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Ocean University of Sri Lanka

“Marine Research for Prosperity of the Nation”
17th November 2022

Abstract Book



Ocean University of Sri Lanka and China-Sri Lanka Joint Center
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Skills Development & Vocational Education Sector, Ministry of Education



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This is the book of abstracts of the 4th Research Symposium of the Ocean University of Sri Lanka with names of all authors, and emails of corresponding authors.

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Message from the Vice Chancellor



With great pleasure, I welcome you to the 4th Research Symposium on “Marine Research for Prosperity of the Nation” held at the Ocean University of Sri Lanka. With the rapid phase of technological advancement, one cannot escape the ubiquitous globalization and the aspects of the Blue Economy. We need to have a universal focus on thinking innovatively while dramatically acting suit to the local environment scenario.

The symposium has created a platform for sharing knowledge on modern advances in all aspects of the blue economy through the latest research findings. Researchers are seeking solutions for numerous emerging issues around the globe. The Ocean University of Sri Lanka has striven to foster high-quality research in Coastal and Marine Environments, Fisheries and Aquaculture, Marine Engineering and Technology, Oceanography and Hydrography, Remote sensing and GIS for Marine Environment, Maritime Transportation and Logistics, and Socio-economic and Marketing as presented with the 4th Research Symposium.

I would like to extend my gratitude to the chairpersons and secretary of the symposium committee, committee members, and Director of the Research and Publication Committee and all our academic members for their tremendous effort to make this event a success. All academics, administrative and academic support staff, and non-academic staff who directly and indirectly contributed for this event are greatly appreciated. I must thank the staff of the symposium secretariat for their tireless service over a period of several months toward this remarkable achievement.

Finally, I invite you all to enjoy an innovative experience at the symposium and a pleasant stay in Tangalle.

Prof. Wasantha Rathnayake, PhD.
Vice Chancellor
Ocean University of Sri Lanka

Message from the Symposium Chair



It is a great pleasure and privilege to compile this message as the Symposium Chair of the 4th Research Symposium of Ocean University of Sri Lanka 2022 (4th RSOCUSL 2022) on behalf of the symposium organizing committee. I herewith welcome all the invitees, presenters, and participants for this important event.

The broad theme of the research symposium this year is “Marine Research for the Prosperity of the Nation” and it provides a conducive environment for undergraduates, scientists, and professionals working on different disciplines to gather, present, and discuss various research findings to establish the roadmap for the Blue Economy. Over 50 presenters are expected to present their research outcomes at five plenary sessions while creating a platform for researchers to share knowledge and experience in order to find solutions for the current issues in the fisheries and marine sectors.

The 4th RSOCUSL is an outcome of great teamwork of academics, administrators, non-academics, and undergraduates of the Ocean University of Sri Lanka. Therefore, I take this opportunity to express my sincere gratitude for their devoted time and effort to make this event a reality. While wishing the 4th RSCOUSL 2022 a great success, I sincerely wish all the presenters and participants a productive and pleasant day!

Dr. S.N. Dushani
Symposium Chair/ 4th RSOCUSL

KEYNOTE SPEECH - I

Dominant role of intra-seasonal variability in counter wind current along the south Sri Lanka coast during summer



Prof. Weiqiang Wang,

Executive director of China-Sri Lanka Joint Centre for Education and Research (CSL-CER)

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The characteristics of the south Sri Lanka coastal current (SSLCC) during summer are examined in this study. Climatological, the SSLC flows eastward as a part of the southwest monsoon current (SMC) during summer. However, westward SSLCC occurred lasting more than 20 days in the summer of 2013, 2016, 2017, and 2018, implying the significant inter-annual variability of the SSLCC. The wavelet spectral analysis shows that there are three significant components responsible for the SSLCC variations, annual (>240 days), semiannual (120-240 days), and intra-seasonal (30-105 days) components. Further analysis indicates that the intra-seasonal signal component associated with boreal summer intra-seasonal oscillation (BSISO) is the main factor leading to westward SSLCC. Firstly, the northward propagation of the BSISO signal induces the westerly wind anomaly and positive wind stress curl anomaly along the south coast of Sri Lanka and eventually favors the westward SSLCC. Secondly, the upwelling Rossby wave signal reflected from Sumatra Island propagates westward and leads to the cyclonic eddy on the south coast of Sri Lanka, responsible for the occurrence of the westward SSLCC.

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KEYNOTE SPEECH - II

Seaports in the Fourth Industrial Revolution



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The 4th industrial revolution is set to change how people, societies, and businesses interact with each other. Under this perspective, ports and terminals are facing a dynamic if not turbulent future as part of global supply chains and transport networks. The successful implementation of 4th industrial revolution-related technologies will provide seaports with a competitive advantage in terms of operational efficiency, financial independence, and sustainable development. However, there is a readiness gap between developed and developing countries in the maritime sector. For instance, the port of Busan (Korea) has a well-defined vision of how to develop a smart port roadmap with the application of several technologies into two separate phases: first, the securing of basic and core technologies for the smart port by 2025; second, the introduction of eco-friendly, automated, digital-oriented technologies by 2030. Given that the port of Busan and the port of Colombo are very similar in relation to the nature of business (container ports mainly handle transshipped cargo), showing what is the strategic plan of the port of Busan can be used as a benchmark in the development of the port of Colombo as a smart port.

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COASTAL AND MARINE ENVIRONMENT

Environmental drivers and ecological implications of a ctenophore swarm in the Bay of Bengal

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We report the environmental drivers of a ctenophore swarm (*Pleurobrachia* spp.) and the associated ecological changes in the estuarine and coastal waters off the largest prograding delta on earth- the Sundarbans, northern Bay of Bengal (BoB). Eight sampling locations were established, of which two stations were from the non-swarm estuarine area, four from the swarm estuarine area and two from the coastal waters of Sundarbans. Hydrographical parameters at the study area were recorded using Conductivity-Temperature-Depth (CTD) profiler. Mesozooplankton (MSP) samples were collected by horizontal towing on surface waters (S) and by column sampling (C) using a Working Party plankton net. Mesozooplankters were sorted into major taxonomic groups, and abundances were estimated (ind./m³) by considering the volume of water filtered through the net. Fish samples from the cast nets of fisher-folks were photographed and preserved in 5% formaldehyde. The water temperature at the swarm locations (S - ca. 19.22°C; C - ca. 18.72°C) was lower than the non-swarm estuarine (S- ca. 20.57°C; C- ca. 20.37°C) and coastal locations (S- ca. 20.34°C; C- ca. 20.16°C). However, salinity showed an opposite trend with higher salinity at swarm locations (S- ca. 24.64; C- ca. 25.01) and relatively lower salinity at the estuarine (S- ca. 22.46; C- ca. 22.57) and coastal non-swarm locations (S- ca. 19.40; C- ca. 19.76). Dissolved oxygen, nutrients (except for NH₄⁺), and Chl *a* concentrations were lower in the swarm area than in non-swarm estuarine and coastal areas. Ctenophore abundance in the swarm locations was 2-8 folds higher than the non-swarm area. The AHCA of fourth-root transformed MSP species by stations data matrix revealed 29.07% dissimilarity in the MSP community between the swarm and non-swarm locations (SIMPROF *Pi*: 3.61, *P*=0.1%). Fish caught from swarm locations consisted of species of less market value, like *Coilia dussumieri*, *Takifugu oblongus* and *Boleophthalmus boddarti* while that from non-swarm locations consisted of commercially important species like *Otolithes ruber*, *Hyporhamphus limbatus* and *Cynoscion nebulosus*. Thus, this study shows how a 'dead end' plankton predator affects the plankton food web organization and fisheries in tropical coastal waters.

Keywords: ctenophora, gelatinous zooplankton, *Pleurobrachia*, Sundarbans

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Comparative study on water quality at Tangalle and Kudawella fishery harbors, Sri Lanka

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Fishery harbors are subjected to a variety of anthropogenic pollution that deteriorates water quality, that affects not only the marine environment but also the hygiene of landed catch. This study was carried out at Tangalle and Kudawella fishery harbors to assess the harbor water quality with comparison to the coastal water of Rekawa as a control site. Surface water samples were collected from three stations at each fishery harbor on 23rd of February 2022 by using a random sampling technique. The temperature was measured in situ, and pH, salinity, dissolved oxygen (DO), electrical conductivity (EC), biological oxygen demand (BOD₅), total dissolved solids (TDS), ammonia concentration, and microbial community were measured in the laboratory. Results revealed that water temperature (<32°C), pH (6.5-9.0), DO (saturation >60%), salinity (35±70 ppt), and ammonia concentration (<0.80 mg/L) were within the acceptable limits in both harbors. However, the average water temperature, BOD₅, EC, DO, and TDS were significantly different among the sampling sites (p<0.05). Tangalle had the highest mean temperature (28.8±0.4°C) while Rekawa had the minimum (27.07±0.21°C). Kudawella had the highest mean BOD₅ (5.30±0.49 mg/L) followed by Tangalle (3.86 ± 0.29 mg/L) and Rekawa (0.15±0.046 mg/L). Kudawella had the highest mean EC (49.13±0.05 mS/cm) followed by Rekawa (49.1±0.1 mS/cm) and Tangalle (48.73±0.25 mS/cm). Rekawa had the highest mean DO (6.62±0.11 mg/L) followed by Tangalle (6.37±0.09 mg/L) and Kudawella (6.20±0.19 mg/L). A significant level of water pollution in Kudawella was indicated by the average BOD₅ value (5.30±0.49 mg/L) which exceeded the recommended safe levels (<4 mg/L) declared by the Central Environmental Authority (CEA) of Sri Lanka. The most probable number (MPN) for fecal coliforms (per 100 ml) was observed only from the Tangalle fishery harbor and the value (66.67+115.5 MPN/100ml) exceeded the recommended safe level of <20 MPN/100ml of CEA. According to the test results of BOD₅ and microbial analysis, this study revealed that the water quality of both fishery harbors has been degraded significantly when compare to the control site-Rekawa. However, spatial and temporal scale long-term study is required to reach conclusions precisely, but this study emphasizes the need for water quality management inside fishing harbors.

Keywords: water quality, fishery harbors, Kudawella, Tangalle

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Comparison of microzooplankton diversity before and during jellyfish swarm in estuarine waters of Sundarban, India

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The scyphozoan jellyfish *Acromitus flagellatus* (Maas, 1903) formed massive aggregations in the River Saptamukhi Channel, situated in Sundarbans, the world's largest deltaic ecosystem. The present study in this mangrove-fringed estuary aims to find the variations in the community structure of microzooplankton (20-200 µm) before the onset of the swarm and during it. It also briefly touches upon the trophic cascade exerted by the swarming jellyfish on the lower trophic levels. This study focused on taxonomic groups representing the microzooplankton community included ciliates, heterotrophic and mixotrophic dinoflagellates, rotifers, foraminiferans, and metazoan larvae (copepod nauplii, bivalve larvae, gastropod larvae). Copepod nauplii was dominated the abundance in all stations both before the swarm (BS) and during the swarm (DS). Tintinnids were dominated the ciliate community, while heterotrophic dinoflagellates were dominated the dinoflagellate community, comprising 35% and 23% in the BS survey and 35% and 25% in the DS survey, respectively. The abundance of planktonic foraminiferans was very low and was obtained only in DS survey. Rotifers were presented in considerable numbers before the jellyfish swarm period. The microzooplankton community remained stable through a jellyfish swarming event, except for a few exceptions. Notably, during the swarm period, microzooplankton abundance showed a positive relationship with *A. flagellatus* numbers, while the mesozooplankton abundance reduced significantly, exhibiting the top-down control by the jellyfish in the pelagic food web.

Keywords: scyphozoa bloom, zooplankton, pelagic food web, Bay of Bengal.

