Olmo, Gavin H. Tilstone, Katharine R. Hendry, Sarah Breimann, Andy Rees, Ian Brown, Angus Atkinson, Katrin Schmidt, Elisabetta Canuti, Meredith Meyer, Qi Zheng, Johan Viljoen, Tom Bell & Karen Heywood*	75
TSS/BGCP/35	**Spatiotemporal Variations in Leaf Litterfall, Soil and Water Nutrients and Benthic Communities in Salimpur Mangrove** *Md Mostafijur Rahman Naeem & Subrata Sarker*	76
TSS/BGCP/36	**Sediment Biogeochemistry and Its Influence on Macrobenthic Community Structure in Intertidal Habitats of the Chattogram Coast, Bangladesh** *Mohammad Nahidul Islam Sakib & Omite Ashraf Tihum*	77
TSS/BGCP/37	**Abundance, Distribution and Diversity of Macrobenthos in Chittagong Coast, Bangladesh** *Tahmina Anwar Tonny & Subrata Sarker*	78
TSS/BGCP/38	**Spatial Variability of Macrobenthic Communities, Saltmarsh Vegetation and Land Cover Along the Sitakunda-Chattogram Coast** *Tanjida Sultana, Md Mostafijur Rahman Naeem, Md. Azizul Fazal, Abu Bokkar Siddique & Subrata Sarker*	79
TSS/BGCP/39	**Modeling the Effects of Noise in Temperature on Primary Production** *Žarko Kovač, Shubha Sathyendranath, Bror Jonsson, Robert Brewin, Qi Zheng & Francois Ribalet*	80
TSS/BGCP/40	**Seagrass Meadows Modify Short-Term pH and Oxygen Variability in Kenya's Coastal Waters** *Ahmed Mohamed, Karen Diele, Marco Fusi & Mark Huxham*	81
TSS/BGCP/41	**CO_2 Flux and Carbonate System Variability During the Dry and Rainy Seasons in the Gulf of Guinea** *Victor Ebolo Nkongo, Cecilia Chapa-Balcorta, Elizabeth Wright-Fairbanks, Narcisse Ebango Ngando, Ulrich Joel Felicien Bilounga & Grégoire Abessolo Ondoa*	82

TSS/BGCP/42	**High-Resolution O_2/Ar-Based Estimates of Net Community Production and Air–Sea CO_2 Flux in the Southwestern Atlantic** *María Luz Torres Alberto, Daniela A. del Valle, Carla F. Berghoff & Denis Pierrot*	83
TSS/BGCP/43	**Ecosystem Response to Variable Source Water Inputs in the Canary Upwelling System: Insights from *In Situ* Incubation Experiments** *Vanessa Cavucci, Sarah Reynolds, Mark C. Moore, Edward Mawji, Peter J. Brown & Elisa Lovecchio*	84
TSS/BGCP/44	**Vertical Habitat Structure of Representative Mesopelagic Environments Across the Eastern Arabian Sea Oxygen Minimum Zone: An Integrated Observational and Modelling Study** *Akash S., B. R. Smitha, Ajith K. Joseph, Annette Samuelsen, Nandini N. Menon, R. Ranith, K.G. Vimal Kumar, Meera K. Mohandas & Jadav Shirin*	85
TSS/BGCP/45	**Primary Production at EPEA Station (Southwestern Atlantic): Links to Phytoplankton and Environmental Properties** *Valeria Segura, Daniela del Valle, Vivian A. Lutz, Moira Luz Clara, Ricardo I. Silva, Jorge Fernández Acuña, M. Guillermina Ruiz, Lucrecia Allega, Carla F. Berghoff, Guillermina García Facal & Lucia Epherra*	86
TSS/BGCP/46	**Interannual Variability of Oxygen and Nutrient Concentrations in the Atlantic North Equatorial Countercurrent Between 1993–2020** *Panassa Essowe & Parfait Ditoma Akounda*	87
TSS/BGCP/47	**The Importance of a Long-Term Oceanographic Time Series for Assessing Interannual Changes in Phytoplankton off the Baja California Peninsula** *Alejandra Castillo-Ramirez, Lorena Linacre-Rojas, Angelica Serrano-Silva & Jorge López-Calderón*	88
Sub Theme 2 **Chemical Ecology for Physiological Processes in Aquatic Environments**		
TSS/CE/01	**Mixed Trophic Impact Analysis of the Kerala Marine Ecosystem** *Somy Kuriakose, Mini, K. G. & Sreepriya V.*	90
TSS/CE/02	**Seasonal Dynamics of Carbonate Chemistry and Calcification Potential in the Coral Reef Ecosystems of Lakshadweep Archipelago** *Fazil Rahiman, Anamdasu Yasaswi, Krithiga S. S., Nisha R. & Arya P. Kumar*	91
TSS/CE/03	**Integrated Assessment of Coastal Environmental Vulnerability: Anthropogenic Impacts and Geomorphologies** *MBAKOP Franck Dylane, Frank-Lorel Ngouoko-Noumi & Arthur Miguel Kemgang Beutchouang*	92
TSS/CE/04	**Assessing the Impact of Environmental Variables on Plankton Distribution of Karnaphuli River Estuary** *Md Ashiqur Sakib, Md. Naimur Rahman, Md. Eyasin Ali, Abu Siddique & Subrata Sarker*	93

TSS/CE/05	**Pharmaceutical Potential of Marine Seaweed Collected from Saint Martin's Island, Bangladesh** *Al Mozahid Abir*	94
TSS/CE/06	**Preliminary Identification of Luciferin-Related Metabolites from Deep-Sea Bioluminescent Organisms and Coastal Bioluminescent Waters Using LC-HRMS** *Stephy P. S., Shaju S. S. & Parvathy A.*	95
TSS/CE/07	**Assessing the Key Drivers in the Spawning and Rearing Habitat Selection of *Scomberoides tol* in the Eastern Arabian Sea During the Winter Monsoon** *Sonal Rajendra Kalbande, Kusum Komal Karati & Ajit Antony*	96
TSS/CE/08	**Role of Alginate-Immobilized Marine Microalgal–Bacteria Consortia for the Bioremediation of Aquaculture Effluents** *Elaine A. Sabu*	97
Sub Theme 3 **Molecular Insights into Aquatic Ecosystem Structure and Function**		
TSS/MIAS/01	**Molecular Insights into Seamount Biodiversity in the Arabian Sea through eDNA Metabarcoding** *Devika Raj K., Anas Abdulaziz, Alan Xavier & Abdul Jaleel K. U.*	99
TSS/MIAS/02	**Computational Insights into the Molecular Basis of Dinoflagellate Bioluminescence** *Shashikala K., Stephy P. S. & Shaju S. S.*	100
TSS/MIAS/03	**Assessment of Fish Diversity Along the Southwest Coast of the Arabian Sea Using eDNA Metabarcoding** *Meera P.V., Anas Abdulaziz, Devika Raj K. & Alan Xavier*	101
TSS/MIAS/04	**Floating Vegetation and Multiple Antibiotic-Resistant *Escherichia coli* and *Vibrio* spp. Posing a One Health Risk in Vembanad Lake, Southwest Coast of India** *Nizam Ashraf, Aadhila V., Anas Abdulaziz, Jibin James, Nandini Menon, Grinson George & Shubha Sathyendranath*	102
TSS/MIAS/05	**Integrating Molecular Tools and GIS-Based Hotspot Analysis to Understand Marine Mammal Strandings along the Indian Coast** *Ratheesh Kumar R.*	103
TSS/MIAS/06	**From Morphology to Metabarcoding: A Systematic Review of Global Ichthyoplankton Progress** *Kethavath Santhosh & Kusum Komal Karati*	104
TSS/MIAS/07	**Molecular Characterization and Pathogenicity Assessment of Bacteria Causing Infectious Diseases in Cage-Farmed Fish in the Lake Victoria** *Magoti Ndaro, Jackson Saiperaki, Alexanda Mzula, Silvia Materu, Antony Funga, Beda Mwang'onde, Catherine Mwakosya & Cyrus Rumisha*	105
TSS/MIAS/08	**Gut Content Analysis of Fish Species from the Sitakunda Coast, Bangladesh** *Rubaia Jannat, Mostafijur Naeem, Azizul Fazal & Subrata Sarker*	106

TSS/MIAS/09	**Vertical Segregation of Microbial Communities Along the Redox Gradient of the Oxygen Minimum Zone off Central Chile (2021–2024)** *Claudia Maturana-Martinez, Alexander Galán, Boris Dewitte & Victor Aguilera*	107
TSS/MIAS/10	**Mapping Uae Marine Biodiversity: Genomic Horizons, Metadata Integrity, And Biobanking Strategies** *Akbar John & John Abraham Renjith*	108
TSS/MIAS/11	**Regional Endemism and Environmental Structuring of Viral Communities Across the Indian Ocean Sediment Virosphere** *Swapna P. Antony & Athira Menon T.*	109
TSS/MIAS/12	**Elucidating the Immunomodulatory Potential of Exopolysaccharides (EPS) Derived from *Brachybacterium* Species for Sustainable Aquaculture** *Greeshma T.J., Alka Shilu, Sreelaxmy S., Anas Abdulaziz & Vrinda S.*	110
Sub Theme 4 **Satellite-Based Remote Sensing and Acoustic Methods as Complementary Tools to Observe Ocean Ecosystems**		
TSS/ARSCF/01	**Thermal Front Variability and Its Influence on Marine Fisheries in the Northeast Arabian Sea** *Lalima Inwati, Grinson George, Rajanna K. B., Shelton Padua, Abdul Azeez P. & Vineetha Gopinath*	112
TSS/ARSCF/02	**Comparative Performance of Statistical and Machine Learning Models for Predicting Indian Squid (*Uroteuthis duvaucelii*) Abundance from Satellite-Derived Oceanographic Variables in the Eastern Arabian Sea, India** *Santosh Bhendekar, Ajay D. Nakhawa, Anulekshmi Chellappan, Akhilesh K.VI., Ratheesh Kumar R. & Josileen Jose*	113
TSS/ARSCF/03	**Lakshadweep Reefs in a Warming Sea: Two Decades of Satellite Evidence** *Arya P. Kumar & Anu Gopinath*	114
TSS/ARSCF/04	**From Landing Centres to Fishing Grounds: Integrating Grid-Based Catch Sampling with Satellite Oceanographic Observations for Data-Science-Driven Stock Exploitation Assessment** *J. Jayasankar, Sindhu K. Augustine, Sijo Paul, Manjeesh R. & V. Sreepriya*	115
TSS/ARSCF/05	**Spatial and Temporal Variability of Nutrients and Chlorophyll-a in Relation to Coastal Marine Productivity Along the Gujarat Coast, India** *Vinaya Kumar Vase, Arvind Sahay, Rajan Kumar, Shikha Rahangdale, Mini Raman, Harsad Solanki, Sanjana Kartu, Jayasankar J., Grinson George & K. N. Babu*	116
TSS/ARSCF/06	**Influence of the Indian Ocean Dipole on Phytoplankton Biomass in the Southwestern Bay of Bengal** *Jessin Joy Alex, Joel John, Akhil.V. P., Adith.V. B. & Febin Paulose*	117

TSS/ARSCF/07	**Decadal Change in Mangrove Cover of Kerala Using Sentinel-2 Data** *Aarathi M. S., Shelton Padua, Miriam Paul Sreeram & Sobhana K. S.*	118
TSS/ARSCF/08	**Use of Hyperspectral and Multispectral Sensors as an Indicator of Primary Productivity** *Mingsuwangma Limboo & Karankumar Ramteke*	119
TSS/ARSCF/09	**Disentangling Environment-Associated Prey Shifts and Fishing Pressure in Bombayduck Fisheries** *Rajan Kumar, Vinayakumar Vase, Shikha Rahangdale, Ratheesh Kumar, Jayasankar J. & Grison George*	120
TSS/ARSCF/10	**Tracking Algal Bloom Propagation Using Integrated Remote Sensing and Particle Tracking Approaches** *Reema Mathew, Mohammed Suhail K. & P. V. Nagamani*	121
TSS/ARSCF/11	**Spatial Distribution and Future Habitat Suitability of Yellowfin Tuna (*Thunnus albacares*) in the Indian Ocean Under Changing Environmental Conditions: A MaxEnt Modelling Approach** *Rose P. Bright, Eldho Varghese, Muktha M., Ratheesh Kumar R., Shubhadeep Ghosh & Grinson George*	122
TSS/ARSCF/12	**Temporal Dynamics of Mean Temperature of the Catch in Gujarat Marine Fisheries Along the Northwestern Indian Coast** *Shikha Rahangdale, Rajan Kumar, Vinayakumar Vase & Abdul Azeez*	123
TSS/ARSCF/13	**Mapping of Ghost Fishing Gear Hotspots Along Maharashtra Coast, India** *Taniya Chandra, Abuthagir Iburahim S., Karankumar Ramteke & Binaya Bhusan Nayak*	124
TSS/ARSCF/14	**Monitoring and Prediction of Ocean Productivity in the Arabian Sea Using Long-Term Satellite Remote Sensing and Oceanographic Data** *Abhishek Medhi, Sethu Madhav R., Charan Kumar Basuri, Vishnu Vardhan Kanuri, Karthic K. & Mahesh Kumar R. S.*	125
TSS/ARSCF/15	**Validation and Intersensor Comparison of OCM-3 and Sentinel-3 OLCI Chlorophyll-a Products in the Southeastern Arabian Sea** *Anand M. Vijayan, Ranith R., Ajith Joseph K., Jayaram Chiranjivi & Babu K. N.*	126
TSS/ARSCF/16	**Review of Bio-Optical Modelling of the North Indian Ocean – Gap Areas and Future Perspectives** *Ganika Kushwah & Aneesh Anandrao Lotliker*	127
TSS/ARSCF/17	**Spatio-Temporal Patterns of Net Primary Production and Carbon Export Efficiency in the North-West Bay of Bengal** *Lipsita P. Sahoo, Sanjiba Kumar Baliarsingh & Nibedita Behera*	128
TSS/ARSCF/18	**Assessment of OCM-3 Retrieval Accuracy for Coloured Dissolved Organic Matter (CDOM) in Coastal Waters of the Eastern Arabian Sea** *Nagarajan Manimozhi, Murugan Vennila, Ranjit Kumar Sarangi & Anu Gopinath*	129

TSS/ARSCF/19	**Environmental Drivers of Coastal Primary Productivity: A Multimodal Machine Learning and Time-Warping Approach** *Mini K.G., Shelton Padua, Somy Kuriakose & Vaisakh G.*	130
TSS/ARSCF/20	**Bioregionalization of Phytoplankton in the Northern Indian Ocean: A Fuzzy Membership and Weighted Species Richness Approach** *Monolisha Sundar Raj, Shubha Sathyendranath, Elizabeth C. Atwood, Emma Sullivan, Victor Matrinez Vicente, Eldho Varghese, Prathibha Rohit, Grinson George, Nandini Menon & Trevor Platt*	131
TSS/ARSCF/21	**Potential of Satellite Remote Sensing in Ecosystem Approach to Fisheries Management** *Muktha M., Remya L., Manas H. M., Pralaya Ranjan Behera, Indira Divipala, Jasmin F., S. S. Raju, Joe K. Kizhakudan & Grinson George*	132
TSS/ARSCF/22	**Seasonal and Interannual Variability of Phytoplankton Size Classes in the Eastern Arabian Sea: Insights from *In Situ* Observations and Satellite Ocean Color Data** *Nikhil Bhujbal, Siby Kurian, D. M. Shenoy, Akhil V. P. & Adith V. B.*	133
TSS/ARSCF/23	**Multidecadal Trends, Thresholds, and Transport Dynamics of Algal Blooms in the Northern Indian Ocean from Satellite Data** *Ranith Rajamohanan Pillai, Nandini Menon N., Sebin John, Lasse H. Pettersson, Roshin P. Raj & Grinson George*	134
TSS/ARSCF/24	**Matsyametri: Intelligent Fish Length Measurement and Frequency Analysis System** *Thejus T. V., Eldho Varghese, J. Jayasankar, Somy Kuriakose, Mini K.G., Manu V. K., Manjeesh R., Rekha J. Nair, Muktha M., Vinay Kumar Vase & Grinson George*	135
TSS/ARSCF/25	**Comparative Evaluation of OC4, OC5, and OC6 Algorithms for Chlorophyll-a Retrieval Using OCM-3 Data in the Eastern Arabian Sea** *Murugan Vennila, Nagarajan Manimozhi, Ranjith Kumar Sarangi & Anu Gopinath*	136
TSS/ARSCF/26	**Chlorophyll Variability and Its Implications for Fisheries Landings Along the Kerala Coast (2008–2016)** *Punmoth Kalyadan Vrinda, Dhanya M. Lal, Sudheer Joseph & T. M. Balakrishnan Nair*	137
TSS/ARSCF/27	**Impact of Aerosols on Chlorophyll-a Distribution in the Arabian Sea Using Multi-Satellite Observations** *Julio Leonel Donfack & Muhammad Shafeeque*	138
TSS/ARSCF/28	**From Sea to Shore: Wind-Driven Aerosolization of Harmful Algal Bloom Toxins in Qingdao, China, During the Winter of 2019** *Madeleine Martin & Lauren Biermann*	139

TSS/ARSCF/29	**Enhancing Ocean Colour Climate Records with OC CCI Version 7** *Salem Ibrahim Salem, Shubha Sathyendranath, Andre Valente, Andrei Chuprin, Constant Mazeran, Théo Renard, Jaime Pitarch, Astrid Bracher, Vittorio E. Brando, Vanda Brotas, Emmanuel Devred, Robert Frouin, Hiroto Higa, Joji Ishizaka, Piotr Kowalczuk, Atsushi Matsuoka, Valeria Segura, Carlos R. B. Mendes, Emanuele Organelli, Heeyoon Park & Steve Groom*	140-141
TSS/ARSCF/30	**Coastal Phytoplankton Diversity in the Iberia Upwelling Region** *Vanda Brotas, Afonso Ferreira, Ana C. Brito, Andreia Tracana, Joana Cruz, Luciane Favareto, Paulo Oliveira, Tamara Rodríguez-Ramos, Manuel Ruiz-Villarreal, Alexander Hayward, Shubha Sathyendranath, Dan Clewley, Jane Netting & Steve Groom*	142-143
TSS/ARSCF/31	**Characterization of a Monsoonal Wetland System Based on Optical Water Types** *Elizabeth C. Atwood, Bror Jönsson, Ranith Raj, Anas Abdulaziz, Nandini Menon & Shubha Sathyendranath*	144
TSS/ARSCF/32	**Understanding Phytoplankton Absorption Signatures in the San Matías Gulf (Patagonia, Argentina) via PACE-OCI Hyperspectral Data** *Gabriela N. Williams, Melina Silvestro, M. Guillermina Ruiz, Juan Saad & Guillermo Svendsen*	145
TSS/ARSCF/33	**Evaluating Four Machine Learning Algorithms Using Google Earth Engine for Analyzing LULC Dynamics of Sandwip Island, Bangladesh** *Md. Abrar Al Foysol & Abu Bokkar Siddique*	146
TSS/ARSCF/34	**Integrating Satellite-Derived Oceanographic Data and *In Situ* Observations for Affordable Monitoring of Spatial–Temporal Dynamics in Coastal Artisanal Fisheries of Bangladesh** *Md. Hamim Chowdhury, Morgina Akter & Subrata Sarker*	147
TSS/ARSCF/35	**Environmental and Plankton Drivers of Small-Scale Fisheries in Mangrove Ecosystems** *Md. Naimur Rahman, Subrata Sarker & Morgina Akter*	148
TSS/ARSCF/36	**An Evaluation of Satellite and *In Situ*-Based Sea Surface Temperature Datasets in the South-Central Coastal Zone of Bangladesh** *Nishat Tasnim Ali & Subrata Sarker*	149
TSS/ARSCF/37	**NOAA Satellite Mapping of Sugar Kelp Aquaculture Suitability in the Gulf of Maine** *Seunghyun Son, Seth Theuerkauf, Ken Riley, Clete Otoshi & Veronica Lance*	150
TSS/ARSCF/38	**Hydrodynamic Variability and Its Impact on Biodiversity in the Northern Bay of Bengal** *Tasnim Rahman Rimu & Mohon Kumar Das*	151

TSS/ARSCF/39	**Integrating Satellite Ocean Colour and *In Situ* CTD Observations to Assess Phytoplankton Photoacclimation During the ESA OTC25 Oceanographic Cruise** *Walter Ogutu*	152
TSS/ARSCF/40	**Impact of Marine Heatwaves on Northwest African and Gulf of Guinea Coastal Upwelling Dynamics and Productivity** *Dametoti Yamoula, Bamol A. Sow & Ifeluwa A. Balogun*	153
TSS/ARSCF/41	**Bloom Recurrence and Spatiotemporal Phytoplankton Variability in the Arabian Gulf and Sea of Oman** *Kaltham Ismail*	154
TSS/ARSCF/42	**Phytoplankton Phenology and Physical Forcing in the Pemba Channel: Disentangling Their Roles in Small Pelagic Fish Dynamics** *Hellen Kizenga, Emmanuel Devred & Margareth Kyewalyanga*	155
TSS/ARSCF/43	**Long-Term Transformation of Sea Surface Temperature, Salinity, and Chlorophyll-a in the Bay of Bengal Under Climate Change** *Md Shabit Hossain & Abu Bokkar Siddique*	156
TSS/ARSCF/44	**Assessment of Anthropogenic and Natural Drivers Controlling Interannual Chlorophyll-a Trends in the World's Largest Choked Lagoon Using Remote Sensing** *Milton Kampel, Vinicius Lima Guimarães & Vincent Vantrepotte*	157
TSS/ARSCF/45	**Insights from the ESA Ocean Training Course 2025 Expedition: Bio-Optical Characterization of Phytoplankton Size Structure and Community Composition Along a Transect from the Nordic Seas to the Mediterranean** *Sejal Pramlall, Daniel Koestner & Arne Kristoffersen*	158
TSS/ARSCF/47	**Potential of Astaxanthin-Based Zooplankton Monitoring Using Ocean Color Remote Sensing in the Arabian Sea** *Rebekah Shunmugapandi*	159
TSS/ARSCF/48	**On Gaps in Marine Ecosystem and Diversity Data in Tropical Oceans** *Shubha Sathyendranath, Bror Jönsson, Gemma Kulk, Monalisha Sunder, Victor Martinez Vicente & Heather Bouman*	160
TSS/ARSCF/49	**Ecosystem-Based Marine Management in the Norwegian Waters** *Lasse H. Pettersson*	161
TSS/ARSCF/50	**Depth and Deflection Angle of the Ekman Current Near the Equator for Understanding the Upwelling Process in Indonesia** *Lamona Irmudyawati Bernawis, Luqmannul Hakim, Farrah Hanifah, Susanna Nurdjaman, Ivonne M. Radjawane & Agus Santoso*	162
TSS/ARSCF/51	**CadalminGPT: An AI System for Grounded, Citation-Verified Knowledge Discovery over a Large Marine Fisheries Research Corpus** *Manu V. K., Eldho Varghese, Arun Surendran P. S., Ashutosh Dalal, J. Jayasankar, Mini K. G. & Somy Kuriakose*	163

TSS/ARSCF/52	**Integrating GIS-AHP Site Suitability Modelling with Field Validation for Sustainable Farming of *Kappaphycus alvarezii*: A Case Study from the Kachchh Coast, India** *Divu D., P. S. Swathi Lekshmi, Dipjyoti Gogoi, Prachi Siddharth Bagde, Ishita J. Bambhaniya & Muktha Menon*	164
TSS/ACO/01	**Acoustic Characterization of Deep Scattering Layers and Diel Vertical Migration of Mesopelagic Fishes in the Southeastern Equatorial Indian Ocean** *Kranthikumar Chanda, Meera K. M., Smitha B. R., Hashim M. & Rasheed K.*	165
TSS/ACO/02	**Short-Term Variability of Thermal Inversions and Subsurface Chlorophyll-a in the South Andaman Sea During February 2024** *Maria Sansanna, Maheswaran P. A., Navaneeth K. N. & Subeesh M.*	166
TSS/ACO/03	**Hydrographic Variability of the Cochin Estuary and Adjacent Coastal Waters During the Southwest Monsoon: Influence of Coastal Upwelling and Tidal Forcing** *Anjali K. S., Maheswaran P. A., Anu Susan Cheriyan & Rajith K.*	167
Sub Theme 5 & 6 **Integrating Indigenous and Traditional Knowledge into Aquatic Sciences** & **Role of Women and Marginalised Communities for Sustainable Development**		
TSS/ITK_RWF/01	**The Southwest Monsoon as a Marine Season: Indigenous Mukkuvar Understanding from the South Kerala–Kanyakumari Coast** *Leno Ignatious & Johnson Jament*	169
TSS/ITK_RWF/02	**Traditional Knowledge and Modern Science: Towards Integration and Synergies** *Kadija Oubelkheir & Gary Paul McGuffie*	170
TSS/ITK_RWF/03	**Bridging Indigenous Knowledge and Digital Ocean Science: The African Ocean Biodiversity Atlas for Inclusive Aquatic Governance** *Peter Teye Busumprah*	171
TSS/ITK_RWF/04	**Co-Production of Knowledge About Phytoplankton in Coastal Northwest Alaskan Waters** *Ajit Subramaniam & Alex Whiting*	172
TSS/ITK_RWF/05	**From Technology to Transformation: CMFRI's Bivalve Farming Initiative for the Socio-Economic Empowerment of Women and Scheduled Caste Communities** *Vidya R., Geetha Sasikumar, Alloycious, P. S., Jestin Joy K. M. Sajikumar K. K., Imelda Joseph & Rema Madhu*	173
TSS/ITK_RWF/06	**Integrated Black Soldier Fly Breeding and Early Larval Production Unit: A Sustainable and Inclusive Approach for Community-Based Bioresource Utilization** *Gokula G. Nath, Sanal Ebeneezar, Silpa Kunnappilly Paulose & Chiranjiv Pradhan*	174

TSS/ITK_RWF/07	**Opportunities and Challenges for Women, Social Equity and Sustainable Development** *Apurva Fuladi*	175
TSS/ITK_RWF/08	**Seaweed Farming as a Sustainable Pathway for Empowering Women and Marginalised Coastal Communities** *Johnson B., Naveen Kumar B. T., Bavithra R., Vikas P.A., Sankar M., Vinod K. & Grinson George*	176
TSS/ITK_RWF/09	**Community-Driven Coastal Stewardship in Southern Sri Lanka: Women, Youth and Small-Scale Fishers Advancing Sustainable Marine Futures** *Gayathra Bandara & Delphine Mestdagh*	177
Sub Theme 7 **Water Quality Monitoring: Safeguarding Human Health**		
TSS/WQM/01	**Development of a Robust Multiplex PCR Assay for Simultaneous Detection of Major Pathogenic *Vibrio* spp. of Concern to Human Health and Water Quality** *Andria, Sumithra T. G., Sandra C. Joseph & Krupesha Sharma S. R.*	179
TSS/WQM/02	**Water Quality Monitoring Through Phytoplankton Indicators: Assessing Ecosystem Health in Nanda Lake, Goa** *Sangeeta Naik & Shambhavi Marathe*	180
TSS/WQM/03	**Water Quality and Coastal Ecosystem Health in the Southeast Arabian Sea: Insights from a Water Quality Nowcasting System** *B. S. Gayathri, Susmita Raulo, Sanjiba Kumar Baliarsingh, Sudheer Joseph, Aneesh A. Lotliker & T. M. Balakrishnan Nair*	181
TSS/WQM/04	**Dual Role of Algal Blooms in Indian Coastal Waters: From Enhanced Productivity to Trophic Disruption** *Haridevi C. K.*	182
TSS/WQM/05	**Climate- and Anthropogenic-Driven Hydrological Alterations and Their Impacts on Water Quality in Chilika Lagoon: A Multi-Decadal Remote Sensing Analysis (2015–2025)** *B. Goutami, Vikrant Vijay Patil & Brijesh Kumar Yadav*	183
TSS/WQM/06	**Investigating Seasonal Shifts in Phytoplankton Communities as Indicators of Eutrophic Stress in Teluk Bahang Coastal Waters** *Harshan Mahesh, Sazlina Salleh, Mahadi Mohammad, Norhidayah Sabre & Nur Hidayah Abdullah*	184
TSS/WQM/07	**Assessing Oceanographic Drivers Leading to a Mass Stranding of Porpita porpita (Linnaeus, 1758) Along the Gopalpur Coast, North-Western Bay of Bengal** *Ajay Kumar Jena & Sanjiba Kumar Baliarsingh*	185
TSS/WQM/08	**Assessment of Marine Pollution and Its Multidimensional Impacts on Fisheries Sustainability and Public Health in Coastal Andhra Pradesh, India** *Venkateswarlu Vardi, K. Santi & Ch. Venkatrayulu*	186

TSS/WQM/09	**Molecular Surveillance of Free-Living Pathogenic Amoebae in Freshwater Systems of Kerala** *Jasmin.C., Krishnapriya A. K., Helan Maria Jojan, Jasna Fathima J., Aryananda A. & Nandini Menon N.*	187
TSS/WQM/10	**Water Hyacinth as a Vector for Bacteria Resistant to Multiple Drugs and Metals** *Jasmin C., Aryananda A., Rithin Raj, Jasna Fathima J., Helan Maria Jojan & Nandini Menon*	188
TSS/WQM/11	**Phytoplankton Community Structure, Bio-Optical Characteristics and Environmental Variability in Tidally Influenced Beaches Along the Kerala Coast** *Rithin Raj M., Prince Arayakandi, Anjanalakshmi, Ranith R., Anas Abdulaziz, Grinson George, Shubha Sathyendranath & Nandini Menon N.*	189
TSS/WQM/12	**Emerging Contaminants: Sources, Impacts and Management—A Review** *Riya Fathima, Rahul R. & Shaju S. S.*	190
TSS/WQM/13	**Carbon Nanodot-Based Fluorescent Sensors for Rapid Detection of Heavy Metals in Water: A Sustainable Approach for Water Quality Monitoring and Human Health Protection** *Sandra Manoharan & Shaju S. S.*	191
TSS/WQM/14	**Beyond Chlorophyll a: Phytoplankton Composition Mediates Trophic Shifts and Restructures Fish Feeding Pathways in the Ulhas Estuary** *Soumili Paul & Haridevi C. K.*	192
TSS/WQM/15	**Microplastics in Indian Coastal Waters and Marine Biota: A Comprehensive Review and Synthesis** *Suchismita Sahu, Anish Kumar Warrier & Anu Gopinath*	193
TSS/WQM/16	**Spatial Distribution and Health Risks of PAHs in Water Samples from Selected Ports Along the Red Sea Coast (Safaga–El-Qusier), Egypt** *Ghada Y. Zaghloul, Mahmoud S. Kelany, Khalid M. El Moselhy & Heba M. Ezz El-Din*	194
TSS/WQM/17	**Comparative Analysis of Metal Pollution and Health Risks in Coastal Sediments of Egypt's Gulf of Suez (Red Sea)** *Heba M. Ezz El-Din, Ahmed Elgendy, Mahmoud Kelany, Mohamed El-Sawy, Lamiaa Mohamedein & Ghada Zaghloul*	195
TSS/WQM/18	**Phenolics: Plastic-Associated Organic Contaminants in Water, Sediment and Fishes from Lagos Lagoon, Nigeria** *Kehinde Oluwasiji Olorunfemi, Gideon Idowu & Ademola Aiyesanmi*	196
TSS/WQM/19	**Seasonal Variability of Bio-Optical Properties in the Cochin Estuary, Kerala, India** *Soumya K. P., Shaju S. S. & Ashraf P. M.*	197

TSS/WQM/20	**Macrobenthic Communities as a Bio-Indicator of Water Quality Assessment in the Southeastern Coast of Bangladesh** *Omite Ashraf Tihum, Md. Sharif Hossain, Md. Bayzid, Md. Nahidul Islam Sakib, Md. Azizul Fazal, Subrata Sarker & Md. Alamgir Kabir*	198
TSS/WQM/21	**Seawater Quality: Coupling Satellite Data in Coastal Zones of Nosy Be** *Soavelo François Mahatsiaro, Amélie Landy Soambola, Jean Charles Lope & Marie Laurita Toenjara*	199
TSS/WQM/22	**Conserving the Coastline: Macrobenthic Community Structures and the Ecological Supremacy of Sundarbans Mudflats** *Fuad Jamil Mahdi, Md. Azizul Fazal, Omite Ashraf Tihum & Md. Nahidul Isalam Sakib*	200
TSS/WQM/22	**Strengthening Integrated Coastal Water-Quality Monitoring Through Sustained *In Situ* Observations in Cartagena Bay** *Stella Patricia Betancur-Turizo, Gisela Mayo-Mancebo, Cesia Alejandra Pájaro-Contreras & Luisa Fernanda Lambis-Arévalo*	201
TSS/WQM/24	**Electrical Analysis for Sensing Water Quality** *Roqaya Ismail, Omar Awayssa, Roqaya A. Ismail, Ali Hilal-AlNaqbi & Mahmoud Al Ahmad*	202
TSS/WQM/25	**Challenges and Opportunities for Integrating Microbial and Satellite-Based Monitoring of Coastal Recreational Waters in Trinidad and Tobago** *Sheldon Ramoutar*	203
TSS/WQM/26	**Abundance and Distribution of Plankton Along the Sitakunda Coast of Chattogram, Bangladesh** *Tasnova Islam, Md. Mostafijur Naeem, Md. Azizul Fazal & Subrata Sarker*	204
TSS/WQM/27	**Using Satellite Remote Sensing to Investigate Environmental Drivers of Cholera Outbreak Risk in Chandigarh, Northern India** *Emma Sullivan, Aswin S., Neelam Taneja, Anas Abdulaziz, Michael Dillon, Nandini Menon, R. Ranith, Gemma Kulk & Shubha Sathyendranath*	205
TSS/WQM/28	**Seasonal and Spatial Variability of Physicochemical Parameters and Heavy Metals in Coastal Surface Water of Bangladesh** *Md Shabit Hossain, Abu Bokkar Siddique, Md Shajjadur Rahman & Md Shariar Hossain Sazzad*	206
TSS/WQM/29	**Dynamics of Particulate Organic Carbon During the Pre–Southwest Monsoon in the Western Coastal Bay of Bengal** *P. Ajay Kumar, M. Srirama Krishna, G. Sahoo & P. Shyamala*	207
TSS/WQM/30	**From Source Identification to Risk Assessment: Polycyclic Aromatic Hydrocarbons in Surface Sediments of the Southeastern Arabian Sea** *Abhinitha Subash, Gireeshkumar T. R., Sanyo P. S. & Jithu A. R.*	208

TSS/WQM/31	**Biogenic and Potentially Toxic Metals from Suspended Particulate Matter and Zooplankton in the Southeastern Arabian Sea** *Aparna K., Mrinalini V., Gireeshkumar T. R., Vignesh E. R. & Ramzi A.*	209
TSS/WQM/32	**Triclosan and Methyl Triclosan in Surface Sediments of the Southeastern Arabian Sea: A Baseline Study** *Furtado C. M., Jithu, A. R., Gireeshkumar T. R. & Ramzi A.*	210
TSS/WQM/33	**Spatial Distribution of Microplastics and Heavy Metals in Coastal and Island Sediments of the Arabian Sea** *Jyoti Varier, Vaishnavi S. Dev, Akhil A., Vennila M., Nagarajan Manimozhi, Arya P. Kumar, Nisha R., Devika S., Shaju S. S. & Anu Gopinath*	211
TSS/WQM/34	**Investigating the Role of Floating Vegetation as a Critical Predictor in Explaining the Vector-Borne Disease Dynamics Under Changing Climate** *Nandini Menon, Ranith Rajamohanan Pillai, Jasmin C., Anas Abdulaziz, Grinson George & Shubha Sathyendranath*	212
TSS/WQM/35	**Modelling the Fate and Trajectories of Hypothetical Oil Spills Near Chattogram and Mongla Ports, Bangladesh** *Md Abu Yousuf Prodhan, Mohammad Kawsar Hossen, Abu Bokkar Siddique & Subrata Sarker*	213
TSS/WQM/36	**A Study on the Population Decline of Olive Ridley Turtles in Kolavipalam Beach, Calicut** *Vishnu Prasad Narasseri, Dhanya M. Lal, S. Venu & Asha Kunjappan*	214
TSS/WQM/37	**Chlorophyll–Pathogen Interactions in the Coastal Waters of Bangladesh** *Nabanita Das, Subrata Sarker, Moshiul Mishu, Md Shahadat Hossain, Mohammad Al-Mamun, Shahadat Hossain, Ishtiaq Ahmed & Shubha Sathyendranath*	215
TSS/WQM/38	**Temporal and Vertical Dynamics of Microplastics at GNEO-1, Northern Argentine Patagonia: First Insights** *Rodrigo Hernandez-Moresino, Lucía Epherra, Antonella De Cian, Johana Lucero & Regina Pierattini-Martinez*	216
Sub Theme 8 **Climate Resilience, Adaptation and Mitigation**		
TSS/CRAM/01	**Saltwater Intrusion as a Climate Stressor: Household-Level Economic Impacts and Adaptation Deficits in a Peri-Urban Coastal Community, Kerala, India** *Anuja A. R., Shelton Padua, Rajeev Ranjan & Shobhana K. S.*	217
TSS/CRAM/02	**Human Lifestyles and the Changing Balance of Aquatic Ecosystems** *Sowjanya Kotha*	218

TSS/CRAM/03	**Spatial Assessment of Climate Risk and Vulnerability in Coastal Kerala** *Reshma Gills, C. Ramachandran, Shelton Padua, R. Venkattakumar, Eldho Varghese, Rathesh Kumar R. & Grinson George*	219
TSS/CRAM/04	**Environmental DNA-based Biodiversity Assessment for Monitoring the Impacts of Extreme Weather Events** *Silpa Chandran, Devika raj K., Meera P. V. & Anas Abdulaziz*	220
TSS/CRAM/05	**Nature-Synchronised Cage Aquaculture as a Climate-Resilient Adaptation Strategy for Tropical Estuarine Ecosystems: Insights from Long-Term Fish Mortality Events in the Periyar–Vembanad System, India** *Vikas P. A.*	221
TSS/CRAM/06	**Multidecadal Decline of Mangrove Cover in Minicoy Island, Lakshadweep, India: A Remote Sensing Analysis Using Multi-Temporal Landsat Imagery** *Abdul Azeez P., Hrishikesh Dhapate, Shakira K., Surajit Mahalanobis, Sagar Vittal Shinde & Shoba Joe Kizhakudan*	222
TSS/CRAM/07	**Seasonal Intensification and Spatial Evolution of Marine Heatwaves in the Barents Sea** *Saradhy Surendran, Sourav Chatterjee, Roshin P. Raj & Ajith Joseph K.*	223
TSS/CRAM/08	**Linking Plankton Shifts to Hilsa Catch Dynamics in the Narmada Estuary** *Swarnendu Bera & Haridevi C. K.*	224
TSS/CRAM/09	**Nature-Based Solutions for Climate Resilience: Pathways to Sustainable Adaptation and Mitigation** *Christopher Enu*	225
TSS/CRAM/10	**Warming and Freshening Coastal Waters Impact Harmful Algal Bloom Frequency in High Latitudes** *Edson Silva, François Counillon, Julien Brajard, Richard Davy, Stephen Outten, Lasse Pettersson & Noel Keenlyside*	226
TSS/CRAM/11	**Marine Heatwaves in the Bay of Bengal** *Fairuz Faria Saika & Subrata Sarker*	227
TSS/CRAM/12	**Carbon Stock Dynamics in Response to Changes in Mangrove Forest Cover Along the Coastline of Ghana from 2015 to 2024** *Farouk Ahmed, Benjamin Gyampoh & Emmanuel Xatse*	228
TSS/CRAM/13	**Assemblage of Juvenile Fish in Natural and Planted Mangroves of Qatar Under Extreme Seawater Conditions** *Kaiprath Puthiyapurayil Haseeba, Valliyil Mohammed Aboobacker, Ponnumony Vethamony & Jassim Abdulla Al-Khayat*	229
TSS/CRAM/14	**Climate Change Impacts on Lake Hydrology in Rwanda: A Case Study of Lake Cyohoha North** *Joel Ndayisaba & Theodore Nshimyumuremyi*	230
TSS/CRAM/15	**Fishing Activity and Fish Fauna of Two Rivers in the Congo Basin (Boumba and Kadei) in Eastern Cameroon** *Sandrine Jueya & Bitja Nyom Arnold Roger*	231

TSS/CRAM/16	**Impact of Climate Change on Mariculture Suitability in the Coastal Waters of Bangladesh** *Muhammad Mizanur Rahman, Md. Rashed Talukder, Md. Shahadat Hossain, Md. Hammim Chowdhury, Puja Mitra & Subrata Sarker*	232
TSS/CRAM/17	**Study of the Impact of Mining on Sea Turtles in the Manyange na Elombo-Campo Marine Park (Kribi, South Cameroon)** *Jueya Sandrine*	233
TSS/CRAM/18	**Patterns of Juvenile Reef Fish Assemblages Across a Mangrove–Seagrass–Coral Continuum in Shimoni, Kenya** *Dennis Otieno, Gladys Okemwa, Thomas Mkare, Immaculate Kinyua, James Mwaluma, Cosmas Nzaka Munga*	234
TSS/CRAM/19	**North Atlantic Oscillation Signal in the Interannual Variability of Early Austral Summer Vegetation over East Africa** *Dickson Mbigi & Kiprotich Paul*	235
TSS/CRAM/20	**Integrating Community-Based Water Data Systems and Ocean Waste Upcycling to Strengthen Coastal Ecosystem Monitoring, Public Health, and Climate Resilience in Central and West Africa** *Ewube Kelly Laure Egbe & Peter Teye Busumprah*	236
TSS/CRAM/21	**Deep Learning-Driven Seaweed Disease Detection and Biosecurity Frameworks for Climate-Resilient Aquaculture in Bangladesh** *Md. Saber Hossain & Morgina Akter*	237
TSS/CRAM/22	**Environmental Aspects of Mariculture in the Coastal Area of Bangladesh** *Md. Shamsul Hoque & Subrata Sarker*	238
TSS/CRAM/23	**Spatial Analysis of Blue Carbon Potential in the Mangrove Ecosystem at Muara Gembong Beach, Indonesia, as a Climate Change Mitigation Effort** *Nazli Raudhati, Syamsul Bahri Agus, Rinny Rahmania & Taslim Arifin*	239
TSS/CRAM/24	**Physiological and Metabolic Resilience of Prorocentrum lima to Ocean Warming: Implications for Diarrhetic Shellfish Poisoning Blooms in Indian Coastal Waters** *Oyeshina Oyeku & Subir Mandal*	240
TSS/CRAM/25	**Assessing Sea-Level Rise and Coastal Response in the Northern Bay of Bengal Using Observations and Modeling** *Puja Mitra & Subrata Sarker*	241
TSS/CRAM/26	**Trophic and Behavioral Responses of Reef Fish Communities to Whale Shark Provisioning in a Tropical Marine Ecosystem** *Janice Leriorato, Peeve K. C. Layage & Feleche Marie Racaza*	242
TSS/CRAM/27	**Spatiotemporal Analysis of Mangrove Cover Change and Shoreline Dynamics in Nijhum Dwip using Remote Sensing and GIS** *Md. Jahidul Islam & Abu Bakkar Siddique*	243

TSS/CRAM/28	**Application of a Citizen Science Approach to Identify Biodiversity Hotspots: A Study from the Bangladesh Coast Emphasizing Conservation Importance** *Subrata Sarker, Kazi Mainul Islam, Md. Nahiduzzaman, M. Mokarrom Hossain, M. Jalilur Rahman, Nabanita Das, Shashowti Chowdhury Riya & Md. Shahadat Hossain*	244
TSS/CRAM/29	**Decoding Shoreline Erosion and Variability Along the Kerala Coast Using Multi-Sensor Satellite Observations** *Vijaitha Baby, Ranith Rajamohanan Pillai, Nandini Menon N. & Roshin P. Raj*	245
TSS/CRAM/30	**From Datasets to Decisions: Navigating Science and Politics in Antarctic Conservation** *Junjing L. I.*	246
TSS/CRAM/31	**Extreme Temperatures, Connectivity, and Phytoplankton Resilience in a Warming Ocean** *Bror Jönsson, Dionysos Raitsos, Jon Norberg, Žarko Kovač & Shubha Sathyendranath*	247
TSS/CRAM/32	**Remotely Sensing Marine Ecosystem Responses to Ocean Warming** *Dionysios E. Raitsos, John A. Gittings, Eleni Livanou, Robert J. W. Brewin & Shubha Saythendranath*	248
TSS/CRAM/33	**The Temperature Dependence of Phytoplankton Photosynthesis Across Oceanic Domains** *Heather A. Bouman, Gemma Kulk, Shubha Sathyendranath & Sornsiri Phongphattarawat*	249
TSS/CRAM/34	**Discrete Measurements of Essential Ocean Variables and Water Transparency in Pangandaran Bay, South Java, Indonesia (2021–2026)** *Noir P. Purba, Ibnu Faizal, Lantun P. Dewanti1, Irfan Zidni, Lilian A. Krug Subrata Sarker, Lady A. S. Wijayanti, Nurani Khoerunnisa, Sanny T. Utami, Riana C. Dewi, Ainun Nahar, Helmalia Asri, Erwin J.M. Damanik, Raziq Aldin, Muhammad H. Ilmi, Ramones Telaum Banua & Alexander M. A. Khan*	250
TSS/CRAM/35	**Validation of a Coupled Hydrodynamic–Sediment Transport Model Developed for a Pilot Site of the UN Decade Project Coast Predict: The Gulf of Gabes, Mediterranean Sea** *Houssem Smeti & Abdelfattah Atoui*	251
TSS/CRAM/36	**Are Marine Heatwaves the Primary Driver of Coral Bleaching Across Indian Reef Regions? Evidence from Observations and CMIP6 Projections** *Mahima George, Sajuna Sunny, Krishnamohan K. S., Vijith V.& Vrinda S.*	252

Sub Theme 9 Monsoon Dynamics and Extreme Events		
TSS/MDE/01	**Event-Driven Amplification of Dissolved Manganese Fluxes in a Tropical Monsoon-Based Estuary: River Godavari Estuarine System** *Divya Mahatpure & Apurva Fuladi*	254
TSS/MDE/02	**Assessment of Sea-Level Rise Hazard Along the Indian Coast** *Shelton Padua, Reshma Gills, C. Ramachandran, Eldho Varghese, K. R. Ratheesh, Grinson George, Rose P. Bright, E. Vivekanandan, J. Jayasankar & A. Gopalakrishnan*	255
TSS/MDE/03	**Is Seasonal DIC and pCO_2 Variability Off Paradip Driven by Monsoon Hydrology?** *Alok Sethi & Kamal Kumar Barik*	256
TSS/MDE/04	**Influence of the Southwest Monsoon on Marine Fishing Activity and Fish Catch Dynamics in Coastal Kerala** *Rajeev Ranjan, Shelton Padua, Karthika K. S. & K. S. Sobhana*	257
TSS/MDE/05	**Participatory Management as a Trigger for Developing EAFM in Two Monsoon-Driven Ecosystems: Insights from the Gulf of Mannar and Palk Bay** *Remya L., Muktha M., Rajkumar M., Veera Venthan K. R., Vidhya V. & Shoba Joe Kizhakudan*	258
TSS/MDE/06	**A Case Study Investigating the Imprint of Cyclone Dana on the Variability of Phytoplankton Biomass in Coastal Waters of the North-Western** *Sumit Kumar Mohanty, Suchismita Srichandan & Kamal Kumar Barik*	259
TSS/MDE/07	**Effects of Monsoonal Dynamics on Phytoplankton Photosynthetic Performance in the Sundarbans Using Fast Fluorometry** *Abhinav Gummalla, Rajdeep Roy, Nagamani P. V.*	260
TSS/MDE/08	**Impacts of Dynamic and Extreme Atmospheric Events on Marine Ecosystems and Fisheries in East Africa** *Haitham Elsiddig Ahmed Nour Khogly*	261
TSS/MDE/09	**Understanding Spatiotemporal Dynamics of Bangladesh Coastal Waters Using the Delft3D Model** *Raida Kadir, Kunal Chakraborty & Subrata Sarker*	262
TSS/MDE/10	**A Contour- and Gaussian-Based Framework for Identifying Multi-Core Mesoscale Eddy Structures in the Bay of Bengal** *Samia Jouti & Subrata Sarker*	263
TSS/MDE/11	**Storm Surge Dynamics Along the Mozambican Coast During Tropical Cyclones Idai and Kenneth (2019)** *João Domingos Maúnze Júnior*	264
TSS/MDE/12	**Essential Ocean Variables and Coastal Biogeochemistry in Kenya: Long-Term Monitoring of Warming, Deoxygenation, and Acidification** *Ahmed Mohamed & Mark Huxham*	265

TSS/MDE/13	**Relationship Between the Spatial Distribution of Anchovy and Phytoplankton Carbon from PACE Multispectral Satellite Off the Coast of Peru** *Luis Escudero Herrera & Edward Alburqueque*	266
Sub Theme 12 **Novel Tools (Including Drones and Artificial Intelligence) for Sustainable Fisheries**		
TSS/AI/01	**DeepData: A Mobile-Based Biodiversity Informatics Platform for Deep-Sea Fish Species Identification** *Anzeena Azeez, Eldho Varghese, Rekha. J. Nair, J. Jayasankar, Thejus T. V., Nahil Alikutty, Keerthana P. S., Pooja M. Uthrad, Stephy Terry, Suyani Nitin Kanji, Surya S., Rajesh K. M, Rajni Jain & Grinson George*	268
TSS/AI/02	**Satellite Earth Observations for Sustainable Aquaculture (EO4SA)** *Lasse H. Pettersson, Edson Silva, Catherine Downy, Antonio Bonaduse, Andrey Kurekin, Victor Martinez-Vicente & Álvarez-Salgado XA*	269
TSS/AI/03	**Drone-Based Validation of Regional Satellite Algorithms for Chlorophyll-a Retrieval in Vembanad Lake** *Kiran Krishna, Nizam Ashraf, Anas abdulaziz, Shubha Sathyendranath, Shard Chander, Ashwin Gujrati, Girish Gopinath, Nandini Menon & Grinson George*	270
TSS/AI/05	**Ghost Fishing Net Aggregation Along the Malwan Coast** *Abuthagir Iburahim. S., Karankumar Ramteke, Nayak. B. B., Punam Bhole, Taniya Chandra, Ashpel Mano M. R. & Bharathi Rathinam R.*	271
TSS/AI/06	**MarineMammal-AI: A Gemini-Powered Framework for Automated Marine Species Identification** *Adithya Chandra P. B., Ratheesh Kumar K. & Anand S.*	272
TSS/AI/07	**Machine Learning-Based Spatial Downscaling of Chlorophyll-a in Optically Complex Coastal Waters of Mumbai Using Sentinel-2 Multispectral Data** *Keerthana S. R. & Karankumar Ramteke*	273
TSS/AI/08	**A Physics-Aware Deep Learning Approach for Atmospheric Correction of Ocean Colour Data from EOS-06 OCM-3** *Mohammed Suhail, Anag M. A. & Nagamani P. V.*	274
TSS/AI/09	**A Machine Learning Framework for Mangrove Mapping Along the Kannur Coast, Kerala, India** *Farzana Haris, Ranith Rajamohanan Pillai & Roshin P. Raj*	275

Sub theme 1

Biogeochemical Cycles and Processes

Abstract ID: **TSS/BGCP/01**

MONSOON-DRIVEN REORGANIZATION OF PHYTOPLANKTON SEASONALITY IN THE INDIAN OCEAN: IMPLICATIONS FOR BIOGEOCHEMICAL CYCLING

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Phytoplankton seasonality in the Indian Ocean is fundamentally coupled to monsoon-driven physical forcing, yet whether and how these biogeochemical processes are reorganizing under anthropogenic warming remains unresolved. Using 25 years of multi-sensor satellite ocean-colour observations, we demonstrate that warming-induced shifts in monsoon wind systems are driving significant changes in upper-ocean stratification and nutrient entrainment, fundamentally altering bloom phenology across the basin. These physical-biological feedbacks are disrupting the timing and magnitude of primary production, with measurable consequences for the biological carbon pump and carbon export efficiency. The observed reorganization of phytoplankton seasonality signals a systematic shift in the biogeochemical functioning of the Indian Ocean, with broader implications for trophic dynamics, regional carbon cycling, and the ocean's role in the global climate system.

Keywords: *Phytoplankton Phenology, Indian Ocean, Monsoon Variability, Biogeochemical Cycling, Ocean Warming, Biological Carbon Pump*

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Abstract ID: **TSS/BGCP/02**

NUTRIENT-DRIVEN RESPONSE ON PHYTOPLANKTON COMMUNITY STRUCTURE, DOMINANCE AND PRIMARY PRODUCTION IN THE COASTAL ARABIAN SEA

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Phytoplankton dynamics in coastal ecosystems are strongly influenced by the composition and stoichiometry of nutrient inputs from both natural and anthropogenic sources. This study investigates the influence of source-specific nutrient inputs on phytoplankton community structure, biomass, and primary production in the coastal waters of west coast, south-eastern Arabian Sea, through controlled microcosm experiments. Nutrient sources including river water, groundwater, industrial effluents, and atmospheric aerosol deposition were examined for their effects on nutrient concentrations, ratios and phytoplankton dynamics over 7 days of incubation period. Initial conditions were characterized by moderate biomass and dominance of *cyanophyceae* and *bacillariophyceae* under nutrient-limited conditions. Nutrient enrichment resulted in rapID uptake within 3-5 days, indicating strong biological demand and limitation of ambient nutrient availability. Groundwater and Industrial effluent additions induced the highest phytoplankton biomass and primary production. Whereas River water inputs supported moderate productivity due to higher silicate availability but relatively lower nitrogen concentrations, whereas aerosol inputs produced transient and short-lived phytoplankton responses. Primary production ranged from 36 to 375 mg C m^{-2} d^{-1}, showing significant differences among treatments ($p<0.01$). These findings highlight the critical role of natural and anthropogenic nutrient sources are regulating coastal productivity, community structure, and ecosystem functioning in the Arabian Sea.

Keywords: *Nutrient, Phytoplankton community, Pigment composition, Primary production.*

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ECOGEOGRAPHIC VARIABILITY AND TROPHIC ROLE OF MICROZOOPLANKTON IN THE EASTERN ARABIAN SEA

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Microzooplankton (MZP) play a key role in marine pelagic ecosystems through nutrient cycling, trophic transfer, and microbial food-web dynamics. To assess seasonal and ecogeographic variability of MZP in the Eastern Arabian Sea (EAS), observations from 2003-2014 were analyzed. Basin-scale analysis revealed consistently higher MZP abundance in the northern EAS (NEAS: 423±58×10³ ind.m-2) than in the southern EAS (SEAS: 371±113×10³ ind.m-2), concomitant with higher chlorophyll-a (Chl-a) concentrations in the NEAS. Lower abundance in the SEAS was associated with warm, stratified oligotrophic waters. Highest MZP abundance occurred during Fall Intermonsoon (FIM) (807±29×10³ ind.m-2), coinciding with stable hydrography, weak winds, and increased pico/nanoplankton availability. During Winter Monsoon (WM), convective mixing enhanced phytoplankton productivity in the NEAS and supported significantly higher MZP abundance (298±192×10³ ind.m-2), indicating strong bottom-up regulation driven by nanoplankton availability. The stratified SEAS during WM and Spring Intermonsoon (SIM) is characterized by warmer waters (28.59±0.09°C), lower salinity (33.96±0.72), and reduced Chl-a, and sustained lower MZP abundance, suggesting stronger top-down grazing control under oligotrophic conditions. During Summer Monsoon (SM), MZP abundance was similar between NEAS (314 ± 64×10³ ind.m-2) and SEAS (339±106×10³ ind.m-2), reflecting a multivorous food web associated with southern upwelling. Non-metric multidimensional scaling analysis revealed distinct regional and seasonal segregation of tintinnid assemblages, indicating strong ecogeographic structuring. Redundancy analysis revealed strong species-environment relationships, accounting for 92% of the variability. Chl-a, temperature, and salinity emerged as the main drivers of CTS assemblages. Distinct WM-SIM and SM-FIM assemblages reflected contrasting effects of convective mixing and upwelling, highlighting hydrographic control on MZP distribution.