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Presence of microplastics in coral reef ecosystems in Southern coast of Sri Lanka - The first evidence

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Growing evidence on the microplastic accumulation in different compartments reveals that plastic is ubiquitous in nature. But yet many knowledge gaps exist on spatial abundance and distribution of microplastics in coral reef ecosystems in our oceans. The present study is an endeavor to evaluate the abundance, distribution, and composition of microplastics (0.1 - 5.0 mm) in Scleractinian corals belong four genera (*Acropora*, *Pocillopora*, *Montipora* and *Goniastrea*), surface waters, and surface sediments in four coral reef ecosystems (Ussangoda, Ahangama, Dondra, and Madiha) in the Southern coast of Sri Lanka. At each study site, 23 coral samples, 12 surface water, and 12 surface sediment samples were obtained in triplicate. Coral samples were obtained using coral cutters. Surface water samples were obtained using a manta net while surface sediments were collected using a metal scoop. Microplastics were extracted from corals using saturated sodium chloride and 37% HCl solutions. As per the microplastic extraction from surface water and surface sediments, wet peroxide oxidation (WPO) method and saturated sodium chloride density separation method were followed accordingly. Extracted microplastics were characterized based on their shape, size, color, and polymer type. The mean abundances of microplastics in corals, surface water, and surface sediments were 655.77 ± 260.5 items kg^{-1} , 6.54 ± 3.83 items m^{-3} and 52.25 ± 34.3 items kg^{-1} (dry weight) respectively. The most dominant type of microplastics found in corals, surface water, and surface sediments were blue-color fiber-shaped, large microplastic (>1 mm). Based on FTIR analysis low-density polyethylene (LDPE) was the most dominant type of polymer in all types of samples. The highest abundance of microplastics was encountered in corals belonging to the genus *Montipora* followed by *Acropora*, *Pocillopora*, and *Goniastrea*. Ahangama reef recorded the highest microplastic abundances in corals and surface water among four study sites.

Ussangoda reef encountered the highest microplastic concentration in surface sediments. Though no significant differences in microplastic concentrations were observed among coral species or study sites, the present study provides the first evidence for the aggregation of microplastic in reef-building corals and reef environments of selected coral reef ecosystems on the Southern coast of Sri Lanka.

Keywords: micro plastic pollution, scleractinian corals, coral reefs, Southern Coast, *Montipora*

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Unravelling the marine mesozooplankton diversity along the coastal waters of Great Nicobar Island

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Marine mesozooplankton constitute a wide array of organisms that serve a critical role in connecting the microbial and marine food web. Additionally, they regulate biogeochemical cycles and biological pump, assist in carbon transfer and fixation, and water quality, water circulation, and climate change. Due to their role in fisheries and biological productivity, they are also essential from a commercial and ecological standpoint. This study aims at understanding the marine mesozooplankton diversity along the eastern coastal waters of Great Nicobar Island, Andaman, and Nicobar Archipelago. The present investigation was carried out along the eastern coastal waters of Great Nicobar Island during the 2021 winter monsoon. Coastal mesozooplankton samples were collected by surface hauling for 10 minutes at a speed of 2 knots using a WP (Working Party) plankton net (Hydro BIOS, Diameter: 60 cm; Mesh size: 200 μm). The study area was divided into three zones: northeast, central-east, and southeast. We have recorded 32 species of mesozooplankton, which are grouped into five phyla and eight classes. Subclass Copepoda (Class Hexanauplia; Superclass Multicrustacea) was the most dominant and diversified taxon with 23 species distributed over the orders Calanoida (14 species), Cyclopoida (six species), and Harpacticoida (three species). The highest mean mesozooplankton biomass of 891.9 mg/m^3 was observed in the central-eastern stations, followed by the stations in the south-eastern (714.9 mg/m^3) and north-eastern (679.7 mg/m^3) coast. The highest mean abundance of mesozooplankton was observed in the central-eastern stations followed by south-eastern and north-eastern sites, accounting for 2136 $\text{no.}/\text{m}^3$, 1969 $\text{no.}/\text{m}^3$, and 1862 $\text{no.}/\text{m}^3$ respectively. Among microplankton population, phylum Myzozoa consisted of five orders, with order Gonyaulacales being the most diverse (26 species) among mixotrophic dinoflagellates, and order Perdiniales being the most diverse among heterotrophic trophic dinoflagellates with 14 species. Phylum Foraminifera, Ciliophore, and Radiozoa also had representative species, but in a comparatively lesser abundance.

One possible explanation for higher planktonic productivity in the central-eastern sites of our study area could be the riverine influx in this region, which also happens to be a protected area (hence less external interference). The central-eastern area was also marked by a high numerical abundance of phylum Foraminifera which may be attributed to the high calcium carbonate content (due to the presence of coral beds in the nearshore waters) here.

There are gap areas pertaining to certain marine taxa which need to be addressed in future studies.

Keywords: plankton, biodiversity, Andaman Sea, Indian Ocean.

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Leaf litter fragmentation and subsequent surface soil carbon changes in a *Ceriops tagal* mono-specific patch of Rekawa mangroves, Sri Lanka

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Mangrove leaf litter fragmentation influences soil carbon accumulation, however, the artificial litter bag experiments used for studying this aspect are unlikely to reflect the natural litter breakdown process in mangroves. The absence of information on leaf litter breakdown under unmodified natural conditions had created a vital knowledge gap in mangroves. The current study aimed to address this gap by focusing on the leaf litter fragmentation and subsequent surface soil carbon changes in depressed and non-depressed sites (measured as relative to the average surface ground level) of a *Ceriops tagal* mono-specific patch of Rekawa mangroves (6.046887 N°; 80.851151 E°). In randomly demarcated three plots (30cm×30cm) at each site, leaf litter was collected. The carbon content of soil samples obtained from the 0-15cm depth layer of the quadrats and the leaf litter was evaluated by Loss On Ignition at 450 °C for 4 hours. The total abundance and % abundance of five litter classes: very large (size >625 mm²), large (625 mm²>size>361 mm²), medium (361 mm²>size>144 mm²), small (144 mm²>size >36 mm²) and very small (size <36 mm²) of each sample were recorded using sequential sieves. The mean total dry weight of leaf litter (mean±SD) per plot between depressed and non-depressed sites (95.90±49.90 g and 74.17±4.50 g) were not significantly different (P>0.05, Mann-Whitney U Test). The depressed site had accumulated higher leaf litter weight than the non-depressed site (p<0.05, Two-sample t-test). The % abundance of each leaf litter class (mean±SD) per plot between depressed and non-depressed sites (very large leaf litter: 5.64±3.65 and 13.84±4.87, large leaf litter: 5.74±3.41 and 11.31±3.60, medium leaf litter: 6.87±2.83 and 17.56±13.75, small leaf litter: 35.20±11.36 and 30.28±11.09, very small leaf litter: 46.55±5.25 and 27.17±8.04 respectively) were not significantly different (P>0.05, Friedman test). The total amount of carbon in leaf litter (mean±SD) per plot (0.048±0.025 gcm⁻² and 0.037±0.002 gcm⁻²) was not different significantly between the two sites (P>0.05, Mann-Whitney U Test). Soil carbon stocks of the 0-15 cm depth layer of depressed and non-depressed sites were 36.20±18.1 t C ha⁻¹ and 49.4±22.5 t C ha⁻¹ respectively. The presence of different litter classes revealed that litter fragmentation is occurring on the top soil of both depressed and non-depressed *Ceriops tagal* sites as the first phase of the blue carbon sinking. The depressed site showed higher blue carbon sinking potential by accumulating more litter.

Keywords: leaf litter, fragmentation, *Ceriops tagal*, mono-specific patch

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Biochemical composition of seaweeds from Okha Coastal regions along the Saurashtra Coast of Gujarat, India

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Marine algae, often known as seaweed, are small photosynthetic organisms that live in seawater. Seaweeds are harvested along the coast and utilized for a variety of purposes such as feed, fertilizer, and as a source of raw material for the industrial production of phytochemicals of commercial importance. In this study, six seaweed species were identified e.g., red seaweed species (*Corallina berteroi* and *Laurencia obtusa*), Green seaweed species (*Ulva lactuca* and *Caulerpa racemosa*), and Brown seaweed species (*Sargassum prismaticum* and *Dictyota ciliolata*). The values of biochemical composition were varying in all seaweed species. Chlorophyll a, chlorophyll b, and total chlorophyll content were highest in *Caulerpa racemosa* (4.11 mg/g, 9.62 mg/g, and 9.54 mg/g respectively). Chlorophyll a, chlorophyll b, and total chlorophyll content were lowest in *Corallina berteroi* (0.01 mg/g, -0.04 mg/g, and -0.03 mg/g respectively). Carotenoid content is highest in *Caulerpa racemosa* (0.73 µg/g) and lowest in *Ulva lactuca* (-0.001). Total soluble sugar content is highest in *Dictyota ciliolata* (1.11 µg/ml) and lowest in *Corallina berteroi* (0.05 µg/ml). Reducing sugar is highest in *Dictyota ciliolata* (1.42 µg/ml) and lowest in *Sargassum prismaticum* (0.32 µg/ml). The protein content is highest in *Caulerpa racemosa* (2.41 mg/g) and lowest in *Corallina berteroi* (0.10 mg/g). Moisture content highest in *Caulerpa racemosa* (95.82 %) and lowest in *Ulva lactuca* (91.52 %), which indicates that these seaweed resources would become important marine resources in the future, not only along India but also all over the world.

Keywords: seaweed, biochemical composition, protein, sugar

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Microplastic contamination in Brown mussels (*Perna perna*) along the Southern coastal waters of Sri Lanka

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Microplastics (MPs) have been recognized as major pollutants in the marine ecosystem. Studying the microplastics accumulation in the marine organisms is important to evaluate the level of MPs pollution in the marine environment and its subsequent effects. The present study aimed to understand the abundance and characteristics of MPs in brown mussels from four selected southern coastal waters of Sri Lanka using Nile Red (NR) staining method. Ten mussels were collected from each of four sites: Pallikudawa (6° 01' 01.72" N, 80° 47' 22.70" E), Seenimodara (6° 00' 02.47" N, 80° 45' 28.19" E), Galle Harbor (6° 01' 52.45" N, 80° 13' 41.09" E) and Unawatuna (6° 01' 02.162" N, 80° 14' 39.58" E). Their tissues were digested with 30 ml of 10% NaOH at 60 °C. MPs were separated by density separation method (1.2 g/l NaCl) from the digested solutions and were filtered using Whitman filter papers (pore size – 11 µm). Non-stained filter papers with MPs were observed under the light microscope (magnification 10×5) and NR stained papers were observed with blue light (430 – 470 nm) under the stereomicroscope (magnification 10×4.5). Mean MP abundance was 4.15±2.8 items/individual (with range of 0 to 10 items/individual) and concentration in soft body tissues of brown mussel was 1.75 ± 0.5 items/g. Concentration of MPs in different locations were varied as, 1.147 items/g in Seenimodara, 1.799 items/g in Pallikudawa, 1.82 items/g in Galle Harbor and 2.363 items/g in Unawatuna. According to the One Way ANOVA test, the mean concentrations of MPs of the four sites were significantly different (p=0.049). The significantly higher concentration of MPs was observed in Unawatuna than that of other three sites and the lowest was reported from Seenimodara. Microplastics Diversity Integrated Index (MPDII) for shape and color was highest at Pallikudawa (1.042) and lowest at Galle Harbor (0.7435). The most commonly detected microplastics were fragments followed by fibers and films. Blue color was dominated (62.38%) in all four sites. This study shows that abundance and diversity of MPs highly varied among different sites along the southern coastal waters of Sri Lanka.

Keywords: microplastics, mussels, Nile Red staining, Sri Lanka

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Preliminary study on occurrence and diversity of macrobenthos community in selected areas of Sangupiddy mudflats, Jaffna

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Macrobenthos is an important component of mud flat ecosystems; they play myriad roles that are essential to maintaining ecosystem functions. The present study was conducted to identify the diversity and occurrence of the macrobenthos community in a selected area of the Sangupiddy mudflats, Jaffna. The sampling of macrobenthos was performed by using the quadrat method. Samples were randomly collected at 4 sampling sites in Sangupiddy mudflats in April 2022. Then, these samples were preserved in 10% formalin-rose bengal solution for further analysis. In the laboratory, the collected sediment samples were washed properly and were sieved. A total of 1,112 individuals of 12 macrobenthos families belonging to 22 species were identified based on their morphological characteristics. They were gastropods (92.4%), bivalvia (7.37%) and polychaeta (0.17%). Furthermore, gastropods were found as the most dominant macrobenthos in the Sangupiddy mudflats during the study period. The present study provides baseline information on available macrobenthos species in the location which are useful for environmental monitoring and management.