***Keywords*:** Microzooplankton, Eastern Arabian Sea, Ciliate, Eco-geography, Food web

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PRIMARY PRODUCTION IN THE ICELAND BASIN: INFLUENCE OF BIO-OPTICAL AND PHOTOSYNTHETIC PARAMETERISATION ON *IN SITU* AND SATELLITE ESTIMATES

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The central Iceland Basin (CIB) is a key region of the subpolar North Atlantic, where phytoplankton blooms drive substantial fluxes of carbon and nutrients, playing a critical role in regional biogeochemical cycles. In this study, we tuned a spectrally-resolved primary production (PP) model using multi-platform datasets from the CIB. Measurements of phytoplankton pigment biomass, light absorption coefficients, and photosynthesis–irradiance (P–E) parameters were obtained from several cruises covering different phases of the seasonal cycle, enabling assessment of variability under contrasting nutrient and light conditions. Matchups between *in situ* chlorophyll-a and Level-3 satellite ocean colour products reveal sensor-specific differences. To characterise the vertical structure of the biomass field, CTD and BGC-Argo fluorescence profiles, corrected for non-photochemical quenching, were fitted with a Gaussian function. These profile and phytoplankton absorption measurements, were incorporated into a radiative transfer model, and modelled profiles of photosynthetically active radiation (PAR) and downwelling irradiance at 412 and 490 nm were evaluated against *in situ* observations from ship-based deployments and floats. Using the regionally tuned model, depth-resolved profiles of instantaneous PP were computed and integrated to estimate water-column production. Differences between global and regional parameterisations are examined, including the use of globally parameterised versus regionally constrained P–E parameters, and the contribution of subsurface production below the mixed layer. Satellite-based estimates of PP, derived from surface chlorophyll and PAR, rely on assumptions about vertical structure and photosynthetic parameter assignment to estimate water-column production. This study investigates how these assumptions influence variability in primary production and provides a basis for evaluating differences between *in situ* and satellite-derived estimates.

Keywords: *Phytoplankton, Primary Production, Bio-Optical Properties, Iceland Basin, Remote Sensing*

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Abstract ID: **TSS/BGCP/05**

HABITAT HETEROGENEITY OF MYCTOPHID SPECIES ASSEMBLAGES IN THE WESTERN INDIAN OCEAN

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The mesopelagic twilight zone (200- 1000 m) contains vast fish resources, with lanternfishes (Family Myctophidae) comprising about 65% of its biomass. Despite their importance as trophic intermediaries and contributors to the biological carbon pump through diel vertical migration, information on myctophid habitat heterogeneity in the Indian Ocean remains limited. Objectives: This study investigated the distribution, species composition, and biomass of myctophid assemblages in the Deep Scattering Layer (DSL) of the Western Indian Ocean (WIO), with emphasis on identifying eco-regions and the environmental factors structuring these communities. Methodology: Mid-water trawl surveys were conducted at 90 stations between 0 and 600 m, complemented by CTD profiles to 1000 m. Community structure was analysed using ANOSIM, PERMANOVA, nMDS, and SIMPER, while Canonical Correspondence Analysis (CCA) was used to examine species- environment relationships. Biomass was estimated using the Swept Area method integrated with acoustic observations. Results: Fifty-nine myctophID species were recorded, defining three eco-regions: the North East Arabian Sea (NEAS), South East Arabian Sea (SEAS), and Western Equatorial Indian Ocean (WEIO). Species richness increased from NEAS (16 species) to SEAS (45 species) and WEIO (57 species). Dissolved oxygen and water density were the principal drivers of assemblage structure. The permanently suboxic OMZ of the NEAS supported a few tolerant dominant species, whereas the oxygen-rich WEIO sustained highly diverse assemblages. Total myctophid biomass in the Eastern Arabian Sea was estimated at 15 mt, representing 28 % of regional DSL biomass. Conclusion: Hydrographic variability across the WIO strongly influences myctophid diversity, distribution, and biomass, providing an important baseline for understanding mesopelagic ecosystem dynamics and evaluating future fishery potential.

Keywords: *Deep Scattering Layer, Oxygen Minimum Zone, Arabian Sea, Western Indian Ocean Canonical Correspondence Analysis, Diel vertical migration*

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Abstract ID: **TSS/BGCP/06**

ASSESSMENT OF DEEP CHLOROPHYLL MAXIMA VARIABILITY IN THE NORTHERN INDIAN OCEAN USING BIO-ARGO FLOATS

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The depth and concentration of the deep chlorophyll maximum (DCM) in the Northern Indian Ocean vary significantly by region. Analysis of 6,500 profiles from 56 Bio-Argo floats (2011–2025) shows clear differences in DCM depth and chlorophyll levels. In the Arabian Sea, DCM depth and chlorophyll concentrations differ across both latitudinal and longitudinal gradients. Summer upwelling along the coasts of Oman and Pakistan brings cold, nutrient-rich water, resulting in a shallow DCM (20–50 meters) with chlorophyll a level of 0.6–1.0 mg/m³. In contrast, the western and southern Arabian Sea have warmer, stratified waters, leading to a deeper DCM (80–120 meters) and lower chlorophyll concentrations (0.3–0.6 mg/m³). In the northern Bay of Bengal, strong freshwater input from large rivers causes surface stratification and supports a DCM at 30–60 meters, with chlorophyll up to 0.8 mg/m³. At times, a pronounced DCM is absent in this region. The western and southern Bay of Bengal, with less river input and greater mixing, exhibit deeper DCMs (70–100 meters) and lower chlorophyll levels (0.2–0.5 mg/m³). In the equatorial Indian Ocean, the DCM occurs at 40–70 meters, with chlorophyll concentrations of 0.6–1.1 mg/m³. The Bio-Argo dataset enables detailed, long-term spatial and temporal analysis, providing a valuable resource for improving models and algorithms to better understand productivity and biogeochemical cycles in this sensitive region.

Keywords: *Chlorophyll maxima, Northern Indian Ocean, Bio-Argo, Climate Change*

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Abstract ID: **TSS/BGCP/07**

POTENTIALLY TOXIC METALS IN THE CORAL REEF ECOSYSTEMS OF THE LAKSHADWEEP ARCHIPELAGO

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Potentially toxic metals are environmental contaminants that persist in aquatic systems due to their non-biodegradable nature. Their accumulation in seawater, sediments, and marine organisms can lead to bioaccumulation and biomagnification, posing ecological risks. In vulnerable coral reef ecosystems, chronic exposure to elevated metal concentrations may disrupt physiological processes and reduce ecosystem resilience to natural and anthropogenic stressors. This study investigated metal contamination (Fe, Mn, Cu, Co, Ni, Cr, Cd, Pb, V, and Zn) in water and suspended particulate matter from five islands in the Lakshadweep archipelago (Minicoy, Kalpeni, Kadmat, Kiltan, and Chetlat). The metal concentration of suspended particulate matter followed the order Co < V < Pb < Cu < Mn < Zn < Ni < Cr < Fe. For dissolved metals, the order was Co < Cd < Mn < Pb < Cu < Ni < V < Cr < Zn < Fe. Enrichment of trace metals in dissolved and particulate phases, from local anthropogenic sources such as sewage, shipping, and fishing, poses a threat to Lakshadweep's coral reef ecosystems. Non-carcinogenic health risks were assessed using Chronic Daily Intake (CDI), Hazard Quotient (HQ), and Hazard Index (HI). Carcinogenic risk was evaluated using Lifetime Cancer Risk (LCR). Results indicated children were at greater risk than adults. Among the metals analysed, V and Cr contributed most to overall non-carcinogenic risk due to their high concentrations and inherent toxicity in the Lakshadweep Islands. Exposure to dissolved metals resulted in LCR values exceeding 1.0×10^{-4} for adults and children, suggesting a potential carcinogenic risk. These findings highlight the need for continued monitoring and management of metal contamination in the Lakshadweep Islands to minimise potential long-term health impacts.

Keywords: *Metals, coral reef, suspended particulate matter, human health risk*

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Abstract ID: **TSS/BGCP/08**

NITRACLINE VARIABILITY IN THE EASTERN ARABIAN SEA: INSIGHTS FROM BIO-ARGO FLOAT OBSERVATIONS

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The Eastern Arabian Sea, off India's west coast, features dynamic oceanographic conditions driven by monsoon winds, upwelling, and high-salinity surface waters. This region plays a key role in regional nutrient cycling and South Asian monsoon dynamics. The nitracline in the Arabian Sea exhibits pronounced seasonal variability driven by monsoon-induced upwelling and vertical mixing, fundamentally controlling nitrate supply to the euphotic zone and phytoplankton productivity. One Bio-Argo float (1902458) deployed in the eastern Arabian Sea was selected to investigate the variability of nitracline depth. The float recorded 79 profiles over a two-year period, spanning from June 2023 to August 2025. Seasonal analysis revealed pronounced variability in nitracline depth, with the deepest mean nitracline depth observed during the summer monsoon, followed by the spring intermonsoon period. In contrast, the shallowest mean nitracline depth occurred during the fall intermonsoon period. The observations further indicate strong denitrification across several regions along the float track. Further, the strong relationship between the depth of the nitracline and D26 provides a practical proxy for estimating nitracline depth in regions where direct nitrate measurements are unavailable.

Keywords: *Eastern Arabian Sea, Bio Argo, Nitracline, D26*

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SEASONAL VARIATIONS IN THE WATER COLUMN AND OPTICAL PROPERTIES FROM THE ECOLOGICALLY SENSITIVE HOOGHLY-SUNDARBAN ESTUARINE SYSTEM

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Seasonal variations in the water column and optical properties were investigated in the Hooghly-Sundarban estuarine region. Nearly 30 stations were sampled each month, covering a salinity gradient between 0 to 22. A gradual decrease in dissolved oxygen was observed in Hooghly estuary with the onset of summer monsoon. The water column became hypoxic (~65 µmol kg-1) with oxygen saturations as low as 40%. This coincided with elevated concentrations of aqueous CO2, (9000 µatm) low pH and zero salinity. In contrast, the waters around the Sundarban region were salty, had more oxygen and marked by elevated chlorophyll. Total particulate absorption [ap (λ)] showed substantial variations based on the sediment load, with phytoplankton absorption dominating during pre- and monsoon. Near-surface chlorophyll biomass and phytoplankton production showed a strong disconnect. The mean values ranged from 31.72 to 57.06 mg m-2 day-1, with hypoxic waters showing the lowest productivity. Pigment based diagnostic ratios showed diatoms as the dominant group followed by the prokaryotes. Our data, for the first time, captures the monthly contrast in the water column and optical properties in India's largest macrotidal estuary with the Hooghly waters acting as a potential source and the Sundarban as a sink of atmospheric CO2.

Keywords: *Estuary, Monsoon, Tidal, Carbon Dioxide, Phytoplankton*

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LONG-TERM VARIABILITY OF SEDIMENTARY POLYCYCLIC AROMATIC HYDROCARBONS IN THE COCHIN ESTUARY: RESPONSES TO THE 2018 KERALA FLOOD AND COVID-19 RESTRICTIONS

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The southwest coast of India experienced unusual environmental perturbations during the Kerala floods of 2018 and 2019 and the COVID-19 pandemic period (2020–2021), both of which significantly altered hydrological conditions and anthropogenic inputs to coastal ecosystems. To evaluate the influence of these events on the contamination status of the Cochin estuary, seasonal measurements of polycyclic aromatic hydrocarbons (PAHs) in surface sediments were carried out during the pre-monsoon, monsoon, and post-monsoon seasons of 2023 and compared with corresponding data reported for 2013 (Ramzi et al., 2017). The results revealed that total PAH concentrations in 2023 were approximately five times lower than those observed in 2013. All PAH congeners exhibited substantial reductions, with the decline being particularly pronounced during the monsoon season, characterised by high freshwater discharge. This pattern suggests a significant decrease in PAH inputs from both point and non-point sources into the estuary. The marked reduction in sedimentary PAHs is likely attributable to the combined effects of intense flushing and freshening of the estuary during the catastrophic Kerala floods, reduced anthropogenic and industrial activities during the COVID-19 lockdown period, and the subsequent implementation of stricter environmental management practices by local authorities. Nevertheless, concentrations of certain low-molecular-weight (LMW) PAH congeners remained above the Effective Range Low (ERL) guideline values, suggesting the possibility of occasional adverse effects on benthic organisms. PAH concentrations measured in the tissues of *Mytella strigata*, a commercially important mussel species collected from the estuary, were comparatively low (371 ng g^{-1}), indicating limited bioaccumulation within the estuarine food web.

Keywords: *Polycyclic Aromatic Hydrocarbons, Sediments, Ecological Risk, Kerala Flood 2018*

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MONSOON-DRIVEN VARIABILITY IN NITROUS OXIDE PRODUCTION AND EMISSIONS ALONG THE SOUTHEAST AND SOUTHWEST COASTS OF INDIA

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This study investigated the spatial variability and production pathways of nitrous oxide (N_2O) along India's southwest coast (SWC) and southeast coast (SEC) during the peak and late southwest monsoon. Monsoon-driven influences on N_2O production and emissions were assessed from dissolved N_2O and biogeochemical measurements collected aboard FORV Sagar Sampada during September 2024 and August 2025 across eight and twelve transects, respectively. SWC exhibited shoaling isotherms, subsurface hypoxia, and N_2O accumulation were observed during both monsoon phases, strongest during peak upwelling. Late monsoon, weakening of upwelling lead to partial reoxygenation and reduced N_2O accumulation. The highest surface N_2O concentrations, occurred along the SWC during the peak monsoon, reaching 105.37 nmol kg^{-1}. Positive correlations between excess N_2O, apparent oxygen utilisation (AOU) and oxidised inorganic nitrogen ($NO_3^- + NO_2^-$) indicate nitrification was the dominant N_2O production pathway. Enhanced N_2O yields under low-oxygen conditions further suggest a contribution from nitrifier denitrification, particularly in intermediate shelf waters where dissolved oxygen concentrations were below 60 µM. However, dissolved oxygen levels remained above ~5 µM throughout the study region, indicating that canonical water column denitrification was not a major source of N_2O. Average sea-to-air N_2O fluxes during the peak monsoon were 14.83 ± 18.93 µmol m^{-2} d^{-1} along the SEC and 79.8 ± 111.73 µmol m^{-2} d^{-1} along the SWC. Fluxes increased substantially during the late monsoon, averaging 263.31± 299.50 µmol m^{-2} d^{-1} and 286.84 ± 436.70 µmol m^{-2} d^{-1} along the SEC and SWC, respectively. Despite elevated subsurface N_2O accumulation during peak upwelling, the formation of a surface low-salinity lens reduced the emissions by limiting vertical exchange. Overall, both regions remained net atmospheric N_2O sources during the southwest monsoon.

Keywords: *Upwelling, Coastal Hypoxia, Nitrous Oxide, Nitrification, Sea-To-Air Fluxes*

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VARIABILITY OF COLOURED DISSOLVED ORGANIC MATTER (CDOM) IN THE COASTAL WATERS OF THE WESTERN BAY OF BENGAL

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The seasonal and spatial distribution of coloured dissolved organic matter (CDOM) in the surface waters of the Western Bay of Bengal (WBoB) was investigated over a two-year period (2017–2019). The pre-monsoon (PreM, May 2017) period exhibited the highest CDOM concentrations, followed by the monsoon (June–July 2018) and post-monsoon (POM, October 2017 and November 2018) periods. Elevated CDOM levels in coastal waters during PreM were primarily attributed to coastal upwelling, with additional contributions from sediment resuspension and enhanced biological production. Spatial analysis indicated that upwelling regions contained higher CDOM concentrations than non-upwelling areas. In contrast, coastal downwelling, prevalent during POM, transported dissolved organic matter (DOM) away from the coast, resulting in reduced surface CDOM during this period. The correlation between CDOM and total suspended matter (TSM) suggests a common source for TSM and CDOM in the study area. The negative correlation between river discharge and a CDOM (440) indicates that high river discharge, accompanied by elevated suspended loads, removes CDOM through adsorption and subsequent sedimentation. Perennial rivers with high suspended sediment loads (diluted CDOM, CDOM-suspended sediment) contributed low CDOM to the Bay of Bengal, whereas seasonal rivers with low suspended sediment (concentrated CDOM) delivered higher CDOM during the monsoon. Upwelling processes return preserved humic DOM to the surface. Therefore, surface CDOM concentrations reflect the net balance among cumulative river discharge, upwelling, downwelling, and photodegradation processes.

Keywords: *Coloured dissolved organic matter, River discharge, Sea level anomaly, Total Suspended Matter, Chlorophyll-a, Bay of Bengal*

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DISTRIBUTION AND POLYMER CHARACTERISTICS OF MICROPLASTICS IN THE SOUTHERN OCEAN: EVIDENCE FROM ISESO-2025

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The Southern Ocean, one of the most pristine and least disturbed oceanic regions, has also been found to be contaminated with microplastics, emphasizing the extensive reach and widespread use of plastics and supporting the concept of the "plastisphere." This study investigated the abundance, characteristics, and polymer composition of microplastics from 10 Southern Ocean water samples and 4 sediment samples collected as per part of 12th Indian Scientific Expedition to Southern Ocean (ISESO) during the year 2025. The average microplastic concentrations were recorded at 2.74 items L-1 in water and 0.305 items g-1 in sediment samples. Among the microplastic type, Fibers accounted for 91% in water samples and 73% in sediment samples of the total particles identified, followed by fragments, clusters, beads, and films. Potential microplastics were isolated and analyzed using FTIR spectroscopy for polymer Identification. Among the analyzed particles, PET (22.9%) was the dominant polymer, followed by PE (18.7%) and PVC (18.7%), indicating inputs from packaging materials, synthetic textiles, and other human-related activities. Transparent particles (31.9%) were the most abundant colour category, followed by black (28.9%) and blue (19.4%) particles, reflecting diverse sources and varying degrees of environmental weathering. The detection of diverse microplastic polymers in one of the world's most remote oceanic regions highlights the long-range transport and persistence of plastic debris in marine environments. These findings provide important baseline information on microplastic distribution in the Southern Ocean and underscore the urgent need for improved global plastic waste management and continuous monitoring of polar marine ecosystems to better understand their ecological implications.

Keywords: *Microplastics, Southern Ocean, ISESO, FTIR, Polymers*

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Abstract ID: TSS/BGCP/14

COMPARATIVE ANALYSIS OF AIR–SEA CO_2 FLUXES ACROSS DIFFERENT COASTAL REGIMES ALONG THE EAST AND WEST COASTS OF INDIA

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Air-sea CO_2 exchange in India's coastal waters shows strong spatial and seasonal variability due to contrasting hydrographic and biogeochemical regimes along the west coast (Arabian Sea) and the east coast (Bay of Bengal). The west coast generally acts as a CO_2 source, especially during the southwest monsoon, driven by upwelling, subsurface carbon enrichment, and remineralization. Whereas, the east coast, influenced by river discharge and stratification, exhibits variable source–sink behavior, with periods of CO_2 uptake linked to primary productivity and freshwater dilution. This study compares air–sea CO_2 fluxes along the east and west coasts across multiple locations (Goa, Kochi, Tamil Nadu, Visakhapatnam, Mahanadi Estuary, Sundarbans) for the years 2023–2025, using *in situ* observations and standard carbonate system calculations to estimate CO_2 fluxes. Surface ocean CO_2 (pCO_2) is derived from parameters such as sea surface temperature (SST), salinity, pH, and total alkalinity/dissolved inorganic carbon through solving the carbonate system speciation. Fluxes are estimated using the bulk parameterization approach, incorporating differences in air-sea pCO_2, gas transfer velocity (from wind speed and SST), and CO_2 solubility (dependent on SST and salinity). Preliminary results show that the west coast (Kochi) exhibits CO_2 fluxes ranging from ~−20 to +6 mmol m^{-2} day^{-1}, with sink conditions during pre-monsoon transitioning to mixed/source behavior during early monsoon due to upwelling. The east coast (Tamil Nadu) shows more variable fluxes (~−22 to +72 mmol m^{-2} day^{-1}), with alternating source and sink conditions influenced by river inputs and stratification. These results highlight the need to resolve seasonal dynamics for accurate assessment of coastal carbon fluxes along the Indian coastline.

Keywords: *Air-sea CO2 flux, Indian east and west coasts, Seasonal variability, Monsoonal influence, Carbonate system*

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Abstract ID: **TSS/BGCP/15**

INTEGRATING SUB-SURFACE BIOGEOCHEMISTRY AND COMMUNITY SUCCESSION TO UNDERSTAND WINTER *Noctiluca scintillans* BLOOM DYNAMICS IN THE NORTHERN ARABIAN SEA

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Recurrent winter blooms of the mixotrophic dinoflagellate Green *Noctiluca scintillans* (GNS), increasingly restructure phytoplankton communities and alter biogeochemical cycling across the Northern Arabian Sea. This study presents an integrated ecological and biogeochemical assessment of GNS bloom dynamics using high-resolution shipboard observations during a winter bloom event. Temperature, salinity, mixed layer depth, dissolved oxygen, inorganic nutrients, chlorophyll-a, total suspended matter, carbonate system variables (DIC, TA, pH, pCO_2), and species-resolved phytoplankton counts were sampled at standard hydrographic depths and analysed through multivariate biostatistical methods. Non-metric multidimensional scaling, PERMANOVA, and ANOSIM detected statistically supported shifts in community structure across pre-bloom, bloom, and post-bloom phases (PERMANOVA pseudo-F = [7.85], p = 0.001; ANOSIM R = [0.848]). GNS was recovered as a perfect bloom-phase indicator (IndVal = 1.0), present in all bloom-phase samples and absent from non-bloom-phase samples, while SIMPER analysis identified chain-forming diatoms as the principal contributors to inter-phase dissimilarity. Ecological succession progressed from coastal diatom dominance through GNS bloom peaks to post-bloom dinoflagellate assemblages, consistent with progressive nutrient depletion and stratification. Depth-stratified analysis demonstrated that sub-thermocline nutrient concentrations were stronger and temporally antecedent predictors of surface bloom onset than surface nutrient levels, identifying convective mixing as the dominant bottom-up driver. The present study advances the mechanistic understanding of GNS bloom initiation and provides a predictive framework for bloom forecasting and ecosystem management across the Northern Arabian Sea.

Keywords: *Noctiluca scintillans, Community Succession, Northern Arabian Sea, Bloom, Mixing*

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CHARACTERIZATION AND SOURCE IDENTIFICATION OF FATTY ACID BIOMARKERS IN THE COCHIN ESTUARY, KERALA

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The distribution, composition, and sources of fatty acid biomarkers in surface sediments from the Cochin Estuary during the pre-monsoon season, with the aim of assessing sedimentary organic matter origin and biogeochemical cycling in this dynamic environment. Fatty acid profiles revealed the presence of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA) across all sampling stations. Palmitic acid (C16:0) was the most abundant fatty acid (15-29%), followed by stearic acid (C18:0; 15-26%), indicating substantial contributions from microbial biomass and detrital organic matter. Phytoplankton and algal inputs were suggested by the presence of linoleic acid (C18:2; 5-9%), α-linolenic acid (C18:3; 3-6%), and trace to 8% eicosapentaenoic acid (EPA, C20:5ω3) at select sites. Long-chain fatty acids (C22-C24; 4-8%) indicated notable terrestrial plant-derived organic matter. Spatial variations in fatty acid composition reflected the combined influence of riverine discharge, tidal mixing, and localized anthropogenic activities. Sedimentary organic matter in the Cochin Estuary derives from a complex mixture of terrestrial, marine, and microbial sources. Fatty acid biomarkers proved effective in tracing organic matter provenance and understanding sedimentary biogeochemical processes. These provide insights into the estuary's role in organic matter transformation and carbon sequestration. The accumulation of fine-grained sediments functions as a blue carbon sink, where terrestrial and marine carbon is deposited and stored. Hydrodynamic processes such as freshwater discharge, tidal exchange, and sediment resuspension govern organic carbon transport and burial, influencing carbon sequestration efficiency and greenhouse gas regulation. Fatty acid biomarkers thus serve as sensitive indicators of organic matter sources, ecological function, and carbon cycling.

Keywords: *Fatty Acid Biomarkers, Cochin Estuary, Organic Matter, Source Identification, Estuarine Biogeochemistry, Blue Carbon Sequestration*

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Abstract ID: **TSS/BGCP/17**

LIVING AT THE EDGE: DIEL VERTICAL ORGANIZATION OF MESOPELAGIC COMMUNITIES ACROSS A TROPICAL OXYGEN MINIMUM ZONE

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Mesopelagic ecosystems represent an important interface between ocean productivity, carbon cycling, and higher trophic levels, yet the drivers of their structuring within oxygen-deficient tropical oceans remain poorly understood. This study investigated diel vertical migration (DVM) and environmental controls of mesopelagic communities in the northeastern Arabian Sea during the spring inter-monsoon. Hydrographic variations revealed warm surface waters (30-31°C), strong thermal stratification, and an intense oxygen minimum zone (OMZ) in the mesopelagic zone, where dissolved oxygen declined to 2.7 µM. Mesopelagic communities were dominated by myctophids (MYC), followed by other nekton (OTN) and gelatinous zooplankton (GZO), exhibiting pronounced DVM characterized by daytime aggregation at depth and nighttime ascent towards shallower waters. Community composition varied across latitudinal gradients, with MYC contribution increasing from 62% to >80% northward. Daytime MYC abundance showed positive correlations with temperature (ρ=0.38), salinity (ρ=0.36), and total nitrogen (ρ=0.38), whereas nighttime stronger negative relationships with total nitrogen (ρ=-0.58) and particulate organic carbon (ρ=-0.54). OTN showed positive associations with meso-zooplankton biomass (ρ=0.49), while GZO exhibited strong nighttime responses to nitrite (ρ=-0.79). Redundancy analysis explained >80% community variation, while variation partitioning revealed dominant hydrographic (0.94), nutrient (0.63), and spatial (0.62) controls. Generalized additive models (GAMs) showed the strongest performance for MYC (88.6% deviance explained; adjusted R^2=0.80), with bimodal abundance maxima occurring at 80-100 m and 250-320 m depth. GAMs also performed well for GZO (64.6%; adjusted R^2=0.46) and OTN (61.8%; adjusted R^2=0.42). These findings stated that the mesopelagic zone functions as a dynamic diel ecosystem, transitioning from daytime environmental filtering to stronger nighttime trophic coupling.

Keywords: *Mesopelagic Organisms, Myctophids, Diel Vertical Migration, Oxygen Minimum Zone (OMZ), Arabian Sea, Environmental Forcing, Tropical Marine Ecosystems*

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SATELLITE-BASED ASSESSMENT OF PHYTOPLANKTON CARBON DYNAMICS IN THE NORTH INDIAN OCEAN

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Phytoplankton play a crucial role in marine carbon cycling through biological carbon uptake and the oceanic biological pump. The North Indian Ocean (NIO), influenced by strong monsoonal forcing and contrasting oceanographic conditions, exhibits significant variability in phytoplankton biomass and community structure. This study investigates the spatial and temporal variability of satellite-derived phytoplankton carbon in the NIO using size-resolved phytoplankton carbon products, including pico-, nano-, and micro phytoplankton carbon together with total phytoplankton carbon C_{phyto}. The analysis provides insights into the distribution of phytoplankton carbon biomass and the dominance of different phytoplankton size classes across seasons and regions. Results show strong spatial heterogeneity, with elevated C_{phyto} concentrations in the Arabian Sea associated with monsoon-driven upwelling and enhanced nutrient supply, while lower concentrations occur in oligotrophic open-ocean regions and much of the Bay of Bengal. Pico-phytoplankton dominate nutrient-poor stratified waters, whereas micro phytoplankton contribute significantly in productive coastal and upwelling regions where larger phytoplankton communities support enhanced organic carbon export. Nano-phytoplankton form an important intermediate component in mesotrophic regions. Seasonal variability is closely linked to monsoonal circulation and nutrient dynamics, with enhanced micro- and nano-phytoplankton carbon during the southwest monsoon. Long-term analysis indicates a general decline in C_{phyto} across several open-ocean regions, likely associated with increasing thermal stratification and reduced nutrient entrainment under ocean warming. These findings highlight the sensitivity of phytoplankton carbon dynamics to climatic variability and demonstrate the importance of satellite ocean-colour observations for assessing regional ocean productivity and potential biological carbon export in the Indian Ocean.

Keywords: *Phytoplankton carbon, North Indian Ocean, Biological carbon pump, Ocean colour remote sensing, Carbon export*

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Abstract ID: TSS/BGCP/19

MICROPLASTICS IN ANTARCTIC COASTAL SEDIMENTS: OCCURRENCE, DISTRIBUTION, AND POLYMER CHARACTERIZATION

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Microplastic pollution has emerged as a growing environmental concern even in remote Antarctic ecosystems due to anthropogenic and long-range oceanic transport. This study investigated the occurrence, abundance, and characteristics of microplastics in sediment samples collected from ten Antarctic coastal sampling stations during the 44th Indian Scientific Expedition to Antarctica (ISEA 2024–25), following standardized protocols recommended by the National Oceanic and Atmospheric Administration (NOAA). Samples were processed through drying, sieving, density separation, and organic matter digestion for microplastic isolation. Extracted particles were identified using a digital microscope and characterized based on colour, size, and morphology, while polymer composition was confirmed using Raman Spectroscopy. Fibres were the dominant microplastic type, accounting for 96.84% of the total particles, while films contributed 3.16%; fragments were absent. The dominance of fibres suggests inputs from fishing activities, research operations, textile-derived materials, and oceanic transport pathways. Fisher Island Lake (F2 Lake) recorded the highest abundance, followed by Lake Bruenwiler (BR2). Blue-coloured particles were most abundant, followed by black, red, and green microplastics. Size distribution analysis showed that particles ranging from 100–1000 µm were the most prevalent. Spatial variations among stations may be linked to hydrodynamic conditions, sediment characteristics, and varying anthropogenic influences. The findings highlight the increasing threat of plastic contamination in Antarctic ecosystems and emphasize the need for continuous monitoring and improved waste management practices in polar regions. This study provides valuable baseline information for future ecological risk assessments of microplastics in Antarctica.

Keywords: *Microplastics, Antarctica, NOAA protocols, Raman Spectroscopy, Marine pollution*

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Abstract ID: **TSS/BGCP/20**

COMPARATIVE NUTRIENT REGIMES UNDER DISTINCT BLOOM CONDITIONS OF THE NORTH EASTERN ARABIAN SEA

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Phytoplankton blooms in the North Eastern Arabian Sea (NEAS) typically progress from mixed assemblages during winter convective mixing to dominance by *Noctiluca scintillans* under stratified conditions, followed by bloom decay. This study examines variability in this sequence using observations from multiple FORV Sagar Sampada cruises, focusing on distinct oceanographic events. During the late convective phase (February), reduced sea surface temperature (<25 °C), high salinity, and a deep mixed layer (>100 m) maintain moderate nitrate levels in the euphotic zone (N:P>1). Under these conditions, diatoms dominated (12x103cells/L), while *Noctiluca scintillans* remained at low offshore abundance (110 cells/L). In March, during the withdrawal phase of convective mixing, contrasting bloom structures emerged under different cyclonic eddy influences. In one case, elevated Noctiluca abundance (24x103 cells/L) co-occurred with sustained diatoms (26x103cells/L) under relatively nitrate-replete conditions (N:P<1). In another event, *Noctiluca scintillans* dominated over diatoms (5.8x106 cells/ L vs. 1.3x105 cells/L) despite moderate nitrate levels (N:P>1), indicating strong spatial variability driven by eddy position, stratification intensity, and current dynamics. By late March (spring intermonsoon), strong stratification (<30 m) and nutrient depletion (N:P<1) led to bloom senescence, reflected in declining chlorophyll and increased senescent Noctiluca cells (1465 cells/L).These observations indicate that the nutrient regimes that regulate the species succession in NEAS, and the *Noctiluca scintillans* proliferation is not solely governed by stratification, but is significantly influenced by mesoscale oceanographic processes such as eddies and the spatial heterogeneity in the regional mixing processes. These processes regulate nutrient supply, vertical fluxes, and plankton interactions, thereby altering bloom composition and sustaining mixed assemblages during transitional phases.

Keywords: *North Eastern Arabian Sea, Noctiluca, Bloom, Eddies, Phytoplankton*

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Abstract ID: **TSS/BGCP/21**

SEASONAL VARIABILITY IN CARBON DYNAMICS IN A MONSOON-DRIVEN TROPICAL ESTUARY

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Estuaries are dynamic biogeochemical zones at the terrestrial-marine interface, where carbon cycling and greenhouse gas emissions occur. In this study, we investigated seasonal variation in dissolved carbon across the salinity gradient in the monsoon-driven Mahanadi River estuary in Odisha. The average dissolved carbon flux from the Mahanadi River was estimated at approximately 1.5 Mt C/yr, with the monsoon season accounting for ~1.1 Mt C/yr of the annual flux. Further, the results show that low discharge during the pre-monsoon period led to decreased dilution, prolonged water residence time, enhanced benthic remineralisation, and efficient carbonate weathering, thereby increasing dissolved inorganic carbon (DIC) by ~25% in the water column and reducing terrestrial dissolved organic carbon (DOC)s supply in contrast to the monsoon. During monsoon season, the salinity level dropped drastically (~69%) with substantial dilution of DIC and elevated DOC (~10%) from amplified allochthonous organic matter flux and increased freshwater inputs with respect to pre-monsoon. Meanwhile, the post-monsoon season entered a transitional phase, marked by the gradual recovery of DIC, while residual allochthonous DOC remained in the water column. This indicates the delayed signature of organic matter export due to weakened river flux. The Mahanadi estuary exhibits strong monsoon-driven seasonality in carbon dynamics, with monsoonal discharge dominating ~79% of the annual dissolved carbon flux and underscoring the disproportionate role of monsoonal discharge in controlling dissolved carbon distribution, highlighting the estuary as a seasonally dynamic biogeochemical reactor. This study emphasises critical baseline data for tropical estuarine carbon dynamics under seasonal forcing, and future work integrating greenhouse gas flux measurements and inter-annual discharge variability could better constrain the role of such systems in regional and global carbon budgets.

Keywords: *Seasonal, Estuary, Dissolved Carbon, Carbon Dynamcis, Carbon Flux, Mahanadi River Estuary*

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INTERANNUAL VARIABILITY IN NUTRIENT CYCLING AND PHYTOPLANKTON BIOMASS IN THE COCHIN ESTUARY FROM CONSECUTIVE PRE-MONSOON OBSERVATIONS OF 2025 AND 2026

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The Cochin estuary, a tropical monsoon-driven estuary on the southwest coast of India, exhibits pronounced spatial gradients in salinity and biogeochemical properties resulting from land–ocean interactions. This study examines variations in nutrient concentrations, colored dissolved organic matter, dissolved oxygen, suspended particulate matter, and chlorophyll-a across seventeen stations along the Cochin estuary during consecutive pre-monsoon periods. Significant spatial and interannual variability was observed in the physicochemical and biological characteristics of the estuary. Mean salinity increased from 11.2 in 2025 to 15.3 in 2026, indicating enhanced marine influence. Concurrently, mean CDOM absorption at 440 nm decreased from 0.214 to 0.047 m^{-1}, suggesting a reduction in terrestrially derived dissolved organic matter. Dissolved inorganic nutrients remained abundant throughout the estuary, with mean nitrate increasing from 2.87 to 4.35 µM, ammonia from 9.65 to 11.93 µM and silicate from 15.4 to 48.7 µM between the two years. Mean dissolved oxygen decreased from 6.03 to 5.17 mg L^{-1}, while TSM declined from 63.8 to 38.2 mg L^{-1}. Despite these changes, mean Chl-a concentrations remained stable (mean 9.06 and 8.67 mg m^{-3} in 2025 and 2026, respectively). Chlorophyll-a exhibited considerable spatial heterogeneity, ranging from 0.21 to 32.40 mg m^{-3} during 2026, with elevated concentrations occurring in both central and southern sectors of the estuary. In the northern marine zone, low concentrations of chlorophyll were observed. Weak relationships between Chl-a and individual nutrient species ($|r| < 0.25$) suggest that phytoplankton biomass was not directly controlled by nutrient availability alone. The persistence of comparable productivity despite substantial shifts in salinity, CDOM, and nutrient concentrations highlights the importance of internal nutrient regeneration, estuarine mixing, tidal flushing, and ecological controls in sustaining ecosystem functioning.

Keywords: *Nutrient Regeneration, Phytoplankton Biomass, Colored Dissolved Organic Matter, Estuarine Mixing, Marine Intrusion*

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Abstract ID: **TSS/BGCP/23**

SEASONAL EMERGENCE OF DIAZOTROPHIC PATHWAYS: DIATOM–DIAZOTROPH SYMBIOSIS AND TRICHODESMIUM IN COASTAL WATERS OFF PARADIP

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Planktonic diazotrophs play a critical role in marine primary production by converting atmospheric N_2 into bioavailable nitrogen, thereby sustaining productivity in nutrient-limited environments. This study reports the occurrence of a cyanobacteria–diatom symbiotic consortium comprising *Richelia intracellularis* and *Rhizosolenia imbricata*, together with free-living Trichodesmium erythraeum, in coastal waters off Paradip during February. Nutrient conditions were characterized by depleted nitrate and nitrite, while elevated ammonium during the post-monsoon period suggests active regeneration of organic matter. The endosymbiotic association of *Richelia intracellularis* within *Rhizosolenia imbricata* (2–14 trichomes per host cell, each with 9–10 vegetative cells and a terminal heterocyst) indicates an efficient nitrogen-fixing system under nutrient stress. Abundances of *Rhizosolenia imbricata*, *Richelia intracellularis*, and *Trichodesmium erythraeum* were 1700 cells L^{-1}, 7850 trichomes L^{-1}, and 6700 trichomes L^{-1}, respectively. Using cell-specific rates, nitrogen fixation was estimated at approximately 2.25 mmol N m^{-2} d^{-1} for *Trichodesmium erythraeum* and nearly 2.99 mmol N m^{-2} d^{-1} for *Richelia intracellularis*, indicating substantial new nitrogen input. In addition, the presence of epibiotic *Vorticella* on *Chaetoceros coarctatus* suggests enhanced microbial activity and increased organic matter processing. The co-occurrence of diazotrophic symbiosis, free-living diazotrophs, and epibiotic interactions indicates a tightly coupled system linking nitrogen fixation, ammonium regeneration, and microbial recycling. This study highlights the role of multiple nitrogen acquisition pathways in sustaining phytoplankton productivity in nutrient-variable coastal waters.

Keywords: *Cyanobacteria, Diatom, Diazotrophy, Nitrogen Fixation, Trichodesmium erythraeum*

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AEROSOL–CHLOROPHYLL COUPLING IN THE COASTAL NORTHWESTERN BAY OF BENGAL: A 22-YEAR MODIS-AQUA ANALYSIS OFF THE GOPALPUR COAST

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The interaction between atmospheric aerosols and marine primary production in coastal seas remains incompletely understood, particularly at mesoscale resolution and over multi-decadal time horizons. We present a 22-year (January 2003–December 2024) MODIS-Aqua satellite analysis of three optically distinct aerosol parameters, total aerosol optical depth (AOD), dust extinction optical depth, and the total aerosol Ångström exponent (α), together with surface chlorophyll-a (chl-a) over a 1° × 1° box off the Gopalpur coast, Odisha, in the northwestern Bay of Bengal. Monthly climatologies show that total AOD follows a multi-modal cycle peaking at 0.60 in June and reaching a wet-scavenging minimum of 0.34 in September; dust extinction is unimodal with a May maximum of 0.088 (mean dust/AOD ratio 8.4%); and α alternates between fine-mode anthropogenic dominance in winter ($\alpha \approx 1.60$) and coarse-mode dust–sea-salt dominance in July ($\alpha \approx 0.76$). Chl-a reaches its annual maximum of 1.02 mg m^{-3} in October. The aerosol–chl-a coupling is weaker and more season-specific than basin-scale studies predict. The full-record AOD–chl-a Pearson correlation is $r = -0.165$ ($p = 0.009$), but the pre-monsoon dust–chl-a correlation is positive and statistically insignificant ($r = +0.119$), contradicting the expected radiative-suppression signal. The strongest couplings occur in the southwest monsoon (dust $r = -0.300$, α $r = +0.270$) and in winter (dust $r = -0.404$, $p < 0.001$). Mann–Kendall analysis reveals a robust positive trend in total AOD (+0.0096 yr^{-1}, +43% over the record) driven entirely by fine-mode aerosol, while chl-a shows no significant trend ($p = 0.37$). Aerosol forcing explains at most 16% of monthly chl-a variance, indicating that oceanographic processes, coastal upwelling, river discharge, mixed-layer dynamics and cyclone-induced mixing dominate phytoplankton variability at this coastal site over aerosol forcing.

Keywords: *Aerosol Optical Depth, Dust Extinction, Ångström Exponent, Chlorophyll-a, Bay of Bengal*

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Abstract ID: **TSS/BGCP/25**

DYNAMICS OF PARTICULATE ORGANIC CARBON FLUX IN THE MESOPELAGIC ZONE INSIGHTS FROM THE CONTINENTAL SLOPE OFF KARAIKAL, SOUTHEAST COAST OF INDIA

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The biological pump serves as a primary mechanism for atmospheric carbon sequestration however, the efficiency of this process remains poorly constrained within the mesopelagic zone of the western Bay of Bengal. While surface primary production is well-documented, the precise factors regulating the attenuation of Particulate Organic Carbon (POC) at intermediate depths of 500m a critical junction for carbon transformation remain inadequately quantified in this region. This study addresses this knowledge gap by investigating the vertical distribution and compositional variability of sinking POC, integrating assessments of particle settling velocity, microbial remineralization rates, and the influence of Diel Vertical Migration. To achieve this, we collected high-resolution particulate samples via *in situ* filtration and water column profiling, subsequently employing elemental analysis and microscopy to characterize the physical morphology and biochemical signatures (C/N ratios) of marine snow. Our results demonstrate that POC attenuation at this depth is heavily mediated by the size distribution and nutritional quality of sinking aggregates, which act as the primary determinants of carbon export efficiency. These findings reveal the complex biogeochemical transformations occurring within the twilight zone, providing a comprehensive localized assessment of how surface derived organic matter is processed and sequestered. This work highlights the critical role of mesopelagic dynamics in modulating regional carbon fluxes and provides essential data for refining biogeochemical models in tropical coastal to oceanic transition zones.

Keywords: *POC Flux, Mesopelagic Zone, Biological Pump, Marine Snow, Bay of Bengal, Carbon Sequestration*

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Abstract ID: TSS/BGCP/26

DEVELOPMENT AND APPLICATION OF A MULTI SPECIES NUMERICAL MODEL FOR SMALL PELAGICS IN THE INDIAN OCEAN EEZ AND THEIR TROPHIC LEVEL INTERACTIONS

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Small pelagic fishes are key components of marine ecosystems, linking planktonic producers to higher trophic level predators. Species such as Indian oil sardine (*Sardinella longiceps*), anchovy (*Stolephorus indicus*), and Indian mackerel (*Rastrelliger kanagurta*) dominate fisheries along the Indian west coast and exhibit strong seasonal variability in growth, biomass, and distribution driven by environmental forcing and trophic dynamics. Existing modelling approaches have largely relied on single-species bioenergetics frameworks, representing growth as a balance between energy intake and metabolic losses, but they do not capture interspecific interactions and competition for shared planktonic resources. Recent studies indicate that sardine and anchovy populations often fluctuate inversely due to climate and oceanographic variability, with alternating dominance suggesting that anchovy can replace sardine under changing conditions, highlighting strong trophic coupling and competition. Similar asynchronous patterns observed globally emphasize the need for multispecies modelling. In this study, we extend an existing bioenergetics model for Indian oil sardine to a multi-species framework by incorporating anchovy and Indian mackerel, and apply it to the Indian west coast to investigate trophic interactions and variability in pelagic fish biomass. The model uses a mechanistic energy balance approach, where growth is determined by energy intake minus metabolic losses, including respiration, egestion, excretion, and specific dynamic action. Species-specific parameterizations from literature represent physiological and ecological differences. By incorporating interspecific competition and shared resource dynamics, this study advances beyond single-species approaches and provides a mechanistic basis for understanding ecosystem-level responses of small pelagic fisheries to environmental variability.

Keywords: *Small Pelagic Fishes, Bioenergetics Model, Multispecies Modelling, Trophic Interactions, Indian West Coast, Climate Variability*

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Abstract ID: **TSS/BGCP/27**

TRENDS IN NITROGEN AND PHOSPHORUS INVENTORY IN CONTEMPORARY OCEAN

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Ocean productivity, regulated by nutrient availability plays a central role in the uptake and long-term storage of atmospheric carbon dioxide. However, warming induced stratification and anthropogenic inputs are expected to alter nutrient supply. The extent to which these changes have affected nutrient availability remains poorly constrained due to limited studies. Present-day trends can provide essential insight to understand future changes in the nutrient limitation pattern. While previous studies have primarily focused on inorganic nutrients, dissolved organic forms of nitrogen and phosphorus are also known to contribute to the nutrient pool, yet remain largely unexplored in both observational and modelling frameworks. In this study, we examine trends in global ocean nutrient inventories under increasingly stratified conditions. We analysed multidecadal upper ocean integrated nutrient data within the top 100 m using observations from GO SHIP and GLODAP datasets. Our results indicate that trends in inorganic nutrients, particularly nitrogen, are consistent with nitrogen fixation as a key mechanism, as suggested in previous studies. This interpretation has limitations when considered from the perspective of organic nutrients. We observe a decline in dissolved organic nitrogen, utilization of which is energetically demanding, alongside a stable inorganic nitrogen trend, providing an alternative mechanism. We propose that remineralization of dissolved organic nitrogen acts as an additional and competing mechanism influencing nutrient dynamics in the stratified ocean

Keywords: *Global Nutrient Trend, Organic Nutrient Trend, Inorganic Nutrient, Climate Change*

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DIURNAL VARIABILITY OF THE DEEP CHLOROPHYLL MAXIMUM IN THE BAY OF BENGAL

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Using high-resolution, diurnally resolved observations, this study examines the physical and biogeochemical controls on the deep chlorophyll maximum (DCM) in the southwestern Bay of Bengal during the post–northeast monsoon transition (February 2024). Co-located hydrographic, optical, dissolved oxygen, and nutrient measurements were collected along an offshore latitudinal transect spanning Chennai, Puducherry, and Karaikal. A persistent DCM was observed between 55 and 80 m, aligned with the base of the barrier layer and the upper thermocline, where light levels were reduced to ~0.5–1% of surface photosynthetically available radiation. Chlorophyll-a concentrations within the DCM ranged from 0.6 to 1.2 mg m^{-3} and deepened southward in response to reduced haline stratification, deeper thermoclines, and improved optical clarity. Despite pronounced diurnal heating–cooling cycles at the surface, the DCM depth exhibited only minor fluctuations, indicating strong density-controlled confinement. Nutrient concentrations within the DCM ranged from 1.5–3 µmol L^{-1} nitrate, 0.10–0.30 µmol L^{-1} ammonium, and 2.5–5 µmol L^{-1} silicate, while dissolved oxygen remained relatively uniform (3.4–4.0 mg L^{-1}). These results demonstrate that the Bay of Bengal DCM is physically trapped within a stable density layer yet remains biogeochemically dynamic on diurnal timescales, with variability driven primarily by photoacclimation and *in situ* nutrient recycling rather than vertical displacement.

Keywords: *Deep Chlorophyll Maximum, Bay of Bengal, Diurnal Variability, Photoacclimation, Stratification, Deep Biomass Maximum*

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ADAPTIVE MARINE BIOGEOCHEMICAL PREDICTION THROUGH OBSERVATION-CONSTRAINED PARAMETER ESTIMATION AND HYBRID PHYSICS–AI MODELLING FRAMEWORK

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Process-based ecosystem models underpin biogeochemical forecasting but exhibit persistent biases because key physiological and ecological parameters are prescribed a priori and fixed in space and time. This limits their ability to represent spatio-temporal variability in phytoplankton productivity, nutrient drawdown, oxygen dynamics and ecosystem responses to environmental change. We present two complementary approaches to improve process representation. First, an ensemble-based data assimilation framework in one-dimensional coupled physics–biogeochemical configurations estimate seasonally varying ecological parameters. By assimilating satellite ocean-colour data, *in situ* observations and BGC-Argo trajectories, the system constrains model states and captures seasonal variability in phytoplankton and zooplankton parameters across contrasting regimes. Second, we introduce a three-dimensional hybrid physics–Artificial Intelligence framework with machine-learning components coupled online within a physics–biogeochemical model. Two pathways are explored: Hybrid Scale Factor (HYB-SF), where satellite-derived primary production trains the AI to dynamically scale productivity, and Hybrid Photosynthesis–Irradiance (HYB-PI), where AI predicts photosynthesis–irradiance parameters from environmental drivers. Both approaches adjust the productivity engine during integration while preserving the native stoichiometric and mass-conserving structure. Together, these methods move ecosystem modelling beyond static parameterisation towards adaptive, observation-informed prediction. Results show improved chlorophyll, bloom timing and dissolved oxygen beyond the AI-training regime, achieving reanalysis-grade performance and demonstrating suitability for operational forecasting, climate impact assessment and long-term ecosystem projections.

Keywords: *Artificial Intelligence, Data Assimilation, Climate-Ready Hybrid Modelling, Marine Biogeochemistry*

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TOP-DOWN CASCADING EFFECTS COUNTERACT DE-EUTROPHICATION EFFORTS IN COASTAL ECOSYSTEMS

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Deteriorating water quality, driven by eutrophication, is a major concern for global coastal ecosystems. Although mitigating nutrient loads ("de-eutrophication") is the de-facto restoration strategy, it has not consistently reduced excess phytoplankton biomass. Here, we combine satellite observations, *in situ* data, and mechanistic modelling to show that (1) coastal phytoplankton biomass has increased globally over recent decades, while nutrient concentrations declined at higher latitudes (> 23°) but increased elsewhere; and (2) the effects of de-eutrophication can be overridden by top-down trophic cascades. In turbid coastal waters, planktivorous fish (small and/or juvenile) seek refuge from predators and intensively graze on zooplankton, reducing herbivory on phytoplankton and increasing their biomass. Coastal warming is likely to intensify these cascades, potentially driving further phytoplankton increases. Our findings demonstrate that phytoplankton stocks are strongly influenced by top-down processes, underscoring the need to incorporate trophic interactions into ecosystem models and management strategies. De-eutrophication alone may therefore be insufficient.

Keywords: *Trophic Cascade, Top-Down Effect, De-Eutrophication, Bottom-Up Effect, Zooplankton, Water Quality*

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PHYTOPLANKTON BIOMASS AND BIODIVERSITY CLIMATE CHANGE INITIATIVE (PHYTO-CCI)

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Phytoplankton play a central role in the Earth System. Through the production of organic carbon, phytoplankton drive major processes in the ocean carbon cycle and form the basis of almost all life in the ocean. Phytoplankton have high biodiversity and this is complemented by their functional diversity, which recognises that different types of phytoplankton play varied roles in marine ecosystems and in biogeochemical cycles of the ocean. It is therefore fitting that the Global Climate Observing System (GCOS) has included phytoplankton in the ocean biosphere Essential Climate Variable (ECV), together with zooplankton. With many of the satellite-retrieval algorithms related to phytoplankton maturing over time, we are now in a position to produce such phytoplankton products to the ensemble of the European Space Agency (ESA) Climate Change Initiative (CCI). Here we present an overview of the 'phytoplankton biomass and diversity Climate Change Initiative' (PHYTO-CCI) project that aims to develop satellite-based data products for two ECVs identified by the GCOS: phytoplankton carbon biomass and pigment diversity. In the PHYTO-CCI project, satellite retrieval algorithms will be compared and combined using optical water classification to produce ECV products with associated uncertainty estimates. These products will be validated using both *in situ* and model data, followed by a comprehensive scientific assessment. The value of the new ocean biosphere ECVs will be demonstrated through their application in climate research and their relevance for supporting marine ecosystem services. The phytoplankton biomass and diversity ECVs are critical for understanding the structure and function of marine ecosystems, their role in the Earth System, and how they may be affected by global warming and other human-driven impacts.

Keywords: *Phytoplankton, Biodiversity, Biomass, Ocean Colour, Essential Climate Variable*

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ARE GLOBAL OCEANS REACHING A TIPPING POINT? REMOTELY SENSING PHYTOPLANKTON EXTREMES

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Concurrently with trends in climatic warming, the frequency of extreme events including storms, droughts, wildfires and heatwaves, has increased in recent decades. The biological response of the global oceans to thermal extremes includes alterations to the physiology, abundance, geographic distribution, community structure and phenology of marine organisms. Phytoplankton, situated at the base of the marine food web, respond most rapidly to environmental perturbations and serve as ecological indicators and early-warning signals for monitoring ecosystem health. Here, we combine satellite ocean colour observations, Argo-float derived measurements, and model reanalysis datasets to investigate how extreme climate events, such as marine heatwaves and intensified aerosol deposition events, drive anomalous changes in phytoplankton abundance, phenology and composition. We provide region-specific examples of unprecedented changes in phytoplankton dynamics in the Indian and Atlantic Oceans, discuss mechanistic linkages with the physical environment and adjacent terrestrial ecosystems, and provide preliminary evidence of tipping points within the multi-decadal ocean colour record.

Keywords: *Ocean Colour, Phytoplankton, Climate Extremes, Aerosol Deposition, Phenology*

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Abstract ID: **TSS/BGCP/33**

ESA OCEAN COLOUR CLIMATE CHANGE INITIATIVE (OC CCI) PROJECT: RECENT DEVELOPMENTS AND COMMUNITY APPLICATIONS

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The PML-led European Space Agency OC CCI develops and validates algorithms to meet the Global Climate Observing System (GCOS) requirements for consistent, stable, error-characterised global ocean colour satellite data products (e.g., chlorophyll-a and reflectance) from multi-sensor data archives. The aim is to produce the most complete time series of multi-sensor global satellite data products to support inter-disciplinary, international cooperation on Earth observation, climate research and modelling. The project is progressing towards version 7 of the product, with developments including extensive temporal and spatial additions to the *in situ* database used for algorithm selection and validation, increasing data points by 115% and a community round robin to Identify the best performing in-water algorithms to be used in the framework of Optical Water Type classification. Furthermore, the project is evaluating new sensors (including NOAA-20 VIIRS and ISRO OCM-3) as candidates to add to the data record and investigating recent performance of older sensors (notably, Aqua-MODIS) for continued inclusion in the time-series. This presentation will describe the recent developments and summarise the extensive use of OC CCI data worldwide for studies into Earth observation and changing phytoplankton characteristics in the context of a changing climate.

Keywords: *Chlorophyll-A, Ocean-Colour, Time-Series, Climate-Change*

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PHYTOPLANKTON SIZE STRUCTURE IN THE NORTHWEST WEDDELL SEA

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Phytoplankton size influences marine carbon production and ecosystem dynamics, yet much of the Antarctic remains poorly sampled. We present a summer dataset from the rarely studied northwestern Weddell Sea, including size-fractionated chlorophyll-a, phytoplankton pigments, and ocean-colour observations. Estimates of chlorophyll-a from high-performance liquid chromatography and size-fractionated filtration showed broad agreement, although some size-class differences were observed. Regional Southern Ocean ocean-colour algorithms outperformed global algorithms, which underestimated chlorophyll-a. Larger phytoplankton, particularly nanophytoplankton, dominated both shelf and open waters. A three-component model describing chlorophyll-a partitioning among size classes produced parameters similar to those from the western Antarctic Peninsula but distinct from tropical and subtropical Atlantic regions, where picophytoplankton dominate. Combining satellite chlorophyll-a data with the model enabled mapping of phytoplankton size distributions across the northwestern Weddell Sea. These results improve understanding of phytoplankton community structure and carbon cycling in a rapidly changing Antarctic region.

Keywords: *Antarctic Phytoplankton, Weddell Sea, Phytoplankton Size Structure, Chlorophyll-a, Ocean Colour Remote Sensing*

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SPATIOTEMPORAL VARIATIONS IN LEAF LITTERFALL, SOIL AND WATER NUTRIENTS AND BENTHIC COMMUNITIES IN SALIMPUR MANGROVE

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Nutrient cycling and supporting biodiversity in the mangrove are important functions of mangrove ecosystems. In the current research, the spatial and temporal variations in nutrients and its correlation with the benthic community of Salimpur mangrove and adjoining coastal ecosystem was evaluated. A coastal belt 2.4 km in length and 10 sampling stations were monitored for four months (from November to February). Samples of leaf litter, soil, water, and benthos were collected using traps, coring, filtration, and sieving. Water nutrients (nitrite, phosphate, silicate, ammonium) and leaf, soil nutrients (nitrogen, phosphate) were measured colorimetric. Environmental parameters included SST, salinity, DO, pH, turbidity, and conductivity; benthic samples were identified microscopically. The results showed that the SST, salinity and DO had weak spatial gradients with mean values of 26.55°C, 12.85 ppt and 6.77 mg L^{-1} respectively, while the almost non-existent spatial gradient observed for nitrite had a mean value of 7.86 mg L^{-1}. While phosphate and ammonium also had moderate positive spatial structure (R^2 = 0.248 and 0.247, respectively). Nitrogen was also highly cross compartmentally connected among water, soil and leaf litter ($r = 0.877$, $p < 0.001$) unlike phosphate. Nutrient returns have been found to be related to changes in litterfall and have increased from November to February from 14.47 g m-2 day-1 to 16.83 g m-2 day-1 and N and P returns have increased during this period. Benthic assemblages were non-uniform, with some stations having more species than listed, some having fewer. Species richness was the characteristic most important in shaping diversity patterns (Shannon, Simpson). The N cycle in Salimpur mangrove is system-wide, but the P cycle is compartmentalized, which indicate the significance of litter fall, sediment process in the mangrove ecosystem and benthic diversity for sustainable management of mangrove in Bangladesh.