Keywords: macrobenthos, diversity, Sangupiddy mudflat, Sri Lanka

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Preventing the entrance of invasive alien species through ballast water: an analysis of the role of law in Sri Lanka

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Ballast water sources have been recognized as major transfer modes of invasive alien species that eventually threaten the marine ecosystems worldwide. As a maritime nation, Sri Lanka has a high risk from invasive alien species that could enter through the ballast water. This research is expected to ascertain the sufficiency of the domestic laws in addressing the problem of entering invasive alien species in to local marine ecosystems, its compatibility and inter-relationship with international laws governing the same, and identifying the loopholes in the domestic law in conserving the marine environment against the invasive alien species linked with ballast water. The research methodology used in this research is the black letter approach of research based on International Conventions and Acts as primary sources and journal articles, books, web articles as secondary sources. The International Maritime Organization (IMO) has codified and adopted the International Convention that is a series of guidelines and regulations to minimize the damage. Due to the country's failure to ratify the BMW Convention, the marine environment in Sri Lanka is under a great threat as the ballast water transfer is the main reason for the spread of invasive alien species in Sri Lankan waters. The Marine Pollution Prevention Act (MPPA) which was enacted to protect the marine system provides criminal, civil liability for those who pollute the ocean. According to the MPPA, Marine Environment Protection Authority has powers to create regulations on ballast water. But currently no regulations incorporated in the MPPA to on this regard. When considering the risks on invasive aquatic species through ballast water, the current legal framework is not sufficient to addresses the issues. The failure of domestic law to be strengthened by International Conventions is a serious weakness. The research recommends such as the need to ratify BWM and thereby take steps to strengthen domestic law for addressing the invasive aquatic species entering through ballast water.

Keywords: invasive alien species, ballast water, ballast water management convention, domestic law

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Shoreline changes at Iranawila and Thoduwawa coastlines; a case study of groyne construction

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Coastal erosion is one of the major hazards observed in the west and southwest coasts of Sri Lanka. Groyne is a hard structural design, commonly used as a mitigation measure to minimize the coastal erosion. However, its effectiveness is still very poor in terms of mitigation of coastal erosion and accretion processes. Therefore, it is important to assess shoreline dynamics raised from such structural designs. The study was carried out in Iranawila and Thoduwawa coastal stretches by studying the shoreline patterns in order to interpret both natural and anthropogenic influences on the adjacent beaches. Magellan Explorer 610 GPS was used for shoreline tracking and collection of ground control points in 2022. Shoreline changes between 2011 and 2021 were analyzed using DSAS tool in ArcGIS by casting digital transects in 25 m intervals with reference to a manually created baseline at landside. The analysis was done under two different scenarios mainly, before and after the constructions of groynes. Uncertainty of the shoreline position was calculated by considering digitizing error, image shift error, tidal error and GPS accuracy. The results showed that accretion occurred in Thoduwawa coastline at a rate of 0.19 ± 36.97 m/year after the groyne construction. However, erosion has taken place in both Iranawila (-1.16 ± 0.51 m/year) and Thoduwawa (-2.3 ± 0.68 m/year) prior to the groyne construction. Groyne construction could increase the succession of the coastline as highest erosion was observed prior to groyne construction. Accuracy assessment showed that the overall uncertainties of the shoreline positions at Iranawila and Thoduwawa were 4.09 m and 5.01 m respectively. Furthermore, the study recommends to monitor future shorelines in other coastlines to evaluate the effectiveness of groynes on more shorelines.

Keywords: shoreline, groyne, coastal erosion

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Comparisons of macrofauna abundance and diversity in rocky and sandy shores at Tangalle, Sri Lanka

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The beach profile is an easily accessible area where high taxonomic diversity is represented as it includes rocky shore (RS) and sandy shore (SS), providing homes for various ranges of fauna. However, studies on comparing diversities and abundance of macrofauna between RS and SS are less. The objectives of the present study were to 1) undertake a comparative analysis of the abundance and diversity of macrofauna in different zones (intertidal, back-shore and vegetation) of RS and SS sites at Tangalle, Sri Lanka; and 2) to estimate the diversity indices at each site. Twenty random quadrats (50 cm × 50 cm) were placed at each of the three zones of the two sites, and the species were identified using a taxonomical key. There were 20 and 13 species in RS and SS respectively. Shannon-Weiner Index, Margalef's index, and Pielou's index for RS were 2.353, 2.721 and 0.784, respectively, while those in SS were 1.445, 2.339 and 0.563. The highest species diversity, richness, and the evenness were represented at the RS. The abundance of the species significantly varied between two sites (Two-way ANOVA: $p = 0.000$), also varied between three zones (Two-way ANOVA: $p=0.014$). The RS had higher mean abundance (18 ± 3 individual m^{-2}), than that of SS (3 ± 0 individual m^{-2}) and the intertidal zone of the RS had the highest mean abundance (30 ± 6 individual m^{-2}). The diversity of the species significantly varied between the two sites (Two-way ANOVA: $p=0.000$) also varied between three zones (Two-way ANOVA; $p=0.001$). The RS had a higher mean species diversity (2 ± 0 individual m^{-2}) than, SS (1 ± 0 individual m^{-2}), and the intertidal zone of the RS had the highest species diversity (3 ± 0 individual m^{-2}). This study highlights the importance of spatial scale analysis of macrofauna and changeable intertidal zone prominent with diversities and abundance.

Keywords: rocky shore, sandy shore, intertidal zone, back-shore zone, macrofauna

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Seawater freshening interacts with nitrogen enrichment to stimulate the photosynthesis and growth of phytoplankton assemblages from the South China Sea

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Due to the impacts of anthropogenic activities and climate change, the frequency and intensity of extreme rainfalls continue to increase. The land-derived inputs due to precipitation both freshen the seawater and enhance the nutrient level, influencing the physiology and species composition of phytoplankton and thus the balance of marine ecosystems. Previous studies showed that phytoplankton dwelling in the interaction of sea- and freshwater of the estuary endure wider salinity variability, by coping with the salinity stress within a shorter period (i.e., 40 min). To investigate how the seawater freshening and nutrient rise interactively affect the photo-physiology, we tracked the photosynthetic capacity and growth of field phytoplankton assemblages in the South China Sea, under a matrix of 5 salinity and 3 nitrogen levels. Results showed that, after 12 hours of cultivation in the Daya Bay, the photosynthetic efficiency (F_V/F_M) of phytoplankton assemblages under low salinity (Sal. 10) was 65% lower than that of control (Sal. 30; F_V/F_M , 0.42 ± 0.01); then, the F_V/F_M gradually increased and exhibited insignificant difference with control after 36 hours' cultivation. After 48 hours of cultivation, however, the F_V/F_M of sal. 10 was ~15% higher than the control, indicating the stimulation upon photosynthesis by seawater freshening. Such stimulating effects by decreasing salinity occurred among other salinity treatments (Sal. 25, Sal. 20, and Sal 15). Furthermore, the stimulation on growth (Chl-a biomass) of phytoplankton showed a similar changing trend as photosynthetic efficiency. Under middle salinity, nutrient nitrogen addition further stimulated photosynthesis and growth. In addition, we testified this finding in Xisha Islands, Nanpeng Islands, and Pearl River Estuary, and obtained similar stimulation effects, except for extending response time duration. Our results demonstrate that the seawater freshening and nutrient enrichment interactively simulate the photosynthesis of phytoplankton, providing insight into the bloom of marine phytoplankton after extreme weather conditions.

Keywords: seawater freshening, nitrogen enrichment, physiology, phytoplankton assemblages, South China Sea

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Current status of the Paraviwella Reef, Tangalle, Southern Sri Lanka concerning stressors

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Paraviwella Reef (6°01'17.3"N 80°48'01.6"E) is well-known among local and foreign visitors. Stakeholders gain a number of use and non-use values from the reef. However, this radiant reef ecosystem has been threatened by both natural and anthropogenic stressors. Therefore, it's imperative to make timely management approaches and developing tools to help protect the reef based on sound policies and strategies generated by continuous baseline data. This study was conducted, in order to supply yearly baseline data on biodiversity on the coral reef in 2021. Paraviwella Reef was assessed for its benthic cover, reef fish diversity from December 2020 to February 2021. Line intercepts transect method and underwater visual belt transect method were used respectively along 30 m long five transects placed perpendicular to the shoreline. Benthic and pelagic species were identified up to the lowest possible taxonomic level. The highest benthic covering category was live hard coral (31.53 ±7.61%)(Mean±SD) comprised of 14 species. Other benthic categories that had significant benthic cover were rock (17.07±5.21%), sand (12.77±3.62%), algae (7.43±2.79%), rubble (7.8±4.1%) and bleached coral (4.43±2.18%). Reef fish belonging to 15 families were recorded and four families among them had noticeable abundance namely, Acanthuridae (25.17±8.84%), Pomacentridae (22.79±10.49%), Chaetodontidae (15.42±5.59%) and Labridae (14.33±2.45%). The reef was an intact shallow fringing reef, where the main coral type was *Montipora aequituberculata* (10.53±4.49%). Although the dead coral and rock had a significant cover, newly flourishing corals on them were distinguishable indicating positive reef recovery. Apart from unavoidable natural stressors, Paraviwella Reef is threatened by unregulated anthropogenic stressors such as coral trampling, coastal pollution, inputs by Kirama Oya and adjacent fishery harbor. Moreover, the likelihood of mechanical damage to the live coral by the combination of higher rubble cover and wave action was observed. The coral-algae phase shift can be expected in no action scenarios with the disappearance of coral. Conclusively, reef health is in moderately critical stage and a better understanding of the current situation and elevated management levels are essential to ensure improved health, in Paraviwella reef. It's recommended to promote volunteerism, awareness and yearly monitoring on the reef structure and processes.

Keywords: benthic cover, reef, coral, fish, stressors

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Massive outbreak of sea nettles from the coastal waters of Odisha, Western Bay of Bengal

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During the winter monsoon survey conducted in January 2021, a vast assemblage of the scyphozoan jellyfish *Chrysaora caliparea* (Reynaud, 1830) was observed in the coastal waters around Rushikulya and Gopalpur on the east coast of India, setting a new swarm record for the Indian Seas. Thousands of live specimens of *C. caliparea* were delineated during this phenomenon. *C. caliparea* samples were collected using a scoop net and bucket and brought to the laboratory for morphological analysis. Hydrographical parameters were recorded using a multiparameter and water samples for phytoplankton and zooplankton were collected using a Niskin sampler and Bongo net respectively. *C. caliparea* abundance in Gopalpur and Rushikulya ranged between 400 to 550 individuals/m³. On the other hand, microzooplankton and phytoplankton average abundances were on the downturn. The average sea surface salinity (SSS), sea surface temperature (SST), and chlorophyll-*a* concentration were 33.60, 26.62°C, and 0.75 mg/m³, respectively in Rushikulya and 33.44, 26.48°C, 0.57 mg/m³, respectively, in Gopalpur swarm stations. The level of dissolved oxygen (DO) was comparatively high in Gopalpur. Together, our research outlines the swarm-forming capacity of scyphozoan jellyfishes in the coastal waters of Rushikulya and Gopalpur, highlighting the need for more investigation into the myriad ways that multiple stressors can undermine ecological balance in these crucial Indian coastal regions.

Keywords: jellyfish, scyphozoa, ooplankton, Indian Ocean, *Chrysaora caliparea*

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A review for identification of medicinal valued mangrove species in Sri Lanka

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This study is aimed to identify the medicinal-valued mangrove species by reviewing local and international research studies. Mangroves are very special, unique ecosystems found in tropical and subtropical regions around the world. Some mangrove species are used in folk medicine since they have some medicinal and defensive properties against various diseases and illnesses. Scientists have found numerous pharmaceutically valued bioactive compounds such as polyphenols, flavonoids, alkaloids, carotenoids, tannins, saponins, steroids, amino acids, carbohydrates, proteins, and vitamins in mangrove species. This review identified mangrove bioactive compounds that shows the activities of antimicrobial, anti-inflammatory, anti-ulcer, anti-diarrheal, anti-cancer, anti-diabetic, anti-HIV, anti-arthritic, analgesic, antioxidant, cytotoxic and anti-inflammatory where those bioactive compounds have been extracted from tissues of mangrove leaves, barks, stems, roots, flowers, fruits, and seeds. A total of 31 mangrove species were identified each containing at least one or more bioactive compounds. Out of those thirty-one mangrove species, nineteen (19), twenty-three (23) and fourteen (14) species have tannins, flavonoids, and saponins compounds respectively. Nine species (9) contain carbohydrates, and steroids while various sugars and proteins are present in seven (7) species. Terpenes were reported in six (6) species. Three species contain lipids, amino acids, sterols, chloroforms, and lignin while gallic acids, quinones, and vitamins are found in two (2) species. Five other species were reported with minor quantities of resins, carotenoids, cardiac glycosides, ethers, and ascorbic acids. The results indicate that there are highly-polar bioactive compounds in mangrove species. The results of this review suggest mangroves as valuable sources of bioactive components, which can be used for the development of drugs.

Keywords: bioactive compounds, mangroves, medicine, pharmaceutical, species

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Community structure and above ground biomass across three sites of Rekawa mangroves, Sri Lanka

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Studies that provide comprehensive information on all the regeneration, community structure, and dry weight aspects of a given single mangrove area are scanty for southern Sri Lanka. Aiming this gap, the field samplings (January and February 2022) were conducted in three random sites of the Rekawa mangrove forest (Site 01: 6° 03' 12.60'' N 80° 50' 27.13'' E, Site 02: 6° 03' 24.96.3'' N 80° 51' 0.39'' E, Site 03: 6° 03' 16.30'' N 80° 50' 44.17'' E). Site 01 was situated near the lagoon water, site 03 was near the land, and site 2 was rather intermediate in position. At each site, three random plots (10m x 10m) were demarcated perpendicular to the high waterline. In each plot, the all-regeneration individuals (seedlings: <30cm, saplings: 30cm-150cm, young trees: 150cm-4m, adult trees: >4m.) were counted species-wise. The above-ground biomass (AGB) of young and adult trees was measured applying their diameter at breast height (DBH) into a common allometric equation described by Komiyama *et al*, 2008. All the four regeneration classes of *Rhizophora mucronata*, *Aegiceras corniculatum*, *Bruguiera sexangula*, *Excoecaria agallocha*, *Bruguiera gymnorrhiza*, *Lumnitzera racemosa*, *Avicennia officinalis*, *Avicennia marina* were identified from all the three sites that indicated good levels of regeneration and forest health in all the sites. This also would imply successful continuation of AGB accumulation of all the three sites. Across all the sites, *Avicennia marina* had highest AGB per species whilst *Aegiceras corniculatum* was the most abundant species. The abundance of seedling, young, adult regeneration classes of the *A. corniculatum* (Mean ± SD number of individuals per 100m²) in site 01 (104.3 ± 16.4, 39.7 ± 30.9, 213.0 ± 14.7) were significantly higher than other two sites (P<0.05; One-Way ANOVA). The site 01 also had significantly higher species diversity than that of other sites (P<0.05; Two Way ANOVA). The above ground biomass (ABG) values of adult tree species in site 01 (1950 ± 549 kg per 100m²) were significantly higher than that of other two sites (P<0.05; Two Way ANOVA). The close proximity of the site 01 to the water line likely resulted higher abundances, diversities and AGB values over the other two sites.

Keywords: regeneration, above ground biomass, mangroves

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Abundance of *Vibrio* spp. associated with coral mucus of the *Pocillopora verrucosa* from the Pareiwella near shore patchy reef, Southern Sri Lanka

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Vibrio is a genus of gram-negative bacteria, typically found in salt water can cause diseases to wildlife and human. Coral mucus with high organic matter content can support the growth of *Vibrio*, where they can exist within the coral surface mucus layer rich with organic matter and surrounding water column. The objective of this study is to identify the abundance of *Vibrio* associated with coral mucus using the culturable technique to understand the status of the reef environment and compare with the literature reference values given as Coral Health Index (CHI) obtained from global level studies comparing the benthic and pelagic life in coral reefs. Mucus samples from the coral *Pocillopora verrucosa* and seawater were collected from the shallow patchy reef located at Pareiwella Beach, Tangalle at various random locations (n = 5) by snorkeling at low tide period. All samples were collected into separate sterile 60 ml syringes for seawater samples and mucus respectively. For culturing purposes 100 μ l from each sample were used on pre-prepared TCBS agar plates and were incubated at 37 °C for 24 hours. *Vibrio* counts were reported as the number of colonies per 100 μ l and converted into colonies per 1 ml (CFU). The number of colonies per μ l was counted on each plate and calculated the average CHI values for both seawater and coral mucus samples. Results revealed that the mean *Vibrio* abundance in coral mucus and seawater was respectively 47.0 \pm 28.0 CFU/ml and 27.0 \pm 8.0 CFU/ml for Pareiwella Reef. CHI values of coral mucus and seawater as respectively 0.96 and 0.97. CFU values were compared with the CHI reference to use to describe the status of the reef as *Pocillopora verrucosa* is the dominant coral in Pareiwella near shore patchy reef. The reported result is closer to indicating the good status of the reef. However, more detailed studies need to determine the CHI values from other coral species to take an overall description of the status of health of the Pareiwella Reef.

Keywords : *Pocillopora verrucosa*, *Vibrio*, Pareiwella Reef, CHI

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Biomass and vegetative carbon stocks of planted *Rhizophora mucronata* in Rekawa Lagoon, Sri Lanka

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Mangroves are highly dynamic and complex ecosystems that have higher primary productivity than terrestrial vegetations. As they have a greater potential for carbon sequestration, mangrove blue carbon services largely support to mitigate atmospheric CO₂ by storing carbon in the forms of their biomass and in the sediment of their substrates. Similarly, to natural mangroves, even planted mangrove also store carbon in to their biomasses as shown by some of international studies. Various mangrove restoration projects were launched in Sri Lanka after the 2004 tsunami for different objectives, however their biomasses and carbon stocks are yet to be studied. This has hindered our knowledge about the role of the planted mangroves in biomass production and thereby storing carbon in Sri Lanka. Addressing this knowledge gap, the current study attempted to assess the biomass and vegetative carbon stock of 14 years old planted *Rhizophora mucronata* at two different plantation sites (site 01: 6° 3.2061' N – 80° 50.4527' and, site 02: 6° 3.2878' N – 80° 50.7379' E) at Rekawa Lagoon, Southern coast of Sri Lanka. The plantation 01 was located closer to the mean low inter-tidal level and the size of the plantation was approximately 500 m² while Plantation 02 (approximately 1000 m² large in size) was located above the high inter-tidal level. The vegetative biomass was determined by using allometric equations based on the diameter at breast height (DBH) of the trees. As structural characteristics, the height and diameter were larger at the low intertidal trees than the trees at the high intertidal level of the same plantation. The mean vegetative organic carbon contents (aboveground + belowground) of the site 1 (33.04±6.48 Mg Cha⁻¹) was significantly higher (p<0.05; Two-Sample t-test) than that of the site 02 (9.76±3.42 Mg Cha⁻¹). The mean total biomass calculated by summation of AGB and belowground biomass (BGB) were 66.1±13.0 Mg ha⁻¹ and 19.53±6.84 Mg ha⁻¹ for the low intertidal (site 01) and high intertidal plantation (site 02) respectively. Thus, the growth, biomass, and carbon sequestration potential were significantly higher in the low intertidal plantation possibly due to preferable salinity, soil wetness and higher nutrient supply.

Keywords: biomass, vegetative carbon stock, *Rhizophora mucronata*, Rekawa Lagoon

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Preliminary study on water bottles used by multiday fishing vessels at the Dikkowita fishery harbor

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Plastics are synthetic materials, shaped into various forms. Marine plastic pollution is considered to be a serious issue at present. Multiday vessels spend a month or more at the sea for fishing. Therefore, they carry water from the land for their drinking water needs. Such water is carried in plastic bottles and they are of different sizes. Fishermen bring back some empty water bottles to land. While a large number of plastic bottles are dumped into the sea that causes marine pollution. Therefore, the Ministry of Fisheries and Aquatic Resources introduced an Act for reducing the use of plastic bottles. The Act states that bottles of different sizes cannot be carried other than the bottles of 5-liter size. This Act is enforced at Dikkowita fishery harbor, Sri Lanka and where the number of bottles carried by multiday vessels and the number of bottles returned by those boats is recorded. The study was performed with data targeted toward the multiday vessels (n=100) in the selected site. The current study surveyed such 100 multiday vessels and revealed that 60% of the bottle quantity carried is returned to the harbor. Out of the returned, 30% were used to refill the water. It was discovered that about 10% of bottles are thrown into the sea. The findings from the study suggest the authorities prepare measures on educating the fishermen and managing to reduce the use of plastic water bottles to prevent marine pollution.

Keywords: Dikkowita fishery harbor, plastic, bottles, multiday vessels

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Assessment of seaweed and the associated fauna at Dickwella, Southern coast of Sri Lanka

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Marine macroalgae are multicellular, macroscopic benthic algae that are important natural resources. This study reveals the abundance and diversity of seaweeds and their associated fauna found at the Dickwella algal bed from January to February in 2022. The random quadrat method was used to collect data from 120 sampling sites. Data was collected once a week between 8 a.m. and 11 a.m. from January to February 2022. The Shannon wiener diversity index (H) was used to investigate the diversity of recorded algae species, and the abundance of each species was determined using the total algal percentage coverage in the quadrats. Standard identification guides were used to identify the seaweeds and associated macro-invertebrates. Results revealed that 17 macroinvertebrate species were presented at the study site. The abundance of macro-invertebrates in the Dickwella algal bed during the study period revealed a high abundance of *Echinometra mathaei* and a low abundance of *Holothuria* sp. The present study revealed 30 algae species belonging to 19 families, of which 45.06% were green algae, while red algae and brown algae were recorded as 34.19% and 20.76% respectively. H values for each week of the month of January, the weekly reported H values for the month of January were 2.35, 2.60, 2.78, and, 3.01. The highest abundance was recorded by the species of *Ulva lactuca* and found in almost all the sampling sites in the study area, and the lowest abundance was recorded by the species of *Chaetomorpha antennina*. The mean total species abundance of Chlorophyta, Phaeophyta, and Rhodophyta species was significantly different. (One-way ANOVA; $p < 0.05$); Chlorophyta (911.75 ± 276) had the highest mean total species abundance (number of species) followed by Rhodophyta (691.75 ± 151.8) and Phaeophyta (420 ± 109). The species diversity significantly varied between the Chlorophyta, Phaeophyta, and Rhodophyta ($P < 0.05$). Accordingly, it can be suggested that the abundance and diversity of seaweed in the Dickwella algal bed indicate ecological importance. Future studies must be directed for long-term investigation on seasonality, complex ecological studies of the area, and further marine algae & macro-invertebrates management and exploration.

Keywords: abundance, seaweed, macroinvertebrates, Sri Lanka

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The shallow geological structure and its disaster assessment by long-term monitoring network in southern coastal cities of Sri Lanka

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Sri Lanka, located in the key fulcrum of one belt and one road, is characterized by a complex geological structure due to intense tectonic activities. Meanwhile, with the development of the economy and the increase of urban construction, the risks are rapidly increasing from geological disasters and major construction projects. Therefore, it is very urgent to explore the urban shallow geological structure and evaluate its potential geological disasters, especially for the southern coastal cities. Galle and Matara, are chosen to be key research areas and in response to the urgent needs of Sri Lanka. A dense array of 50 short-period seismographs will be deployed for continuous data recording. The effective signals extracted from ambient noise will be used to detect the shallow structure. The potential geological disasters will be evaluated based on the parameters of compaction degree, slope, relief degree, and rock physical properties. The grade division of geological disasters and the assessment of urban vulnerability are comprehensively evaluated. These results will provide an important scientific basis for the classification of geological disasters and engineering construction plans in the future in the southern coastal cities. And they will potentially solve the major livelihood issues of people's well-being in Sri Lanka during the process of urban construction under the strong support from CAS China-Sri Lanka Joint Center for Education and Research. More importantly, we train the young scientist for Sri Lanka to realize the long-term observation experiment in Sri Lanka, which could play an important role in the "one belt and one road" marine strategy.

Keywords: shallow structure, geological disasters, ambient noise, one belt and one road, monitoring network

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Assessment of most preferable offshore wind energy potential areas in Sri Lanka

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With the concern of increasing demand for electrical power, there is an urgent need for renewable energy sources for electricity generation in Sri Lanka. Being an island nation, Sri Lanka has the potential of offshore wind energy resources for electrical power generation. However, lack of systematic data collection hinders the validation. To overcome this, the current project aims to find the most preferable offshore wind energy potential sites in coastal areas with the highest potential for electrical power generation by analyzing reliable data sources. Therefore, wind speed data were obtained from 10 locations covering the entire coastline of Sri Lanka. Based on the available data, Weibull Probability Density Function was utilized to analyze the behaviour of the local wind flow and the wind power density along with the capacity factor, provides a quantitative measure of wind energy available at any location, used to measure the actual wind power that can be generated locally. The results indicated that the highest potential were found in Jaffna, Nadukkuda, Hambantota and Kokilai compared to the other sites. In these four sites, Weibull distribution was optimal while the wind power density and capacity factor were higher and optimal compared to other locations. Further, Hambantota site was identified as the best Weibull distribution with a wind power density of 538.08 W/m² and a capacity factor of 24.76%. The annual actual power generation of this site was 1.167 MWh/m². Consequently, Hambantota can be identified as an area with the highest offshore wind potential in the coastal region of Sri Lanka. The total offshore wind power generation in the areas identified under this project is 9.936 GWh, which is 24.56% of the total power generation and 44.99% of the renewable energy generation. It is relatively higher value. Therefore, the development of above mentioned four areas are timely and strategically important for the country's energy sector in Sri Lanka.