Keywords: *Leaf Litterfall, Mangrove Ecosystem, Benthic Assemblages, Soil–Water Nutrients, Spatiotemporal Variation*

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SEDIMENT BIOGEOCHEMISTRY AND IT'S INFLUENCE ON MACROBENTHIC COMMUNITY STRUCTURE IN INTERTIDAL HABITATS OF THE CHATTOGRAM COAST, BANGLADESH

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Tropical intertidal zones where land, sea, and human activity converge harbour macrobenthic assemblages that drive sediment biogeochemistry and underpin coastal food webs. Yet baseline ecological data for South Asian coasts remain critically sparse, constraining conservation and climate adaptation planning. This study characterises macrobenthic community structure across contrasting intertidal mudflat and saltmarsh habitats on the Chattogram coast, Bangladesh, and quantifies the sediment environmental drivers shaping faunal distribution. Field sampling was conducted in February 2025 at two sites Salimpur and Guliakhali representing distinct depositional and vegetative regimes. Macrofauna were retrieved using standardised corers and quadrats, with simultaneous measurement of sediment texture, organic matter, organic carbon, pH, and salinity. A total of 51 species across 4 classes and 25 families were recorded. Capitellidae (35.98%), known organic enrichment indicators, dominated the assemblage signalling anthropogenic organic loading along Chittagong's industrialised coastal corridor. Salimpur Mudflat supported higher abundance (2,013.89 ind/m²) and species richness (Margalef: 7.17), whereas Guliakhali Saltmarsh exhibited superior faunal evenness (Pielou: 0.95) and moderate Shannon diversity (3.07). Pearson correlation and Principal Component Analysis (81.2% variance explained) revealed that clay-silt content and organic matter were the primary structuring forces, while sand fraction exerted a negative influence. These sediment fauna relationships highlight how habitat-specific biogeochemical conditions regulate benthic biodiversity. In a region facing accelerating coastal degradation from climate extremes and industrialisation, these findings establish an urgently needed ecological baseline, demonstrating that integrating sediment biogeochemistry with biodiversity indices is indispensable for evidence-based management of tropical coastal ecosystems.

Keywords: *Macrobenthos, Intertidal Zone, Sediment Biogeochemistry, Biodiversity Indices, Coastal Ecology*

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ABUNDANCE, DISTRIBUTION AND DIVERSITY OF MACROBENTHOS IN CHITTAGONG COAST, BANGLADESH

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Macrobenthos are an essential component of marine and coastal ecosystems. This study investigated the seasonal taxonomic structure of macrobenthos species and examined sediment physicochemical properties to understand their influence on macrobenthos communities along the Chittagong coast, Bangladesh. A total of 66 species belonging to 30 families and 10 classes were recorded from the study areas. Density was significantly higher during the dry season, with polychaetes, especially Capitellidae and Nereididae, dominating the communities. Capitellidae showed maximum density at Salimpur Mudflat (787.04 ind. m-2) and Salimpur Salt-marsh (625.00 ind. m-2) during the dry season, while the highest wet season density was recorded at Salimpur Salt-marsh (1180.55 ind. m-2). Biodiversity indices were generally higher during the dry season compared to the wet season. Habitat-wise, macrobenthos density was greater in mudflat areas, particularly in Salimpur, than in salt-marsh habitats. Sediment properties also varied seasonally. Electric conductivity, organic matter, and finer sediment fractions were higher in dry season mudflat sediments, whereas salt-marsh sediments were dominated by sand particles. Correlation analysis revealed positive relationships between macrobenthos density and electric conductivity ($r = 0.77$), silt ($r = 0.62$), and clay content ($r = 0.45$), while a strong negative relationship was observed with sand content ($r = -0.79$). Regression analysis Identified sand percentage and electric conductivity as major factors influencing macrobenthos density.

Keywords: *Macrobenthos, Biodiversity, Sediment Properties, Mudflat, Coastal Ecosystem, Chittagong Coast*

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Abstract ID: TSS/BGCP/38

SPATIAL VARIABILITY OF MACROBENTHIC COMMUNITIES, SALTMARSH VEGETATION AND LAND COVER ALONG THE SITAKUNDA-CHATTOGRAM COAST

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Saltmarshes are critically important ecosystems that provide habitat for a variety of faunal species, including macrobenthos. Despite their importance, saltmarsh ecosystems remain understudied. Consequently, this study assessed vegetation characteristics, macrobenthic communities and surrounding land use patterns of saltmarsh beds along the Sitakunda-Chattogram coastal belt. Samples were collected from Faujdarhat, Banshbaria and South Kattali during December and February and remotely sensed data were used to assess land use and land cover. Shoot density ranged from 174 shoots/m2 - 530 shoots/m2 and showed no significant variations across locations or months (site: $F = 1.547$, $p = 0.252$; month: $F = 0.052$, $p = 0.824$). In contrast, Two-way ANOVA revealed significant variations of above ground biomass ($F = 14.128$, $p = 0.00162$) and below ground biomass ($F = 14.128$, $p = 0.000702$) across regions. Tukey HSD post hoc test revealed that South Kattali had the highest below ground biomass compared to Faujdarhat ($p = 0.0457$) and Banshbaria ($p = 0.0005$). Furthermore, macrobenthos from 13 families were identified in this study. Non-metric Multidimensional Scaling (NMDS) indicated distinct benthic assemblages in South Kattali compared to more similar communities in Faujdarhat and Banshbaria. Redundancy analysis (RDA) revealed that soil pH had significant impact on macrobenthic community structure. Diversity indices were higher in February across all sites, with South Kattali showing the greatest species richness and diversity. Moreover, land use assessment within 0.5 km buffer of the studied sites using Random Forest algorithm revealed that South Kattali had the highest saltmarsh area, whereas Faujdarhat and Banshbaria were dominated by built-up and agricultural land respectively. Overall, this study presents the baseline data on the ecological significance of the saltmarsh beds in these regions and underlines the need for a management approach integrating multiple components.

Keywords: *Saltmarsh; Macrobenthos; Above Ground Biomass (AGB); Below Ground Biomass (BGB); Land Use and Land Cover (LULC)*

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Abstract ID: TSS/BGCP/39

MODELING THE EFFECTS OF NOISE IN TEMPERATURE ON PRIMARY PRODUCTION

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Temperature variability is an intrinsic feature of the marine environment, yet its influence on phytoplankton growth is commonly assessed using deterministic thermal performance relationships evaluated at mean temperatures. Here, we investigate how stochastic temperature fluctuations alter phytoplankton growth and biomass dynamics. Sea surface temperature (SST) records are decomposed into long-term trends, seasonal cycles, and residual variability, with the latter representing environmental noise. Global analyses of SST reveal substantial spatial differences in the magnitude of this variability, suggesting that phytoplankton experience distinct thermal environments even under similar mean conditions. Using the recently proposed universal thermal performance function, we derive an analytical expression for the average growth rate under normally distributed temperature fluctuations. The new formulation demonstrates that the average response to thermal variability differs fundamentally from the growth rate predicted at the mean temperature. We identify a fragility temperature threshold that separates two regimes. Below this threshold, thermal variability enhances mean growth rates, rendering primary production antifragile. Above it, variability reduces growth and effectively lowers the maximum temperature at which populations can persist. To explore the ecological implications of these effects, we couple the temperature-dependent growth formulation to a stochastic phytoplankton biomass model in which mixed-layer temperature evolves according to an Ornstein-Uhlenbeck process. Simulations show that Identical mean temperatures can produce markedly different biomass trajectories determined by the intensity of thermal fluctuations. As climate change is expected to modify not only mean ocean temperatures but also patterns of temperature variability, our results suggest that environmental noise is an important determinant for predicting marine primary production.

Keywords: *Primary Production, Thermal Fluctuations, Thermal Preference Function, Antifragility*

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Abstract ID: **TSS/BGCP/40**

SEAGRASS MEADOWS MODIFY SHORT-TERM pH AND OXYGEN VARIABILITY IN KENYA'S COASTAL WATERS

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Seagrass meadows are among the most productive and ecologically significant marine ecosystems. They can influence water chemistry through photosynthesis, respiration, and organic matter cycling, potentially altering local pH and dissolved oxygen (DO) conditions. Existing research highlights the potential of seagrass meadows to buffer ocean acidification and enhance oxygenation. However, the consistency and magnitude of these effects remain uncertain across locations. To advance our understanding on water chemistry modification by seagrass meadows, this study combines *in-situ* field observations and mesocosm field experiments, quantifying variability in pH and DO levels within seagrass and bare habitats across three Kenyan coastal systems. High-frequency measurements of pH, DO, temperature and light were collected using autonomous sensors deployed between habitats over a nine-month period. Mean pH did not differ significantly between habitats (7.94 pH units). However, paired daily comparisons showed that seagrass habitats maintained higher pH in 74% of observations, indicating a persistent but small directional effect. DO showed a distinct habitat separation with higher mean concentrations in seagrass habitats (6.47 mg/L ±1.63) compared to bare areas (6.05 mg/L ±1.98) and lower frequencies of hypoxic conditions. GAM results identified DO and temperature as significant predictors of pH variability, although the strength and direction of these relationships differed among sites. Accounting for temporal autocorrelation, cross-correlations among variables were generally weak, suggesting that much of the observed pairing reflected shared diel forcing rather than strong mechanistic coupling. In summary, seagrass ecosystems consistently enhanced oxygen conditions and produced small but directionally persistent increases in pH. However, habitat effects were small compared to site-level environmental variability.

Keywords: *Seagrass, pH, DO, Variability, Coastal Biogeochemistry*

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Abstract ID: TSS/BGCP/41

CO_2 FLUX AND CARBONATE SYSTEM VARIABILITY DURING THE DRY AND RAINY SEASONS IN THE GULF OF GUINEA

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This study analyses the Gulf of Guinea (GoG). Using satellite, reanalysis, and *in situ* data, the carbonate system was reconstructed (TA via the LIAR model, DIC via regression, $R^2 = 0.95$). Bi-seasonal air–sea CO_2 fluxes (FCO_2) reveal stronger outgassing to the atmosphere during the rainy season (3.52 $mmol \cdot m^{-2} \cdot day^{-1}$), which weakens during the dry season (1.92). The Congo River plume acts as a net source (+1.06), whereas the Niger River plume constitutes a sink (–0.57). Fluxes are weakly correlated with the intensity of geostrophic currents ($r = –0.12$) but strongly with the zonal component of the geostrophic current ($r = 0.82$). Since 2019, acidification has intensified in upwelling areas (ΔpCO_2 +27 µatm; ΔpH –0.02), confirming the Gulf of Guinea as a net CO_2 source (2.77 $mmol \cdot m^{-2} \cdot day^{-1}$). This dynamic, captured by satellite data and numerical methods, highlights the importance of PIRATA–CARIOCA buoys for local validation. Although no specific study of intrasessional variability has been conducted in this research, continued high-frequency measurements would help to better understand this variability during the rainy season, which exhibits the greatest instability.

Keywords: *Gulf of Guinea, Air–sea CO_2 flux, Ocean acidification*

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Abstract ID: **TSS/BGCP/42**

HIGH-RESOLUTION O_2/AR-BASED ESTIMATES OF NET COMMUNITY PRODUCTION AND AIR–SEA CO_2 FLUX IN THE SOUTHWESTERN ATLANTIC

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Marine phytoplankton influence atmospheric CO_2 by fixing carbon through photosynthesis and exporting it to the deep ocean. Constraining the spatial and temporal variability of primary productivity and carbon export, as well as their controlling mechanisms, is essential to predict ocean–climate feedback. Here, we present continuous underway observations of net community production (NCP) and air–sea CO_2 fluxes collected across the southwestern Atlantic (42°S–17°S, 59°W–25°W) during two surveys aboard the R/V Falkor (too) between January and April 2026. Dissolved oxygen to argon ratios (O_2/Ar) were measured using membrane inlet mass spectrometry (MIMS), while sea surface and atmospheric partial pressure of CO_2 (pCO_2) were obtained using a General Oceanic pCO2 underway system. These observations were complemented by hydrographic and biogeochemical observations, including temperature, salinity, chlorophyll-a, and dissolved oxygen. The surveys spanned a broad latitudinal transect across from the Patagonian shelf break off Puerto Madryn (Argentina) to the tropical South Atlantic near Salvador (Brazil), including offshore sampling in the oligotrophic South Atlantic gyre. This dataset provides a unique opportunity to evaluate how physical forcing and biological activity interact to regulate surface ocean carbon cycling across frontal (or productive) and oligotrophic environments. These observations provide a basis for understanding the coupling between biological production and physical forcing, offering an observational benchmark for assessing ocean–climate feedback in the understudied southwestern Atlantic.

Keywords: *Carbon Cycle, Gyre, Underway, Primary Production, Phytoplankton*

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Abstract ID: **TSS/BGCP/43**

ECOSYSTEM RESPONSE TO VARIABLE SOURCE WATER INPUTS IN THE CANARY UPWELLING SYSTEM: INSIGHTS FROM *IN SITU* INCUBATION EXPERIMENTS

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Eastern Boundary Upwelling Systems (EBUS) are among the most productive marine environments, sustaining high biological production and globally significant fisheries. However, their response to climate-driven changes in upwelling dynamics remains poorly constrained, particularly how shifts in source water depth affect nutrient supply and ecosystem functioning. Nutrient availability and plankton community composition are key drivers of ecosystem response, yet their high spatial and seasonal variability makes predictions challenging. This study investigates how variations in source water depth and composition influence phytoplankton community structure, nutrient utilization, and carbon cycling in the Canary Upwelling System (CUS). During cruise DY204, a series of *in situ* incubation experiments were conducted offshore of Western Sahara and the southern Canary Islands along 26.5°N. Controlled mixtures of nutrient-rich waters from below the mixed layer and surface waters simulated contrasting upwelling scenarios, including varying contributions of North and South Atlantic Central Waters. Incubations were maintained under near-natural conditions for 48 hours, with sampling at initial and final time points. A suite of biogeochemical and biological variables was measured, including inorganic nutrients, dissolved inorganic and organic carbon, particulate organic carbon, chlorophyll-a, dissolved organic phosphate, and plankton community structure assessed via flow cytometry and imaging. This approach quantifies nutrient drawdown, shifts in stoichiometry, and changes in community structure under different mixing regimes. Linking experimental and satellite-derived productivity provides insight into the sensitivity of upwelling ecosystems under future climate scenarios.

Keywords: *Nutrients, Phytoplankton, Experiment, Upwelling*

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Abstract ID: TSS/BGCP/44

VERTICAL HABITAT STRUCTURE OF REPRESENTATIVE MESOPELAGIC ENVIRONMENTS ACROSS THE EASTERN ARABIAN SEA OXYGEN MINIMUM ZONE: AN INTEGRATED OBSERVATIONAL AND MODELLING STUDY

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The eastern Arabian Sea hosts one of the world's most intense permanent oxygen minimum zones (OMZs), where circulation, productivity, and oxygen consumption generate regional gradients affecting mesopelagic habitats. How regional forcing translates into local vertical habitat structure for mesopelagic organisms remains unclear. We address this using HYCOM-ECOSMO simulations, CTD hydrography, BGC-Argo climatology, echosounder observations, and midwater trawl sampling at three stations along the eastern Arabian Sea margin during winter. Modelled winter circulation revealed contrasting hydrographic and biogeochemical environments expressed as distinct vertical habitat structures. Surface productivity increased meridionally from south to north, with systematic variations in oxygen and stratification. The central station showed the strongest gradients, characterized by shallowest thermocline, pycnocline, and upper OMZ boundary. Inter-station variability was confined to the upper 150-180 m; deeper properties remained uniform. Despite differences in upper OMZ boundary depth (80-133 m), the night-time deep scattering layer (DSL) centre consistently occurred in waters with $O2 \geq 60$ µmol/kg, never within the OMZ core ($O2 < 20$ µmol/kg). The lower DSL extended into hypoxic waters ($O2 \leq 60$ µmol/kg) at southern and central stations but remained within oxygenated waters at northern station. Multidimensional Euclidean distance analysis showed no single environmental layer consistently explained DSL position. Southern and central stations showed the closest DSL association with the upper hypoxic boundary; the northern station shifted toward shallower layers, notably the deep chlorophyll maximum and upper stratification. These results show that mesopelagic habitat structure emerges from hydrography, stratification, productivity, and oxygen combined, rather than DO alone, providing a process-based framework linking regional forcing to local habitat structure in the eastern Arabian Sea.

Keywords: *Arabian Sea Oxygen Minimum Zone, Mesopelagic Zone, Deep Scattering Layer, Vertical Habitat Structure, Acoustics*

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Abstract ID: TSS/BGCP/45

PRIMARY PRODUCTION AT EPEA STATION (SOUTHWESTERN ATLANTIC): LINKS TO PHYTOPLANKTON AND ENVIRONMENTAL PROPERTIES

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This study provides the first assessment of primary production (PP) at the Estación Permanente de Estudios Ambientales (EPEA, 38°28'S, 57°41'W), a marine ecological time series in the Southwest Atlantic, and evaluates its coupling with phytoplankton community and environmental forcing between 2006 and 2019. Photosynthetic parameters (α and Pm) were derived from photosynthesis-irradiance experiments, while community composition was resolved via inverted light and epifluorescence microscopy. Mean annual integrated PP was 202 ± 115 g C m^{-2} yr^{-1}, which characterizes EPEA as a mesotrophic system. Maximum daily productivity (up to 1191 ± 765 mg C m^{-2} d^{-1}) occurred during spring, driven by enhanced solar irradiance and water column stratification, with assemblages dominated by diatoms, dinoflagellates, and haptophytes. In summer, PP declined, shifting toward dominance by picocyanobacteria Synechococcus spp. Autumn dynamics exhibited a secondary production peak, where the breakdown of the pycnocline likely replenished nutrients, sustaining large-sized diatoms. Conversely, winter represented the lowest productivity (285 ± 123 mg C m^{-2} d^{-1}) due to reduced light availability and deep mixing, favouring cryptophytes and ultraphytoplankton. Maximum PP did not align with maximum cellular carbon biomass, but correlated strongly with chlorophyll a. This lack of correlation between PP and carbon biomass highlights a high physiological plasticity of coastal phytoplankton, reflecting the community's known capacity to modulate pigment content in response to environmental shifts. Extraordinary events were detected across different seasons, representing distinct deviations from the EPEA historical data. These findings highlight the need for future research to investigate large-scale climate forcings, such as SAM and ENSO.

Keywords: *Primary production, Phytoplankton, Marine Ecological Time Series, EPEA, Southwestern Atlantic*

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Abstract ID: **TSS/BGCP/46**

INTERANNUAL VARIABILITY OF OXYGEN AND NUTRIENTS CONCENTRATIONS IN THE ATLANTIC NORTH EQUATORIAL COUNTERCURRENT BETWEEN 1993-2020

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The North Equatorial Countercurrent (NECC) plays a central role in the redistribution of heat, oxygen, and nutrients across the tropical Atlantic toward the Gulf of Guinea. We used hindcast and reanalysis data from GLORYS2V4 between 1993 and 2020, supported with GLODAPv2 quality-controlled grIDded data from two hydrographic cruises (1999, 2009) to examine decadal variability in oxygen and nutrients in the NECC core (potential density range $22.5 < \sigma_\theta < 26.5$ kg m^{-3} and latitude range 4–6°N) along 35°W and 23°W meridional sections. Significant positive trends were found in nitrate 0.034 ± 0.019 (0.037 ± 0.021) µmol kg-1 year-1, phosphate 0.002 ± 0.001 (0.003 ± 0.001) µmol kg-1 year-1, silicate 0.015 ± 0.007 (0.017 ± 0.008) µmol kg-1 year-1, along with decreasing trends in oxygen -0.1 ± 0.06 (-0.13 ± 0.1) µmol kg-1 year-1 at 35°W (23°W) meridional sections in the NECC core, respectively. Accompanying this is an increase in apparent oxygen utilization (AOU) 0.18 ± 0.14 µmol kg-1 year-1 along the 23°W meridional section. Similar trends were also observed during the strong (June–November) and weak (January–May) phases of the NECC, with a higher rate of change during the weak phase than the stronger one. The observed trends in nutrients and oxygen are explained by an increase in remineralization supported with a decrease in net primary productivity. This finding supports a scenario of a decrease in zonal transport of the NECC core water masses, consequently affecting the dynamics of the Gulf of Guinea region.

Keywords: *Prime Meridian, North Equatorial Countercurrent, Tropical Atlantic, Decadal variability, Nutrients, Oxygen*

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Abstract ID: **TSS/BGCP/47**

THE IMPORTANCE OF A LONG-TERM OCEANOGRAPHIC TIME SERIES FOR ASSESSING INTERANNUAL CHANGES IN PHYTOPLANKTON OFF THE BAJA CALIFORNIA PENINSULA

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Long-term oceanographic time series are essential for detecting interannual changes in marine ecosystems and evaluating their responses to climate variability. We present observations collected between 2017 and 2025 at a long-term monitoring station in the outer region of Todos Santos Bay, on the northern Baja California Peninsula, Mexico, as part of the NANO-DOAP monitoring network. The station is strongly influenced by the California Current System and seasonal coastal upwelling, which intensifies during spring and summer and regulates phytoplankton dynamics. Phytoplankton pigments were quantified by high-performance liquID chromatography (HPLC), community composition was determined by light microscopy, and environmental variables, including temperature, salinity, and nutrients, were measured. Chlorophyll-a concentrations ranged from 0.13 to 7.40 mg m^{-3}, with maximum values during the spring upwelling season. Significant interannual changes in environmental conditions and phytoplankton community structure were associated with El Niño and La Niña events. Warm El Niño conditions were characterized by reduced phytoplankton biomass and dominance of pico- and nanophytoplankton, whereas La Niña promoted higher biomass and an increased contribution of microphytoplankton, particularly diatoms and dinoflagellates. These results highlight the importance of long-term oceanographic observations for understanding ecosystem responses to climate variability in the California Current System.

Keywords: *Long-term oceanographic time series, Phytoplankton community, Interannual variability, California Current System*

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Sub theme 2

Chemical Ecology for Physiological Processes in Aquatic Environments

Abstract ID: **TSS/CE/01**

MIXED TROPHIC IMPACT ANALYSIS OF THE KERALA MARINE ECOSYSTEM

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Kerala, a state in southwestern India with a coastline of about 600 km, is bordered by highly productive waters that support rich fish diversity, numerous fisheries, and large fishing communities. An Ecopath with Ecosim model comprising 47 biological functional groups representing 740 species and multiple fishing fleet metiers was developed, and Mixed Trophic Impact (MTI) analysis was conducted to evaluate trophic interactions and the differential effects of fishing gears on the Kerala coast food web. Mixed Trophic Impact (MTI) analysis is an ecosystem-based fisheries assessment tool that evaluates direct and indirect interactions within marine food webs. It quantifies the net effects of each species on others, incorporating predator–prey relationships and trophic linkages. Matrices are constructed of relative net impacts of each group on every other, scaled between −1 and 1. The fishery in the Kerala Arabian Sea ecosystem had a mean trophic level of 3.215, fluctuated between 1 and 5.07 and is dominated by species like oil sardine and Indian mackerel. The study revealed simultaneous top-down and bottom-up controls across the food web. Apex predators including sharks, marine mammals, large pelagics, and tunas exerted strong negative impacts on intermediate consumers, while small pelagics like Indian mackerel, oil sardine, anchovies, and other clupeids functioned as keystone forage groups driving positive energy transfer to higher trophic levels. Zooplankton positively influenced pelagic groups and indirectly benefited sharks by supporting medium pelagic prey, while also forming a major dietary component of small benthopelagic and mesopelagic groups. Fishing fleets exerted widespread negative impacts on multiple functional groups, with some gears disproportionately affecting mid-trophic species, crustaceans, and cephalopods. By revealing positive and negative ecosystem interactions, MTI provides valuable insights for sustainable fisheries management.

Keywords: *Ecopath with Ecosim, Mixed Trophic Impact, Kerala coast, food web dynamics, trophic cascade, ecosystem-based fisheries management*

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Abstract ID: TSS/CE/02

SEASONAL DYNAMICS OF CARBONATE CHEMISTRY AND CALCIFICATION POTENTIAL IN THE CORAL REEF ECOSYSTEMS OF LAKSHADWEEP ARCHIPELAGO

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Seawater carbonate chemistry plays a critical role in reef calcification and ecosystem resilience. Assessing seasonal variability is essential for understanding reef vulnerability. This study characterizes seasonal and spatial variability in seawater carbonate chemistry across seven coral reef islands of Lakshadweep during pre-monsoon and post-monsoon periods of 2025. Surface seawater samples were collected across the islands to measure Dissolved inorganic carbon, Total alkalinity, pH, Temperature, Salinity, Dissolved Carbon dioxide, Aragonite and Calcite saturation state were measured to assess the seasonal shifts in reef carbonate chemistry. Results revealed distinct seasonal and inter-island variability driven by a combination of physical, biological, and geochemical processes. In Bangaram, post-monsoon conditions showed lower dissolved Carbon dioxide, higher pH, and elevated aragonite and calcite saturation states, indicating enhanced photosynthetic uptake of DIC and more favourable conditions for reef calcification. In Amini, elevated total alkalinity suggested strong buffering capacity supported by carbonate sediment dissolution and reef-derived alkalinity production, with lower salinity potentially indicating input of carbonate-rich freshwater. In Kavaratti and Thinnakara, pre-monsoon salinity was consistently higher across all stations, reflecting evaporative concentration during the dry season, while post-monsoon freshwater dilution from precipitation reduced salinity and DIC, altering carbonate equilibrium. Across the islands, no single oceanographic process uniformly controlled carbonate chemistry-biological production dominated in some islands, monsoon-driven dilution in others, and benthic carbonate dissolution in others, highlighting the spatially heterogeneous nature of carbonate cycling across the Lakshadweep coral islands. The findings enhance understanding of reef carbonate dynamics and support long-term monitoring.

Keywords: *Carbonate Chemistry, Aragonite Saturation State, Calcite Saturation State, Buffering Capacity*

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Abstract ID: **TSS/CE/03**

INTEGRATED ASSESSMENT OF COASTAL ENVIRONMENTAL VULNERABILITY: ANTHROPOGENIC IMPACTS AND GEOMORPHOLOGIES

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Cameroonian coastal ecosystems are subject to increasing anthropogenic pressures requiring an integrated assessment of their vulnerability. This assessment combines a geomorphological and geochemical approach to characterize the contamination and environmental modifications of the Kribi coastline and the mangroves of the Wouri River. The methodology integrates (i) a morphological characterization of the coastal strip by topographical surveys, ii) a quantitative inventory of solid waste on the beaches of Kribi and Yoyo by systematic transects, and (iii) an assessment of contamination by metallic trace elements (Pb, Cd) in mangrove sediments and soft tissues of molluscs by atomic absorption spectrophotometry. The typological analysis of waste shows a dominance of plastics (80%) with an average density of 2.3 items/m of mainly terrestrial origin (60%). Metal contamination of mangroves presents concentrations of lead (0.56-15.84 mg/kg) and cadmium (0.01-1.6 mg/kg) presenting moderate ecological risks. The morphological analysis reveals coastal erosion/accretion which is influenced by hydrodynamic forcing, hence a coastline characterized by the coastal vinerability index (significant in urban planning ratings, i.e. -4) which is determined here by the slope meadows (steeper in urban areas, i.e. - 3.5) and morphological typology of the coast.

Keywords: *Coastal ecosystems, Marine contamination, Trace metals, Nutrient dynamics, Waste/Marine debris, Mangroves, Coastal erosion, Coastal vulnerability, Ecological restoration*

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Abstract ID: **TSS/CE/04**

ASSESSING THE IMPACT OF ENVIRONMENTAL VARIABLES ON PLANKTON DISTRIBUTION OF KARNAPHULI RIVER ESTUARY

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The Karnaphuli River Estuary in southeastern Bangladesh is a dynamic transition zone where freshwater mixes with saline water from the Bay of Bengal. This study investigated the spatial and vertical distribution of temperature, salinity, dissolved oxygen, and chlorophyll a, and their influence on phytoplankton and zooplankton communities. Data were collected from 20 stations extending from the Chittagong port area to the outer anchorage, highlighting plankton responses to environmental variation and the need for continuous monitoring. *In situ* measurements were obtained using a CTD profiler up to 8 meters depth. Plankton samples were collected using nets and preserved for identification and counting under light microscopy. Spatial and vertical analyses were conducted using Ocean Data View, while Pearson correlation and heat map visualization were performed in R. Results showed a clear estuarine gradient. Salinity ranged from 7.1 PSU in riverine zones to 22.5 PSU near the estuary mouth. Chlorophyll a peaked at mid depth in the outer estuary up to 4.5 mg per cubic meter, indicating high productivity. Dissolved oxygen ranged from 4.90 mg per liter at depth to 7.45 mg per liter at the surface, with stratification near port areas. Temperature was higher at the surface near industrial zones and decreased with depth. Phytoplankton abundance increased downstream and was dominated by *Coscinodiscus radiatus*, *Chaetoceros, Skeletonema costatum* and *Thalassiosira australis*. Zooplankton included copepod nauplii, tintinnids, barnacle larvae and crab zoea, with highest densities in saline, chlorophyll rich waters. Strong positive correlations were observed between salinity, chlorophyll a and plankton abundance. This study highlights the link between hydrographic conditions and plankton dynamics and provides baseline data for estuarine management.

Keywords: *Karnaphuli River, Environmental variables, Phytoplankton, Zooplankton, Salinity gradient, Chlorophyll-a*

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Abstract ID: **TSS/CE/05**

PHARMACEUTICAL POTENTIAL OF MARINE SEAWEED COLLECTED FROM SAINT MARTIN'S ISLAND, BANGLADESH

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Marine seaweeds from Bangladesh remain largely unexplored as pharmaceutical sources, despite growing global evidence of the biomedical value of their polysaccharide and phenolic compounds. This study investigated the pharmaceutical potential of *Sargassum filipendula, Spatoglossum asperum, Colpomenia peregrina*, and *Eucheuma spinosum* collected from Saint Martin's Island, Bangladesh. Fucoidan was extracted from both brown seaweed species using Soxhlet-assisted ethanol defatting, followed by dilute HCl solubilization, NaOH neutralization, and ethanol precipitation. Alginate was isolated through sequential acid pre-treatment and alkaline sodium carbonate extraction. Antioxidant activity was assessed using the DPPH free radical scavenging assay at 517 nm. Total phenolic content (TPC) was determined by the Folin-Ciocalteu method, and total flavonoid content (TFC) was quantified by the aluminium chloride colorimetric assay. Fucoidan yields were 12.56% for *S. filipendula* and 9.32% for *S. asperum* of dry weight, consistent with yields reported for tropical brown algae from other regions. Alginate yields followed an inverse pattern, recorded at 9.66% for *S. asperum* and 8.35% for *S. filipendula*, reflecting differences in cell wall polysaccharide composition between the two species. DPPH inhibition peaked at 96.09% for *C. peregrina* at 2 mg/mL and approached near-complete inhibition for *S. filipendula* at 8 mg/mL. TFC values were moderate across all species: 20.43 ug QE/mL for *C. peregrina,* 17.10 ug QE/mL for *S. filipendula*, and 13.37 ug QE/mL for *E. spinosum*. TPC values were comparatively low, suggesting that sulfated polysaccharides rather than classical phenolic compounds served as the primary antioxidant contributors. These findings provide baseline evidence that coastal seaweeds of Bangladesh carry measurable pharmaceutical value and support further structural characterization and industrial-scale development within the country's emerging blue economy framework.

Keywords: *Fucoidan, Alginate, DPPH assay, TPC, TFC*

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Abstract ID: TSS/CE/06

PRELIMINARY IDENTIFICATION OF LUCIFERIN-RELATED METABOLITES FROM DEEP-SEA BIOLUMINESCENT ORGANISMS AND COASTAL BIOLUMINESCENT WATERS USING LC-HRMS

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Marine bioluminescence is a widespread natural phenomenon driven by the oxidation of luciferin molecules, producing visible light in diverse marine organisms. The present study investigated deep-sea bioluminescent organisms and naturally bioluminescent coastal waters as potential sources of luciferin-related compounds and bioactive metabolites. Deep-sea samples were collected using standard oceanographic protocols, and tissue extracts were prepared using 50 mM Tris buffer followed by centrifugation. The recovered supernatants were pooled, filtered, and preserved for biochemical, spectroscopic, microscopic, and chromatographic analyses. Field observations were conducted in the Kumbalangi coastal region of Kerala, India, to document naturally occurring marine bioluminescence. Microscopic examination revealed the presence of planktonic organisms belonging to known bioluminescent groups, while hydrographic parameters were analyzed to assess environmental conditions associated with luminescent activity. Preliminary biochemical and spectroscopic investigations indicated stable fluorescence and bioluminescence in the extracted fractions. Liquid Chromatography–High Resolution Mass Spectrometry (LC-HRMS) analysis identified several luciferin derivatives, putative luciferin precursors, oxidized metabolites, and conjugated aromatic compounds within the bioluminescent extracts. These compounds exhibited structural similarities to molecules previously reported in marine bioluminescent systems and may play important roles in light-emitting oxidative reactions. The findings provide preliminary evidence and its highlights the potential of deep-sea organisms as valuable sources of novel compounds for applications in bioimaging, biosensing, and marine biotechnology.

Keywords: *Bioluminescence, Luciferin, Deep-Sea Organisms, LC-HRMS, Marine Biotechnology, Coastal Waters.*

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Abstract ID: TSS/CE/07

ASSESSING THE KEY DRIVERS IN THE SPAWNING AND REARING HABITAT SELECTION OF *Scomberoides tol* IN THE EASTERN ARABIAN SEA DURING THE WINTER MONSOON

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Understanding the early life history and spawning habitats of economically important Carangids is crucial for sustainable fisheries management. The carangid Needle scaled queenfish (*Scomberoides tol*) plays a vital role in Indian marine fishery as a commercially important species with year-round commercial fishery. Hence, this study investigate the spatial distribution and environmental drivers of the eggs and larva of the Needle scaled queenfish (*Scomberoides tol*) along the Eastern Arabian Sea (EAS) during the Winter Monsoon. Ichthyoplankton surveys reveal that the primary spawning grounds are distributed across the coastal-to-offshore regions of the central and southern EAS. While egg distribution was restricted to the southern latitudes, larval distribution was more extensive, dispersing from southern to central EAS. To understand the drivers of this spatial heterogeneity, a Principal Component Analysis (PCA) was employed to evaluate the influence of key environmental variables. The PCA biplot demonstrated distinct ecological preferences for the early life stages. *S. tol* larva exhibited a positive relation with Sea Surface Temperatures (SST) and zooplankton biomass, indicating the important role of zooplankton for larval survival. Conversely, *S. tol* eggs exhibited negative relation with zooplankton biomass. It suggests the adults might not have preferred the high zooplankton biomass region as their spawning ground as many zooplankton are predator of fish eggs and neither the egg can avoid the predator nor they require external food for their survival. Larval dispersal, influenced by swimming behaviour and ocean current, the *S. tol* larva distribution has extended from the southern part to central part of the EAS, where rearing grounds are characterised with high zooplankton These findings suggest that *S. tol* utilizes the central and southern EAS during the winter monsoon, selecting warm, productive waters to maximize reproductive success and larval recruitment.

Keywords: *Scomberoides tol, Ichthyoplankton, Spawning and Rearing habitat, Eastern Arabian Sea, Environmental drivers, Zooplankton biomass, Winter mosoon.*

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Abstract ID: **TSS/CE/08**

ROLE OF ALGINATE IMMOBILIZED MARINE MICROALGAL-BACTERIA CONSORTIA FOR THE BIOREMEDIATION OF AQUACULTURE EFFLUENTS

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The present study deals with the nutrient dynamics and microbial ecology in commercial aquaculture ponds during a crop cycle of *Litopenaeus vannamei*. The high intensity culture was held for 100 days until harvest and ponds were maintained with biosecured zero-water exchange. At regular intervals, the abundance of culturable bacterial (aerobic-anaerobic) groups (heterotrophs, total anaerobes, methane-oxidizers, nitrate-reducers, denitrifiers, sulfur-oxidizers and sulfate reducers) belonging to biogeochemical cycles were enumerated along with various physicochemical parameters. The ammonia, nitrite and nitrate strongly influenced the physiological bacterial groups' abundance. The strong relationship of bacterial groups with phytoplankton biomass and abundance clearly showed the trophic interconnections in nutrient exchange/recycling. The results of the study revealed that the major drivers that interweaved biogeochemical cycles are the three dissolved nitrogen species, which microbially mediated various aerobic-anaerobic assimilation/dissimilation processes in the pond ecosystem. For aquaculture bioremediation, 163 bacteria were isolated and screened with specific activities (denitrification, methane oxidation, sulfur oxidation, phosphate accumulation-solubilization) and phytoplankton species were tested for nutrient assimilation capacity. With the potential of mutualistic existence, three selected bacteria and four microalgal species were tested in various combinations for their nutrient removal efficiency as immobilized microalgal-bacteria consortia. From the present study it has been found that dual microalgal species with the three selected bacteria under immobilized condition (*Chlorella vulgaris* - *Nannochloropsis salina* - *Spingomonas flavimaris* - *Halomonas venusta* - *Pseudomonas aeruginosa*) showed 80% of nitrate and 91% phosphate of removal efficiency. This study suggests the application of such microalgal-bacteria consortia for the sustainable aquaculture.

Keywords: *Bioremediation, Biogeochemical Cycles, Microalgal-Bacteria Consortia, Aquaculture*

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Sub theme 3

Molecular Insights into Aquatic Ecosystem Structure and Function

Abstract ID: TSS/MIAS/01

MOLECULAR INSIGHTS INTO SEAMOUNT BIODIVERSITY IN THE ARABIAN SEA THROUGH eDNA METABARCODING

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Seamounts are volcanic geomorphological features rising at least 1000m above the seafloor, with highly variable geology, nutrient dynamics, and biodiversity shaped by their formation history and regional oceanography. Their unique physical processes support diverse pelagic and benthic communities by providing key feeding grounds, spawning aggregation sites, and refugia. However, biodiversity assessment in deep-sea ecosystems such as seamounts has been constrained by limitations of conventional taxonomic methods, including dependence on intact specimens, limited sample accessibility, time-intensive processing, and insufficient taxonomic expertise. Recent advances in environmental DNA (eDNA) analysis provide a robust alternative, enabling rapid, non-invasive, and highly sensitive detection of organisms from environment samples. In this context, the present study applies eDNA metabarcoding to investigate the overall organismal diversity associated with three seamounts in the Arabian Sea, which are not yet explored. Water and sediment samples were collected aboard the RV Sindhu Sankalp. eDNA was extracted using a commercially available kit with a modified protocol optimized in our laboratory and amplified using cytochrome c oxidase subunit I (COI) gene primers. Amplicons were sequenced on the PromethION 2 Solo platform (Oxford Nanopore Technologies), and taxonomic assignment was performed against the MIDORI GenBank COI database. A total of 1409 and 364 Molecular Operational Taxonomic Units (MOTUs) were detected in water and sediment, respectively. At the phylum level, Arthropoda and Mollusca dominated both environments in relative abundance. These were followed by Cnidaria and Chordata in the water column, and Bacillariophyta and Annelida in sediments. The eDNA approach can be combined with satellite observations, where spatial and temporal environmental variability is captured, to facilitate an integrated assessment of marine ecosystems across local to global scales.

Keywords: *Environmental DNA, Biodiversity, Seamount, Arabian Sea*

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Abstract ID: **TSS/MIAS/02**

COMPUTATIONAL INSIGHTS INTO THE MOLECULAR BASIS OF DINOFLAGELLATE BIOLUMINESCENCE

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Computational Insights into the Molecular Basis of *Dinoflagellate bioluminescence* is one of the most widespread natural light-emitting phenomena in marine environments, yet the molecular origin of its chemiexcitation process remains elusive. Herein, we combine molecular dynamics simulations, time-dependent density functional theory calculations, and electronic-state correlation analyses to elucidate the reactive intermediates and electronic processes underlying light generation. Our results identify a dioxetanolate species as the key high-energy intermediate responsible for chemiexcitation. The decomposition of this four-membered peroxide proceeds through a concerted cycloreversion pathway, converting chemical energy into electronic excitation and generating the emissive biolumiphore. Analysis of the excited-state landscape reveals a favorable coupling between bond cleavage and population of the emissive state, providing a molecular rationale for the high luminescence efficiency of the system. The predicted absorption and emission characteristics are in excellent agreement with available experimental observations, lending strong support to the proposed reaction pathway and the identity of the biolumiphore. Furthermore, characterization of the intermediate and its electronic structure provides insight into the factors governing excited-state formation and radiative decay. Collectively, these findings establish a molecular-level mechanism for dinoflagellate bioluminescence, identify dioxetanolate-mediated chemiexcitation as the origin of light emission, and advance the understanding of peroxide-driven excited-state generation in biological systems.

Keywords: *Dinoflagellate luciferin, Bioluminescence, Dioxetanolate intermediate*

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Abstract ID: TSS/MIAS/03

ASSESSMENT OF FISH DIVERSITY ALONG THE SOUTHWEST COAST OF ARABIAN SEA USING eDNA METABARCODING

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The Arabian Sea, particularly its dynamic southwestern region influenced by intense monsoonal upwelling, harbours a rich yet underexplored diversity of fish, much of which remains hidden beneath the surface of conventional survey methods. Assessments of fish diversity based solely on landing data often fail to reflect the true biodiversity, as they overlook non-commercial, rare, and unobserved species present in the ecosystem. The present study aims to understand the fish diversity along the south west coast of Arabian sea using Environmental DNA (e-DNA) technique. Water samples were collected aboard the FORV Sagar Sampada followed by eDNA filtration and extraction of e-DNA using commercially available kit. The extracted DNA were amplified via polymerase chain reaction (PCR) with fish-specific primers targeting the cytochrome c oxidase subunit I (COI) gene followed by sequencing on the Oxford Nanopore platform. Taxonomic assignment of amplicon sequence variants (ASVs) was performed against the MitoFish mitochondrial genome database. A total of 555 species, representing 400 genera, 178 families, and 49 orders, were identified across the major fish classes Actinopterygii and Chondrichthyes, highlighting a rich and diverse assemblage captured through eDNA signals. Transect-wise comparisons at the genus level further revealed clear differences in diversity patterns across sampling locations, indicating variations in community structure and distribution. Overall, this study demonstrates the effectiveness of eDNA-based approaches in uncovering hidden and comprehensive fish diversity in the Arabian Sea, providing a more inclusive assessment than conventional methods. The findings offer valuable baseline data for biodiversity monitoring, support ecosystem-based management, and contribute to the conservation of marine resources in a region of high ecological and economic importance.

Keywords: *Diversity, e-DNA, fish, Metabarcoding*

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Abstract ID: TSS/MIAS/04

FLOATING VEGETATION AND MULTIPLE ANTIBIOTIC-RESISTANT *Escherichia Coli* AND *Vibrio* SPP. POSING A ONE HEALTH RISK IN VEMBANAD LAKE, SOUTHWEST COAST OF INDIA

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The nuisance caused by invasive floating vegetation, particularly *Eichhornia* sp., to transportation, fishing, recreation, benthic fauna, and the total carbon budget is a major concern worldwide. Vembanad Lake, situated along the southwest coast of India, becomes extensively covered with *Eichhornia* during the rainy season, causing the problems noted above. This study examines the possible role of these invasive floating plants in harbouring multiple antibiotic-resistant *Escherichia coli* and *Vibrio* species, as well as their potential for local transport and subsequent sinking, thereby making the lake a reservoir of antibiotic-resistant *E. coli* and *Vibrio*. Molecular surveillance using quantitative real-time PCR showed that the roots of the floating plants harboured bacterial loads 2–3 orders of magnitude higher than those in the water samples. qPCR analysis detected *E. coli and Vibrio* sp. in all samples collected from Vembanad Lake, suggesting a potential role in pathogen transmission. Antibiotic resistance was widespread, with approximately 80% of *Vibrio* sp. isolates and 66% of *E. coli* isolates resistant to cefalexin. In addition, 61% of *Vibrio* isolates were resistant to tetracycline, and 50% of *E. coli* isolates were resistant to erythromycin. Notably, significant regional variations were observed in the antibiotic resistance profiles of the isolates. The organic-rich root matrices of floating plants provide ideal microhabitats for pathogen colonization and the selection of resistance genes. These findings underscore the critical role of aquatic hydrophytes as biological reservoirs for enteric pathogens and antibiotic-resistant bacteria in tropical lakes. In the context of climate change, eutrophication, and rising antimicrobial resistance, the management of floating plants may represent an important public health intervention to protect water quality and human health in vulnerable tropical aquatic ecosystems.

Keywords: *Hydrophytes, Antibiotic resistance, Pathogenic bacteria, Public Health, Water quality*

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Abstract ID: **TSS/MIAS/05**

INTEGRATING MOLECULAR TOOLS AND GIS-BASED HOTSPOT ANALYSIS TO UNDERSTAND MARINE MAMMAL STRANDINGS ALONG THE INDIAN COAST

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Marine mammals play a crucial role in the health and function of marine ecosystems as apex predators and sentinel species. The threats to marine mammal populations have grown as a result of increased anthropogenic pressures such as fisheries interactions, vessel traffic, habitat degradation, marine pollution and climate-induced environmental changes, including strandings. The research was conducted on the west coast of India, across the states of Gujarat, Maharashtra, Goa, Karnataka, and Kerala, to understand the spatial and temporal distribution of marine mammal strandings between 2023 and 2025. Stranding information was gathered through primary field surveys, community-based reporting networks, and secondary surveys (scientific literature, media records, and national databases). Species identification was done based on morphology and validated by molecular methods (not in all cases) using mitochondrial COI gene sequencing. Geospatial information was combined with validated records to explore spatial patterns and define stranding hotspots in the data through Geographic Information System (GIS) software. During the study period, a total of 349 marine mammal stranding records were reported across 19 species, 13 genera, and 5 families. The most common species stranded were the Indian Ocean humpback dolphin (*Sousa plumbea*, ~42%) and the Indo-Pacific finless porpoise (*Neophocaena phocaenoides*, ~34%). The number of stranding incidents increased from 2023 to 2025, peaking in 2025, while Goa had the highest number of stranding records. The molecular identification of species and the incorporation of records with GIS-based spatial analysis enabled the identification of stranding hotspots and enhanced the reliability of distributional assessment. The results highlight that, overall, integrated stranding surveillance, molecular taxonomy and GIS-based spatial analyses are increasingly important approaches for marine mammal conservation in India.

Keywords: *GIS, Hotspots, India, Marine mammals, Molecular analysis, Stranding*

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Abstract ID: TSS/MIAS/06

FROM MORPHOLOGY TO METABARCODING: A SYSTEMATIC REVIEW OF GLOBAL ICHTHYOPLANKTON PROGRESS

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Ichthyoplankton research, focusing on fish eggs and larvae, is essential for understanding marine ecosystem health, fish recruitment, and fisheries sustainability. Early studies mainly described morphology, while later work examined how oceanographic factors such as temperature, salinity, and circulation affect larval distribution and survival. However, species identification remains difficult because many eggs and larvae share similar developmental features and diagnostic characters are often lost during collection or preservation. This creates an identification gap in traditional morphological studies. Recent molecular methods, especially DNA barcoding and metabarcoding, have improved taxonomic resolution and allow more accurate identification of multiple species from plankton samples. Despite these advances, research remains uneven across regions, with many developing areas still poorly studied. Climate change is further altering ocean conditions and shifting breeding timing, distribution, and recruitment success. Therefore, an integrated approach combining morphology, molecular tools, and oceanographic modelling is needed to improve understanding of early fish life stages and support sustainable fisheries management

Keywords: *Ichthyoplankton, DNA Barcoding, Phenology, Ecosystem based fishery management, Climate change*

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Abstract ID: TSS/MIAS/07

MOLECULAR CHARACTERIZATION AND PATHOGENICITY ASSESSMENT OF BACTERIA CAUSING INFECTIOUS DISEASES IN CAGE-FARMED FISH IN THE LAKE VICTORIA

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Despite government initiatives in East African countries promoting cage fish farming to compensate for income losses from declining capture fisheries, disease-related mortalities have become a major challenge, causing significant economic losses for farmers. Therefore, this study aimed to identify and characterize the etiological agents responsible for infectious diseases in cage-farmed fish in Lake Victoria, Tanzania. Fish samples were collected from six districts in the Lake Victoria Basin (LVB), which are known for their extensive cage fish farming operations. Eighty-one fish cage samples were cultured, tested biochemically, and 16S rRNA genes sequenced for identification. Three pathogenic bacteria namely *Citrobacter freundii, Pseudomonas aeruginosa*, and *Streptococcus agalactiae* were isolated and identified. Pathogenicity trials demonstrated that *P. aeruginosa* exhibited the highest mortality rate (86.7%), followed by *C. freundii* (66.7%) and *S. agalactiae* (40%). The phylogenetic analysis clustered pathogens of the same species together regardless of their geographical origins, suggesting a common source of infections. The study calls for harmonized efforts to enhance disease control strategies and reduce the impact on aquaculture operations, as farmers likely deal with the same bacterial strains.

Keywords: *Cage Fish Farming, Pathogenic bacteria, Fish Diseases, Lake Victoria Basin*

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Abstract ID: **TSS/MIAS/08**

GUT CONTENT ANALYSIS OF THE FISH SPECIES FROM SITAKUNDA COAST, BANGLADESH

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The coastal waters of Sitakunda provide an important habitat for various marine and estuarine fish species and serve as a productive fishing ground. However coastal environments and feeding ecology are affected by human activities such as shipbreaking, industrial waste and coastal pollution. This study aimed to identify fish species examine their gut contents and analyze the feeding patterns. Fish samples were collected from 20 stations over a four-month period with the help of local fishermen. A total of 27 fish species were identified, and their morphometric measurements including total length, standard length, fork length, and body weight were recorded. Gut content analysis used frequency of occurrence, numerical percentage, volumetric percentage, and Index of Relative Importance (IRI%), while feeding intensity and feeding patterns were assessed through gut fullness, GASI, and Amundsen plot analysis. The findings showed that fish size, feeding intensity, and diet varied significantly among species. Consistent growth patterns were shown by a high positive relationship between length and weight ($R^2 = 0.852$). Crustaceans, mostly *Acetes* sp. were dominant, followed by zooplankton, indicating their carnivorous and opportunistic eating behavior. Other food items like mollusks, fish remains, phytoplankton, plant debris, and polychaetes were also identified. The detection of microfibers among fifteen species indicates human influence. The information on feeding ecology and environmental conditions can provide valuable information to conserve biodiversity and secure sustainable fisheries management.

Keywords: *Gut Content Analysis, Feeding Behaviour, Fish Diversity, Sitakunda Coast, Coastal Pollution, Morphometric Analysis, Microfiber Contamination, Sustainable Fisheries Management*

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Abstract ID: **TSS/MIAS/09**

VERTICAL SEGREGATION OF MICROBIAL COMMUNITIES ALONG THE REDOX GRADIENT OF THE OXYGEN MINIMUM ZONE OFF CENTRAL CHILE (2021–2024)

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Oxygen gradients are among the main selective forces shaping marine microbial community structure (i.e., diversity and abundance), particularly within Oxygen Minimum Zones (OMZs) worldwide. To assess the influence of physicochemical variability on microbial communities, water column samples were collected over three years along the redox gradient associated with the OMZ at the COSMOS time-series station off Coquimbo, central Chile, a semi-permanent upwelling center characterized by intense wind forcing. Microbial communities were characterized using 16S rRNA gene sequencing together with physical (temperature, salinity, depth, and oxygen), chemical (inorganic nutrients and greenhouse gases), and biological (chlorophyll-a and bacterial abundance) variables. Results revealed strong vertical stratification of microbial communities, mainly driven by oxygen availability and depth-related nutrient gradients. Surface communities were associated with warmer, oxygen-rich, chlorophyll-enriched waters, whereas communities at the upper boundary and core of the OMZ were linked to elevated nitrate, phosphate, silicate, and CO_2 concentrations and low oxygen levels. The oxycline acted as a transitional zone with the highest alpha diversity, harboring both generalist and specialist taxa. Surface waters exhibited the greatest order-level diversity and unique indicator taxa, while deeper layers were dominated by specialized groups adapted to hypoxic conditions. Despite seasonal upwelling variability, the marked vertical stratification remained relatively stable over time, likely reflecting the persistence of a well-defined OMZ during a negative Pacific Decadal Oscillation phase combined with successive La Niña events. These findings highlight the role of oxygen and nutrient gradients in structuring microbial communities and underscore the ecological importance of OMZs in shaping metabolic niches and biogeochemical cycling in the Eastern South Pacific.

Keywords: *Microbial Community, Oxygen Minimum Zones, COSMOS time-series station, Redox gradient, Pacific Decadal Oscillation*

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Abstract ID: **TSS/MIAS/10**

MAPPING UAE MARINE BIODIVERSITY: GENOMIC HORIZONS, METADATA INTEGRITY AND BIOBANKING STRATEGIES

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The Arabian Gulf and adjacent Gulf of Oman together constitute one of the most ecologically significant critical yet underrepresented marine regions in the world. Despite hosting globally important tropical marine biomes. Characterized by hyper-salinity, extreme seasonal sea surface temperatures, and acute hypoxia, these waters host evolutionary distinct populations of dugongs, sea turtles, pearl oysters, brain corals, and commercially critical fish species, marine megafauna, biogenic reef builders, and endemic invertebrates. Despite their physiological significance as natural laboratories for ocean warming, systematic genomic characterization of United Arab Emirates (UAE) marine biodiversity remains limited across international databases repositories. This study presents a systematic, record-by-record database analysis of gaps in the representation of UAE marine species across the National Center for Biotechnology Information (NCBI) GenBank, Sequence Read Archive (SRA), Bio Sample, and Barcode of Life Data Systems (BOLD). Our analysis identified a four-tier classification of evaluating genomic representation: Fully Represented, Partially Represented, Data Exists but Unusable. Of 26 global reference genome assemblies examined across all taxa evaluated for representative regional species, only one the grey mangrove *Avicennia marina* (GCA_013168755.1) was confirmed as derived from a UAE-origin specimen. For nine of the ten taxonomic groups examined, UAE populations contribute no assembly-grade nuclear reference genomes to international databases. Analysis of short-fragment barcode data (e.g., COI, 16S, and rbcL) revealed a previously undescribed category of data gap, characterized by severe data stratification. These findings highlight the need to bridge the gap between the UAE's ecological significance and its genomic invisibility, providing a strong rationale for the establishment of a UAE Marine Biobank.

Keywords: *Arabian Gulf, Biobanking, UAE, Marine Genomics, Biorepository*

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Abstract ID: **TSS/MIAS/11**

REGIONAL ENDEMISM AND ENVIRONMENTAL STRUCTURING OF VIRAL COMMUNITIES ACROSS THE INDIAN OCEAN SEDIMENT VIROSPHERE

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Marine sediment viromes harbour extensive genetic novelty, yet the factors shaping their biogeographic distribution remain poorly understood. This study compares sediment-associated viral communities across three Indian Ocean provinces: the Arabian Sea, Bay of Bengal, and Central Indian Ocean. Using a common bioinformatic framework, 7,767 viral operational taxonomic units (vOTUs) were recovered from 28 samples spanning 0-5,200 m. Viral communities exhibited pronounced regional differentiation, with only 46 vOTUs (0.7%) shared across all three provinces, while 96.2% were region-specific. Community composition was significantly associated with regional identity, although strong collinearity between region and depth complicated the separation of geographic and environmental effects. A depth-controlled comparison between AS and BoB confirmed that regional differences persisted at comparable depths. Despite extensive regional separation, a small shared viral core was identified, with higher prevalence and relative abundance than region-specific lineages. Functional analyses revealed regional variation in viral replication strategies, including elevated predicted lysogeny in the abyssal CIO. Auxiliary metabolic gene profiles also differed, particularly in energy metabolism-associated functions in BoB. Comparisons with viral reference databases further indicated substantial unexplored genomic diversity across all three provinces. These findings reveal strong regional differentiation, a limited shared viral core, and distinct ecological and functional signatures across Indian Ocean sediment viromes. This comparative framework advances understanding of marine viral biogeography and highlights the value of regionally resolved datasets for investigating deep-sea microbial ecosystem functioning.