Keywords: offshore wind energy, Weibull probability density function, wind power density, capacity factor

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Marine debris abundance on three selected beaches in Galle, Sothern coast of Sri Lanka

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The accumulation of debris in aquatic ecosystems is a rapidly increasing long-term and the widespread threat that represents a great challenge for remediation. The inadequate disposal practices and littering behavior in developing countries have resulted in considerable quantities of litter in beaches affecting its aesthetic appeal. This study was conducted to categorize and quantify the macro- (> 2.5cm) marine debris in selected beaches in Galle District. The sampling was conducted 03 times from April to May, 2022 in Jungle Beach, Light House Beach and Mahamodara Beach in Galle District. Beach clean-ups were taken placed in all three beaches at different time of the day but its impact was minimized by collecting data before cleaning. The 20 m x 4 m transects were sampled in triplicate keeping 50 m distance between transects in each beach. Marine litter was categorized according to the CSIRO global plastic pollution survey and One-way ANOVA was performed in SPSS version 21 for comparison of abundance in beaches. Marine debris abundance in three beaches was 0.35 items/m². The respective reported marine debris abundance in Light House Beach, Mahamodara Beach and Jungle Beach were 0.62, 0.27, and 0.25 items/m² and there was no significant difference of debris abundance among the beaches ($p = 0.39$). The litter composition is dominated by plastics (81%) with 42% soft plastics, 29% hard plastics and 10% of plastic straps. In addition, papers (7%), COVID 19 related PPEs (4%), glass (3%), metal (2%) and timber, rubber, cloth materials (1%) were the other debris types presented in the beaches. This study reveals that plastic related items are dominating in all the studied beaches and these items might be from the anthropogenic activities of the area.

Keywords: beach pollution, COVID 19, macro-debris, plastics

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Assessment of the status of plastic pollution on the coast of Modera, Sri Lanka

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Plastics in the marine environment have become a serious issue as it threatens biodiversity, the marine environment, and community health. Even though people are becoming more aware of the risks this material poses to life, there is still an increasing amount of plastic pollution in our oceans. As an island State, Sri Lanka too experiences greater levels of plastic pollution in its coastal and marine areas. Beach plastics are only one part of marine plastic pollution and there are several sources that are contributing. The present study aimed to quantify macro-plastics distribution and their composition in the coastal stretch of Modera Beach in Colombo. Sampling was done by using a systematic quadrat (1m x 1m) sampling method along the coast in the selected site over a period of two months. In order to gather the plastic waste, the study site was divided into three equal zones that encompassed a length of about 60 m along the coast; starting from the Kelani River inlet and moving farther away. The macro- plastic debris collected was categorized into 19 types with an overall average of 15 nos m⁻². Of the collected plastic debris, the majority of the plastic pollution was contributed by plastic bags (24%) followed by food wrappers/ containers/packets were the one mostly (15%), beverage bottles (12%), plastic pellets (11%) and straws (24%). They collectively contribute to nearly 70% of the plastic debris collected at the site. Plastic debris was high in number near the river inlet (an average of 26 nos m⁻²) and decreased (4 nos m⁻²) when moved further away. The results of the study demonstrated that there is a severe problem with the presence of more plastic debris along the Modera shore, which may have an influence on local fisheries, tourism, and other beach-related recreational activities.

Keywords: plastic pollution; plastic debris, Modera, macro-plastics, pollution abatement

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Distribution patterns of fouling organisms on *Rhizophora mucronata* prop-roots

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Submerged prop roots of *Rhizophora mucronata* provide substrate for fouling organisms however studies on this scope are very limited in Sri Lanka. The current study was carried out in two mangrove sites (Site 01-4 ppt: Low salinity and Site 02-10 ppt: High salinity) of Rekawa Lagoon Sri Lanka. Site 01 was located in the upper lagoon area closer to freshwater inputs while site 02 was from the lagoon mouth area. Four *R. mucronata* submerged prop roots of from each site were randomly cut to study the fouling organisms. From the top to the bottom of the root, each root was divided into four different vertical zones named the 1st, 2nd, 3rd, and 4th zones consecutively. The abundance and diversity of countable fouling organisms per unit surface area (m⁻²) of each root zone were compared using a two-way ANOVA test. The abundance of non-countable fouling organisms (such as microalgae masses) was calculated using a simplified filament counting technique. Totally, twenty-three fouling species were identified, including 19 countable species and 4 non-countable species. The mean abundance of total countable fouling organisms did not vary between the two sites but between the four zones ($p < 0.05$; Two-way ANOVA) where the 2nd zone showed the highest abundance ($15438 \pm 11746 \text{ m}^{-2}$) while the 4th zone showed the lowest ($1656 \pm 925 \text{ m}^{-2}$). The mean abundance of filamentous fouling organisms did not vary between the sites and zones. The reduced fouling abundances in 1st zone could be due to frequent waves hitting while in 3rd and 4th zones, the sediment browsing from the muddy bottom is likely to have reduced the abundances. The mean diversity of countable fouling organisms did not vary between root zones while the mean diversity of site 02 ($315.2 \pm 82.8 \text{ m}^{-2}$) was higher ($p < 0.05$) than that of site 01 ($245.2 \pm 109.3 \text{ m}^{-2}$). Thus, the middle area of the root (2nd zone) appeared to have provided the most suitable conditions for the countable fouling organisms. The high saline conditions at site 02 also apparently have supported a higher abundance and diversities of fouling organisms than the low saline conditions at site 01.

Keywords: *Rhizophora mucronata* , fouling organisms, salinity, Rekawa Lagoon

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FISHERIES AND AQUACULTURE

The impact of Sri Lankan economic crisis on the marine fisheries sector in Galle District

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The fishing industry has a major contribution to the Sri Lankan economy. Sri Lanka is currently facing a severe economic crisis that has affected multiple sectors. This study tries to investigate how the economic crisis in Sri Lanka has affected the fishing industry in the Galle District. The coastal district of Galle is one of the major fishing towns in Sri Lanka, hence, it was selected for this study. Data were collected from 104 fishermen and 73 fish traders using a pretested questionnaire. Secondary data was obtained from the Ministry of Fisheries and Aquatic Resources Development. Data analysis was performed by using MS Excel and SPSS statistical package. The study found that multi-day fishing activities were more heavily affected than single-day fishing activities. The cost of a multi-day trip has increased by 102.22% in 2022 compared to 2021. Increased prices of food fish have led to reduced consumption among consumers. The selling price of various types of fish has increased by 60-150% in the year 2022 compared to the year 2021. Based on the findings of this study, it is evident that the economic crisis in Sri Lanka has significantly affected the fisheries sector of the Galle District.

Keywords: Sri Lanka, economic crisis, fisheries sector

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Assessment of microbial quality of packed and non-packed dried prawns available in the local market, Tangalle, Sri Lanka

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Dried fish is an important protein source in Sri Lankan cuisine. It holds a considerable place among several types of dried fish products in the local market. Since there is an idea that packed products have higher quality, consumers highly prefer those products. As the possibility of adding various types of contaminants during the whole processing period is very high, it is very important to assess the microbiological quality of packed and non-packed dried prawns. This study was conducted from January to March 2022 to assess the microbial quality of packed and non-packed dried prawns sold in the local market of Tangalle, Sri Lanka. The non-packed dried prawns were bought from the local market and were stored in opened gunny bags and packed dried prawns were bought from the supermarket. The aerobic plate count method was used to determine the total viable count (TVC). Thiosulfate-Citrate-Bile salts -Sucrose agar (TCBS) and MacConkey agar were used for the qualitative screening of bacteria. TVC of non-packed and packed dried prawns were $14.6 \times 10^{15} \pm 3.67 \times 10^{15}$ CFU/g and $3.78 \times 10^{15} \pm 1.15 \times 10^{15}$ CFU/g respectively. There was a significant difference in TVC of packed and non-packed dried prawns (Two sample t-test, $p=0.041$; $p<0.05$). Selective media screening showed the growth of coliforms and *Vibrio sp* in both packed and non-packed dried prawn samples. TVC of both non-packed and packed dried prawns were reported over the acceptable limit (5.0×10^5 CFU/g) of the Sri Lanka Standard Institute although packed dried prawns have shown lower CFU value than the non-packed product. Further studies need to be conducted to analyze the potential contaminations during the value chain as well as the possible public health risks.

Keywords: dried prawns, total viable count, microbial quality

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Morphological analysis of *Portunus pelagicus* (Linnaeus, 1758) species complex (Crustacea: Brachyura: Portunidae) in Sri Lankan waters

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Recent studies on genetic analyses in combination with morphometric and morphological studies have shown that the commercially important blue swimming crab *Portunus sp.* species has been revised and four distinct species as *P. armatus*, *P. pelagicus*, *P. reticulatus* and *P. segnis* have been recognized based on their morphological and DNA characters as well as biogeographical considerations (Lai et al., 2010). The blue swimming crab (*Portunus sp.*) is an important export-oriented fishery that has grown to be an important source of income and employment for fishermen and traders in Sri Lanka. However, very limited studies have been carried out to identify the *P. pelagicus* species complex which is important in the blue swimming crab fishery in Sri Lanka. The species can be identified by a combination of characteristics of the carapace, abdomen, male first gonopod, and different color patterns. A total of 72 samples were collected from three selected areas; Jaffna (24), Kalpitiya (36), and Mannar (12). Fourteen measurements were taken in morphometric analysis and standardized using ratios. Measurements were made to the nearest 0.02 mm using a Vernier caliper. The morphometric ratios among male crabs of different locations revealed significant differences in carapace width (without the 9th tooth) to carapace length (1.77 ± 0.109) (One-way ANOVA; $P = 0.013$), carapace width (with the 9th tooth) to carapace length (2.18 ± 0.162) ($P = 0.01$) and cheliped merus length to width (3.33 ± 0.538) ($P = 0.029$) while other four ratios were not significant ($P > 0.05$). The estimated relationship between carapace width to body weight showed a positive relationship ($CW = 0.01556 BW + 8.571$) where the R^2 value was 0.84. Of the 72 specimens examined, 79% specimens were identified as *P. reticulatus*, and 10% of specimens also showed characteristics more similar to *P. reticulatus*, except for the number of spines on the anterior margin of the merus. Based on several characteristics, *P. segnis* were observed in 7% of specimens. However, 4% of specimens sampled in the study presented some confusing characteristics related to *P. segnis*. This study evaluated the status of the *Portunus sp.* in Sri Lankan waters emphasizing its morphological similarities or mixing of characters to other species in the complex for a better understanding of the species complex. Our results provided useful baseline information on the blue swimming crab complex present in Sri Lankan waters which is important for their management.

Keywords: blue swimming crab, morphometry, morphology, species complex

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Bacterial microflora associated with different body parts of giant freshwater prawn, *Macrobrachium rosenbergii* (De Man) in Kattakaduwa Reservoir, Tangalle, Sri Lanka

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Giant freshwater prawn (*Macrobrachium rosenbergii*) is regarded as a pioneer crustacean species in the Sri Lankan fishery industry and a highly valuable species in both domestic and export markets. Though studying the bacterial microflora associated with this species is significant for public health concerns, such studies are rare in Sri Lanka. Therefore, this study was carried out to analyze bacterial flora associated with different body parts of *M. rosenbergii* at Kattakaduwa Reservoir Tangalle, Sri Lanka. Prawn samples were collected from three different places in the reservoir. Microbial counts in shells, muscles, and gut were separately studied for total viable count (TVC) and pathogenic bacteria. TVC in nutrient agar was determined using the aerobic plate count method. Qualitative screening of bacteria genera was done by using selective agar media (Thiosulphate Citrate Bile salt Sucrose agar, MacConkey agar, and Salmonella Shigella agar). Highest TVC was recorded in the gut ($12.4 \pm 0.2 \log_{10}$ CFU/g) where shells and muscles showed $9.7 \pm 0.4 \log_{10}$ CFU/g and $11.2 \pm 0.3 \log_{10}$ CFU/g respectively. There was a significant difference between the mean TVCs of different body parts of the freshwater prawns (One-way ANOVA t; $P < 0.05$). *Vibrio* and *Escherichia coli* were reported in the muscle and gut whereas *Salmonella* spp. or *Shigella* spp. were not recorded in any of the body parts. The results of the study revealed that the presence of *Vibrio* spp. and *E. coli* in freshwater prawn samples and possible public health risks need to be analyzed with further studies.

Keywords - *Macrobrachium rosenbergii*, giant freshwater prawn, bacterial microflora, *Vibrio*, *Escherichia coli*

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Utility of the mitochondrial Cytochrome Oxidase I (COI) barcoding in discriminating bigeye trevally, *Caranx sexfasciatus* (Quoy & Gaimard, 1825) from the phenotypically mutualistic *Caranx* species

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Bigeye trevally (*Caranx sexfasciatus*) has been considered as a commercially valuable aquaculture carangid fish with ornamental and food values. Characteristic intra/interspecific cryptic speciation among individuals of *C. sexfasciatus*, *C. ignobilis*, *C. tille* and *C. melampygyus* is pronounced due to the environmental conditions, developmental changes and hybrid speciation. This makes confusion over traditional species identification based on phenotypic characters. This study aimed to describe the utility of mitochondrial cytochrome oxidase I (COI) barcoding gene region (~ 655bp) in discriminating the above *Caranx* species. Consensus sequences (MZ555707, MZ55516, MZ555710 and MZ555715) of four individuals of *C. sexfasciatus* were derived from the PCR amplification using the universal fish primer pair, FishF1/R1. Nucleotide divergence was calculated using the pairwise *P*-distance among geographically isolated reference sequences of the relevant species, considering *Katsuwonus pelamis* (Skipjack tuna) as an outgroup for a resolution of the results. The maximum likelihood tree was constructed under bootstrap 1,000 pseudoreplicates. Conspecific and congeneric nucleotide divergence was observed as $0.000 \pm 0.000 - 0.017 \pm 0.003$ and $0.046 \pm 0.009 - 0.091 \pm 0.011$ respectively. Phylogeographic analyses indicates six geographically isolated haplotypes: A, B, C, D, E and F within *C. sexfasciatus* and their *P*-distances can be mentioned as 0.003 ± 0.002 , 0.004 ± 0.001 , 0.005 ± 0.002 , 0.006 ± 0.002 , 0.041 ± 0.008 and 0.046 ± 0.009 respectively. Pairwise *P*-distance between the haplotypes: E and F with *C. melampygyus* ranged from 0.000 ± 0.000 to 0.023 ± 0.06 . Overall conspecific and congeneric *P*-distances are compatible with the 0.02 criteria to differentiate two individuals as two species. The separation of the six clades/haplotypes of *C. sexfasciatus* provides clues to the evolutionary lineage of their common ancestor.

EX037

ORAL

Haplotype A encounters in the Indo-Malaysian Archipelago show the lowest divergence from their common ancestor and haplotypes B, C and D encounter in peripheral areas show a considerably higher divergence from the common ancestor, which reveals the cleavage of the above haplotypes and cryptic speciation resulting from the Centre-of-Overlap phenomenon. Nucleotide divergence between haplotype E/F and *C. melamphygus* lies close to the marginal *P*-value of 0.02 speciation criteria and facilitates the possibility of hybrid speciation. Further studies are required to understand the hybrid speciation within the family.

Keywords: Carangidae, centre of overlap, cryptic species, hybrid species, P-distance

EX037

ORAL

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Growth performance and survival rate of *Holothuria scabra* juveniles cultured in hapa nursery system

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Sea cucumbers are a very valuable marine species with high potential as a profitable industry in aquaculture. Researchers have been doing numerous studies to increase this species' potential for aquaculture as a result of its recent population decline. Scaling up the hatchery production of juvenile sandfish *Holothuria scabra* is inhibited by limited hatchery space and the associated high operational costs. To shorten the hatchery rearing phase, ocean nursery systems like floating hapa nets have been used with good prospects but with limitations during rough sea conditions. The present study aims to fulfil the data gap on the growth performance and survival rate of sea cucumber juveniles in different stocking densities which are produced from the hatchery and identify the impact on the growth performance of *H. scabra* juveniles cultured with seaweeds using hapa nursery system from selected areas in Northern Province, Sri Lanka. In this study, *H. scabra* was subjected to compare the survival rate and growth performance with different stocking densities following the randomized complete blocked design. This study performed on the growth performance and survival rate of *H. scabra* early juveniles with three different densities in three hapa nets at 250 ind. m⁻³, 500 ind. m⁻³, and 750 ind. m⁻³, respectively. Also, one hapa nursery net was prepared to culture the *H. scabra* with seaweed (*Kappaphycus alvarezii*). The effects of stocking density on growth performance and survival rate were determined in a 60-day field experiment. The growth performance and survival rate were calculated and according to the study result, the highest survival rate, weight and length gain was observed in hapa number 01 (250 ind m⁻³).

Keywords: Sea cucumber, hapa nursery system, survival rate, Jaffna, Sri Lanka

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Morphometric characters and gender composition of hammerhead sharks (Family Sphyrnidae) landed in Negombo fishery harbor, Sri Lanka

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Hammerhead sharks (*Sphyrna lewini*) in the family Sphyrnidae are one of the most unique groups of large sharks because they are characterized by a laterally elongated rostrum or cephalofoil. There are 10 species of hammerhead sharks, the largest of which (i.e., with a total length of over 150 cm at maturity) are found worldwide. Hammerhead sharks are the slowest growing and are vulnerable to commercial, recreational, and artisanal fisheries. Hammerhead sharks have been intensively studied worldwide for their fisheries, growth parameters and biology. However, studies from the tropical Indian Ocean region are limited. This study was undertaken to obtain information about morphometric characters and gender composition of hammerhead sharks (family Sphyrnidae) landed in Negombo fishery harbor, Sri Lanka. Samples were obtained from fishing vessels caught in international waters. A total of 124 sharks were measured from January to August 2022. Total length (TL), fork length (FL), standard length (SL), and clasper length (for males; CL) were measured in all sharks and total weight (TW) was measured. The TL of the measured specimens ranged from 106.68 - 360.68 cm with a mean \pm SD size of 144.83 cm \pm 44.68) and mean \pm SD weight is 17.25 \pm 24.83 kg). Of the total number of sharks landed, 81 were female (66%) and 41 were male (32%). The percentage of female sharks landed is higher than the percentage of male sharks in Negombo fishery harbor. This study will be continued to analyze the stomach contents, maturity status, catch composition and mortality rate between male and female hammerhead sharks landed at Negombo fishery harbor in order to better understand their mortality rate at each maturity stage and ecological importance.

Keywords: hammerhead shark, shark fishery, Negombo fishery harbor, gender composition

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Production and sensory evaluation of instant fish soup powder using three different fish species

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The present study developed an instant soup premix utilizing dried fish powder. The study was to develop a proper tasty instant soup and select the suitable fish available in the Sri Lankan market, considering the price and consumer preference. Three different fish species namely, *Katsuwonus pelamis* (Skipjack tuna), *Caranx ignobilis* (Trevallies), and *Sardinella albella* (Sardinella) were bought from Ceylon Fishery Harbour Corporation and fish powder was prepared from each species separately according to the following method. The taken fish samples were cleaned and washed separately. Then sliced into small pieces and dipped in diluted lime juice for 5 minutes, Then the fish was boiled for 15-20 minutes in an electric steamer with boiling water and then dried for an hour in an air fryer maintained at 100°C. Then the dried fish was ground (5 minutes) until it became a fine powder. Finally, 40 g of each fish powder was separately mixed with the corn (90 g), oats (30 g), pepper(1 g), cinnamon (1 g), turmeric (1.5 g), citric acid (1 g), salt (25 g), sugar (10 g), ginger (5 g) and dry curry leaves (2 g). Then all ingredients were ground into a fine powder. 40 g of that powder was mixed with 75 ml of water and cooked at 100°C for around 5 minutes to boil. The mixtures were stirred well so that no lumps were formed. Instant fish soup samples were served hot to the semi-trained sensory panel consisting of 30-panel members. Their preference was evaluated for appearance, color, fishy odor, fish flavor, texture, taste, and overall acceptability by using a 9-point hedonic scale. The sensory evaluation test was conducted for appearance, color, fishy odor, taste, texture, and overall palatability. According to the Kruskal-Wallis test, appearance ($p = 0.548$), color ($p = 0.311$), fishy flavor ($p = 0.025$), taste ($p = 0.065$), texture ($p = 0.0578$), and overall palatability ($p = 0.579$) were not significantly different in all the mixtures. When the entire study is taken into account, *Sardinella* is the best fish for making instant soup among the three fish species used (Skipjack tuna, Trevallies, *Sardinella*) according to the cost per unit and consumer preference.

Keywords: instant soup, Kruskal-Wallis test, hedonic, sensory evaluation

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Water quality and growth dynamics of *Litopenaeus vannamei* at Arachchikattuwa, Sri Lanka

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White leg shrimp (*Litopenaeus Vannamei*) farming is a key commercial aquaculture industry in Sri Lanka and is mainly distributed in the Puttalam District in the North Western province. There is very limited research works were done on the culture and growth performance of *L.vannamei* with the study of different growth rates and checking water quality parameters in brackish water ponds in Sri Lanka. So, the present study attempted to evaluate the survival and growth of *L. vannamei* culture in the Arachchikattuwa area with the study of different growth rates and checking water quality parameters. The study was conducted during three months period from August to November 2021. Water quality parameters (ammonia, pH, Secchi depth, and salinity) of six ponds and the growth rate of shrimps were measured in duplicates at each pond. Data were analyzed using Minitab 16 statistical software considering 0.05 as the significance level. According to the Kruskal-Wallis test, the ammonia of the ponds did not show significant differences between each other. The mean ammonia (mean±SD) of the pond 01, 02, 03, 04, 05 and 06 were 0.05±0.07, 0.04±0.08, 0.05±0.09, 0.08±0.11, 0.08±0.14 and 0.08±0.10 respectively. According to the Kruskal-Wallis test pH of the ponds did not show significant differences between each other. The mean±SD pH of the pond 01, 02, 03, 04, 05 and 06 were 7.63±0.21, 7.60±0.20, 7.63±0.19, 7.71±0.19, 7.67±0.21 and 7.61±0.20 respectively. According to the Kruskal-Wallis test salinity of the ponds did not shows significant differences between each other. The mean±SD salinity of the pond 01, 02, 03, 04, 05 and 06 were 14.07±2.14, 13.66±2.33, 13.41±3.08, 14.67±1.22, 14.96±0.16 and 13.90±2.16 respectively. According to the Kruskal-Wallis test, the Secchi septh of the ponds did not show significant differences between each other. The mean±SD Secchi depth of the pond 01, 02, 03, 04, 05 and 06 were 16.41±1.91, 17.60±2.49, 17.30±2.87, 19.60±3.14, 22.85±5.62 and 20.74±6.95 respectively. According to the One-Way, ANOVA test shrimp growth in ponds did not show significant differences between each other. The mean±SD shrimp growth of the Pond 01, 02, 03, 04, 05 and 06 were 6.57±4.23, 7.19±4.53, 10.4±7.29, 7.82±5.20, 8.36±5.69 and 9.85±6.44 respectively.

Keywords: *Litopenaeus vannamei*, water quality, growth dynamics, pond culture

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Solar power to supplement the energy demands of Sri Lankan multiday fishing boats: Are we ready to conquer the crisis?

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The current economic crisis in Sri Lanka has intensified public frustration over fuel consumption, driven by limited supply and higher prices. Consequently, many fisherfolks have become more vulnerable in this situation, without being able to fulfil their fuel demand conveniently at an affordable price. The objective of this study was to assess the potential of incorporating solar power as a secondary energy source to supplement the energy demands of multiday fishing boats. A semi-structured questionnaire was distributed amongst a group of skippers (n=43) to obtain their responses on the concept. They were questioned in order to get a comprehensive understanding of their average fuel demand, expenses on fuel, issues regarding obtaining fuel, the potential of solar panel installation, and their willingness to adapt to clean energy sources such as solar power. The results were analyzed using MS Excel. The CIRCLES method was used as a framework to elaborate the responses in a meaningful way. Engines of multiday boats are powered by diesel and the average consumption ranges between 3500 L-5000 L on a trip of 10-20-days. All the respondents replied that they have burning issues obtaining fuel amid the recent economic crisis in the country. The majority of the respondents (82%) replied that they have faced power-related emergencies at sea, which made them acclaim the availability of a secondary energy source on board. Among them, 92% are certain that they will have better security and safety at sea with a secondary power source on board. 88% responded that they are aware of the general uses of solar panels. 27% of the respondents operate/own boats that are already installed with 50W-150W solar panels. However, their productive lifespan doesn't usually exceed 3 years due to salt deposition. 90% expressed their strong willingness to install solar panels while the rest is uncertain due to some reasons beyond their control. It is concluded that there is a positive attitude from the fisher folks to adapt to this technology that reduces their fuel costs and improves their onboard safety and quality of life and affirms environmental stewardship. It is recommended that government shall provide incentives to introduce this technology in an improved manner to the existing multiday boats while developing partnerships to construct new vessels with sophisticated and advanced green technologies.