Keywords: *Indian Ocean, Viral Biogeography, Marine Sediments, Metagenomics, Regional Endemism, Viral Ecology*

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Abstract ID: TSS/MIAS/12

ELUCIDATING THE IMMUNOMODULATORY POTENTIAL OF EXOPOLYSACCHARIDES (EPS) DERIVED FROM *Brachybacterium* Species FOR SUSTAINABLE AQUACULTURE

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The aquaculture sector faces increasing threats from climate-related stress, recurrent disease outbreaks, and mounting antimicrobial resistance (AMR) that endanger fisheries and aquatic ecosystems. Such threats underline the need for safe and sustainable alternatives to traditional chemicals and antibiotics. Marine microorganisms associated with aquatic organisms like corals; deep-sea animals are a potential yet underexplored source of bioactive compounds with applications in aquatic animal health under the One Health framework. This study explores the exopolysaccharides (EPS) produced by *Brachybacterium* sp. isolated from Arabian Sea as potential immunostimulant and antioxidant for aquaculture.

Bacterial isolates were obtained from the CSIR-NIO Regional Centre, Cochin, as part of the MoES-TEDS Deep Ocean Mission project. Of 35 isolates screened in a toxicity assay using *Artemia salina*, highest survival of *Artemia* was demonstrated when exposed to two *Brachybacterium* strains (MMRF 2105 and MMRF 2049) and they were further screened for EPS production. EPS was extracted from culture supernatants via ethanol precipitation and characterized using FTIR spectroscopy. The spectra indicated the presence of hydroxyl, carboxyl, and glycosidic groups typical of polysaccharide structures. *Artemia* nauplii treated with EPS were challenged with *E. coli* for 96 hrs. The survival improved in a dose-dependent manner, and prophenoloxidase activity increased significantly at higher EPS concentrations, suggesting the EPS activates innate immune defence mechanisms.

Ongoing studies are evaluating the immunomodulatory effects in *Penaeus monodon* and *Danio rerio* to assess the feasibility of using EPS as a shrimp and fish feed additive for stimulation of host immune defenses. Overall, these findings identify marine *Brachybacterium* sp. as a promising natural immunostimulant for aquaculture applications. The results are consistent with the One Health framework in providing a sustainable alternative to the regular antibiotics and chemicals, for improving the aquatic health, protecting marine biodiversity and preventing the spread of antimicrobial resistance

Keywords: *One Health, Sustainable Aquaculture, Exopolysaccharides (EPS), Brachybacterium Sp., Immunomodulation, Antimicrobial Resistance*

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Sub theme 4

Satellite-Based Remote Sensing and Acoustic Methods as Complementary Tools to Observe Ocean Ecosystems

Abstract ID: TSS/ARSCF/01

THERMAL FRONT VARIABILITY AND ITS INFLUENCE ON MARINE FISHERIES IN THE NORTH EAST ARABIAN SEA

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Global climate change affects oceanographic features and environmental conditions, thereby influencing marine fisheries. A front is a narrow gradient zone of water between two distinct water masses differing in properties such as temperature, nutrients, and density. Ocean fronts enhance nutrient availability and primary productivity, serving as preferred habitats for marine organisms and playing a significant role in fish aggregation. This study investigates the spatial and temporal variability of thermal fronts in the North East Arabian Sea (NEAS) and their relationship with fish production. Thermal fronts were identified using Aqua MODIS 8-day composite sea surface temperature (SST) data for the period 2010–2022. Frontal occurrence and intensity were analyzed to understand long-term changes in frontal dynamics. Hotspot analysis was performed to identify persistent frontal regions and delineate areas of recurrent frontal activity within the NEAS. A correlation was observed between hotspot and fisheries production data. The findings will improve understanding of oceanographic variability and fisheries dynamics and provide scientific support for ecosystem-based and sustainable fisheries management in the NEAS.

Keywords: *Thermal fronts, Remote Sensing, Hotspot Analysis, Marine Fisheries, Annual Variability*

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Abstract ID: TSS/ARSCF/02

COMPARATIVE PERFORMANCE OF STATISTICAL AND MACHINE LEARNING MODELS FOR PREDICTING INDIAN SQUID (*Uroteuthis duvaucelii*) ABUNDANCE FROM SATELLITE-DERIVED OCEANOGRAPHIC VARIABLES IN THE EASTERN ARABIAN SEA, INDIA

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Understanding the environmental determinants of squid distribution is critical for ecosystem-based fisheries management and habitat forecasting. This study evaluated the performance of statistical and machine-learning approaches for predicting catch per unit effort (CPUE) of Indian squid along the Maharashtra coast, eastern Arabian Sea. Geo-referenced trawl observations were integrated with satellite-derived environmental variables including sea surface temperature (SST), chlorophyll-a concentration (Chl-a), sea surface height (SSH), salinity, diffuse attenuation coefficient at 490 nm (Kd490), ocean current velocity, wind speed, depth, and temporal information. Five modelling approaches were compared, including Multiple Linear Regression (MLR), Gamma Generalized Linear Model (GLM), Generalized Additive Model (GAM), Random Forest (RF), and Gradient Boosting Machine (GBM). Model performance was evaluated using independent test datasets and quantified through coefficient of determination (R^2), root mean square error (RMSE), and mean absolute error (MAE). Machine-learning approaches substantially outperformed traditional statistical models. Random Forest achieved the highest predictive performance (R^2 = 0.855, RMSE = 0.523), followed by GBM (R^2 = 0.798, RMSE = 0.587). Among statistical approaches, GAM provided superior performance (R^2 = 0.727) and explained 82.4% of model deviance. Variable importance analysis identified seasonality, spatial location, Kd490, and SSH as dominant predictors of squid abundance. The results demonstrate that squid distribution in the eastern Arabian Sea is governed by nonlinear environmental processes and strong seasonal dynamics. While Random Forest provides the highest forecasting accuracy, GAM offers superior ecological interpretability and is recommended for management applications.

Keywords: *Indian squid, Habitat suitability, GAM, Random Forest, Remote Sensing, Arabian Sea*

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Abstract ID: **TSS/ARSCF/03**

LAKSHADWEEP REEFS IN A WARMING SEA: TWO DECADES OF SATELLITE EVIDENCE

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India's Lakshadweep Archipelago - the Arabian Sea's only true atoll complex supports one of the region's most ecologically significant coral reef systems. Accelerating climate stressors, particularly sea level rise and ocean warming, are increasingly threatening reef survival. This study quantifies these compound threats using 20 years of satellite observations and explores their implications for reef resilience and early warning systems. We analysed monthly sea level anomaly (SLA) data from CMEMS satellite altimetry alongside NOAA Coral Reef Watch SST and Degree Heating Week (DHW) records across the Lakshadweep region (2005–2025), using standard trend detection and correlation methods including Mann–Kendall testing and Sen's slope estimation. Sea levels rose at 3.8 ± 0.6 mm/year, accelerating from 3.2 to 4.3 mm/year across the two decades, with a cumulative rise of ~76 mm. Concurrent SST warming of 0.21°C/decade has steadily eroded the coral thermal safety margin, effectively eliminating it by 2024. Severe bleaching-level heat stress occurred in 2010, 2016, and 2024, with the 2024 event reaching near-record intensity despite weak El Niño conditions, reflecting a clear shifting-baseline effect. Importantly, SLA anomalies showed significant correlation with subsequent heat stress, peaking at a +2-month lag, identifying sea level as a practical early warning indicator for bleaching events. With bleaching recurrence now at 6 - 8 years and approaching reef recovery timescales, these findings highlight the urgent need to integrate satellite-based monitoring into national coral reef adaptation and management strategies.

Keywords: *Coral Reef Bleaching, Sea Level Rise, Thermal Stress, Satellite Remote Sensing, Climate Adaptation*

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Abstract ID: TSS/ARSCF/04

FROM LANDING CENTRES TO FISHING GROUNDS: INTEGRATING GRID-BASED CATCH SAMPLING WITH SATELLITE OCEANOGRAPHIC OBSERVATIONS FOR DATA-SCIENCE-DRIVEN STOCK EXPLOITATION ASSESSMENT

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India's marine fish catch monitoring system has traditionally collected data at landing centres, the harbours where boats return with their catch. This gives a good national picture but misses information about the actual fishing grounds, since fish are caught in one place but counted in another. A newer approach fixes this by recording each trip to the specific 1° × 1° grid square where fishing happened. In 2024, this grid-based system covered 3,135 grid-month combinations across 11 coastal states, the most detailed fisheries dataset for Indian waters. However, 40% of grids had too few recorded trips for reliable numbers, causing huge swings in catch-per-effort estimates, especially in some Tamil Nadu and Karnataka grids. Satellite data can help fill these gaps. Combining fishing data with satellite measurements of ocean conditions, such as chlorophyll levels, sea temperature, productivity, and water layer depth, helps explain why catch rates vary so much by place and month. For example, shallow water layers during monsoon push fish closer to the surface, making them easier to catch even when the actual population hasn't changed. Various data analysis methods are compared, from traditional statistical models to machine learning techniques like XGBoost. A combined approach is recommended: one method for standardizing catch data, another for estimating safe fishing limits, a simpler method for species with limited data, and machine learning to flag patterns signalling overfishing or changing ocean conditions. A step-by-step plan for 2026-2029 outlines how to build this system, from collecting satellite data to creating a live dashboard that helps guide decisions like seasonal fishing bans.

Keywords: *Grid-Based Catch Sampling, Satellite Oceanography, Chlorophyll-a, Sea Surface Temperature, Net Primary Productivity, Stock Assessment, Fisheries Data Science, Indian EEZ*

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Abstract ID: TSS/ARSCF/05

SPATIAL AND TEMPORAL VARIABILITY OF NUTRIENTS AND CHLOROPHYLL-a IN RELATION TO COASTAL MARINE PRODUCTIVITY ALONG THE GUJARAT COAST, INDIA

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The present study analyzed the temporal and spatial variability of environmental parameters and their influence on chlorophyll-a concentration using multivariate statistical techniques. Physicochemical variables, including temperature, salinity, dissolved oxygen, pH, nitrate, phosphate, silicate, and chlorophyll-a were subjected to Principal Component Analysis (PCA), correlation analysis, and seasonal trend evaluation. PCA results showed that the first two principal components explained approximately 52–60% of the total environmental variability, with PC1 dominated by nutrient variables (nitrate, phosphate, and silicate) and chlorophyll-a, while PC2 was associated with temperature and dissolved oxygen variability. Correlation analysis revealed strong positive relationships between nitrate and phosphate ($r \approx 0.72$), silicate and chlorophyll-a ($r \approx 0.64$), and a moderate positive association between nitrate and chlorophyll-a ($r \approx 0.58$). Temperature exhibited a negative correlation with dissolved oxygen ($r \approx -0.69$), indicating thermal regulation of oxygen availability. Seasonal analysis demonstrated elevated nutrient concentrations and chlorophyll-a values during monsoon and post-monsoon periods, with chlorophyll-a showing an increase of nearly 30–40% during nutrient enrichment phases. Spatial variability indicated that coastal stations exhibited relatively higher nutrient concentrations and chlorophyll-a levels compared to offshore waters, reflecting enhanced biological productivity in nearshore regions. Nutrient-rich waters consistently supported higher chlorophyll-a concentrations, indicating active phytoplankton growth and productive marine habitats. The study confirms that nutrient availability acts as the primary bottom-up driver of chlorophyll variability, while temperature and salinity regulate ecosystem structure and productivity.

Keywords: *Nutrients, Primary Productivity, PCA, Northeastern Arabian Sea*

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Abstract ID: TSS/ARSCF/06

INFLUENCE OF THE INDIAN OCEAN DIPOLE ON PHYTOPLANKTON BIOMASS IN THE SOUTHWESTERN BAY OF BENGAL

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The SWBoB, encompassing the seasonally occuring SLD, is one of the most biologically productive regions of the BoB during the summer monsoon. During this period, southwesterly winds generate positive wind stress curl and associated Ep, facilitating upwelling of nutrient-rich waters into the euphotic zone and enhancing phytoplankton growth, as evidenced by elevated SChl concentrations. The eastward SMC, from south of Sri Lanka into the BoB, contributes to regional productivity by advecting nutrient-enriched waters along its pathway. Despite its high biological productivity, SWBoB exhibits substantial interannual variability driven by large-scale climate modes. Using a 26-year record of merged satellite observations and model-derived NPP estimates, this study investigates interannual variability of SChl, phytoplankton biomass, and NPP in SWBoB. Partial regression analyses reveal that IOD exerts a stronger influence on regional productivity than ENSO. nIODs are characterized by intensified southwesterly monsoon winds, enhanced wind stress curl, and stronger Ep, which increase the entrainment of nutrient-rich waters into the euphotic layer, leading to elevated SChl concentrations, phytoplankton biomass, and NPP. Conversely, pIODs weaken upwelling and nutrient supply, resulting in reduced biological productivity. The analysis also reveals significant shifts in phytoplankton community structure, with nIOD phases favoring larger micro and nanophytoplankton, whereas pIOD phases are associated with an increased dominance of picophytoplankton. Such changes in phytoplankton size composition have important implications for carbon export efficiency and trophic energy transfer within the marine food web. Overall, these findings highlight the critical role of IOD-driven ocean–atmosphere interactions in regulating ecosystem dynamics in the SWBoB and demonstrate the value of satellite remote sensing and model-derived products for monitoring climate-induced variability in the BoB.

Keywords: *South West Bay of Bengal (SWBoB), Sri Lanka Dome (SLD); Ekman Pumping (EP), Surface Chlorophyll (SChl), Southwest Monsoon Current (SMC), Net Primary Productivity (NPP), Indian Ocean Dipole (IOD, negative IOD -nIOD, positive IOD- pIOD)*

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Abstract ID: TSS/ARSCF/07

DECADAL CHANGE IN MANGROVE COVER OF KERALA USING SENTINEL-2 DATA

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Mangrove ecosystems are known to be one of the most productive ecosystems, serving as nurseries for many fish species and a barrier against natural disasters like sea surges, cyclones, etc. It is renowned for its ability to sequester carbon and is one of the biggest hotspots of biodiversity in the world. Despite their significance, 90% of the mangroves in Kerala were lost, being reduced from 70 km² to 9.45 km² in 5 decades (1975-2023) due to development, aquaculture, and changed coastal land-use patterns. Thus, it is crucial to regularly assess and monitor the mangrove cover. The study aimed to map and monitor mangrove cover changes along the coastal districts of Kerala, India, using remote sensing techniques and GIS. Open-access, high-resolution Sentinel-2 MSI data from 2017 and 2026 were obtained and processed using the Sentinel Application Platform (SNAP) and Quantum GIS 3.40. Images were classified using two approaches: Random Forest (RF) supervised classification of the Sentinel-2 MSI bands and the bands in combination with spectral indices. The classification accuracy was assessed through field visits. The Google Earth Pro historical imagery and Google Street View were also used to assess the field condition. The results indicated an overall rise in mangrove cover over the decade. Compared to the bands-only classification approach, classification of the bands in combination with spectral indices showed highest overall accuracy (>90%). The pixel-based classification of the satellite bands, along with spectral indices, offers a better option in separating the mangroves from other vegetation with improved results and can help to assess, monitor, and conserve the mangrove stands of Kerala.

Keywords: *Mangrove, Change Analysis, Remote Sensing, Sentinel 2, Spectral Indices*

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Abstract ID: **TSS/ARSCF/08**

USE OF HYPERSPECTRAL AND MULTISPECTRAL SENSORS AS AN INDICATOR OF PRIMARY PRODUCTIVITY

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This study aimed at determining the relationship of multispectral and hyperspectral sensors and the primary productivity in the near coast area of different locations, namely Juhu, Mahim, Khar Danda, Manori, and Thane, which are located in the busy metropolitan city Mumbai in India. The evaluation of the different nutrients was consequently considered. Water samples were collected during both the dry and rainy seasons with twenty-one sampling points in different months. Parameters indicating water quality and nutrients were based on the APHA method. *In-situ* measurements focused on chlorophyll-a and key nutrients such as nitrate, nitrite, ammonia, phosphate, and silicate and their correlation with Sentinel-2A satellite and PRISMA satellite bands was examined. Chlorophyll-a has been used as a proxy parameter for trophic status estimation due to its strong association with water quality and also considering its optical characteristics in the remote sensing perspective. Chlorophyll-a ranged between 5.812 µg/L to 0.340 µg/L. The Sentinel 2 platform offers greatly improved spatial resolution over other satellite platforms designed for water-based chlorophyll-a retrievals and includes a "red-edge" band at 704 nm. The results showed a significant difference. The Pearson correlation with Chlorophyll-a with the band 5 / 6 / 7 (Red-edge bands) was weak and not strong in the dataset. While, in PRISMA, Chlorophyll-a ($r = 0.77$), strong positive correlation with reflectance at 934 nm. The findings of satellite reflectance demonstrate a good potential of integrating satellite imagery for nutrient monitoring in coastal waters, though the limited sample size restricted the statistical significance of the correlations and suggests the need for further study.

Keywords: *Hyperspectral, Multispectral, Chlorophyll-a, Nutrients*

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DISENTANGLING ENVIRONMENT-ASSOCIATED PREY SHIFTS AND FISHING PRESSURE IN BOMBAYDUCK FISHERIES

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Bombayduck fisheries are influenced by both environmental change and fishing pressure, acting partly through shifts in prey availability. This study applies a dynamic prey-mediated modelling approach to examine how environmental variability, prey-field change, and fishing effort jointly influence Bombayduck catch-per-unit-effort. The model links environmental conditions to the abundance of two major prey groups, *Coilia* and *Acetes,* and then relates prey availability to Bombayduck CPUE using a time-varying effective-prey index. This allows Bombayduck dependence on *Coilia* and *Acetes* to shift gradually through time rather than assuming a fixed prey relationship. Environmental variables such as salinity, mixed layer depth, sea surface temperature, bottom temperature, and sea surface height are reduced into major environmental gradients using principal component analysis. Bombayduck CPUE is then modelled using effective prey availability, environmental state, lagged CPUE, temporal trend, and lagged fishing effort as an indicator of fishing pressure. The outputs identify how environmental change is associated with changing prey suitability, estimate annual shifts in Bombayduck prey dependence, and assess whether fishing pressure explains additional variation beyond environmental and prey-mediated effects. Overall, the framework shows how prey replacement, environmental forcing, and exploitation pressure may interact to shape Bombayduck fishery dynamics. It provides a practical approach for environment-focused fisheries assessment where long-term catch, effort, prey, and environmental data are available, but direct diet information is limited.

Keywords: *Acetes, Bombayduck, Northeastern Arabian Sea, Prey, Dynamic Model*

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Abstract ID: TSS/ARSCF/10

TRACKING ALGAL BLOOM PROPAGATION USING INTEGRATED REMOTE SENSING AND PARTICLE TRACKING APPROACHES

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Algal blooms are a growing concern in many marine and coastal regions, affecting ecosystems, fisheries, and water quality. Timely tracking and prediction of bloom propagation are therefore essential to provide early warnings to aquaculture and coastal stakeholders. This study explores integrating satellite remote sensing and particle-tracking models to understand the spatio-temporal evolution of algal blooms. Remote sensing provides synoptic, repeat observations that enable bloom detection, spatial extent, and temporal variability using ocean colour products such as chlorophyll-a and related indices. These observations serve as initial conditions for the model, allowing particles to be seeded at the locations where high biomass is detected, and also help validate particle-tracking simulations. Lagrangian particle-tracking techniques are used to simulate bloom transport, where bloom patches are represented as discrete passive particles whose trajectories are governed by ocean circulation fields, including advection by currents, turbulent diffusion, and ocean surface winds. By coupling these models with remote-sensing-derived bloom locations, it becomes possible to predict bloom propagation patterns and assess downstream impacts. The framework can be further improved by incorporating biological processes such as growth, decay, and nutrient interactions alongside physical transport. Such coupling would enhance predictive accuracy and provide a more realistic representation of bloom evolution in coastal and open-ocean environments. This integrated approach provides a reliable framework for monitoring and forecasting algal bloom propagation, supporting informed ecological assessment and marine resource management in dynamic coastal environments.

Keywords: *Algal Blooms, Remote Sensing, Bloom Indices, Particle-Tracking, Ocean Colour*

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Abstract ID: TSS/ARSCF/11

SPATIAL DISTRIBUTION AND FUTURE HABITAT SUITABILITY OF YELLOWFIN TUNA (*Thunnus albacares*) IN THE INDIAN OCEAN UNDER CHANGING ENVIRONMENTAL CONDITIONS: A MAXENT MODELLING APPROACH

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Climate change is expected to influence the distribution and habitat dynamics of many marine species, including yellowfin tuna (*Thunnus albacares*). This study aims to predict the potential distribution of yellowfin tuna across the Indian Ocean and identify the major environmental factors influencing habitat suitability. A total of 3,330 occurrence records from OBIS, GBIF, and CMFRI spanning 1993–2025 were integrated with oceanographic environmental datasets. Since yellowfin tuna are strongly associated with subsurface waters near the thermocline, most environmental variables were analysed at approximately 100 m depth. These variables included subsurface temperature, salinity, dissolved oxygen, ocean currents speed, net primary productivity, mixed layer depth (MLD), sea surface height and eddy kinetic energy (EKE), which collectively influence the tuna distribution, movement, and feeding behaviour in the Indian Ocean. The potential distribution of Yellowfin Tuna was modelled using the Maximum Entropy (MaxEnt) approach based on presence-only data. The model captured the complex non-linear relationships between tuna occurrence and environmental variables while assessing temporal changes in habitat suitability. Model performance was evaluated using temporally blocked cross-validation to reduce spatial and temporal autocorrelation effects. Among multiple iterations, the final model was selected based on an Area Under the Curve (AUC) value greater than 0.8, indicating good predictive performance. The results identified current speed, sea surface height and net primary productivity as the most important drivers of yellowfin tuna distribution. Habitat suitability maps revealed consistently favourable regions in the western-central Indian Ocean and the hotspots associated with strong eddies.

Keywords: *Yellowfin Tuna, Maxent, Habitat Suitability, Environmental Layers, Indian Ocean, Climate Change, Species Distribution Modelling*

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Abstract ID: TSS/ARSCF/12

TEMPORAL DYNAMICS OF MEAN TEMPERATURE OF THE CATCH IN GUJARAT MARINE FISHERIES ALONG THE NORTHWESTERN INDIAN COAST

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Mean Temperature of the Catch (MTC) has emerged as an important ecological indicator for understanding long-term responses of marine fishery resources to climate variability, fishing expansion and ecosystem restructuring. MTC reflects the average thermal affinity of exploited species weighted by their contribution to fishery landings, thereby providing insights into shifts in species composition, habitat utilization and fishing patterns under changing environmental conditions. The present study evaluated temporal changes in the MTC of major marine fishery resources landed along the Gujarat coast during 1985–2019 using long-term catch statistics and species-specific preferred temperature estimates. Resource groups including pelagic fishes, demersal fishes, crustaceans and molluscs were examined separately to evaluate contrasting thermal responses among ecological guilds. Species-specific temperature preferences were compiled from published literature and global thermal affinity databases and integrated with annual catch composition data to estimate yearly MTC values. Temporal trends in MTC were analyzed to assess long-term changes in the thermal structure of Gujarat marine fisheries and their possible linkage with changing fishing practices, hydrographic variability and expansion of fishing operations across spatial and depth gradients. The methodological framework emphasizes ecosystem-level interpretation of fishery landings by integrating species thermal preferences with time-series catch composition, thereby providing a climate-sensitive perspective of marine resource utilization. The study highlights the utility of MTC as a simple but powerful ecological indicator for evaluating fisheries responses to environmental variability, changing resource availability and fishery expansion in tropical marine ecosystems. The framework can support ecosystem-based fisheries management and climate-resilient fishery assessment approaches in the northern Indian Ocean region.

Keywords: *Northeastern Arabian Sea, Tropicalization, Marine Fisheries, Ecosystem Effect*

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Abstract ID: **TSS/ARSCF/13**

MAPPING OF GHOST FISHING GEAR HOTSPOTS ALONG MAHARASHTRA COAST, INDIA

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Abandoned, Lost, or otherwise Discarded Fishing Gear (ALDFG), commonly known as "ghost nets", constitutes a significant portion of marine debris, adversely impacting biodiversity, habitats, and fisheries-based livelihoods. Along the Maharashtra coast (877.97 km), intense fishing activity and dynamic oceanographic processes drive persistent ALDFG accumulation, necessitating proactive, data-driven management. This study developed a GIS-based predictive framework to map ghost fishing hotspots by integrating citizen science, spatial analysis, and remote sensing. Data were collected from August 2025 to March 2026 along the coastal districts of Maharashtra: Mumbai, Raigad, Palghar, Sindhudurg, and Ratnagiri. Fisher-reported GPS coordinates and coastal observations were analysed using Kernel density estimation (KDE) and spatial cluster analysis ($p < 0.05$). By synthesising satellite-derived bathymetry and ocean current dynamics with fishing effort data, the model generates a composite risk surface identifying debris convergence zones. Validation confirms high reliability in identifying hotspots where intense fishing intersects with oceanographic drift. This approach provides a scalable, remote-sensing-integrated pathway for marine debris management in tropical coastal systems, supporting sustainable fisheries and a cleaner Arabian Sea. By synthesising oceanographic data with fisheries activity, this approach provides a scalable pathway for marine debris management in tropical coastal systems. This framework serves as a vital decision-support tool for targeted retrieval and resilient coastal governance in a global context.

Keywords: *Ghost Nets, Marine Debris, Citizen Science, Predictive Framework, Kernel Density Estimation*

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Abstract ID: TSS/ARSCF/14

MONITORING AND PREDICTION OF OCEAN PRODUCTIVITY IN THE ARABIAN SEA USING LONG-TERM SATELLITE REMOTE SENSING AND OCEANOGRAPHIC DATA

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The Arabian Sea is one of the most productive ecosystems in the tropical Indian Ocean facing rapid oceanographic transformations (viz., rapid ocean warming, extreme positive Indian Ocean Dipole (IOD) events, inhibition of nutrient mixing from deeper, cooler layers). These changes have contributed to significant decrease in primary productivity, with cascading effects on oxygen minimum zones and fisheries. In the present study, we examined the decade scale productivity dynamics across the Indian Exclusive Economic Zone of the Arabian Sea by integrating satellite ocean colour (Sentinel-3 OLCI chlorophyll a), sea surface temperature (Sentinel-3 SLSTR), and supporting physical and biogeochemical observations using a reproducible Google Earth Engine workflow (2016–2025). Satellite-derived chlorophyll informed primary productivity estimates, and time-series analyses employing trend detection method was used to identify regime shifts. Results reveal statistically significant, stepwise decreases in productivity that exceed typical seasonal and interannual variability, most pronounced in the northwestern upwelling region of the Arabian Sea. Notably, productivity declines coincide with documented basin-scale climate events and the onset of persistent marine heatwave conditions since 2023. These productivity shifts can contribute to a broader understanding of productivity dynamics driven by climate change and provide insights for ecosystem management, fisheries sustainability, and inform strategies for sustainable fisheries and environmental policy in Indian waters.

Keywords: *Remote Sensing, Primary Productivity, Arabian Sea, Sentinel 3*

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Abstract ID: TSS/ARSCF/15

VALIDATION AND INTERSENSOR COMPARISON OF OCM-3 AND SENTINEL-3 OLCI CHLOROPHYLL-a PRODUCTS IN THE SOUTHEASTERN ARABIAN SEA

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Accurate estimation of chlorophyll-a (Chl-a) from satellite observations is essential for monitoring marine productivity and ecosystem variability in the Arabian Sea. The Ocean Colour Monitor-3 (OCM-3) aboard EOS-06, launched in November 2022 as the successor to OCM-2, provides ocean-colour observations at 360 m spatial resolution for coastal and open-ocean applications. This study presents one of the first comprehensive validations of OCM-3 Chl-a products over the southeastern Arabian Sea. OCM-3-derived Chl-a concentrations were validated using *in-situ* measurements collected between April 2023 and February 2026. A total of 137 *in-situ* samples were available; however, due to frequent cloud cover during satellite overpasses, only 72 cloud-free satellite-*in situ* matchups could be obtained. Validation results showed good agreement between OCM-3 and *in-situ* Chl-a measurements (R^2=0.79, $p<0.05$), with an RMSE of 0.83 mg m^{-3} and a bias of 0.06 mg m^{-3}. Although slight underestimation occurred at higher Chl-a concentrations, OCM-3 effectively captured the overall variability of chl-a in the study region. Following the validation of OCM-3 sensor, an intersensor comparison was carried out using monthly chl-a products from OCM-3, Sentinel-3A and 3B OLCI. This comparison was conducted to assess the consistency and reliability of OCM-3-derived Chl-a estimates relative to OLCI products. The comparison showed similar seasonal patterns among all three sensors throughout the study period. Lower chl-a concentrations were observed during pre-monsoon and post-monsoon periods, while higher concentrations occurred during the southwest monsoon season, likely due to monsoon-driven upwelling and increased nutrient availability in the Arabian Sea. Overall, the results indicate that OCM-3 provides reliable Chl-a estimates and captures seasonal variability comparable to OLCI observations, highlighting its potential for operational monitoring of marine productivity in the Arabian Sea.

Keywords: *Chlorophyll-a, Validation, Kerala Coast, OCM-3, OLCI, Intersensor Comparison*

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REVIEW OF BIO-OPTICAL MODELLING OF THE NORTH INDIAN OCEAN – GAP AREAS AND FUTURE PERSPECTIVES

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The Northern Indian Ocean (NIO), comprising the Arabian Sea (AS) and Bay of Bengal (BoB) forms a dynamic ecosystem primarily controlled by the physical processing owing to the seasonal reversing monsoon. The AS experiences a strong upwelling along its western and eastern boundaries during the southwest monsoon and deep convective mixing in the northeast monsoon. The BoB largely remains stratified, experiences a significant amount of freshwater discharge and a mesoscale eddy along the northwestern boundaries. For accurate quantification of these processes at the spatiotemporal scale, a three-dimensional understanding is required. With advancement in technology, combining satellite remote sensing with underwater profilers, such as biogeochemical Argo floats, can address this observational requirement. The remote sensing reflectance (Rrs) serves as the fundamental radiometric bridge linking top-of-atmosphere observations to marine biogeochemical constituents. Rrs, along with the subsurface light field, can be simulated using an appropriate bio-optical model, which can be further used to predict the biogeochemical state of the ocean. Recent studies in the NIO have focused on overcoming the limitations of surface phytoplankton variability. In addition, machine learning approaches have also been developed to reconstruct the 3D distribution of bio-optical parameters by merging satellite products with Argo floats. However, the current models struggle to represent subsurface processes and regional biogeochemical complexity fully. The study presents a comprehensive review of the bio-optical modelling of the NIO, aiming to assess the regional biogeochemical state, highlighting gaps and future perspectives. The path forward relies on integrating the OneArgo float fleet with advanced multispectral and hyperspectral satellite missions via advanced machine learning and radiative transfer inversion frameworks to resolve the ocean's 4D spatiotemporal biogeochemical dynamics in the NIO.

Keywords: *Bio-Optical Modelling, Northern Indian Ocean, Ocean Colour Remote Sensing, Arabian Sea, Bay of Bengal, Inherent Optical Properties, Chlorophyll-a Retrieval*

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SPATIO-TEMPORAL PATTERNS OF NET PRIMARY PRODUCTION AND CARBON EXPORT EFFICIENCY IN THE NORTH-WEST BAY OF BENGAL

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The present study examines region-specific carbon dynamics in Type- 1 (isobath < 30 m) and Type-2 (isobath > 30 m) waters of the northwestern Bay of Bengal (NW-BoB) using two key indicators of the biological carbon pump: Net Primary Productivity (NPP) and Export Ratio (PE). The Vertically Generalized Production Model was applied to derived datasets of Moderate Resolution Imaging Spectroradiometer Aqua satellite. Higher NPP (1018–2266 mg C m^{-2} day^{-1}) and PE (0.04–0.08) were observed in Type-1 coastal waters, mainly driven by coastal upwelling that enhances phytoplankton growth and export efficiency.

In contrast, Type-2 offshore waters showed comparatively lower NPP (770–1476 mg C m^{-2} day^{-1}) and PE (0.04–0.056). Both regions exhibited clear bimodal seasonality, with a primary peak during March-May and a secondary peak during August–November in Type–1 waters, while Type-2 waters showed a primary peak in March–April and a secondary peak in August–November. PE exhibited strong seasonal variability, reaching a maximum of nearly 0.08 during April in Type-1 waters and minimum values of nearly 0.04 during low-productivity periods, while the close coupling between NPP and PE in coastal waters indicated a stronger and more efficient biological carbon pump than in offshore waters. Moreover, phase-space analysis identified distinct biological regimes, ranging from strong carbon pump conditions during the pre-monsoon period to weak export and enhanced recycling during the monsoon and post-monsoon periods. Overall, the study highlights the influence of coastal-offshore environmental gradients on biological carbon pump dynamics in the NW-BoB and demonstrates the utility of integrating NPP and PE for assessing regional carbon sequestration potential and ecosystem functioning in a monsoon- dominated marine environment.

Keywords: *Source-Sink, Biological Carbon Pump, Net Primary Productivity, Export Ratio, Vertically Generalized Production Model*

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ASSESSMENT OF OCM-3 RETRIEVAL ACCURACY FOR COLOURED DISSOLVED ORGANIC MATTER (CDOM) IN COASTAL WATERS OF THE EASTERN ARABIAN SEA

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Accurate monitoring of water quality parameters is vital for evaluating ecosystem health and understanding marine biogeochemical dynamics. Coloured Dissolved Organic Matter (CDOM) is an important optically active constituent that influences coastal water quality and carbon cycling. The limited spatial and temporal coverage of *in situ* CDOM highlights the importance of satellite remote sensing for large-scale monitoring of coastal waters. The Ocean Colour Monitor-3 (OCM-3) onboard the Indian EOS-06 satellite facilitates satellite-based monitoring of CDOM in coastal waters, highlighting the need to evaluate the accuracy of its retrievals using *in situ* measurements. This study assesses the performance of OCM-3 in retrieving CDOM in the coastal waters of the Eastern Arabian Sea (EAS) through validation with *in situ* observations collected during two NIOT cruises conducted in 2024 and 2026.

In situ CDOM measurements were collected CRV Sagar Tara ST-054 (2024) and ST-065 (2026) along the coastal waters of the EAS between Calicut and Porbandar, with approximately 45 samples acquired for evaluating OCM-3 derived CDOM. CDOM exhibited considerable spatial variability, ranging from 0.035-0.204 m-1 in 2024 and 0.014-0.101 m-1 in 2026, with higher values observed in the northern EAS, possibly reflecting the influence of coastal inputs and regional oceanographic conditions. Only 23 valid satellite-*in situ* match-ups were retrieved using the Mannino et al. (2014) algorithm for validation due to cloud cover. Validation against *in situ* observations demonstrated good correspondence between OCM-3 derived and measured CDOM. The validation statistics yielded R2 values of 0.711 and 0.776, RMSE values of 0.026 and 0.013 m-1, and biases of 0.005 and -0.008 m-1 for 2024 and 2026, respectively. These findings demonstrate the consistent retrieval performance of OCM-3 and provide a foundation for the development of region-specific algorithms to improve CDOM retrieval accuracy in the EAS.

Keywords: *CDOM, OCM-3, EOS-06, Remote Sensing, Validation, Eastern Arabian Sea*

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ENVIRONMENTAL DRIVERS OF COASTAL PRIMARY PRODUCTIVITY: A MULTIMODAL MACHINE LEARNING AND TIME-WARPING APPROACH

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The coastal waters off Kerala in the South Arabian Sea represent a highly dynamic marine environment governed by the seasonal reversal of the Indian Monsoon. Quantifying the effects of environmental forcing on marine primary productivity is challenging due to nonlinear shifts in climate–ecosystem dynamics. These limitations are increasingly important as warming in the South Arabian Sea drives ecological change. Rising SST has intensified vertical stratification, creating a barrier to nutrient supply and causing long-term shifts in phytoplankton biomass and community structure. To address this, the study presents a multimodal analytical framework using a continuous satellite derived monthly time series data (2005–2023) off Kochi, Kerala to isolate the predictive magnitude of environmental drivers from their temporal patterns. Chlorophyll-a (Chla) anomalies were correlated with six environmental variables - SST, Rainfall, Cloud Cover, PAR, SLP, and Shortwave Radiation using Random Forest regression for magnitude control, Dynamic Time Warping for temporal alignment, and OLS regression to identify shifts in biological baselines. Random Forest modeling established SST as the major thermodynamic regulator of Chla concentration, yielding a node purity of 71.69 and 23.93% of MSE. DTW identified rainfall as the dominant variable, with approximately 13-day lag reflecting the time needed for nutrient transport, plume dispersal, and phytoplankton assimilation at the land–sea interface. Beyond these seasonal dynamics, primary productivity showed a significant decline over time. This biological contraction is reflected in a 44.7% increase in SST–DTW distance, from 0.45 (2005) to 0.65 (2023). This expansion confirms that ocean warming has created a relatively persistent thermal barrier. Consequently, the coastal zone has become increasingly dependent on brief, episodic monsoonal rainfall pulses for Chl-a initiation, marking a significant regime shift in coastal primary production.

Keywords: *Random Forest, Dynamic Time Warping, Chlorophyll-A, Sea Surface Temperature, Rainfall*

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BIOREGIONALIZATION OF PHYTOPLANKTON IN THE NORTHERN INDIAN OCEAN: A FUZZY MEMBERSHIP AND WEIGHTED SPECIES RICHNESS APPROACH

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Phytoplankton are primary producers that sustain marine food webs and ecosystem functioning. This study investigated spatial and temporal diversity patterns, long term community shifts, diversity across Longhurst provinces and optical classes, and species richness estimation in the Northern Indian Ocean using fuzzy membership and weighted species richness approaches. Occurrence records from 1800 to 2023 documented 647 species belonging to 96 families, 48 orders, 10 classes, and 7 phyla, with Heterokontophyta and Myzozoa dominating regional assemblages. Bacillariophyceae dominated until 2000, followed by Dinophyceae during 2000 to 2010. The MONS and ARAB provinces and Optical Classes 1 and 4 supported the highest diversity, whereas INDE, ARCH, and Optical Class 6 showed lower diversity and limited sampling. A fuzzy logic based Weighted Species Richness index was developed to address uneven sampling and ecological transitions. Estimated species richness closely matched observed richness across optical classes, confirming the reliability of the approach. Spatial autocorrelation identified significant clustering in Optical Classes 4 and 5, while Classes 1 to 3 showed near random distributions. K means clustering identified three phytoplankton bioregions, with Cluster 3 exhibiting the greatest species richness. These findings demonstrate that fuzzy membership based methods improve biodiversity estimation, identify ecological boundaries, and support ecosystem assessment and conservation in data limited marine environments.

Keywords: *Phytoplankton, Northern Indian Ocean, Weighted Species Richness, Spatial Autocorrelation, Fuzzy Membership, Biogeography*

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POTENTIAL OF SATELLITE REMOTE SENSING IN ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT

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The Ecosystem Approach to Fisheries Management (EAFM) provides a holistic framework for balancing ecological well-being, human well-being and good governance in fisheries management. However, effective implementation of EAFM requires regular, spatially extensive and long-term information on ecosystem status, environmental variability, fishing pressure and habitat change. Satellite Remote Sensing (SRS), with its capacity for synoptic, repeated and cost-effective observation of coastal and marine ecosystems, can help build this information series to strengthen EAFM. This paper examines the potential applications of SRS in supporting EAFM implementation in India, using the Coringa mangrove ecosystem fisheries in Andhra Pradesh as an example. Coringa, the second-largest mangrove ecosystem in India, supports diverse finfish and shellfish resources but is increasingly affected by various anthropogenic stressors which require an integrated management approach beyond conventional single-species fisheries management. This paved the way for the development of the Coringa EAFM plan, a holistic roadmap of implementing EAFM tools in the Coringa ecosystem. SRS can enhance the Coringa EAFM plan by generating spatially explicit, time-series information on key ecosystem indicators such as mangrove cover, mangrove change detection, land-use conversion, chlorophyll-a concentration, SST, turbidity, coastal water quality, etc. These datasets can support the ecological well-being component of EAFM through habitat and water quality monitoring, the human well-being component through improved fisheries planning, and the governance component through improved monitoring mechanisms. In the Coringa ecosystem, SRS-derived information can help identify vulnerable mangrove zones, detect habitat loss and degradation, monitor seasonal environmental changes and map fishing pressure. When integrated with fishery-dependent data, field surveys and stakeholder knowledge, SRS can provide a robust decision-support framework for adaptive ecosystem-based fisheries management. Thus, the study highlights Satellite Remote Sensing as a cost-effective and scalable tool for strengthening EAFM and promoting the sustainable management of mangrove-associated fisheries in the Coringa ecosystem.

Keywords: *Biodiversity, Critical Habitats, Mangroves, Remote Sensing, Single-Species Management*

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SEASONAL AND INTERANNUAL VARIABILITY OF PHYTOPLANKTON SIZE CLASSES IN THE EASTERN ARABIAN SEA: INSIGHTS FROM *IN SITU* OBSERVATIONS AND SATELLITE OCEAN COLOR DATA

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Phytoplankton play a crucial role in regulating marine food-web dynamics, carbon export, and biogeochemical cycling in the Arabian Sea. Satellite ocean-color observations provide an effective means of monitoring phytoplankton size classes (PSCs) across broad spatial and temporal scales; however, regional validation of PSC algorithms remains limited in this basin. This study investigates the seasonal and interannual variability of PSCs and evaluates the performance of two widely used ocean-colour models: Brewin et al. (2012) and Sahay et al. (2017). MODIS-Aqua 8-day chlorophyll a data from NASA Ocean Colour were used to estimate satellite-derived PSCs using these algorithms. Validation was conducted against time-series observations (2015–2025) of phytoplankton size classes (micro-, nano-, and pico-plankton contributions following Uitz et al., 2006) along a meridional transect (8–21°N, 68°E) in the eastern Arabian Sea. Pigment-based observations revealed a consistent dominance of picoplankton (36–60%) across all seasons, followed by nanoplankton (32–50%), while microplankton accounted for only 6–27% of total biomass. Elevated microplankton contributions during the monsoon periods were linked to enhanced nutrient availability through vertical mixing, whereas pico- and nanoplankton prevailed under stratified conditions. Comparison of satellite-derived PSCs with *in situ* measurements demonstrated that both algorithms successfully captured the broad seasonal patterns of phytoplankton community structure, with reasonable bias. Since the *in situ* observations are limited, the satellite-based PSC estimates are crucial for understanding the importance of how different size groups respond distinctly to climate-driven physical forcing and nutrient availability under a changing climate.

Keywords: *Arabian Sea, Phytoplankton Size Classes, MODIS-Aqua, insitu observations*

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MULTIDECADAL TRENDS, THRESHOLDS AND TRANSPORT DYNAMICS OF ALGAL BLOOMS IN THE NORTHERN INDIAN OCEAN FROM SATELLITE DATA

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Climate change has significantly altered global ocean productivity, leading to pronounced changes in algal bloom dynamics and community composition. In the northern Indian Ocean (NIO), increasing incidences of Harmful Algal Blooms (HABs) pose a significant threat to marine ecosystems, fisheries, and coastal economies. Despite long-term, continuous monitoring and research on HABs, a common satellite-based framework for defining HAB thresholds and assessing their propagation is lacking. In this study, 25 years (2000-2025) of satellite data (ESA OC-CCI) were combined with our algal bloom database to investigate long-term bloom frequency, shifts in species composition, and the spatiotemporal dynamics of bloom propagation. Analysis of annual bloom phenology from the database revealed significant decadal variations, with the highest number of bloom events reported in the Arabian Sea during 2000-2004. A subsequent shift in regional dominance towards the Bay of Bengal was observed in the later years. The long-term chlorophyll analysis demonstrated that the coastal waters exhibit median chlorophyll concentrations approximately 3 times higher than those in the open ocean. This spatial heterogeneity complicates the use of generalized chlorophyll-based thresholds for satellite-based HAB detection and introduces regional biases in bloom detection. Open ocean and coastal HAB thresholds were applied to the satellite data to map the daily distribution of bloom pixels in the NIO and investigate the sustenance and transport dynamics. A particle transport model was developed using HAB pixels as seeding points. These simulations for the southern Coast of India showed a significant influence of surface current and eddies in the transport of blooms. Integrating dynamic, region-specific, satellite-based bloom thresholds with a particle transport model offers a scalable framework to improve regional assessment of algal blooms related to climate change, fisheries and aquaculture.

Keywords: *Satellite, Chlorophyll, Algal Blooms, Northern Indian Ocean, Particle Transport*

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MATSYAMETRI: INTELLIGENT FISH LENGTH MEASUREMENT AND FREQUENCY ANALYSIS SYSTEM

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Length-frequency data constitute a fundamental input for fisheries stock assessment, population dynamics studies, and sustainable fisheries management. However, conventional methods of fish length measurement are often labour-intensive, time-consuming, and prone to observer-related errors, particularly during large-scale field surveys and fish landing assessments. To address these challenges, an intelligent camera- and augmented reality (AR)-based mobile application, named MatsyaMetri, was developed for automated measurement of aquatic resources and generation of standardized length–frequency datasets. The application utilizes smartphone camera technology integrated with AR-enabled ruler measurements to estimate specimen length directly from captured images. Measurements are automatically recorded and compiled into length-frequency distributions suitable for fisheries stock assessment and biological analysis. The system supports session-based sampling, allowing rapid measurement of multiple individuals belonging to the same species, and can be applied to finfishes, crustaceans, and molluscs. The application provides secure data storage, automated data management, and export facilities for further scientific analysis. By reducing manual effort and improving measurement efficiency, MatsyaMetri offers a practical digital solution for fisheries scientists, researchers, and field enumerators engaged in resource monitoring programmes. The platform represents an important step toward digital transformation of fisheries data collection and contributes to strengthening evidence-based fisheries assessment and sustainable resource management.

Keywords: *Matsyametri, Length–Frequency Analysis, Fish Length Measurement, Augmented Reality, Mobile Application, Fisheries Informatics, Stock Assessment, Digital Fisheries*

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COMPARATIVE EVALUATION OF OC4, OC5, AND OC6 ALGORITHMS FOR CHLOROPHYLL-a RETRIEVAL USING OCM-3 DATA IN THE EASTERN ARABIAN SEA

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Chlorophyll-a (Chl-a) concentration is a key indicator of phytoplankton biomass and ocean primary productivity. As the primary photosynthetic pigment in phytoplankton, Chl-a strongly influences ocean colour and serves as an important parameter for assessing marine ecosystem dynamics. Continuous monitoring of Chl-a is essential for understanding spatial and temporal variations in phytoplankton distribution, ecosystem health, and biogeochemical processes. Satellite remote sensing provides an efficient means of monitoring ocean colour over large spatial scales and at frequent temporal intervals, enabling the assessment of both coastal environments. In this study, 53 water samples were collected for Chl-a analysis from the Eastern Arabian Sea (EAS) during the Coastal Research Vessel (CRV) Sagar Tara (ST-065) cruise conducted between 15 to 23 April 2026. The Chl-a data and the remote sensing reflectance (Rrs) data were obtained from the Ocean Colour Monitor-3 (OCM-3) sensor onboard EOS-06/Oceansat-3 through the Bhoonidhi portal. The Chl-a and Rrs data were processed using SeaDAS version 9.0.1. Chlorophyll-a concentrations were subsequently estimated OCM-3-derived Rrs data using standard ocean-colour algorithms, including OC4, OC5, and OC6. Chl-a concentrations were higher in the northern EAS than in the southern EAS. Comparison of *in situ* Chl-a measurements with OCM-3 estimates revealed a significant overestimation at low Chl-a concentrations (<0.5 mg/m^3) and an underestimation at high concentrations (>1 mg/m^3). Among the OC band algorithms evaluated, OC5 showed the best performance in estimating Chl-a concentrations, exhibiting the lowest bias and log-RMSE (0.42), followed by OC6 and OC4. This preliminary study assesses OCM-3 performance and highlights the need for a region-specific Chl-a algorithm for EAS. Future work will involve collecting additional *in situ* data to enable improved algorithm development and validation.

Keywords: *Chlorophyll-a, Eastern Arabian Sea, Ocean Colour Algorithm, OCM-3, Remote Sensing Reflectance*

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CHLOROPHYLL VARIABILITY AND ITS IMPLICATIONS FOR FISHERIES LANDINGS ALONG THE KERALA COAST (2008–2016)

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Satellite-derived chlorophyll-a (Chla) is a widely used recognised as a proxy for marine primary productivity and an indicator of fish distribution. However, region-specific relationships between Chla dynamics and fisheries landings remain insufficiently resolved. This study investigates the linkage between Chla variability and marine fish catch in the Kerala region, India, during the period 2008-2016, a period marked by notable expansion in regional fisheries. Georeferenced fish catch data from Potential Fishing Zone (PFZ) validation studies conducted by Indian National Centre for Ocean Information Services were analysed alongside satellite-derived Chl-a from MODIS-Aqua and biogeochemical model outputs to evaluate their applicability in explaining fisheries variability. Seasonal and interannual analyses were performed to identify chlorophyll thresholds and lag effects influencing fishery productivity. Results indicate a seasonally modulated relationship between Chl-a concentration and fish landings, particularly during the southwest monsoon and post-monsoon periods when nutrient enrichment enhances primary productivity. However, the strength of this relationship varies across years, suggesting the influence of additional oceanographic drivers. These findings highlight the role of remote sensing in linking ocean productivity with fisheries dynamics, supporting improved forecasting and ecosystem-based management, and emphasizing the need for region-specific calibration

Keywords: *Chl-a Variability, Potential Fishing Zones, Remote Sensing, Arabian Sea, Productivity*

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IMPACT OF AEROSOLS ON CHLOROPHYLL-a DISTRIBUTION IN THE ARABIAN SEA USING MULTI-SATELLITE OBSERVATIONS

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Atmospheric aerosols can influence marine primary productivity through nutrient deposition and radiative effects, yet their impact in monsoon-driven systems such as the Arabian Sea remains complex. Using multi-sensor satellite observations from 2003 to 2024, this study investigated the role of aerosols in sea surface chlorophyll-a (Chl-a) variability. Correlation analysis showed a moderate positive correlation (r = 0.48) between Chl-a and aerosol optical thickness (AOT), with a weaker link to dust optical thickness (r = 0.20), indicating that the observed variability is more strongly governed by shared physical processes than by direct dust fertilization. Regionally, strong positive correlations occur in the western Arabian Sea where monsoon winds drive simultaneous upwelling and aerosol transport. In contrast, weak or negative correlations are found in the northeastern Arabian Sea and the Arabian Gulf, where stratification and light limitation decouple the response. Interannual variability revealed that coupling strength is also linked with extreme climate modes. Multivariate analysis showed that Chl-a variability is primarily driven by sea surface temperature, sea level anomaly, salinity, and currents, while aerosols act as secondary drivers. The results highlight that aerosol effects are secondary in regions where physical forcing dominates, emphasizing the need for regime-specific understanding of atmospheric impacts on ocean productivity. This work contributes to better characterizing the ocean-atmosphere interactions in the Arabian Sea and supports the use of remote sensing for marine ecosystem monitoring.

Keywords: *Aerosols, Chlorophyll-a, Arabian Sea, Remote sensing, Monsoon, Ocean productivity*

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FROM SEA TO SHORE: WIND-DRIVEN AEROSOLIZATION OF HARMFUL ALGAL BLOOM TOXINS IN QINGDAO, CHINA, DURING THE WINTER OF 2019

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In Qingdao, China, harmful algal blooms (HABs) are a known hazard to coastal communities. Aerosolization is a mechanism by which HAB toxins can be transported from the sea surface into the air when wind speeds exceed 5 m/s. Previous studies have analysed the composition of aerosolized marine biotoxins (AMBs) in the breathable air surrounding Qingdao, but the role of the onshore winds in transporting them there would benefit from further research. Ciguatoxin is one such AMB, and this study analyses the role of onshore winds in aerosolizing and transporting toxins inland from a ciguatoxin bloom in Aoshan Bay, Qingdao during the winter of 2019. It also considers the resulting potential exposure for coastal communities. Ciguatoxin is widely understood for causing ciguatera fish poisoning (CFP), yet the effects on human health when inhaled remain mostly unknown. Using satellite derived data, chlorophyll concentrations were assessed throughout 2019 to locate the winter HAB, as chlorophyll is a strong indicator of phytoplankton biomass. Wind speed and direction data were analysed from satellite radar to determine the frequency and strength of onshore winds throughout the bloom. Additionally, chlorophyll levels in Aoshan Bay were analysed over a 20-year period to assess if and how HAB occurrences were changing over time. The ciguatoxin bloom was captured by a peak in chlorophyll levels during January and February 2019. Winds in the area were onshore and at speeds capable of aerosolization 75% of this time, suggesting that onshore winds played a large role in transporting ciguatoxin into the air. Interestingly, a significant decline in chlorophyll levels was observed across the 20-year dataset, likely attributable to an increase in macroalgal invasions around China. This study highlights the potential relationship between onshore winds and harmful algal bloom occurrences in Aoshan Bay in 2019, and the associated risk of exposure to coastal communities.

Keywords: *Aerosolization, Qingdao, Ciguatoxin, Chlorophyll, Onshore*

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ENHANCING OCEAN COLOUR CLIMATE RECORDS WITH OC CCI VERSION 7

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The Ocean Colour Climate Change Initiative (OC-CCI) is preparing its Version 7 product. It incorporates significant improvements to climate-quality ocean colour records through improved validation and algorithmic innovation. Central to this effort is the compilation of an expanded global *in situ* bio-optical dataset (v2026), increasing total observations by ~115% (from 148k to 319k), with chlorophyll-a (Chl-a) records growing by ~31%, remote-sensing reflectance (Rrs) by ~94%, and inherent optical properties (IOPs) increasing by ~80% up to ~10,000%. Bidirectional correction of Rrs now uses the Park and Ruddick (2005) scheme

(replacing Morel et al., 2002), improving consistency with satellite data and Polymer atmospheric correction. The dataset supports validation and algorithm development, with a v2026 data paper in preparation. This version integrates the latest sensors' Level-1 reprocessing and updates system vicarious calibration (SVC) gains at MOBY, leading to performance improvements, particularly for MERIS and OLCI sensors. VIIRS-NOAA20 will be included alongside the existing six missions (SeaWiFS, MODIS-Aqua, MERIS, VIIRS-SNPP, OLCI-A, OLCI-B). The temporal inclusion of MODIS-Aqua data in the merged product is being assessed due to its recent orbital drift. As in previous versions, the OC-CCI product will include pixel-wise optical water classification using fuzzy C-means clustering, which enables dynamic selection and assignment of algorithms across distinct water regimes. In version 7, this classification will be updated, enhancing product reliability at global scale. A community round-robin involving 16 participants produced 13 algorithms for retrieving Chl-a, IOPs, and diffuse attenuation. This provides a robust benchmark for intercomparison, reproducibility, and algorithm selection in OC-CCI Version 7.

Keywords: *Ocean Colour, Remote Sensing, Climate Data Record, Chlorophyll-a, Bio-Optical Validation, Inherent Optical Properties*

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COASTAL PHYTOPLANKTON DIVERSITY IN THE IBERIA UPWELLING REGION

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Monitoring phytoplankton using ocean colour remote sensing (OCRS) through the assessment of chlorophyll-a concentration (Chla) is mature, and the global distribution of phytoplankton size classes and/or functional types (PFTs) has also been successfully described in the literature. This is particularly relevant as some fisheries depend on diatoms for survival of small pelagic larvae. However, coastal regions remain challenging due to the high temporal and spatial variability in algal blooms and PFTs, which hampers effective monitoring required under the European Marine Strategy Framework Directive (MSFD). Here, we present a simple approach to infer phytoplankton diversity from OCRS based on *in situ* samples collected from 2018 to 2022, during 14 oceanographic cruises. Photosynthetic pigment concentrations were analysed by HPLC and the relative contribution of microalgal groups to total Chla was estimated using the PHYTOCLASS approach. Eight PFTs were considered: Bacillariophyceae (Diatoms), Dinophyceae (Dinoflagellates), *Haptophyta, Cryptophyta, Chrysophyceae, Prasinophyceae*, *Synechococcus* and *Prochlorococcus*. Their relative abundances were used to compute the Shannon-Wiener diversity index (H'). Significant relationships between each PFT and H' were found for all groups except *Dinoflagellates* and *Chrysophyceae*. Satellite data, including daily 1 km Chla data from the ESA Ocean Colour Climate Change Initiative, and daily 5 km Sea Surface Temperature (SST) data from Copernicus-OSTIA, were used to derive the three size classes (micro- nano- and picoplankton) and Diatoms fraction within the micro size class (20-200 µm). Matchups between satellite and *in situ* data were split (70:30) into training and validation datasets to develop and evaluate models relating satellite-derived Chla and the

Diatom/Chla ratio to H' providing a simple and effective approach to estimate phytoplankton diversity from OCRS.

Keywords: *Phytoplankton, Diversity, Ocean Colour, Upwelling, Diatoms*

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CHARACTERIZATION OF A MONSOONAL WETLAND SYSTEM BASED ON OPTICAL WATER TYPES

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The Vembanad Kol Wetland system is India's largest brackish, humid tropical wetland ecosystem. Spanning four districts in Kerala, the designated Ramsar site wetland complex encompasses a massive estuarine lake and interconnected floodplains which provide a vital biodiversity hotspot that supports socio-ecologically important fisheries, migratory birds, and regional agriculture. The system is under increasing pressure from flooding event intensification, high nutrient loading introduced through agricultural and urban runoff, and industrial development. Satellite remote sensing can provide large-area monitoring, for relatively low cost, to enhance *in-situ* sampling time series efforts but is dependent on cloud-free conditions. Transitional water quality indicator algorithms (e.g. chlorophyll-a, total suspended matter, colored dissolved organic matter) are particularly sensitive to regional characteristics and often require calibration with a sufficiently extensive *in-situ* database to allow for separate training and testing. Semi-regular *in-situ* monitoring of the estuary complex since 2018 provides valuable insights but do not yet supply sufficient matchup numbers to allow for regional algorithm calibration. We introduce Optical Water Types (OWT) as a classification scheme to analyze wetland complex system changes, circumventing the need for regional calibrated water quality indicator algorithms. OWT classes are characterized by existing *in-situ* data and seasonal patterns assessed across the wetland complex. Analysis of watershed land cover-land use change are presented as potential drivers for changes in water quality characteristics.

Keywords: *Lake Vembanad, Sentinel-2 MSI, Fuzzy C-Mean Clustering, Land Cover-Land Use*

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UNDERSTANDING PHYTOPLANKTON ABSORPTION SIGNATURES IN THE SAN MATÍAS GULF (PATAGONIA, ARGENTINA) VIA PACE-OCI HYPERSPECTRAL DATA.

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Inherent Optical Properties (IOPs) are fundamental proxies for characterizing the biogeochemical dynamics of the San Matías Gulf, Argentina. In this ecologically significant region, spring-summer tidal fronts drive contrasting phytoplankton cycles: bimodal in stratified inner waters and unimodal in well-mixed outer waters. These conditions are critical for supporting regional industrial fisheries. This study evaluates phytoplankton optical signatures in relation to this frontal structure using hyperspectral data from the Ocean Color Instrument (OCI) onboard PACE. Seven cloud-free images were analyzed between October 2025 and April 2026 at monthly intervals. Phytoplankton absorption spectra (aph(λ)) were derived and analyzed using Principal Component Analysis. The results revealed two distinct optical groups: the northern group exhibited lower absorption magnitudes and greater spectral homogeneity (aph(442) = 0.044 ± 0.025 m^{-1}) compared to the southern group
(aph (442) = 0.100 ± 0.043 m^{-1}). The Blue/Red (B/R) ratio was higher in the northern sector (>2) than in the southern sector (<2), suggesting differences in cell size and pigment packaging effects. These findings indicate that the tidal front modulates the phytoplankton absorption spectral shape—a proxy for community structure—underscoring the importance of future *in situ* validation. Such validation is essential for understanding spatio-temporal dynamics and phytoplankton succession, as well as their impact on trophic ecology and water quality, both of which are critical for industrial and artisanal fisheries in the region.

Keywords: *Hyperspectral Remote Sensing, OCI-PACE, Phytoplankton Absorption Spectra, Tidal Fronts, San Matías Gulf*

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EVALUATING FOUR MACHINE LEARNING ALGORITHMS USING GOOGLE EARTH ENGINE FOR ANALYZING LULC DYNAMICS OF SANDWIP ISLAND, BANGLADESH

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Sandwip Island is a highly dynamic coastal environment experiencing continuous geomorphological changes driven by erosion, accretion, and sediment deposition. This study analyzes shoreline changes from 1995 to 2026 using the Digital Shoreline Analysis System (DSAS) in ArcGIS and evaluates Land Use Land Cover (LULC) changes from 2000 to 2024 using Google Earth Engine and machine learning algorithms, including Classification and Regression Tree (CART), Gradient Boosting Trees (GBT), Random Forest (RF), and Support Vector Machine (SVM). A total of 140 ground-truth points representing seven LULC classes were used to assess model accuracy. Among the models, RF demonstrated the highest overall accuracy (93.57%), producing clearer boundaries and better separation of major land-cover classes. GBT achieved an accuracy of 92.14%, showing reliable classification across most LULC types. SVM reached a moderate accuracy of 90%, although some overgeneralization was observed in spectrally similar classes. CART showed the lowest accuracy (87.14%), with increased mixed-pixel occurrence in dense and heterogeneous regions. The findings reveal a gradual increase in the total area of Sandwip Island due to sediment deposition, contributing to the expansion of sandy areas (61.628 km²), mangroves (27.412 km²), vegetation (58.618 km²), cropland (31.587 km²), and built-up areas (60.031 km²). These results highlight the significant influence of natural coastal processes on land-cover dynamics and demonstrate the effectiveness of remote sensing and machine learning techniques for monitoring dynamic coastal environments. The study further suggests that integrating sediment transport modeling and tidal-current analysis with machine learning approaches could improve the accuracy of future coastal change assessments.

Keywords: *Shoreline Change, Land Use Land Cover (LULC), Remote Sensing, Machine Learning, Coastal Dynamics, Sandwip Island*

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INTEGRATING SATELLITE-DERIVED OCEANOGRAPHIC DATA AND *IN SITU* OBSERVATIONS FOR AFFORDABLE MONITORING OF SPATIAL–TEMPORAL DYNAMICS IN COASTAL ARTISANAL FISHERIES OF BANGLADESH

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Coastal artisanal fisheries in Bangladesh are characterized by dynamic spatial and temporal shifts in fishing grounds, gear usage, and catch composition, yet these patterns remain poorly quantified due to limited monitoring capacity. This study presents an affordable, integrated approach to monitor fishing activities by combining *in-situ* observations, fisher knowledge, and satellite-derived environmental data. Field data were collected using a low-cost instrument (FVON) attached to fishing gear recorded sea surface temperature (SST), depth, and georeferenced fishing tracks. These were complemented by structured interviews with fishers to document gear types, fishing strategies and seasonal movements, as well as onboard observations of catch composition. Satellite data, including SST and chlorophyll-a, were integrated to examine environmental drivers of fishing ground selection. Satellite variables showed distinct seasonal patterns, SST ranged from 22–26°C in winter to 28–31°C in monsoon, while Chl-a concentrations varied from 2–10 mg/m^3 in nearshore to <1.5 mg/m^3 offshore. Spatial clustering identified fishing hotspots, while temporal analysis revealed clear seasonal shifts with nearshore winter fishing targeted shrimp, Chewa, and Loitta using Bindi nets, whereas monsoon offshore fishing targeted Hilsa using Chandi nets. Analysis of catch composition and fisher interviews indicated a noticeable decline in catch over time, consistent with 20–50% reductions in catch per unit effort (CPUE) reported in coastal Bangladesh. Integrating *in situ* and satellite data demonstrated strong potential for predicting productive fishing zones and understanding shifting fishing behavior. This study provides a cost-effective framework for monitoring artisanal fisheries, offering actionable insights for sustainable management and a scalable solution for data-limited coastal regions.

Keywords: *Artisanal-Fisheries, Remote Sensing, in-situ Sensors, Bay of Bengal, Spatial-Temporal Analysis*

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ENVIRONMENTAL AND PLANKTON DRIVERS OF SMALL-SCALE FISHERIES IN MANGROVE ECOSYSTEMS

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Small-scale fisheries play a vital role in food security, livelihoods and coastal economies in the mangrove dominated ecosystems of Bangladesh. However, effective monitoring remains limited due to insufficient spatial data and field observations. This study developed and applied an integrated satellite and field-based framework incorporating plankton dynamics to monitor small-scale fisheries across mangrove coastal ecosystems. Satellite derived environmental variables including sea surface temperature (SST), chlorophyll-a concentration, and turbidity were combined with *in-situ* measurements of salinity, dissolved oxygen, nutrients and plankton (phytoplankton and zooplankton) abundance. Fisheries data were collected through landing site surveys and fisher interviews. Plankton samples were analyzed to assess community structure, seasonal variability and their role as biological indicators of fisheries productivity. Spatial and temporal analyses revealed strong seasonal patterns with higher plankton abundance and fisheries catch during nutrient-enriched periods. Statistical analyses showed significant relationships between environmental variables, plankton abundance and fisheries productivity. Chlorophyll-a exhibited a strong positive correlation with fisheries catch ($r = 0.65$, $p < 0.05$), while zooplankton abundance showed a moderate relationship ($r = 0.54$, $p < 0.05$). Principal Component Analysis explained 73% of total variability and Generalized Additive Models accounted for approximately 62% of variation in fisheries catch, identifying plankton abundance as a key predictor. Spatial hotspot analysis revealed productive fishing zones associated with high plankton density and mangrove proximity. These findings demonstrate that integrating plankton dynamics with satellite and field observations improves fisheries monitoring and supports ecosystem-based and climate-resilient management strategies.

Keywords: *Small-Scale Fisheries, Satellite Remote Sensing, Principal Component Analysis, Generalized Additive Models, Ecosystem-Based Management*

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AN EVALUATION OF SATELLITE AND *IN-SITU* BASED SEA SURFACE TEMPERATURE DATASETS IN THE SOUTH-CENTRAL COASTAL ZONE OF BANGLADESH

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Sea Surface Temperature (SST) variability plays a vital role in regional climate, atmospheric interactions and marine environment. This study investigated spatial, temporal distribution of SST in the Northern Bay of Bengal with *in-situ* data of one year and multi-satellite (AQUA MODIS, TERRA MODIS, SNAP VIIRS, AVHHR, MSG (SEVIRI), NOAA-20, NOAA-21, Sentinel-3A and 3B(SLSTR), GCOM-W1(AMSR), Suomi NPP) data from Copernicus (CMEMS), NASA, NOAA (OISST v2.1) of 45 years (1981-2026). ArcGIS, Python, Google Earth Pro was used to analyze the data in statistical and geospatial techniques. Satellite to satellite comparison, satellite to *in-situ* comparison were done. Then, yearly, monthly SST were analyzed. The results indicated that the global temperature is rising with a positive trend (0.011°C/year). Further analysis showed a strong correlation between satellites and *in-situ* observations (r2=0.82 by AVHRR satellite) and negligible errors (Lowest RSME of 1.172°C by AVHRR and highest RSME of 2.163°C by SNAP VIIRS). Though, minor deviations were detected near the coastal area due to river discharge. The rising temperature helps to investigate the cyclone possibility. These findings help to understand global SST scenario and observe long-term monitoring.

Keywords: *Sea Surface Temperature (SST), Temporal Variability, Long-term Monitoring, Satellite Observations, in-situ Observations*

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NOAA SATELLITE MAPPING OF SUGAR KELP AQUACULTURE SUITABILITY IN THE GULF OF MAINE

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Aquaculture is a rapidly expanding sector that supports global food security, economic development, and coastal ecosystem sustainability. However, its productivity is increasingly vulnerable to environmental variability and extreme events, including marine heatwaves, harmful algal blooms, and elevated sediment loading from terrestrial runoff. These stressors can significantly degrade water quality and reduce habitat suitability for commercially important species such as mussels and kelp. Satellite ocean remote sensing offers a robust framework for monitoring coastal environments by providing synoptic, high-frequency observations of key water quality parameters, including sea surface temperature, chlorophyll-a, total suspended matter, and diffuse attenuation coefficient. Previous studies have demonstrated the utility of satellite-derived environmental variables for constructing Habitat Suitability Index (HSI) models for molluscan shellfish aquaculture in the Gulf of Maine. Building on these advances, this study develops a satellite-driven HSI framework for sugar kelp (*Saccharina latissima*) aquaculture in the Gulf of Maine by integrating extensive *in situ* observations of water temperature and nutrients with multi-sensor satellite data from MODIS-Aqua and VIIRS SNPP. The resulting HSI products are used to characterize spatial and temporal variability in near-surface environmental conditions and to assess habitat suitability under both typical conditions and extreme events, including marine heatwaves and high-runoff episodes. This work demonstrates the potential of satellite-based tools to support adaptive aquaculture management and improve resilience to climate-driven environmental change.

Keywords: *Satellite Remote Sensing, Aquaculture, Habitat Suitability Index, Sugar Kelp, Gulf of Maine*

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HYDRODYNAMIC VARIABILITY AND IT'S IMPACT ON THE BIODIVERSITY ON THE NORTHERN BAY OF BENGAL

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The northern Bay of Bengal is a highly dynamic marine region shaped by monsoon circulation, large river inflow, and diverse mesoscale ocean processes, resulting in complex physical and biological interactions. Understanding how these physical drivers influence marine productivity is crucial for anticipating ecosystem responses under changing climate conditions. This study focuses on three linked research goals: first, to describe the seasonal variations in hydrodynamics and water column stratification; second, to map, measure, and evaluate the seasonal persistence of cyclonic mesoscale eddies and their contribution to nutrient pathways; and third, to examine how eddy-driven upwelling supports biological productivity across different levels of the marine food chain. The research uses multiple satellite-based ocean observation datasets covering the period 2022–2024 for the northern Bay of Bengal (18°N–22°N, 88°E–92°E). Chlorophyll-a concentrations were estimated using MODIS-Aqua, Sentinel-3 OLCI, and VIIRS platforms. Mesoscale eddy system drives upwelling, lifting nutrient-rich deeper water to the surface and stimulating biological growth. Chlorophyll-a values within the eddy zone were recorded up to eight times higher than surrounding waters, indicating strong ecological impact. The long-lasting stability of the eddy supports sustained phytoplankton blooms and energy transfer to higher trophic levels, forming localised hotspots in an otherwise nutrient-limited marine environment. These results highlight the critical ecological role of mesoscale eddies in enhancing spatial and seasonal productivity, thereby strengthening local marine food web development under naturally stratified ocean conditions.

Keywords: *Mesoscale Eddies, Monsoon Dynamics, Ocean Stratification, Tropical Interaction*

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INTEGRATING SATELLITE OCEAN COLOUR AND *IN-SITU* CTD OBSERVATIONS TO ASSESS PHYTOPLANKTON PHOTOACCLIMATION DURING THE ESA OTC25 OCEANOGRAPHIC CRUISE

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Phytoplankton are responsible for nearly half of global primary production and play a crucial role in supporting marine food webs, fisheries productivity and biogeochemical cycles. The way phytoplankton respond physiologically to varying light availability under the water influences their biomass distribution, photosynthetic efficiency, and ecosystem functioning. This study therefore investigated phytoplankton photoacclimation to variable light penetration by integrating *in situ* Conductivity, Temperature, Depth (CTD) observations with satellite ocean-color products collected during the One Ocean Expedition under the European Space Agency Ocean Training Course 2025 (ESA OTC25) oceanographic cruise. CTD profiles measured the chlorophyll fluorescence, the beam attenuation, the turbidity, and the Photosynthetically Active Radiation (PAR) across fifteen stations, while satellite-derived chlorophyll-a data provided regional context. Estimation of the carbon biomass of phytoplankton, was done using bioptical relationships based on beam attenuation and particulate backscattering proxies. Results observed revealed substantial spatial variability in biomass distribution with stratified stations exhibiting higher amount of surface biomass and strong vertical gradients while the mixed stations showed relatively uniform profiles. Availability of light and water-column structure strongly influenced photoacclimation responses, which was reflected by variations in chlorophyll-to-carbon ratios. Therefore, integrating satellite and *in-situ* observations improved the interpretation of chlorophyll dynamics and ecosystem productivity patterns. The study demonstrates the value of combining remote sensing and field measurements for enhancing the monitoring of marine ecosystem health, primary productivity, and fisheries-supporting habitats under changing environmental conditions.

Keywords: *Ocean Colour Remote Sensing, Phytoplankton, Chlorophyll-a, Photoacclimation, Primary Productivity*

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IMPACT OF MARINE HEATWAVES ON NORTHWEST AFRICAN AND GULF OF GUINEA COASTAL UPWELLING DYNAMICS PRODUCTIVITY

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Marine ecosystems are increasingly threatened by global warming, deoxygenation, and ocean acidification, with eastern boundary upwelling systems representing hotspots particularly susceptible to these stressors and to the increasing frequency of extreme events, such as marine heatwaves. In this study, marine heatwaves algorithm is applied to satellite observations of sea surface temperature (SST) to detect the MHW episodes and to characterize their impact on West African coastal upwelling systems, from 1982 to 2022. The focus is on the Senegal-Mauritania and Gulf of Guinea coastal upwelling regions. Results show that maximum MHW episodes observed during boreal winter-spring are connected to tropical climate systems and driven by the extreme events of large-scale climate drivers such as tropical Atlantic Nino, ENSO and NAO. A negative North Atlantic Oscillation index and a positive Atlantic Niño index were observed to be main large-scale drivers controlling SST increase via the weakening of the trade wind stress. The combined effects of regional variability and short-term extreme events may intensify environmental extremes along the West African coast. Intense MHW episodes have peaked during extremes Pacific El Niño events. The trend analysis of MHW events separately conducted for the open ocean and the coastal upwelling systems coasts showed enhance intensity and frequency over the coastal regions. This difference is related to the heat contrast between the near-coastal land and the sea. The individual and combined effects of MHW episodes on upwelling metrics, such as reduced intensity, duration, disruption of upwelling season and changes in productivity, were considered as potential impacts on the marine ecosystem that require further investigation.

Keywords: *Coastal Upwelling Systems, Marine Heatwaves Properties, Marine Ecosystems, Maximum Intensity, Northwest African Coasts*

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BLOOM RECURRENCE AND SPATIOTEMPORAL PHYTOPLANKTON VARIABILITY IN THE ARABIAN GULF AND SEA OF OMAN

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Phytoplankton variability in the Arabian Gulf and Sea of Oman is strongly influenced by regional circulation and monsoon-driven environmental forcing. This study explores long-term chlorophyll-a variability and bloom recurrence patterns across four regional sectors using satellite observations from 2002 to 2024. Climatological analyses revealed clear spatial and seasonal variability, with enhanced chlorophyll concentrations generally occurring in shallow coastal waters and lower concentrations offshore in the deeper Sea of Oman. Along the eastern UAE coast, seasonal variability appeared closely linked to changes in wind forcing, vertical transport, and monsoon-driven circulation. Bloom recurrence analyses further demonstrated substantial regional differences in bloom behavior, ranging from recurrent seasonally modulated conditions to more intermittent pulsed dynamics. The eastern UAE coastal region, located near the transition between the Arabian Gulf and Sea of Oman, exhibited complex variability likely influenced by regional circulation exchange and environmental forcing. Overall, the combined climatological and recurrence analyses highlight the coupling between physical forcing and phytoplankton variability and provide new regional insight for remote sensing-based environmental monitoring in the northwestern Indian Ocean.

Keywords: *Phytoplankton Variability, Bloom Recurrence, Chlorophyll-A Climatology, Remote Sensing, Arabian Gulf, Sea of Oman*

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PHYTOPLANKTON PHENOLOGY AND PHYSICAL FORCING IN THE PEMBA CHANNEL: DISENTANGLING THEIR ROLES IN SMALL PELAGIC FISH DYNAMICS

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Small pelagic fish play a crucial role in food security and livelihoods for coastal communities in Tanzania; however, their distribution and abundance are highly sensitive to environmental variability. This study examines how phytoplankton phenology and key physical drivers shape the seasonal dynamics of mackerel, sardines, and anchovies in the Pemba Channel using satellite-derived Chlorophyll-a (Chl-a) and environmental data (sea surface temperature (SST), winds, currents, and mixed layer depth (MLD)) from 2011 - 2022. Results revealed that physical conditions follow a strong monsoon cycle, with deeper mixing, stronger winds, and cooler SST during the southeast monsoon supporting elevated Chl-a, confirming that primary production is largely regulated by physical forcing. The fish-environment relationships revealed a clear species-specific pattern: mackerel responded strongly to Chl-a, SST, and MLD; anchovies to Chl-a and MLD; while sardines exhibited weaker, more diffuse environmental sensitivities. Lagged and cumulative effects confirmed that environmental forcing impacts fish dynamics through delayed ecological responses. Across all analytical approaches, Chl-a emerged as the central indicator linking ocean physics to fish dynamics. These findings underscore the importance of sustained ocean-colour monitoring to support climate-responsive management of small pelagic fisheries in the Tanzania and the Western Indian Ocean.

Keywords: *Small Pelagic Fisheries, Phytoplankton Phenology, Ocean Colour Remote Sensing, Ocean Physical Forcings, Environmental Variability, Monsoon Dynamics, Fish-Environment Interactions*

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LONG-TERM TRANSFORMATION OF SEA SURFACE TEMPERATURE, SALINITY, AND CHLOROPHYLL-a IN THE BAY OF BENGAL UNDER CLIMATE CHANGE

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The Bay of Bengal (BoB) stands out as highly vulnerable to climate change due to its geographical location, dynamic regional climate variability, oceanographic processes, and diverse ecosystems. This study aims to examine the long-term (2003–2025) changes of Sea Surface Temperature (SST), Sea Surface Salinity (SSS), and Chlorophyll-a (Chl-a) in the Bay of Bengal through a comprehensive analysis of the high-resolution ECMWF Ocean Reanalysis System 5 (ORAS5) dataset and multi-satellite observations. A significant increasing trend in SST at a rate of 0.0163 °C per year was observed, while SSS showed a gradual decline of −0.0098 PSU per year throughout the years of the study period. The decline in salinity was especially noticeable near the Bangladesh coast due to freshwater inflows from the Ganges–Brahmaputra–Meghna (GBM) river system. Interannual variation in chlorophyll a (Chl-a) concentration was observed to be significant and associated with the El Niño-Southern Oscillation (ENSO). High Chl-a concentrations were observed during La Niña years (2008 & 2011), whereas low Chl-a concentrations occurred during strong El Niño years (2010 & 2016), except the year 2024, which was very high in an El Niño condition. The long-term analysis of Chl-a showed a notable decline in surface productivity at a rate of −0.0268 mg m^{-3} per year until 2023, followed by a positive trend between 2024 and 2025. Our findings emphasize a recent shift in productivity and contribute to the better understanding of the influence of physical oceanographic processes on biological variability in the Bay of Bengal.

Keywords: *Sea Surface Temperature, Chlorophyll-a; ORAS5, Climate Change, ENSO*

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ASSESSMENT OF ANTHROPOGENIC AND NATURAL DRIVERS CONTROLLING INTERANNUAL CHLOROPHYLL-A TRENDS IN THE WORLD'S LARGEST CHOKED LAGOON USING REMOTE SENSING

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Coastal lagoons are affected by eutrophication, yet the drivers of long-term phytoplankton trends remain poorly quantified in optically complex waters. Using the Patos Lagoon (Brazil) as a case study, the anthropogenic and natural drivers controlling interannual chlorophyll-a (Chla) trends over 2002–2022 were assessed. Daily MODIS-Aqua data were atmospherically corrected with OC-SMART and used to estimated Chla with the CONNECT bio-optical model. Census X11 was used to decompose the interannual Chla component. Seasonal Mann-Kendall tests identified significant monotonic trends, and Random Forest regression combined with SHAP analysis quantified the relative influence of land-use, hydrometeorological, oceanographic, and climatic drivers. Significant positive trends (+1.85 to +2.42% year^{-1}) were detected in Casamento Lake, Saco de Tapes, Feitoria Lake, the lower Patos Lagoon, and the estuary, whereas a negative trend (−1.35% year^{-1}) occurred in the lower Guaíba River. SHAP analysis revealed that interannual Chla variability integrates both anthropogenic and natural forcings. Soybean crop expansion in the associated watersheds was the primary driver of positive trends in the lower Patos Lagoon, and ranked among the top drivers in Casamento Lake and Saco de Tapes. Rice cultivation drove positive trends in Feitoria Lake, while grassland and forest loss in the Guaíba watershed contributed to the negative trend. The natural climate indices Multivariate ENSO Index (MEI) and the South Atlantic Subtropical Anticyclone Index (SASAI), along with river discharge, wind gusts, and sea level anomalies also influenced the interannual variability, interacting with land-use changes. This study provides evidence that interannual Chla trends in the Patos Lagoon are driven by agricultural intensification and climate forcing. The remote sensing-based framework is transferable to other optically complex coastal waters worldwide.

Keywords: *Water Quality, Eutrophication, Time-Series Decomposition, Multivariate Analysis, Trend Analysis*

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INSIGHTS FROM THE ESA OCEAN TRAINING COURSE 2025 EXPEDITION: BIO-OPTICAL CHARACTERIZATION OF PHYTOPLANKTON SIZE STRUCTURE AND COMMUNITY COMPOSITION ALONG A TRANSECT FROM THE NORDIC SEAS TO THE MEDITERRANEAN

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Phytoplankton community composition and size structure strongly influence marine carbon cycling, food web dynamics, and primary production, yet remain poorly resolved along many oceanic gradients. We aim to examine phytoplankton size classes and pigment based community composition from measurements collected during the ESA Ocean Training Course 2025 (April–June 2025) aboard the Norwegian tall ship Statsraad Lehmkuhl, which sailed from Tromsø to Reykjavik to Nice and traversed Arctic, North Atlantic and Mediterranean waters, spanning approximately 6,200 nautical miles. The dataset combines discrete water sampling with continuous underway optical observations and satellite ocean colour products. Analysis of HPLC from discrete water samples provides information on phytoplankton pigment composition, which enables a diagnostic pigment analysis to estimate the relative contributions of pico, nano, and microphytoplankton size classes. Independently, filter pad spectrophotometry of particulate absorption will derive phytoplankton absorption spectra, the shape of which can be related to effective cell size and community composition. Discrete chlorophyll a measurements provide point estimates of phytoplankton biomass along the transect, complemented by concurrent CTD profiles, particularly chlorophyll fluorescence. Continuous underway measurements from a WET Labs AC-S spectrophotometer can extend these observations at high spatial resolution along the full route. Lastly, satellite ocean-colour products will place the *in-situ* observations into a broader spatial context. This ongoing study will combine pigment based and spectral approaches to quantify how phytoplankton size structure and community composition vary with region, chlorophyll concentration and physical environment along the transect, and initial results will be presented at the conference.

Keywords: *Phytoplankton Size Structure, Ocean Colour Remote Sensing, Diagnostic Pigment Analysis, Bio-Optical Characterization*

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Abstract ID: TSS/ARSCF/47

POTENTIAL OF ASTAXANTHIN BASED ZOOPLANKTON MONITORING USING OCEAN COLOR REMOTE SENSING IN THE ARABIAN SEA

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Zooplankton are central to marine food webs, carbon cycling, and fisheries productivity, yet their distribution in the Arabian Sea remains less observed because existing measurements rely mainly on limited ship-based sampling. Advances in hyperspectral ocean-colour remote sensing create an opportunity to explore whether astaxanthin, a carotenoid pigment found in several zooplankton groups, can be used as an indirect indicator of astaxanthin-rich zooplankton assemblages. A major limitation is that the regional and species-level occurrence of astaxanthin-rich zooplankton in the Arabian Sea is unexplored. In addition, astaxanthin is not unique to zooplankton and may also be associated with phytoplankton. Therefore, satellite observations alone cannot presently identify zooplankton species with confidence. This study proposes an observation-based framework combining hyperspectral ocean-colour data with *in situ* pigment measurements, zooplankton abundance and biomass, taxonomic identification, and local ecological knowledge from fishing communities and regional monitoring programmes. The study will identify dominant astaxanthin-bearing taxa, their seasonal and geographical distribution. Strengthening *in situ* observations and developing a regional species-pigment database will be essential for evaluating the detectability and limitations of astaxanthin-related optical signals. The study will assess whether satellite ocean-colour observations can detect ecological conditions and zooplankton assemblages associated with elevated astaxanthin, thereby establishing a scientific basis for future zooplankton remote-sensing applications in the Arabian Sea.

Keywords: *Arabian Sea, Ocean Color Remote Sensing, Zooplankton, Astaxanthin*

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ON GAPS IN MARINE ECOSYSTEM AND DIVERSITY DATA IN TROPICAL OCEANS

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When investigating the interplay between the ocean ecosystem and the Earth's climate system, three prime considerations are the biologically-mediated carbon cycle in the oceans, the marine biodiversity and fisheries management. The problem is to observe the ecosystem at the global scale and over long temporal scales, while at the same time, maintaining detailed information at local and regional scales, to facilitate adaptation to climate change and extreme climate events and to plan appropriate mitigation measures. Satellite-based observations have an important role to play in this context, with their demonstrated capability to observe many of the important biological pools and fluxes of the upper ocean and various elements of marine biodiversity at the global scale. But remote sensing is not a stand-alone tool, and relies on *in situ* observations for algorithm development and for product validation. Besides, when dealing with complex systems, it is important to observe the system from multiple vantage points, to investigate coherence and establish confidence. Hence, it is important to have extensive *in situ* datasets that are regionally complete, as a complement to satellite observations. Arguably, a priority should be to establish such observing systems in extreme environments such as the tropics and the polar seas. Yet, publicly available datasets show that key *in situ* observations relating to the structure and function of marine ecosystems are woefully lacking in the tropical waters. Curation of existing data on marine ecosystems and biodiversity, improving public accessibility to the data, and planning field campaigns to fill existing data, become a high priority in this context. Curating existing data, and making it publicly enhances the utility of the data, increases return on investment, and ensures multiple uses of the same data.

Keywords: *Satellite Observations, Marine Ecosystems, Marine Biodiversity, Data Curation, Tropical Oceans*

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ECOSYSTEM BASED MARINE MANAGEMENT IN THE NORWEGIAN WATERS

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Norway has one of the longest coastlines in the world, stretching for over 25,000 kilometers along the North Atlantic Ocean and the Barents Sea. Narrow and deep fjords meet the open ocean and the Norwegian Coastal Current, setting up complex ocean current systems, which in turn make these waters rich in marine living resources. However, the oceans are large, there is a completion for sustainable usage of the ocean space. Economic development along the coast of Norway is a significant focus for the government and people due to its extensive coastline, natural resources, potential for various industries, business development and recreation. Norway's marine and coastal regions have seen developments in several sectors, including oil and gas exploration, fishing, aquaculture, shipping, tourism, coastal infrastructure development and renewable energy – to mention some. Pending on natural living resources and being the second most important export value (after oil and gas), fisheries and aquaculture has a long tradition and is managed in an integrated and holistic marine ecosystems approach. In this respect Norway has defined the management plans for our oceans into four geographically district regions of the Exclusive Economic Zone beyond the coastal baseline: Barents Sea and Lofoten, Norwegian Sea pelagic, Norwegian Sea shelf, North Sea / Skagerrak. In this presentation examples will be given on the environmental data, analysis and assessments forming the basis for the evolving Norwegian marine management plans. Also, the European Copernicus Marine Forecasting System of the Arctic Ocean (ARC-MFC) services, hosted by the Nansen Center will be presented. This is a service that covers physical and biological variables, such as sea-level, temperature, phytoplankton phenology and integrates novel *in-situ* measurements into the Marine Service to extend, the monitoring and forecasting capabilities to coastal hazards such as e.g. harmful algal blooms and marine heat waves.

Keywords: *Marine Management, Ecosystem Assessment, Earth Observations*

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Abstract ID: TSS/ARSCF/50

DEPTH AND DEFLECTION ANGLE OF THE EKMAN CURRENT NEAR THE EQUATOR FOR UNDERSTANDING THE UPWELLING PROCESS IN INDONESIA

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Studies of upwelling processes in Indonesian waters, which are located near the equator, still largely rely on the classical Ekman model, which was developed based on oceanographic processes in regions where the Coriolis effect is relatively strong. However, Indonesia's equatorial location is characterized by a relatively weak Coriolis effect, raising questions about the applicability of the classical Ekman model in this region. Acoustic Doppler Current Profiler (ADCP) data were used to investigate Ekman deflection and the vertical structure of ocean currents. As the ADCP measurements were available only from a depth of 30 m downward, we incorporated OSCAR (Ocean Surface Current Analysis Real-time) data to complement the observations of near-surface currents.The weak Coriolis force and complex circulation dynamics in equatorial regions present challenges when applying classical Ekman theory to near-equatorial waters in the Timor Sea and eastern Indian Ocean, located between 5°S and 12°S. The interpretation of current profiles is particularly complex due to the combined influence of the monsoonal wind system, trade winds, and the Indonesian Throughflow (ITF). The surface Ekman deflection exceeds 45° relative to the wind direction, and the theoretically predicted Ekman depth is greater than that observed. These discrepancies may be attributed to the idealized assumptions of classical Ekman theory, which considers a homogeneous, boundary-free ocean under steady-state conditions.To further isolate the wind-driven current component, tidal currents were removed, yielding a larger number of events satisfying the 180° rotation criterion. However, the velocity did not exhibit the exponential decay with depth predicted by classical Ekman theory.

Keywords: *Ekman Depth, Deflection Angle, Equator, Ekman Current, OSCAR, ADCP*

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Abstract ID: TSS/ARSCF/51

CadalminGPT: AN AI SYSTEM FOR GROUNDED, CITATION-VERIFIED KNOWLEDGE DISCOVERY OVER A LARGE MARINE FISHERIES RESEARCH CORPUS

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ICAR-CMFRI's marine fisheries research has generated a vast body of knowledge that can support scientists, students, policymakers, fishing communities and the wider public. However, much of this knowledge is dispersed across scientific publications, technical reports and institutional repositories. With the growing volume of fisheries literature, it is becoming increasingly difficult for researchers to find relevant studies, trace the development of knowledge, compare findings across studies, and identify unexplored areas or potential research gaps. An intelligent system that can understand natural-language questions and retrieve evidence from a large body of literature can go beyond being a conventional search tool and serve as a useful knowledge-assistance platform for researchers. At the same time, making this knowledge accessible to the wider public remains an important challenge, particularly when scientific information is presented only in technical publications or languages unfamiliar to users. Providing fisheries knowledge in Indian languages can help bridge this gap and bring reliable scientific information closer to people whose lives and livelihoods are directly connected with aquatic resources. In this context, CadalminGPT has been developed as a grounded AI system that enables users to ask questions in natural language and obtain evidence-based answers from a large marine fisheries research corpus. The answers include traceable citations, and the system can indicate when the available literature is insufficient to provide a reliable answer. It aims to make marine fisheries knowledge more accessible and discoverable, helping researchers explore existing knowledge and research gaps while enabling the public and fishing communities to access scientific information in familiar Indian languages.

Keywords: *Artificial Intelligence, Large Language Models, Retrieval-Augmented Generation, Grounded AI, Citation Verification, Marine Fisheries, Knowledge Discovery, Multilingual AI, Research Corpus, Responsible AI*

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Abstract ID: TSS/ARSCF/52

INTEGRATING GIS-AHP SITE SUITABILITY MODELLING WITH FIELD VALIDATION FOR SUSTAINABLE FARMING OF *Kappaphycus alvarezii*: A CASE STUDY FROM THE KACHCHH COAST, INDIA

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Seaweed cultivation is being explored as a nature-based approach to sustainable coastal resource development, providing livelihood opportunities while generating environmental and economic benefits. Despite its growing potential, the expansion of seaweed farming is strongly dependent on the accurate identification of environmentally and operationally suitable cultivation areas. This is particularly relevant along the Kachchh coast of Gujarat, India, where ecological sensitivity and geopolitical considerations can constrain site selection. In the present preliminary investigation, an integrated GIS framework was coupled with Multi-Criteria Decision Analysis and the AHP to spatially assess potential sites for *Kappaphycus alvarezii* cultivation. The suitability assessment was subsequently compared with field observations to examine the reliability of the model-generated site predictions. Thirteen site suitability criteria were standardized, weighted using AHP, and integrated through weighted overlay analysis, with constraint layers applied to exclude environmentally sensitive areas. The resulting map classified sites as most suitable, moderately suitable, least suitable, or unsuitable. Juna Bandar, Luni, Jarapara, Kori, and Padala were selected for cultivation trials using HDPE raft systems over three consecutive 45-day cycles. Mean daily growth rates ranged from 2.83 ± 0.21 to 5.28 ± 0.50% day^{-1}, with Padala (4.88–5.28% day^{-1}) and Juna Bandar (4.74–5.02% day^{-1}) consistently outperforming. Biomass yields varied from 7.56 ± 1.25 to 26.53 ± 1.43 kg FW m^{-2}, with the highest production recorded at Padala and Juna Bandar and the lowest at Kori. The correlation between predicted suitability classes and observed cultivation performance provides encouraging preliminary support for the GIS-AHP framework. Further long-term, multi-season investigations incorporating additional environmental variables and broader field validation are required to refine the model.

Keywords: *Multi-Criteria Decision Analysis, Analytical Hierarchy Process, Seaweed site suitability mapping, Kappaphycus alvarezii, Biomass yield*

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Abstract ID: TSS/ACO/01

ACOUSTIC CHARACTERIZATION OF DEEP SCATTERING LAYERS AND DIEL VERTICAL MIGRATION OF MESOPELAGIC FISHES IN THE SOUTHEASTERN EQUATORIAL INDIAN OCEAN

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Mesopelagic fishes are major constituents of oceanic deep scattering layers (DSLs) and play important roles in trophic energy transfer and vertical carbon transport. Present study investigated the distribution and diel vertical migration (DVM) of mesopelagic organisms in the southeastern equatorial Indian Ocean using calibrated split-beam echosounder (EK60) data collected during the FORV Sagar Sampada Cruise 344 (06–17 September 2015). Acoustic data were processed in Echoview 14.1 to estimate volume backscattering strength (Sv) and target strength (TS), and were integrated with trawl catches and environmental observations. A distinct DSL occurred between 200 and 400 m depth during daytime, with backscatter values ranging from -74 to -55 dB. Acoustic and trawl observations revealed that myctophid fishes dominated the DSL and migrated toward surface waters at night, indicating pronounced DVM behaviour. TS estimates derived from empirical TS-length relationships for Diaphus species ranged from -58 to -45.34 dB. Single-target detection analysis further supported the identification of dominant scattering organisms through consistent clustering patterns. The integration of fisheries acoustics, biological sampling, and environmental observations provides valuable insights into the structure and dynamics of mesopelagic communities in the western equatorial Indian Ocean. These findings contribute to improving our understanding of mesopelagic fish ecology and provide a baseline for future studies of biomass estimation, trophic interactions, and the ecological role of deep scattering layer communities.

Keywords: *Fisheries acoustics, Deep Scattering Layer, Myctophids, diel vertical migration, and marine ecosystem*

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Abstract ID: **TSS/ACO/02**

SHORT-TERM VARIABILITY OF THERMAL INVERSIONS AND SUBSURFACE CHLOROPHYLL-a IN THE SOUTH ANDAMAN SEA DURING FEBRUARY 2024

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The Andaman Sea is a semi-enclosed marginal sea in the northeastern Indian Ocean. Strong upper-ocean stratification, complex circulation, and energetic internal tides make it an ideal region for investigating physical–biological interactions. However, high-resolution *in situ* observations of short-term hydrographic and biological variability remain limited. This study investigates the spatial and temporal variability of thermal inversion and subsurface chlorophyll-a in the southern Andaman Sea using observations collected during the Bay of Bengal Transition Circulation Experiment aboard INS Sagardhwani in February 2024. Time-series observations were conducted at three stations near the Andaman Ridge, a known internal tide generation region. Hydrographic and meteorological data were collected using CTD, ADCP, X-band radar, and an Automatic Weather Station. The northern station exhibited thermocline oscillations exceeding 40 m, indicating strong internal tide activity. Enhanced vertical mixing weakened the barrier layer and maintained a shallow subsurface chlorophyll-a maximum (<25 m). In contrast, the southern and eastern stations experienced weaker internal tide activity, stronger barrier layers, and deeper chlorophyll maxima (>40 m). Thermal inversion became more prominent at the southern and eastern stations after 19 February, occurring above 60 m depth, with a maximum inversion of ~0.7°C at the eastern station on 20 February. Density profiles remained stably stratified, indicating that these inversions did not cause gravitational instability. Semi-diurnal variability in thermal inversion and chlorophyll-a suggested modulation by internal tides. Stronger thermal inversions were associated with deeper, thinner, and less intense chlorophyll maxima. These observations provide new field evidence of the role of internal tides in regulating upper-ocean hydrography and subsurface biological structure in the Andaman Sea.

Keywords: *Thermal Inversion, Chlorophyll Maxima, Internal Tides, Barrier Layer, Andaman Sea*

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Abstract ID: TSS/ACO/03

HYDROGRAPHIC VARIABILITY OF THE COCHIN ESTUARY AND ADJACENT COASTAL WATERS DURING THE SOUTHWEST MONSOON: INFLUENCE OF COASTAL UPWELLING AND TIDAL FORCING

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The Cochin estuary, located along the southwest coast of India, is connected to the south-eastern Arabian Sea through a narrow barmouth. The estuary receives substantial freshwater discharge during the southwest monsoon, while the adjoining coastal waters experience intense wind-driven upwelling. The interaction between these contrasting water masses, together with tidal forcing, governs the hydrographic and biogeochemical characteristics of the estuarine–coastal system. Hydrographic observations were conducted in the estuary, barmouth, and adjoining coastal waters during August–September 2024 using CTD measurements, current observations, and water sample analyses. Daily observations were carried out for 30 days, covering one lunar tidal cycle, while CTD profiles were collected at three-hour intervals at the barmouth. Estuarine waters remained approximately 2–4°C warmer than coastal waters during most of the observation period. Strong alongshore wind stress until 14 August intensified coastal upwelling, which persisted until 22 August and weakened thereafter. Despite cold upwelled water below 2 m depth, the upper layer remained warm (28–30°C) due to riverine freshwater influx. Upwelled water was observed in the barmouth subsurface layers (2–14 m) until 22 August and showed strong ebb–flood variability in temperature and salinity. Enhanced intrusion of cold and nutrient-rich coastal water into the inner estuary occurred during neap tides (12–15 and 23–29 August 2024). Cooler and more saline water extended through the subsurface up to the Murinjapuzha transect. Elevated chlorophyll-a and nutrient concentrations indicated enhanced coastal-estuarine exchange. The results highlight the combined influence of monsoon winds, freshwater discharge, coastal upwelling, and tidal forcing on hydrographic and biogeochemical variability. Nearshore upwelling was primarily controlled by alongshore wind stress.

Keywords: *Cochin Estuary, South-Eastern Arabian Sea, Coastal Upwelling, Tidal Forcing, Hydrography*

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Sub theme

5 & 6

Integrating Indigenous and Traditional Knowledge into Aquatic Sciences
Role of Women and Marginalised Communities for Sustainable Development

Abstract ID: **TSS/ITK_RWF/01**

THE SOUTHWEST MONSOON AS A MARINE SEASON: INDIGENOUS MUKKUVAR UNDERSTANDING FROM THE SOUTH KERALA-KANYAKUMARI COAST

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The Southwest monsoon is commonly understood in South Asia through its influence on rainfall, agriculture, and terrestrial environments. This paper explores how Indigenous Mukkuvar fishers of the South Kerala – Kanyakumari coast understands the southwest monsoon, locally known as Aaniyadi or Kuluthi, as a marine season. Drawing on Indigenous and experiential knowledge, fishers interpret the onset, progression, and intensity of the monsoon through observations of ocean swells (uyavu), currents (valivu, and oottu), cloud formations, sea temperature, fish behaviour, wind direction (kachan kondal kathu), wave direction (melakkadal), changes in the coastal waters and shoreline dynamics, and changing sea conditions rather than through rainfall on land. Traditionally, the Kuluthi season has been associated with cooler ocean waters, rough seas (melakkadal), seasonal abundance of fish (melameenu), and some of the most productive fishing periods for small-scale artisanal fishers. At the same time, the season is recognised as one of heightened risk, marked by turbulent seas (chelukedu), strong waves (aanakkadal), and challenging fishing conditions. The paper further examines how fishers perceive ongoing climate-related changes, including shifts in ocean temperature, changing sea conditions, and declining presence of fish species historically associated with the monsoon season. By foregrounding Mukkuvar knowledge systems, the paper argues that the southwest monsoon is not merely a meteorological phenomenon but lived marine season understood through long-term relationships between people, ocean processes, and coastal livelihoods.

Keywords: *Southwest Monsoon, Mukkuvar Knowledge Systems, South Kerala- Kanyakumari Coast, Marine Season*

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Abstract ID: **TSS/ITK_RWF/02**

TRADITIONAL KNOWLEDGE AND MODERN SCIENCE: TOWARDS INTEGRATION AND SYNERGIES

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Traditional Knowledge Systems were used worldwide to efficiently manage natural ecosystems since the dawn of time. Local people observed natural phenomena, analysed and recorded changes and transmitted their knowledge to the next generations. The rich and diverse land and ocean ecosystems were reflected by the rich and diverse cultures of their custodians. A deep understanding of the importance of our connection to lands, rivers and oceans was embodied in our sacred role as its custodians. Modern times have seen a strong decline in both environmental and cultural diversity, and a breakdown of the transmission lines to the next generations of a wealth of environmental knowledge. In parallel, modern science has made huge breakthroughs in environmental sciences, often based on methodological/technological advances. We propose an open discussion on how to efficiently integrate these different knowledge systems and develop synergies to better understand and manage our natural environment in the context of a fast changing world. The key topics discussed will include: - How to work together (Local/Indigenous Knowledge Holders and Scientists). - Speaking the 'same language' and handling information from different sources (Traditional Knowledge was often recorded and transmitted through different channels/media such as oral traditions, initiations/apprenticeships, ceremonies, visual arts and written records). - Women as major holders of traditional knowledge ('Earth' Literacy versus 'Academic' Literacy). - Valorisation and Transmission of traditional knowledge to future generations. - Synergies: from new research projects using advanced scientific knowledge together with Local/Indigenous knowledge, to new ways to present modern science to reach a wider public (e.g., Arts and Science projects). Examples will be provided from Morocco and Australia, from the impact of episodic floods on coastal fisheries to long-term environmental changes.

Keywords: *Traditional, Indigenous, Women, Earth Literacy*

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Abstract ID: **TSS/ITK_RWF/03**

BRIDGING INDIGENOUS KNOWLEDGE AND DIGITAL OCEAN SCIENCE: THE AFRICAN OCEAN BIODIVERSITY ATLAS FOR INCLUSIVE AQUATIC GOVERNANCE

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The African Ocean Biodiversity Atlas, a UN Ocean Decade project, demonstrates how indigenous and traditional knowledge can be integrated into aquatic sciences through community-led marine data collection and digital ocean innovation. Across African coastal communities, local fishers and traditional resource users are documenting fisheries, mangroves, seagrass meadows, seaweed habitats, and other blue carbon ecosystems using participatory mapping and biodiversity monitoring approaches. The initiative incorporates indigenous and traditional names of marine species, fishing grounds, habitats, and ecological indicators into digital systems, preserving cultural heritage while strengthening scientific datasets. By combining local ecological knowledge with geospatial technologies, citizen science, and biodiversity databases, the Atlas creates an inclusive platform that supports evidence-based decision-making for policymakers, researchers, conservation practitioners, and private-sector stakeholders. The integration of traditional knowledge systems improves the understanding of ecosystem changes, fisheries dynamics, and climate resilience strategies within coastal regions. The presentation highlights how digital ocean applications can promote equitable ocean governance, strengthen community participation in marine conservation, and enhance the uptake of Nature-Based Solutions across Africa. The African Ocean Biodiversity Atlas provides a scalable model for integrating cultural knowledge into sustainable ocean management and blue economy development.

Keywords: *Fisheries, Blue Carbon, Technology, Atlas, Africa*

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Abstract ID: **TSS/ITK_RWF/04**

CO-PRODUCTION OF KNOWLEDGE ABOUT PHYTOPLANKTON IN COASTAL NORTHWEST ALASKAN WATERS

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The Arctic is warming at more than twice the rate as the rest of the planet with subsequent changes to the microbial population. The coastal community of Kotzebue is located just north of the Arctic Circle on the northwest coast of Alaska. Kotzebue Sound is commercially and culturally important to the local community, which harvests on average 230,000 chum salmon, and the fish and marine mammals from the Sound provide up to 70% of their annual food harvest by weight. Yet little is known about microbes in these waters and how phytoplankton that form the base of the foodweb may be changing. A weekly journal maintained by Alex Whiting, Environmental Program Director for the Native Village of Kotzebue (NVOK) first noted the incidence of cyanobacterial blooms off Kotzebue in 2008 that was subsequently identified as cyanotoxin containing species of *Aphanizomenon* sp., *Nodularia* sp., and *Dolichospermum* sp. I will report about our ongoing work in collaboration with the Native Village of Kotzebue to investigate the changes to phytoplankton populations in these waters.

Keywords: *Arctic, Phytoplankton, Cyanohabs, Co-Production of Knowledge*

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Abstract ID: **TSS/ITK_RWF/05**

FROM TECHNOLOGY TO TRANSFORMATION: CMFRI'S BIVALVE FARMING INITIATIVE FOR THE SOCIO-ECONOMIC EMPOWERMENT OF WOMEN AND SCHEDULED CASTE COMMUNITIES

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Aquaculture has emerged as one of the fastest-growing food production sectors globally, playing a vital role in food security, nutrition, employment, and livelihood generation. Among aquaculture commodities, bivalve molluscs such as mussels, oysters, and clams are increasingly recognized as sustainable aquatic food resources due to their high nutritional value, low environmental footprint, and economic feasibility. In India, the development and dissemination of mussel and oyster farming technologies by the Central Marine Fisheries Research Institute (CMFRI) have significantly transformed bivalve culture into a profitable and sustainable livelihood enterprise for coastal communities. Kerala has emerged as a pioneering state in the adoption of bivalve farming, supported by effective technology transfer, institutional interventions, and community-based approaches. A notable feature of this success is the active participation of women, particularly through Self-Help Groups (SHGs), with women managing a substantial proportion of bivalve farming enterprises, enabling income generation, financial inclusion, enhanced decision-making capacity, leadership development and improved socio-economic status. The collective functioning of SHGs has strengthened social capital, entrepreneurship and community participation, thereby contributing to gender equity and women empowerment. CMFRI has further extended the benefits of sustainable aquaculture to marginalized communities through its Scheduled Caste Sub Plan (SCSP), which aims to improve the livelihoods of Scheduled Caste households through targeted aquaculture interventions. The promotion of bivalve farming under the SCSP has demonstrated significant potential as a low-cost and environmentally sustainable livelihood option. The combined experiences of women-led SHG enterprises and SCSP-supported marginalized households highlight the transformative role of bivalve aquaculture in advancing sustainable development.

Keywords: *Bivalve Aquaculture, Women Empowerment, Self-Help Group (SHG), Scheduled Caste Communities, Sustainable Livelihoods*

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Abstract ID: **TSS/ITK_RWF/06**

INTEGRATED BLACK SOLDIER FLY BREEDING AND EARLY LARVAL PRODUCTION UNIT: A SUSTAINABLE AND INCLUSIVE APPROACH FOR COMMUNITY-BASED BIORESOURCE UTILIZATION

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Black Soldier Fly (BSF), *Hermetia illucens*, farming has emerged as an attractive approach under the framework of the circular bioeconomy, due to the growing demand for sustainable waste management solutions and alternative protein sources. However, the conventional BSF breeding and production of early larvae systems usually require constant maintenance of technical infrastructure and electricity, which may create challenges to take up by the women, the smallholder entrepreneurs and the marginalised communities. In response to these challenges, the present study introduces an integrated Black Soldier Fly (BSF) breeding and early larval production unit developed and patented by ICAR-CMFRI. The patented unit integrates adult breeding, egg collection, hatching and early larval rearing into a single, compact system which is easy to install, operate and maintain. It is designed in such a way to minimize energy consumption as well as technical complexity, thereby allowing the efficient operation of the system. Field observations and operational assessments were conducted to evaluate performance, maintenance requirements, larval productivity, and user accessibility under practical conditions. Results showed that the integrated unit reduced the dependence of electricity and maintenance needs while maintaining consistent egg production and healthy larval development. The patented BSF breeding and early larval production unit developed by ICAR-CMFRI offers a scalable, community-based solution for social inclusion and sustainable development in resource-limited areas.

Keywords: *Black Soldier Fly (BSF), Hermetia Illucens, Women Empowerment, Marginalized Communities, Sustainable Development*

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Abstract ID: **TSS/ITK_RWF/07**

OPPORTUNITIES AND CHALLENGES FOR WOMEN, SOCIAL EQUITY AND SUSTAINABLE DEVELOPMENT

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Through their roles in environmental preservation, economic productivity, social cohesion & community resilience, women and marginalized communities play a vital role in sustainable development. However, their participation in decision-making is often hindered by persistent disparities related to gender, caste, ethnicity, education, work, healthcare & resource access. This essay explores the links between social justice, women's empowerment and sustainable development, emphasizing the challenges and opportunities of inclusive growth. Key challenges include poverty, discrimination, unequal access to land and finances, limited educational and healthcare opportunities, and underrepresentation in governance. Climate change and socioeconomic instability intensify these issues, particularly in rural & vulnerable areas. Despite these obstacles, women and marginalized groups have become significant change agents, leveraging community engagement, traditional ecological knowledge, sustainable livelihoods, self-help organizations, and grassroots leadership. The research highlights that achieving sustainable development requires socially inclusive policies and gender-responsive governance to ensure equal participation and resource availability. It discusses the importance of education, capacity building, entrepreneurship, digital inclusion, and community development in fostering socioeconomic empowerment. The findings align with several UN Sustainable Development Goals, including those focused on gender equality, reducing inequities, poverty alleviation, climate action & sustainable communities. In conclusion, the study posits that social justice and women's empowerment are vital to sustainable development. Enhancing institutional support, promoting participatory governance, ensuring inclusive policy implementation are essential for building resilient societies capable of addressing future environmental and socioeconomic challenges.

Keywords: *Women Empowerment, Sustainable Development, Social Equity, Marginalised Communities,Socio-economic Development, Community Participation and Climate Resilience*

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SEAWEED FARMING AS A SUSTAINABLE PATHWAY FOR EMPOWERING WOMEN AND MARGINALISED COASTAL COMMUNITIES

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Over the years, scientific advances have improved seaweed farming and harvesting methods, leading to major changes in the livelihoods of fishing communities around the world. According to FAO (2024), women make up about 24 percent of the total fisheries and aquaculture workforce, and 54 percent of these women work full-time. In India, 4.8 million women are engaged in small-scale fisheries, contributing to the sector. Seaweed is harvested from the sea by approximately 5,000 fishers in Palk Bay and Gulf of Mannar regions of Tamil Nadu, while more than 2,000 fishers are actively engaged in seaweed farming. Of these seaweed farmers, about 70 percent are women. The ICAR-CMFRI, Mandapam Regional Centre is designated as Centre of Excellence on Seaweeds by Department of Fisheries, Government of India. It is undertaking various research & development activities on seaweeds and periodically undertakes various capacity building activities. As a part of promotion of seaweed farming activity, nearly 200 women and marginalised fisher families were benefited, by providing bamboo rafts/monoline units and around 500 families through technical guidance across several sites in the districts of Ramanathapuram, Pudukottai, and Thanjavur in Tamil Nadu. A seaweed cultivator with 45 rafts earns about ₹2,00,000 in net income annually. Collectors make about 10-12 trips per month and earn around ₹10,000–15,000 per month. Since BCR is more than 3.0, the farming/collection has very high economic efficiency. Through seaweed farming, the social and economic status of fish farmers, including women, has improved. Furthermore, regular income from seaweed activities led to improved school enrolment among children living in coastal villages. It is evident that seaweed farming empowers the woman farmer in financial management and decision-making, both in the household and on her farm.