Keywords: multiday fishing vessels, fuel, solar energy

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OCEANOGRAPHY,
HYDROGRAPHY,
REMOTE SENSING
AND GIS AND
MARINE
ENGINEERING

Design and manufacturing of an electric battery formulated utilizing seawater

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Seawater electric batteries can be named as a green electricity source especially for houses in the coastal area and for fishing boats at low cost. In addition to that, it is a solution to the prevailing energy crisis in the world. In this battery, the cathode is a copper plate and the anode is a zinc plate. As seawater is an already ionized fluid, it is used as the electrolyte of the battery. The results showed zinc anode produced voltage and current with numbers of 846 mV and 3.51 mA respectively within one cell of the battery. The battery consists of 15 cells which are connected in series. The battery generates 12.69 V and 3.51 mA. This generated current can be amplified by using an N-P-N Silicon transistor to maximize the current. By using the battery, an LED bulb of 2.5 Watts can be targeted to be lit up with 225 Lumen with low energy consumption, a long-lifetime response, and together with climate resistance technically and economically. The combination of LED lamps and seawater batteries will be an efficient and effective technology to be introduced for fishing boats and houses in coastal areas.

Keywords: seawater, battery, zinc, copper

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Design and analysis of pick and place robotic arm for laboratory experiments

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This research focuses on the design, modeling, and analysis of a pick-and-place robotic arm that uses Arduino programming to perform weight-based object sorting. A sensor is used to measure the weight of the object which has to be picked and placed. Aside from that, the safety factor was increased by 1.4, and current industrial components in the industry were used. The robotic assembly was designed using SolidWorks 21 software. Finite element analysis was crucial in the development of the design, modeling, and analysis processes. The robotic assembly is controlled by a microcontroller-based system, which in turn controls stepper and servo motors via a motor driver L298D. This is an industrial-type system that uses basic sorting concepts to save manual time and effort.

Keywords: robotic arm, pick and place, arduino

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Preliminary study on sea level rise around the North coast of Sri Lanka from 1993 to 2020

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Sea level rise is a global issue that impacts land areas around the globe. Most islands, including Sri Lanka (SL), are at high risk of sea level rise. Therefore, knowledge of the current status of this global issue and countermeasures is critical. However, an accurate interpretation of sea level fluctuations around SL is scarce. We conducted the present study to determine whether there has been a significant sea level rise on the north coast of SL over the past 28 years (1993-2020). This study analyzed a coordinate grid (9-11 °N, 79-83 °E) representing the northern oceanic region of SL using freely available and preprocessed Level 4 satellite altimetry data (Global Ocean Gridded L4 Sea Surface Heights & Derived Variables Reprocessed 1993-2020) from the Copernicus Marine Service website. The general trend of sea level was temporally and spatially analyzed in the selected area using R software (v 4.1.2) applying the Absolute Dynamic Topography (ADT) variable, which contains sea surface height data over geoid. ADT is considered as sea level height in this study. The general trend of temporal variation of sea level rise (Δ ADT) was analyzed by subtracting the long-term mean ADT from the monthly mean ADT values. A simple linear regression analysis was performed to test the significance of sea level rise over the past 28 years with a 95% confidence interval. The overall spatial trend of sea level was calculated by averaging the ADT values of the 28 years for each coordinate. The results showed that the temporal trend is statistically significant at the confidence level considered ($p < 0.05$), and the rate of sea level rise on the north coast of SL from 1993 to 2020 was 3.18 ± 0.23 mm/y. Our study concludes that sea level rise on the north coast of SL is significant over the past 28 years, and these results are a prerequisite for future climate change-associated management efforts.

Keywords: sea level rise; absolute dynamic topography; satellite altimetry; R software

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Analyzing the changes of shoreline from Dickowita Fishery Harbour to Negombo, Sri Lanka

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The shoreline is one of the rapidly changing coastal landforms due to natural and anthropogenic activities. Shoreline change analysis is one of the crucial factors in understanding shoreline accretion, erosion, and coastal morphodynamics in a specific area. The study was conducted about 28 km along the coast, extending from Dickowita Fishery Harbour to Negombo in Western Province, and 4 km from the Mundal Divisional Secretariat Division in North Western Province, Sri Lanka. The coastal area of the Mundal DS division which could be considered the nearest region that gets the minimum anthropogenic impacts on the shoreline was also analyzed to compare the shoreline changes of the from Dickowita Fishery Harbour to Negombo. This study aims to analyze the shoreline changes and calculate erosion, and accretion rates using remote sensing and geographic information system (GIS). The application of remote sensing and GIS has led to quantitative and qualitative analyses of coastal change trends. Multi-temporal satellite images from the Google Earth Pro software during the period between 2005 to 2021 were used to delineate shorelines through visual interpretation. The Digital Shoreline Analysis System (DSAS) as a software extension in ArcGIS was used for the statistical analysis of End Point Rate (EPR), Net shoreline movement (NSM), and shoreline change envelop (SCE) to calculate shoreline change rates. The results of the study indicate exceptional shoreline changes of maximum accretion of 134.89 m NSM with EPR of 8.34 m/year while minimum erosion is 61.87 m with a 3.83 m/year EPR from Dickowita Fishery Harbour to Negombo. The coastline in Mundal DS Division shows maximum accretion of 12.58 m NSM with 1.57 m/year EPR and minimum erosion of 2.17 m NSM with 17.38 m/year EPR. The study area has applied more coastal protective structures to lower the effect of coastal erosion and has developments of commercial ports and harbors at a higher rate than the Mundal DS Division. Though the hard and soft coastal protective strategies could be capable of getting accretion only for the particular area, they have been least impacted on the total study area in terms of protecting the shoreline from erosion. Therefore, further studies are needed to verify the negative or positive impacts of coastal protective strategies on neighboring coastal areas.

Keywords: shoreline, accretion, erosion, DSAS, GIS

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A new approach to assessing shoreline dynamics in sandy beaches using Remote Sensing and GIS technologies

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Shoreline is a boundary where water and land separate and it is a highly dynamic area subject to erode or accrete over time. High-resolution satellite images are recognized as a more effective and efficient solution to identify the dynamics of the shorelines under spatial scales. This study attempts to understand the assessing shoreline dynamics in sandy beaches using high-resolution satellite images from Google Earth (GE) Pro with special reference to Pallikkudawa Beach and Red Beach on the Southern coast of Sri Lanka. GE images were available for recent-past 15 years from 2005 to 2020 and ArcGIS 10.5.1 software was used for data processing and analysis. Shoreline change statistics were calculated under three shoreline indicators such as waterline, dry-wet line, and vegetation line using digital Shoreline Analysis System in the ArcGIS software. A new index called Spatial Shoreline Dynamics Index (SSDI) was developed using the ratio between shoreline length and its displacement to compare shoreline dynamics. The mean Shoreline Change Envelope (SCE) values of all three boundaries in Pallikkudawa Beach ($13.18\text{m} \pm 2.23$) were significantly lower (two-sample t-test: $n=43$; $p<0.05$) than that of the Red Beach values ($18.59\text{m} \pm 4.37$). According to the SSDI values, it was identified that the shoreline dynamics are higher in Red Beach (1.37) than the Pallikkudawa Beach (1.26). Further, it showed that there was a significant difference (regression test: $n=43$; $p<0.5$) observed between shoreline change statistics and beach slope. The overall uncertainty of the shoreline position in Red Beach is 5.93 m and that of Pallikkudawa Beach is 6.56 m. On the whole, Red Beach is highly dynamic than Pallikkudawa Beach.

Keywords: Google earth pro, DSAS, spatial shoreline dynamics index, beach slope

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Remote Sensing and GIS approach in the assessment of seagrass distribution in Rekawa Lagoon, Sri Lanka

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Seagrass is an important structural and functional component of the global marine ecosystem that offers important ecosystem services including mitigation of climate change and in fisheries. Seagrass ecosystems are reported to decline at an alarming rate all over the world due to natural disturbances and human-associated activities. As inadequate information exists on the ecology and distribution of Sri Lankan seagrasses, this study investigates the spatio-temporal dynamics of seagrass meadows over the last 12 years in Rekawa Lagoon, southern coast of Sri Lanka. Landsat 5 (TM), Landsat 8, and Landsat 9 (OLI/TIRS) images of 30 m × 30 m spatial resolution covering the Rekawa Lagoon area acquired from the United States Geological Survey (USGS) at different years during the period from 2009 to 2022 were used for the study. All the radiometrically corrected satellite images were classified using supervised and unsupervised classification techniques, which were performed in ArcGIS 10.6.1., into classes; mangroves, other terrestrial plants, freshwater algae, seagrass, and other aquatic plants with the support from the field data. The Google Earth images, topographic maps, local knowledge, and ground-truthed data were used for the validation of the results. Then the area of the seagrass was calculated using the classified images for the two monsoon periods from 2009 to 2021. Maps indicated that the area of the seagrass varied from 18900, 34200, 36900, and 46800 m² in the South-west (SW) monsoon period of 2009, 2013, 2018, and 2021 respectively within the lagoon. It changed to 15300, 9900, 60300 and 32400 m² for the Northeast monsoon period. The seagrass distribution is higher in the SW monsoon period except in 2018. Field investigations indicated that there were two species within the lagoon in 2022 (*Syringodium isoetifolium* and *Halophila decipiens*) whereas three species were recorded in 2018. Furthermore, the seagrass distribution within the lagoon changed from time to time within the lagoon and the dominant species also changed after 2018. According to the present study, the distribution of seagrass species was very limited and patchy, and their coverage was small in Rekawa Lagoon. Therefore, there is a serious threat to seagrass existence within the lagoon. More studies are needed to understand seagrass ecology in the lagoon to help the efficient management of this valuable coastal habitat.

Keywords: seagrass, Rekawa Lagoon, remote sensing

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Enhancement of Sri Lankan rainfall due to Indian ocean warming

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Studies showed that sea surface temperature (SST) warming in the tropical Indian Ocean (IO) has been increasing in response to anthropogenic global warming. Moreover, it has been suggested that SST warming in IO has significant impacts on the convection and rainfall in tropical region. Sri Lanka, being in the tropical IO also experiences the impacts of IO SST warming, yet how IO SST warming affects Sri Lankan rainfall variability remains unclear. Therefore, this study investigates how increased warming in the IO effect the seasonal rainfall of Sri Lanka and associated mechanisms, utilizing observational/reanalysis datasets from 1981 to 2020. Data from the Global Precipitation Climatology Project (GPCP), Climate Hazards Group Infra-Red Precipitation with Station (CHIRPS), and National Oceanographic and Atmospheric Administration (NOAA) have been used as the primary data sources. Multivariate regression and Pearson correlation analysis were used to identify the relationships between Indian Ocean warming and the rainfall variability of Sri Lanka using Python v.3.9 including supportive packages. Results revealed a significant relationship between the North-western IO SST in the second inter-monsoon season (SIM: October to November) and the primary rainy season (OND: October to December) of Sri Lanka, which significant at 99% confidence interval ($r = 0.5$). We show that the SST warming in the North-western IO during SIM will lead to wetter rainy seasons under anthropogenic global warming. The anomalous SST warming in the North-western IO, alters the zonal SST gradients and strengthens the low-level circulation during SIM. The strengthened winds and associated moisture advection in turn, contribute to the enhancement of OND rainfall of Sri Lanka. Thus, the SST warming in the North-western IO may facilitate wetter rainy seasons in the future and therefore, this study renders the importance of further investigations to understand the future projections of OND rainfall of SL.

Keywords: Indian Ocean warming, rainfall, Sri Lanka

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Effect of warm pool heat content on Indian ocean dipole

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Indo-Pacific Warm Pool (IPWP) is known to have significant impacts on weather and climate via ocean-atmospheric interactions and teleconnections. For example, the Indian Ocean Dipole (IOD) which is one of the dominant climate oscillations in the tropics, is significantly influenced by the characteristics of IPWP (i.e., thermal characteristics). Considering the importance, this investigates the spatial and temporal variability of thermal characteristics of the IPWP (i.e., Sea Surface Temperature (SST), Thermocline depth (TCL), Ocean Heat Content (OHC), and upper 200m Thermal Stratification (TS)) and show that, how changes in thermal characteristics of IPWP impact on IOD events during the period from 1980 to 2020. It is found that the thermal characteristics of the Indonesian Archipelagic region (IAR: 15°S - 5°N and 90°E -130°E) are more important for the IOD and the influence from OHC on IOD variability is dominant ($r = -0.75$, $p < 0.01$) over other thermal parameters during the IOD peak phase (SON: September to November). In addition, we have examined the rainfall patterns and wind anomalies regressed onto OHC anomalies and identified the increase of precipitation with low-level convergence in the IAR. Thus, OHC in the IAR plays an important and significant role influencing IOD variability and show that the strengthening of OHC in the IAR will leads to stronger negative IOD events. Therefore, understanding of the factors that influence the OHC variability in the IAR under global warming will be important for disaster management and prevention of IO-rim countries associated with extreme IOD events.