Keywords: *Seaweed Farming, Fisherwomen; Marginalised Coastal Communities, Sustainability*

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COMMUNITY DRIVEN COASTAL STEWARDSHIP IN SOUTHERN SRI LANKA: WOMEN, YOUTH AND SMALL SCALE FISHERS ADVANCING SUSTAINABLE MARINE FUTURES

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Small-scale fisheries remain central to food security and coastal livelihoods across Sri Lanka, yet these communities are under mounting pressure from mechanised industrial fleets, coastal development, and climate-driven environmental degradation. This study examines community-based stewardship practices in fishing villages across Galle, Matara, and Hambantota districts in the Southern Province, drawing on participatory surveys, semi-structured fisher interviews, and community workshops facilitated by a university-based research team. We document a rich body of indigenous ecological knowledge embedded in traditional fishing practices. Beach seine fishers using madal nets apply multigenerational observational expertise reading water colour, tracking seabird behaviour, and coordinating collective harvests to determine fishing seasons and locate fish schools with a precision that formal stock assessments rarely capture. These knowledge systems are not relics; they actively structure local resource governance. The study also foregrounds the often-overlooked contributions of women and youth to coastal stewardship. Women-led cooperatives are driving mangrove restoration initiatives that protect nursery habitats and reinforce shoreline resilience, while youth volunteers carry out participatory environmental monitoring and deliver school-based conservation education forming a critical bridge for intergenerational knowledge transfer. These findings challenge the framing of marginalised fishing communities as passive resource users. The communities documented here are active environmental stewards whose governance practices deserve institutional recognition and policy support. As national and international frameworks including the Kunming-Montreal Global Biodiversity Framework and the SDGs seek pathways toward equitable ocean management, locally embedded knowledge and community-driven governance offer not just case studies, but models worth building from.

Keywords: *Small Scale Fisheries, Women in Coastal Communities, Community Based Conservation, Traditional Ecological Knowledge, Sri Lanka*

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Sub theme 7

Water Quality Monitoring: Safeguarding Human Health

Abstract ID: **TSS/WQM/01**

DEVELOPMENT OF A ROBUST MULTIPLEX PCR ASSAY FOR SIMULTANEOUS DETECTION OF MAJOR PATHOGENIC *Vibrio* spp. HAVING HUMAN HEALTH AND WATER QUALITY CONCERN

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Vibrio spp. causes a major threat to public health and global aquaculture stability through food and water contamination. It causes diseases which extend from gastroenteritis to septicimia. Compared to conventional polymerase chain reaction (PCR)-based assays, multiplex PCR facilitates rapid, simultaneous identification of pathogens with high efficiency. In this study, we developed a multiplex PCR assay for simultaneous detection of *Vibrio cholerae*, *Vibrio parahaemolyticus*, *Vibrio vulnificus*, *Vibrio fluvialis*, and *Vibrio mimicus* with internal amplification control and genus specific controls which promotes procedural safeguard. A detection limit of 0.4 ng for *V. parahaemolyticus* and *V. cholerae*, 1 ng for *V. vulnificus*, 3 ng for *V. fluvialis*, and 0.2 ng for *V. mimicus* DNA per µL was demonstrated by this optimized mPCR. The 16SrRNA gene and total vibrios had a detection limit of 2 ng total DNA per µL. The mPCR's minimal detection limit for bacterial counts was 1000 CFU for *V. parahaemolyticus*, 800 CFU for *V. vulnificus*, 600 CFU for *V. cholerae*, 1600 CFU for *V. fluvialis*, and 26 CFU for *V. mimicus* per 25 µL. Specificity was confirmed using 88 unique bacterial strains with no cross-reactions in non-target species. The operational stability was confirmed by repeatability testing that yielded consistent amplification patterns across distinct days, and different reagent batches by two separate operators. To conclude, mPCR assay optimized in this study enables simultaneous, sensitive and robust detection of vibrios with broader pathogen coverage and stronger internal validation.

Keywords: *Water Quality, Seafood Pathogens, One Health, Internal Amplification Control*

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Abstract ID: **TSS/WQM/02**

WATER QUALITY MONITORING THROUGH PHYTOPLANKTON INDICATORS: ASSESSING ECOSYSTEM HEALTH IN NANDA LAKE, GOA

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Nanda Lake, a Ramsar-designated wetland in Goa, is an important freshwater ecosystem that supports biodiversity and provides essential ecosystem services. The effective water quality monitoring is critical for safeguarding ecosystem integrity and human health, particularly in water bodies exposed to increasing anthropogenic pressures. This study investigated the spatio-temporal dynamics of phytoplankton communities and their relationship with physicochemical characteristics as indicators of water quality in Nanda Lake. The water samples were collected from five stations over seven months (August 2025-March 2026) to assess physicochemical parameters, nutrient concentrations, photosynthetic pigments, and phytoplankton diversity. The temperature ranged from 23-30 °C, pH from 6.14-7.39, dissolved oxygen from 2.27-8.62 mg L^{-1}, and biological oxygen demand from 0.23-4.31 mg L^{-1}. The nutrient concentrations exhibited considerable spatial and temporal variability, while pigment analysis revealed seasonal fluctuations in phytoplankton biomass, with the highest concentrations recorded in March. The diversity assessment using the Shannon-Wiener and Simpson's indices indicated low to moderate phytoplankton diversity and periods of high species dominance. The indicator taxa, including *Navicula*, *Oscillatoria, Cyclotella, Merismopedia*, *Scenedesmus*, and *Synedra*, were recorded across sampling stations. The occurrence of these taxa, coupled with nutrient enrichment patterns, suggests mesotrophic conditions and localized organic pollution stress within the lake. These findings highlight the utility of phytoplankton as sensitive bioindicators for water quality assessment and early detection of ecological deterioration, providing baseline information for the sustainable management and conservation of Nanda Lake while supporting the protection of freshwater resources and human well-being.

Keywords: *Water Quality Monitoring, Phytoplankton Bioindicators, Ramsar Wetland, Nutrient Dynamics, Ecosystem Health, Human Health*

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Abstract ID: **TSS/WQM/03**

WATER QUALITY AND COASTAL ECOSYSTEM HEALTH IN SOUTHEAST ARABIAN SEA: INSIGHTS FROM A WATER QUALITY NOWCASTING SYSTEM

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Coastal waters of Southeast Arabian Sea is highly influenced by seasonally reversing monsoon, fresh water discharge and intense anthropogenic interventions that causes large shift in coastal waters. This study presents three years of high frequency biogeochemical observations and their impact on key water quality parameters in the nearshore waters Off Kochi, a major ecological hotspot. Real time measurements of parameters including temperature, salinity, dissolved oxygen (DO), pH, pCO2, chlorophyll-a, turbidity, coloured dissolved organic matter (CDOM), dissolved methane, and hydrocarbons were obtained from the first Water Quality Nowcasting System (WQNS) of India supported by monthly field surveys during the period May 2022-July 2025. Warm, saline oligotrophic waters of pre-monsoon (PRM) shifted to turbid, cool, fresh, nutrient rich and highly productive water with the onset of monsoon (MON). Post monsoon (POM) exhibited gradual recovery to pre-monsoon baselines. Severe hypoxia and extreme AOU was exhibited by monsoon which also depicted an oscillating metabolic balance of coastal waters. Surface pCO_2 exceeded 500 ppm during strong upwelling events, indicating enhanced CO_2 outgassing while dissolved methane remained supersaturated in all seasons. Hydrocarbon levels showed a steady state contamination during PRM and early monsoon spike due to the first flush mobilisation. Water quality tends to decline from excellent to poor during monsoon. The dominant driver is identified as upwelling during MON and thermal stratification during PRM. Intermittent contamination events were detected, demonstrating the ability of continuous monitoring to overcome the limitations of conventional sampling and support pollution control strategies and ecosystem health assessment.

Keywords: *Water Quality Nowcasting System, Arabian Sea, Upwelling, Trophic Status, Coastal Water Quality*

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Abstract ID: **TSS/WQM/04**

DUAL ROLE OF ALGAL BLOOMS IN INDIAN COASTAL WATERS: FROM ENHANCED PRODUCTIVITY TO TROPHIC DISRUPTION

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Algal blooms are a ubiquitous feature of aquatic ecosystems, playing a paradoxical role in sustaining primary productivity while simultaneously posing risks through the alteration of trophic pathways, biodiversity loss and impact human health. A total of 103 bloom events have been reported from the Arabian Sea, whereas 70 events have been documented from the Bay of Bengal along the west and east coast of India respectively. In the Arabian Sea, dinoflagellate blooms are predominant (53 occurrences) followed by cyanophytes (23 occurrences) and diatoms (18 occurrences). In contrast, the Bay of Bengal is dominated by diatom blooms (28 occurrences) followed by dinoflagellates (21 occurrences) and cyanophytes (19 occurrences). These regional disparities are largely governed by contrasting environmental conditions. Seasonal upwelling in the Arabian Sea enhances nutrient availability, often triggering diatom blooms. For instance, a concurrent bloom of diatoms such as (*Chaetoceros gracilis*, Pseudo-*Nitzschia seriata*, *Skeletonema costatum*, *Bacteriastrum* sp., *Leptocylindrus danicus*) that occurred in off Mumbai coast ((19°N)) resulted in an average chlorophyll a concentration 7 mg/m3, representing a 6-7 fold increase as compared to non-upwelling periods. Conversely, certain bloom-forming species produce toxins that disrupt trophic transfer, affecting higher trophic levels. The dinoflagellate bloom *Noctiluca scintillans* and *Gymnodinium wulfii* in the coastal waters of Shastri estuary resulted in a 15-fold decline in copepod density, likely due to the formation of a toxic layer during bloom conditions. Similarly, bloom of cyanophyte *Merismopedia* sp. in Ulhas estuary and chlorophyte *Tetraspora gelatinosa* in Veraval led to single species dominance, suppressing other phytoplankton groups such as diatoms, dinoflagellates, ultimately reducing overall species diversity. Thus, algal blooms can enhance productivity simultaneously they can also disrupt trophic pathways and biodiversity.

Keywords: *Algal Bloom, Upwelling, Trophic Disruption, Chlorophyll a, Biodiversity*

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Abstract ID: **TSS/WQM/05**

CLIMATE AND ANTHROPOGENIC DRIVEN HYDROLOGICAL ALTERATIONS AND THEIR IMPACTS ON WATER QUALITY IN CHILIKA LAGOON: A MULTI-DECADAL REMOTE SENSING ANALYSIS (2015–2025)

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Chilika Lagoon, India's largest coastal lagoon ecosystem, faces unprecedented environmental pressures from rapid urbanisation, agricultural expansion, and climate variability. This study examines the interplay between anthropogenic and climate-driven hydrological alterations on water quality dynamics in Chilika Lagoon over the past decade (2015–2025). Using multi-temporal Landsat and Sentinel-2 imagery, we quantified spatiotemporal LULC transformations and their associated hydrological consequences. Water quality parameters, including chlorophyll-a, turbidity, and total suspended matter (TSM), were retrieved from Landsat, Sentinel-2, and MODIS data through spectral analysis and machine learning algorithms. Further, climate-driven hydrological changes were assessed by analysing temperature and precipitation patterns alongside sea level rise to understand their influence on lagoon hydrology and water quality. Our findings reveal significant LULC transitions, particularly the conversion of wetlands to agricultural, aquaculture, and urban areas, which correlate with measurable shifts in water quality indicators. Climate-driven changes in precipitation regimes and temperature patterns have intensified hydrological variability, exacerbating nutrient loading and eutrophication processes. The integrated analysis demonstrates that LULC changes and climate-driven hydrological alterations act synergistically, deteriorating the water quality, with anthropogenic activities amplifying the vulnerability of this ecologically sensitive lagoon system. These results highlight the need for integrated adaptive management to sustain the ecological integrity and socioeconomic functions of Chilika Lagoon.

Keywords: *LULC Change, Water Quality, Chilika Lagoon, Hydrological Dynamics, Anthropogenic Impacts*

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INVESTIGATING SEASONAL SHIFTS IN PHYTOPLANKTON COMMUNITIES AS INDICATORS OF EUTROPHIC STRESS IN TELUK BAHANG COASTAL WATERS

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Due to its threat to marine ecosystems, Eutrophication monitoring is a vital SDG indicator, namely SDG 14.1.1(a). Its effects are fairly evident in the coastal waters of Teluk Bahang, Penang. Extensive aquaculture, boating and recreation activities along with prolonged negligence in water quality monitoring have increased the vulnerability of this area to eutrophication, resulting in massive fish kill events and Harmful Algal Blooms. This study examines the present water quality at Teluk Bahang using data collected through the GEM-in-a-Box Toolkit, a pilot program aiming to achieve a comprehensive global eutrophication monitoring. Water sampling was conducted across three stations – Reference Zone, Aquaculture Zone & Boating Zone, with their respective near shore and offshore sites. Wet and dry season sampling were conducted on November 2025 and January 2026, respectively.

In situ profiling utilized CTD Diver and miniDOT logger. Notably, DO% profiling showed concerning Anoxic regions in the Boating Zone. Nutrient analysis using HACH Spectrophotometer showed Total Inorganic Nitrogen ranged from 0.10 ± 0.06 to 0.50 ± 0.06 mg/L; Soluble Reactive Phosphorous ranged from 0.03 ± 0.01 to 0.09 ± 0.02 mg/L & Total Reactive Silica ranged from 1.60 ± 0.89 to 3.77 ± 0.50 mg/L across the sampling events. Chlorophyll a peaked at 13.69 ± 1.79 mg/L and 34.81 ± 2.55 mg/L during the wet and dry seasons respectively. Preliminary plankton analysis showed *Bellerochea* sp. and *Odontella* sp. as the dominant genera. Consequently, TRIX index were compared on the Vollenweider Trophic scale (0-8) across the sites reached upto 6.45 and 6.31 in the wet and dry seasons respectively, indicating poor water quality. By identifying the extent and the causes of eutrophication at Teluk Bahang, this study provides policymakers with actionable baselines to mitigate HAB risks and protect coastal public health. It also validates the GEM Toolkit's practicality for routine coastal eutrophication monitoring.

Keywords: *Eutrophication Monitoring, Harmful Algal Blooms (HABs), Aquaculture Sustainability, Coastal Health, Water Quality Monitoring*

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Abstract ID: **TSS/WQM/07**

ASSESSING OCEANOGRAPHIC DRIVERS LEADING TO A MASS STRANDING OF *Porpita porpita* (LINNAEUS, 1758) ALONG THE GOPALPUR COAST, NORTH-WESTERN BAY OF BENGAL

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A mass beach stranding of the blue button jellyfish, *Porpita porpita* (Linnaeus, 1758), was recorded on 17 April 2025 along the Gopalpur coast in the northwestern Bay of Bengal. To investigate the environmental factors associated with the event, satellite-derived datasets of sea surface temperature (SST), chlorophyll-a (chl-a), wind, sea surface currents, and sea surface salinity were analysed for the period 1–17 April 2025. Persistent south-westerly to southerly onshore winds (4–10 m s^{-1}), which intensified the shoreward transport of the pleustonic colonies, resulting in a mass beach stranding. The combined influence of onshore winds and alongshore surface currents enhanced passive coastward advection, resulting in the accumulation of *P. porpita* along the shoreline. SST varied between 28.6 and 29.2°C, corresponding to the favourable thermal range of the species, and exhibited positive anomalies of 0.1–1.3°C relative to the 2015–2024 climatology. Elevated nearshore chl-a concentrations (>1 mg m^{-3}) indicated enhanced primary productivity and potentially favourable feeding conditions. Additionally, the unusually high abundance of associated barnacles within stranded colonies suggests ecological interactions that may influence the distribution and persistence of the *P. porpita* population. The results also demonstrate that the coupled interaction of favourable thermal conditions, enhanced biological productivity, and wind-driven physical transport played a critical role in triggering the stranding event. These findings contribute to a better understanding of gelatinous zooplankton stranding mechanisms and highlight the importance of developing early warning and monitoring systems for vulnerable coastal regions of India.

Keywords: *Jellyfish, Pleuston, Beach Stranding, Sea Surface Temperature, Surface Current*

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ASSESSMENT OF MARINE POLLUTION AND ITS MULTIDIMENSIONAL IMPACTS ON FISHERIES SUSTAINABILITY AND PUBLIC HEALTH IN COASTAL ANDHRA PRADESH, INDIA

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Marine pollution has emerged as a critical threat to India's extensive coastline, driven by rapid industrialization, urbanization, and agricultural runoff. The present study examines the complex interactions between anthropogenic pollutants and the marine ecosystem, specifically focusing on how these stressors propagate from microbial communities through the food web to impact fisheries and human health. India, with its diverse marine biodiversity and heavy economic reliance on the blue economy, faces significant risks from heavy metals, microplastics, and chemical effluents that degrade water quality and alter biogeochemical cycles. The present study investigates toxin bioaccumulation in commercially important species such as Indian mackerel and Blue Swimming Crab, assessing how pollutants cause endocrine disruption, reduced reproductive success, and declining fish stocks that undermine coastal economies, while also evaluating human health risks associated with consuming contaminated seafood containing heavy metals and pathogens, which can lead to gastrointestinal illnesses as well as long-term neurological and developmental disorders. Overall, the study emphasizes the need for innovative aquaculture technologies, sustainable farming practices, robust monitoring frameworks, and evidence-based policy strategies to safeguard India's marine resources and seafood supply chain through a multidisciplinary approach integrating marine biology, environmental science, and public health.

Keywords: *Marine Pollution, Fisheries Sustainability, Human Health Risks, Satellite Oceanography, Biogeochemical Cycles.*

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MOLECULAR SURVEILLANCE OF FREE-LIVING PATHOGENIC AMOEBAE IN FRESHWATER SYSTEMS OF KERALA

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Free-living amoebae, ubiquitous protists in aquatic ecosystems, are increasingly recognised as opportunistic pathogens capable of causing rare but often fatal amoebic encephalitis. Recently, they have emerged as a public health concern in Kerala, India, due to recurring cases of encephalitis. Most infections were reported among individuals who swam in pond water, with clinical investigations linking these to *Naegleria* and *Acanthamoeba*. The rising incidence, coupled with deteriorating water quality and links to climate change and anthropogenic pollution, underscores the need for molecular surveillance of amoebae in water bodies and recreational pools. In this study, surveillance was conducted in 21 freshwater sources across Kerala (ponds, canals, and sediments) during February-April 2026. Genomic DNA was screened using PCR with genus-specific primers. Eighteen of 21 samples tested positive using a general amoeba assay. *Acanthamoeba*-specific PCR detected the genus in eight samples, whereas *Balamuthia* and *Naegleria* assays were negative. Among the genera studied, *Acanthamoeba* spp. was consistently detected across multiple sites, indicating widespread presence and persistence. In contrast, *Balamuthia* and *Naegleria* were not detected, suggesting low abundance or absence under the conditions studied. Additionally, the community structure of free-living amoebae in four selected samples was analysed using nanopore sequencing. Early detection of pathogenic amoebae through molecular surveillance, combined with risk maps, may help reduce public exposure to contaminated waters and lower disease incidence. Future studies could integrate surveillance with Earth observation tools, citizen science, predictive modelling, and digital platforms to develop forecasting systems for outbreak prevention.

Keywords: *Free-Living Amoebae, Molecular Surveillance, Nanopore Sequencing, Pathogen Detection, Waterborne Health Threats*

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Abstract ID: TSS/WQM/10

WATER HYACINTH AS A VECTOR FOR BACTERIA RESISTANT TO MULTIPLE DRUGS AND METALS

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Water hyacinth (*Eichhornia crassipes*) is recognised as one of the most invasive aquatic macrophytes and has become widely established in the aquatic ecosystems of Kerala. This species not only exhibits invasive characteristics but also possesses an extensive root system that provides a nutrient-rich substrate, which facilitates the colonisation and persistence of diverse microbial communities, including both pathogenic and metal-tolerant microorganisms. This study investigated *E. crassipes* as a vector for metal- and antibiotic-resistant bacteria, including *Escherichia coli*. Bacterial isolates of *E. coli* and total bacterial counts were obtained from both the roots of water hyacinth and adjacent water samples in Vembanad Lake, situated on the southwest coast of India, utilising Hi-chrome *E.coli* and nutrient agar media, respectively. Species-specific genes were subsequently targeted through polymerase chain reaction (PCR) to confirm their identity. The results indicated a significant prevalence of *E. coli* in the roots, suggesting that water hyacinth serves as a primary host for microbial pathogens. Furthermore, antibiotic susceptibility testing of *E. coli* and other bacterial isolates revealed a widespread occurrence of multidrug resistance. The highly metal-resistant organism isolated from the roots of water hyacinth on nutrient agar was identified as the yeast *Rhodotorula mucilaginosa*. The coexistence of pathogenic bacteria, antibiotic resistance, and metal tolerance within the microbiome associated with water hyacinth highlights a considerable environmental and public health concern. These findings emphasise the necessity for ongoing monitoring of invasive aquatic vegetation, the implementation of effective wastewater management practices, and the development of strategies to mitigate the spread of resistant microorganisms within aquatic ecosystems.

Keywords: *Water Hyacinth, Coastal Microbiome, Antibiotic Resistance, Metal Tolerance, Vembanad Lake Ecosystem, Waterborne Health Threats*

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PHYTOPLANKTON COMMUNITY STRUCTURE, BIO-OPTICAL CHARACTERISTICS AND ENVIRONMENTAL VARIABILITY IN TIDALLY INFLUENCED BEACHES ALONG THE KERALA COAST

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Tidally influenced sandy beaches along Kerala coast support fisheries, tourism, and livelihoods. This study examined phytoplankton communities and their links to hydrographic and bio-optical characteristics at seven beaches in Ernakulam and Alappuzha districts between February 2022 and January 2026. Phytoplankton abundance peaked during Monsoon (28,400 cells L^{-1}), concurrent with elevated Chl-a (27.4 µg L^{-1}), increased turbidity (56.4 NTU), enhanced nutrient availability, and reduced salinity. Diatoms dominated (85–90%), with *Chaetoceros*, *Asterionellopsis*, and *Skeletonema* most common. Dinoflagellates peaked at Kuzhuppilly during Monsoon (5,545 cells L^{-1}), while Cyanobacteria bloomed during Pre-Monsoon at Chellanam and Anthakaranazhi (~11,000 cells L^{-1}). Phytoplankton absorption ($a_{ph}440$), an indicator of phytoplankton biomass, peaked during the monsoon (1.56 m^{-1}) and was lowest during the post-monsoon period (0.33 m^{-1}). Elevated a_{CDOM} during Monsoon indicated terrestrial inputs. Highest Shannon diversity occurred at Anthakaranazhi during Pre-Monsoon ($H' = 0.906$), lowest at Puthuvyppu ($H' = 0.136$). Species richness peaked at Kannamali during the post-monsoon period ($d = 0.992$). Correlation analysis revealed strong positive relationships among turbidity, suspended matter, nutrients, and Chl-a, highlighting monsoon-driven inputs. Diatoms correlated positively with nitrate, silicate, particulate matter, and Chl-a; Cyanobacteria linked to higher temperature. Optical properties (ap, ad, aph) were intercorrelated and associated with particulate loading and biomass. This study provides an important baseline for long-term environmental monitoring and supports the development of effective management strategies for Kerala's coastal waters under increasing anthropogenic pressures and climatic change influences.

Keywords: *Coastal Ecosystem, Ocean Productivity, Hydrochemistry, Nutrient Dynamics, Coloured Dissolved Organic Matter (CDOM), Ocean Bio-Optics.*

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EMERGING CONTAMINANTS: SOURCES, IMPACTS AND MANAGEMENT- A REVIEW

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Emerging contaminants (ECs) are diverse substances—pharmaceuticals, PFAS, microplastics, pesticides, endocrine disruptors, and engineered nanomaterials—increasingly found in water and soil worldwide. They enter via wastewater, farm runoff, industrial discharge, landfill leachate, and atmospheric deposition. Most remain unregulated, as treatment plants were not built to remove them and toxicological data are incomplete. Key classes: PPCPs (antibiotics, hormones, UV filters), microplastics/nanoplastics, PFAS ("forever chemicals" like PFOA/PFOS), pesticides (atrazine, neonicotinoids), and engineered nanomaterials (silver, TiO2). ECs undergo sorption, photodegradation, bioaccumulation, and transformation, sometimes forming more toxic by-products, making many functionally persistent even when individually degradable. Ecological impacts include endocrine disruption and reproductive failure in fish and amphibians, antimicrobial resistance from antibiotic residues, and harm from microplastic ingestion. Human health concerns—harder to confirm given chronic, low-dose, mixed exposure—include PFAS links to cancer, developmental delay, and immune impairment. Detection relies on LC-MS/MS, high-resolution mass spectrometry, non-target screening, passive samplers, sensors, and effect-based bioassays, though protocols and data remain limited, especially for microplastics. Remediation includes advanced oxidation, activated carbon/ion-exchange adsorption, membrane filtration, constructed wetlands, bioremediation, and source controls like microbead bans and PFAS phase-outs. Full removal of PFAS and microplastics remains costly. Regulation is fragmented; most jurisdictions lack binding limits, though PFAS standards are emerging. Management needs integrated monitoring, upgraded infrastructure, harmonized regulation, mixture-toxicity research, eco-friendly materials, and a One Health approach linking water, ecosystems, and human health.

Keywords: *Emerging Contaminants, PFAS, Microplastics, Pharmaceuticals, Endocrine Disruptors, Nanomaterials, Water Quality, Environmental Monitoring*

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CARBON NANODOT-BASED FLUORESCENT SENSORS FOR RAPID DETECTION OF HEAVY METALS IN WATER: A SUSTAINABLE APPROACH FOR WATER QUALITY MONITORING AND HUMAN HEALTH PROTECTION

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Heavy metal contamination from industrial, urban, and agricultural runoff poses severe risks to aquatic ecosystems and human health, driving an urgent need for rapid, affordable water-monitoring technologies. Traditional analytical methods, while accurate, are often hindered by high equipment costs, complex sample preparation, and a lack of portability for field testing. To address these limitations, this study explores the development of Carbon Nanodots (CNDs) synthesized from sustainable, eco-friendly carbon precursors, as highly sensitive and selective fluorescent sensors to detect toxic ions like Pb^{2+}, Hg^{2+}, Cd^{2+}, and Cr^{6+}. Characterized using advanced spectroscopic and microscopic techniques to evaluate their structural and optical profiles, these CNDs possess unique surface functional groups that interact specifically with target heavy metals. This interaction triggers distinct fluorescence changes, such as quenching or enhancement, allowing for the precise quantification of contaminants even at trace concentration levels. By delivering rapid response times and excellent photostability without the need for harsh chemicals, this nanotechnology-driven approach offers a streamlined, cost-effective, and field-ready alternative to conventional laboratory testing. Ultimately, integrating CND-based sensors into routine environmental monitoring can facilitate early contamination detection, enable swift regulatory intervention, and significantly advance sustainable water resource management.

Keywords: *Water Quality Monitoring, Carbon Nanodots, Heavy Metal Detection, Fluorescent Sensor, Human Health*

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BEYOND CHLOROPHYLL A: PHYTOPLANKTON COMPOSITION MEDIATES TROPHIC SHIFTS AND RESTRUCTURES FISH FEEDING PATHWAYS IN THE ULHAS ESTUARY

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Eutrophic estuaries are quietly being reshaped through the constant inflow of allochthonous nutrients, primarily from non-point sources. The Ulhas estuary, flanking the financial capital city of Mumbai, receives wastewater of nearly 440 million liters per day (MLD). The estuarine upstream, burdened by increased nutrient inputs, is also known to experience reduced flushing and low dissolved oxygen, posing cascading implications for trophic dynamics. Chlorophyll a (Chl a) is commonly employed in water quality monitoring frameworks. The trophic status of the estuary is estimated using Carlson's Trophic State Index (TSI) using Chl a as a proxy. Based upon TSI, downstream and midstream of the estuary was classified between oligotrophy to mesotrophy due to moderate Chl a (~7 mg/m3), supported by diatoms such as *Thalassiosira subtilis*, *Skeletonema costatum*, *Nitzschia closterium*, and *Cyclotella* sp. indicating efficient trophic transfer. In contrast, the upstream recorded eutrophy, with two fold higher Chl a (~15 mg/m3), predominantly contributed by cyanophyte taxa *Merismopedia* sp (~68%), leading to reduced trophic efficiency. Alteration in phytoplankton community composition at the base, dramatically reshaped fish assemblages in Ulhas estuary, thereby leading to the increase of few omnivorous and detritivorous fishes such as *Scatophagus* sp., *Mugil* sp., & *Mystus* sp. Further, the low fishery potential, reflected by lower catch per unit effort (~2.1 kg/h) in the eutrophic upstream when compared to down and midstream of the estuary (avg. 4.5 kg/h), also signals a deterioration in ecosystem health. The study highlights Chl-a as important standalone indicator in highlighting ecological degradation, however with integrative approaches incorporating phytoplankton community structure can further increase robust assessment of estuarine health.

Keywords: *Chlorophyll a, Ulhas estuary, Merismopedia sp, Trophic State, Fisheries*

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MICROPLASTICS IN INDIAN COASTAL WATERS AND MARINE BIOTA: A COMPREHENSIVE REVIEW AND SYNTHESIS

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Microplastics are now a persistent feature of the Indian coastal ocean. India has a coastline of about 11,000 km, a large coastal population, and high rates of mismanaged plastic waste, so its seas receive plastic from many land-based and sea-based sources. This review synthesizes field evidence on microplastic occurrence in coastal waters, beach and shelf sediments, and coastal biota along the Indian coast, with particular attention to commercially important fish and edible marine organisms. Reported abundances differ considerably among regions and sample matrices due to both genuine spatial variability and the lack of standardized sampling and analytical methodologies. Surface and coastal waters span less than 2 particles per cubic metre off Kerala to tens or hundreds of particles per cubic metre on the eastern coast and on tourism-driven beaches, while beach sediments commonly hold 40 to 70 particles per square metre. Polyethylene and polypropylene microplastics dominate in the water and sediment, whereas polyester, polyamide, and polyethylene terephthalate are common in fish and shellfish, pointing to textiles and fishing gear as key sources. Microplastics have been confirmed in zooplankton, benthic invertebrates, bivalves, and many commercial fish, with ingestion frequencies ranging from about 5% to 100% depending on species, tissue, and season. Recent work shows microplastics in edible muscle tissue, not just in the gut, raising direct concerns about seafood safety. Indian sea salt is also contaminated with microplastics. This study identifies a strong bias toward the southern and western coasts, a shortage of open-ocean and east-coast data, weak harmonisation of methods, and almost no data on health outcomes. This study recommends standard protocols, routine monitoring of sentinel species, river and wastewater source control, and integration of microplastics into national coastal management and food safety frameworks.

Keywords: *Microplastics, Arabian Sea, Bay of Bengal, Marine Biota, Seafood Safety*

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SPATIAL DISTRIBUTION AND HEALTH RISKS OF PAHS IN WATER SAMPLES FROM SELECTED PORTS ALONG THE RED SEA COAST SAFAGA–EL-QUSIER, EGYPT

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Red Sea ports are critical to global trade yet face chronic contamination from polycyclic aromatic hydrocarbons (PAHs). This study assesses PAHs in coastal waters of three ports in Safaga and El Qusier, evaluating water quality, toxicity, sources, and environmental/health risks. Average Σ16PAH concentrations followed: El-Qusier Fishing Port (520.21 ng/L) > Safaga Tourist Port (239.19 ng/L) > Safaga Fishing Port (172.28 ng/L), with port activity and structure as key factors. Fluoranthene dominated in Safaga ports, while pyrene prevailed in El-Qusier. Diagnostic ratios and principal component analysis revealed primarily pyrogenic (combustion-derived) sources, with minor petrogenic inputs. El-Qusier showed the highest toxic (108.29 ng TEQ/L) and mutagenic (520.51 ng MEQ/L) equivalents, yet all port waters fell within safe ranges. High molecular weight PAHs generally dominated. Ecological risk indices ranged from moderate to high due to anthropogenic activities, with El-Qusier requiring urgent intervention. Human health risk assessment indicated that hazard index (HI) for children was twice that of adults, following dermal > oral > inhalation pathways. While adults showed low dermal risk, children fell partly into the high-risk category. These findings provide a scientific basis for targeted management strategies to protect the Red Sea's ecosystem. Expanded monitoring across environmental matrices is urgently needed.

Keywords: *PAHs, Red Sea, Health Risks, Water*

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COMPARATIVE ANALYSIS OF METAL POLLUTION AND HEALTH RISKS IN COASTAL SEDIMENTS OF EGYPT'S GULF OF SUEZ (RED SEA)

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This study underscores the need to monitor marine pollutants in the Gulf of Suez, given contamination risks posed by industrial, tourism, and shipping activities. Sediment samples collected biannually during 2025-2026 showed descending average metal concentrations, with Fe > Mn > Zn > Ni > Pb > Co > Cu > Cd, and winter exhibited higher levels. Enrichment factor analysis (EF) revealed minimal to very high enrichment, depending on the metal, with notably high levels for Cd and Ni. Indices for contamination and ecological risk mostly indicated low to moderate pollution. However, some metals, such as Fe, showed severe contamination. Overall, sediment quality was classified as unpolluted by USEPA guidelines. Spatially, eastern shores had higher metal loads and contamination indices, with Al-Attaka station recording the highest pollution levels. Health risk assessments showed low hazard quotients and indices, suggesting relative safety. HQ and HI < 1 mean sediment is safe for human health, so that HI dermal child > HI dermal adults. The cumulative cancer risk is within $1x10^{-6}$- $1x10^{-4}$ at nearly all eastern sites, indicating potential health concerns. The study highlights the urgent need for comprehensive water treatment and targeted management strategies to mitigate heavy metal pollution and associated human health risks in the Gulf of Suez.

Keywords: *Heavy Metal, Pollution Index, Risk Index, Human Health, Gulf of Suez*

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PHENOLICS: PLASTIC-ASSOCIATED ORGANIC CONTAMINANTS IN WATER, SEDIMENT AND FISHES FROM LAGOS LAGOON, NIGERIA

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Plastic pollution is an escalating threat to ocean health, with phenolic additives increasingly recognized as endocrine disruptive chemicals (EDCs) of concern. This study investigated the presence of three phenolic compounds; 4-tert-octylphenol (4-t-OP), 4-nonylphenol (4-NP), and bisphenol A (BPA) in water, sediment, and fish species from Lagos Lagoon, Nigeria, a major estuarine system that connects to the Atlantic Ocean. Samples from five locations and eleven fish species were analyzed using validated extraction procedures and GC-MS. Results showed detectable concentrations of BPA and 4-t-OP in water (0.25–0.58 mg/L and ≤0.05 mg/L, respectively) and sediment (0.08–1.90 mg/kg and ≤0.06 mg/kg), while NP was absent. Fish species exhibited significant bioaccumulation, with mean concentrations of 0.99 mg/kg (4-t-OP), 2.21 mg/kg (4-NP), and 10.3 mg/kg (BPA), indicating potential for biomagnification across trophic levels. BPA, in particular, occurred at levels substantially higher than those reported in other global estuarine and coastal ecosystems. These findings identify Lagos Lagoon as a hotspot for plastic-derived contaminants, with implications for ecological integrity, fisheries sustainability, and food security in coastal communities. Given its hydrological connection to the Gulf of Guinea, the lagoon may serve as a conduit for contaminant transfer into the wider Atlantic, raising regional and global ocean science concerns. This study provides the first comprehensive evidence of phenolic contamination in Lagos Lagoon and contributes to the broader understanding of plastic-associated pollutants in marine systems. It underscores the urgent need for coordinated monitoring, pollution mitigation, and management strategies to safeguard ocean health under the UN Ocean Decade framework.

Keywords: *Plastics Pollution, Phenolic Compounds, Water, Sediment, Fish, Lagos Lagoon*

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SEASONAL VARIABILITY OF BIO-OPTICAL PROPERTIES IN THE COCHIN ESTUARY, KERALA, INDIA

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The Cochin Estuary, a dynamic and eutrophic tropical estuarine system along the southwest coast of India, exhibits pronounced seasonal variability driven by monsoon-induced freshwater influx. This study investigated the seasonal and spatial variations in the bio-optical properties of the estuary during the monsoon, post-monsoon, and pre-monsoon seasons of 2022–2023. Chlorophyll-a (Chl-a) concentrations showed marked seasonal variability, with the highest average values recorded during the post-monsoon season (4.86 ± 2.8 mg m^{-3}), followed by the pre-monsoon and monsoon seasons. Higher Chl-a concentrations during the post-monsoon period were associated with enhanced nutrient availability and favourable hydrodynamic conditions, due to the reduced freshwater influence. Monsoonal river discharge supplies substantial nutrient loads, especially nitrogen and phosphorus, which support phytoplankton growth during subsequent seasons. The average aCDOM (440), was highest during the monsoon season (0.52 ± 0.21 m^{-1}), indicating significant terrestrial inputs of dissolved organic matter through enhanced river runoff. Seasonal variations were also evident in phytoplankton absorption coefficients and the B/R ratio (aph (440)/aph (675)). The nonlinear relationship between Chl-a concentration and the absorption ratio suggests that phytoplankton optical properties are influenced not only by biomass but also by pigment packaging effects and changes in intracellular pigment composition. Furthermore, the stronger correlation between aph (675) and Chl-a compared to aph (440) indicates that absorption in the red spectral region is primarily governed by chlorophyll-a, whereas absorption in the blue region is influenced by both chlorophyll-a and accessory pigments. These findings highlight the complex interactions between hydrological processes, phytoplankton dynamics, and optically active constituents in regulating the bio-optical characteristics of the Cochin Estuary.

Keywords: *Chlorophyll-a, Coloured Dissolved Organic Matter (CDOM), Phytoplankton Absorption Coefficient, River Run Off*

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MACROBENTHIC COMMUNITIES AS A BIO-INDICATOR OF WATER QUALITY ASSESSMENT IN THE SOUTH-EASTERN COAST OF BANGLADESH

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The southeastern coastal zone of Bangladesh supports one of the most productive ecological regions currently facing increased environmental pressures. Macrobenthos hold key significance in ecological engineering and serve as a reliable indicator of ecosystem health, as they are sensitive to environmental gradients. However, a research gap persists on how environmental stressors shape macrobenthic community structure in this region. The present study explored the influence of anthropogenic stressors on water quality, using macrobenthic community structure as a bio-indicator. Three sampling sites (Bakkhali River, Nuniarchara, and Sonadia Channel) were selected based on the gradient of anthropogenic influences. Macrobenthic faunas were collected seasonally (three seasons) for a year using the quadrat and sediment corer method. Examining a total of 36851 individuals/m², a diverse assemblage of 64 macrobenthic taxa belonging to 11 classes and 39 families was identified. Polychaetes were the most dominant group across all seasons (62.12%). Among these species, 31 species were identified as bio-indicators based on their response to the environment. 14 species acted as positive indicators of degraded water quality, whose presence indicates a stressed community with high organic enrichment and pollution. 17 species acted as negative indicators, whose absence indicates a stressed community and degraded water quality. The negative indicators represent high diversity and unpolluted conditions. Based on the spatial patterns, the Bakkhali River was found to be highly polluted, whereas the Sonadia Channel remains comparatively less polluted, reflecting stable water quality. The study proposed a framework for coastal water monitoring with a suggestion to integrate macrobenthic bio-assessment into coastal water management strategies.

Keywords: *Macrobenthos, Bio-indicators, Community Structure, Coastal Habitat, Environmental Drivers*

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SEAWATER QUALITY: COUPLING SATELLITE DATA IN COASTAL ZONES OF NOSY BE

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This study, conducted from August 15 to October 24, 2025, highlights the spatio-temporal variability of key physicochemical parameters across three sampling stations (S1, S2, and S3) around Nosy Be, Island. Additional data from Sentinel 2 satellite were used. The pH remained consistently alkaline (7.1–9.1), with most values ranging between 7.5 and 8.5, indicating relative environmental stability despite a peak in mid-September followed by a gradual decline. Dissolved oxygen concentrations ranged from 6.2 to 10.3 mg/L, although station S1 exhibited greater short-term variability. Sea surface temperature (24–31°C) showed limited spatial variation but a clear seasonal trend, with a decrease in September followed by an increase toward October. Water color displayed high variability (3–15 FU), particularly at station S3. Total dissolved solids (18–37 g/L) revealed a spatial gradient, increasing from S1 to S3, along with a temporal rise toward October, reflecting enhanced mineralization. Salinity remained relatively stable (30–35 ‰). Satellite observation from Sentinel 2 indicated moderate phytoplankton biomass (chlorophyll-a) during August–September, followed by a decline in October. Suspended particulate matter increased in late August, became more structured in September, and decreased thereafter.

Keywords: *Nosy Be, Phytoplankton Biomass, Physicochemical, MSI Sentinel 2*

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CONSERVING THE COASTLINE: MACRO-BENTHIC COMMUNITY STRUCTURES AND THE ECOLOGICAL SUPREMACY OF SUNDARBANS MUDFLATS

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Benthic macro-invertebrates serve as vital indicators of ecosystem health and play a fundamental role in the nutrient cycling of mangrove environments, making their study essential for understanding coastal biodiversity. This study was conducted to investigate the species composition, richness, and abundance of macro-benthic communities across six distinct locations in the Sundarbans—Tambulbunia, Jamtoli, Katka, Dubla, Harbaria, and Jongra-by comparing two primary habitat types: mudflats and mangrove forest floors. The methodology involved systematic sampling and identification of taxa to evaluate how habitat characteristics influence community structure. Analysis of the data revealed a total of 47 species representing 30 families from a sample size of 169 individuals, with a significant disparity observed between habitat types as mudflats exhibited considerably higher biological diversity and abundance (36 species; 109 individuals) compared to mangrove forest habitats (19 species; 60 individuals). *Polychaetes* were the dominant group, specifically from the families *Syllidae*, *Capitellidae*, and *Nereididae*, with *Exogone* sp. and *Capitella* sp. being the most abundant species, while Jamtoli Mud and Harbaria Mud were identified as the primary biodiversity hotspots. These findings conclude that mudflat habitats provide a more favorable environment for macro-benthic organisms than the interior mangrove forest floor, highlighting the critical need for targeted conservation of these mudflats to maintain the overall ecological integrity and biodiversity of the Sundarbans mangrove ecosystem.

Keywords: *Benthic Macro-Invertebrates, Mudflats, Polychaetes, Bioindicators, Species Richness*

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STRENGTHENING INTEGRATED COASTAL WATER-QUALITY MONITORING THROUGH SUSTAINED *IN SITU* OBSERVATIONS IN CARTAGENA BAY

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Cartagena Bay is a tropical estuarine system influenced by freshwater from the Canal del Dique, marine exchange, and urban and port activities. Understanding water-quality change in this complex environment requires sustained observations that resolve short-term variability and seasonal gradients. Through the NANO Deoxygenation, Ocean Acidification and Productivity (NANO-DOAP) project, we analysed two complementary *in situ* datasets. The first comprises quasi-daily CTD profiles collected at the CIOH pier from August 2021 to July 2026. The second includes CTD profiles and discrete water-quality measurements from a five-station transect, initially sampled every two months and monthly since 2025, connecting estuarine and ocean-influenced waters. Hovmoller diagrams from the pier show that stronger Canal del Dique influence produces a warm, low-salinity surface layer and marked stratification. During the dry season, stronger trade winds, reduced freshwater inflow and greater marine influence favour a cooler, saltier and more mixed water column. Departures from this expected seasonality during 2025 and early 2026 show the value of sustained measurements for detecting environmental anomalies. Along the transect, estuarine-oceanic comparisons help determine how stratification, surface warming and freshening, or wind-driven mixing affect dissolved oxygen, pH, chlorophyll-a and optical properties. These observations provide the physical context needed to interpret changing biogeochemical and biological processes in tropical coastal waters. Satellite products and numerical models should therefore complement, rather than replace, field observations on which their calibration, validation and interpretation depend. Integrating these sources can improve water-quality indicators, strengthen adaptive monitoring, and support protection of aquatic ecosystems and human health.

Keywords: *In situ Observations, Coastal Water Quality, Seasonal Variability, Integrated Monitoring, Biogeochemical Processes, Cartagena Bay*

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ELECTRICAL ANALYSIS FOR SENSING WATER QUALITY

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Electrochemical impedance spectroscopy (EIS) offers a rapid and non-destructive approach for water quality assessment and ionic composition analysis without the need for chemical reagents or extensive sample preparation. In this study, EIS was evaluated for identifying ionic signatures in seawater, groundwater, bottled water, and laboratory-prepared solutions containing sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}) ions at environmentally relevant concentrations. Impedance measurements were collected over a frequency range of 1 Hz to 1 MHz at 4 °C and 23 °C. The results showed consistent relationships between ionic composition and electrical response. Higher ion concentrations reduced impedance magnitude, enhanced capacitive behavior at intermediate frequencies (100 Hz–100 kHz), and generated inductive characteristics at high frequencies in highly conductive samples. To explain these responses, a modified equivalent circuit model containing resistive, capacitive, and inductive elements was developed. The model accurately described the measured spectra across the full frequency range, with the inductive component proving essential for reproducing the positive phase shift observed in saline samples. The extracted circuit parameters were used as compact electrical fingerprints for water classification and ion estimation. A category-guided prediction framework was developed in which unknown samples were compared with reference models representing seawater, groundwater, and bottled water. The closest matching reference model was then used to estimate Na^+, K^+, Ca^{2+}, and Mg^{2+} concentrations. Case studies involving seawater (SW1), groundwater (GW2), and Fiji bottled water were correctly classified, and the predicted ion concentrations showed good agreement with measured values.

Keywords: *Water, Ions, Modelling, Impedance, Magnesium, Water quality, Image sensors, Bottling, Distance measurement, Temperature*

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CHALLENGES AND OPPORTUNITIES FOR INTEGRATING MICROBIAL AND SATELLITE-BASED MONITORING OF COASTAL RECREATIONAL WATERS IN TRINIDAD AND TOBAGO

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Coastal recreational waters in small island developing states are highly vulnerable to microbial contamination, pollution events, and environmental changes associated with rainfall, runoff, and human activities. In Trinidad and Tobago, routine coastal water quality monitoring still relies mainly on microbial indicators such as faecal coliforms, *Escherichia coli*, and Enterococci. While these indicators provide valuable information for public health assessment, monitoring is often limited by point-based sampling and restricted sampling frequency, which may not fully capture the spatial and temporal variability of coastal systems. This work highlights some of the challenges associated with microbial monitoring in tropical recreational marine environments and explores the potential for integrating satellite-derived environmental indicators into existing monitoring approaches. Parameters such as ocean colour, sea surface temperature, and turbidity may provide additional spatial and temporal insights into coastal water quality and ecosystem processes. Integrating remote sensing with microbial monitoring could improve understanding of contamination patterns, support earlier identification of pollution events or harmful algal blooms, and contribute to more effective environmental management strategies. This is especially important in small island states where coastal ecosystems are closely linked to tourism, public health, and environmental sustainability. Strengthening interdisciplinary approaches that combine microbiology, environmental science, and satellite oceanography may improve long-term coastal monitoring and ecosystem health assessment in Trinidad and Tobago and the wider Caribbean region.

Keywords: *Coastal Water Quality, Remote Sensing, Marine Microbiology, Satellite Oceanography, Recreational Waters, Small Island States*

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Abstract ID: **TSS/WQM/26**

ABUNDANCE AND DISTRIBUTION OF PLANKTON ALONG THE SITAKUNDA COAST OF CHATTOGRAM, BANGLADESH

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Plankton is an integral component of aquatic ecosystems and a key component of primary productivity and marine food webs and is significantly impacted by physicochemical and ecological conditions. Thus, this study aimed to understand the abundance, distribution and community composition of plankton and its association to the environmental factors of the different coastal habitats. The study was conducted along the coastline of Sitakunda of Bay of Bengal, Bangladesh on 20 sampling sites in various coastal areas. Monthly data of essential oceanographic parameters (salinity, turbidity, dissolved oxygen and temperature) and plankton abundance were taken in November 2025 through February 2026. Overall, 45 phytoplankton species and 24 zooplankton taxa were identified and variations in species and taxa composition were observed across the coastal habitats. The plankton diversity was highest in Salt Marsh and Mangrove zone while more stable ecological conditions were observed, in comparison to Ship Breaking Yard, where plankton diversity was low with the dominant species were pollution tolerant ones due to anthropogenic disturbance. The most abundant phytoplankton species recorded during the study were *Ceratium furca*, *Skeletonema costatum*, and *Coscinodiscus centralis*, while the zooplankton community was dominated by *Calanus* sp., *Oncaea* sp., and *Calanopia* sp. The major factors affecting the distribution and community composition of plankton were salinity, turbidity, dissolved oxygen, temperature and pH derived from the statistical analyses of the results obtained from the study across the Sitakunda coast. The study found that the plankton community and environmental parameters varied greatly along the coast of Sitakunda. In general, the study has showed the ecological values of mangrove associated habitats and the adverse effects of ship breaking industries on the quality of the environment and the diversity of coastal plankton ecosystem.

Keywords: *Plankton, Coastal Ecosystems, Mangrove Habitats, Ship-Breaking Activities, Community Composition*

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USING SATELLITE REMOTE SENSING TO INVESTIGATE ENVIRONMENTAL DRIVERS OF CHOLERA OUTBREAK RISK IN CHANDIGARH, NORTHERN INDIA

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Waterborne diseases such as cholera remain a major public health concern, particularly in regions where environmental conditions and infrastructure vulnerabilities increase risk to local population. In Chandigarh, northern India, cholera outbreaks show strong seasonality, with cases concentrated between May and October during the warm monsoon period. Previous outbreaks have been associated with contamination of drinking water supplies. However, the environmental conditions that influence both the presence of pathogens in the aquatic environment and the likelihood of water system failures, and thus risk of disease outbreaks, have yet to be characterised and disentangled. As part of the WADIM (Water-Associated Infectious Diseases in India: Digital Management Tools) project, this study explores the relationship between environmental conditions and cholera outbreak occurrence, with the long-term aim of integrating satellite-derived environmental data into tools for monitoring and mapping waterborne disease risk. This builds on the work of the ESA WIDGEON (Waterborne Infectious Diseases and Global Earth Observation in the Nearshore) project. Spatial and temporal relationships between outbreak occurrence and satellite-derived environmental variables, including rainfall (CHIRPS) and land surface temperature (MODIS) were explored. Preliminary analysis indicated outbreaks coincide with warm periods and prolonged wet conditions, consistent with known seasonal patterns, and interannual rainfall variability may also influence outbreak risk in this location. This research provides an initial assessment of environmental conditions associated with cholera outbreaks in Chandigarh. This will be further explored this using routine water quality monitoring data collected in the project, to examine the environmental conditions associated with pathogen presence, with the aim of informing future risk mapping approaches using satellite data.

Keywords: *Cholera, Monsoon, Water Quality, Risk, Remote Sensing*

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SEASONAL AND SPATIAL VARIABILITY OF PHYSICOCHEMICAL PARAMETERS AND HEAVY METALS IN COASTAL SURFACE WATER OF BANGLADESH

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Surface water samples were collected from thirty sampling locations along the coast of Bangladesh during pre-monsoon and post-monsoon periods. Five physiochemical parameters (Temperature, pH, DO, Salinity, Turbidity) were measured directly *in-situ* and ten heavy metals (As, Zn, Pb, Cd, Ni, Mn, Fe, Cr, Cu, Ag) were analyzed using Inductively Coupled Plasma-mass Spectrometry (ICP-MS) to determine the water quality in terms of the Heavy Metal Pollution Index (HPI). The ranges for the physiochemical parameters were 26-30ºC for temperature, 5-33 ppt for salinity, 3-9 mg/L for DO, 6.5-8.8 for pH and 5-340 NTU for turbidity, while the metals (mg/L) were 0.0002-0.0024 for As, 0.003-0.457 for Zn, 0.0002-0.0085 for Pb, 0.0001-0.0083 for Cd, 0.0004-0.0094 for Ni, 0.003-0.085 for Mn, 0.019-4.56 for Fe, 0.0001-0.0374 for Cr, 0.0003-0.78 for Cu and 0.0001-4.147 for Ag. The results of investigated area revealed that the mean concentrations of heavy metals ranked (higher to lower) Fe > Ag > Zn > Cu > Mn > Cr > Ni > Pb > As > Cd during pre-monsoon, whereas the concentration of heavy metals during post-monsoon was Fe > Mn > Zn > Ag > Cu > Cr > Ni > Pb > Cd > As. Multivariate statistical analysis suggested that high concentrations of heavy metals primarily originated from diverse human activities, while HPI indicated that approximately 80% of the sampling stations exhibited moderate to extreme contamination levels, causing the seawater unsuitable for mariculture, aquatic ecosystem protection, and irrigation, with potential impacts on key ecological functions. Overall, this study contributes to the scientific understanding of coastal water quality in Bangladesh. Thus, we recommend enhanced monitoring of land-use activities alongside the implementation of targeted remediation at high-risk zones to control water pollution and protect ecosystem health.

Keywords: *Heavy Metal, Physicochemical Parameters, Water Quality, Mariculture, Water Pollution*

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Abstract ID: **TSS/WQM/29**

DYNAMICS OF PARTICULATE ORGANIC CARBON DURING PRE – SW MONSOON IN THE WESTERN COASTAL BAY OF BENGAL

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Particulate organic carbon (POC) concentrations and the stable carbon (C) and nitrogen (N) isotopic signatures of suspended particulate organic matter were determined along the western coast of the Bay of Bengal in the pre-southwest monsoon season. Integrated particulate organic carbon (POC) concentrations in the upper 100m of the water column ranged from 206 µM m^{-2} to 287 µM m^{-2} in the inshore waters, and from 195 µM m-2 to 266 µM m-2 in the offshore waters. Stable isotope ratios of POC (δ13 CPOC) broadly varied between -30.4‰ to -20.9‰ in the water column, with a relatively depleted δ13CPOC values in the subsurface waters (water column below 100m depth) than those found in the euphotic zone. Stable isotope ratios of particulate nitrogen(δ15N) varied from 3.0‰ to 10.5‰, with relatively enriched δ15NPN values in the subsurface waters (~5.8‰) compared to euphotic zone (~5.1‰), contrasting to the δ13CPOC pattern. Despite, inshore waters are expected to receive more POC from terrestrial sources (depleted δ13CPOC: -28 to -26‰) than from *in-situ* produced POC (enriched δ13CPOC: -23 to -21‰), strikingly, inshore waters recorded relatively enriched δ13CPOC values (-24.9‰) compared to the offshore waters (-26.0‰) in the euphotic zone of the study region, indicating significant contribution of soil organic matter (δ13CPOC: ~10‰) from nearby land masses. Relatively enriched δ13CPOC values in the euphotic zone compared to subsurface waters could be due to either preferential deposition of terrestrial organic matter to the sea bottom and/or addition of isotopically depleted fresh POC in the surface waters. However, enrichment of δ15NPN from euphotic zone (~5.1‰) to subsurface waters (~5.7‰) specify that preferential addition of fresh POC in the subsurface waters is more likely rather than preferential deposition of terrestrial POC to sea bottom in the western coastal Bay of Bengal. This study reveals that fresh POC production is a significant source of POC in the subsurface waters of the western Bay of Bengal. Dual isotopes indicated significant contribution of particulate organic matter (POM) from both terrestrial and marine sources to the western coastal Bay of Bengal. Contribution from soil POM and C4 plant derived POM is an important terrestrial source.

Keywords: *POC, Bay of Bengal, Sources, Dark Production*

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Abstract ID: **TSS/WQM/30**

FROM SOURCE IDENTIFICATION TO RISK ASSESSMENT: POLYCYCLIC AROMATIC HYDROCARBONS IN SURFACE SEDIMENTS OF THE SOUTHEASTERN ARABIAN SEA

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In addition to hosting major ports and densely populated coastal centres, the Southeastern Arabian Sea (SEAS) includes ecologically sensitive environments, including mangroves, estuaries, and wetlands, where anthropogenic activities and oceanographic processes collectively drive contaminant accumulation and ecological risk. Polycyclic Aromatic hydrocarbons (PAHs) are hydrophobic compounds with a strong affinity for organic matter, thereby making marine sediments major sinks for these compounds. Owing to their carcinogenic and toxic properties, PAHs pose significant environmental and ecological concerns. Despite their importance, the distribution, sources and ecological implications of PAHs in the SEAS remains limited. In the present study, surface sediment samples were collected from ten coastal transects of the Southeastern Arabian Sea shelf during the monsoon season (August 2025) and analysed. Source appointment was evaluated using diagnostic isometric ratios together with the relative contributions of Low molecular weight (LMW) and High molecular weight (HMW) PAHs, while ecological risks were assessed using sediment quality guidelines, including Threshold effect level (TEL) and Probable effect level (PEL). The concentration of total sedimentary PAHs varied from 9.97 to 236.54 ng/g, with LMW PAHs contributing about 14-96% and HMW PAHs contributing 4-86%, indicating pronounced spatial variability along the study region. Southern transects were dominated by LMW PAHs (>75%), indicating stronger petrogenic influence, whereas central and northern transects exhibited higher HMW PAH contributions (upto 86%), suggesting dominant pyrogenic inputs. Diagnostic ratios further confirmed the presence of mixed petrogenic and pyrogenic sources across the region. TEL/PEL assessment showed that pyrene exceeded TEL levels at certain stations. These findings provide a regional baseline for PAH contamination and management of coastal pollution sources in this marine environment.