Keywords: Indo-Pacific Warm Pool, Indian Ocean Dipole, Ocean Heat Content, Indonesian Archipelagic region

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The intra-seasonal variability in the equatorial intermediate current of the Indian Ocean

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This study focuses on the Intra-Seasonal Variability (ISV; 30–105 days) of the Equatorial Intermediate Current (EIC; 200–1000 m) in the eastern Indian Ocean by taking full use of three deep-sea moorings (80°E, 85°E and 93°E). Observations reveal the characteristics and the generation process of EIC ISV, with aid of reanalysis data and ocean model experiments. The standard deviations (STDs) of the EIC ISV at the mooring sites are approximately 35%, 40%, and 59% of the STDs of the 10-day low pass EIC, respectively, suggesting the importance of the intra-seasonal components. The power spectral shows a prominent peak at 90 days and secondary peaks at 30–60 days. The significance of 90-day variability is caused by the equatorial basin resonance of low-order modes. The EIC ISV tends to intensify toward the west and has maximum amplitudes at depths of 400–600 m between 80–85°E. The spatial distribution is determined by the wave propagation rays. The EIC ISV is generated by the intra-seasonal equatorial zonal wind forcing with the contribution of the direct waves and the reflected waves. The wind forcing takes about 40 days to establish the EIC ISV.

Keywords: intra-seasonal variability, equatorial intermediate current, spatial distribution characteristic, wind-driven generation process

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Study on the wind speed limitation in the Suez Canal for an ultra large container vessel by mean of simulator

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Since the maneuvering ability of a ship in confined waters is very much limited due to the available depth and width of navigable sea room. It is very important to have predetermined weather limitation criteria to proactively assess the risk of losing control; so that the master can confidently decide whether to enter or not to enter the confined waters. The maximum ship length for the Suez Canal is 400 m but the broader, higher windage, and deeper she is, the handling becomes more challenging to the Pilots and ship handlers and is accident prone. In this study an experienced Pilot and a competent Helmsman conduct three simulator exercises where the wind speed and direction tests on steering an Ultra large 24,000 TEU Container (ULCC) ship model determined safe navigation limits in the Suez Canal utilizing the TRANSAS 5000 Bridge Simulator in the area of the *Ever Given* grounding. The limitations of the simulation are as follows. The baseline direction is $351^{\circ}(T)$ therefore the vessel needs to maintain a course over ground (COG) of $351^{\circ}(T)$ to keep the ship in the middle of the baseline to be safe from grounding. To compare the vessel's ability to counteract the beam wind speeds of 25 kt, 30 kt, and 35 kt exercises 1, 2, and 3 were carried out respectively. Course over ground $351^{\circ}(T)$ and Speed Over ground 9 kt were kept constant in all the exercises while the only variable was the ship heading. The findings of the study state that the maximum beam wind must be 30 kt or less for the vessel to safely coop up. These findings would be important to Suez Canal authorities to not let the ultra-large container carriers enter and transit the canal if the impacted factor wind speeds are expected to rise above 30 kt., and if a vessel in transit when the wind picks up to these limits makes use of the mooring crew supplied from the Suez authority to moor the ship.

Keywords: Suez Canal, wind speed limitation, simulator

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Simulator analysis of maneuvers to bring a container vessel to a complete stop with equipment failures in the Suez Canal

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The Suez Canal was blocked by the *Evergiven* container ship for six days due to grounding. The ship kept the canal blocked obstructing the other traffic passing through it from the red sea to the Mediterranean Sea and vice versa until the vessel was refloated. Giving recognition to the inability to try out different methods to find out how to stop a vessel as soon as possible when another vessel is grounded and blocking the Suez Canal in real life, a NTPRO 5000 full mission bridge simulator was used to study the maneuverability of the vessel under different conditions and parameters. This simulator-based study compared the outcomes of different stopping maneuvers with three different bridge equipment failures to ascertain the best possible method to avoid collision with a grounded vessel ahead. In exercise 1 the vessel was stopped at a distance of 797 m from the grounded vessel ahead with all ship's bridge equipment in good working order. Exercise 2 had an engine failure which was introduced to stop the vessel with not less than 400 m to the grounded vessel with the help of the steering system and anchors. During exercise 3 a steering failure was introduced to stop the vessel at a distance of not less than 600 m from the grounded vessel with the help of engine movements, bow thrusters, and anchors. The key variables and results in table 01 of this research indicate that a navigator using engine movements + rudder movements + fish tailing + anchor dredging + bow thrusters together is the most effective method to bring his own vessel to a complete stop with a distance of at least 01 ship's length to the vessel aground ahead. A limitation of this study is that all three exercises under three different equipment failures were conducted in a simulated environment under environmental conditions current 0 knots, Wind speed 15 – 25 knots from 290°, and obtained the following results. Exercise 01 managed to stop the experimental vessel within the shortest time (06 minutes and 42 seconds) and with the longest distance to the vessel aground (797 m). But the lateral deviation, of course, is 09 degrees to the Port side with a distance of 57 m and therefore the possibility of the experimental vessel going aground is high. Exercise 02 managed to stop the experimental vessel at 12 minutes and 37 seconds with a distance to the vessel aground of 463 m which is the longest time taken and 2nd largest distance to the vessel aground. But here the lateral deviation, of course, is 02 degrees to starboard with a distance of 37 m and there the possibility of an experimental vessel going aground is very less. In exercise 03 the experimental vessel stopped within 08 minutes and 34 seconds with a distance to the vessel aground of 612m which is the 2nd shortest time and distance. In this exercise, the lateral deviation of course is 03 degrees to the

port side with a distance of 27 m, and there the possibility of the experimental vessel going aground is lesser than in the 1st exercise.

Keywords: *Evergiven* container ship, simulator study, stopping maneuvers, bridge equipment failures

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SOCIO-ECONOMICS AND MARKETING

Relationship between monthly income levels and fish consumption patterns of Sri Lankans

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EX015

ORAL

Being an island, Sri Lanka has a strong potential market for fresh fish consumption. Because it is one of the cheapest sources of protein in Sri Lankan diets, and fish is truly essential for supporting human health. Recent studies have found that fish consumption preferences are affected by several factors including monthly income level. However, there is a research gap in the information regarding the variation of fish consumption with the monthly income of Sri Lankans. Therefore, the present study evaluates how the different monthly income levels influence fish consumption. Data were gathered through a questionnaire completed by a total of 100 randomly selected individuals from different socio-economic backgrounds in Sri Lanka. Three categories (i.e., < Rs. 50000, between 50000 -100000, and Rs. > 100000) of salary scales were considered to analyze the quantity of fish consumed by people. The average fish consumption was found to be 0.85 kg per capita per week. The results showed that fish consumption levels do not influence by income levels (Kruskal-Wallis test: DF=2, H=4.09, p>0.05). The reasons for these findings might be linked to the availability of fish both from sea and freshwater for the Sri Lankans and the prices of fish are in a bearable range for the majority. The questionnaire responses showed that the Sri Lankans irrespective of their job categories, spend money for buying fish for the consumption as an essential food commodity.

Keywords: income, fish consumption, public sector, questionnaire

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Exploring the current patterns of fish consumption behavior in Kandy District, Sri Lanka

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EX026

ORAL

Many factors affect fish consumption behavior and they vary among consumers. Therefore, a clear understanding of patterns of fish consumption behavior is important for executing strategies to promote fish consumption thereby improving community health. To explore the fish consumption behavior and factors associated with fish consumption, a consumer behavior survey was conducted in the Kandy District from January to February 2022 using a self-administrated questionnaire. Data collection was started at randomly selected locations within the district and a convenience sample of 130 consumers was interviewed. Data analysis was done using RStudio. Findings revealed that 57% of consumers prefer fish and fishery products as their prime source of animal protein, 62% of consumers consume fresh fish, and a majority (93.8%) preferred marine fish over freshwater fish. There was a median difference between marine fish and freshwater fish in terms of taste, smell, freshness, availability, and convenience in cooking. However, there was no significant median difference in marine and freshwater fish prices. A remarkable portion of urban consumers (58%) in Kandy has a variety of seeking behavior toward fish. The findings of this study revealed that residential areas, education level, awareness of the nutritional value of fish, and having a refrigerator are the important factors that influence the consumers' fish consumption pattern in Kandy. However, the increased cost of living, vegetable price hike, and the X-press pearl ship incident has not made any considerable impact on their fish consumption behavior. In conclusion, the findings of this study have some managerial implications in improving the fish consumption behavior of the Kandy people for a healthy life.

Keywords: consumers, consumer behavior survey, variety seeking behavior, cost of living, X-press pearl ship

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Present status of the socio-economic condition of the Negombo fishing community after the disasters during the past five years

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Natural and anthropogenic impacts continuously influenced to the coastal environment, local populations who lives in the coastal area, and the economy of Sri Lanka during the past few years. The X-press Pearl ship accident was one of the biggest marine disasters in the fishing community. Furthermore, floods, COVID 19 pandemic in 2019, the Easter Sunday attack in 2019, and fuel crisis in 2022 also impacted on the incomes of the Sri Lankan coastal fishing community. The purpose of this study was to identify the effects of the above incidents on the Negombo fishing community and study the social and economic impacts on the fishing community. The survey was conducted in Mankuliya, Kuththuduwa, and Pitipana areas in Negombo. There were 25 fishing families randomly selected from each fishing village. Primary data were collected using a combination of a structured questionnaire and informal in-depth interviews with the fisheries community in the study area. Secondary data were collected from books, reports, journals, publications, articles, and online sources. The data were analyzed and tabulated using Microsoft Excel and Google Forms. There were 97.3% of fishermen affected by the shipwreck 74.3% of their fishing gear and boats were severely destroyed as a result of the catastrophe. Beach seines were mostly destroyed (38%) and cast nets were moderately damaged (31%). Gill nets (25%) and "Yoth pannaya" (6 %) were also damaged less than other types of nets. Prior to the accident, the fish catch was typical, but after the ship accident, it began to decline and is currently at an all-time low. In addition, *the COVID-19 impact has also caused a decline in fish consumption, and the Easter-Sunday attack influenced the decline the fishing in the Negombo area. The government compensated 94 % of those who were harmed by the ship accident. Fish catch and consumption has declined with the natural and anthropogenic impacts during the last few years and the income fluctuated due to the said causes. However, the source of the major impact remains obscure yet and requires clarification through the secondary data at the fisheries ministry.*

Keywords: disasters, X-press pearl, fishing community, livelihoods

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MARITIME TRANSPORTATION AND LOGISTICS

An analysis of the potential of developing Port of Galle as cruise hub and yacht marina in Southeast Asia

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The Port of Galle is one of the main ports in Sri Lanka. It is currently handling both cargo and passenger vessels in its terminals. The high priority given to container vessel and bulk carrier operations has overshadowed the importance of passenger vessel handlings in Sri Lanka. Therefore, this research is designed as an exploratory study to analyze the potential of developing the port of Galle as a passenger vessel hub in the Southeast Asia region. One of the main objectives of the study was to identify cruise hub and yacht marina impacting factors and evaluate their importance for the Galle Port development as a passenger vessel hub in the region. The second main objective was to measure the current port of Galle's potentiality as a cruise hub and yacht marina in the region and provide recommendations for future developments. Both qualitative and quantitative data were collected through expert interviews and using previous research studies as the main data collection methods. Cruise hub and yacht marina impacting factors were collected through the previous research studies and, the factor rating method was used to identify the most relevant impacting factors to the region. Descriptive statistics (mean and standard deviation) were used to calculate the importance of identified factors to the Galle Port. Finally, the benchmarking method was used to measure the current port of Galle's potentiality as a cruise hub and yacht marina in the region. Identified most relevant cruise terminal impacting factors to the region were categorized under four main categories. Those categories are terminal facilities, the natural environment of the hinterland, tourists attractions, and Connectivity. Identified yacht marina impacting factors were categorized under five categories namely, accessibility, marketability, utilization, validity, and natural environment. As result outcomes, the terminal facilities category was identified as the most important cruise hub category, while the marketability of the port became the most important yacht marina category for the Galle Port. The study also provides insight into the current port of Galle's potentiality as a yacht marina and cruise hub in the region. In the conclusion, appropriate development strategies for the port of Galle were discussed using the results of the analysis while providing recommendations to overcome the current challenges of port operations.

Keywords: Port of Galle, cruise hub, yacht marina, impacting factors, development strategy

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