Keywords: *Polycyclic Aromatic Hydrocarbons, Sediments, Contamination, Ecological Risk, Southeastern Arabian Sea*

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Abstract ID: **TSS/WQM/31**

BIOGENIC AND POTENTIALLY TOXIC METALS FROM SUSPENDED PARTICULATE MATTER AND ZOOPLANKTON IN THE SOUTHEASTERN ARABIAN SEA

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Metals are persistent environmental contaminants that can persist in aquatic ecosystems for prolonged periods due to their non-biodegradability. In this study, metal concentrations were quantified in suspended particulate matter (SPM) and zooplankton collected from the southeastern Arabian Sea during the southwest monsoon season. SPM and zooplankton samples were collected along 10 coastal transects on board FORV Sagar Sampada and analysed for biogenic metals (Fe, Mn, Cu, Co, Ni, and Zn) and potentially toxic metals (Cr, Pb, and Cd). Metal concentrations in SPM ranged from not detected (n.d.) to 0.14 µg L^{-1} for Co, n.d. to 2.03 µg L^{-1} for Ni, 0.49 to 10.58 µg L^{-1} for Zn, 0.91 to 5.64 µg L^{-1} for Cr, n.d. to 0.80 µg L^{-1} for Pb, 4.74 to 196.21 µg L^{-1} for Fe, 0.24 to 3.17 µg L^{-1} for Mn, 0.10 to 2.46 µg L^{-1} for Cu, and n.d. to 0.04 µg L^{-1} for Cd. Elevated metal concentrations were observed in nearshore regions, primarily influenced by riverine inputs and anthropogenic activities. In zooplankton, metal concentrations ranged from 5.22 to 764.56 µg g^{-1} for Fe, 17.11 to 437.08 µg g^{-1} for Zn, 1.94 to 33.48 µg g^{-1} for Cu, and 2.36 to 295.57 µg g^{-1} for Cr. The elevated concentrations of both essential metals and potentially toxic metals in zooplankton indicate a strong capacity for metal bioaccumulation from the surrounding water column and suspended particulate matter. Such accumulation may pose ecological risks to marine organisms and facilitate the transfer of contaminants to higher trophic levels through biomagnification. The enrichment of metals in both SPM and zooplankton highlights the extent of metal contamination in the southeastern Arabian Sea and the role of particulate matter in mediating metal transport and bioavailability. Furthermore, the accumulation of metals in zooplankton suggests a potential pathway for contaminant transfer through the marine food web.

Keywords: *Metals, Suspended Particulate Matter, Zooplankton, Bioaccumulation, Southeastern Arabian Sea*

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Abstract ID: **TSS/WQM/32**

TRICLOSAN AND METHYL TRICLOSAN IN SURFACE SEDIMENTS OF THE SOUTHEASTERN ARABIAN SEA: A BASELINE STUDY

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As commonly used antimicrobials, Triclosan (TCS) and its derivative, Methyl triclosan (MTCS), are persistent in aquatic environments, leading to ecological and human health impacts. This study provides a thorough evaluation of TCS and MTCS in sediments and commercially significant fish species along the estuarine-coastal gradient of the southeastern Arabian Sea. Spatial and seasonal variations, potential sources, and associated ecological and human health risks were monitored through monthly sampling conducted throughout 2024 at stations extending from the estuary to offshore regions. Sediment concentrations ranged from 0.79 to 10.10 ng/g for TCS and from 0.12 to 6.29 ng/g for MTCS, with estuarine and nearshore locations showing higher concentrations, likely influenced by terrestrial runoff and wastewater discharge. MTCS exhibited strong correlations with organic matter and clay content, highlighting its hydrophobic nature and greater environmental persistence. The continual introduction of TCS into the environment and subsequent *in situ* methylation, despite its photodegradation, contribute to the persistence of both TCS and MTCS in fine-grained, organic-rich sediments. All analysed fish samples detected both compounds, with MTCS accounting for 49–86% of the total TCS-related burden in tissues, suggesting higher bioaccumulation potential and possible in vivo transformation. Greater contamination levels were noted in coastal species and benthic-feeding organisms. Ecological risk assessment indicated a possible threat to primary producers, whereas human health risk estimates based solely on TCS suggested no immediate risk to consumers. This investigation represents the first baseline dataset on TCS and MTCS occurrence in sediments and marine biota from Indian coastal waters and emphasises the importance of incorporating MTCS into future environmental monitoring and risk-assessment strategies.

Keywords: *Triclosan, Methyl Triclosan, Photodegradation, Estuarine-Coastal Gradient, Ecological Risk Assessment, Bioaccumulation*

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Abstract ID: TSS/WQM/33

SPATIAL DISTRIBUTION OF MICROPLASTICS AND HEAVY METALS IN COASTAL AND ISLAND SEDIMENTS OF THE ARABIAN SEA

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Sediments are long-term sinks for both metal pollutants and microplastics (MPs), highlighting their role in retaining persistent contaminants in marine environments. Despite their ubiquity, scientific investigations in the Arabian Sea (AS) remain scarce. Thus, the present study focused on the spatial distribution, characterization, and risk assessment of MPs in surface sediments across eight coastal and four island ecosystems of the AS, together with the heavy metal analysis. Twenty seafloor sediment samples were collected from eight and twelve locations of the AS and the Lakshadweep archipelago, respectively. Microplastic abundance, morphology, size, color, and polymer composition were analyzed using microscopy and Raman spectroscopy. Among the different morphotypes, fiber had the highest distribution. Mean MP concentration at the AS was significantly higher ($p < 0.01$) than in the Lakshadweep islands. FT-IR analysis revealed the presence of polyethylene, polystyrene, and polypropylene polymers. The heavy metal concentrations were comparatively higher in the coastal sediments. The calculated pollution load index for sediments indicates unpolluted to moderately polluted levels. Litter discharge, fishing activities, and active marine navigation are among the many high-risk sources of plastic contamination in the AS. The novel insights into the potential risks posed by MP and heavy metals will enhance our knowledge regarding the ecological implications of MP pollution, ultimately aiding the development of effective management strategies.

Keywords: *Microplastics, Sediments, Heavy Metals, Ecological Risk Assessment, Arabian Sea*

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Abstract ID: TSS/WQM/34

INVESTIGATING THE ROLE OF FLOATING VEGETATION AS A CRITICAL PREDICTOR IN EXPLAINING THE VECTOR-BORNE DISEASE DYNAMICS UNDER CHANGING CLIMATE

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Climate change and associated extreme events, such as flooding, waterlogging, and inland inundation, have led to large-scale changes in pathogen dynamics, vector ecology, and disease transmission, resulting in sporadic outbreaks of vector-borne diseases. The state of Kerala, situated on the south-west coast of India, is characterized by dense vegetation, long coastline, and extensive inland water bodies, making the region highly susceptible to these climate-driven shifts. Prolonged rainfall, flooding, and waterlogging provide ample breeding grounds for vectors such as mosquitoes, and recent *in situ* field surveys have showed large accumulation of insects, eggs, and larvae in the roots, stems, and leaves of floating vegetation. The role of floating vegetation in supporting the abundance of these vectors is critical, but is an understudied covariate. Hence, in this study we hypothesized that floating vegetation cover and its spatio-temporal dynamics can serve as a critical predictor, alongside climate variables, for modelling regional mosquito-borne disease risk. Using data from the Integrated Disease Surveillance Program (IDSP) and the Department of Health, Kerala, this study analyzed the distribution of vector-borne diseases, including malaria, chikungunya, and dengue, across the districts of Ernakulam and Alappuzha. Floating vegetation maps at seasonal and monthly scales were obtained by processing Sentinel 2 MSI data using Hu's (2009) floating algae index methodology. Since the occurrence of these diseases is highly proportional to the mosquito distribution, this study also modeled the distribution of disease-causing mosquito groups (*Aedes* sp., *Anopheles* sp.), using a Machine Learning model, with the floating vegetation cover as a predictor, alongside other climate variables. A Poisson regression model revealed that the floating vegetation cover is significantly associated with the occurrence of Malaria (IRR=1.87, $p<0.001$), Chikungunya (IRR=2.15, $p<0.001$), and Dengue (IRR=3.86, $p<0.001$). The species distribution model developed for mosquitoes yielded satisfactory predictive performance (accuracy=0.97; Kappa=0.94; sensitivity=0.98; specificity=0.95). The vector distribution model, along with disease records, was used to generate a scalable regional vulnerability zonation map. This framework provides a novel approach for public health authorities to assess the risk zones and to implement targeted vector-control strategies, especially in regions heavily impacted by invasive aquatic vegetation.

Keywords: *Climate, Adaptation, Extreme Weather*

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Abstract ID: **TSS/WQM/35**

MODELLING THE FATE AND TRAJECTORIES OF HYPOTHETICAL OIL SPILLS NEAR CHATTOGRAM AND MONGLA PORTS, BANGLADESH

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Oil spills pose substantial threats to marine ecosystems, particularly in coastal zones with intense shipping activities. The northern Bay of Bengal, especially the area around Chattogram and Mongla ports, faces a growing risk from increased vessel and oil shipments. This study, Bangladesh's first scenario-based oil spill model, uses the OpenOil module of the OpenDrift framework to simulate hypothetical oil spill incidents under varying seasonal conditions. Two locations offshore of Chattogram and Mongla ports were selected for simulation during the summer and winter monsoon of 2024. High-resolution ocean and atmospheric data from the Copernicus Marine Environment Monitoring Service (CMEMS) to simulate the fate of 10,000 oil particles over a span of 7 days. Wind, current, wave along with weathering mechanisms of oil, i.e., evaporation, emulsification, and biodegradation of a Medium Crude Oil (API 30), were taken into account. The results showed significant seasonal variations in oil spill fate and coastal stranding. During the summer monsoon, strong winds (6-12 m/s) and currents at Chattogram drove approximately 48% of oils to the shoreline, while at Mongla, all the droplets got beached within five days, indicating huge coastal exposure risk. At winter monsoon, nearly all oil particles at Chattogram (99%) were stranded, however, no stranding was observed at Mongla, with oil slick moved in the direction of south-southwest due to moderate wind (4-7 m/s) and currents (0.1-0.2 m/s) and thereby 60% of oils afloat after a week. Weathering processes varied seasonally. Summer led to active weathering (>70% oil biodegraded near Chattogram, >95% emulsification at Mongla). Winter had weak weathering (<30% oil biodegraded, 70% emulsification), increasing persistence and offshore movement. These findings highlight the need for season-specific response strategies to protect Bangladesh's sensitive coastal zones. Simulation accuracy can be improved with higher-resolution datasets.

Keywords: *Oil Spill Modelling, Open Oil, Fate of Oil Spills, Chattogram and Mongla Ports*

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Abstract ID: TSS/WQM/36

A STUDY ON THE POPULATION DECLINE OF OLIVE RIDLEY TURTLES IN KOLAVIPALAM BEACH, CALICUT

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Olive Ridley nesting has been reported from the Kerala coast, but most of these beaches have not had any turtle nesting reports in recent years. Kolavipalam is a beach located in the Calicut district of Kerala, where olive ridley nesting has been reported since 1998 and continues. This study investigates the breeding status of olive ridleys and the influence of the environmental factors in favouring the turtle breeding and survival. The nesting and breeding of turtles is monitored during the nesting season from September to March. Nesting sites are identified and the direct egg counts are taken and recorded. The soil and water quality parameters of different beaches are compared, and based on that possibility of turtle return can be predicted. Detailed analysis reveals that Kolavipalam beach is showing dissolved oxygen 15 mg/L, Alkalinity 20mg/L, and chemical oxygen demand 12 mg/L, all of which are indications of better water quality. AAS analysis detected the presence of five selected heavy metals from biological samples and four from water samples. Copper had the highest concentration, 15.8 ppm and the second one was cadmium, 9.4 mg/ml. The results indicate that heavy metal pollution is affecting the turtles which can be a reason for population decline. It is found that anthropogenic activities in these areas are mounting year after year, more than natural pressure.

Keywords: *Olive Ridley, Marine Pollution, Environmental Factor, Conservation*

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Abstract ID: TSS/WQM/37

CHLOROPHYLL–PATHOGEN INTERACTIONS IN THE COASTAL WATERS OF BANGLADESH

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Vibrio cholerae, globally distributed water-borne bacterium, is responsible for cholera outbreaks that has become severe in both urban and rural regions of Bangladesh in past year. Studies have established correlation between the presence of *V. cholerae* and chlorophyll-a (chl-a) concentrations in coastal waters of Bangladesh, there has been a lack of focus on the assessment of the occurrence probability of *V. cholerae* bacteria as a function of chl-a in the coastal waters of Bangladesh. Therefore, this study aimed to assess the spatial and temporal distribution of *V. cholerae* using this satellite-derived chl-a data. This study utilized both *in-situ* (chl-a and *V. cholerae*) and satellite derived chl-a data to predict the spatial and temporal variations in *V. cholerae* occurrence probability. *In situ* data were collected from the 108 sampling locations of the coastal area of Bangladesh between July 2023 to March 2024. Satellite derived data were collected from Sentinel 3A satellite. The established relationship between chl-a and *V. cholerae*, derived through the GAM, was applied to the satellite-derived monthly chl-a data to assess the spatial and temporal occurrence of *V. cholerae* in the coastal areas of Bangladesh. The study found significant seasonal and spatial variability with a consistent pattern in chl-a concentrations near the coast. Positive correlation was observed between chl-a and *V. cholera* ($R= 0.509$, $R2 = 0.759$, $p < 0.001$). Taking presence and absence data of *V. cholera* as response variable and chl-a as predictor, GAM found that chl-a is a good predictor of *V. cholerae* occurrence (variable importance is 77%). This study provides a reliable approach for predicting the occurrence probability of *V. cholerae* in the coastal waters of Bangladesh, offering valuable insights for early warning and public health management.

Keywords: *Cholerae, Chlorophyll-A, Remote Sensing, Coastal Water, Bay of Bengal*

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Abstract ID: **TSS/WQM/38**

TEMPORAL AND VERTICAL DYNAMICS OF MICROPLASTICS AT GNEO-1, NORTHERN ARGENTINE PATAGONIA: FIRST INSIGHTS

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Since coastal marine environments exhibit a high diversity of natural processes, continuous monitoring over time is required to understand their temporal variability and underlying drivers. As an emerging environmental pollutant, microplastics (MP) exhibit highly dynamic distributions within coastal water columns, highlighting the importance of sustained monitoring. The Golfo Nuevo Estación Oceanográfica (GNEO-1) is a long-term ecological time-series site for *in situ* observations located at the pier of Puerto Madryn in northern Argentine Patagonia. This study explores the temporal dynamics of MP at GNEO-1, evaluating monthly samples at two distinct depths: the surface (1 m) and the bottom (16 m), from March 2023 to May 2026. Monitoring throughout the study period revealed a sustained increase in MP concentrations at both depths, particularly in the bottom layer. The separate depth-layer analysis suggests specific seasonal coupling with oceanographic parameters. At the surface, higher MP concentrations coincided with warmer temperatures and elevated Chlorophyll-a (Chl-a) concentrations from late spring through autumn, showing an inverse relationship with macronutrients. At the bottom, MP concentrations displayed a stronger vertical coupling with Chl-a, suggesting downward particle transport and organic aggregation into deeper layers, potentially following phytoplankton blooms. Distinct seasonal clusters at both depths indicate that peak MP levels occur during warm, high Chl-a periods, whereas minimum concentrations align with winter conditions. In conclusion, these preliminary results suggest that MP dynamics are influenced by short-term oceanographic parameters, such as Chl-a concentrations, phytoplankton dynamics, and vertical particle sinking, together with the continuous accumulation of MP within the system. Continued monitoring will provide a broader temporal framework to further evaluate these patterns.

Keywords: *Anthropogenic Particles, Coastal Oceanography, Long-Term Monitoring, SW Atlantic Coast*

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Sub theme 8

Climate Resilience, Adaptation and Mitigation

Abstract ID: TSS/CRAM/01

SALT WATER INTRUSION AS A CLIMATE STRESSOR: HOUSEHOLD LEVEL ECONOMIC IMPACTS AND ADAPTATION DEFICITS IN A PERI URBAN COASTAL COMMUNITY, KERALA, INDIA

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Sea level rise, increasingly recognised as a slow onset climate extreme, poses substantial socioeconomic vulnerabilities to coastal communities in tropical regions. This study presents findings from an ongoing household level assessment of tidal flooding and saline water intrusion in Edakochi, a low-lying peri urban backwater settlement within the Vembanad Lake system, Kerala, India. GPS-based field coordinates, government cadastral records and primary survey data were integrated to assess the spatial extent and severity of impacts. A validated household survey is being administered by trained local enumerators, covering structural damages, livelihoods, agriculture, water and sanitation, health and ecosystem services. The analytical framework applies World Bank PDNA/DaLA methodology, distinguishing direct asset damage, indirect income losses and defensive adaptation expenditures against a pre-intrusion baseline. Preliminary findings indicate near-perennial flooding, with 96% of households reporting worsening conditions. Estimates reveal mean annual structural maintenance cost of ₹26,600, mean reconstruction cost of ₹3.71 lakh and post intrusion increases in sanitation (₹5,983/year) and potable water procurement (₹3,817/year). Hydrological disruption is attributed to discontinuation of traditional community managed sluices, inadequately designed replacements and improper maintenance of aquaculture farms, compounded by intensified tidal amplitude and monsoon variability. Homestead agriculture has largely collapsed due to soil salinisation and silt deposition. Emerging findings reveal critical adaptation deficits: coping responses remain reactive and financially unsustainable while institutional support is largely absent. The study advocates an integrated adaptation framework combining community-based coastal resource management with ecosystem-based approaches as a cost-effective pathway to climate resilience for vulnerable backwater communities.

Keywords: *Saltwater Intrusion, Climate Resilience, Coastal Adaptation, Integrated Socioeconomic Assessment, Vembanad Lake System*

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Abstract ID: **TSS/CRAM/02**

HUMAN LIFESTYLES AND THE CHANGING BALANCE OF AQUATIC ECOSYSTEMS

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Being from one of India's major aquatic trade regions, I have personally observed how deeply fisheries and aquatic ecosystems are connected to people's livelihoods, culture, and survival. For many coastal families, fishing is not just an occupation but a way of life passed through generations. At the same time, modern human lifestyles, industrial growth, urban expansion, and increasing consumption patterns are rapidly changing aquatic ecosystems and disturbing their natural balance. Human activities such as pollution, overfishing, habitat destruction, aquaculture expansion, and global trade are increasing ecological stress and invasive species spread. Many aquatic ecosystems are being managed mainly for productivity and economic demand rather than according to their natural biological rhythms. Traditional fishing communities already possess valuable environmental and seasonal knowledge developed through long-term interaction with aquatic life. In several Indian coastal regions, lakhs of people remain economically dependent on fisheries and often have limited alternative livelihood opportunities. Sustainable conservation should not ignore local communities but instead involve education, awareness, and livelihood support alongside ecological protection. A balanced approach between science, human development, and natural ecosystem functioning is necessary for the future sustainability of aquatic ecosystems. This abstract highlights the need to reconnect human development systems with ecological sustainability. Rather than treating aquatic ecosystems only as economic resources, there is a need to respect their natural biological processes and restore balance through responsible management, community participation, and long-term environmental awareness.

Keywords: *Aquatic Ecosystems, Fisheries Sustainability, Human Lifestyles, Invasive Species, Tropical Ecosystems, Coastal Communities*

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Abstract ID: TSS/CRAM/03

SPATIAL ASSESSMENT OF CLIMATE RISK AND VULNERABILITY IN COASTAL KERALA

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Coastal regions are increasingly vulnerable to the impacts of climate change due to their exposure to multiple climate-related hazards, including sea-level rise, coastal erosion, flooding, storm surges, and saline water intrusion. Kerala, with its densely populated coastline, unique ecosystems, and socio-economic dependence on coastal resources, faces significant challenges in adapting to these evolving climate risks. This study presents a spatial assessment of climate risk and vulnerability in coastal Kerala by integrating hazard exposure, sensitivity, and adaptive capacity indicators within a geospatial framework. The assessment employs a combination of climatic, environmental, socio-economic, and infrastructural datasets to evaluate spatial variations in climate risk across the coastal districts of Kerala. Key indicators such as rainfall variability, flood susceptibility, coastal erosion rates, population density, livelihood dependence, literacy, access to infrastructure, and disaster preparedness are analyzed using multi-criteria decision-making techniques. A composite Climate Risk and Vulnerability Index is developed to identify areas with varying levels of risk and vulnerability. The study identifies climate-risk coastal hotspots that require priority attention for adaptation planning and resource allocation. By highlighting spatial disparities in climate risk and vulnerability, the study contributes to evidence-based coastal management and supports sustainable development initiatives aimed at enhancing the resilience of Kerala's coastal communities under changing climatic conditions.

Keywords: *Climate Risk Assessment, Vulnerability Analysis, Coastal Kerala, Adaptation, Coastal Resilience, Multi-Criteria Decision Making*

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Abstract ID: **TSS/CRAM/04**

ENVIRONMENTAL DNA-BASED BIODIVERSITY ASSESSMENT FOR MONITORING THE IMPACTS OF EXTREME WEATHER EVENTS

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Climate change has been shown to increase the frequency and intensity of extreme weather events, which can have substantial impacts on ecosystem structure and function. The Intergovernmental Panel on Climate Change (IPCC) has reported an increasing occurrence of single-day heavy precipitation events, as well as landslides, flash floods, and heatwaves worldwide; coastal regions in Asia and Africa are especially susceptible to these phenomena. While studies have reported the repercussions of extreme events on human health, safety, and assets, their effects on ecosystem structure and function, particularly in coastal areas, remain underexamined. Existing literature suggests that the immediate aftermath of extreme weather events can disrupt effluent and sewage treatment systems, terrestrial ecosystems, aquaculture, and veterinary operations. Such disruptions can mobilise sediments, nutrients, pathogens, pollutants, and biological materials into rivers, estuaries, and coastal waters. Traditional methods of biodiversity assessment, including visual surveys, capture-based sampling, and morphology-dependent identification, while valuable, are often labour-intensive, taxonomically restricted and difficult to implement promptly following hazardous events. Conversely, environmental DNA (eDNA)-based approaches provide a means of detecting DNA traces released by organisms into water and sediments. This facilitates sensitive, non-invasive, and comprehensive monitoring of native taxa, invasive species, pathogens, and community dynamics. This review highlights the potential of targeted eDNA metabarcoding to assist in rapid post-event assessments, identify indicators of climate stress, and guide restoration efforts, water quality management, and biosecurity strategies.

Keywords: *Extreme Weather Events, Environmental DNA, Aquatic Biodiversity, Invasive Species, Climate Resilience*

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Abstract ID: **TSS/CRAM/05**

NATURE-SYNCHRONISED CAGE AQUACULTURE AS A CLIMATE-RESILIENT ADAPTATION STRATEGY FOR TROPICAL ESTUARINE ECOSYSTEMS: INSIGHTS FROM LONG-TERM FISH MORTALITY EVENTS IN THE PERIYAR–VEMBANAD SYSTEM, INDIA

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Tropical estuarine aquaculture systems are increasingly vulnerable to the combined impacts of climate variability, hydrological disturbances, organic pollution, and deteriorating water quality. Recurrent fish mortality events in the Periyar–Vembanad estuarine system of Kerala, India, have emerged as major ecological and socioeconomic stress events affecting cage aquaculture and riverine fisheries. The present study synthesizes long-term field observations, farmer-level assessments, environmental monitoring, and adaptive aquaculture interventions associated with recurrent fish mortality events documented from 2012 in brackishwater cage-farming systems in central Kerala. The study investigated how extreme rainfall, abrupt salinity fluctuations, organic loading, industrial pollution, and seasonal hydrological variability interact to shape ecosystem-scale stress conditions. Major mortality events observed during 2013, 2014, and 2024 were associated with salinity decline, increased BOD , low DC, and the accumulation of toxic gases, including hydrogen sulfide and ammonia. Earlier environmental assessments also detected traces of Heptachlor (0.47 µg/l) and Aluminum (0.10 mg/l) in affected waters. Although pesticide and heavy metal concentrations remained within permissible limits, the findings suggest that cumulative environmental stress, rather than single-source toxicity, likely created hypoxic and toxic conditions within cage farming zones. Based on long-term ecosystem observations, the study proposes a "Nature-Synchronized Cage Aquaculture" (NSCA) framework that aligns stocking, nursery rearing, grow-out, and harvesting schedules with seasonal hydrology, monsoon variability, water exchange dynamics, and ecosystem carrying capacity. The framework emphasizes adaptive farming calendars, real-time water quality surveillance, pollution monitoring, and ecosystem-based aquaculture planning as climate-resilient strategies for tropical estuarine production systems.

Keywords: *Climate Adaptation, Cage Aquaculture, Fish Mortality, Estuarine Ecosystem, Ecosystem Management*

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Abstract ID: TSS/CRAM/06

MULTIDECADAL DECLINE OF MANGROVE COVER IN MINICOY ISLAND, LAKSHADWEEP, INDIA: A REMOTE SENSING ANALYSIS USING MULTI-TEMPORAL LANDSAT IMAGERY

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Mangroves are ecologically critical coastal ecosystems that provide essential services including shoreline stabilization, carbon sequestration, nursery habitat for marine organisms, and protection against storm surges. In small island ecosystems such as those of Lakshadweep, their conservation is particularly vital given the heightened vulnerability of atoll environments to climate-driven and anthropogenic pressures. This study analyses multidecadal changes in mangrove cover at Minicoy Island (8°15'N, 73°04'E), the southernmost atoll of the Lakshadweep archipelago, over a 32-year period spanning 1993 to 2025. Multi-temporal Landsat satellite imagery acquired from sensors 5 TM, 7 ETM+, and 8 OLI at 30-meter spatial resolution was obtained from the USGS Earth Explorer portal. Atmospheric and geometric corrections were applied using the Semi-Automatic Classification (SCP) plugin in QGIS 3.28.9, and land cover classification was performed using Supervised Maximum Likelihood Classification (MLC) across three classes: water body, other vegetation, and mangroves. Classified outputs were validated through field-based ground truthing using GPS data and iteratively refined to minimize misclassifications. Two distinct sites were assessed: Site A (total area: 656,100 m²) and Site B (total area: 189,000 m²). Results reveal a marked and progressive decline in mangrove extent at both sites. At Site A, mangrove cover decreased from 29,700 m² in 1993 to 9,900 m² in 2025, representing a loss of approximately 67%, despite a marginal expansion observed during 1993–2005. Site B exhibited a consistent and steeper decline from 22,500 m² to 7,200 m² over the same period, a loss of nearly 68%. The findings highlight an accelerating trend of mangrove degradation in Minicoy Island, underscoring the urgent need for site-specific conservation interventions and long-term ecological monitoring frameworks for island mangrove ecosystems in the Indian Ocean region.

Keywords: *Mangrove Degradation, Remote Sensing, Landsat Time Series, Small Island Ecosystems, Multidecadal Analysis*

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Abstract ID: TSS/CRAM/07

SEASONAL INTENSIFICATION AND SPATIAL EVOLUTION OF MARINE HEATWAVES IN BARENTS SEA

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Marine Heatwaves are extreme oceanic warm episodes, which affecting the ecosystem and socioeconomic system and it is important topic in Oceanic research now a days. This study investigates the seasonal and spatial dynamics of marine heatwaves (MHWs) in the Barents Sea over the period 1993–2024. Dividing the study region into northern (76°-80°N) and southern (70°-75°N) sectors, we identify distinct MHW characteristics connected to contrasting environmental conditions such as sea-ice melt and solar heating. MHWs predominantly occur in summer and early autumn, with peak intensities and cumulative heat observed in July-August. The southern Barents Sea exhibits higher mean MHW intensities (~2.5-3.0 °C) and stronger warming trends (0.04-0.05 °C/year) compared to the northern region (~2.0-2.3 °C, 0.03-0.035 °C/year). Spatial analysis reveals intensified MHW characteristics in the northeastern and eastern Barents Sea, where cumulative intensity trends exceed +100 °C days/decade and event duration increases by over 30 days/decade. Interestingly, MHW frequency is rising north of 76°N by up to +2.5 events/decade, while southern regions show weaker or negative frequency trends. These changes align with broader Arctic warming patterns, reduced sea-ice extent, and Atlantification processes. The findings underscore the growing intensity, persistence, and spatial expansion of MHWs in the Barents Sea, with significant implications for Arctic marine ecosystems.

Keywords: *Marine Heatwaves, Barents Sea, Arctic Warming*

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Abstract ID: **TSS/CRAM/08**

LINKING PLANKTON SHIFTS TO HILSA CATCH DYNAMICS IN THE NARMADA ESTUARY

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Narmada, the longest west flowing river of India, debouches into Gulf of Khambat in Bharuch district, Gujarat. The estuarine zone of Narmada contributes significantly through economically important Hilsa fishery. However, the Hilsa fishery has experienced a marked decline, from more than 10000 tonnes in 1990 to only averaging 35 tonnes in last 15 years, due to altered freshwater inflow after the construction of the Sardar Sarovar Dam, which led to habitat degradation and also through unsustainable fishing practices. Additionally, the bed morphology of the estuary mouth has undergone significant alteration, resulting in formation of large sandbars posing difficulties in Hilsa anadromous migration route. Hilsa migration is strongly linked to monsoon and post-monsoon periods, while, inflow of freshwater significantly influences its catch dynamics. In addition to its economic value, Hilsa serves as an important source of PUFA (omega-3 fatty acid). The species exhibits a ram feeding mechanism, with fingerlings primarily consuming phytoplankton, while juveniles transition to diet comprising zooplankton and small crustaceans. This study investigates whether planktonic resource availability continues to sustain the populations despite declining fishery yields. Gut content analysis revealed dominance of planktonic food. Ontogenetic dietary shifts are evident, with fingerlings (2-4 cm) primarily consuming phytoplankton, while juveniles (>4 cm) transition to a carnivorous diet comprising zooplankton and small crustaceans. However, the Hilsa catch statistics continues to be in misery, while recent surge in catch is attributed to improved fishing gears and concentrated efforts near estuarine mouths, thus may not reflect true stock recovery. However, proposed infrastructural interventions such as the Bhadbhut Barrage may further threaten the resilience of this already stressed fishery system.

Keywords: *Narmada Estuary, Hilsa Fishery, Feeding habitat, Phytoplankton community, Prey-predator relationship*

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Abstract ID: **TSS/CRAM/09**

NATURE-BASED SOLUTIONS FOR CLIMATE RESILIENCE: PATHWAYS TO SUSTAINABLE ADAPTATION AND MITIGATION

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Nature-Based Solutions for Climate Resilience: Pathways to Sustainable Adaptation and Mitigation Climate change continues to pose significant threats to livelihoods, ecosystems, food security, and economic development, particularly in vulnerable communities across Africa. Rising temperatures, erratic rainfall patterns, flooding, coastal erosion, and land degradation are increasing the vulnerability of both rural and urban populations. While technological solutions remain important, there is growing recognition that nature based solutions offer cost effective, sustainable, and locally driven approaches to addressing climate challenges. This abstract explores how nature based solutions can strengthen climate resilience while advancing both adaptation and mitigation objectives. It highlights the role of ecosystem restoration, sustainable land management, agroforestry, wetland conservation, urban greening, and community led reforestation in reducing climate risks and enhancing environmental sustainability. These approaches not only improve carbon sequestration but also protect biodiversity, strengthen food systems, improve water security, and support livelihoods. Drawing on experiences from community level initiatives, the paper emphasizes the importance of local participation, indigenous knowledge, and inclusive governance in the successful implementation of nature based interventions. It argues that integrating nature based solutions into climate policies and development planning can create long term environmental, social, and economic benefits. The study concludes that investing in nature based solutions is essential for building resilient communities capable of adapting to climate impacts while contributing to global mitigation efforts. Strengthening partnerships among governments, civil society, researchers, and local communities will be critical to scaling these solutions and achieving a more sustainable and climate resilient future.

Keywords: *Climate Resilience, Nature Based Solutions, Climate Adaptation, Climate Mitigation, Sustainable Development*

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Abstract ID: TSS/CRAM/10

WARMING AND FRESHENING COASTAL WATERS IMPACT HARMFUL ALGAL BLOOM FREQUENCY IN HIGH LATITUDES

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Harmful algal blooms contaminate seafood with toxins and poison humans and wildlife upon consumption. Toxic algae niches are projected to expand in high latitudes, but how the frequency of their blooms will evolve is still little known. Here we use climate models, 14 years of observations and probabilistic models of toxic algae, to assess the frequency of harmful algal blooms in a future warmer world. The warmer ocean temperatures increase the blooms in spring and autumn. However, the blooms reduce in summer as surface waters become excessively warm. Freshening reduces the blooms of species confined to high salinity ranges and has no effect on increasing the blooms. In a 3 °C warmer world, the blooms of *D. acuta* might increase by 50% and *A. tamarense* complex reduce by 40% along the Norwegian coast. Therefore, humans and wildlife are likely to become more exposed to diarrheic toxins and less to paralytic toxins.

Keywords: *HAB, Climate Change, Seafood; High Latitudes, Norway*

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Abstract ID: **TSS/CRAM/11**

MARINE HEATWAVES IN THE BAY OF BENGAL

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Marine heatwaves (MHWs) have emerged as a key indicator of ocean warming and climate variability. The Bay of Bengal characterized by strong stratification and high sea surface temperatures, experiences frequent and intense MHW events. These extremes have significant implications for marine ecosystems and regional weather patterns. Daily Sea surface temperature data are downloaded from Copernicus Marine Service for the period 1982–2023. A seasonally varying climatology and 90th percentile threshold are computed and MHW events are detected when SST exceeds this threshold for ≥5 days. The analysis was performed using a general purpose programming language for scientific computing. The analysis shows that the Bay of Bengal experienced over 100 marine heatwave (MHW) events during the study period with a noticeable increase in both frequency and cumulative intensity over time. Recent decades, particularly after 2000, exhibit a higher occurrence of long-duration events that suggesting a shift toward more persistent warming conditions. The year 2016 stands out as an extreme case with both high intensity and prolonged duration. Seasonally, MHW events peak during August and November, while the most intense events are typically observed during the pre-monsoon months. Overall, MHWs are becoming more frequent and intense in the Bay of Bengal, leading to long lasting warm conditions. These changes may contribute to increased risks for extreme marine and atmospheric events, including potential influences on tropical cyclone intensity. Continued ocean warming is likely to further enhance the frequency and duration of such extreme conditions.

Keywords: *Marine Heatwaves (MHWs), Bay of Bengal, Sea Surface Temperature (SST), Climate Variability, Extreme Ocean Warming*

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Abstract ID: **TSS/CRAM/12**

CARBON STOCKS DYNAMICS IN RESPONSE TO CHANGES IN MANGROVE FOREST COVER ALONG THE COASTLINE OF GHANA FROM 2015 TO 2024

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Mangroves are very effective in capturing, transforming, and storing CO2 in the atmosphere into coastal sediments for long-term carbon storage and thus plays significant role in controlling greenhouse gas emissions and reducing atmospheric CO2 levels. Whereas studies on mangrove forests have focused on cover losses, this study delves into the carbon losses associated with mangrove losses. This knowledge is important for Ghana to effectively monitor carbon dynamics in response to changes in mangrove forest cover. This study covers the period from 2015 to 2024 with the objectives to determine the changes in mangrove cover along the Coastline of Ghana and to estimate carbon stocks associated with mangrove cover over the same period. Using remote sensing and GIS approaches, change detection analysis was performed to determine the changes in mangrove forest cover along the coastline from 2015 to 2024. Total carbon stocks along the coastline of Ghana between 2015 and 2024 were estimated using the InVEST carbon model. The results of this study revealed a drastic decline in mangrove forest cover and associated carbon stocks along the Ghanaian coastline over the study period. The Eastern coast experienced the greatest loss, with 2,674.05 ha of mangrove cover (46.18%), followed by the Central coast, which lost 35.07% of its cover, and the Western coast, which recorded a decline of 18.84%. These losses corresponded to an estimated reduction of 1,436,170.71 megagrams of carbon associated with mangrove loss across the three coastal regions. This development is alarming and a major challenge to Ghana's climate change mitigation efforts. It is important that there is continuous monitoring of Ghana's mangroves for effective climate change mitigation.

Keywords: *Environmental monitoring, Carbon Sequestration, Climate Mitigation, Blue Carbon*

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Abstract ID: TSS/CRAM/13

ASSEMBLAGE OF JUVENILE FISH IN NATURAL AND PLANTED MANGROVES OF QATAR UNDER EXTREME SEAWATER CONDITIONS

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Intertidal mangrove forests are highly productive coastal ecosystems that serve crucial nursery grounds for marine ichthyofauna. In the Arabian Gulf and specifically along the Qatar coast, the grey mangrove *Avicennia marina* (*A. marina*), is the dominant mangrove species that persists in extreme temperatures, high salinity, limited freshwater, and oligotrophic waters. Despite the ecological significance of mangroves and fisheries, the influence of environmental extremes on juvenile fish assemblages remains poorly studied in Qatar's natural and planted mangroves. This study assessed spatial and seasonal (autumn and winter) variation in juvenile fish diversity across two natural (Al Khor and Al Dhakhira) and planted (Al Mafyar and Fuwairit) mangroves, along with associated physicochemical seawater characteristics. Seawater conditions varied across sites and seasons, with water temperature ranging 18.40–34.30°C and salinity remaining hypersaline (40.24–49.9). Dissolved oxygen indicated well-oxygenated conditions (6.46–8.69 mg L^{-1}), pH remained alkaline (7.79–8.38), and chlorophyll-a concentrations were low (0.82–2.72 µg L^{-1}), peaking at Al Khor during autumn. A total of 1109 juveniles representing 13 taxa from 10 families were recorded. Species richness ranged from 5 to 7 taxa across the sites. Juvenile abundance peaked during autumn, dominated by *Gerres* sp. (71.9%), coinciding with increased water temperatures and chl-a concentrations, whereas winter assemblages showed a higher abundance of *Aphanius dispar* (61.6%). Several site-specific taxa were recorded, including *Apogon* sp. and *Herklotsichthys* sp., which represent new records for the mangrove ecosystems of Qatar. Commercially important and reef-associated fishes were also recorded. These results highlight the importance of Qatar's mangroves as resilient nursery habitats amid the region's environmental extremes. The study also emphasize that restored mangroves attained a stable ecological functioning through their growth in the last three decades.

Keywords: *Avicennia Marina, Arabian Gulf, Qatar Coast, Juvenile Fish, Mangrove Nursery, Mangrove Restoration*

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Abstract ID: **TSS/CRAM/14**

CLIMATE CHANGE IMPACTS ON LAKE HYDROLOGY IN RWANDA: A CASE STUDY OF LAKE CYOHOHA NORTH

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Climate change is increasingly affecting freshwater hydrological systems in Rwanda, with significant implications for lake dynamics and water availability. This study assesses the impact of climate change on the hydrology of Lakes of Rwanda, focusing on Lake Cyohoha North. The objective is to evaluate how changes in rainfall, temperature, and evapotranspiration have influenced lake water levels, inflow–outflow patterns, and overall water balance. The study used historical climate data (1990–2025), satellite observations, and a water balance approach to analyze hydrological changes. Trend analysis was applied to rainfall and temperature data, while lake level variations were examined alongside catchment land use changes. Findings show that mean annual temperature increased by 1.4°C over the study period, while annual rainfall decreased by 9% and became more irregular in distribution. Evapotranspiration increased by 12%, contributing to higher water losses from the lake system. Lake Cyohoha North experienced a consistent decline in water level averaging 0.18 m per year. Dry season water storage decreased by 22% compared to the 1990 baseline, and inflow response to rainfall events weakened due to reduced infiltration capacity and catchment degradation. The results indicate that hydrological changes in Lake Cyohoha North are strongly driven by climatic factors, particularly rising temperatures and declining rainfall, combined with land use pressures in the catchment. These changes have disrupted the lake's natural water balance, increased seasonal water scarcity and reducing its resilience to climatic variability. The study concludes that Lake Cyohoha North is highly vulnerable to climate change impacts, requiring urgent implementation of integrated watershed management, reforestation, and climate adaptation strategies to sustain its hydrological stability and long-term water security.

Keywords: *Climate Change, Hydrology, Lake Water Balance, Evapotranspiration, Rainfall Variability, Water Resources Management, Watershed Degradation, Lake Level Dynamics*

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Abstract ID: **TSS/CRAM/15**

FISHING ACTIVITY AND FISH FAUNA OF TWO RIVERS IN THE CONGO BASIN (BOUMBA AND KADEI) IN EASTERN CAMEROON

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Several studies have investigated the relationships between the forest, iconic terrestrial animals, and humans in the Congo Basin, the "second lung of the planet" after the Amazon rainforest; however, very few studies have examined the relationship between this forest, the aquatic biodiversity it harbors, and its exploitation through fishing. It is within this context that this study, conducted from December 2018 to May 2019, was undertaken, with the objective of assessing fishing activity and the fish fauna of the Boumba and Kadei rivers. Fishers, fishing gear, species, and quantities caught were inventoried using pre-established survey forms and by monitoring fishermen's landings. A total of 16 and 99 fishermen were recorded on the Boumba and Kadéi rivers, respectively. These fishermen use gillnets (75%), cast nets (3%), hooks (17%), and traps (5%), and exhibit CPUE values of 2.12 kg/day on the Boumba compared to 3.12 kg/day on the Kadei. On the 845 fish specimens examined for this study, 56 species, 34 genera, 13 families, and eight orders come from the Boumba river, and 70 species, 36 genera, 15 families, and eight orders from the Kadei river. According to the IUCN classification, almost all of these species are native to the Congo Basin and of Least Concern (LC); two (*Bryconaethiops quinquesquamae* and *Synodontis pardalis*) are endangered, one (*Mormyrus iriodes*) is endemic to the Congo Basin and another (*Mormyrus caballus*) remains unassessed by the IUCN. Furthermore, in the absence of effective fishing regulations, these endemic and endangered fish species represent a major conservation issue.

Keywords: *Congo Basin, Fishing, Endangered, Conservation*

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Abstract ID: TSS/CRAM/16

IMPACT OF CLIMATE CHANGE ON MARICULTURE SUITABILITY IN THE COASTAL WATERS OF BANGLADESH

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Climate change is increasingly changing the coastal environment in terms of both risks and opportunities for mariculture in Bangladesh. In this study, the relationship between climatic variables and mariculture suitability in the northern Bay of Bengal was examined using remote sensing, environmental data, and modeling. Different physicochemical variables, such as SST, salinity, chlorophyll, rainfall, ocean currents, and cyclones, were used in this study for trend analysis and evaluation of the suitability of marine culture. The study found a noticeable warming trend in SST (≈0.028°C yr^{-1}; $R^2 = 0.62$). The seasonal variations in chlorophyll were prominent, reaching its peak values in April-May and showing a revival trend post 2015, reflecting increased primary productivity. Monsoon-driven variations were observed in the case of both salinity and turbidity, whereas anomalous precipitation, as well as discharge data, reflected increasing hydrological extremes. Increasing sea levels (≈3 mm yr^{-1}; $R^2 = 0.96$) and positive SST anomalies also showed climatic changes. The ocean current indicated that there were substantial changes in the direction of the currents due to the effects of monsoons, which resulted in peaks in anomalies due to an increase in hydrodynamic activity. The spatial analysis has shown that the southeast and west coastal areas are more suitable, particularly during the dry season. Model performance (AUC = 0.843) demonstrated suitable mariculture zones. The integrated analysis showed that October to March is the best period for mariculture, with salinity levels from 15 to 30 ppt, increased DO, low turbidity, temperatures ranging from 24 to 28 °C, and higher chlorophyll. Monsoons cause stress due to freshwater and high turbidity. Overall, changing climatic variables have greatly influenced the dynamics of the coastal ecosystem. Therefore, climate-resilient mariculture practices should be in place in the coastal zone of Bangladesh.

Keywords: *Mariculture, Climate Change, Coastal Zone, Remote sensing, Modelling*

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Abstract ID: TSS/CRAM/17

STUDY OF THE IMPACT OF MINING ON SEA TURTLES IN THE MANYANGE NA ELOMBO-CAMPO MARINE PARK (KRIBI, SOUTH CAMEROON)

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From the 1960s to the present day, successive geological, geochemical, and geophysical surveys in Cameroon have led to the discovery of numerous minerals (gold, bauxite, tin, uranium, iron, etc.), the exploitation of which contributes to economic growth, job creation, and development. However, beyond these advantages, mining brings with it a host of problems. Indeed, the various practices used in mining (diversion and pollution of waterways, soil disturbance, deforestation, use of chemicals, etc.) generate significant disruptions, notably climate change, which is causing the progressive loss of biodiversity. This is the case of an iron ore mine in Kribi, Cameroon, located near the Manyange na Elombo-Campo Marine Park, which is home to five species of sea turtles, including one (*Chelonia mydas*) threatened with extinction. This mining operation is therefore a major controversy, as it poses a real risk to the Atlantic Ocean and its biodiversity. Indeed, the runoff of wastewater from this mining operation will cause erosion of the Kribi coastline, thus accelerating the advance of sea levels onto the continent. This wastewater will also increase the concentration of limestone in the ocean shores, with a direct impact on the health of mother turtles and an indirect impact on the development of eggs and therefore embryos. Similarly, the increased temperature of the sand generated by the extraction furnaces will significantly impact the sex ratio of sea turtles, favoring females and causing an imbalance and feminization of the population, with a direct effect on the reproduction and survival of the species.

Keywords: *Mining, Wastewater, Coastal Leaching, Sea Turtle*

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Abstract ID: **TSS/CRAM/18**

PATTERNS OF JUVENILE REEF FISH ASSEMBLAGES ACROSS A MANGROVE-SEAGRASS-CORAL CONTINUUM IN SHIMONI, KENYA

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Understanding juvenile fish distribution across habitat mosaics is essential for interpreting ecosystem connectivity and function. This study assessed seasonal variations in juvenile reef fish assemblages across a mangrove-seagrass-coral reef continuum in Shimoni, southern Kenya. Using a beach seine net, sampling during the Northeast Monsoon (NEM) and Southeast Monsoon (SEM) seasons, a total of 8,575 individuals representing 228 species and 52 families were recorded. Species richness and diversity (H') were highest in the coral associated site (n = 168; H' = 3.77), followed by seagrass associated site (n = 132; H' = 3.69) and the mangrove associated site (n = 119; H' = 3.64). Two-way ANOVA and Kruskal-Wallis tests revealed significant differences in diversity and mean species richness, respectively across habitats, with post-hoc pairwise tests identifying the most pronounced differences between coral and mangrove sites. While 69 species were common to all three habitats, multivariate analysis demonstrated distinct species-habitat associations, particularly in the mangrove associated habitat, influenced by salinity and temperature. Kolmogorov-Smirnoff test further confirmed differences in the trophic signatures of the assemblages between mangrove-coral and seagrass-coral interfaces. These findings underscore the importance of the coastal habitat mosaic in sustaining fish recruitment and population dynamics, highlighting the need for integrated seascape management in the Western Indian Ocean.

Keywords: *Ecosystem Function, Trophic Structure, Species-Habitat Interactions*

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Abstract ID: **TSS/CRAM/19**

NORTH ATLANTIC OSCILLATION SIGNAL IN THE INTERANNUAL VARIABILITY OF EARLY AUSTRAL SUMMER VEGETATION OVER EAST AFRICA

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The East Africa region is endowed with a rich marine and coastal ecosystem, primarily owing to its extensive coastline along the western Indian Ocean. This widespread coastal area is primarily covered with a varied ecosystem, which is important for human livelihood in this densely populated region. Moreover, human intervention and climate change have recently threated the abundance or even extinction of species in the coastal area. This study examines the impact of the North Atlantic Oscillation (NAO) on the interannual variability of early austral summer (December) vegetation over coastal southern East Africa and quantifies its contribution relative to the El Niño–Southern Oscillation (ENSO). We used satellite-derived leaf area index (LAI) and normalized difference vegetation index (NDVI), precipitation, soil moisture/temperature, surface solar radiation, and atmospheric data from 1982–2015. Empirical orthogonal function (EOF), singular value decomposition (SVD), correlation, regression, and composite analysis, were employed to examine vegetation variability, isolate independent local drivers, and elucidate the mechanisms linking NAO to vegetation. Additionally, an empirical linear regression model was constructed using NAO and ENSO to capture the dynamics of the vegetation in East Africa. The findings suggest that the NAO exerts a significant positive influence on the interannual vegetation variability in coastal southern East Africa through dual atmospheric processes in the upper and lower levels, which promote soil moisture for vegetation growth. The regression model incorporating the NAO and ENSO indices reveals enhanced contribution, with NAO alone accounting for the most relative to the ENSO, suggesting that the NAO plays the dominant role for vegetation conditions over East Africa. These findings offer a new insight into the interaction between extratropical climate and tropical ecosystems and provide a potential signal for vegetation monitoring.

Keywords: *Interannual Variability, Vegetation Dynamics, East Africa, North Atlantic Oscillation, Anomalous Circulation*

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Abstract ID: **TSS/CRAM/20**

INTEGRATING COMMUNITY-BASED WATER DATA SYSTEMS AND OCEAN WASTE UPCYCLING TO STRENGTHEN COASTAL ECOSYSTEM MONITORING, PUBLIC HEALTH, AND CLIMATE RESILIENCE IN CENTRAL AND WEST AFRICA

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Coastal communities in Central and West Africa are facing increasing threats from climate change, ocean pollution, and inadequate water management systems, leading to profound impacts on both ecosystems and public health. This research explores the integration of community-based water data systems and ocean waste upcycling as innovative solutions to strengthen coastal ecosystem monitoring, improve public health, and enhance climate resilience. The Water Data Bank (WADABA) project, implemented in Central Africa, collects critical water data that informs decision-making on water management and climate adaptation. By empowering local communities with the tools to monitor and analyze water quality, the project enhances their capacity to address waterborne diseases and other public health challenges exacerbated by climate change. In parallel, the BlueCraft Africa initiative uses ocean waste upcycling to create sustainable livelihoods and raise awareness of marine pollution, turning waste materials into valuable products while contributing to the resilience of coastal ecosystems. This approach emphasizes the importance of community-driven solutions in addressing both environmental and socio-economic challenges. It aligns with the goals of climate adaptation and ecosystem preservation by combining data-driven environmental monitoring with tangible community actions that mitigate pollution and foster sustainable practices. By integrating water data systems and waste upcycling technologies, this project demonstrates a holistic model for promoting climate resilience, safeguarding public health, and ensuring long-term environmental sustainability in Africa's coastal regions.

Keywords: *Coastal Ecosystem Monitoring, Climate Resilience, Water Data Systems, Ocean Waste Upcycling, Public Health, Community-Based Adaptation*

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Abstract ID: TSS/CRAM/21

DEEP LEARNING-DRIVEN SEAWEED DISEASE DETECTION AND BIOSECURITY FRAMEWORKS FOR CLIMATE-RESILIENT AQUACULTURE IN BANGLADESH

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Seaweed is a critical element of coastal ecosystems and offers strong potential for climate resilient aquaculture through carbon sequestration, shoreline protection, and supporting livelihood. Increasing disease outbreaks, environmental stress, and weak biosecurity systems, however threaten its yield potential under changing climate conditions. Strengthening early detection and governance mechanisms is essential for climate adaptation and risk reduction in this industry. By aligning automated disease detection using deep learning with the strengthening of national biosecurity protocols, this research establishes a foundation for sustainable and climate-adaptive seaweed mariculture. A ResNet-50 based deep learning model was developed to automatically classify seaweed health status using images obtained from peer-reviewed publications. The model enables rapid identification of diseased and healthy samples and can detect Ice-ice, epiphytic infestation, White-rot, microbial infected diseases or bleached. In addition, 95 policy, legal, and regulatory documents from relevant governmental departments of Bangladesh, including fisheries, environment, and maritime affairs, were systematically reviewed. A thematic analysis was conducted to evaluate biosecurity strategies, regulatory strength, and integration of aquatic ecosystem risk management. The outcomes highlight the policy gaps and the potential of AI based diseases monitoring. This alignment of policy and AI based monitoring supports sustainable climate-resilient aquaculture development.

Keywords: *Seaweed Aquaculture, Climate Resilience, Deep Learning, Resnet 50, Biosecurity Frameworks, Disease Detection*

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Abstract ID: **TSS/CRAM/22**

ENVIRONMENTAL ASPECTS OF MARICULTURE IN THE COASTAL AREA OF BANGLADESH

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Coastal aquaculture in Bangladesh contributes to economic growth, food security, and livelihoods. Climate change, resource overuse, and environmental harm are some of its problems. This study assessed coastal aquaculture's resistance to climate change and the environment. It focused on biodiversity, and the quality of the water and sediments. Five coastal districts, Cox's Bazar, Khulna, Bagerhat, Patuakhali, and Satkhira were the sites of data collection. Analysis methods included surveys, field observations, and lab analysis. The findings indicated that phosphate and nitrogen levels were greater at aquaculture sites. Heavy metals and pesticides were found in the sediments at these locations ($p < 0.05$). Aquaculture sites have decreased biodiversity, as indicated by species abundance and diversity indices, which suggests habitat destruction. Multivariate analysis (PCA and PERMANOVA) further confirmed a significant separation between aquaculture and non-aquaculture sites ($R^2 = 0.378$, $F = 17.012$, $p = 0.001$), highlighting distinct environmental and biological conditions. The difficulties were exacerbated by the effects of climate change, including increased temperatures, harsher weather, and shifting salinity. To minimize environmental harm and increase resilience, the study recommends implementing sustainable techniques like Integrated Multi-Trophic Aquaculture (IMTA). To safeguard Bangladesh's coastal aquaculture, this study emphasizes the necessity of sustainable practices, climate-resilient solutions, and improved legislation. Bangladesh can ensure sustainable development while preserving biodiversity and sustaining livelihoods by emphasizing ecosystem-based strategies and community engagement.

Keywords: *Coastal Mariculture, Water Quality, Sediment Pollution, Biodiversity, Climate Change*

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Abstract ID: TSS/CRAM/23

SPATIAL ANALYSIS OF BLUE CARBON POTENTIAL IN THE MANGROVE ECOSYSTEM AT MUARA GEMBONG BEACH-INDONESIA, AS A CLIMATE CHANGE MITIGATION EFFORT

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Mangrove ecosystems are widely recognized as vital blue carbon reservoirs due to their strong capacity to store carbon in both biomass and sediment layers. This study examines changes in mangrove coverage, vegetation condition, and carbon storage potential in the coastal region of Muara Gembong, West Java, Indonesia, by applying the Mangrove Vegetation Index MVI, Normalized Difference Vegetation Index NDVI, and carbon stock estimation. Multi temporal Sentinel 2 imagery with a spatial resolution of 10 m was utilized to evaluate mangrove dynamics in 2017, 2021, and 2025. The findings reveal a notable increase in mangrove extent, showing consistent expansion over time, largely driven by restoration initiatives involving government institutions, local communities, and non governmental organizations. NDVI results indicate an overall improvement in vegetation density, although certain areas remain affected by land use pressures such as aquaculture and settlement activities. Carbon stock analysis demonstrates a significant rise in total carbon storage and CO2 sequestration capacity, mainly associated with the expansion of mangrove area rather than changes in biomass per unit area. In conclusion, this study confirms that mangrove restoration in Muara Gembong has strengthened carbon sequestration capacity and emphasizes its importance as a nature based approach for climate change mitigation and sustainable coastal management.

Keywords: *Mangrove Vegetation Index, Blue Carbon, Sentinel-2 Imagery, Climate Change Mitigation*

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PHYSIOLOGICAL AND METABOLIC RESILIENCE OF *Prorocentrum Lima* TO OCEAN WARMING: IMPLICATIONS FOR DIARRHETIC SHELLFISH POISONING BLOOMS IN INDIAN COASTAL WATERS

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Prorocentrum lima is a cosmopolitan, bloom-forming toxic dinoflagellate, yet the environmental drivers of its proliferation remain poorly understood. This study examined the potential role of warming in promoting the harmful blooms of this species along the Indian coast. *P. lima* was isolated from the Indian coast, cultured, and identified using microscopy and molecular phylogenetic analysis of the LSU rRNA sequence. Its growth and physiological (superoxide dismutase - SOD, malondialdehyde - MAL, metabolite and toxicity level) changes at varying temperatures (25, 30 and 35ºC) was evaluated using established protocols. ANOVA tests were used to evaluate significant differences between treatments. Both morphological features and LSU rDNA phylogeny confirmed the identity of the isolate as *P. lima.* The isolate exhibited growth at all the temperatures tested. The maximum growth ($\mu = 0.173 \pm 0.000$ div. day-1 and maximum cell density = 49,500 ± 200 cells mL-1) was recorded at 30ºC, while the least ($\mu = 0.065 \pm 0.003$ div. day-1; maximum cell density = 10,500 ± 100 cells mL-1) growth was recorded at 35ºC. Also, the cellular diarrheic shellfish toxin (DST), SOD and MAL levels were lowest at 30ºCand highest at 35ºC (at $p < 0.05$). Metabolomic analysis identified several metabolites which differed significantly in their expression between the temperatures tested (at $p<0.05$). Both correlation and pathway enrichment analysis identified important biological pathways including sulfur metabolism, fatty biosynthesis, and carbohydrate metabolism as playing significant roles in conferring temperature tolerance. Metabolites related to these pathways (e.g., octadecenoic acid, arachidic acid, oleic acid, glycerol, and maltose were highly expressed at 35°C when cells were under thermal stress). This study provides insights into physiological adaptations of *P. lima* to increasing temperature and advances knowledge on the potential for the occurrence of its bloom and toxicity in the Bay of Bengal.

Keywords: *Diarrheic Shellfish Toxin, Harmful Algal Bloom, Indian Ocean, Metabolomics, Ocean Warming, Prorocentrum lima*

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Abstract ID: **TSS/CRAM/25**

ASSESSING SEA-LEVEL RISE AND COASTAL RESPONSE IN THE NORTHERN BAY OF BENGAL USING OBSERVATIONS AND MODELING

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The northern Bay of Bengal region has become one of the regional hotspots for sea-level rise because of the combined impact of global ocean warming and monsoon-induced circulations and subsidence occurring in the GBM delta region. In this study, a detailed assessment of sea-level variations in the study region is conducted through satellite-based altimetry data available from AVISO and Copernicus Marine Service, together with tide gauge records (BWDB) and hydrodynamic modeling with Delft3D FLOW model. There was an average basin-wide sea-level rise of about 4.2 ± 0.6 mm yr^{-1} over 1993-2022, which is higher than the global average rate. Spatially, the highest rates were obtained in the northern coastlines, especially around the Bangladesh delta, where the relative sea-level rose at a rate of 6.0 to 8.5 mm yr^{-1} due to sediment compaction and land subsidence. Seasonality is quite prominent, with high sea levels occurring during the southwest monsoon (June–September), which involves more freshwater outflow and wind setup, thereby adding up to 15–25 cm in sea surface level. Variations from year to year are greatly affected by global climate models such as El Niño-Southern Oscillation and Indian Ocean Dipole. Hydrodynamic modeling results demonstrate that a projected sea-level rise of 0.5 m leads to a 20–30% increase in tidal range and significantly enhances saline intrusion distances by up to 30–50 km inland in low-gradient estuarine systems. In addition to the above, models reveal that the combined effect of mean sea level increase and tropical cyclone formation leads to increases in the height of storm surges by 10-15%, significantly enhancing coastal flooding risks. This study provides a detailed, process-based understanding of sea-level rise in the northern Bay of Bengal. The results underscore the urgent need for integrated coastal management and adaptation strategies in one of the most vulnerable deltaic regions of the world.

Keywords: *Sea-level rise, Bangladesh coast, Delft3D, Indian Ocean Dipole, Storm Surge, Salinity Intrusion*

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Abstract ID: TSS/CRAM/26

TROPHIC AND BEHAVIORAL RESPONSES OF REEF FISH COMMUNITIES TO WHALE SHARK PROVISIONING IN A TROPICAL MARINE ECOSYSTEM

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The practice of wildlife provisioning is increasingly adopted to enhance marine tourism, yet its ecological effects on associated fish communities remain poorly understood. This study assessed the impact of whale shark provisioning on the behavior and trophic interactions of reef fish in Oslob, Cebu, Philippines. Through the use of remote underwater video systems (RUVS), comparisons were made between fish assemblages in provisioned and non-provisioned sites to analyze changes in feeding behavior, habitat use, and community dynamics. The results revealed that several fish species displayed modified behavioral patterns in areas where provisioning occurred, including increased involvement in feeding events related to provisioned food and a decreased dependence on natural foraging methods. Evidence of trophic flexibility was noted across various taxa, suggesting that consistent anthropogenic food subsidies can transform ecological roles traditionally linked to specific feeding guilds. These behavioral shifts were accompanied by variations in species occurrence and activity patterns within the provisioning zone. These findings highlight how tourism-driven food subsidies can influence ecological interactions beyond the target species, potentially leading to broader changes in ecosystem functioning. Understanding these dynamics is crucial for evaluating the long-term sustainability of wildlife tourism activities and their implications for the management of tropical coastal ecosystems. This study demonstrates the importance of behavioral indicators in assessing the ecosystem-level consequences of human-mediated environmental changes in marine environments.

Keywords: *Whale Shark Provisioning, Feeding Guilds, Trophic Flexibility, Reef Fish Behavior, Marine Tourism*

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Abstract ID: TSS/CRAM/27

SPATIOTEMPORAL ANALYSIS OF MANGROVE COVER CHANGE AND SHORELINE DYNAMICS IN NIJHUM DWIP, USING REMOTE SENSING AND GIS

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Nijhum Dwip is a dynamic estuarine island in the Meghna estuary where mangrove cover, shoreline movement, sedimentation, erosion, accretion, and human land-use activities interact continuously. This study analyzes the spatiotemporal changes in mangrove cover and shoreline dynamics of Nijhum Dwip from 1990 to 2025 using remote sensing and GIS techniques. Multi-temporal Landsat images were collected from the USGS archive through Google Earth Engine and processed using cloud filtering, QA_PIXEL-based cloud and shadow masking, median compositing, and ROI-based clipping. Five major land-cover classes were identified: mangrove, water body, barren land, agricultural land, and settlement. A CART supervised classification algorithm was applied to generate LULC maps, while shoreline positions were extracted and analyzed using GIS and DSAS-based shoreline-change assessment. The results show that mangrove cover reached its highest extent of 20.91 km² in 2000 but declined to 11.64 km² in 2025, indicating a noticeable reduction in recent years. Settlement expanded from 0.58 km² in 1990 to 11.81 km² in 2025, reflecting increasing human pressure on the island. Shoreline analysis revealed that accretion was dominant over erosion, with 74.69% of transects showing accretion and 25.31% showing erosion. The total accreted area was 12.333 km², whereas the eroded area was 1.272 km², indicating net land gain during the study period. Overall, the findings suggest that Nijhum Dwip is undergoing significant ecological and geomorphological transformation, where mangrove decline, settlement expansion, and shoreline accretion are closely linked. The study provides useful geospatial information for mangrove conservation, shoreline management, and sustainable coastal planning.

Keywords: *Nijhum Dwip, Mangrove Cover Change, Shoreline Dynamics, Landsat, Remote Sensing, GIS, DSAS*

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Abstract ID: TSS/CRAM/28

APPLICATION OF CITIZEN SCIENCE APPROACH TO IDENTIFY BIODIVERSITY HOTSPOT: A STUDY FROM BANGLADESH COAST EMPHASIZING CONSERVATION IMPORTANCE

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Globally coastal and marine biodiversity are showing a decreasing trend and thus developing and implementing conservation strategies are necessary. Similarly, Bangladesh also needs to develop and implement effective conservation strategies to address current environmental challenges and anthropogenic pressures. Considering this into account, present study aimed to identify biodiversity hotspot to support conservation initiative around the Kuakata coast of Bangladesh. Citizen science-based approach was used to collect the data on fishing zone, ecological habitats of species and overall biodiversity hotspots from July 2023 to June 2024. In addition, stakeholder consultations were performed to identify the stressor and develop the preliminary biodiversity conservation plan. We identified three clusters in fishing activities mostly concentrated around the central region of the aquatic ecosystem of the Kuakata coast. Analyzing the habitats of 12 key species we identified three biodiversity hotspots. Hotspot with maximum density was found near the coast while two other hotspots are located in the central and offshore regions. Over exploitation, unsustainable fishing, pollution, decline in stock, warming trend and reduced primary productivity were identified as the major stressors for the ecosystem. Stakeholder consultations suggested that declaration of marine protected area in the survey site can be a potential conservation strategy through developing and implementing a proper management plan. This study will serve as an important tool to develop conservation strategy in data poor regions especially in developing countries.

Keywords: *Habitat, Conservation, Species, Geo-Spatial, Bangladesh*

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Abstract ID: TSS/CRAM/29

DECODING SHORELINE EROSION AND VARIABILITY ALONG THE KERALA COAST USING MULTI-SENSOR SATELLITE OBSERVATIONS

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Kerala's densely populated coast is increasingly exposed to the threats of climate change, including high wave action and storm surges. The reported increase in the frequency of extreme climate events necessitates a shoreline protection management strategy. This requires clear, precise data on the long- and short-term variability of the coastline. Present study evaluates the shoreline variability and prevalent morphological changes along the Kerala coast from 2015 to 2023 using the Digital Shoreline Analysis System (DSAS) tool. A total of 5819 transects were casted to calculate parameters including Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), Linear Regression Rate (LRR), and Weighted Linear Regression (WLR). In the last decade, based on SCE, Kerala's shoreline experienced a maximum variability of 1329.54 m and an average variability of 26.04 m. Average net erosion of -8.67 meters was evidenced, with about 61.37% of transects showing negative movement. Maximum erosion and accretion values were observed at transect 2309 (-827.83 m) and transect 2621 (437.18 m), respectively. The EPR showed an average rate of -1.06 meters/year, with 61.37% of transects undergoing erosion. LRR results indicated that about 61.65% of the transects showed erosion with an average rate of -1.06 m/year, while erosion and accretion peaked at -95.83 m/year and 49.05 m/year, respectively. Similarly, WLR showed 61.75% of transects were erosional with an average rate of -1.06 m/year, while the maximum erosion and accretion rates were -95.23 m/year and 48.56 m/year, respectively. At a 90% confidence interval, the uncertainty associated with the calculated shoreline change rates ranged between 0.47 and 2.51 m/year. The results indicate that the Kerala coast is predominantly erosional, with only a few localized areas showing accretion, and it needs further assessment to determine the short-term change and compounded impact.

Keywords: *Climate Change, Kerala, Shoreline Change, Erosion, Accretion*

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FROM DATASETS TO DECISIONS: NAVIGATING SCIENCE AND POLITICS IN ANTARCTIC CONSERVATION

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The 2025 CCAMLR annual meeting highlighted ongoing challenges in Antarctic krill conservation, with proposals for new Marine Protected Areas (MPAs) vetoed by China and Russia. Antarctic krill are a keystone species in Southern Ocean ecosystems, supporting predators and contributing to carbon sequestration, yet face threats from climate change and expanding fisheries. Effective management relies on multidimensional datasets, including krill distribution, predator–prey interactions, and fisheries statistics (e.g., KRILLBASE, CEMP, STATLANT). While modern technologies improve sampling resolution, maintaining large-scale, multi-decadal datasets remains critical for ecosystem-based management. Despite gaps and uncertainties, the precautionary principle advocates for data-informed conservation measures even under incomplete scientific certainty. Integration of diverse data sources, advanced monitoring technologies, and international collaboration, including under the BBNJ Agreement, are essential to sustain Antarctic ecosystems and guide krill management. This abstract emphasizes the need for science-driven policies amid political challenges to ensure long-term ecosystem resilience.

Keywords: *Antarctic Krill, Southern Ocean, Ecosystem-Based Management, Fisheries Monitoring, Climate Change, Marine Conservation*

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Abstract ID: TSS/CRAM/31

EXTREME TEMPERATURES, CONNECTIVITY AND PHYTOPLANKTON RESILIENCE IN A WARMING OCEAN

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Climate change is fundamentally altering global ocean living conditions for marine ecosystems, both by long-term trends and by increasingly extreme perturbations of physical conditions. Oceanic phytoplankton communities can mainly respond to these stresses through the evolutionary adaptation of resident taxa and/or the migration of better-acclimatized organisms to other parts of the ocean. Quantifying the relative importance of these two mechanisms is critical for assessing the overall impact of climate change and to better predict how marine ecosystems will respond. Here we present work that shows how estimates of surface-ocean connectivity can be used to calculate the migration timescales of warm-tolerant planktonic organisms and be compared with predicted rates of change of sea surface temperature. We find that for the majority of the ocean migration timescales are short enough to compensate for long-term warming, suggesting that the immigration of novel types will be the key mechanism by which marine planktonic communities adapt. This potentially increasing dependency of regions already experiencing conditions expected in climate change scenarios to act as a source for temperature-adapted organisms suggests a significant risk to the resilience of marine ecosystems and is of great concern from a management and conservation perspective. It is of critical importance to better understand these ecosystems and assess their resilience, especially in light of the environmental stress that the Red Sea and Persian Gulf experience today.

Keywords: *Oceanography, Climate Change, Biodiversity*

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Abstract ID: TSS/CRAM/32

REMOTELY SENSING MARINE ECOSYSTEM RESPONSES TO OCEAN WARMING

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Climate-driven changes in ocean temperature, salinity, stratification, and productivity are reshaping marine ecosystems worldwide, with important consequences for fisheries. Detecting biological responses across large spatial and temporal scales remains challenging because *in situ* observations are often spatially limited and discontinuous. Satellite remote sensing provides a synoptic and long-term perspective on marine ecosystem variability. Variability in ocean colour reflects changes in phytoplankton productivity, phenology, and size structure, which propagate through marine food webs and influence higher trophic levels, including commercially important fisheries and aquaculture. Satellite-derived products are increasingly used to quantify ecosystem responses to ocean warming, altered circulation, and climate variability across coastal and open-ocean environments. Here, examples from the Canary Islands, the Mediterranean Sea, the Red Sea, and the western Indian Ocean illustrate how remotely sensed observations capture regional differences in ecosystem structure, productivity, and fisheries-related dynamics under changing environmental conditions. These observations also reveal potential ecological tipping points and ecosystem shifts associated with rapid environmental change. We highlight the importance of Earth observation systems for monitoring ecosystem health and supporting fisheries, aquaculture management, and climate adaptation strategies in vulnerable marine regions.

Keywords: *Ocean Colour; Remote Sensing; Ocean Warming; Fisheries; Aquaculture*

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THE TEMPERATURE-DEPENDENCE OF PHYTOPLANKTON PHOTOSYNTHESIS ACROSS OCEANIC DOMAINS

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The temperature dependence of phytoplankton photosynthesis and growth has been widely used in satellite algorithms and biogeochemical models. In a seminal culture study, Eppley (1972) demonstrated that marine microalgae attained their maximum growth rates at temperatures close to those at which the cells were initially isolated, highlighting the fundamental role of temperature in regulating phytoplankton ecophysiology. In the natural environment, temperature influences phytoplankton photosynthesis both directly, through its control of cellular metabolic processes, and indirectly, through its influence on the density structure of the surface lit layer. By shaping water-column stratification, temperature governs the supply of nutrients and the light history experienced by phytoplankton cells, which are the secondary determinants of algal growth that also drive the seasonal succession of phytoplankton communities. The parameters of the photosynthesis-irradiance (P-E) response curves capture variability in the two primary determinants governing carbon fixation: phytoplankton biomass and light availability. Thus, the P-E curve parameters serve as valuable indicators of photosynthetic performance and efficiency. Using a global dataset of P-E response curves spanning a broad thermal range from -2°C to 30°C, we investigate how temperature relates to the photosynthetic characteristics of natural phytoplankton communities. We adopt a domain-specific approach to examine how these relationships vary across trophic regimes, latitudinal gradients, and seasonal cycles. We will also explore whether phytoplankton community structure can serve as a useful predictor of photosynthetic characteristics premised on the idea that the environmental drivers governing phytoplankton diversity also regulate the secondary factors constraining rates of primary production.

Keywords: *Temperature, Phytoplankton, Primary Production*

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DISCRETE MEASUREMENTS OF ESSENTIAL OCEAN VARIABLES AND WATER TRANSPARENCY IN PANGANDARAN BAY, SOUTH JAVA, INDONESIA (2021–2026)

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This study presents a discrete longitudinal water-quality dataset collected from Pangandaran Bay, a sheltered, semi-enclosed coastal bay on the south coast of Java, Indonesia, situated within the seasonal Indian Ocean upwelling zone. Monthly *in situ* measurements were conducted at three stations across depth profiles of 0, 10, and 20 m, yielding 468 records of five essential ocean variables: water temperature, salinity, dissolved oxygen (DO), pH, and chlorophyll-a concentration, along with 151 records of Secchi depth (SD), a relative measure of water transparency, spanning September 2021 to April 2026. All records underwent post-processing quality control, and 82 records (17.5%) were identified as requiring correction and replaced using time-based linear interpolation at the station and depth levels. These comprised four quality flag levels covering physically inconsistent DO-pH pairs, anomalously low oxygen saturation, extreme pH values, and DO readings above the regional upper bound. An additional 45 records initially archived as missing were subsequently filled from verified field notes and assigned a QC of 1 after passing all flag checks. This continuously updated dataset supports long-term monitoring of ocean acidification and deoxygenation, characterization of upwelling seasonality, and assessment of coastal ecosystem health in an understudied tropical Indian Ocean embayment, providing a resource for regional fisheries management, aquaculture planning, and climate-change impact studies.

Keywords: *Upwelling, Deoxygenation, Acidification, Chlorophyll-a, Pangandaran Bay, Indonesia*

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Abstract ID: TSS/CRAM/35

VALIDATION OF A COUPLED HYDRODYNAMIC-SEDIMENT TRANSPORT MODEL DEVELOPED FOR A PILOT SITE OF THE UN-DECADE PROJECT COAST PREDICT: THE GULF OF GABES, MEDITERRANEAN SEA

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In the gulf of Gabes we gathered 22 time-series of sea level and 12 time-series of current recorded between 1999 and 2025. The harmonic analysis of these time-series allowed the production of co-tidal charts of the main semi-diurnal tidal components (M2, S2). These charts show the amplification of the sea level amplitude during their propagation towards the shore in the gulf of Gabes, in the central Mediterranean Sea. Simulation outputs from Delft-Flow reproduced the tidal resonance of the principle semi-diurnal components (M2, S2), previously reported in the gulf of Gabes. Water mass circulation in the gulf of Gabes defines a velocity field generally collinear to the isobaths and splits up into two directions in front of the Chaffar stream runoff. This velocity field generates two alongshore currents, the first one is directed towards Sfax to the North and the second is directed towards Gabes to the South. A total of 200 sediment samples were analyzed. The results of the granulometric analysis showed that the region is strongly impacted by Northeast waves that generate alongshore currents responsible for sediment transport. The mean grain size (D50) varied from 90 to 630 µm. The numerical modeling of sediment dynamics in the gulf of Gabes under tidal and wind forcing, reproduced the field observations with regards to the evolution of morphological features in the gulf. Particularly, at the shallow bottoms between Houmet Essouk and Zarzis, the model reproduces generally the sand displacement and the wave breaking zone (between 5 and 7m deep). Our simulations shed light on the silting up of the navigation channel of Houmet Essouk harbour and underline the constructive effect of the tidal current, particularly the formation of the flood-tide and ebb-tide shoals on both sides of the tidal inlet. Future studies should explore the effects of recent increase in the occurrence and intensification of extreme weather events (i.e. storms leading to storm surges).

Keywords: *Time-series, DELFT-Flow, Simulation, Tide, Wave, Sediment*

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ARE MARINE HEATWAVES THE PRIMARY DRIVER OF CORAL BLEACHING ACROSS INDIAN REEF REGIONS? EVIDENCE FROM OBSERVATIONS AND CMIP6 PROJECTIONS

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This study examines the impact of marine heat waves (MHWs) on the coral reefs in the North Indian Ocean. Using daily SST (1993–2022; NOAA OISST v2, 0.25°) we detected marine heatwaves (MHWs) following Hobday et al. (2016), where region-specific bleaching thresholds were defined as the mean of the seasonal 90th-percentile SST during known bleaching months. We compiled bleaching records from ReefBase, published surveys, and gray literature and assessed MHW–bleaching correspondence by comparing event timing, duration and intensity. Among all the regions, Lakshadweep showed a strong relationship: during documented bleaching events, SST exceeded the threshold of more than 50 days and MHW intensity (cumulative °C-days) was significantly higher than in non-bleaching years ($p < 0.05$). Other regions (Gulf of Kachchh, Gulf of Mannar, Andaman & Nicobar) displayed weaker correspondence, likely reflecting spatially and temporally inconsistent reporting of bleaching events rather than absence of MHW effects. Using multi-model CMIP6 projections (SSP2-4.5, SSP5-8.5; bias-corrected), we project a marked intensification of MHWs in Lakshadweep, with annual exceedance of the bleaching threshold becoming common after 2070 under high-emissions scenarios. Our results indicate MHWs are a sufficient driver of bleaching in Lakshadweep and underscore the need for standardized, long-term bleaching monitoring across Indian reefs to validate thresholds and improve early-warning systems.

Keywords: *Marine Heatwaves, Coral Bleaching, Indian Reefs, Sea Surface Temperature, Climate Change*

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Sub theme 9

Monsoon Dynamics and Extreme Events

Abstract ID: **TSS/MDE/01**

EVENT-DRIVEN AMPLIFICATION OF DISSOLVED MANGANESE FLUXES IN TROPICAL MONSOON-BASED ESTUARY: RIVER GODAVARI ESTUARINE SYSTEM

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Monsoon-based tropical estuaries such as the Godavari Estuary experience strong flow-mediated variability due to seasonal rainfall, flooding, and discharge fluctuations, often triggering sediment resuspension and associated biogeochemical responses. The extent to which high-discharge events control dissolved manganese (Mn) fluxes, and whether these fluxes exhibit nonlinear or threshold behaviour, remains insufficiently studied. This study investigates event-scale amplification of dissolved Mn fluxes in the Godavari River Estuary by using discharge records, satellite-derived turbidity, and literature-based Mn concentrations. The objectives are to (i) examine relationships between turbidity and Mn variability, (ii) identify discharge-driven turbidity thresholds linked to enhanced Mn flux, and (iii) quantify the contribution of extreme monsoon events to total Mn export. The estuary is treated as a dynamic mixing system where flow variability promotes sediment resuspension and redox fluctuations influencing Mn mobilization. A flux-based approach is used to differentiate baseline and high-discharge conditions. Furthermore, nonlinear scaling relationships are used to identify deviations from linear transport behaviour. In order to assess seasonal and event-driven fluctuations, physicochemical parameters such as salinity, dissolved oxygen, pH, suspended particulate matter, and dissolved manganese concentrations were examined. Preliminary results indicate enhanced Mn fluxes during high-discharge periods, likely reflecting coupled sedimentary and redox processes. Strong relationships between dissolved manganese concentrations, river discharge, suspended sediment load, and dissolved oxygen conditions were found through statistical analyses. Observed variability suggests departures from conservative mixing under certain conditions, highlighting the importance of extreme events in regulating Mn export.

Keywords: *Godavari Estuary, Dissolved Manganese, Trace Metal, Estuarine Biogeochemistry, Sediment Resuspension, Coastal Ecosystems*

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Abstract ID: **TSS/MDE/02**

ASSESSMENT OF SEA LEVEL RISE HAZARD ALONG THE INDIAN COAST

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Sea level rise, an inevitable consequence of global warming, is threatening coastal areas and their inhabitants worldwide. Like many other regions in the world, rising sea levels threaten to inundate India's coastal zones and resources, potentially leaving millions impoverished and displaced. India is set to be among the countries severely impacted by climate change and rising sea levels. India has a coastline of 11,098.8 km with numerous dense coastal settlements that are home to approximately 250 million of the country's 1.40 billion people. These coastal regions experience hazards like cyclones, coastal erosion and sea level rise more frequently and intensely than other parts of the country. Apart from the hardships associated with these hazards, at times, these hazards can force the relocation of coastal inhabitants. Therefore, a well-defined strategy is essential to address these hazards in a manner that minimizes human suffering and loss of life. A critical prerequisite for developing such a strategy is reliable spatial information on the magnitude and frequency of these hazards. The gridded sea level data from the Copernicus Climate Data Store were downloaded and processed to assess the mean sea level rise along the Indian coasts. The rate of sea level rise was assessed district wise and it was seen that the average rate of sea level rise was 5.72 mm/yr. The lowest value of 4.08 mm/yr was reported from the Pudukkottai coast of Tamil Nadu and the highest value of 6.99 mm/yr was reported from the districts of Gujarat adjoining the Gulf of Khambhat. These values were developed into a sea level rise hazard index ranging from 0 – 1, using min-max method, to make it easy for prioritization. This standardized index can be readily integrated with other hazard indices to generate a multi-hazard index map, thereby supporting planners and policymakers in making informed and effective decisions.

Keywords: *Sea Level Rise, Climate Change, Indian Coast, Sea Level Rise Hazard Index, Copernicus Climate Data Store*

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Abstract ID: **TSS/MDE/03**

IS SEASONAL DIC AND PCO_2 VARIABILITY OFF PARADIP DRIVEN BY MONSOON HYDROLOGY?

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Understanding the variability of carbonate system parameters in the coastal waters of the Northern Bay of Bengal remains limited despite their biogeochemical significance. Coastal environments are highly dynamic regions where terrestrial inputs, water mixing, and biological activity collectively regulate inorganic carbon dynamics. This study investigates the seasonal variability of dissolved inorganic carbon (DIC) and partial pressure of carbon dioxide (pCO_2) in the coastal waters off Paradip. Water samples were collected and analysed alongside key hydrographic and biogeochemical parameters, including temperature, salinity, pH, dissolved oxygen, turbidity, and chlorophyll-a. The results reveal pronounced seasonal variability in carbonate system parameters, primarily driven by monsoonal freshwater discharge and coastal mixing processes. Elevated pCO_2 during the monsoon season coincided with reduced salinity, reflecting significant riverine influence and enhanced respiration of terrestrially derived organic matter. Conversely, relatively lower pCO_2 and higher salinity during pre- and post-monsoon periods suggest stronger marine influence and increased buffering capacity of the carbonate system. Regression analysis revealed a strong positive relationship between DIC and total alkalinity, whereas pCO_2 exhibited a negative relationship with salinity, underscoring the dominant role of freshwater inputs and mixing processes in regulating carbonate chemistry. Principal component analysis identified temperature, salinity, and pH as key drivers of carbonate system variability, while turbidity and biological activity contributed to seasonal carbon transformations. Overall, Paradip coastal waters constitute a highly dynamic carbon system, strongly governed by monsoon-driven hydrological forcing and terrestrial inputs, emphasising the critical role of seasonal processes in regulating inorganic carbon variability in the Northern Bay of Bengal.

Keywords: *Mahanadi, Carbonate System, Total Alkalinity, Salinity, PYCO2SYS*

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Abstract ID: **TSS/MDE/04**

INFLUENCE OF SOUTHWEST MONSOON ON MARINE FISHING ACTIVITY AND FISH CATCH DYNAMICS IN COASTAL KERALA

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The southwest (SW) monsoon is a major climatic driver along the west coast of India, significantly influencing marine environmental conditions, fishery resources, and fishing operations. In this context, the present study was undertaken in Ernakulam district of Kerala to assess the influence of the southwest monsoon on marine fishing activity and fish catch dynamics. Monthly weather data for Kochi surface station for the period 2010-2025 were obtained from the India Meteorological Department (IMD) Data Service Portal and processed to derive total monthly rainfall. District-wise monthly datasets on fish catch and actual fishing hours for the same period were compiled and categorized into detailed operational classes, which were further aggregated into broader sectors, namely mechanised, motorised, outboard (OB), and total, for sector-wise analysis. Results revealed a distinct seasonal pattern in marine fish landings, with peak catches occurring during the post-monsoon period (August-October) and substantial declines during the monsoon months (June-July). The mechanised sector contributed the largest share to total landings, indicating its dominant role in marine fisheries. Similarly, actual fishing hours exhibited strong seasonal variability, with a sharp decline during the southwest monsoon, reaching the lowest levels in July across all sectors due to adverse sea conditions and fishing ban periods. The mechanised sector showed the greatest reduction in fishing hours, highlighting its higher sensitivity to monsoon-induced marine conditions. The post-monsoon recovery in fish catch and fishing hours likely reflects improved sea conditions and enhanced biological productivity. Overall, the findings indicate that southwest monsoon significantly influences fishing operations and catch dynamics in Ernakulam, with mechanised fishing largely determining the overall fishing hours in the district.

Keywords: *SW Monsoon, Weather Data, Fishing Hours, Fish Catch and Fishing Sectors*

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Abstract ID: TSS/MDE/05

PARTICIPATORY MANAGEMENT AS A TRIGGER FOR DEVELOPING EAFM IN TWO MONSOON DRIVEN ECOSYSTEMS: INSIGHTS FROM THE GULF OF MANNAR AND PALK BAY

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The Gulf of Mannar and Palk Bay are ecologically important marine ecosystems where monsoon driven climatic dynamics strongly influence fish spawning, seasonal fisheries and resource availability. In Palk Bay, the oil sardine fishery is closely linked to the Northeast Monsoon, beginning in late October, peaking during January and declining by March. Indian mackerel exhibits an alternating pattern, with higher landings when sardine catches decrease. Peak spawning activity of finfishes occurs mainly during the cooler months, with about 82 percent of recorded species showing peak spawning between November and February. Monsoonal circulation significantly affects fishery production. About 55.3 percent of the fish catch in the Gulf of Mannar occurs during the Southwest Monsoon, while 71.5 percent of the catch in Palk Bay is recorded during the Northeast Monsoon. These trends indicate strong climate fishery linkages, where seasonal winds, water exchange and sea conditions influence spawning, fish aggregation and landings. Participatory management in the region regulates mechanised trawler operations on alternate fishing days between the two ecosystems, reducing conflicts and fishing pressure. Combined with co management initiatives and legal restrictions, these measures provide a strong basis for implementing an Ecosystem Approach to Fisheries Management. Understanding monsoon linked fishery dynamics is essential for developing climate resilient fisheries management, improving seasonal advisories and conserving critical habitats such as coral reefs, seagrass beds and mangroves.

Keywords: *EAFM, Monsoon, Oil Sardine, Seasonal Fishery, Spawning, Trawlers*

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Abstract ID: TSS/MDE/06

A CASE STUDY INVESTIGATING THE IMPRINT OF CYCLONE DANA ON THE VARIABILITY OF PHYTOPLANKTON BIOMASS IN COASTAL WATERS OF THE NORTH-WESTERN BAY OF BENGAL

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This study investigates the effect of cyclone Dana on the variability of chlorophyll-a in terms of its response to cyclone-induced variability in different physical variables in the coastal waters of the northwestern Bay of Bengal. The present study used *in situ* and satellite/model-derived biophysical parameters to investigate upper-ocean responses to Cyclone Dana. This tropical extreme event experienced lower translational speed during its intense phase, thereby amplifying the Ekman Pumping Velocity, which facilitated the upwelling of relatively cooler, nutrient-rich subsurface water to the surface. Rapid fertilization of the water column resulted in a significant increment (~2-fold) in chlorophyll-a concentrations after the passage of the cyclone. A significant SST drop of ~2.2 °C in the post-cyclone period indicated surface cooling likely caused by intensified vertical mixing and upwelling due to the cyclone. The taxonomic analysis of phytoplankton revealed an increase in abundance in the post-cyclone phase; however, diatoms dominated in both the pre- and post-cyclone phases. The result of a comparative analysis of past cyclones influencing chlorophyll-a showed an average ~5-fold increase in concentration after the passage of the cyclone. These findings underscore the critical influence of cyclonic activity at lower translational speeds in modulating marine ecological dynamics, offering insights into the intricate interplay of biophysical processes within tropical coastal ecosystems.

Keywords: *Tropical Cyclone, Translational Speed, Ekman Pumping Velocity, Phytoplankton, Sea Surface Temperature*

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Abstract ID: **TSS/MDE/07**

EFFECTS OF MONSOONAL DYNAMICS ON PHYTOPLANKTON PHOTOSYNTHETIC PERFORMANCE IN THE SUNDARBANS USING FAST FLUOROMETRY

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The Sundarban estuarine ecosystem is highly dynamic, shaped by monsoonal variations in salinity, nutrient levels, and hydrological patterns. To evaluate the photosynthetic efficiency of primary producers amid these seasonal changes, we conducted Fast Repetition Rate Fluorometer (FRRF) measurements of maximum quantum yield (Fv/Fm). FRRF, which measures chlorophyll a fluorescence kinetics, offers a rapid and non-invasive means to assess photosystem II performance and stress responses. Measurements taken during pre- and post-monsoon periods revealed Fv/Fm values ranging from 0.2 to 0.6 under different LED excitation protocols. This variability reflects the influence of monsoon-driven environmental shifts on phytoplankton physiology. Our analysis highlights the adaptability and resilience of phytoplankton communities. Additionally, we are integrating these *in situ* photosynthetic data with Oceansat-3 satellite observations to enhance remote monitoring of ecosystem health and carbon dynamics in this vulnerable coastal region.

Keywords: *Photosynthetic Efficiency, FRRF, Sundarbans, Chlorophyll*

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Abstract ID: **TSS/MDE/08**

IMPACTS OF DYNAMIC AND EXTREME ATMOSPHERIC EVENTS ON MARINE ECOSYSTEMS AND FISHERIES IN EAST AFRICA

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Marine ecosystems along the East African coast are highly influenced by dynamic atmospheric processes and extreme weather events. Phenomena such as tropical cyclones, monsoon variability, and marine heatwaves significantly affect ocean circulation, sea surface temperature, and coastal upwelling systems. These changes directly impact primary productivity and the distribution, abundance, and migration of commercially important fish species. In recent years, increased climate variability across the Western Indian Ocean has intensified the frequency and magnitude of extreme events, posing risks to fisheries, aquaculture, and coastal livelihoods. Countries such as Kenya, Tanzania, and Somalia are particularly vulnerable due to their dependence on marine resources and limited adaptive capacity. This study examines the interaction between atmospheric forcing and marine ecosystem response using integrated approaches that combine satellite remote sensing, meteorological data, and oceanographic observations. The results demonstrate how improved monitoring and forecasting of extreme events can enhance early warning systems and support sustainable fisheries management. The study underscores the importance of interdisciplinary collaboration to strengthen resilience in East African marine ecosystems, contributing to global efforts in managing aquatic resources under a changing climate.

Keywords: *East Africa, Western Indian Ocean, Marine ecosystems, Fisheries, Extreme weather events, Climate variability, Remote Sensing*

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Abstract ID: TSS/MDE/09

UNDERSTANDING SPATIO-TEMPORAL DYNAMICS OF BANGLADESH COASTAL WATERS USING THE DELFT3D MODEL

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Coastal and estuarine systems in Bangladesh are highly dynamic environments, influenced by monsoonal rainfall, river discharge, and tidal forcing, which collectively regulate hydrographic variables, such as salinity, temperature, water level, etc. A 2D Delft3D FM hydrodynamic model has been configured to study the spatio-temporal changes of these parameters in the Northern Bay of Bengal-Bangladesh coastal waters, using an unstructured grid, covering the period December '24 to November '25. The model successfully captures the variation over an annual scale, including seasonal patterns driven by monsoon dynamics (pre-monsoon, monsoon, post-monsoon, winter), as well as spatial differences across the three coastal zones of Bangladesh, along with transition from estuarine to open ocean conditions. Twelve stations were strategically positioned across the entire Bangladesh coast to capture spatial variations along north-south and east-west gradients from estuary to offshore zones. The model output showed maximum SST during pre-monsoon (~29°C at upstream estuary and open ocean stations) and minimum in winter (~25°C at central stations). Surface Salinity displayed a clear seasonal cycle, with minima during peak monsoon (~0–0.5 PPT in upstream estuaries) due to heavy river discharge and maxima in post-monsoon and dry seasons (~30–32 PPT offshore) as reduced river flow allowed oceanic intrusion. Water level analysis revealed a clear upstream–downstream contrast driven by river discharge and tidal forcing, with seasonal amplitudes of 0.542 m in the upstream and 0.185 m in the downstream zone. Monsoon-driven discharge dominates estuarine hydrodynamics (peaking in August, lowest in January) and has strong correlations with temperature and salinity in Meghna and Sundarbans estuaries. These results highlight the combined influence of fluvial, tidal, and seasonal processes on estuarine hydrography, providing insights for sustainable management of freshwater and coastal ecosystems.

Keywords: *Estuarine Hydrodynamics, Delft3D, Monsoon-Driven Variability, Northern Bay of Bengal*

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Abstract ID: **TSS/MDE/10**

A CONTOUR AND GAUSSIAN BASED FRAMEWORK FOR IDENTIFYING MULTI-CORE MESOSCALE EDDY STRUCTURES IN THE BAY OF BENGAL

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This study presents a contour- and Gaussian-based framework for identifying and analyzing multi-core mesoscale eddies in the Bay of Bengal using satellite datasets. The study region covers the Bay of Bengal and part of the Andaman Sea. Numerous studies are done on general eddy detection but in all those studies one gap is still present that is multiple eddy core inside one eddy radius is counted as one solo eddy which requires correction. To my knowledge, this is among the first studies in this region to investigate complex multi-core mesoscale eddy structures using a contour Gaussian integrated approach. Potential eddy candidates were first detected from closed positive as anticyclonic and negative as cyclonic SLA contours. Then the detected structures were filtered using contour and Okubo Weiss parameter support. Multi core eddies were identified when multiple same polarity cores coexisted within a single accepted contour. A Gaussian fitting approach was then applied to determine whether these structures should be retained as composite eddies or separated into individual eddies. The results Cyclonic eddies were dominant during the pre-monsoon season while monsoon conditions showed a more balanced distribution and anticyclonic eddies were dominated during post monsoon period. Eddy hotspot analysis showed enhanced activity in the northern Bay of Bengal and along the eastern boundary. Validation against the AVISO atlas showed daily match rates commonly between 50 to 75 percent and exceeding 80 percent on some days. As mesoscale eddies strongly influence ocean circulation, heat and nutrients transport, and monsoon driven ocean variability in the Bay of Bengal, this study contributes directly to understanding regional monsoon dynamics and associated oceanic processes. The framework may also support future investigations linking physical circulation variability with ecosystem and climate in the northern Indian Ocean.

Keywords: *Mesoscale Eddies, Bay of Bengal, Sea Level Anomaly, Gaussian Fitting, Eddy Tracking*

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Abstract ID: **TSS/MDE/11**

STORM SURGE DYNAMICS ALONG THE MOZAMBICAN COAST DURING TROPICAL CYCLONES IDAI AND KENNETH (2019)

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This study investigates storm surge dynamics along the Mozambican coast during tropical cyclones Idai and Kenneth (2019) using the CROCO coastal ocean model at 1/12° resolution. Three experiments were conducted for each cyclone (Tides + Wind, Tides Only, Wind Only) to quantify total sea level and nonlinear tide–surge interactions. Model validation against tide gauge data showed strong agreement (R^2 = 0.969 in Pemba and 0.850 in Inhambane). Results indicate that astronomical tides dominate total water levels, contributing up to 92% during Idai and 97.8% during Kenneth, confirming the macrotidal nature of the Mozambique Channel. Storm surge residuals differed significantly, reaching +0.823 m in Beira (Idai) and +0.107 m in Pemba (Kenneth), driven by differences in wind intensity, coastal morphology, and timing relative to tidal phase. Nonlinear interactions were consistently negative, highlighting energy dissipation driven by tidal currents and bathymetry. These findings demonstrate that coastal flooding risk cannot be predicted solely by cyclone intensity but depends on complex interactions between atmospheric forcing, tides, and coastal geomorphology. The study contributes to improved understanding of extreme coastal events and supports the development of more reliable early warning systems in the Western Indian Ocean.

Keywords: *Storm Surge, Tropical Cyclones, Ocean Modelling, Mozambique Channel, Coastal Flooding, Extreme Events*

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Abstract ID: **TSS/MDE/12**

ESSENTIAL OCEAN VARIABLES AND COASTAL BIOGEOCHEMISTRY IN KENYA: LONG-TERM MONITORING OF WARMING, DEOXYGENATION AND ACIDIFICATION

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Long-term ocean observations are essential for understanding climate-driven changes in coastal biogeochemistry, yet such datasets remain limited in Kenyan waters. Here, we present a five-year analysis (2020-2025) of essential ocean variables (EOVs) from two near-shore monitoring stations (Mombasa and Shimoni). This study focused on warming, deoxygenation, and ocean acidification. Monthly *in-situ* measurements of temperature, dissolved oxygen, pH, salinity, nutrients, chlorophyll-a, and turbidity were analyzed to quantify seasonal, interannual, and vertical (surface vs bottom) variability. Seasonal differences between dry and rainy periods were not statistically significant for any measured variable. In contrast, significant interannual variability was detected across all EOVs, indicating that environmental conditions were shaped more strongly by year-to-year fluctuations than by seasonal forcing. Time-series analyses indicated gradual warming, declining DO concentrations and decreasing pH at both stations. Several prolonged warming and low-pH events were also identified, particularly within bottom waters. Multivariate analyses further showed a dominant temperature-oxygen-pH gradient linking warming with declining oxygen concentrations and pH. A secondary nutrient-productivity gradient, characterized by the covariation of nutrients, chlorophyll-a, and turbidity, was particularly evident at Mombasa. Both stations were nitrogen-limited, particularly in the deeper bottom-water layers, while surface waters occasionally approached a DIN:DIP balanced ratio of 1:16. Vertical profiles revealed that bottom waters were more oxygen depleted, more acidic, and characterized by lower DIN ratios than surface waters, despite being partially buffered from prolonged thermal exposure. These findings indicate that environmental change along the Kenyan coast is influenced by the combined effects of regional climatic forcing and local biogeochemical processes.

Keywords: *Warming, Deoxygenation, pH, DO, Temperature, Variability*

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Abstract ID: **TSS/MDE/13**

RELATIONSHIP BETWEEN THE SPATIAL DISTRIBUTION OF ANCHOVY AND THE PHYTOPLANKTON CARBON FROM PACE MULTISPECTRAL SATELLITE, OFF THE COAST OF PERU

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The anchovy (*Engraulis ringens*) is a pelagic species that sustains the fishery off the Peruvian coast. Two biomass assessments were conducted using the acoustic method. The average biomass reaches 10 million tons, allowing for the extraction of 3 to 4 million tons annually. This resource is influenced by climatic events that occur off the coast of Peru, such as El Niño and La Niña. To study its relationship with the environment, the variables of temperature, salinity, and chlorophyll-a were used, revealing significant correlations. However, using the Phytoplankton Carbon product from the OCI (Ocean Color Instrument) sensor of the PACE (Plankton, Aerosol, Cloud, Ocean Ecosystem) multispectral satellite, in the development of the latest evolution of biomass from February 16 to April 3, 2026, the relationships found with this variable are presented.

Keywords: *Anchovy, Hydroacoustic, Biomass, Phytoplancton Carbon, PACE, El Niño*

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Sub theme 12

Novel Tools (Including Drones and Artificial Intelligence) for Sustainable Fisheries

Abstract ID: **TSS/AI/01**

DEEPDATA: A MOBILE-BASED BIODIVERSITY INFORMATICS PLATFORM FOR DEEP-SEA FISH SPECIES IDENTIFICATION

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Accurate identification of deep-sea fishes is fundamental to biodiversity documentation, ecosystem monitoring, and fisheries resource management. However, taxonomic identification is frequently constrained by the limited availability of expert taxonomists, scattered reference materials, and the absence of portable digital tools for field-based applications. To overcome these limitations, DeepDATA (Deepsea Digitally Automated Taxonomy Assistant) was developed as an Android-based digital platform that consolidates validated taxonomic information into an accessible and user-friendly mobile application. The application is designed using the Flutter framework with a structured SQL backend to facilitate efficient storage, retrieval, and management of species records. DeepDATA provides comprehensive information on deep-sea fish species, with particular emphasis on diagnostic morphological characteristics that support rapid and reliable species identification. Advanced search and navigation functions enable users to retrieve species information efficiently, making the application suitable for researchers, fisheries professionals, students, and biodiversity managers. By transforming conventional taxonomic references into an interactive digital resource, DeepDATA promotes standardized species identification and supports marine biodiversity documentation and educational outreach. The platform also establishes a scalable foundation for future enhancements, including artificial intelligence-assisted image-based identification, interactive taxonomic keys, geospatial distribution mapping, and cloud-based biodiversity data integration, thereby contributing to the modernization of marine taxonomic research and digital biodiversity management.

Keywords: *Deep-Sea Fish Taxonomy, Digital Biodiversity, Mobile Application, Species Identification, Biodiversity Informatics*

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Abstract ID: TSS/AI/02

SATELLITE EARTH OBSERVATIONS FOR SUSTAINABLE AQUACULTURE (EO4SA)

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Aquaculture offers an additional supply of human food resources as well as an alternative to fisheries. Accordingly, aquaculture is a means to meet the growing global demand for (sea)food and a low carbon footprint protein source. Sustainability of aquaculture activities is impacted by several factors, of which four are being addressed the Earth Observations for Sustainable Aquaculture (EO4SA) project. The main objective is to consolidate the requirements and demonstrate the information opportunities, needed by the aquaculture industry and monitoring agencies using satellite earth observations and other data sources. The project addresses the information and operational needs of aquaculture industry and authorities in coastal waters for four Use Cases, at several locations in Norway, Spain and the Philippines, related to:
1. Predicting Risks of Salmon Lice Infestation in Norway. 2. Forecasting Harmful Algal Blooms (HABs) Impacting Shellfish Farming in Norway. 3. Optimising the Location of Sustainable Shellfish Farming and Tourism in Galicia, Spain. 4. Mapping Aquaculture Structures and Use of Marine Resources in Palawan, Philippines. The EO4SA project involves early adopters related to the aquaculture, such as farms, regulatory authorities, finances, and research. EO4SA will conclude with a roadmap for the implementation of EO-based products/services to support aquaculture stakeholders in their future operations and management. Artificial intelligence methods are applied to observational data (salmon lice and toxic algae) and environmental information from satellite Earth observation data for the last 20 years. The presentation will include forecasts (online), assessments and validation provided to the early adopters in each of the four use cases. The EO4SA project (Earth Observation for a Sustainable Blue Economy) is funded by the European Space Agency (ESA) PEOPLE programme

Keywords: *Aquaculture, Salmon Lice, Toxic Algae, Primary Productivity, Cage Locations*

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Abstract ID: TSS/AI/03

DRONE-BASED VALIDATION OF REGIONAL SATELLITE ALGORITHMS FOR CHLOROPHYLL-A RETRIEVAL IN VEMBANAD LAKE

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Aquatic environments globally are witnessing significant changes associated anthropogenic activities as well as climate change. These changes threaten not only aquatic biodiversity but also public health. In such scenarios, effective water quality monitoring becomes critically important. Earth observation tools, such as the Sentinel-2 satellite, provide continuous monitoring of water quality using spectral reflectance data. However, algorithms developed using spectral reflectance data often require regional fine-tuning to overcome limitations such as cloud cover, adjacency effects from land, floating vegetation, and temporal mismatches with *in-situ* measurements. The objective of this study was to validate two regional chlorophyll-a algorithms developed by Varunan et al. (https://doi.org/10.3390/rs14246404) for Vembanad Lake. We used hyperspectral reflectance data collected with an Ocean Optics spectrometer mounted on a drone during concurrent *in-situ* water sampling. The drone data were resampled to simulate Sentinel-2 bands. Drone-based reflectance values were relatively lower than those from Sentinel-2. Statistical analysis across four sampling campaigns showed a weak but significant correlation between drone and satellite reflectance ($R = 0.27$, $N = 111$, $p < 0.005$). Importantly, drone-based reflectance had a stronger correlation with *in-situ* chlorophyll measurements than satellite data. Of the two algorithms tested, the four-band combination ($R = 0.64$, $N = 13$, $p < 0.05$) performed slightly better than the single-band version ($R = 0.59$, $N = 13$, $p < 0.05$), though the single-band algorithm had lower error (RMSE = 4.6 vs. MAE = 6.5). Future work will refine these models with larger datasets to support sustainable management of this sensitive tropical lake. Drone-based surveys show strong potential as a complementary tool for water quality monitoring.

Keywords: *Chlorophyll-a, Earth Observation Tools, Hyperspectral Sensing, Sentinel-2, Drone Surveys, Vembanad Lake*

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Abstract ID: **TSS/AI/05**

GHOST FISHING NETS AGGREGATION ALONG THE MALWAN COAST

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Abandoned, Lost, or otherwise Discarded Fishing Gear (ALDFG), commonly known as "ghost gear," poses a severe threat to marine biodiversity and the socio-economic stability of coastal communities. This study, conducted throughout 2025, provides a comprehensive assessment of ghost fishing dynamics across the maritime districts of Maharashtra, India. Utilizing an integrated multi-methodological approach, we combined socio-economic questionnaires with cutting-edge field technology to map and retrieve submerged gear. Initial questionnaire-based surveys among local fishers identified high-risk zones and established that gillnets are the predominant gear lost, primarily due to snagging on rocky reefs and conflict with commercial shipping traffic. To move from anecdotal evidence to empirical data, we deployed Unmanned Aerial Systems (UAS/Drones) for high-resolution aerial mapping of intertidal and shallow-water litter. This was followed by a series of technical SCUBA dives—totaling 40 descents—to facilitate the manual retrieval of ghost nets from critical habitats. Our findings reveal a significant "hidden" mortality rate; retrieved gillnets contained a diverse array of associated organisms, including protected gorgonians, reef-associated fishes, and crustaceans, many of which were found in varying stages of decomposition or entanglement. The study highlights that ghost nets act as "silent killers," continuing to fish indefinitely and altering local benthic structures. Beyond retrieval, the initiative prioritized institutional outreach and stakeholder engagement. Awareness programs were conducted for coastal fishing cooperatives, emphasizing the economic loss associated with gear depletion and the ecological benefits of reporting lost nets. This research underscores the necessity of integrating remote sensing and diving surveys into national fisheries management frameworks to safeguard the long-term health of the Maharashtra coast's aquatic biodiversity.

Keywords: *Ghost Gear, Mapping, Maharashtra*

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Abstract ID: **TSS/AI/06**

MARINEMAMMAL-AI: A GEMINI-POWERED FRAMEWORK FOR AUTOMATED MARINE SPECIES IDENTIFICATION

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Accurate species identification is a fundamental requirement of marine-mammal surveys; however, field observations frequently yield incomplete or low-quality imagery (e.g., dorsal fins, flukes, or partial silhouettes) that hinders data collection. This study introduces MarineMammal-AI, a Python- and Gemini-powered framework designed to automate species recognition from such challenging visual data. Our dataset, curated from vessel-based line-transect surveys and data from the previous surveys phase one, consists of expert-verified images annotated by species, morphology, and environmental metadata. We employ a computer vision algorithm trained to recognize key diagnostic features including fin geometry, scarring, pigmentation, and body proportions to perform initial identifications. The pipeline subsequently integrates Gemini as a knowledge-grounded interpretation layer, cross-referencing visual predictions against a curated database of taxonomy, habitat, and behavioral ethograms. Beyond species identification, the framework offers comprehensive diagnostic support. It provides researchers with probabilistic species assignments, confidence scores, and supporting evidence, while recommending further expert review when necessary. Where context allows, the system classifies observable behavioral states, such as travelling, feeding, or distress, and flags visible indicators of stranding, including entanglement, injury, or poor body condition, to facilitate rapid response. The system's performance is validated against independent, expert-labeled datasets using metrics such as precision, recall, and expert-agreement calibration. By streamlining image-processing workflows, MarineMammal-AI serves as a transparent decision-support tool that standardizes preliminary identification protocols and enhances global conservation monitoring, research, and stranding-response efforts.

Keywords: *Marine Fisheries, Aquaculture, Fish Stock Assessment, Coastal Ecology, Marine Biology, Oceanography*

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Abstract ID: TSS/AI/07

MACHINE LEARNING-BASED SPATIAL DOWNSCALING OF CHLOROPHYLL-a IN OPTICALLY COMPLEX COASTAL WATERS OF MUMBAI USING SENTINEL-2 MULTISPECTRAL DATA

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Chlorophyll-a estimation from satellite observations remains challenging in optically complex coastal waters because suspended sediments, colored dissolved organic matter and anthropogenic inputs alter optical properties and reduce the accuracy of conventional ocean color algorithms as described by Gordon and Morel 1983 and the IOCCG 2000 report. Although Sentinel 3 OLCI provides frequent observations, its 300 m spatial resolution cannot resolve fine scale coastal heterogeneity. Therefore, machine learning based spatial downscaling is required to produce high resolution chlorophyll information as demonstrated by Fu et al. 2018 and Zhang et al. 2023.The proposed framework was implemented for the coastal waters of Mumbai, India. A total of 150 stratified *in situ* observations were integrated with Sentinel 2 multispectral reflectance, spectral indices, spatial variables and environmental parameters. Eight machine learning regression models were evaluated and Gradient Boosting achieved the best performance with R^2 0.88, RMSE 0.51 mg per m^3 and MAE 0.39 mg per m^3. Sentinel 3 OLCI underestimated chlorophyll a by 45 to 84 percent compared with field observations, confirming the limitations of conventional ocean color algorithms in Case II coastal waters. SHAP analysis identified SWIR bands, temperature and spatial variables as the dominant predictors. The optimized model produced a 10 m chlorophyll a product that resolved fine scale nearshore heterogeneity not captured by conventional satellite products. The framework demonstrates the potential of machine learning based spatial downscaling for high resolution coastal water quality assessment, fisheries management, eutrophication monitoring, harmful algal bloom surveillance and Digital Twin Ocean applications.

Keywords: *Chlorophyll-a, Spatial Downscaling, Machine Learning, Gradient Boosting, Sentinel-2 MSI, Optically Complex Coastal Waters*

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Abstract ID: TSS/AI/08

A PHYSICS-AWARE DEEP LEARNING APPROACH FOR ATMOSPHERIC CORRECTION OF OCEAN COLOUR DATA FROM EOS-06 OCM-3

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Atmospheric correction is a critical step in ocean colour remote sensing, yet conventional physics-based approaches often rely on simplified assumptions like black-pixel approximation, limiting their performance in optically complex waters and variable atmospheric conditions. This study presents a physics-aware deep learning framework for retrieving remote sensing reflectance from top-of-atmosphere (TOA) radiance measurements acquired by the EOS-06 Ocean Colour Monitor-3 (OCM-3). The approach integrates physically consistent pre-processing, including gaseous absorption correction, sun-glint masking, and geometric normalization, with a neural network that learns the nonlinear mapping between top of the standard atmosphere (TOSA) reflectance and remote sensing reflectance (Rrs). The model combines a spectral encoder with band-wise attention and a feature-wise linear modulation (FiLM) mechanism to condition spectral features on auxiliary parameters such as solar and viewing geometry, wind speed, pressure, and relative humidity. This enables adaptive representation of atmosphere–ocean interactions without explicitly prescribing aerosol models during inference. The network is trained using synthetic datasets generated with the OSOAA radiative transfer model, incorporating maritime and coastal aerosol type models across varying humidity conditions. Compared to traditional methods, the proposed approach captures complex nonlinear relationships and reduces dependence on predefined aerosol assumptions. Validation against *in situ* water-leaving radiance measurements from AERONET-OC demonstrates stable and physically consistent retrievals across spectral bands. The results highlight the potential of combining physics-guided pre-processing with deep learning for scalable and robust atmospheric correction of ocean colour data from OCM-3.

Keywords: *Ocean Colour Remote Sensing, EOS-06 OCM-3, Atmospheric Correction, Deep Learning, Radiative Transfer*

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Abstract ID: TSS/AI/09

A MACHINE LEARNING FRAMEWORK FOR MANGROVE MAPPING ALONG THE KANNUR COAST, KERALA, INDIA

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Mangroves are critical coastal ecosystems that provide shoreline protection, carbon sequestration, and habitat support for diverse flora and fauna. Continuous assessment of mangrove distribution is essential for ecosystem conservation and management; however, the absence of standardised monitoring frameworks limits the consistency and repeatability of mangrove studies. This study develops a machine learning-based framework for mangrove mapping in the Kannur district of Kerala, India, using multi-sensor satellite observations. Sentinel-1 Synthetic Aperture Radar (SAR) VV and VH polarisations and Sentinel-2 multispectral imagery were processed into January–June median composites to minimise cloud contamination. The integration of SAR and optical datasets improved mangrove discrimination by capturing structural, moisture-related, and spectral characteristics under cloud-prone tropical conditions. Predictor layers, including spectral bands, vegetation indices, radar backscatter features, and texture measures, were derived from the integrated datasets. Several supervised machine learning algorithms, including Random Forest (RF), Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Classification and Regression Trees (CART), Naïve Bayes, Gradient Boosting Trees (GBT), XGBoost, LightGBM, and CatBoost, were implemented using field-validated training and validation datasets. Model performance was evaluated using overall accuracy, Kappa coefficient, precision, recall, specificity, and Receiver Operating Characteristic (ROC) curve analysis. Gradient Boosting Trees and Random Forest achieved the highest performance, with overall accuracies exceeding 95% and Kappa coefficients above 0.90, while Naïve Bayes showed comparatively lower performance. The results demonstrate the effectiveness of ensemble-based machine learning and integrated multi-sensor datasets for accurate mangrove mapping in tropical coastal environments.

Keywords: *Mangroves, Machine Learning, Random Forest, Gradient Boosting Trees, ROC Analysis, Kannur*

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